LECTURE 9: MECHANISM DESIGN

Recap

- Players may have the possibility to “communicate” to alter the outcome of the game.
- They may announce the intended action (cheap talk) in order to facilitate coordination.
- In games with incomplete information, players may consider taking actions that signal their type (signaling), or find out the type of the other player (screening).
  - e.g. provide warranties to signal the quality of your products.
  - e.g. go to university to signal your skills.

Mechanism design

Mechanism design: system put in place by the less-informed player to create motives for the more-informed player to take actions beneficial to the less-informed player.

Mechanism design examples

- **Price discrimination**
  - Seller/buyer.
  - Source of incomplete information: buyers' willingness to pay is unknown to the seller.
  - Mechanism design: price system that makes buyers with high willingness-to-pay buy higher quality products at a higher price.
- **Incentives for effort**
  - Manager/employee.
  - Source of incomplete information: the manager cannot observe how hard employees work.
  - Mechanism design: align the incentives of employees to the incentives of the manager, and induce employees to exert high effort.

Mechanism design: the 2 constraints

- **Incentive compatibility**
  - Make sure that the agents (the informed players) do what we want them to do.
- **Participation constraint**
  - Make sure that the agents have sufficient payoff, otherwise they may go elsewhere.

Example 1: Price discrimination

- Different consumers have different valuations for the same product.
  - Bob willing to pay $20; Bill willing to pay $10.
- Is it optimal to charge the same price ($10) to both consumers?
- To maximize profit, the seller will try to sell the good for $20 to Bob; and for $10 to Bill.

- **Price discrimination**

Price discrimination in practice…

Price discrimination: limitations and solution

- Price discrimination is often not feasible: sellers may not observe individual consumers' willingness to pay.

- Then what? Seller may design a price system to implement some sort of price discrimination:
  - Price system that will separate buyers into different groups and allow the seller to increase profit.

Price discrimination: airlines

- Two types of seats: Economy and first-class.
- Two types of travellers: tourists (#70) and business travellers (#30).
- Business travellers are willing to pay a higher price than tourists.

	Cost to the airlines	Reservation price		Airline's profit	
		Tourists	Business	Tourists	Business
Economy	100	140	225	40	125
First class	150	175	300	25	150

Price discrimination: profit

- Selling to a business traveller
  - Profit for first-class ticket: 300-150=150
  - Profit for economy ticket: 225-100=125
- Selling to a tourist
  - Profit for first-class ticket: 175-150=25
  - Profit for economy ticket: 140-100=40

Better sell first-class tickets to business travellers, and economy tickets to tourists....

Problem: individual travellers' type is unknown

Price discrimination may not be simple to implement...

- The airline initially does not have enough information on types of customers, and cannot ask different prices to different travellers.
- Demographics (age; gender etc.) may provide information on the type...but it may be illegal/unethical to use this information.
- If the airline asks 300 for a first-class seat, business travellers will rather buy an economy class ticket.
  - If the economy ticket is at 140, business travellers would prefer pay 140 for an economy seat, rather than pay 300 for a first-class seat.
  - If the economy ticket is at 140, business travellers have consumer surplus of 225 -140 = 85 in economy class ticket.

Solution?

- Design a price mechanism such that business travellers choose to buy first-class tickets, and tourists choose to buy economy class tickets.
- Suppose the airline charges X for economy, and Y for first-class.
- X and Y should be such that tourists choose economy, and business travellers choose first-class.
- Two constraints.
- Constraint #1: **Participation constraint**
  - Charge maximum 140 for economy class, otherwise tourists drop off. **(X<140)**
  - Charge maximum 300 for first-class. **(Y<300)**

Incentive compatibility (Constraint #2)

- Prices have to be such that business travellers prefer buying first-class tickets:

$$225 - X < 300 - Y$$

surplus of business travellers if buy economy

surplus of business travellers if buy first-class

$$\Rightarrow Y < X + 75$$

  - i.e. the first-class ticket should not be more than $75 more expensive than the economy ticket

Incentive compatibility (Constraint #2)

- Prices have to be such that tourists prefer buying economy tickets:

$$140 - X > 175 - Y$$

$$\Rightarrow Y > X + 35$$

  - i.e. the first-class ticket should be between $35 and $75 more expensive than the economy ticket.

Outcome...

- Since X=140 (maximum price), then Y=215 at maximum (140+75).
- By pricing first-class seats at 215 and economy seats at 140, the airline can separate the two types.
- Note that business travellers have a surplus of 85=300-215
  - First-class seats are sold at rebate price (215 vs. 300).
- Total profit: (140-100)70+(215-150)30=4,750

Application: iPhone 6S

- 16GB model: cost of components is $208, price is $649
- 64GB model: cost of components is $229, price is $749
- 128GB model: cost of components is $265, price is $849
- ($30-40 cost differential, but a $100 price differential)

Application: Coach

- COACH sells designer handbags, wallets, shoes, jewelry etc. It has two methods of sale:

1. Full price at its own stores and at selected retailers. Full price only, never any discount. Average age of shopper is 35; average expenditure is $1,100.
2. Discount outlet stores that sell last season's products for less. Stores usually 100km away from nearest full-price retailer. Average age of shopper is 45; average expenditure is $770.

Application: Kindle

Kindle 2's price:

- 2/09, $399;
- 7/09, $299
- 10/09, $259
- 6/10, $189

Example 2: Incentives for effort

- **Incentives for effort**
  - manager/employees
  - Source of incomplete information: the manager cannot observe how hard employees work, consequently employees may not work as hard as they are supposed to (moral hazard).

MORAL HAZARD PROBLEM: unobservable actions distort an agent's incentives after the transaction is made

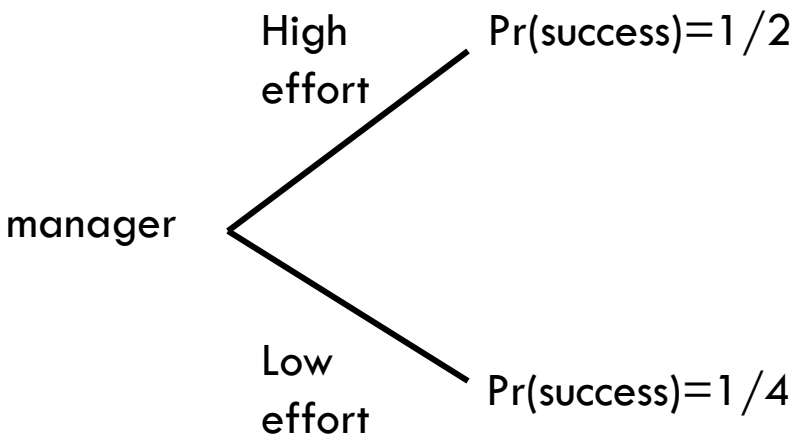
  - Mechanism design: align the incentives of the employee to the incentives of the manager.

Moral hazard examples

- Insurance
  - Health Insurance -- Insured are more willing to eat poorly, smoke etc.
  - Home Insurance -- less willing to install alarms and better locks
  - Car Insurance -- take more risks while driving
- Work
  - Employees may not produce high effort, and still get paid.

Project supervision

- A company owner hires a manager to supervise a project.



- In case of success, the profit is $1million. In case of failure it is $0.

Risk aversion and utility

- The manager is risk averse, his utility is given by:
  - $u=\sqrt{y}$, where y is income (in million of $)
- The disutility of effort is 0.1.
- The outside option is $90k, yielding utility of $\sqrt{0.09}=0.3$

Observable effort

- If the firm can observe effort, contracts are simple:
  - Either work hard or be fired.
  - To induce the manager to exert high effort, we must pay him at least $160k:
    - u= √0.16-0.1=0.3
    - If we pay less than $160k, he will resign and take the outside option
- Simple contract: The employee is paid $160k in exchange for high effort.

Unobservable effort

- Suppose effort can not be observed.
  - The manager's output may be observed, but not his effort level.
- How to induce high effort?
- Compensation contract must rely on something that can be directly observed and verified.
  - Project's success or failure -- Related to effort.
  - Imperfect but relevant information.
  - Compensation rule:
    - Pay a basic wage (x) if the project fails
    - Pay more (y) if the project succeeds, such that y>x

Incentive compatibility and participation constraint

Incentive compatibility	Participation constraint
Putting in high effort must be better than putting in low effort	Putting in high effort must be better than the outside option

Incentive compatibility

- Make sure that the manager prefers high effort to low effort

$$\frac{1}{2}\sqrt{y}+\frac{1}{2}\sqrt{x}-0.1\geq\frac{1}{4}\sqrt{y}+\frac{3}{4}\sqrt{x}$$

Utility if high effort **Utility if low effort**

- Solves to: $\sqrt{y}-\sqrt{x}\geq 0.4$

In order to induce high effort, success has to be sufficiently rewarded relative to failure.

Participation constraint

- Make sure that the manager is willing to work for you:

$$\frac{1}{2}\sqrt{y}+\frac{1}{2}\sqrt{x}-0.1\geq 0.3$$

Utility if high effort **Utility if outside option**

- Solves to: $\sqrt{y}+\sqrt{x}\geq 0.8$

In order to keep the manager, the expected compensation has to be large enough.

Solving

- Two constraints:

$$\sqrt{y} - \sqrt{x} \geq 0.4$$

$$\sqrt{y} + \sqrt{x} \geq 0.8$$

- By substitution: $0.4 + \sqrt{x} + \sqrt{x} \geq 0.8$

$$\Rightarrow \sqrt{x} = 0.2$$

$$\Rightarrow \sqrt{y} = 0.6$$

Solving

- $\sqrt{y}=0.6$ means $y=0.36$, or \$360k
- $\sqrt{x}=0.2$ means $x=0.04$, or \$40k
- The manager is paid \$40k if the project fails and \$360k if it succeeds.
- The reward for success must be large enough to compensate for:
  - the cost of effort (0.1)
  - the risk of receiving no bonus in case the project fails (50%)

Stick and carrot

- Low base salary.
- The payment for success is very large, and just enough to induce the manager to exert high effort.

Basic wage and bonus

- Why not give $0 in case of failure?
  - x=0
- To ensure participation, y would have to be very large:

$$\sqrt{y}+\sqrt{x}\geq 0.8 \Rightarrow \sqrt{y}\geq 0.8 \Rightarrow y\geq 0.64$$

- The compensation for success would have to be $640k
- Better provide a base salary of $40k.

Applications

- **Store managers**:
  - profitability of local outlet depends on store managers' staffing and stocking decisions (effort is important).
  - Profits are easy to measure at store level.
- **CEOs:**
  - compensation based on the stock price.
  - stock price is an imperfect measure of firm performance.

Case study: Safelite Glass Corporation

- Largest installer of automobile glass in the US.
- 1994: CEO Garen Staglin instituted a new compensation scheme for glass installers.
- A very competitive industry so costs and productivity really matters to get prices down and response time up.

Previous System

- Paid an hourly wage rate and overtime.
- Pay did not vary with number of windows installed.
- Installer's job is monitored and they are required to meet minimum quality standards.
- Managers were worried that installers just did the minimum number of windows per week to keep their jobs.

New System

- Installers would be paid each week the maximum of:
  - Amount they would have made according to the old hourly wage system
  - A fixed amount per job completed
- Consequently, enterprising installers could do a lot better.
  - Possibility to sometimes double compensation compared to the old system.

Outcomes

- Increased productivity per worker
  - Number of windows installed per week increased by 44%
  - Changed behaviour
    - Technicians didn't drive as far for a job
    - Checked they had parts at beginning of day
    - Maintained tools
- Unit labour costs fell from $44.43 to $35.24 per window
  - Average compensation per worker rose but productivity rose even more

Summary

- Incomplete information is the rule rather than the exception.
- Less-informed players put systems in place to create motives for the more-informed player to take actions beneficial to them. (mechanism design).
  - Discriminate between buyers
  - Encourage effort
- Mechanism design is not perfect; but it is an improvement for the less-informed compared to not using mechanism design.