Topics in Bank Management: Lecture 7

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Ch. 5: Equilibrium in the Credit Market

- So far, we have been looking at models of a single loan.
- Now, we want to look at the entire industry: the supply and demand for loans.
- A basic question is: what is the equilibrium outcome of an industry, e.g. what is price and quantity?
- Usually, the answer is given by the intersection of the supply and demand curves.
- However, the supply curve of loans may not be monotonic, i.e. for higher interest rates, the supply of loans may actually decrease.
- This is called a *backward-bending* supply curve.
- The supply curve and demand curve may not intersect. This results in what is called *credit rationing*, where demand exceeds supply.
- For example, during the financial crisis, there was a "credit crunch", i.e. banks were unwilling to lend at any interest rate.

Equilibrium Credit Rationing

- *Equilibrium credit rationing* occurs whenever some borrower's demand for a loan is turned down, even if the borrower is willing to pay all price and nonprice (collateral, etc) requirements of the contract.
- Not that equilibrium credit rationing is *not* when:
  - Borrowers are turned down for poor credit history, low income, etc.
  - Regulation imposes constraints on the prices banks can charge, e.g. interest rate limits
  - A very large loan is turned down by the bank, due to constraints on the bank's financing capacity

Equilibrium Credit Rationing

- Economists classify credit rationing into 2 types:
  - Type I: Partial or complete rationing of *all* borrowers within a certain group
  - Type II: Within a group of homogeneous borrowers (lenders cannot distinguish between them), some obtain a loan, others do not
- We will be looking at Type II credit rationing.
- How widespread is it empirically? It is difficult to tell, because it is difficult to observe loan "quality".
- If it exists, this implies that there are many projects that should be funded but cannot get a loan.
- If markets are complete, any borrower can borrow up to the net present value of all cash flows he can generate in the future.
- Therefore, there can be no credit rationing in complete markets.

Backward-Bending Supply of Credit

- Equilibrium credit rationing can appear when the expected return on a bank loan is not *monotonic* in the interest rate.
- For now, assume this is true. We will see models that can generate this supply curve later on.

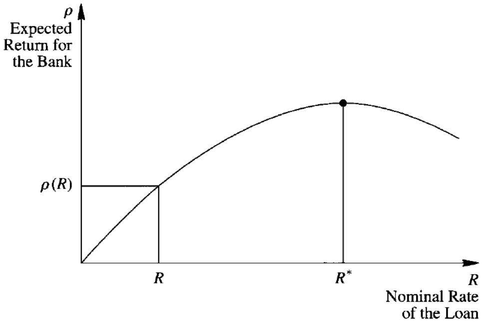

Figure 5.1
Expected return to the bank as a function of nominal rate of loan.

- First, let's see how a backwards-bending supply curve can result in nonexistence of equilibrium.
- Assume that there is a monopolistic bank where the above relationship between expected return on a loan, and the nominal rate on the loan.
- A monopolistic bank will never offer an interest rate above R^*, the nominal rate that maximizes the expected return.

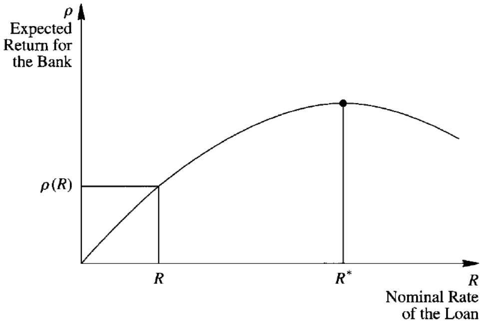

Figure 5.1
Expected return to the bank as a function of nominal rate of loan.

- Any borrower who would accept a rate higher than R^*, would also accept R^*.

- What about a competitive industry, with many firms and customers?
- Assume that the aggregate demand curve is decreasing in price (nominal interest rate), as usual.
- The aggregate supply curve depends on the *cost of financing* for banks, e.g. through deposits.
- In a competitive equilibrium, we assume firms make zero profit due to free entry.
- Therefore, the bank's expected rate of return ρ equals the cost of financing.
- Assume that the supply of deposits increases with the interest rate paid by banks.
- Then, the capacity to finance loans is not monotonic in the expected return: a high interest rate margin (rate on loans - rate on deposits) can result in an overall lower supply of loans.
- This can result in a backward-bending supply curve.

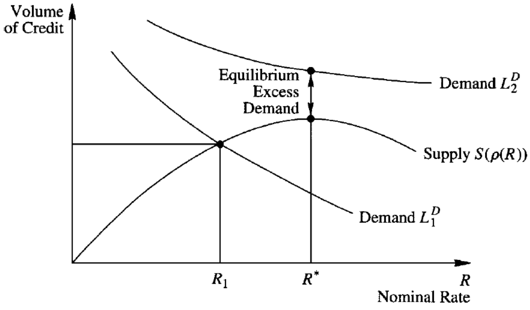

Figure 5.2
Equilibrium credit rationing.

- Suppose the supply curve is given by $S(\rho(R))$.
- If the demand curve is given by L_1^D, the curves intersect and equilibrium exists.
- If the demand curve is given by L_2^D, equilibrium does not exist and there is credit rationing.
- In credit rationing, the interest rate will be R^*, banks make zero profit, and there will be excess demand in equilibrium.

5.3: Equilibrium Credit Rationing

- Now, we can examine models that generate the non-monotonic relationship between expected return on a loan ρ, and the nominal interest rate R.
- This result can be generated by the various types of asymmetric information situations we have seen: adverse selection, costly state verification, or moral hazard.
- First, let's look at a model of adverse selection, based on Stiglitz & Weiss (1981).

5.3.1: Adverse Selection

- Suppose borrowers differ by a risk factor θ, which is unobserved by the bank.
- θ can take a value in the interval $\left[\underline{\theta}, \bar{\theta}\right]$.
- For example, it may represent the probability of project failure, as we saw in the model of screening via collateral last week.
- The bank only knows the distribution of θ in the population of potential borrowers.
- Assume that the bank can only offer a single contract; all borrowers will bring the same amount of collateral C.
- This rules out screening via different types of contracts intended for different types of borrowers.
- Assume the bank offers the same standard debt contract to everyone: borrowers must repay R (if they can).
- If the borrower cannot repay R, the bank seizes the collateral and the entire cash flow of the project.

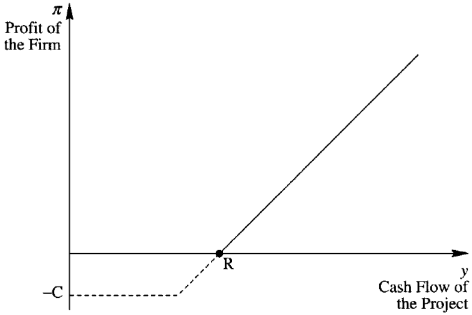

Figure 5.3
Profit to the firm as a function of cash flow from project.

- The borrower's profit function is $\pi(y) = \max(-C, y - R)$.
- Note that this is a convex, increasing function of y.

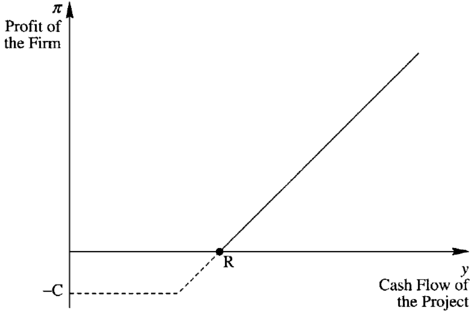

Figure 5.3
Profit to the firm as a function of cash flow from project.

- Recall the definition of second-order stochastic dominance: a lottery A second-order stochastically dominates B if:
  - A has at least the same mean as B, but lower variance, or;
  - all risk-averse (i.e. concave) utility functions prefer A to B.
- For a convex utility/profit function, a probability distribution on y that has *higher* variance will be preferred, given the same mean.

- We will assume that $E[\pi(y)|\theta]$ is an increasing function of θ.
- This will be satisfied if a higher θ means that the distribution of cash flows has same mean but higher variance.
- Assume that borrowers have a reservation level $\bar{\pi}$ for expected profits; if a project has an expected return below $\bar{\pi}$, the firm will not try to borrow money to invest in it.
- For example, this may be the risk-free interest rate.
- The total demand for loans is given by the number of firms with expected profits higher than $\bar{\pi}$.
- Since $E[\pi(y)|\theta]$ is an increasing function of θ (by assumption), there is at most, one value θ^* that satisfies

$$E[\pi(y)|\theta] = \bar{\pi}$$

- Since $E\left[\pi(y)|\theta\right]$ is an increasing function of θ (by assumption), there is at most, one value θ^* that satisfies

$$E\left[\pi(y)|\theta\right] = \bar{\pi}$$

- Let's assume this value exists. Then demand for loans is determined by the population of borrowers in the range $\left[\theta^*, \bar{\theta}\right]$.
- Consider the banks' expected profits, which depends on the repayment R and the distribution of cash flows of borrowers.
- The effect of an increase in the interest rate on banks' expected profits has two channels:
- (1) It increases the profit of a given single loan, since the repayment goes up;
- (2) It decreases the expected profit of the borrower, $E\left[\pi(y)|\theta\right]$, for every θ.
  - Therefore, θ^* increases and the number of applicants decreases;
  - the population of firms that demand a loan becomes more risky.

- An increase in the interest rate *decreases* the demand for loans.
- The less risky firms will drop out of the market.
- The overall effect on banks' expected profits will depend on which effect dominates.
- This can result in the non-monotonic relationship between banks' expected profit and interest rate.

Role of Assumptions

- The key assumptions that result in credit rationing are:
- (1) Banks cannot distinguish between firms.
- If they could distinguish between different risk classes, they could offer design different contracts to screen different types of firms.
- (2) The parameter θ ranks borrowers by increasing risk (variance of cash flows).
- If, instead, θ represented the mean of cash flows, an increase in interest rates would *decrease* the average risk of the borrowing population, and credit rationing would not occur.
- (3) The function relating banks' expected profit to interest rate is single-peaked.
- If it is increasing, equilibrium exists without credit rationing.

5.3.2: Costly State Verification

- The adverse selection model above assumes the standard debt contract, but does not prove it is optimal.
- A model based on costly state verification can generate credit rationing, and also result in an optimal debt contract.
- Let $\tilde{y}$ denote the random return of the borrower's project. It is unobserved by the bank, unless the bank pays an auditing cost γ.
- Let $R = 1 + r$ denote the nominal repayment for an investment of 1.
- Let $f(y)$ denote the probability density function of $\tilde{y}$, with a support of $\left[\underline{y}, \bar{y}\right]$.
- The expected return to the lender as a function of R is:

$$\begin{aligned}\rho(R) &= E\left[y - \gamma | y < R\right] + E\left[R | y \geq R\right] \\ &= \int_{\underline{y}}^{R} (y - \gamma) f(y) dy + \int_{R}^{\bar{y}} R f(y) dy\end{aligned}$$

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$$= \int_{\underline{y}}^{R} (y - \gamma) f(y) dy + \int_{R}^{\bar{y}} R f(y) dy$$

- We assume that f is continuous. Then the derivative of expected return with respect to R is:

$$\frac{\partial \rho}{\partial R} = (R - \gamma) f(R) + \int_{R}^{\bar{y}} f(y) dy$$

- For R close to $\bar{y}$, the maximum possible cash flow, this becomes negative, since $f(\bar{y}) > 0$.
- Therefore, $\rho(R)$ has an interior maximum and credit rationing may arise.
- An increase in nominal rate increases the probability of failure of the borrower.
- When failure is costly to the *lender*, then an increase in R may decrease the net return to the bank.

5.3.3: Moral Hazard

- Suppose the borrower is a firm that has a choice between a "good" technology and a "bad" technology.
- For an investment of 1:
  - The "good" technology produces return G with probability π_G, and zero otherwise.
  - The "bad" technology produces return B with probability π_B, and zero otherwise.
- Assume the "good" technology has a higher expected return: $\pi_G G > \pi_B B$.
- Also assume $B > G$. Therefore, $\pi_B < \pi_G$: the "bad" technology is *riskier* than the good one.

5.3.3: Moral Hazard

- The loan contract specifies a repayment $R = 1 + r$ in case of success.
- The "good" technology will be chosen if

$$\pi_G(G - R) \geq \pi_B(B - R)$$

- Let $\hat{R} = \frac{\pi_G G - \pi_B B}{\pi_G - \pi_B}$. Then the condition is equivalent to $R \geq \hat{R}$.
- The expected return on the loan for the bank as a function of R will be:

$$\begin{cases} \pi_G R & \text{if } R < \hat{R} \\ \pi_B R & \text{if } \hat{R} \leq R \leq B \end{cases}$$

- There is no reason to increase R beyond B, since the repayment cannot exceed B in any case.
- Supply of loans is an increasing function of expected return, ρ.
- As long as supply is not infinitely elastic, the function $S(\rho(R))$ will have a local maximum at $\hat{R}$.

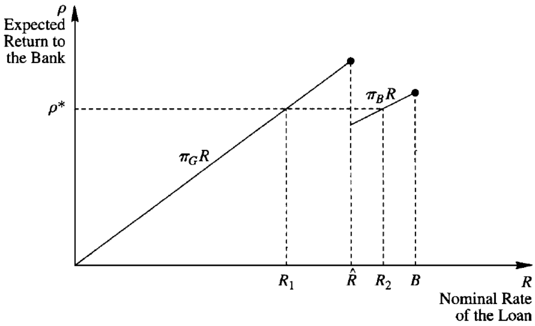


Figure 5.4
Expected return to the bank as a function of R in Bester-Hellwig (1987) model: Case 1.

- In this case, $S(\rho(R))$ will have a global maximum at $\hat{R}$.

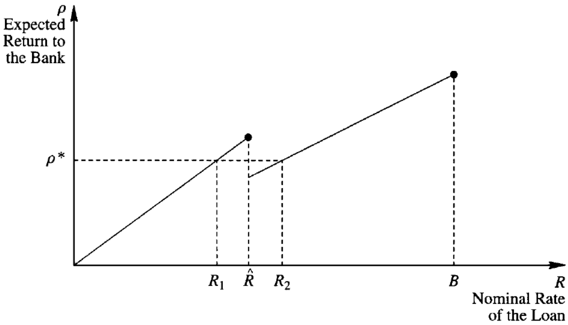


Figure 5.5
Expected return to the bank as a function of R in Bester-Hellwig (1987) model: Case 2.

- In this case, $S(\rho(R))$ will have a local maximum at $\hat{R}$.

- In either case, the non-monotonicity of $S(\rho(R))$ means it is possible that supply and demand will not intersect.
- Credit rationing will occur for a supply function that is strictly increasing in ρ if
$$D > S(\rho(\hat{R}))$$
- where D is the demand for credit at a nominal interest rate of $\hat{R}$.

5.4: Equilibrium with a Broader Class of Contracts

- As we saw last week, a banker with heterogeneous borrowers may benefit from discriminating among them by offering different contracts.
- Assume there are two values for θ: θ_L, θ_H, where θ_H has a higher risk.
- Assume the wealth constraint is not binding (i.e. the borrower has some ability to self-finance) and collateral is costly.
- Therefore, the perfectly secured (100 % value of loan secured by collateral) loan solution is inefficient.
- Bank will offer two contracts: γ_L, γ_H. If $\gamma_L = \gamma_H$, it is a pooling equilibrium; otherwise, it is separating.
- Due to competition, the expected profit on each contract is zero:

$$\rho_L(\gamma_L) = \rho_H(\gamma_H) = \rho_0$$

- ρ_0 is the bank's cost of funds.

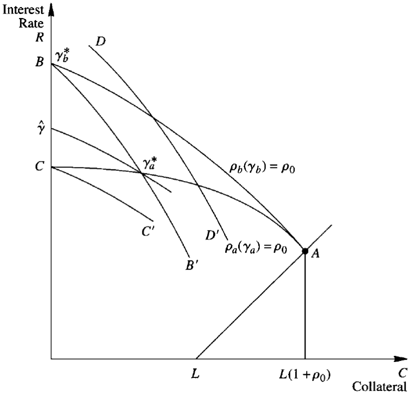
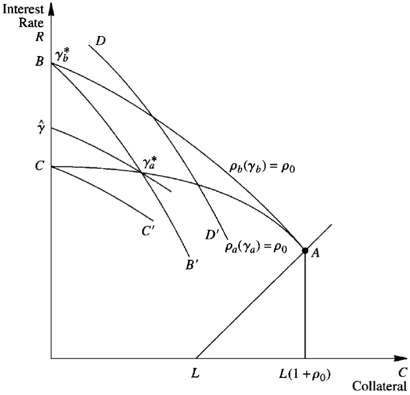


Figure 5.6
Separating equilibrium in Bester (1985) model: The only candidate is (γ_L^*, γ_H^*).

- Bank's isoprofit curves are AB, AC.
- Type-H firm's isoprofit curves are BB', DD', steeper than type L.
- Type-L firm's isoprofit curves are CC'.



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Separating equilibrium in Bester (1985) model: The only candidate is (γ_L^*, γ_H^*).

- A separating equilibrium is when γ_L^* is preferred by L-type firms, and γ_H^* is preferred by H-type firms.
- Here, the H-type is indifferent between γ_b^* and γ_a^*, and the L-type strictly prefers γ_a^*.
- If equilibrium exists, there is no credit rationing.

- For next week, please read Chapter 7.1-7.2.3 in Freixas & Rochet.