Econ 221
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Chapter 14. Design of Incentives

- Principal designs a mechanism (game) for agents to play in order to achieve desirable outcomes.
- There are two kinds of mechanism design problems.
  - Adverse selection, or hidden information.
  - Moral hazard, or hidden action.

14.2 Terminology

- In both adverse selection and moral hazard problems, the principal must design mechanism to satisfy two conditions.
  - Incentive condition: agents must be willing to reveal hidden information, or obey principal's instruction for actions.
  - Participation condition: agents must be willing to play mechanism instead of taking outside option.

14.1 Price discrimination

- Screening versus signaling.
  - Screening and signaling are both responses to adverse selection.
  - As in signaling, key is separation of different types of informed player.
  - Unlike in signaling, uninformed player (principal) moves first by committing to a mechanism for informed player (agent) to play.

- Original story of price discrimination.
  - Parisian can be rich or poor.
  - Rich type is willing to pay more for same improvement in quality of train service than poor type.
  - Providing higher quality is increasingly more costly to rail company.
  - Rail company chooses service quality and ticket price in order to maximize profits, without knowing type of individual traveler.

- Setup of underlying adverse selection problem.
  - Payoff to Traveler (agent) with marginal valuation v who pays ticket price t for service quality q is $vq - t$, and is 0 from taking outside option.
  - Marginal valuation $v_H = 10$ for rich type is higher than marginal valuation $v_L = 4$ for low type.
  - Total cost of providing quality q is $\frac{1}{2}q^2$ (marginal cost is q) per passenger.
  - Payoff to Company (principal) is $t - \frac{1}{2}q^2$ per passenger.

- Full information.
  - Imagine that Company observes type of Traveler; i.e., Company knows whether v is $v_H = 10$ or $v_L = 4$.
  - For any choice of q, Company will charge vq to extract all surplus from Traveler and obtain profit $vq - \frac{1}{2}q^2$, so the optimal choice of q is just v.
  - Since $v_H = 10 > v_L = 4$, Company provides higher quality to rich type than to poor type.
  - Company's choice is socially optimal.

- Adverse selection: Company can't tell type of Traveler.
  - Now the full-information pricing scheme (mechanism) of charging $v_H^2 = 100$ for quality v_H and $v_L^2 = 16$ for quality v_L no longer separates the two types.
  - It violates the incentive condition that Traveler must be willing to choose the option intended by Company: Rich type will choose the option for poor type because $10 \cdot 10 - 100 < 10 \cdot 4 - 16$.
  - Company's profit from rich type is also $\frac{1}{2}v_L^2 = 8$, which is lower than $\frac{1}{2}v_H^2 = 50$ under full information.

- Pricing schemes that achieve separation.
  - Company can reduce the price for high quality without changing either quality provision.
  - To satisfy incentive condition of rich type, price t_H for high quality v_H must be such that $v_H^2 - t_H \geq v_H v_L - v_L^2$, that is, $t_H \leq v_H(v_H - v_L) + v_L^2 = 10 \cdot (10 - 4) + 4^2 = 76$.
  - If Company sets $t_H = 76$, its profit is $t_H - \frac{1}{2}v_H^2 = 26$ from rich type and $\frac{1}{2}v_L^2 = 8$ from poor type, which is more than $\frac{1}{2}v_L^2 = 8$ from both types by offering full-information pricing scheme.

- Even more profitable pricing schemes by reducing service quality and ticket price for poor type and raising ticket price for rich type, with changing high quality.
  - Poor type's participation condition holds if quality q_L and price t_L satisfy $v_L q_L - t_L \geq 0$, so Company can set $t_L = 4q_L$.
  - Rich type's incentive condition holds if the price t_H for high quality $q_H = v_H$ satisfies $v_H^2 - t_H \geq v_H q_L - t_L$, so Company can set $t_H = 100 - 6q_L$.

- If Company chooses $q_L = v_L = 4$, then we get back previous separation scheme.
- Suppose instead Company marginally reduces q_L from $v_L = 4$, and correspondingly, reduces t_L to $4q_L$ and raises t_H to $100 - 6q_L$.
- Company's profit from poor type $t_L - \frac{1}{2}q_L^2 = 4q_L - \frac{1}{2}q_L^2$ marginally decreases, but Company's profit from rich type $t_H - \frac{1}{2}v_H^2 = 50 - 6q_L$ increases by more.

14.5 Incentives for effort

- Now we study second type of mechanism design problems: moral hazard.
  - As in adverse selection, key is incentive condition and participation condition.
  - Unlike in adverse selection, incentive condition is about making sure that agent is willing to follow principal's recommendation.

- Basic story of managerial compensation.
  - Manager of Firm can either work or shirk.
  - Working is costly to manager, while shirking is not.
  - Manager is risk-averse, and Firm is risk-neutral.
  - Working increases probability that Firm's output is high relative to shirking.
  - Firm observes output but not Manager's choice.

- Set up an example as a mechanism design problem.
  - Payoff to Manager (agent) who gets paid wage w is $\sqrt{w} - 2$ if Manager works, and is $\sqrt{w}$ if Manager shirks.
  - Manager's payoff from taking outside option is 0.
  - If Manager works, output y is 100 with probability 0.9 and 0 with probability 0.1.
  - If Manager shirks, output y is 100 with probability 0.5 and 0 with probability 0.5.
  - Payoff to Firm (principal) is $y - w$.

- Observable effort: suppose Firm observes whether Manager works or shirks.
  - Then Firm pays Manager only when Manager works.
  - Manager's participation condition is satisfied if Firm pays 4 regardless of output.
  - Firm's expected profit is $0.9 \cdot 100 + 0.1 \cdot 0 - 4 = 86$.
  - This is best Firm could achieve: expected wage bill is minimized when Firm provides full insurance to Worker to cover the effort cost.

- Moral hazard: now suppose that effort is unobservable.
  - Wage contract (mechanism) under observable effort no long works well.
  - It satisfies participation condition: Manager will sign the contract.
  - But it violates incentive condition: Manager will shirk, as wage is independent of output but effort is costly.
  - Firm's expected profit is $0.5 \cdot 100 + 0.5 \cdot 0 - 4 = 46$.

- Firm can do better by linking wage to output.
  - Suppose Firm pays $w > 0$ when output is 100 and 0 when output is 0.
  - Incentive condition is satisfied so long as $w \geq 25$, as $0.9 \cdot \sqrt{w} + 0.1 \cdot 0 - 2 \geq 0.5\sqrt{w} + 0.5 \cdot 0$.
  - Participation condition is satisfied whenever incentive condition is.
  - Firm's expected profit is maximized by setting $w = 25$: $0.9 \cdot (100 - 25) + 0.1 \cdot 0$ is higher than 46.