

# Lecture 9: Price Discrimination

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# Outline

- 1 Perfect price discrimination
- 2 Third-degree price discrimination: “pricing-to-market”
- 3 Second-degree price discrimination
- 4 Bundling
- 5 Durable goods and secondary markets
- 6 Pharmaceutical pricing after patent expiration

# 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 a price depending on the quantity purchased (electricity, telephone service)
- Consider three 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
  - ③ Second-degree price discrimination: each customer pays her own price, depending on characteristics of purchase (bundling)
- Throughout, consider just monopoly firm.

# 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  $p(q) = MC(q)$ !
- Perfectly discriminating monopolist makes much higher profits (takes away all of the consumer surplus)

## Perfect price discrimination (PPD) 2

This simple example illustrates:

- Profit motive for price discrimination
- In order for PPD to work, assume consumers can't trade with each other: *no resale condition*. 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: public goods problem).
  - Purchase constraints also prevent resale and support price discrimination: *limit two per customer sales?*
- Lower consumer welfare (no consumer surplus under PPD) but high output.
- When consumers demand more than one unit, but have varying WTP for each unit, firm may offer *price schedules* or *quantity discounts* (example: electricity, telephone pricing, TTC tokens)
- Next: focus on models 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.
- graph
- 

$$p_1^{PD} = \frac{5}{2} \quad p_2^{PD} = \frac{5}{4}$$

$$q_1^{PD} = \frac{5}{2} \quad q_2^{PD} = \frac{5}{2}$$

$$CS_1^{PD} = \frac{25}{8} \quad CS_2^{PD} = \frac{25}{16}$$

$$\pi_1^{PD} = \frac{25}{4} \quad \pi_2^{PD} = \frac{25}{8}$$

Compare with outcome when monopolist cannot price-discriminate.

# 3rd-degree price discrimination (3PD) 3

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

- $\max_p \pi^m = p * (5 + 5 - (1 + 2) * p) = p * (10 - 3p)$

- 

$$p_1^M = \frac{5}{3} \quad p_2^M = \frac{5}{3}$$

$$q_1^M = \frac{10}{3} \quad q_2^M = \frac{5}{3}$$

$$CS_1^M = \frac{50}{9} \quad CS_2^M = \frac{25}{36}$$

$$\pi_1^M = \frac{50}{9} \quad \pi_2^M = \frac{25}{9}$$

## 3rd-degree price-discrimination (3PD) 4

### Effects of 3PD:

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

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

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

Average consumer welfare higher under 3PD: specific to this model

## 3rd-degree price discrimination (3PD) 5

In general, 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)

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

This is the “Ramsey pricing rule”: (roughly speaking) consumers with less-elastic demands should be charged higher price

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

# 2nd-degree price discrimination 1

- Firm charges different price depending on characteristics of the purchase. These characteristics include:
  - Amount purchased (nonlinear pricing). Examples: sizes of grocery products
  - Bundle of products purchased (bundling, tie-ins). Examples: fast-food “combos”, cable TV
- Difference with 3rd-degree PD: here, assume that monopolist *cannot classify consumers into groups*, ie., it knows there are two groups of consumers, but doesn't know who belongs in what group. Set up a pricing scheme so that each type of consumer buys the amount that it should: rely on consumer “self-selection”
- Groups, or “types”, of consumers are distinguished by their willingness-to-pay for the firm's product. Characteristic of purchase is a signal of a consumer's type. So signal-contingent prices proxy for type-contingent prices.

## 2nd-degree price discrimination 2

- Simple example: airline pricing
- Assume firm cannot distinguish between business travellers and tourists, but knows that the former are willing to pay much more for 1st-class seats.
- Formally: firm wants to price according to **type** (business or tourist) but cannot; therefore it does next best thing: set prices for 1st-class and coach seats so that consumers “self-select”.
- Airline chooses prices of first-class ( $p_F$ ) vs. coach fares ( $p_C$ ). such that business travellers choose first-class seats and tourists choose coach seats. This entails:
  - ① Ensuring that each type of traveller prefers his “allocated” seat (**self-selection constraints**):

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

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

- ② Ensuring that  $u_B(\text{first class}) - p_F > 0$ , and  $u_T(\text{coach}) - p_C > 0$ , so that both types of travellers prefer travelling to not: **participation constraints**

## 2nd-degree price discrimination 3

- Airline pricing example: add some numbers
- 2 travellers, one is business (B), and one is tourist (T), but monopolist doesn't know which.
- Plane has one first-class seat, and one coach seat.

$$u_B(F) = 1000 \quad u_B(C) = 400$$

$$u_T(F) = 500 \quad u_T(C) = 300$$

- If firm knew each traveller's type, charge  $p_C = 300$ , and  $p_F = 1000$ .
- But doesn't know type, so set  $p_C$ ,  $p_F$ , subject to:

$$1000 - p_F \geq 400 - p_C \quad \text{Type B buys first class} \quad (3)$$

$$300 - p_C \geq 500 - p_F \quad \text{Type T buys coach} \quad (4)$$

$$1000 - p_F \geq 0 \quad \text{Type B decides to travel} \quad (5)$$

$$300 - p_C \geq 0 \quad \text{Type T decides to travel} \quad (6)$$

## 2nd-degree price discrimination 4

### Solution to airline pricing example

- Charge  $p_C = 300$ . Any higher would violate (6), and any lower would not be profit-maximizing.
- If charge  $p_F = 1000$ , type B prefers coach seat: violate constraint (3). By constraint (3), type B must receive net utility from first-class of at least 100, which he would get from purchasing coach at price of 300. Thus upper bound on  $p_F$  is 900, which leaves him with net utility=100.
- Lower bound on  $p_F$  is 500, to prevent type T from preferring first-class.
- To maximize profits, charge the upper bound  $p_F = 900$ .

## 2nd-degree price discrimination 5

In general:

- $p_C = u_B(C)$ : Charge “low demand” types their valuation (leaving them with zero net utility)
- $p_F = u_F(F) - (u_F(C) - p_C)$ : 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  $\implies$  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.

# Bundling: indirect price discrimination

- Indirect price discrimination is pervasive, and many market institutions can be interpreted in this light.
- Stigler: Block booking
- Monopoly offers two movies: *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 → preferences for the two products are *negatively correlated*
- Monopolist would like to charge each theater a different price for GWW (same with GGG), but that is against the law. 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)
- What about price discrimination? Akin to charging theater B 7000 and 3000 for GWW and GGG, and theater A 8000 and 2000.

- This will not work if preferences are not negatively correlated:

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

- With or without bundling, preferences of theater B (low type) dictate market prices.

- Also will not work if “extremely” negatively correlated:

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

Here, monopolist maximizes profits by just selling GWW to A, and GGG to B: need one product to be “better” than other (cable TV bundling?)

- More generally, (this view of) bundling illustrates other methods of indirect price discrimination

# Other examples

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

Consumer type	WTP for new	WTP for old
Hi	8000	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

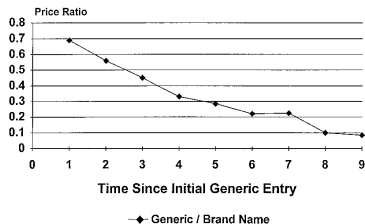
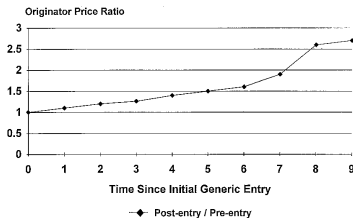
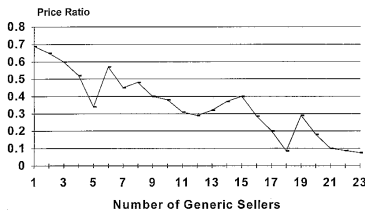


FIGURE 2.



Deflated with the CPI



# Pharmaceutical pricing after patent expiration

TABLE III.  
BRAND-NAME PRICE REGRESSION<sup>a</sup>

Variable	Fixed Effects	TS Fixed Effects <sup>b</sup>	TS Fixed Effects <sup>c</sup>
NMFT	0.007 (2.25)	— —	— —
NMFTTHAT	— —	0.011 (2.97)	0.016 (3.96)
Constant	-1.487 (101.97)	-1.479 (95.12)	-1.486 (101.38)
N	343	179	179

<sup>a</sup> Dependent variable:  $P_B$  ( $t$  statistics in parentheses).

<sup>b</sup> First-stage fixed-effects model (column 1 of Table II)

<sup>c</sup> 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