Lecture 9: Price Discrimination

EC 105. Industrial Organization.

Matt Shum
HSS, California Institute of Technology

Price discrimination

- Up to now, consider situations where each firm sets one uniform price
- Consider cases where firm engages in non-uniform pricing:
  1. Charging customers different prices for the same product (airline tickets)
  2. Charging customers different prices depending on time of purchase (concerts, airlines again)
  3. Charging customers a price depending on the quantity purchased (electricity, telephone service)

3 types of price discrimination

1. Perfect price discrimination: charging each consumer a different price. Often infeasible.
2. Third-degree price discrimination: charging different prices to different *groups* of customers
   - Senior or student discounts
3. Second-degree price discrimination: each customer pays her own price, depending on characteristics of purchase
   - Ex: nonlinear pricing, bundling

Perfect price discrimination (PPD) 1

- Graph.
- Monopolist sells product with downward-sloping demand curve
- Each consumer demands one unit: demand curve graphs number of consumers against their willingness-to-pay for the product.
- Perfect price discrimination: charge each consumer her WTP
- Perfectly discriminating monopolist produces **more** than "regular" monopolist: both produce at q where $MC(q) = MR(q)$, but for PD monopolist $MR(q) = p(q)$. PD monopolist produces at perfectly competitive outcome where $p(q) = MC(q)$!
- Perfectlly discriminating monopolist makes much higher profits (takes away all of the consumer surplus)
- Lower consumer welfare (no consumer surplus under PPD) but high output.

Perfect price discrimination (PPD) 2

- Clearly, there is profit motive for price discrimination
- In order for PPD to work, assume consumers can't trade with each other:
  - Requires *no resale*. With resale, marginal customer buys for whole market.
  - Equivalent to assuming that monopolist knows the WTP of each consumer: if consumers could lie, same effect as resale (everybody underreports their WTP).
  - Purchase constraints also prevent resale and support price discrimination: *limit two per customer* sales?
- Typically, information requirement of PPD too severe.
- Next: focus on settings where monopolist doesn't know the WTP of each consumer.

3rd-degree price discrimination (3PD) 1

- Monopolist only knows demand functions for *different groups* of consumers (graph): groups differ in their price responsiveness
- Cannot distinguish between consumers in each group (ie., resale possible within groups, not across groups)
  - Student vs. Adult tickets
  - Journal subscriptions: personal vs. institutional
  - Gasoline prices: urgent vs. non-urgent
- Main ideas: under optimal 3PD—
  1. Charge different price to different group, according to *inverse-elasticity* rule. Group with more elastic demand gets lower price.
  2. Can increase consumer welfare: group with more elastic demand gets lower price under 3PD.

3rd-degree price discrimination (3PD) 2

- Consider two groups of customers, with demand functions

$$\text{group 1: } q_1 = 5 - p$$
$$\text{group 2: } q_2 = 5 - 2 * p$$

  (graph)
- Assume: monopolist produces at zero costs

3rd-degree price discrimination (3PD) 3

If monopolist price-discriminates:

- $\max_{p_1,p_2} p_1 * (5 - p_1) + p_2 * (5 - 2 * p_2)$. Given independent demands, solves the two problems separately.
- $$\begin{aligned} p_1^{PD} &= \tfrac{5}{2} & p_2^{PD} &= \tfrac{5}{4} \\ q_1^{PD} &= \tfrac{5}{2} & q_2^{PD} &= \tfrac{5}{2} \\ CS_1^{PD} &= \tfrac{25}{8} & CS_2^{PD} &= \tfrac{25}{16} \\ \pi_1^{PD} &= \tfrac{25}{4} & \pi_2^{PD} &= \tfrac{25}{8} \end{aligned}$$

3DPD: Inverse elasticity redux

Price-discriminating monopolist follows *inverse elasticity rule* with respect to each group:

$$\frac{(p_i - MC(q_i))}{p_i} = -\frac{1}{\epsilon_i}$$

or (assuming constant marginal costs)

$$\frac{p_i}{p_j} = \frac{1 + \frac{1}{\epsilon_j}}{1 + \frac{1}{\epsilon_i}}$$

Consumers with less-elastic demands should be charged higher price:

- Senior discounts
- Food at airports, ballparks, concerts
- Caveat (as before): this condition satisfied only at optimal prices (and elasticity is usually a function of price)

3DPD vs. uniform pricing

If monopolist doesn't price-discriminate (uniform pricing):

- $\max_p \pi^m = p * (5 + 5 - (1 + 2) * p) = p * (10 - 3p)$
-
$$\begin{aligned} p_1^M &= \tfrac{5}{3} & p_2^M &= \tfrac{5}{3} \\ q_1^M &= \tfrac{10}{3} & q_2^M &= \tfrac{5}{3} \\ CS_1^M &= \tfrac{50}{9} & CS_2^M &= \tfrac{25}{36} \\ \pi_1^M &= \tfrac{50}{9} & \pi_2^M &= \tfrac{25}{9} \end{aligned}$$

Welfare effects of 3DPD

- 3PD affects *distribution of income*: higher price (lower demand) for group 1, lower price (higher demand) for group 2, relative to uniform price scheme
- Total production is same (5) under both scenarios (specific to this case). In general, if total output higher under 3PD, increases welfare in economy.
- Higher profits for monopolist under 3PD (always true: if he can 3PD, he can make *at least* as much as when he cannot)

Welfare effects cont'd

- Compare per-unit consumer welfare (CS/q) for each group under two scenarios:

$$
\begin{array}{ll}
(CS/q)_1^M = \frac{5}{3} = 1.67 & (CS/q)_2^M = \frac{5}{12} = 0.42 \\
(CS/q)_1^{PD} = \frac{5}{4} = 1.25 & (CS/q)_2^M = \frac{5}{8} = 0.625
\end{array}
$$

  Group 2 gains; group 1 loses
- Compare weighted average of (CS/q) under two regimes: $\frac{CS_1+CS_2}{q_1+q_2}$
  1. without PD: 1.25
  2. with PD: 1.5625
- So average consumer welfare higher under 3PD:
  - specific to this model

2nd-degree price discrimination

- Second degree price discrimination is a general rubric for many types of firm pricing and product design policies.
- Main jist: Firm charges different price depending on characteristics of the purchase.
- These characteristics include:
  - Amount purchased (nonlinear pricing). Examples: sizes of grocery products
  - Quality of product purchased: high-end, low-end (Banana Republic vs. Gap vs. Old Navy)
  - Bundle of products purchased (bundling, tie-ins). Examples: fast-food "combos", cable TV

3rd degree vs. 2nd degree PD

- Compared to 3DPD, here we assume that monopolist has even less information.
  - It *cannot classify consumers into groups*, ie., it knows there are two groups of consumers, but doesn't know who belongs in what group.
  - It cannot ask consumers to announce their group truthfully...
  - Firm designs specific product for each type of consumer, and prices them so that consumers "self-select" into different products and hence pay different prices.
  - *indirect* price discrimination

Ex: airline pricing

- Firm cannot distinguish between business travellers and tourists
  - But knows that the former value higher quality seats more. Hence:
  - Hence: firm set prices for 1st-class (p_F) and coach seats (p_C) so that consumers "self-select".
  - This is called *market segmentation*
- This involves two types of constraints:
  1. **Self-selection constraints** ensure that each type of traveller chooses the appropriate seat:

$$u_B(\text{first class}) - p_F > u_B(\text{coach}) - p_C \quad (1)$$
$$u_T(\text{coach}) - p_C > u_T(\text{first class}) - p_F \quad (2)$$

  2. **Participation constraints** ensure that each type of traveller purchases a plane ticket:

$$u_B(\text{first class}) - p_F > 0 \quad (3)$$
$$u_T(\text{coach}) - p_C > 0 \quad (4)$$

  (Prevents airline from setting exhobitant prices)

Airline pricing: add some numbers

- Suppose

$$u_B(F) = 1000 \quad u_B(C) = 400$$
$$u_T(F) = 500 \quad u_T(C) = 300$$

- Under perfect information, airline should charge

$$p_C = 300; \quad p_F = 1000.$$

- But under these prices, B would buy coach seat instead!
- Under imperfect information, airline prices must obey constraints:

$$\begin{aligned} 1000 - p_F &\geq 400 - p_C && \text{Type B buys first class} \\ 300 - p_C &\geq 500 - p_F && \text{Type T buys coach} \\ 1000 - p_F &\geq 0 && \text{Type B decides to travel} \\ 300 - p_C &\geq 0 && \text{Type T decides to travel} \end{aligned}$$

Airline pricing: solution

$$
\begin{aligned}
1000 - p_F &\geq 400 - p_C && \text{Type B buys first class} && (5)\\
300 - p_C &\geq 500 - p_F && \text{Type T buys coach} && (6)\\
1000 - p_F &\geq 0 && \text{Type B decides to travel} && (7)\\
300 - p_C &\geq 0 && \text{Type T decides to travel} && (8)
\end{aligned}
$$

- What are airline's optimal prices?
- Charge $p_C = 300$. Any higher would violate (8), and any lower would not be profit-maximizing.
- If charge $p_F = 1000$, type B prefers coach seat: violate constraint (5). Hence, upper bound on p_F is 900, which leaves him just indifferent b/t coach and 1-class.
- To maximize profits, charge $p_C = 300$ and $p_F = 900$.

Features of optimal solution

In general:

- $p_C = u_B(\mathrm{C})$: Charge "low demand" types their valuation (leaving them with zero net utility)
- $p_F = u_F(\mathrm{F}) - (u_F(\mathrm{C}) - p_C)$: Charge "high demand" types just enough to make them indifferent with the two options, given that "low demand" receive zero net utility.
- At optimal prices, only constraints 1 and 4 are binding: participation constraint for low type, and self-selection constraint for the high type $\Longrightarrow$ make low type indifferent between buying or not, and make high type indifferent between the "high" and "low" products
- General principle which holds when more than 2 types
- See this in next lecture.

Another 2DPD example: Bundling

- 2DPD is pervasive, and many market institutions can be interpreted in this light.
- Stigler: *Block booking* of movies
- Pervasive practice:
  - Movie companies force theaters to show all their movies
  - Cereals: forcing supermarkets to carry entire product line
  - Cable TV: Tribune company
  - Academic journals: Elsevier

Block booking

- Film distributor offers: *Gone with the Wind* and *Getting Gertie's Garter*.
- There are movie theaters with "high" and "low" WTP for each movie:

Theater	WTP for GWW	WTP for GGG
A	8000	2500
B	7000	3000

- Specific assumption about preferences:
  - Theater A is "high" for GWW, and "low" for GGG.
  - Theater B is "low" for GWW and "high" for GGG $\longrightarrow$
  - preferences for the two products are *negatively related*
- Monopolist would like to charge each theater a different price for GWW (same with GGG), but that is unlawful.
- Question: does bundling the movies together allow you to price discriminate?

Bundling 2

- Without bundling, monopolist charges $7000 = \min(8000, 7000)$ for GWW and $2500 = \min(2500, 3000)$ for GGG.
  - Total profits: $2 * (7000 + 2500) = 19500$.
- With bundling, monopolist charges $10000 = \min(8000 + 2500, 7000 + 3000)$ for the bundle.
  - profits = 2*10000 (higher)
- Akin to price discrimination: charging (7000, 3000) to theater B, and (8000, 2000) to theater A

Bundling 3

- The optimality of bundling is delicate:
  1. This will not work if preferences are not negatively correlated:

Theater	WTP for GWW	WTP for GGG
A	8000	2500
B	7000	1500

     Here a-la carte and bundle prices coincide (7000, 1500)
  2. Also will not work if "extremely" negatively correlated:

Theater	WTP for GWW	WTP for GGG
A	8000	10
B	20	4000

     Firm optimizes by prices (8000, 4000), and just selling GWW to A, and GGG to B

Other examples

- Consider a simple durable goods market: cars live two periods (new/used)

Consumer type	WTP for new	WTP for old
Hi	5000	2000
Low	3000	3000

- Without secondary markets, consumers can only buy new cars, and hold onto them for two periods.
- Pricing without secondary markets?
- Pricing with secondary markets?

Pharmaceutical pricing after patent expiration

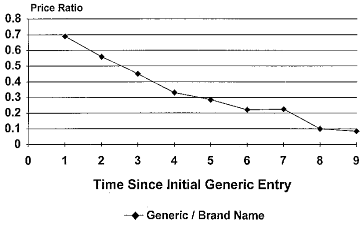
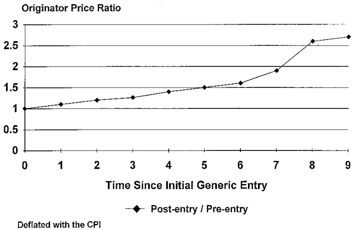
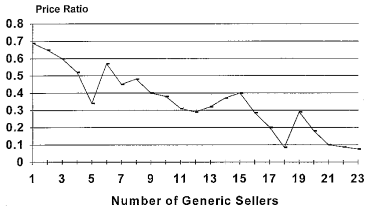


FIGURE 2.





Pharmaceutical pricing after patent expiration

TABLE III.
BRAND-NAME PRICE REGRESSION[a]

Variable	Fixed Effects	TS Fixed Effects[b]	TS Fixed Effects[c]
NMFT	0.007	—	—
	(2.25)	—	—
NMFTHAT	—	0.011	0.016
	—	(2.97)	(3.96)
Constant	−1.487	−1.479	−1.486
	(101.97)	(95.12)	(101.38)
N	343	179	179

[a] Dependent variable: P_B (t statistics in parentheses).
[b] First-stage fixed-effects model (column 1 of Table II)
[c] First-stage variance components with time trend (column 2 of Table II)

What is going on?

Conclusions

- Perfect PD: monopolist gets higher profits, consumers pay more
- 3rd-degree PD: monopolist gets high profits, but possible that consumers are *better off*.
- 2nd-degree PD: used when monopolist cannot distinguish between different types of consumers.
- Indirect price discrimination