Lecture 9: Price Discrimination

EC 105. Industrial Organization. Fall 2011

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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.**
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

- group 1: \( q_1 = 5 - p \)
- group 2: \( q_2 = 5 - 2 \times p \)

(graph)

Assume: monopolist produces at zero costs
If monopolist price-discriminates:

- \( \max_{p_1, p_2} p_1 \cdot (5 - p_1) + p_2 \cdot (5 - 2 \cdot p_2) \). Given independent demands, solves the two problems separately.

Graph

\[
\begin{align*}
p_{PD1} &= \frac{5}{2} & & p_{PD2} = \frac{5}{4} \\
q_{PD1} &= \frac{5}{2} & & q_{PD2} = \frac{5}{2} \\
CS_{PD1} &= \frac{25}{8} & & CS_{PD2} = \frac{25}{16} \\
\pi_{PD1} &= \frac{25}{4} & & \pi_{PD2} = \frac{25}{8}
\end{align*}
\]

Compare with outcome when monopolist cannot price-discriminate.
If monopolist doesn’t price-discriminate (uniform pricing):

\[
\max_p \pi^m = p \ast (5 + 5 - (1 + 2) \ast p) = p \ast (10 - 3p)
\]

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

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

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

\[
\pi_1^M = \frac{50}{9} \quad \pi_2^M = \frac{25}{9}
\]
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:

\[
\begin{align*}
(CS/q)_1^M &= \frac{5}{3} = 1.67 \quad & (CS/q)_1^{PD} &= \frac{5}{4} = 1.25 \\
(CS/q)_2^M &= \frac{5}{12} = 0.42 \quad & (CS/q)_2^M &= \frac{5}{8} = 0.625
\end{align*}
\]

Group 2 gains; group 1 loses
- Compare weighted average of \((CS/q)\) under two regimes: \(\frac{CS_1 + CS_2}{q_1 + q_2}\)
  - without PD: 1.25
  - 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 satisfies only at optimal prices (and elasticity is usually a function of price)
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, i.e., 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):

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

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

  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
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:

\[ 1000 - p_F \geq 400 - p_C \quad \text{Type B buys first class} \quad (3) \]
\[ 300 - p_C \geq 500 - p_F \quad \text{Type T buys coach} \quad (4) \]
\[ 1000 - p_F \geq 0 \quad \text{Type B decides to travel} \quad (5) \]
\[ 300 - p_C \geq 0 \quad \text{Type T decides to travel} \quad (6) \]
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 $p_F = 900$. 

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 ⇒ 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:

<table>
<thead>
<tr>
<th>Theater</th>
<th>WTP for GWW</th>
<th>WTP for GGG</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8000</td>
<td>2500</td>
</tr>
<tr>
<td>B</td>
<td>7000</td>
<td>3000</td>
</tr>
</tbody>
</table>

- 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?
Without bundling, monopolist charges $7000 = \min(8000, 7000)$ for GWW and $2500 = \min(2500, 3000)$ for GGG. Total profits: $2 \times (7000 + 2500) = 19500$.

With bundling, monopolist charges $10000 = \min(8000 + 2500, 7000 + 3000)$ for the bundle: profits $= 2 \times 10000$ (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:

<table>
<thead>
<tr>
<th>Theater</th>
<th>WTP for GWW</th>
<th>WTP for GGG</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8000</td>
<td>2500</td>
</tr>
<tr>
<td>B</td>
<td>7000</td>
<td>1500</td>
</tr>
</tbody>
</table>

With or without bundling, preferences of theater B (low type) dictate market prices.
Also will not work if “extremely” negatively correlated:

<table>
<thead>
<tr>
<th>Theater</th>
<th>WTP for GWW</th>
<th>WTP for GGG</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8000</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>20</td>
<td>4000</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Consumer type</th>
<th>WTP for new</th>
<th>WTP for old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hi</td>
<td>8000</td>
<td>2000</td>
</tr>
<tr>
<td>Low</td>
<td>3000</td>
<td>3000</td>
</tr>
</tbody>
</table>

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 1.
measures the time, in years, since the initial entry into the market by generics. Note that the data suggest an upward drift in real brand-name prices. These data are consistent with the observations made by Grabowski and Vernon's (1992). The figure shows a 50% rise in brand-name price five years after generic entry. The trend runs counter to the notion that brand-name producers engage in vigorous price competition with generic entrants. Figure 2 offers a analogous view of the behavior of generic prices during the period following initial market penetration. Note that three years after generic entry generic prices are less than 50% of the brand-name price. These data are supportive of the view that the generic market represents a highly competitive fringe to the brand-name drug market.

Figure 3 presents information on the behavior of generic prices relative to brand-name prices as the number of firms selling a compound increases. The graph in Figure 3 suggests that expanded entry is consistent with a downward drift in the ratio of generic to brand-name price. The relationship is not monotonic as the time path of prices was. This indicates that the timing of entry by generics does not occur continuously over time. Figure 4 shows the number of generic entrants in relation to the years since patent protection was lost. The graph reflects the fact that on average about five generic producers enter a market during the first postpatent year of the brand-name product.
Generic Entry and the Pricing of Pharmaceuticals

Table III.
Brand-Name Price Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Fixed Effects</th>
<th>TS Fixed Effects</th>
<th>TS Fixed Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMFT</td>
<td>0.007</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>(2.25)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMFTHAT</td>
<td>—</td>
<td>0.011</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>—</td>
<td>(2.97)</td>
<td>(3.96)</td>
</tr>
<tr>
<td>Constant</td>
<td>−1.487</td>
<td>−1.479</td>
<td>−1.486</td>
</tr>
<tr>
<td></td>
<td>(101.97)</td>
<td>(95.12)</td>
<td>(101.38)</td>
</tr>
<tr>
<td>N</td>
<td>343</td>
<td>179</td>
<td>179</td>
</tr>
</tbody>
</table>

*Dependent variable: \( P_B \) (\( t \) statistics in parentheses).
*First-stage fixed-effects model (column 1 of Table II)
*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