Monopoly

Monopoly 2: Price Discrimination and Natural Monopoly
Monopoly
Overview

Definition: A firm is a monopoly if it is the only supplier of a product in a market. A monopolist’s demand curve slopes down because firm demand equals industry demand.

Five cases:

1. Base Case (One price, perishable good, non-IRS Costs).
2. Natural Monopoly
3. Price Discrimination - MAIN FOCUS!
4. Bundling
5. Durable Goods
A firm is a natural monopoly if it can produce the market quantity $Q$, at lower cost than two or more firms.

To argue for a natural monopoly, have to establish subadditivity of cost function: $C(Q) < C(q_1) + C(q_2) + ... + C(q_K)$ where $Q = \sum_{i=1}^{K} q_i$.

Claim: if $AC$ is declining everywhere, subadditivity is satisfied.

However, the reverse is not always true, i.e. economies of scale is sufficient but not necessary for natural monopoly.

It is often argued that electrical, gas, telephone and other utilities are natural monopolies. Why?
Monopoly will maximize profits at \((P_M, Q_M)\).

\((P_s; Q_s)\) are perfectly competitive and, hence, welfare maximizing (not counting fixed costs), but a firm would make a loss in this case.

How to regulate a natural monopoly?

1. Pay a subsidy to the firm to cover losses,
2. or have firms bid based on price: ”franchise bidding”
3. or, even better, have firms bid based on both a fee to operate, but also the price they will charge consumers.
We distinguish between three types of price discrimination:

1. First degree ("personalized" prices to extract full surplus)
2. Second degree (have customers choose between a menu of quantities/prices - "self-selection")
3. Third degree ("market segment" based pricing)

Price discrimination always increases firm profits, but its effects on consumer surplus are ambiguous.
First-Degree Price Discrimination

Monopolist knows the WTP of each customer, and charges a different price from each.

The key idea is all the consumer surplus is extracted.

The best way to think of this is that it is done with a lump sum fee and quantity restriction, or an access fee and $P = MC$.
Price Discrimination
First Degree

[Graph showing demand and marginal cost]
Price Discrimination
First Degree

Demand
Marginal Cost

P
Q
MC
B
A
PA
PB

Allan Collard-Wexler
Econ 465 Market Power and Public Policy
September 13, 2016
Price Discrimination

First Degree
Claim: This type of price discrimination leads to an efficient outcome.

What’s the MR curve of a monopolist who can charge the area under the demand curve?

Implementation problem: how does the monopolist know its demand curve?
Price Discrimination
Third Degree

This is "market segmentation".

Two segments:

- \( \max_{q_1, q_2} \pi(q_1, q_2) = TR_1(q_1) + TR_2(q_2) - TC(q_1 + q_2) \)
- \( MR_1(q_1^m) = MC(q_1^m + q_2^m) \)
- \( MR_2(q_2^m) = MC(q_1^m + q_2^m) \)
- Equate marginal revenues across two markets!
- Marginal revenues might be the same, but not the resulting prices!
Price Discrimination
Third Degree

Market Segment 1

Market Segment 2

P
P^1
P^2
MC
MR
Q
Q
Claim: $p_1^m(1 + \frac{1}{\left|\epsilon_1\right|}) = p_2^m(1 + \frac{1}{\left|\epsilon_2\right|})$

Price in market with less elastic demand is higher (Ramsey pricing principle)

Examples: Cinema pricing; Book Pricing

In general, welfare consequences are ambiguous.
Second-Degree Price Discrimination

This is the case where you can’t effectively segment the market.

Instead you get people to choose between different pricing plans ("tariffs").

- Cell phone plans are a good example.
- Quantity discounts (ever wonder how Starbucks sets prices across sizes?)

In some cases, a much harder problem to analyze.

We will do a simple version to build intuition, then a more rigorous treatment to show generality of intuition.
## Price Discrimination

Second Degree: Easy version (also assuming MC = 0)

### Willingness to Pay

<table>
<thead>
<tr>
<th>Type</th>
<th>No.</th>
<th>No Restr</th>
<th>Restr’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tourist</td>
<td>10</td>
<td>350</td>
<td>300</td>
</tr>
<tr>
<td>Business</td>
<td>10</td>
<td>800</td>
<td>200</td>
</tr>
</tbody>
</table>

- **Strategy 1:** price single ticket (NR) at 350
  
  \[
  \text{Revenue} = 350 \times 20 = 7000
  \]

- **Strategy 2:** price single ticket (NR) at 800
  
  \[
  \text{Revenue} = 800 \times 10 = 8000
  \]

- **Strategy 3:** price (R,NR) at (300,800)
  
  \[
  \text{Revenue} = 300 \times 10 + 800 \times 10 = 11,000
  \]
## Price Discrimination

Second Degree: Easy version (also assuming MC = 0)

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<td>800</td>
<td>400</td>
</tr>
</tbody>
</table>

- **Strategy 3:** price (R,NR) at (300,800)
  
  Revenue = 300 \times 10 + 800 \times 10 = 11,000

  ... DOESN’T WORK: business buys restricted fare!

- **Strategy 4:** price (R,NR) at (300,700)
  
  Revenue = 300 \times 10 + 700 \times 10 = 10,000
Two type example:

- Consumer surplus from drinking $q$ ounces of coffee and paying $t_i$ is given by:
  $\theta_i q - t$ where $i = 1; 2$;
- with $(\lambda, 1 - \lambda)$ percent of each type in population
- $\theta_1 < \theta_2$, i.e. $\theta_2$ people get higher marginal utility from each ounce of coffee ("H" types).
- Costs are given by $C(q_i)$
Price Discrimination
Second Degree

Monopolist offers two sizes of coffee: \((q_1, t_1), (q_2, t_2)\) and corresponding pricing.

Maximization problem:

\[
\max_{\{(q_1, t_1), (q_2, t_2)\}} \lambda(t_1 - C(q_1)) + (1 - \lambda)(t_2 - C(q_2))
\]

such that people (a) buy and (b) buy the bundle they are supposed to

\[
\begin{align*}
\theta_1 q_1 - t_1 & \geq 0 \quad \text{(IR-L)} \\
\theta_2 q_2 - t_2 & \geq 0 \quad \text{(IR-H)} \\
\theta_1 q_1 - t_1 & \geq \theta_1 q_2 - t_2 \quad \text{(IC-L)} \\
\theta_2 q_2 - t_2 & \geq \theta_2 q_1 - t_1 \quad \text{(IC-H)}
\end{align*}
\]
Price Discrimination
Second Degree

- Let’s get rid of some of these constraints:

- Claim: IR-L and IC-H automatically imply IR-H.
  Proof:
  \[
  \theta_2 q_2 - t_2 \geq \theta_2 q_1 - t_1 \quad (IC-H)
  \]
  \[
  > \theta_1 q_1 - t_1 \quad (\text{since } \theta_2 > \theta_1)
  \]
  \[
  > 0 \quad (IR-L)
  \]

- Claim: IR-L binds at an optimum.
  Proof: Suppose not. If monopolist increases \( t_1 \) and \( t_2 \) by \( \varepsilon \), he still satisfies IR-L. IC-L and IC-H are unchanged (\( \varepsilon \) cancels from both sides), and IR-H continues to hold. But then monopolist increases profit (price increased by \( \varepsilon \), so we can’t be at an optimum. Contradiction.
Claim: IC-H binds.

Proof: Suppose not. Increase $t_2$ by $\varepsilon$ such that IC-H still holds. IR-L not affected, so IR-H still holds. IC-L not affected. So once again monopolist increased profits! Contradiction.

Claim: IC-L is satisfied automatically given other constraints. Assume for now and verify at optimum.
"Simplified" Maximization problem:

$$\max_{\{(q_1,t_1),(q_2,t_2)\}} \left\{ \lambda (t_1 - C(q_1)) + (1 - \lambda)(t_2 - C(q_2)) \right\}$$

subject to

$$t_1 = \theta_1 q_1$$

$$t_2 - t_1 = \theta_2 q_2 - \theta_2 q_1$$
Price Discrimination
Second Degree

So we can write the problem as:

\[
\begin{align*}
\max_{(q_1, q_2)} & \quad \lambda (\theta_1 q_1 - C(q_1)) \\
& \quad +(1 - \lambda)(\theta_2 q_2 + (\theta_1 - \theta_2)q_1 - C(q_2))
\end{align*}
\]

Giving FOC’s:

\[
\begin{align*}
\theta_1 - (1 - \lambda)\theta_2 &= \lambda C'(q_1) \\
\theta_2 &= C'(q_2)
\end{align*}
\]

For H-types, ”large” coffee size is socially optimal
Price Discrimination
Second Degree

For L-types, suboptimal:

\[ \theta_1 - (1 - \lambda)\theta_2 < \theta_1 - (1 - \lambda)\theta_1 = \lambda \theta_1, \text{ so } \theta_1 > C'(q_1). \]

That is, small coffee size is too small.

Moreover, L-types enjoy zero surplus: \( \theta_1 q_1 - t_1 = 0 \), and are just indifferent between buying coffee and not.

Last step:

- Verify IC-L: since IR-L binds, \( \theta_1 q_2 \leq t_2 \). Subtract IR-L (which binds) from both sides: \( \theta_1 q_2 - \theta_1 q_1 \leq t_2 - t_1 \).

- H-types enjoy surplus: \( \theta_2 q_2 - t_2 \geq 0 \). Proof: Use IC-H and IR-L.
Price Discrimination
Second Degree

More than 2 types of consumers:
If there are $K$ types, $\theta_1 < \theta_2 < \theta_3 < \ldots < \theta_K$

1. Optimality at the top. Marginal cost of largest coffee cup is equal to marginal benefit of ”H” types.
2. Lowest type gets no surplus
3. All other types enjoy some surplus
4. Only downward IC constraints matter, i.e.

$$t_i - t_{i-1} = \theta_i q_i - \theta_{i-1} q_{i-1}$$

5. $q_i > q_{i-1}$
Price Discrimination

Second Degree

Problems and Examples: See Handout
Second-Degree Price Discrimination with Competition

What happens to the results above when there are many competing firms, with each competitor offering a menu of prices and quantities? This is probably a situation that you are more likely to encounter in everyday life.

Intuition:

1. Individual rationality constraint becomes important. No longer clear that participation constraint will bind for lowest type consumer; this person can be ”lured” by the competitor.

2. You’ll end up leaving some surplus to the marginal consumer.

3. As \( n \) grows larger, quantity distortion decreases

Largely an empirical question right now.
Borenstein and Rose (1994): Competition and Price Dispersion in Airline Industry

- Considerable price dispersion within airline (across customers). Average dispersion between two tickets on same carrier and same route is 36 percent of ticket price.

- Much less price dispersion across airlines serving the same route (97 percent of total price dispersion is within airline).

- Variation in dispersion across markets: 3.6 percent of ticket price (Eastern Boston-LaGuardia shuttle) to 86 percent of ticket price (TWA, Phoenix-Las Vegas flight).

- Price dispersion increases with number of competing airlines.