MODELS OF MONOPOLY

Definition of Monopoly

- A monopoly is a single supplier to a market
- This firm may choose to produce at any point on the market demand curve

Barriers to Entry

- The reason a monopoly exists is that other firms find it unprofitable or impossible to enter the market
- Barriers to entry are the source of all monopoly power
    - there are two general types of barriers to entry
        - technical barriers
        - legal barriers

Technical Barriers to Entry

- The production of a good may exhibit decreasing marginal and average costs over a wide range of output levels
  - in this situation, relatively large-scale firms are low-cost producers
    - firms may find it profitable to drive others out of the industry by cutting prices
    - this situation is known as **natural monopoly**
    - once the monopoly is established, entry of new firms will be difficult
- Another technical basis of monopoly is special knowledge of a low-cost productive technique
  - it may be difficult to keep this knowledge out of the hands of other firms
- Ownership of unique resources may also be a lasting basis for maintaining a monopoly

Legal Barriers to Entry

- Many pure monopolies are created as a matter of law
  - with a patent, the basic technology for a product is assigned to one firm
  - the government may also award a firm an exclusive franchise to serve a market

Creation of Barriers to Entry

- Some barriers to entry result from actions taken by the firm
  - research and development of new products or technologies
  - purchase of unique resources
  - lobbying efforts to gain monopoly power
- The attempt by a monopolist to erect barriers to entry may involve real resource costs

Profit Maximization

- To maximize profits, a monopolist will choose to produce that output level for which marginal revenue is equal to marginal cost
  - marginal revenue is less than price because the monopolist faces a downward-sloping demand curve
    - he must lower its price on all units to be sold if it is to generate the extra demand for this unit
    - Since $MR = MC$ at the profit-maximizing output and $P > MR$ for a monopolist, the monopolist will set a price greater than marginal cost

Profit π is the difference between revenue and cost, both of which depend on q:

$$\pi = R(q) - c(q)$$

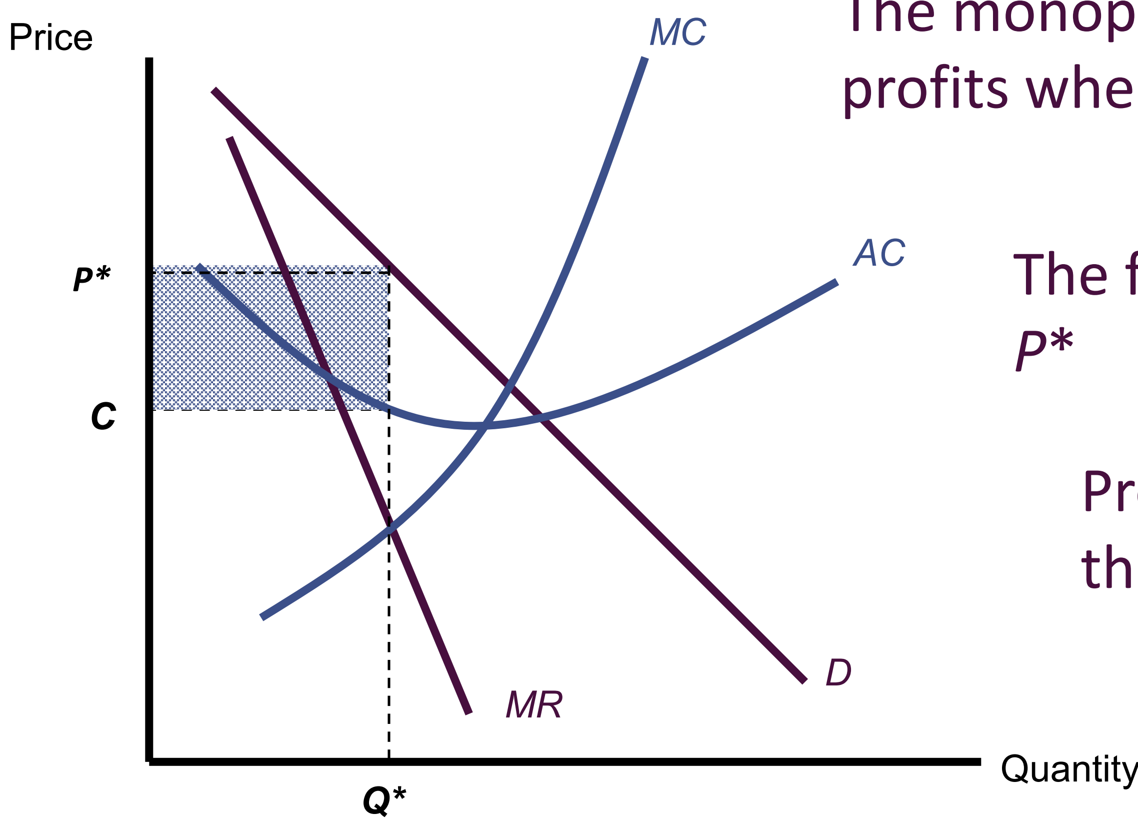
If the profit function is concave, as q is increased from zero, profit will increase until it reaches a maximum and then begin to decrease. Thus the profit-maximizing q^* is the solution of the problem

$$\max_q R(q) - c(q)$$

The FOC are necessary and sufficient conditions if $R(q) - c(q)$ is concave:

$$\frac{dR(q)}{dq} - \frac{dc(q)}{dq} = 0$$

But $\frac{dR(q)}{dq}$ is marginal revenue and $\frac{dc(q)}{dq}$ is marginal cost. Thus the profit-maximizing condition is that $MR = MC$



The monopolist will maximize profits where *MR* = *MC*

The firm will charge a price of *P**

Profits can be found in the shaded rectangle

The Inverse Elasticity Rule

The gap between a firm's price and its marginal cost is inversely related to the price elasticity of demand facing the firm

$$\frac{P - MC}{P} = -\frac{1}{e_{Q,P}}$$

where $e_{Q,P}$, is the elasticity of demand for the entire market

Proof:

$$MR = \frac{dR(q)}{dq} = \frac{d[p(q) \cdot q]}{dq} =$$

$$= p(q) + q\frac{dp(q)}{dq} = p(q) + p(q)\frac{q \cdot dp(q)}{p(q) \cdot dq} =$$

$$= p(q) + p(q)\frac{1}{e_{Q,P}}$$

where $e_{Q,P} = \frac{p(q) \cdot dq}{q \cdot dp(q)}$ is the demand elasticity

Replacing into the profit maximizing condition $MR = MC$, we get

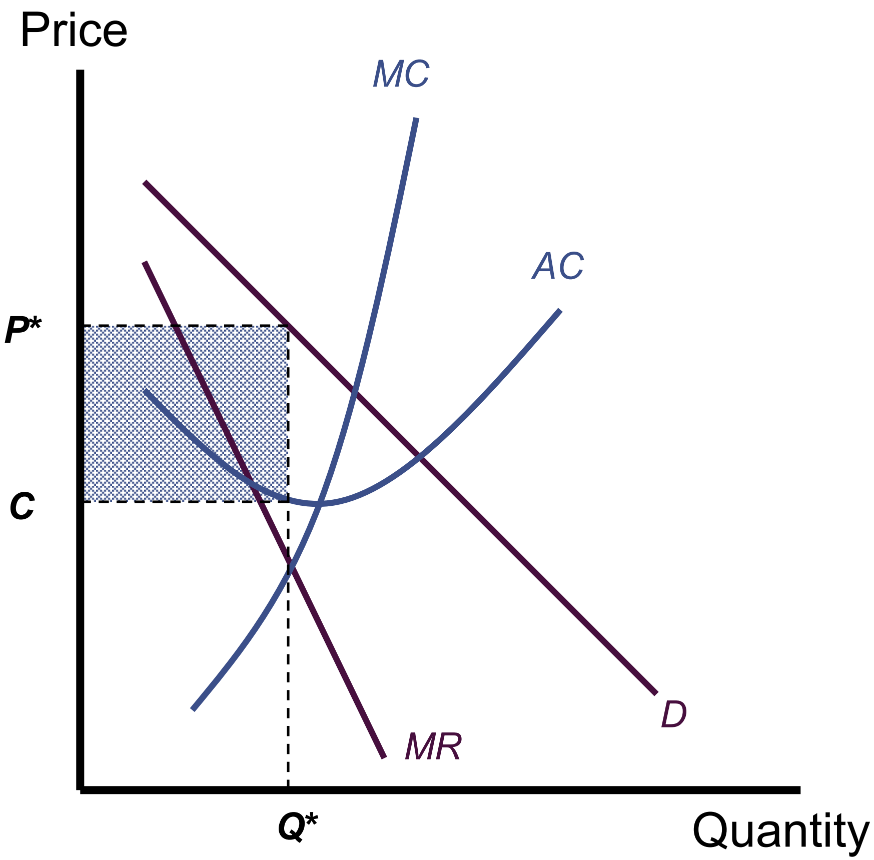
$$p(q) + p(q)\frac{1}{e_{Q,P}} = MC$$

$$\frac{p(q) - MC}{p(q)} = -\frac{1}{e_{Q,P}}$$

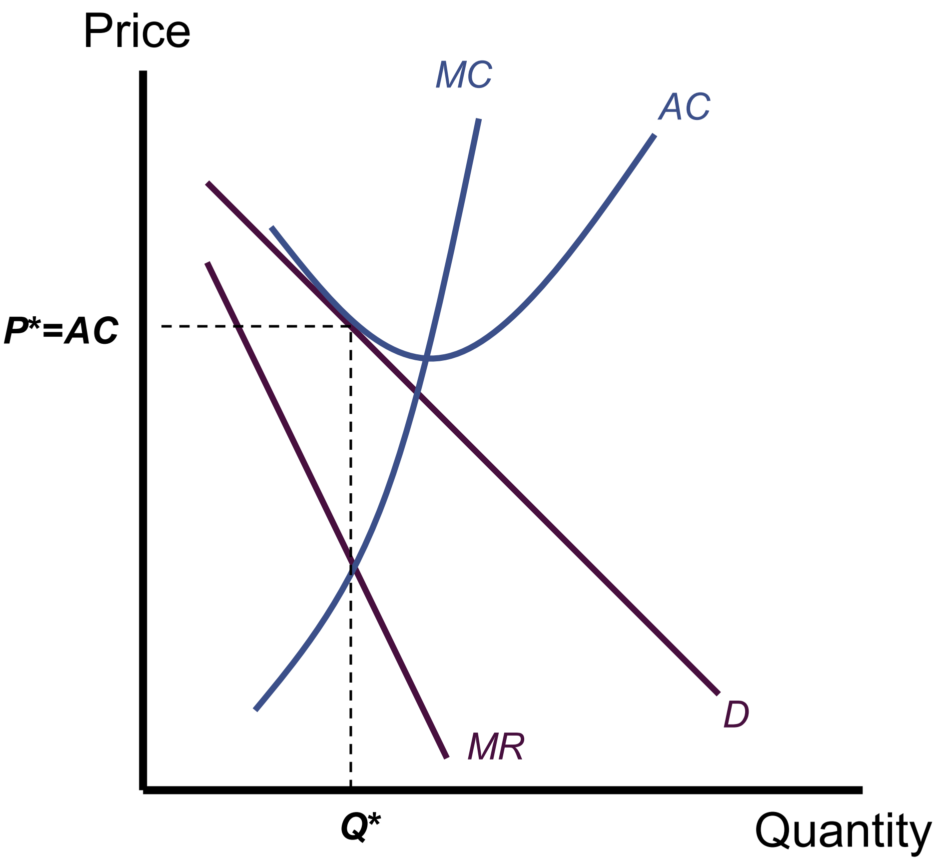
- Two general conclusions about monopoly pricing can be drawn:
  - a monopoly will choose to operate only in regions where the market demand curve is elastic
    - $e_{Q,P} < -1$
    - the firm's "markup" over marginal cost depends inversely on the elasticity of market demand

Monopoly Profits

- Monopoly profits will be positive as long as $P > AC$
- Monopoly profits can continue into the long run because entry is not possible
  - some economists refer to the profits that a monopoly earns in the long run as <u>monopoly rents</u>
    - the return to the factor that forms the basis of the monopoly
- The size of monopoly profits in the long run will depend on the relationship between average costs and market demand for the product



Positive profits



Zero profit

Example: Monopoly with Linear Demand

- Suppose that the market for frisbees has a linear demand curve of the form

$$Q = 2{,}000 - 20P \text{ or } P = 100 - Q/20$$

- The total costs of the frisbee producer are given by

$$C(Q) = 0.05Q^2 + 10{,}000$$

- To maximize profits, the monopolist chooses the output for which *MR = MC*
- We need to find total revenue

$$TR = P \cdot Q = 100Q - Q^2/20$$

- Therefore, marginal revenue is

$$MR = 100 - Q/10$$

while marginal cost is

$$MC = 0.01Q$$

- Thus, *MR = MC* where

$$100 - Q/10 = 0.01Q$$

$$Q^* = 500 \qquad P^* = 75$$

- At the profit-maximizing output,

$$C(Q) = 0.05(500)^2 + 10{,}000 = 22{,}500$$

$$AC = 22{,}500/500 = 45$$

$$\pi = (P^* - AC)Q = (75 - 45)\cdot 500 = 15{,}000$$

- To see that the inverse elasticity rule holds, we can calculate the elasticity of demand at the monopoly's profit-maximizing level of output
- $e_{Q,P} = \frac{\partial Q}{\partial P}\frac{P}{Q} = -20\ \left(\frac{75}{500}\right) = -3$
- The inverse elasticity rule specifies that

$$\frac{p(q) - MC}{p(q)} = -\frac{1}{e_{Q,P}} = \frac{1}{3}$$

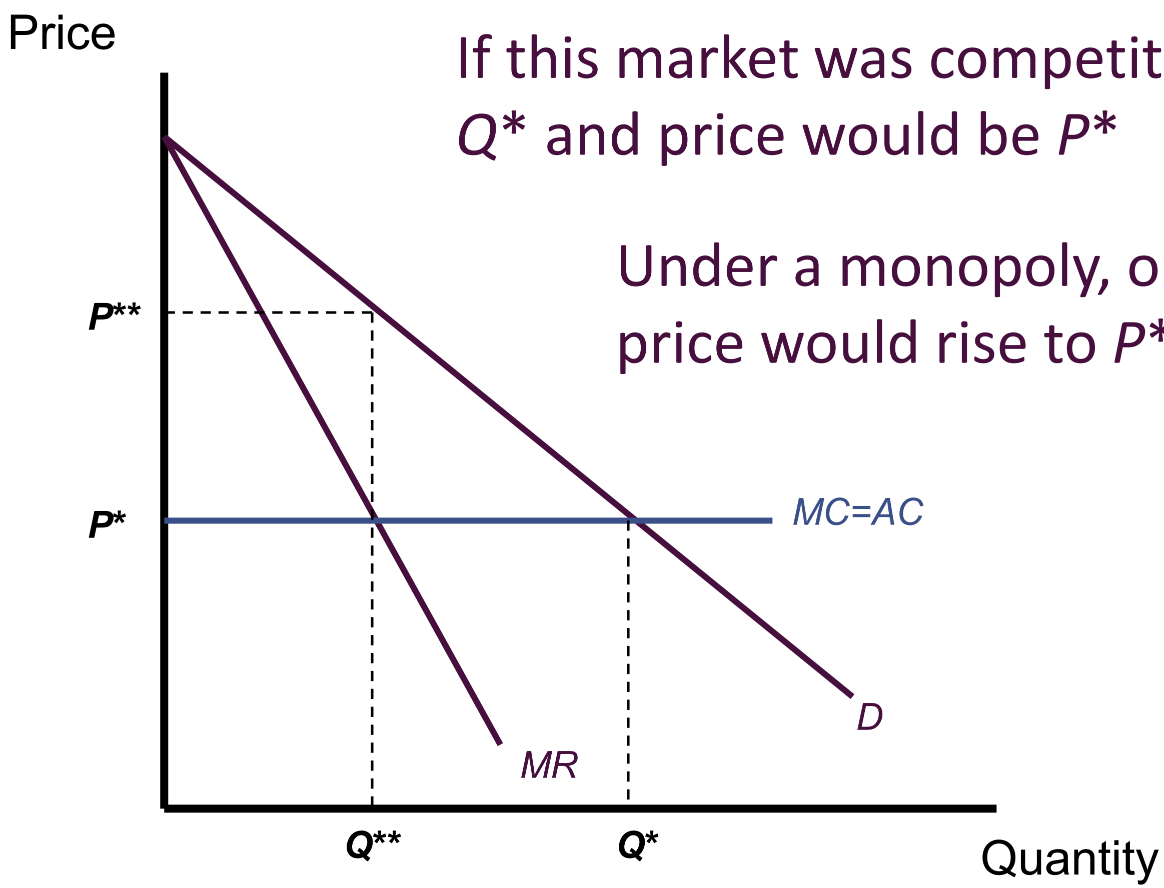
Since $P^* = 75$ and $MC = 50$, this relationship holds

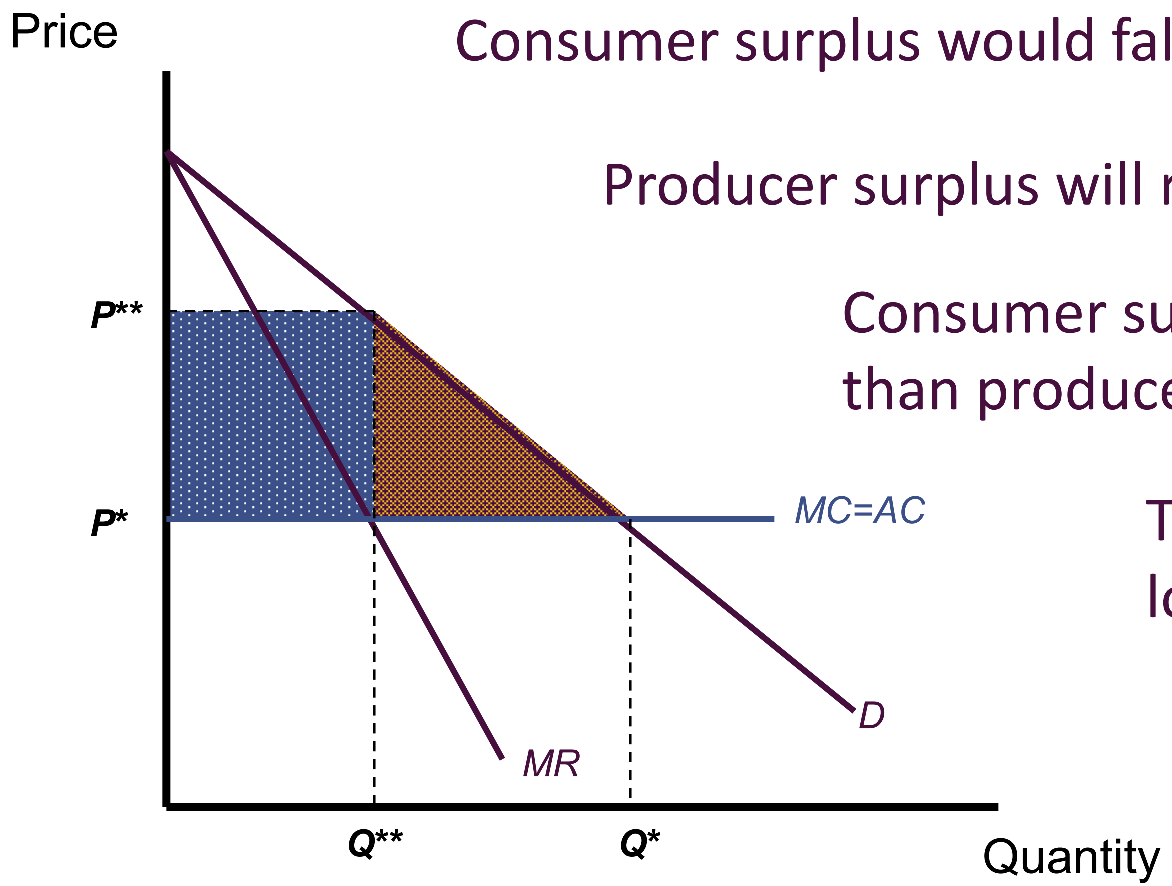
Monopoly and Resource Allocation

- To evaluate the allocational effect of a monopoly, we will use a perfectly competitive, constant-cost industry as a basis of comparison
  - the industry's long-run supply curve is infinitely elastic with a price equal to both marginal and average cost

If this market was competitive, output would be *Q** and price would be *P**

Under a monopoly, output would be *Q*** and price would rise to *P***





Consumer surplus would fall

Producer surplus will rise

Consumer surplus falls by more than producer surplus rises.

There is a deadweight loss from monopoly

Welfare Losses and Elasticity

- Assume that the constant marginal (and average) costs for a monopolist are given by c and that the compensated demand curve has a constant elasticity:

$$Q = P^e$$

where e is the price elasticity of demand ($e < -1$)

- The competitive price in this market will be

$$P_c = c$$

and the monopoly price is given by

$$P_m = \frac{c}{1 + \frac{1}{e}}$$

- The consumer surplus associated with any price (P_0) can be computed as

$$CS = \int_{P_0}^{\infty} Q(P)dP = \int_{P_0}^{\infty} P^e dP = \left.\frac{P^{e+1}}{e+1}\right|_{P_0}^{\infty} = -\frac{P_0^{e+1}}{e+1}$$

Therefore, under perfect competition

$$CS_c = -\frac{c^{e+1}}{e+1}$$

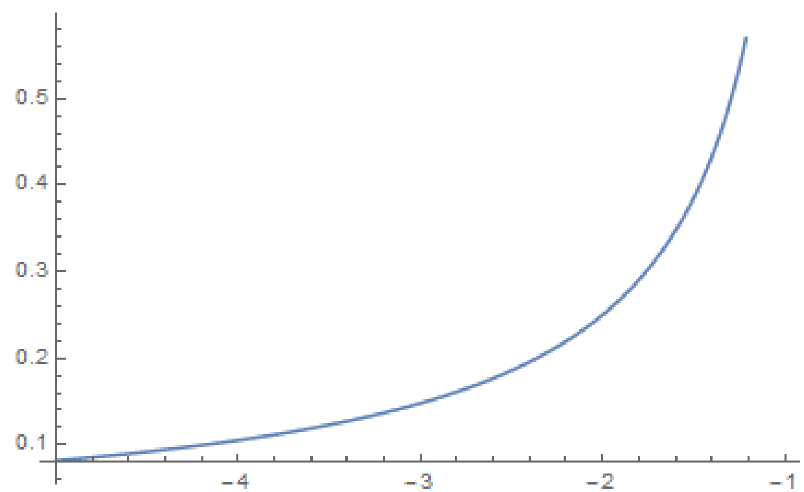
And under monopoly

$$CS_m = -\frac{\left(\frac{c}{1+\frac{1}{e}}\right)^{e+1}}{e+1}$$

- Taking the ratio of these two surplus measures yields

$$\frac{CS_m}{CS_c} = \left(\frac{1}{1+\frac{1}{e}}\right)^{e+1}$$

- If $e = -2$, this ratio is ½
    - consumer surplus under monopoly is half what is under perfect competition
    - This ratio decreases by elasticity (absolute value of e)



- Monopoly profits are given by

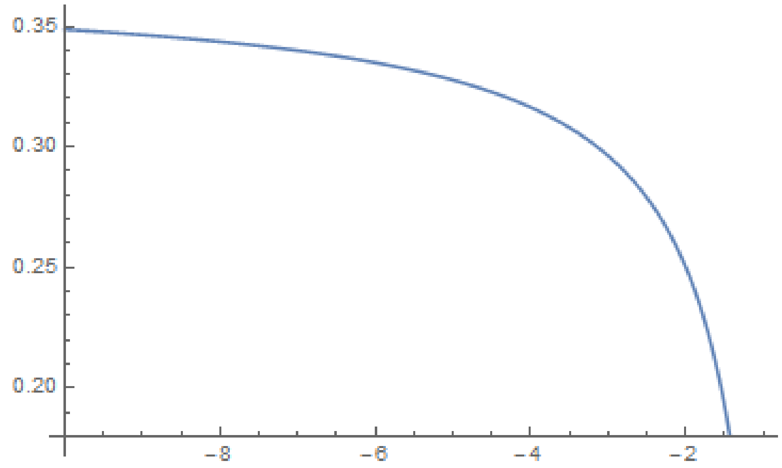
$$\pi_m = P_m Q_m - cQ_m = \left(\frac{c}{1+\frac{1}{e}} - c \right) Q_m$$

$$\pi_m = \left(\frac{-\frac{c}{e}}{1+\frac{1}{e}} \right) \cdot \left(\frac{c}{1+\frac{1}{e}} \right)^{e} = -\left(\frac{c}{1+\frac{1}{e}} \right)^{e+1} \cdot \frac{1}{e}$$

- To find the transfer from consumer surplus into monopoly profits we can divide monopoly profits by the competitive consumer surplus

$$\frac{\pi_m}{CS_c} = \left(\frac{e+1}{e}\right)\left(\frac{1}{1+\frac{1}{e}}\right)^{e+1} = \left(\frac{e}{1+e}\right)^{e}$$

- If $e = -2$, this ratio is ¼
- This ratio is increasing by the elasticity (absolute value of e)



Monopoly and Product Quality

- The market power enjoyed by a monopoly may be exercised along dimensions other than the market price of its product
  - type, quality, or diversity of goods
- Whether a monopoly will produce a higher-quality or lower-quality good than would be produced under competition depends on demand and the firm's costs
- Suppose that consumers' willingness to pay for quality (X) is given by the inverse demand function $P(Q,X)$ where

$$\frac{\partial P}{\partial Q} < 0 \; and \; \frac{\partial P}{\partial X} > 0$$

- If costs are given by $C(Q,X)$, the monopoly will choose Q and X to maximize

$$\pi = P(Q,X)Q - C(Q,X)$$

- First-order conditions for a maximum are

$$\frac{\partial \pi}{\partial Q} = P(Q, X) + Q\frac{\partial P}{\partial Q} - \frac{\partial C}{\partial Q} = 0$$

$$\frac{\partial \pi}{\partial X} = Q\frac{\partial P}{\partial X} - \frac{\partial C}{\partial X} = 0$$

- *MR* = *MC* for output decisions

- Marginal revenue from increasing quality by one unit is equal to the marginal cost of making such an increase

The level of product quality that will be opted for under competitive conditions is the one that maximizes net social welfare

$$SW = \int_0^{Q^*} P(Q, X)dQ - C(Q, X)$$

Maximizing with respect to X yields

$$\frac{\partial SW}{\partial X} = \int_0^{Q^*} P_x(Q, X)dQ - C_x(Q, X)$$

- The difference between the quality choice of a competitive industry and the monopolist is:
  - the monopolist looks at the marginal valuation of one more unit of quality assuming that Q is at its profit-maximizing level
  - the competitive industry looks at the marginal value of quality averaged across all output levels
- Even if a monopoly and a perfectly competitive industry chose the same output level, they might opt for diffferent quality levels
  - each is concerned with a different margin in its decision making

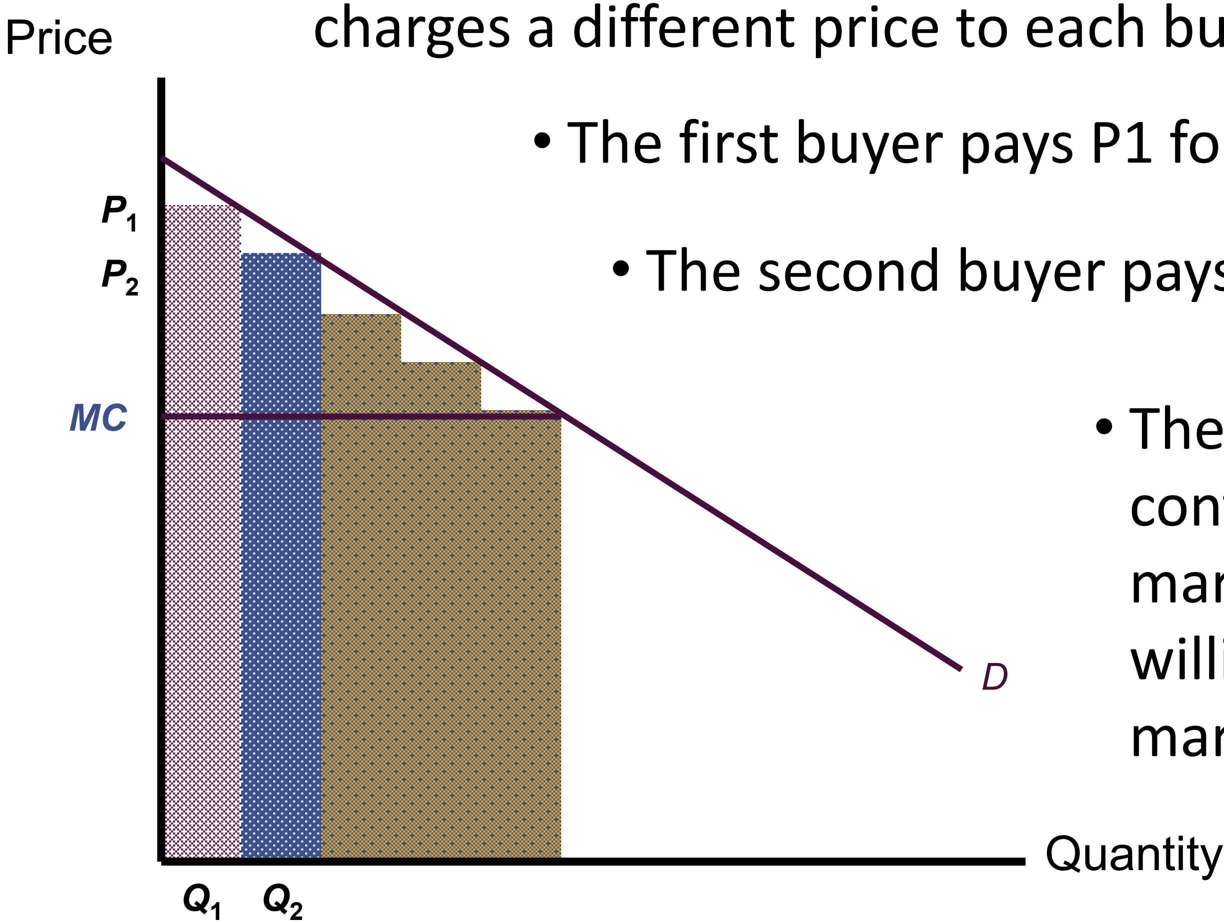
Price Discrimination

- A monopoly engages in price discrimination if it is able to sell otherwise identical units of output at different prices
- Whether a price discrimination strategy is feasible depends on the inability of buyers to practice arbitrage
  - profit-seeking middlemen will destroy any discriminatory pricing scheme if possible
    - price discrimination becomes possible if resale is costly

Perfect Price Discrimination

- If each buyer can be separately identified by the monopolist, it may be possible to charge each buyer the maximum price he would be willing to pay for the good
    - perfect or first-degree price discrimination
        - extracts all consumer surplus
        - no deadweight loss

- Under perfect price discrimination, the monopolist charges a different price to each buyer
  - The first buyer pays P1 for Q1 units
    - The second buyer pays P2 for Q2-Q1 units



- The monopolist will continue this way until the marginal buyer is no longer willing to pay the good's marginal cost

- Recall the example of the frisbee manufacturer
- If this monopolist wishes to practice perfect price discrimination, he will want to produce the quantity for which the marginal buyer pays a price exactly equal to the marginal cost

- Therefore,

$$P = 100 - Q/20 = MC = 0.1Q$$
$$Q^* = 666$$

- Total revenue and total costs will be

$$R = \int_0^{Q^*} P(Q)dQ = 100Q - \frac{Q^2}{40}\Bigg|_0^{666} = 55.511$$
$$c(Q) = 0.05Q^2 + 10{,}000 = 32{,}178$$

Profit is much larger (23,333 > 15,000)

Market Separation

- Perfect price discrimination requires the monopolist to know the demand function for each potential buyer
- A less stringent requirement would be to assume that the monopoly can separate its buyers into a few identifiable markets
  - can follow a different pricing policy in each market
  - <u>third-degree price discrimination</u>

- All the monopolist needs to know in this case is the price elasticities of demand for each market
  - set price according to the inverse elasticity rule
- If the marginal cost is the same in all markets,

$$P_i\left(1+\frac{1}{e_i}\right)=P_j\left(1+\frac{1}{e_j}\right)$$

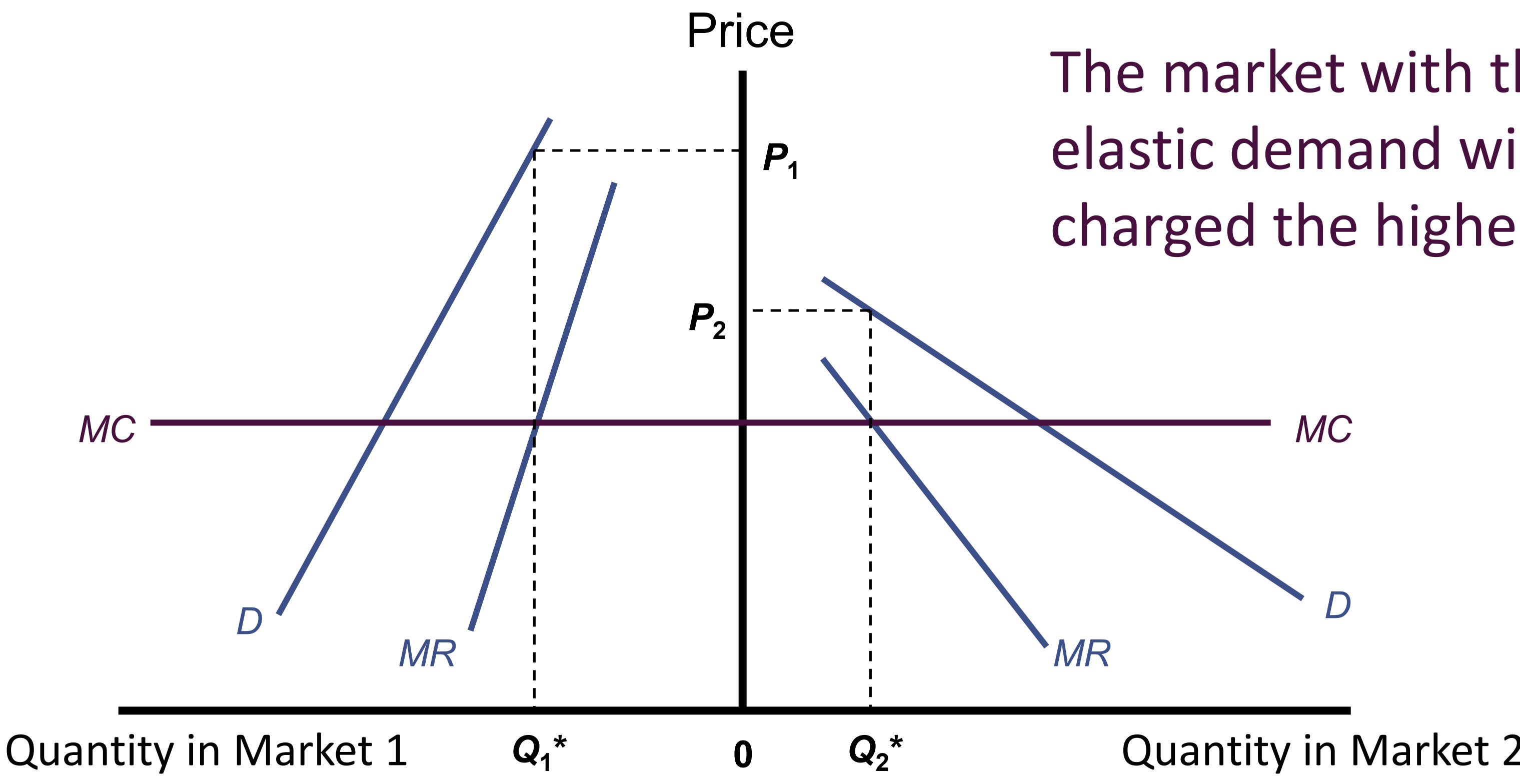
This implies that

$$\frac{P_i}{P_j}=\frac{1+\frac{1}{e_j}}{1+\frac{1}{e_i}}$$

The profit-maximizing price will be higher in markets where demand is less elastic

If two markets are separate, maximum profits occur by setting different prices in the two markets

The market with the less elastic demand will be charged the higher price



Third-Degree Price Discrimination: an example

- Suppose that the demand curves in two separated markets are given by

$$Q_1 = 24 - P_1$$
$$Q_2 = 24 - 2P_2$$

$$R_1 = P_1Q_1 = (24 - Q_1)Q_1 = 24Q_1 - Q_1^2$$

- Suppose that $MC = 6$

- Profit maximization requires that

$$MR_1 = 24 - 2Q_1 = 6 = MR_2 = 12 - Q_2$$

- Optimal choices and prices are

$$Q_1 = 9 \quad P_1 = 15$$
$$Q_2 = 6 \quad P_2 = 9$$

- Profits for the monopoly are

$$\pi = (P_1 - 6)Q_1 + (P_2 - 6)Q_2 = 81 + 18 = 99$$

- The allocational impact of this policy can be evaluated by calculating the deadweight losses in the two markets
- the competitive output would be 18 in market 1 and 12 in market 2

$$DW_1 = 0.5(P_1 - MC)(18 - Q_1) = 0.5(15 - 6)(18 - 9) = 40.5$$

$$DW_2 = 0.5(P_2 - MC)(12 - Q_2) = 0.5(9 - 6)(12 - 6) = 9$$

$$DW = DW_1 + DW_2 = 49.5$$

- If this monopoly was to pursue a single-price policy,

The optimal price and quantities will be

$Q = 9 \quad P = 15$

At this price only market 1 is served (price is too high for consumer in market 2)

- The deadweight loss is bigger with one price than with two:

$$DW = DW_1 + DW_2 = 40.5 + (12 - 6)12 \cdot 0.5 = 76.5$$

Two-Part Tariffs

- A linear two-part tariff occurs when buyers must pay a fixed fee for the right to consume a good and a uniform price for each unit consumed

$$T(q) = a + pq$$

- The monopolist's goal is to choose *a* and *p* to maximize profits, given the demand for the product

- Because the average price paid by any demander is

$$p' = T/q = a/q + p$$

this tariff is only feasible if those who pay low average prices (those for whom q is large) cannot resell the good to those who must pay high average prices (those for whom q is small)

- One feasible approach for profit maximization would be for the firm to set $p = MC$ and then set a equal to the consumer surplus of the least eager buyer (marginal)
  - this might not be the most profitable approach
  - in general, optimal pricing schedules will depend on a variety of contingencies
- Suppose there are two different buyers with the demand functions

$$q_1 = 24 - p_1$$

$$q_2 = 24 - 2p_2$$

- If $MC = 6$, one way for the monopolist to implement a two-part tariff would be to set $p_1 = p_2 = MC = 6$

$$q_1 = 18 \qquad q_2 = 12$$

- With this marginal price, demander 2 obtains consumer surplus of 36
  - this would be the maximum entry fee that can be charged without causing this buyer to leave the market
- This means that the two-part tariff in this case would be

$$T(q) = 36 + 6q$$

Monopolist profits are

$$36 + 36 = 72$$

Suppose that monopolist sets a a equal to CS of demander 1 (demander 2 is excluded from the market)

$$T(q) = 162 + 6q$$

Monopolist profits are

$$162$$

- The optimal pricing to keep both consumers in the market is not the first case, but:

$$T(q) = 9 \ + 9q$$

See example on the book

Important Points to Note:

- The most profitable level of output for the monopolist is the one for which marginal revenue is equal to marginal cost
  - at this output level, price will exceed marginal cost
  - the profitability of the monopolist will depend on the relationship between price and average cost
- Relative to perfect competition, monopoly involves a loss of consumer surplus for demanders
  - some of this is transferred into monopoly profits, whereas some of the loss in consumer surplus represents a deadweight loss of overall economic welfare
  - it is a sign of Pareto inefficiency

- Monopolies may opt for different levels of quality than would perfectly competitive firms
- A monopoly may be able to increase its profits further through price discrimination – charging different prices to different categories of buyers
- the ability of the monopoly to practice price discrimination depends on its ability to prevent arbitrage among buyers