Topics in Bank Management: Lecture 6

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4.4: Moral Hazard

- A moral hazard situation is one where the borrower has to take an action (*after* receiving the loan) that will affect the return to the lender, but the lender cannot control this action.
- Assume the borrower's random return $\tilde{y}$ is a continuous random variable.
- The distribution of $\tilde{y}$ is affected by an action e ("effort") chosen by the borrower, not observed by the lender.
- Assume both borrower and lender are risk-neutral.
- Given a contract $R(\cdot)$, the borrower will choose the effort level e^* that maximizes his expected utility:

$$V(R, e) = E\left[(y - R(y))\right] - \phi(e) = \int (y - R(y)) f(y, e) dy - \phi(e)$$

4.4: Moral Hazard

$$V(R,e) = E\left[(y - R(y))\right] - \phi(e) = \int (y - R(y))f(y,e)dy - \phi(e)$$

- $f(y,e)$ is the density function of the return y, for a given effort e
- $\phi(e)$ is a convex, increasing, cost function specifying the disutility from effort e
- The optimal e^* for the borrower must satisfy this condition (by definition):

$$V(R,e) \leq V(R,e^*) \qquad \text{for all } e$$

- This is the *effort constraint*.

4.4: Moral Hazard

- Suppose the minimum expected return demanded by the lender is U_L^0.
- The *individual rationality constraint* specifies that the expected utility of the lender must be at least U_L^0:

$$E\left[R(y)|e\right] \geq U_L^0$$

- The *limited liability* constraints are:

$$0 \leq R(y) \leq y \qquad \text{for all } y$$

- The program to solve for an optimal contract (from the point of view of the borrower) is:

$$\max_{R(\cdot)} V(R, e^*)$$
$$0 \leq R(y) \leq y \qquad \text{for all } y$$
$$V(R, e) \leq V(R, e^*) \qquad \text{for all } e$$
$$E\left[R(y)|e^*\right] \geq U_L^0$$

Monotone Likelihood Ratio

- Suppose the lender observes a cashflow y. What does this tell him about the effort that the borrower chose?
- Consider two effort levels $e_1 > e_2$.
- Using Bayesian updating, the posterior probability that high effort e_1 was chosen, conditional on observing y, is:

$$P(e_1|y) = \frac{P(e_1)f(y|e_1)}{P(e_1)f(y|e_1) + P(e_2)f(y|e_2)}$$
$$= \frac{1}{1 + \frac{P(e_2)}{P(e_1)}\frac{f(y|e_2)}{f(y|e_1)}}$$

- This conditional probability increases with y if $\frac{f(y|e_2)}{f(y|e_1)}$ decreases with y.
- This is called the "monotone likelihood ratio" (MLR) property.

- Assume the MLR property. Then, a higher observed y is an appropriate signal for inferring that e was probably higher.
- The optimal repayment function is of the following type, for some y^*:

$$R(y) = \begin{cases} 0 & \text{if} y \geq y^* \\ y & \text{if} y < y^* \end{cases}$$

- The optimal contract will give the borrower the maximum reward, $R(y) = 0$, when the outcome is good $(y \geq y^*)$.
- Maximum penalty $(R(y) = y)$ when the result is bad: $(y < y^*)$.
- However, this is not seen in practice. The standard debt contract, as we've seen before, has a single repayment level, and the borrower is supposed to repay as much of R as possible out of the available cash flow.

4.5: Incomplete Contract Approach

- A *complete* contract is one that specifies what the parties should do for every possible state of nature.
- Just as with complete markets, if both parties agree to a complete contract, it can only improve efficiency, since it allows for complete risk sharing across all states.
- However, complete contracts are not seen in the real world.
- The theory of incomplete contracts assumes that some states of nature are observable by both parties, but not *verifiable*.
- This means that a third party (e.g. a court) would not be able to enforce the contract, since it cannot verify which state (and therefore which contingent actions) should occur.

4.5: Incomplete Contract Approach

- An incomplete contract will typically involve:
- a verifiable signal;
- a delegation to one of the parties, the power to choose among a predetermined set of actions, in case this signal is realized.
- For example: the signal could be the firm defaults on its loan.
- Then, the creditors take over the firm, and have the choice of liquidation, renewal of the loan, or issuing new shares.

4.5.1: Inalienability of Human Capital

- This approach, based on Hart & Moore (1994), stresses the fact that the borrower/entrepreneur can always threaten to walk away from the contract.
- This implies: (1) some profitable projects will not be funded;
- (2) the time profile of repayments will be affected by the liquidation value of the project.
- Suppose a risk-neutral entrepreneur/borrower wants to invest I in a project that yields cash flows y_t, $t = 1, \ldots T$.
- Assume the risk-free rate is 0.
- If the borrower is not cash-constrained, he will invest iff $I \leq \sum_t y_t$.

- Assume limited liability. Then the repayment R_t must satisfy $0 \le R_t \le y_t$, for $t = 1, ..., T$.
- The entrepreneur will use his ability to walk away strategically.
- At any time, the borrower can threaten to end the contract and default, possibly incurring an opportunity cost of lost future cash flows.
- If this threat is credible, then the borrower and lender enter into a bargaining game. Assume the creditor obtains at least the liquidation value of the project, and possibly more if the project is not liquidated.

- The outcome will be determined by how the bargaining game is solved. We will assume two extreme cases:
- 1) All bargaining power is held by the lender;
- 2) All bargaining power is held by the borrower.

Case 1: All bargaining power held by lender

- Let V_t denote the value of the project to the lender if the entrepreneur quits (may be more than liquidation).
- Suppose the debt is repudiated at time t.
- Under the assumption that the lender has all the bargaining power, it receives the full value of its repayments.

$$\sum_{\tau=t}^{t} R_t$$

- Any contract $(R_1, ..., R_T)$ satisfying the limited liability constraint $0 \leq R_t \leq y_t$ will be repudiation-proof, that is, the borrower has no incentive to default on repayments.

Case 1: All bargaining power held by lender

- Among such repudiation-proof contracts, the one with the largest NPV is $R_t = y_t$ for all t.
- Therefore, the maximum amount of debt that can be borrowed is $\sum_{\tau=1}^{T} y_\tau$.
- A project will be funded iff its NPV is non-negative, which means there are no efficiency losses (profitable projects that do not get funded).

Case 2: All bargaining power held by borrower

- Suppose that all bargaining power is held by borrower.
- A contract will be repudiation-proof if

$$\sum_{\tau=t}^{T} R_t \leq V_t \qquad \text{for all } t = 1, \ldots, T$$

- That is, at any point in time, the sum of the remaining repayments is no greater than the value to the lender if the entrepreneur walks away.
- In this case, the lender is not made worse off if the entrepreneur walks away.
- The project will be undertaken only if the present value of repayments exceeds the volume L of the loan:

$$L \leq \sum_{t=1}^{T} R_t \qquad \text{and } A + L \geq I$$

- where A is the wealth of the entrepreneur.

Case 2: All bargaining power held by borrower

- Some profitable projects will not be financed because the entrepreneur cannot credibly commit to a repayment scheme that gives him negative consumption.
- The inefficiency here arises from the possibility of renegotiation of the contract.

4.6: Collateral as a Screening Device

- Suppose there are different types of borrowers, denoted by risk parameter θ.
- The borrower's investment project can either fail ($\tilde{y} = 0$) or succeed ($\tilde{y} = y$).
- θ is the probability of failure. Assume there are two types of borrowers: θ^L, θ^H, with $\theta^L < \theta^H$
- $theta^L$ is "low risk", θ^H is "high risk".
- The proportion of borrowers in the population of each type v^L, v^H are common knowledge, with $v^L + v^H = 1$.
- Assume both the borrower and lender are risk-neutral.

Collateral

- Assume that borrowers have the capability of initially putting down some amount of collateral.
- The lender can offer a menu of loan contracts: (C^L, R^L) and (C^H, R^H), where C specifies the amount of collateral the borrower must provide, and R specifies the repayment in case of success.
- If the project fails ($\tilde{y} = 0$), the lender can liquidate the collateral.
- If there is liquidation, the borrower loses C^k (where $k \in \{L, H\}$), and the lender gains δC^k.
- $\delta < 1$ represents the costs of liquidation.
- If the project succeeds ($\tilde{y} = y$), there is no liquidation; the lender gets R^k and the borrower gets $y - R^k$.

Symmetric Information Case

- Assume that θ is observable by the lender.
- Assue that the lender has all the bargaining power. Therefore, it can offer a contract that gives zero surplus to the borrower.
- The borrower's individual rationality constraint is:

$$EU = (1 - \theta^k)(y - R^k) - \theta^k C^k = U^k \qquad \text{for } k = L, H$$

- U^k is the reservation utility of the borrower. The borrower will reject the contract if it does not provide at least U^k expected utility.

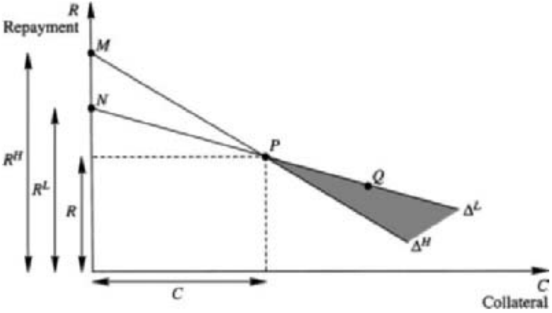

Figure 4.5
Borrowers' indifference curves: low risks Δ^L, high risks Δ^H.

$$EU = (1-\theta)(y-R) - \theta C = U$$
$$R = \frac{U}{\theta - 1} + \frac{\theta C}{\theta - 1} + y$$

- Slope $= \frac{\theta}{\theta-1}$. As θ goes from 0 to 1, the slope becomes steeper.

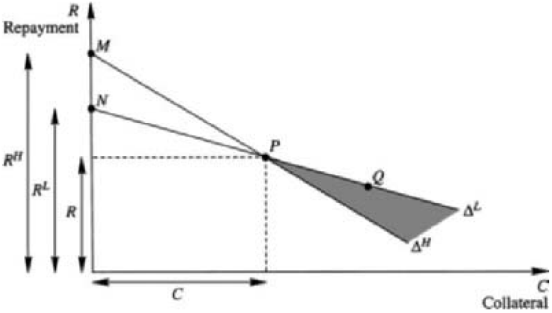

Figure 4.5
Borrowers' indifference curves: low risks Δ^L, high risks Δ^H.

- Since $\theta^H > \theta^L$, the indifference curve for θ^H (high risk types) will be steeper.
- The intersection of the two indifference curves is P.
- Both types of borrowers will be indifferent between accepting and rejecting a contract at this point.

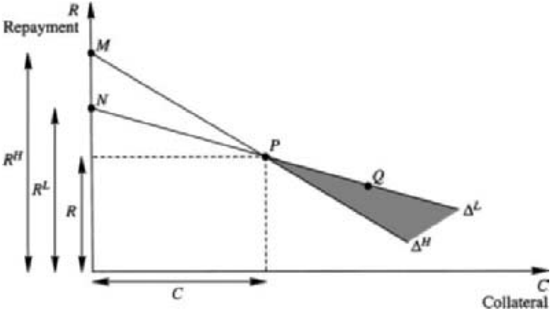

Figure 4.5
Borrowers' indifference curves: low risks Δ^L, high risks Δ^H.

- Since liquidation is costly, the lender prefers to an offer a contract with as little collateral as possible, which are points M and N, which have zero collateral.

Asymmetric Information Case

- Now, suppose θ is not observable by the lender.
- If the lender offers two contracts M and N, both types of borrowers sill claim to be the low-risk type, choose N, and get a lower repayment.
- This is an example of a *pooling equilibrium*: different types behave the same way and the lender cannot distinguish between them.
- The average expected return to the lender will be $(1-\bar{\theta}R^L$, where R^L is the maximum repayment acceptable to type L borrowers:

$$R^L = y - \frac{U^L}{1-\theta^L}$$

- $\bar{\theta}$ is the average probability of failure over the entire population of borrowers:

$$\bar{\theta} = v^L\theta^L + v^H\theta^H$$

- In this situation, high-risk type borrowers obtain an *informational rent*: utility higher than his reservation utility, due to asymmetric information.
- If there were no low-risk type borrowers, they would have to repay a higher amount:

$$R^H = y - \frac{U^H}{1 - \theta^H}$$

- If the lender wants high risks to behave differently, he needs to offer a different contract (C, R) satisfying these conditions:

$$(1 - \theta^H)(y - R^H) \geq (1 - \theta^H)(y - R) - \theta^H C$$
$$(1 - \theta^L)(y - R) - \theta^L C \geq U^L$$

- The first equation ensures that high-risk types prefer the contract $(0, R^H)$ to (C, R).
- The second equation ensures that low-risk types will accept the contract (C, R).

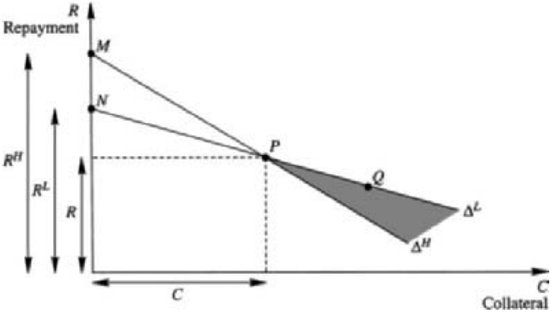

Figure 4.5
Borrowers' indifference curves: low risks Δ^L, high risks Δ^H.

- The set of contracts satisfying these conditions is the shaded region.
- If the lender offers a contract $(0, R^H)$ and (C, R) in this region, this is a *separating equilibrium*: different types of borrowers behave differently and can be distinguished by their actions.

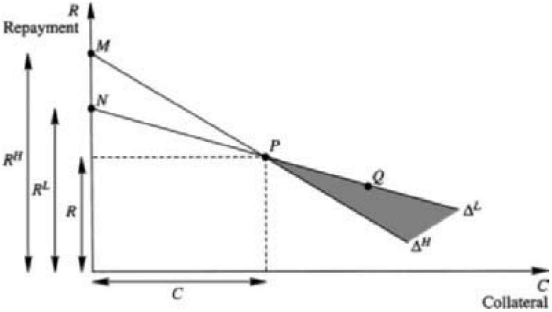

Figure 4.5
Borrowers' indifference curves: low risks Δ^L, high risks Δ^H.

- Within the set of menus that can distinguish different borrower types, which one is the most efficient?
- Liquidation is costly, so it is efficient to minimize the expected amount of loss in liquidation.
- (M, P) is more efficient than any other point in the shaded region, since the amount of collateral for the low-risk type contract is minimized.

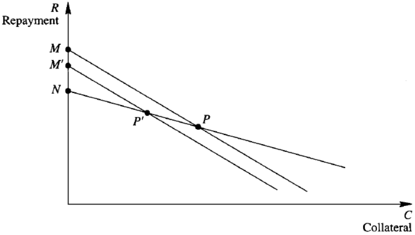

Figure 4.6
Optimal menu of loan contracts.

- We can improve further on (M, P) by decreasing the amount repaid by the high-risk type from M to M'.
- This results in a loss for the lender, but it is made up by a lower collateral amount on the low-risk type contract P'.
- The optimal menu will be (M', P'), which depends on the proportions v^H and v^L.
- When v^L is close to 1, the single contract N will be offered to both types.
- When v^H is close to 1, (M, P) will be offered.

- In this model, the only role of collateral is to induce different types of borrowers to behave differently.
- Collateral is a costly (and therefore credible) signal, similar to e.g. costly education in signaling models of education.

- Please check the website later today for the reading for next week.