31E11100 - Microeconomics: Pricing

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Lecture 4: Menu pricing
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Plan for this lecture

- In the last lecture we discussed price discrimination that was based on seller's direct information about buyer types
- But buyers' characteristics are to a large extent their private information
  - Some buyers value higher quality more than others, for example
  - Difficult for the seller to know the tastes of indifidual consumers
  - Is there a profitable way to induce consumers self-select between different price-quality offers?

- Ìn this lecture, we analyse this question with a simple theoretical model
- As a model of pricing, this is a model of second-degree price discrimination or menu pricing
  - How to design a menu of alternative price-quality bundels that consumers may choose from?
  - Or, how to design a non-linear pricing scheme, i.e. a set of different price-quantity bundles?
- But more broadly, this model is a classical example in information economics, within contract theory/mechanism design literature
  - How to design an incentive scheme under asymmetric information?

Examples of Second-Degree Price Discrimination or Menu Pricing

- Quantity discounts: "3 for the price of 2" -offers at supermarkets
- Differential fixed fee, variable fee combinations:
  - Pricing of different plans for smart phones.
  - Gym membership fees vs entrant fee
- Quality versioning
  - First-class, Business and Economy airfare.
  - Book versions: hardcover and papeback
  - Different speeds on broadband.
  - Insurance with different deductibles.
- Damaged goods?

Information Economics: Basic Model of Screening

- An uninformed party (principal) offers a menu of alternatives to an informed party (agent).
- The seller is the principal and the buyer is the agent.
- The menu consists of a list $\{(q^l, t^l)\}_{l=1}^{L}$.
  - q stands for a physical allocation to the agent: could be quality or quantity
  - t is the transfer that the agent makes to the principal: price
  - Hence choosing (q^l, t^l) means that the agent gets physical allocation q^l in exchange for paying t^l.
  - Notice that this is **not** a per unit price but a total price for q^l.

- Agent's utility from q depends on her private type $\theta \in \Theta$.
- Assume that there are two types: $\theta \in \{\theta^H, \theta^L\}$
- Quasilinear utility.
  - Agent:
$$u_A(\theta, q, t) = \theta v(q) - t.$$
  - Principal:
$$u_P(\theta, q, t) = t - c(q).$$
  - Here we interpret $v(q)$ as the utility from allocation q. Assume increasing utility with diminishing marginal utility: $v'(q) \geq 0$, $v''(q) \leq 0$
  - $c(q)$ is the cost of providing allocation (quantity or quality) q. Assume increasing convex cost: $c'(q) \geq 0, c''(q) \geq 0$.

- Seller makes an offer $\{q^l, t^l\}_{l=1}^L$.
  - She does not know the type of the buyer (but has a belief on the likelihoods of the different types).
  - With two types, set $\lambda = \Pr\{\theta = \theta^H\}, 1 - \lambda = \Pr\{\theta = \theta^L\}$.
- Buyer of type θ picks the pair $\left(q^l, t^l\right)$ that gives her the maximal utility or picks nothing if that gives higher utility.
  - Since each type picks at most one pair, we can restrict the number of alternatives offered to be at most the number of different types of buyers.
  - With two types of buyers $\theta \in \{\theta^H, \theta^L\}$, enough to consider two pairs $\{(q^1, t^1), (q^2, t^2)\}$.
- Call the pair chosen by θ^i as $\left(q^i, t^i\right)$ for $i \in \{H, L\}$.
- Examples: Insurance company screening privately known risk types, Monopoly bank screening projects with privately known success rate, Regulator screening public utilities with privately known marginal cost, etc.

- Since θ^H chooses $\left(q^H, t^H\right)$ over $\left(q^L, t^L\right)$, we have

$$\theta^H v\left(q^H\right) - t^H \geq \theta^H v\left(q^L\right) - t^L.$$

- Similarly for θ^L

$$\theta^L v\left(q^L\right) - t^L \geq \theta^L v\left(q^H\right) - t^H.$$

- These constraints are called *incentive compatibility* constraints.
- If the agent can secure a payoff of $\underline{u}$ by not trading with the principal at all, then we also must have:

$$\begin{aligned} \theta^H v\left(q^H\right) - t^H &\geq \underline{u}, \\ \theta^L v\left(q^L\right) - t^L &\geq \underline{u}. \end{aligned}$$

  - These constraints are known as *individual rationality or participation constraints*.

Summary of the problem

The principal's problem is:

$$\max_{\{(q^H,t^H),(q^L,t^L)\}} \lambda \left(t^H - c\left(q^H\right)\right) + (1-\lambda)\left(t^L - c\left(q^L\right)\right)$$

subject to

$$\theta^H v\left(q^H\right) - t^H \geq \theta^H v\left(q^L\right) - t^L,$$

$$\theta^L v\left(q^L\right) - t^L \geq \theta^L v\left(q^H\right) - t^H,$$

$$\begin{aligned} \theta^H v\left(q^H\right) - t^H &\geq \underline{u}, \\ \theta^L v\left(q^L\right) - t^L &\geq \underline{u}. \end{aligned}$$

- This is a simple model of adverse selection:
  - The agent has private information at the time when the principal proposes the contract.
  - This private information gives (at least some type of) the agent some surplus even if the principal make a take-it-or-leave-it offer.
  - Model generates a genuine sharing of surplus.
  - Will the outcome be socially efficient as in the case where the principal knows θ?
- The more general theory framework encompassing this model is called Mechanism Design.
  - Treated in research track Microeconomics 4 in detail.
  - First steps outlined in the handout by Juuso Välimäki (on the course web page).

First- vs. Second-degree price discrimination

- Recall from last lecture that under first-degree price discrimination the monopolist could use a two-paritt tariff to extract all surplus from a buyer, i.e. choose $\left(\widehat{q}^i, \widehat{t}^i\right)$ for $i \in \{H, L\}$ such that:

$$\begin{aligned} \widehat{q}^i \text{ is efficient:} \quad & c'\left(\widehat{q}^i\right) = \theta^i v'\left(\widehat{q}^i\right), \\ \widehat{t}^i \text{ captures suplus} \quad : \quad & \widehat{t}^i = \theta^i v\left(\widehat{q}^i\right). \end{aligned}$$

- Suppose the monopolist attempts this in the case where the type is not observable.
- Then types θ^H would select $\left(\widehat{q}^L, \widehat{t}^L\right)$ (why?)

- Recall the incentive contraints.
- If the seller wants θ^H to pick $\left(q^H, t^H\right)$ and θ^L to pick $\left(q^L, t^L\right)$ from $\left\{\left(q^H, t^H\right), \left(q^L, t^L\right)\right\}$, it must be that:

$$\begin{aligned} \theta^H v\left(q^H\right) - t^H &\geq \theta^H v\left(q^L\right) - t^L, \\ \theta^L v\left(q^L\right) - t^L &\geq \theta^L v\left(q^H\right) - t^H. \end{aligned} \tag{1}$$

- Sum these together to get:

$$\left(\theta^H - \theta^L\right)\left(v\left(q^H\right) - v\left(q^L\right)\right) \geq 0.$$

- Since $v(q)$ is increasing and $\theta^H > \theta^L$, we see that $q^H \geq q^L$.

- Furthermore if the buyer can get 0 by refusing to trade, the participation constraints are:

$$\begin{aligned} \theta^H v\left(q^H\right) - t^H &\geq 0, \\ \theta^L v\left(q^L\right) - t^L &\geq 0. \end{aligned} \tag{2}$$

- The first two inequalities are called the incentive compatibility constraints. They ensure that each type of buyers chooses the bundle that is intended for them.
- The latter inequalities are called individual rationality constraints. They ensure that the payoff from buying is at least as large as the payoff from not buying.
- The monopolist's problem is to maximize profit subject to these constraints.

$$\max_{\{(q^H,t^H),(q^L,t^L)\}} \lambda\left(t^H - c\left(q^H\right)\right) + (1-\lambda)\left(t^L - c\left(q^L\right)\right)$$

subject to IC and IR.

Analyzing the model

- We start with two observations:
- First, IC for H must bind.
  - If not, then you can increase profit by increasing t^H a little
  - Note, IR cannot bind for H, since she could get a positive payoff by choosing $\left(q^L, t^L\right)$
- Second, IR for L must bind
  - If not, then you could increase profit by increasing both prices by the same amount
- Using these, we can solve the model

- Use IR of type L to solve

$$t^L = \theta^L v\left(q^L\right).$$

- Use IC of H to solve

$$t^H = t^L + \theta^H v\left(q^H\right) - \theta^H v\left(q^L\right) = \theta^H v\left(q^H\right) - \left(\theta^H - \theta^L\right) v\left(q^L\right).$$

- But then:

$$\theta^H v\left(q^H\right) - t^H = \left(\theta^H - \theta^L\right) v\left(q^L\right) > 0 \text{ if } q^L > 0.$$

- We call $\left(\theta^H - \theta^L\right) v\left(q^L\right)$ the information rent of the high type.

- Hence the maximization problem becomes:

$$\max_{q^H,q^L}\{\lambda\left(\theta^H v\left(q^H\right)-\left(\theta^H-\theta^L\right)v\left(q^L\right)-c\left(q^H\right)\right)$$
$$+\left(1-\lambda\right)\left(\theta^L v\left(q^L\right)-c\left(q^L\right)\right)\}.$$

- FOC with respect to q^H :

$$\theta^H v'\left(q^H\right)=c'\left(q^H\right).$$

- Hence q^H is chosen efficiently.
- FOC with respect to q^L :

$$-\lambda\left(\theta^H-\theta^L\right)v'\left(q^L\right)=\left(1-\lambda\right)\left(c'\left(q^L\right)-\theta^L v'\left(q^L\right)\right).$$

- From this we see that q^L is smaller than the efficient level. This helps monopolist extract more profit from the high type.

Conclusions from the model

- This abstract framework allows us to make some observations, that turn out to hold very generally in this type of models:
  - Higher types buy larger quantities, or better qualities, and earn a positive information rent
  - Low type earns no rents and is indifferent between participating and not
  - The allocation for the low type is distorted
- Profit maximizing solution hence trades off efficiency and rent extraction.
- In the next lecture we continue with this model and its application to second-degree price discrimination

Further readings

- For a text-book treatment of menu pricing, see e.g. Belleflamme and Peitz: “Industrial Organization”, chapter 9.
- Screening models are also analyzed in advanced microeconomics text books, such as Jehle and Reny: "Advanced Microeconomic Theory" Chapter 8, or Mas-Colell, Whinston and Green: "Microeconomic Theory", Chapter 13.
- For a much deeper discussion about the type of models treated in this lecture, see Salanie: "The Economics of Contracts", MIT Press, or Bolton and Dewatripont: "Contract Theory", MIT Press.
- Seminal articles on monopoly pricing under asymmetric information are Mussa and Rosen (1978): "Monopoly and Product Quality", Journal of Economic Theory, and Maskin and Rilery (1984): "Monopoly with Incomplete Information", Rand Journal of Economics.