**Price Discrimination and Monopoly: Linear Pricing**

**Introduction**

- Prescription drugs are cheaper in Canada than the United States
- Textbooks are generally cheaper in Britain than the United States
- Examples of *price discrimination*
  - presumably profitable
  - should affect market efficiency: not necessarily adversely
  - is price discrimination necessarily bad – even if not seen as “fair”?
Feasibility of price discrimination

- Two problems confront a firm wishing to price discriminate
  - *identification*: the firm is able to identify demands of different types of consumer or in separate markets
    - easier in some markets than others: e.g. tax consultants, doctors
  - *arbitrage*: prevent consumers who are charged a low price from reselling to consumers who are charged a high price
    - prevent re-importation of prescription drugs to the United States
- The firm then must choose the *type* of price discrimination
  - first-degree or personalized pricing
  - second-degree or menu pricing
  - third-degree or group pricing

Third-degree price discrimination

- Consumers differ by some observable characteristic(s)
- A uniform price is charged to all consumers in a particular group – linear price
- Different uniform prices are charged to different groups
  - “kids are free”
  - subscriptions to professional journals e.g. *American Economic Review*
  - airlines
    - the number of different economy fares charged can be very large indeed!
  - early-bird specials; first-runs of movies
Third-degree price discrimination (cont.)

- The pricing rule is very simple:
  - consumers with low elasticity of demand should be charged a high price
  - consumers with high elasticity of demand should be charged a low price

Third degree price discrimination: example

- Harry Potter volume sold in the United States and Europe
- Demand:
  - United States: $P_U = 36 - 4Q_U$
  - Europe: $P_E = 24 - 4Q_E$
- Marginal cost constant in each market
  - $MC = $4
The example: no price discrimination

- Suppose that the same price is charged in both markets
- Use the following procedure:
  - calculate aggregate demand in the two markets
  - identify marginal revenue for that aggregate demand
  - equate marginal revenue with marginal cost to identify the profit maximizing quantity
  - identify the market clearing price from the aggregate demand
  - calculate demands in the individual markets from the individual market demand curves and the equilibrium price

The example (npd cont.)

United States: \( P_U = 36 - 4Q_U \)
Invert this:
\[ Q_U = 9 - P/4 \] for \( P \leq $36 \)

Europe: \( P_U = 24 - 4Q_E \)
Invert
\[ Q_E = 6 - P/4 \] for \( P \leq $24 \)

Aggregate these demands
\[ Q = Q_U + Q_E = 9 - P/4 \] for \( $36 \leq P \leq $24 \)
\[ Q = Q_U + Q_E = 15 - P/2 \] for \( P < $24 \)

At these prices only the US market is active

Now both markets are active
The example (npd cont.)

Invert the direct demands

\[ P = 36 - 4Q \text{ for } Q \leq 3 \]
\[ P = 30 - 2Q \text{ for } Q > 3 \]

Marginal revenue is

\[ MR = 36 - 8Q \text{ for } Q \leq 3 \]
\[ MR = 30 - 4Q \text{ for } Q \leq 3 \]

Set \( MR = MC \)

\[ Q = 6.5 \]

Price from the demand curve \( P = 17 \)

Substitute price into the individual market demand curves:

\[ Q_U = 9 - P/4 = 9 - 17/4 = 4.75 \text{ million} \]
\[ Q_E = 6 - P/4 = 6 - 17/4 = 1.75 \text{ million} \]

Aggregate profit = \((17 - 4) \times 6.5 = 84.5 \text{ million}\)
The example: price discrimination

- The firm can improve on this outcome
- Check that MR is not equal to MC in both markets
  - MR > MC in Europe
  - MR < MC in the US
  - the firms should transfer some books from the US to Europe
- This requires that different prices be charged in the two markets
- Procedure:
  - take each market separately
  - identify equilibrium quantity in each market by equating MR and MC
  - identify the price in each market from market demand

The example: (pd cont.)

Demand in the US:

\[ P_U = 36 - 4Q_U \]

Marginal revenue:

\[ MR = 36 - 8Q_U \]

MC = 4

Equate MR and MC

\[ Q_U = 4 \]

Price from the demand curve \( P_U = $20 \)
The example: (pd cont.)

Demand in the Europe:
\[ P_E = 24 - 4Q_U \]
Marginal revenue:
\[ MR = 24 - 8Q_U \]
MC = 4
Equate MR and MC
\[ Q_E = 2.5 \]
Price from the demand curve \[ P_E = $14 \]

The example (pd cont.)

- Aggregate sales are 6.5 million books
  - the same as without price discrimination
- Aggregate profit is \((20 - 4) \times 4 + (14 - 4) \times 2.5 = $89\) million
  - $4.5 million greater than without price discrimination
No price discrimination: non-constant cost

- The example assumes constant marginal cost
- How is this affected if MC is non-constant?
  - Suppose MC is increasing
- No price discrimination procedure
  - Calculate aggregate demand
  - Calculate the associated MR
  - Equate MR with MC to give aggregate output
  - Identify price from aggregate demand
  - Identify market demands from individual demand curves

The example again

Applying this procedure assuming that MC = 0.75 + $Q/2$ gives:
Price discrimination: non-constant cost

- With price discrimination the procedure is
  - Identify marginal revenue in each market
  - Aggregate these marginal revenues to give aggregate marginal revenue
  - Equate this MR with MC to give aggregate output
  - Identify equilibrium MR from the aggregate MR curve
  - Equate this MR with MC in each market to give individual market quantities
  - Identify equilibrium prices from individual market demands

The example again

Applying this procedure assuming that $MC = 0.75 + \frac{Q}{2}$ gives:

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<th></th>
<th>United States</th>
<th>Europe</th>
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<td>0 5 10</td>
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<tr>
<td>MR</td>
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</tbody>
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Some additional comments

• Suppose that demands are linear
  – price discrimination results in the same aggregate output as no price discrimination
  – price discrimination increases profit
• For any demand specifications two rules apply
  – marginal revenue must be equalized in each market
  – marginal revenue must equal aggregate marginal cost

Price discrimination and elasticity

• Suppose that there are two markets with the same MC
• MR in market $i$ is given by $MR_i = P_i(1 - 1/\eta_i)$
  – where $\eta_i$ is (absolute value of) elasticity of demand
• From rule 1 (above)
  – $MR_1 = MR_2$
  – so $P_1(1 - 1/\eta_1) = P_2(1 - 1/\eta_2)$ which gives

$$\frac{P_1}{P_2} = \frac{(1 - 1/\eta_2)}{(1 - 1/\eta_1)} = \frac{\eta_1 \eta_2 - \eta_1}{\eta_1 \eta_2 - \eta_2}.$$
Third-degree price discrimination (cont.)

- Often arises when firms sell differentiated products
  - hard-back versus paper back books
  - first-class versus economy airfare
- Price discrimination exists in these cases when:
  - “two varieties of a commodity are sold by the same seller to two buyers at different net prices, the net price being the price paid by the buyer corrected for the cost associated with the product differentiation.” (Phlipps)
- The seller needs an easily observable characteristic that signals willingness to pay
- The seller must be able to prevent arbitrage
  - e.g. require a Saturday night stay for a cheap flight

Product differentiation and price discrimination

- Suppose that demand in each submarket is \( P_i = A_i - B_iQ_i \)
- Assume that marginal cost in each submarket is \( MC_i = c_i \)
- Finally, suppose that consumers in submarket \( i \) do not purchase from submarket \( j \)
  - “I wouldn’t be seen dead in Coach!”
  - “I never buy paperbacks.”
- Equate marginal revenue with marginal cost in each submarket
  \[ A_i - 2B_iQ_i = c_i \Rightarrow Q_i = (A_i - c_i)/2B_i \Rightarrow P_i = (A_i + c_i)/2 \]
  \[ \Rightarrow P_i - P_j = (A_i - A_j)/2 + (c_i - c_j)/2 \]

It is highly unlikely that the difference in prices will equal the difference in marginal costs
Other mechanisms for price discrimination

- Impose restrictions on use to control arbitrage
  - Saturday night stay
  - no changes/alterations
  - personal use only (academic journals)
  - time of purchase (movies, restaurants)
- “Crimp” the product to make lower quality products
  - Mathematica®
- Discrimination by location

Discrimination by location

- Suppose demand in two distinct markets is identical
  - \( P_i = A = BQ_i \)
- But suppose that there are different marginal costs in supplying the two markets
  - \( c_j = c_i + t \)
- Profit maximizing rule:
  - equate MR with MC in each market as before
  - \( \Rightarrow P_j = (A + c_i)/2; P_j = (A + c_j + t)/2 \)
  - \( \Rightarrow P_j - P_i = t/2 
eq c_j - c_i \)
  - difference in prices is not the same as the difference in prices
Third-degree price discrimination and welfare

- Does third-degree price discrimination reduce welfare?
  - not the same as being “fair”
  - relates solely to efficiency
  - so consider impact on total surplus

Price discrimination and welfare

Suppose that there are two markets: “weak” and “strong”

- The discriminatory price in the weak market is \( P_1 \)
- The discriminatory price in the strong market is \( P_2 \)
- The uniform price in both markets is \( P_U \)
- The maximum gain in surplus in the weak market is \( G \)
- The minimum loss of surplus in the strong market is \( L \)
Price discrimination and welfare

![Diagram showing price discrimination and welfare](image)

It follows that $\Delta W \leq G - L = (P_U - MC)\Delta Q_1 + (P_U - MC)\Delta Q_2 = (P_U - MC)(\Delta Q_1 + \Delta Q_2)$

Price discrimination and welfare (cont.)

- Previous analysis assumes that the same markets are served with and without price discrimination
- This may not be true
  - uniform price is affected by demand in “weak” markets
  - firm may then prefer not to serve such markets without price discrimination
  - price discrimination may open up weak markets
- The result can be an increase in aggregate output and an increase in welfare
New markets: an example

Demand in “North” is \( P_N = 100 - Q_N \); in “South” is \( P_S = 100\alpha - Q_S \)

Marginal cost to supply either market is $20

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Linear Pricing

The example: continued

Aggregate demand is \( P = (1 + \alpha)50 - Q/2 \) provided that both markets are served

Equate MR and MC to get equilibrium output \( Q_A = (1 + \alpha)50 - 20 \)

Get equilibrium price from aggregate demand \( P = 35 + 25\alpha \)
The example: continued

Now consider the impact of a reduction in $\alpha$
Aggregate demand changes
Marginal revenue changes
It is no longer the case that both markets are served
The South market is dropped
Price in North is the monopoly price for that market

The example again

Previous illustration is too extreme
MC cuts MR at two points
So there are potentially two equilibria with uniform pricing
At $Q_1$ only North is served at the monopoly price in North
At $Q_2$ both markets are served at the uniform price $P_U$
Switch from $Q_1$ to $Q_2$:
  decreases profit by the red area
  increases profit by the blue area
If South demand is “low enough” or MC “high enough” serve only North
Price discrimination and welfare (cont.)

In this case only North is served with uniform pricing
But MC is less than the reservation price $P_{R}$ in South
So price discrimination will lead to South being supplied
Price discrimination leaves surplus unchanged in North
But price discrimination generates profit and consumer surplus in South
So price discrimination increases welfare

Price discrimination and welfare again

• Suppose only North is served with a uniform price
• Also assume that South will be served with price discrimination
  – Welfare in North is unaffected
  – Consumer surplus is created in South: opening of a new market
  – Profit is generated in South: otherwise the market is not opened
• As a result price discrimination increases welfare.