REVIEW SESSION CLASS SLIDES

8. Basic Competition Economics

Merger Antitrust Law

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Demand, Revenues, Costs and Profit Maximization

Demand curves/inverse demand curves

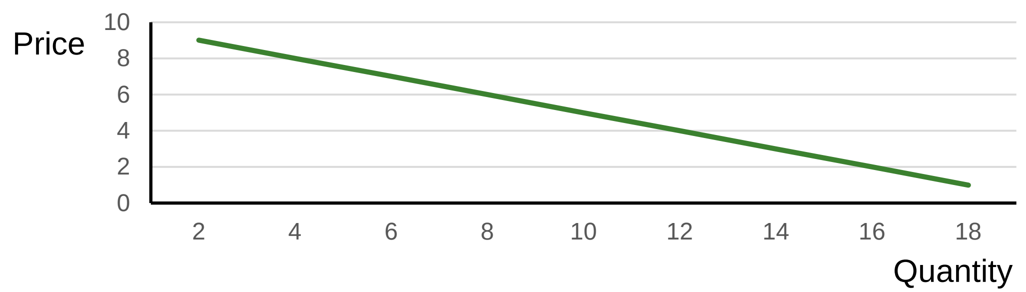
Demand: The total quantity *q* customers are willing to purchase at a price *p*
Demand curve: Traces the relationship between *q* and *p* (where *p* is a function of *q*)
Inverse demand curve: Traces the relationship between *p* and *q* (where q is a function of p)

Demand Curve

$$q = 20 - 2p$$

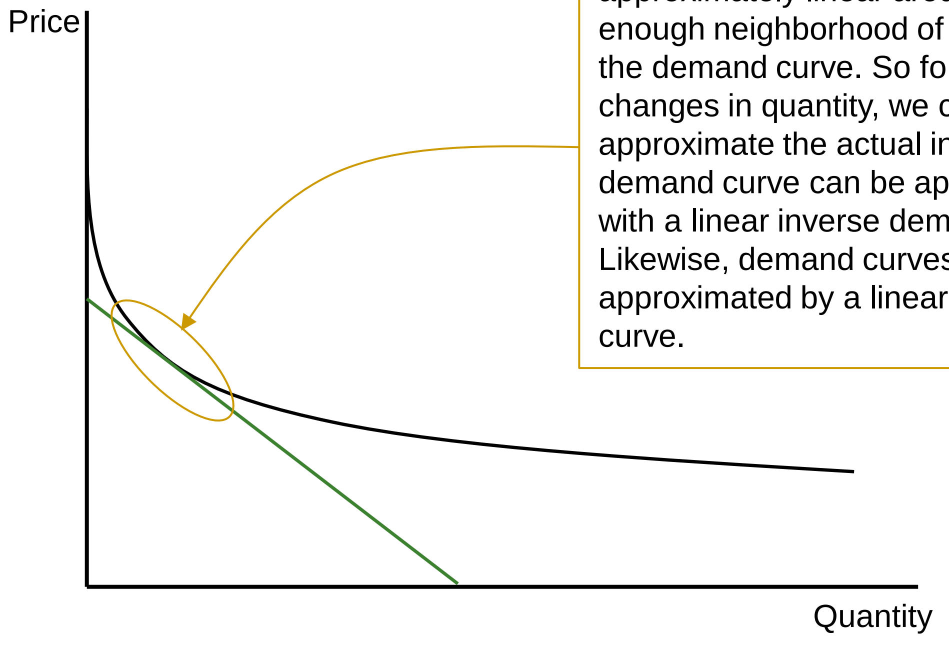
Inverse Demand Curve

$$p = \frac{20 - 2q}{2} = 10 - \frac{1}{2}q$$



Demand curves

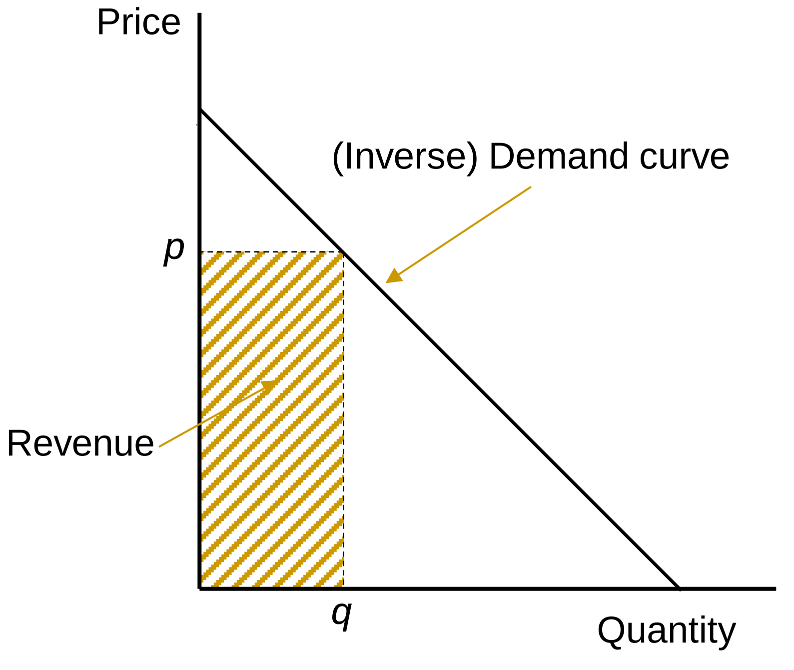
- Example: Nonlinear inverse demand curve with no x-axis intercept



Note: Demand curves are approximately linear around any small enough neighborhood of any point on the demand curve. So for small changes in quantity, we can approximate the actual inverse demand curve can be approximated with a linear inverse demand curve. Likewise, demand curves can be approximated by a linear demand curve.

Revenues

Revenue = Price times quantity (= *pq*)



Revenue and marginal revenue

- *Marginal revenue (MR)*:
  - *Definition*: The net additional revenue the firms earns by increasing its output by one unit

$$MR(q) = R(q+1) - R(q),$$

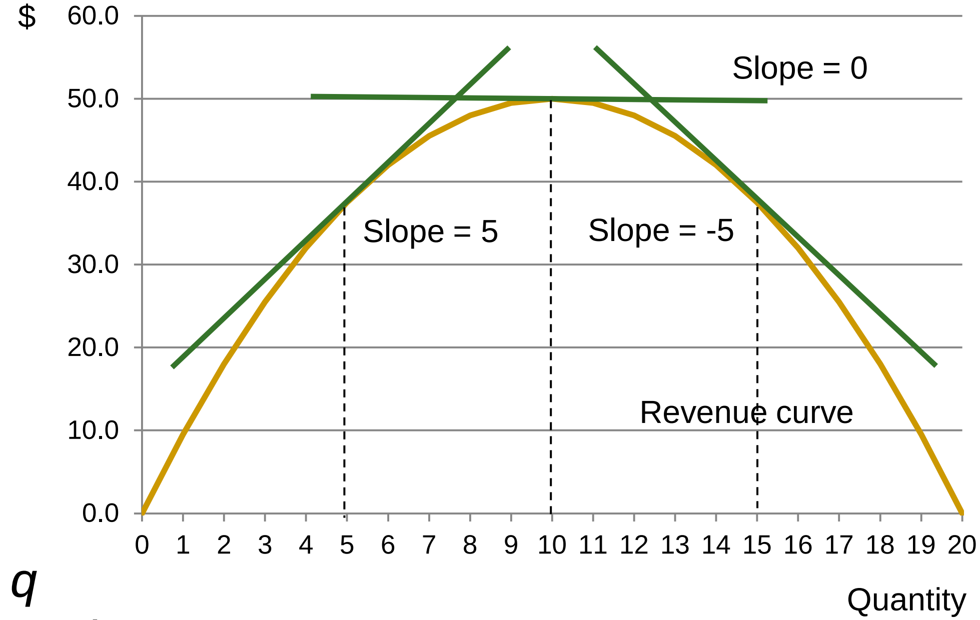
    where, at a production level q, $MR(q)$ is the firm's marginal revenue and $R(q)$ is the firm's revenue
  - Marginal revenue is less than price when the firm faces a downward-sloping demand curve
    - The market price will have to decrease after adding the incremental output in order to clear the market
    - This lower price will apply to preexisting sales as well as incremental sales, making marginal revenue less than price

Revenue and marginal revenue

- *Example:*
  - Demand curve: $q = 20 - 2p$
  - This yields an inverse demand curve: $p = 10 - \frac{1}{2}q$
  - Revenues:

$$R(q) = p(q)q$$
$$= \left[10 - \frac{1}{2}q\right]q$$
$$= 10q - \frac{1}{2}q^2.$$

This is a quadratic equation.
Its curve is a parabola



  - *Factoid*: Marginal revenue at q is simply the slope of the demand curve at q
    - The slope is determined by the tangent line at q

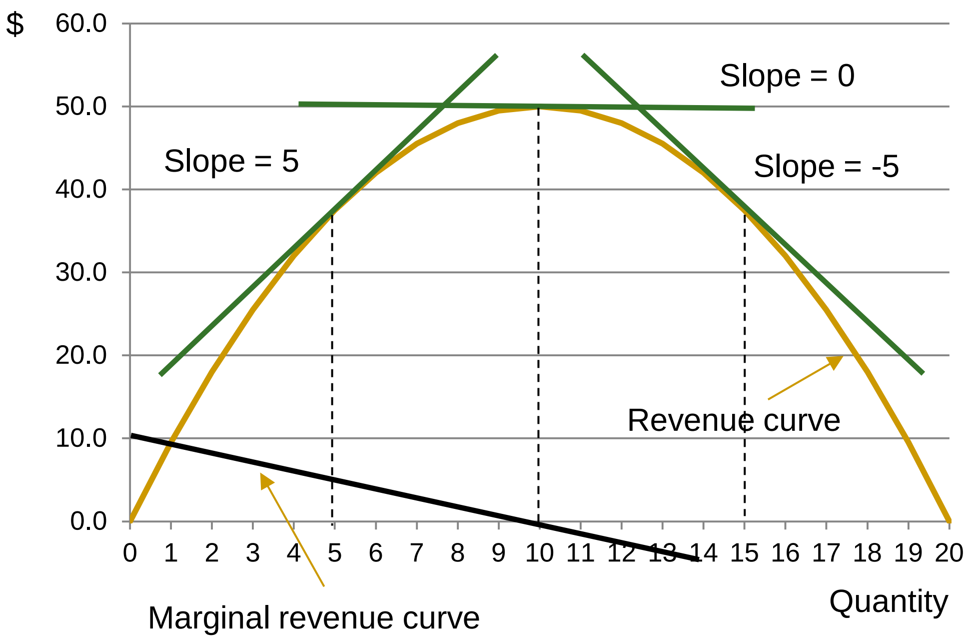
Revenue and marginal revenue

- Marginal revenue and linear inverse demand curves
  - The rule
    - Say $p = a + bq$
    - Then $R = pq = (a + bq)q = aq + bq^2$
    - So $MR(q) = a + 2bq$
  - If you are given a demand curve
    - First, rearrange the demand curve into an inverse demand curve
    - Second, apply the above rule to the inverse demand curve
  - Example:

$$p = 10 - \frac{1}{2}q$$

$$MR = 10 - q$$

The “2” in this equation says that the marginal revenue curve falls twice as fast as its associated linear demand curve



Marginal revenue

- Interpreting marginal revenue

Marginal revenue (MR) = The revenue gain from the incremental sales without any price adjustment

-minus-

the revenue loss from decrease price on all sales necessary to clear the market given the additional units of output

or equivalently

= the revenue gain from incremental sales (the sale of one additional unit)

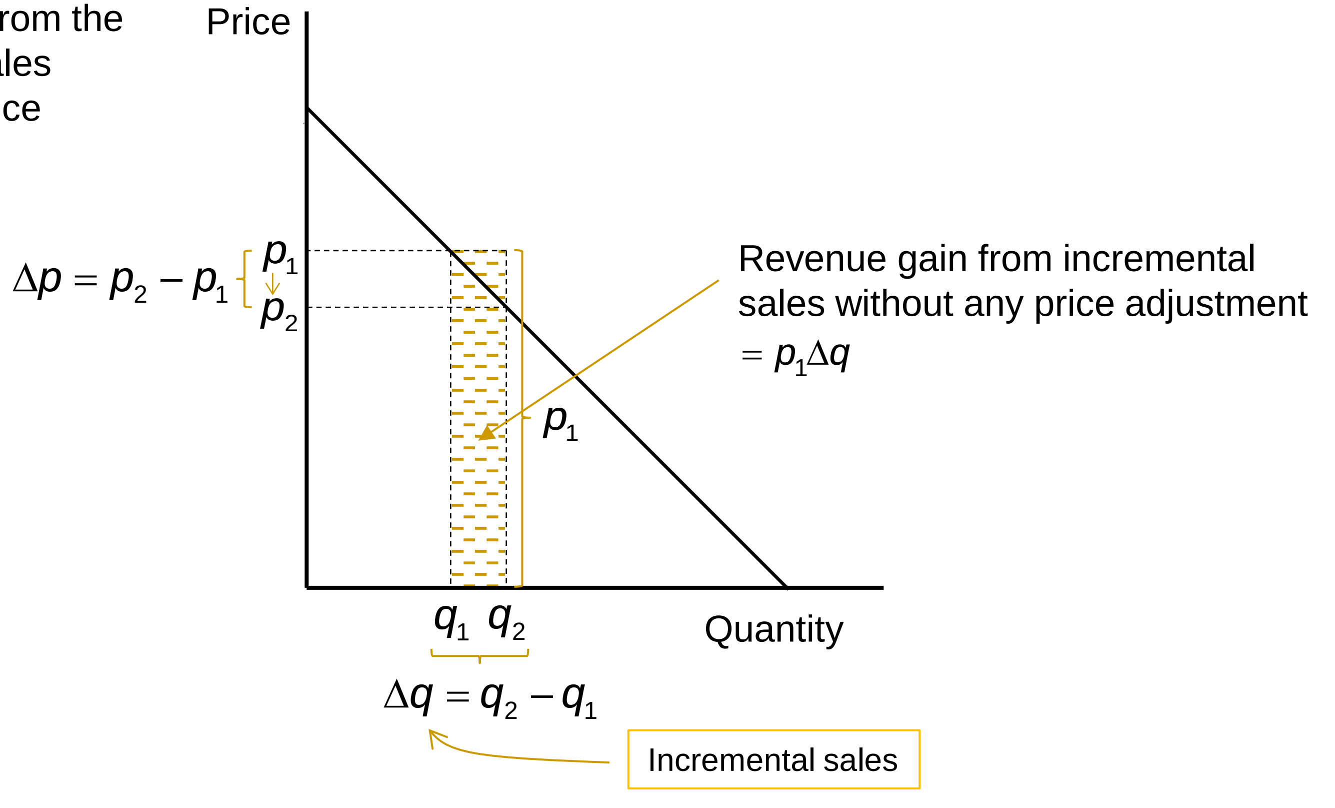
-minus-

– revenue loss from lower price on preexisting sales

The next three slides demonstrate this

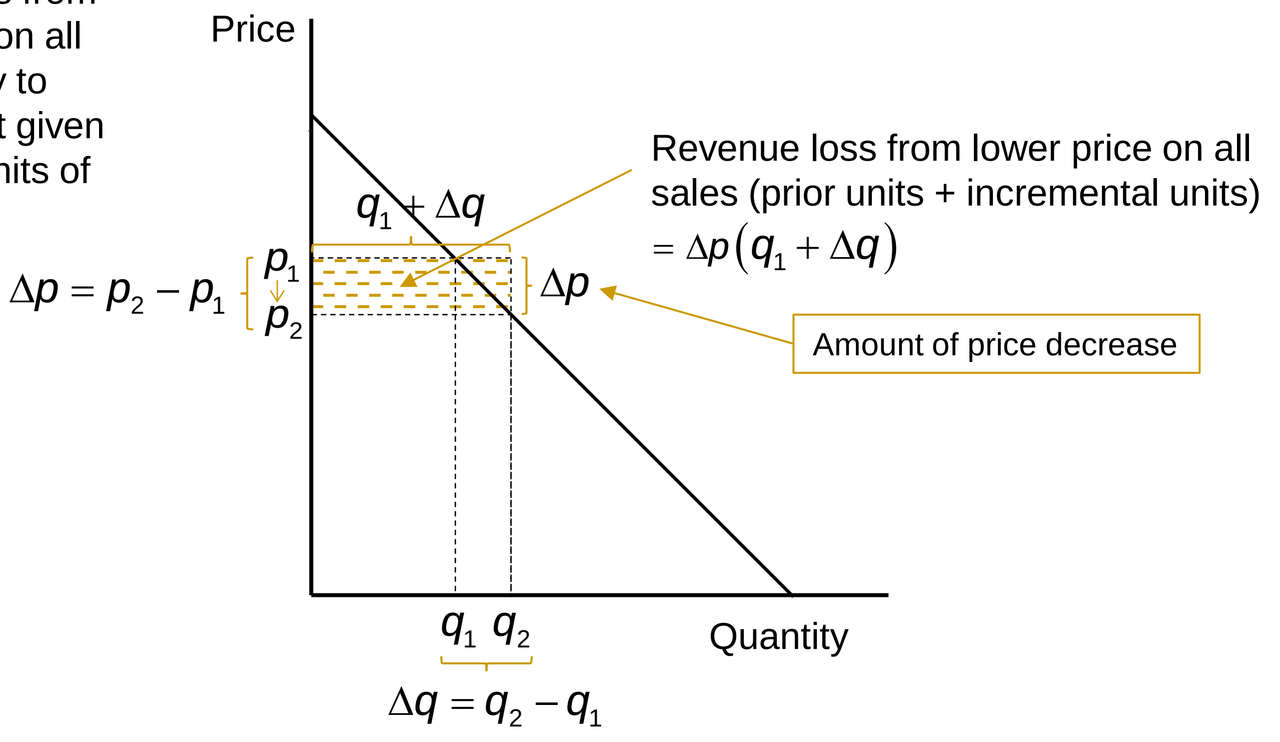
Marginal revenue

Step 1. Look first at the revenue gain from the incremental sales without any price adjustment:



Marginal revenue

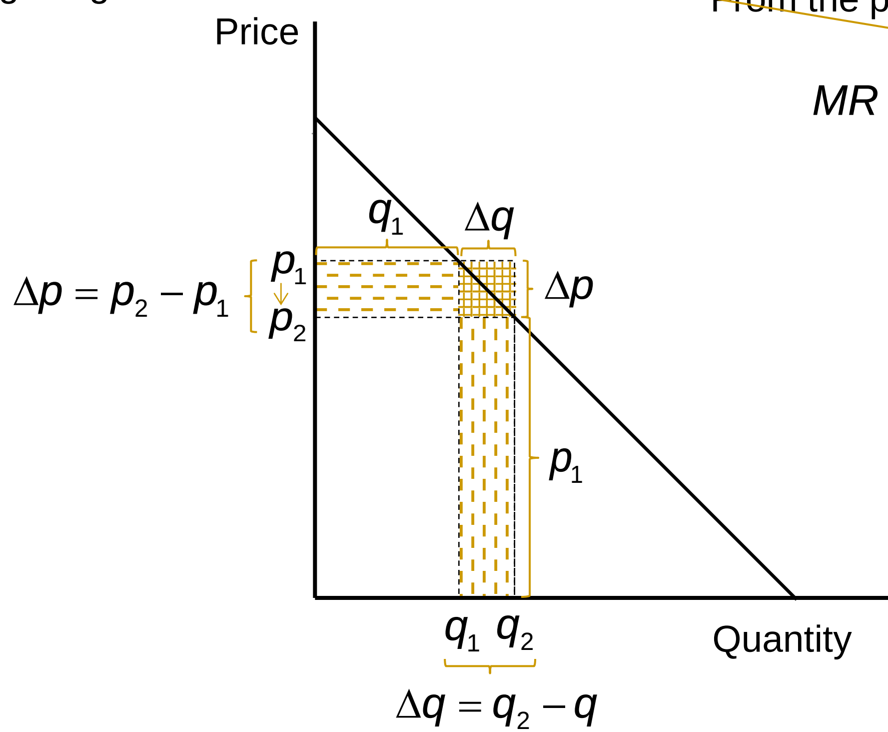
Step 2. Now look at the revenue loss from decrease price on all sales necessary to clear the market given the additional units of output



Marginal revenue

Marginal revenue (mr) = The revenue gain from the incremental sales without any price adjustment
– the revenue loss from decreased price on all sales necessary to clear the market given the additional units of output

Step 3. Putting it together:



From the prior two slides:

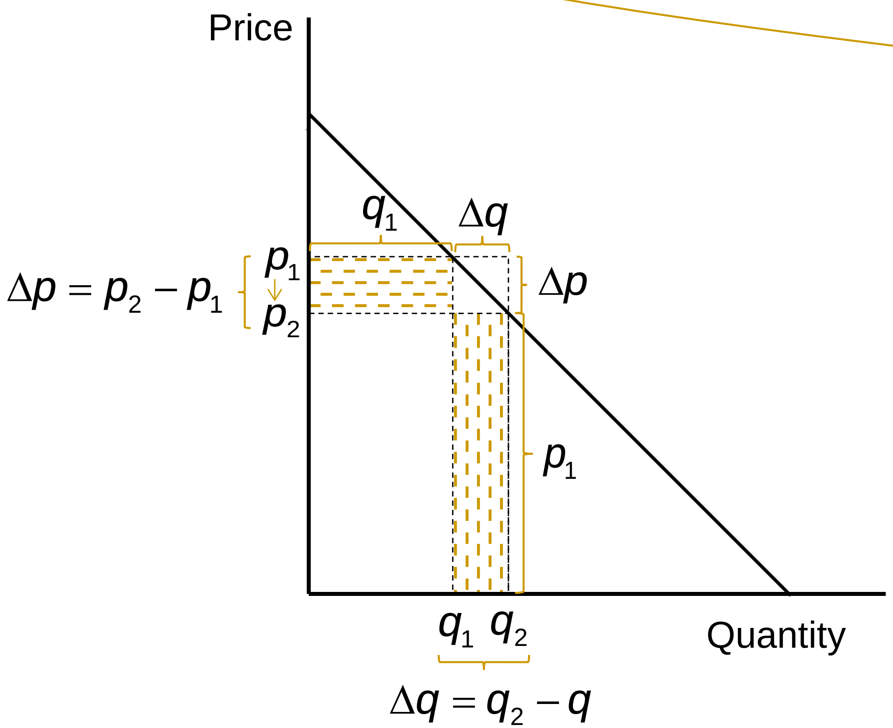
$$MR \equiv \frac{\Delta r}{\Delta q} = p_1 \Delta q + \Delta p \left(q_1 + \Delta q \right)$$

Marginal revenues

Equivalently,

Marginal revenue (mr) = Revenue gain from *incremental* sales at lower price
– the revenue loss from the decreased price on *preexisting* sales necessary to clear the market given the additional units of output

$$MR \equiv \frac{\Delta R}{\Delta q} = (p_1 + \Delta p)\Delta q + \Delta p q_1$$



Revenues and marginal revenues

- Relationship between revenues and marginal revenue
  - Discrete case

Read this " R of q": This is the revenues at production level q.

$$R(q) = \sum_{i=1}^{q} mr_i$$

- That is, total revenues for a production level q is equal to the sum of the marginal revenues for units 1 to q

  - Continuous case (for diehard calculus fans):

$$\frac{dR(q)}{dq} = mr(q)$$

and

$$R(q) = \int_0^q mr(q)dq$$

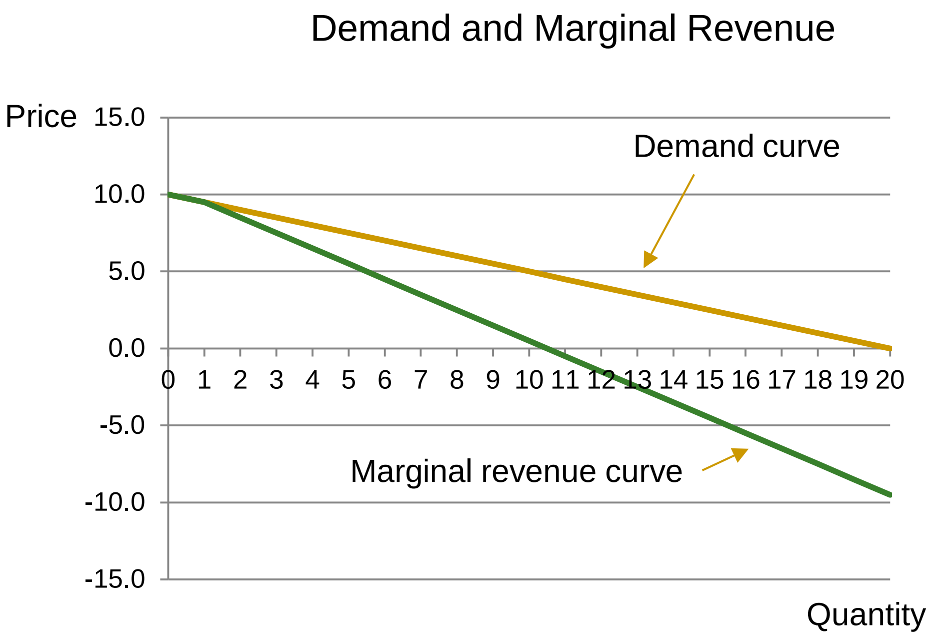
Revenue and marginal revenue

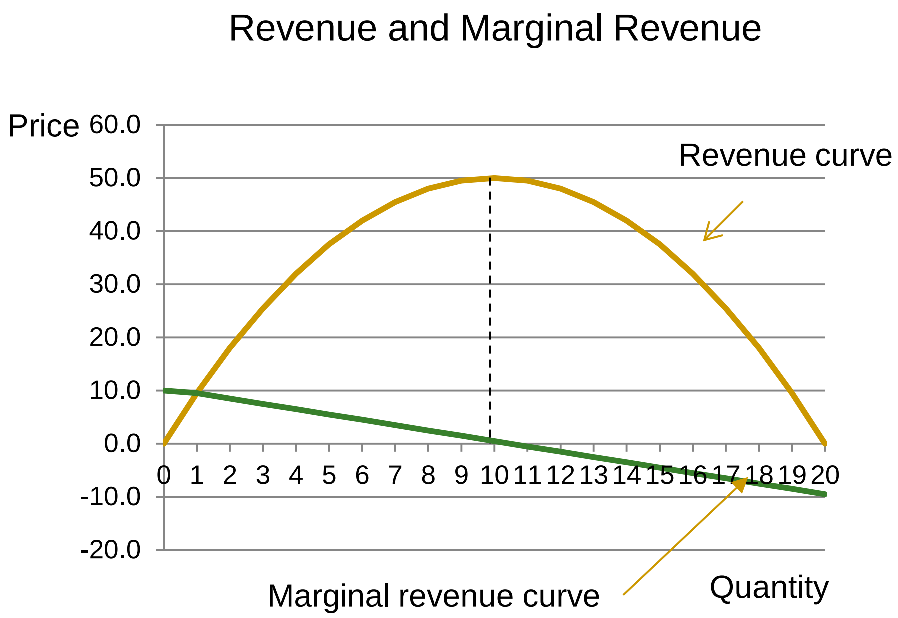
- Graphing revenue and marginal revenue curves

Example: $p = 10 - \frac{1}{2}q$

$$R = pq = 10q - \frac{1}{2}q^2$$

$$MR = 10 - q$$





Costs

- Some basic terms
  - *Total costs (C(q))*
    - The total cost of producing a production level *q*
    - Costs *C*(*q*) = fixed cost (*F*) + variable cost V(*q*))
  - *Fixed costs* (*F*)
    - Costs of production that do not vary with the quantity produced
  - *Variable costs* (*V*(*q*))
    - Costs of production that vary with the production level and that are incurred producing a level q
  - *Marginal cost (MC*(*q*))
    - The additional costs the firm would incur for producing one additional unit having produced q units
    - *MC*(*q*) =*C*(*q*+1) + *C*(*q*)
  - Generally

$$C(q) = F + \sum_{i=1}^{q} mc_i$$

Costs

- Some basic terms
  - *Profits ($\pi(q)$)*
    - Revenues minus costs earned at a production level *q*
    - $\pi(q) = R(q) - C(q)$
  - *Marginal profit ($m\pi$)*
    - The net additional profit that the firm would make if it produced an additional unit
    - Or equivalently, marginal revenues minus marginal costs:

$$\begin{aligned} m\pi(q) &= \pi(q+1) - \pi(q) \\ &= \left[R(q+1) - C(q+1)\right] - \left[R(q) - C(q)\right] \\ &= \left[R(q+1) - R(q)\right] - \left[C(q+1) - C(q)\right] \\ &= mr(q) - mc(q) \end{aligned}$$

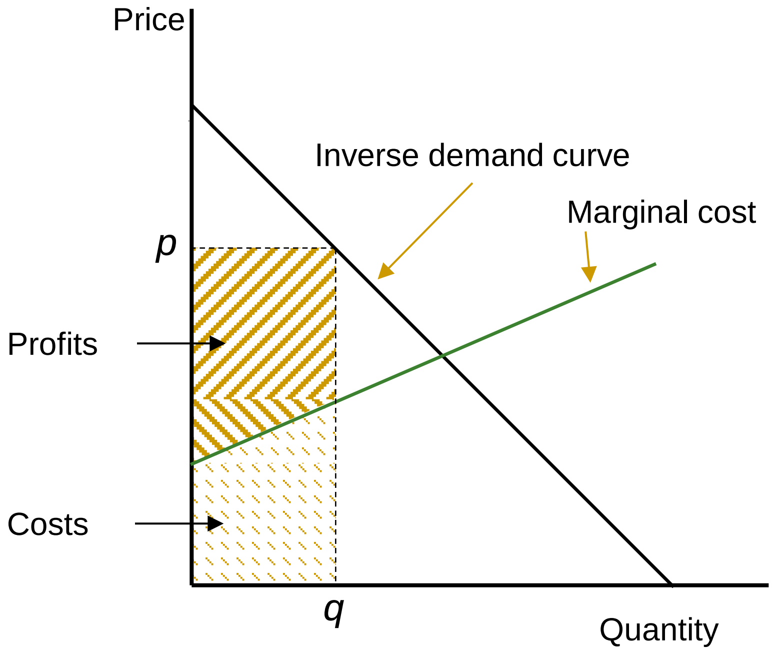
    - This also implies:

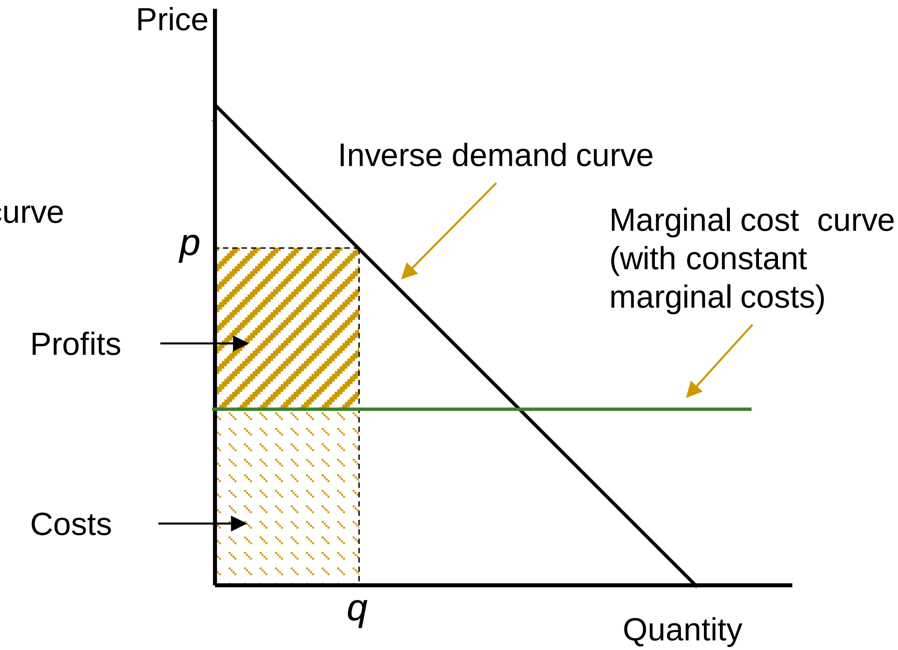
$$\pi(q+1) = \pi(q) + m\pi(q)$$

That is, the firm's profits at *q* + 1 is the firm's profit at *q* plus the marginal profit (positive or negative) the firm would earn if it produced another unit

Marginal costs

Marginal cost (*mc*): The cost *mc* of producing the (q + 1)th unit after producing *n* units
Marginal cost curve: Traces the relationship between *q* and *mc*

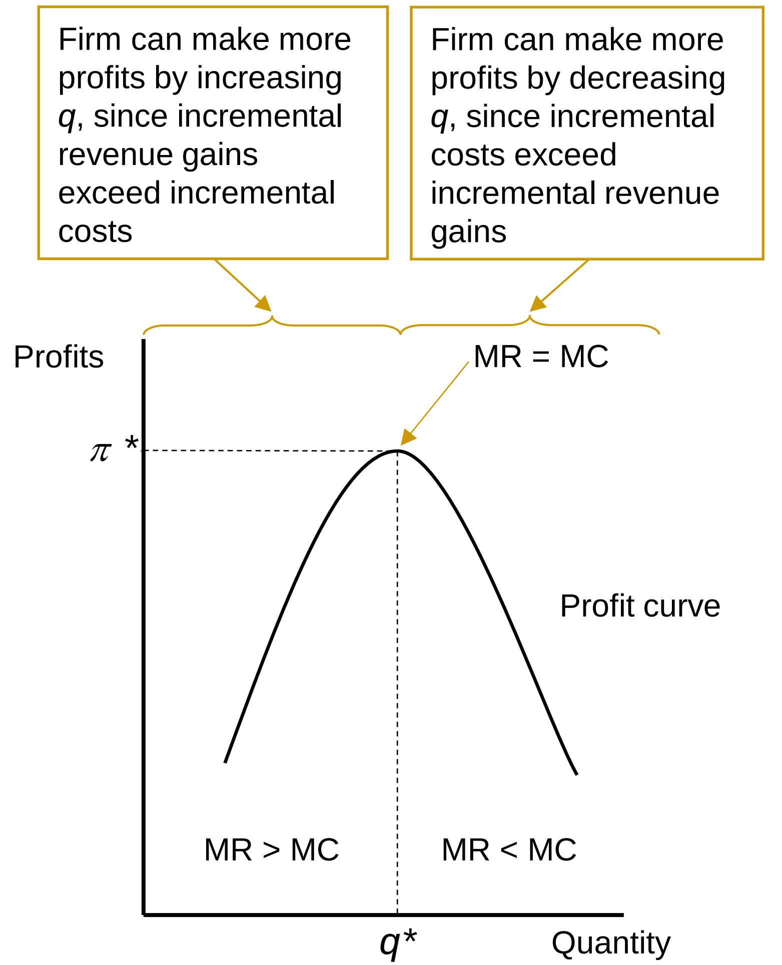




Query: The marginal cost curve is shown upward sloping. Why might that be?
Can the marginal cost curve be flat or even downward sloping?

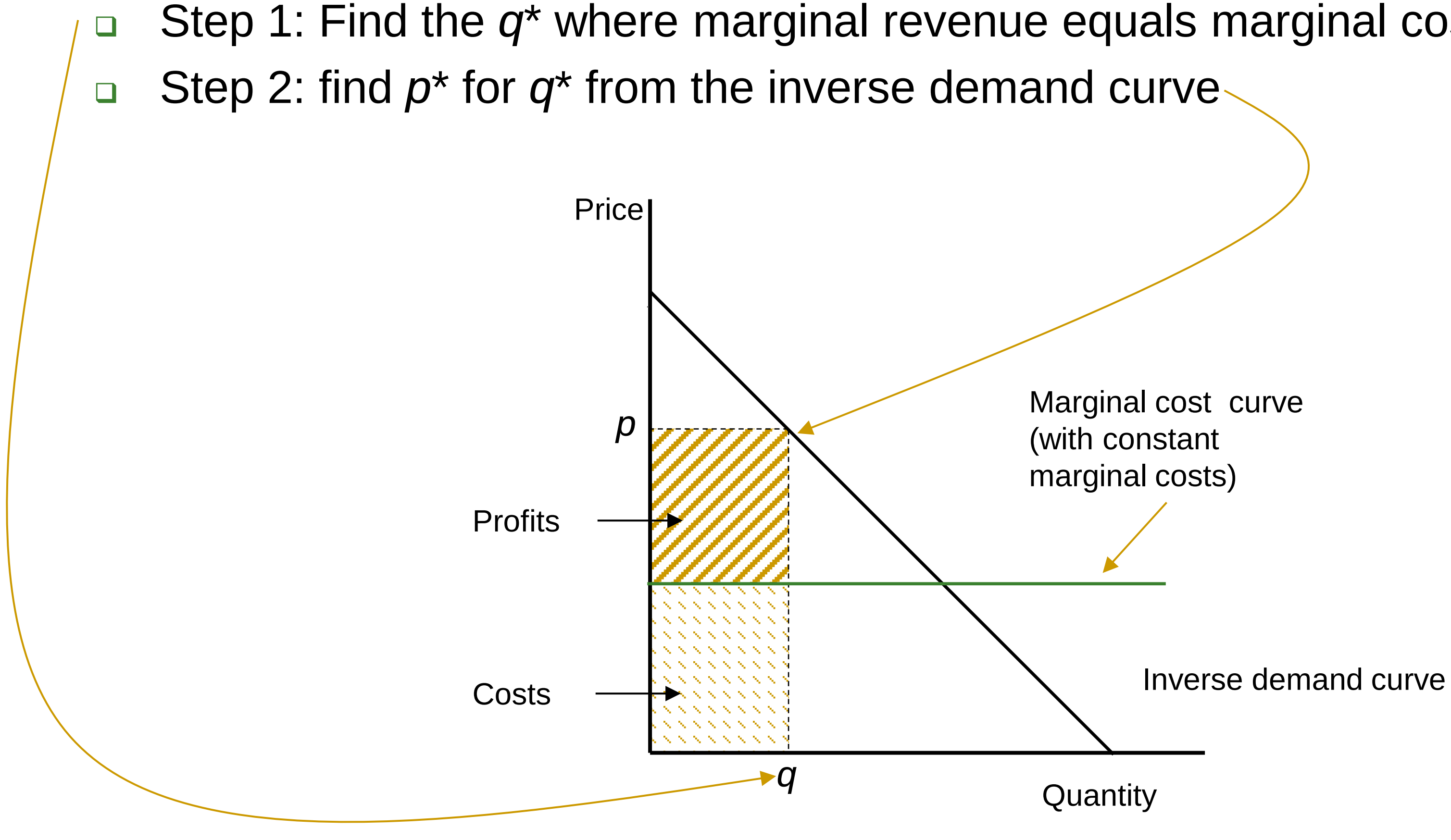
Profit maximization

- Firms maximize profits when $MR = MC$



Profit maximization

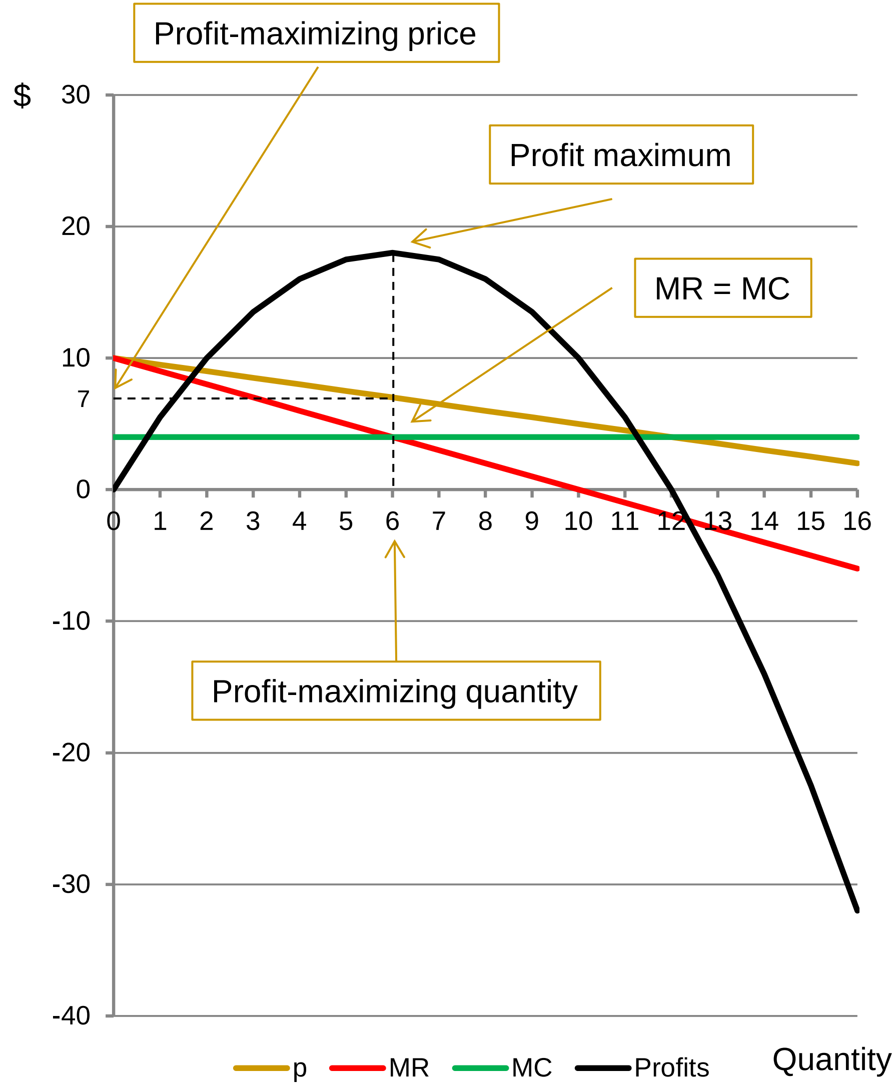
- Determining the profit-maximizing quantity and price
  - Step 1: Find the *q** where marginal revenue equals marginal cost
  - Step 2: find *p** for *q** from the inverse demand curve



Profit maximization

- Numerical version $p = 10 - \frac{1}{2}q$

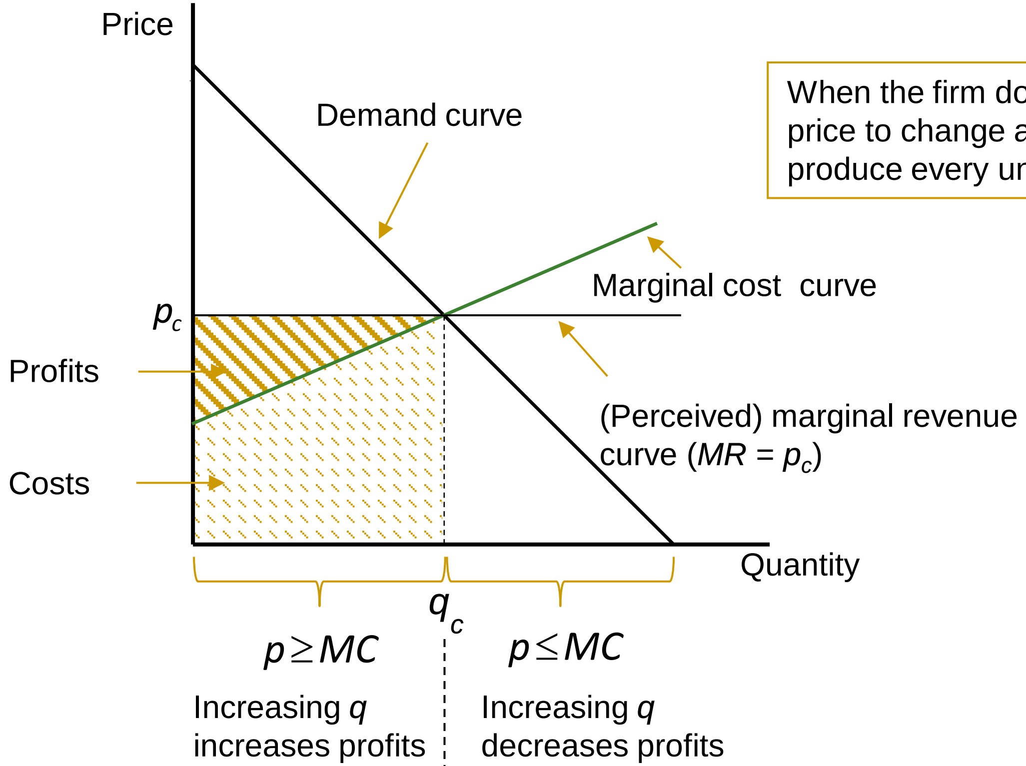
Quantity q	Price p	Revenue R	Marginal Revenue MR	Marginal Costs MC	Total Costs C	Profits Π
0	10.0	0.0			0.0	0.0
1	9.5	9.5	9.5	4.0	4.0	5.5
2	9.0	18.0	8.5	4.0	8.0	10.0
3	8.5	25.5	7.5	4.0	12.0	13.5
4	8.0	32.0	6.5	4.0	16.0	16.0
5	7.5	37.5	5.5	4.0	20.0	17.5
6	7.0	42.0	4.5	4.0	24.0	18.0
7	6.5	45.5	3.5	4.0	28.0	17.5
8	6.0	48.0	2.5	4.0	32.0	16.0
9	5.5	49.5	1.5	4.0	36.0	13.5
10	5.0	50.0	0.5	4.0	40.0	10.0
11	4.5	49.5	-0.5	4.0	44.0	5.5
12	4.0	48.0	-1.5	4.0	48.0	0.0
13	3.5	45.5	-2.5	4.0	52.0	-6.5
14	3.0	42.0	-3.5	4.0	56.0	-14.0
15	2.5	37.5	-4.5	4.0	60.0	-22.5
16	2.0	32.0	-5.5	4.0	64.0	-32.0
17	1.5	25.5	-6.5	4.0	68.0	-42.5
18	1.0	18.0	-7.5	4.0	72.0	-54.0
19	0.5	9.5	-8.5	4.0	76.0	-66.5
20	0.0	0.0	-9.5	4.0	80.0	-80.0



Perfect Market Equilibria

Competitive firms

- Competitive firms take prices as given
  - → Each individual firm perceives that its output decision does not affect the market-clearing price
  - This means that the firm acts as if $MR = p_c$



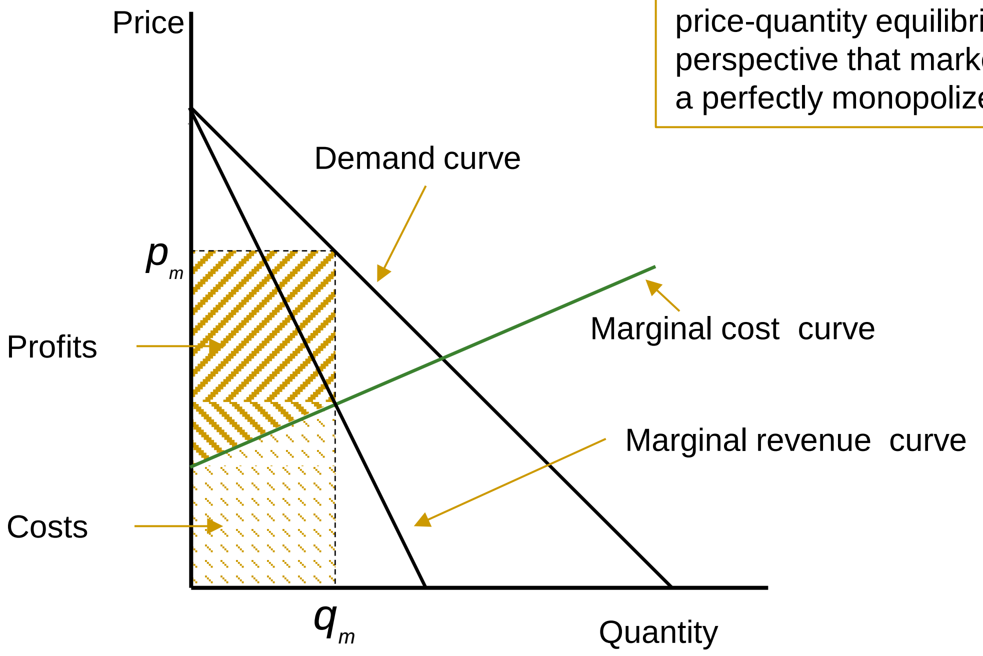
When the firm does not expect the market-clearing price to change as the firm expands output, the firm will produce every unit for which $p \geq MC$

Rule: As always, the FOC is $MR = MC$. If the firm is competitive, then $MR = p_c$ and so FOC is $p_c = MC$.

Monopolist Firm

- A monopolist choice of output *q* affects the market-clearing price *p*

Note: If firms are profit-maximizing, the worst price-quantity equilibrium from a consumer perspective that market can support is that of a perfectly monopolized market



Rule: Monopolists price at *MR* = *MC*, where marginal revenue is determined by the aggregate demand curve

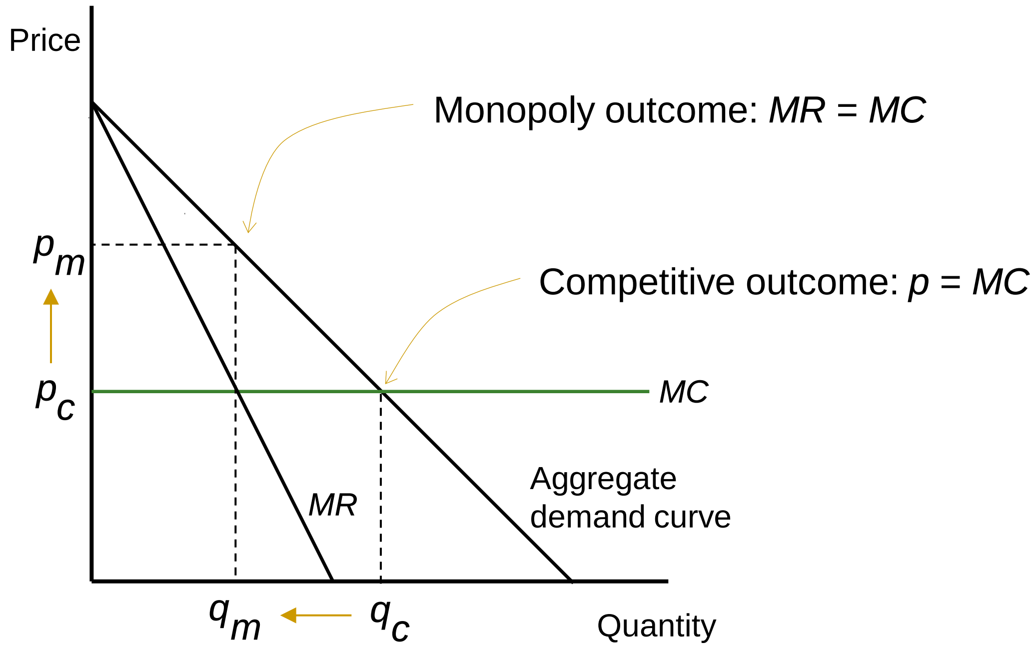
Public policy on monopolies

- Modern view on why monopolies are bad:
  - Increase price and decrease output
  - Shift wealth from consumers to producers
  - Create economic inefficiency ("deadweight loss")

  - May (or may not) have other socially adverse effects
    - Decrease product or service quality
    - Decrease the rate of technological innovation or product improvement
    - Decrease product choice

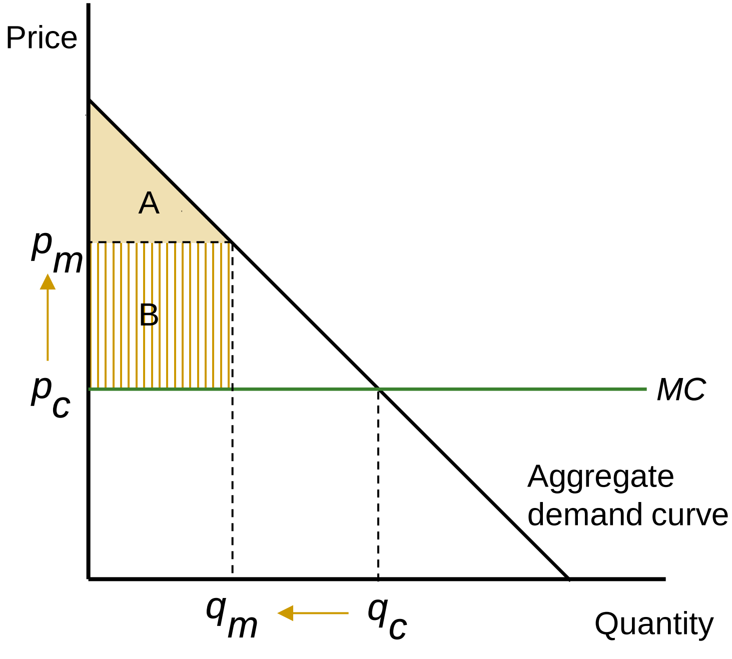
Public policy on monopolies

- Output decreases: $q_c > q_m$
- Prices increase: $p_c < p_m$



Public policy on monopolies

- Shift in wealth from inframarginal consumers to producers*
  - Total wealth created ("surplus"): A + B
  - Sometimes called a "rent redistribution"

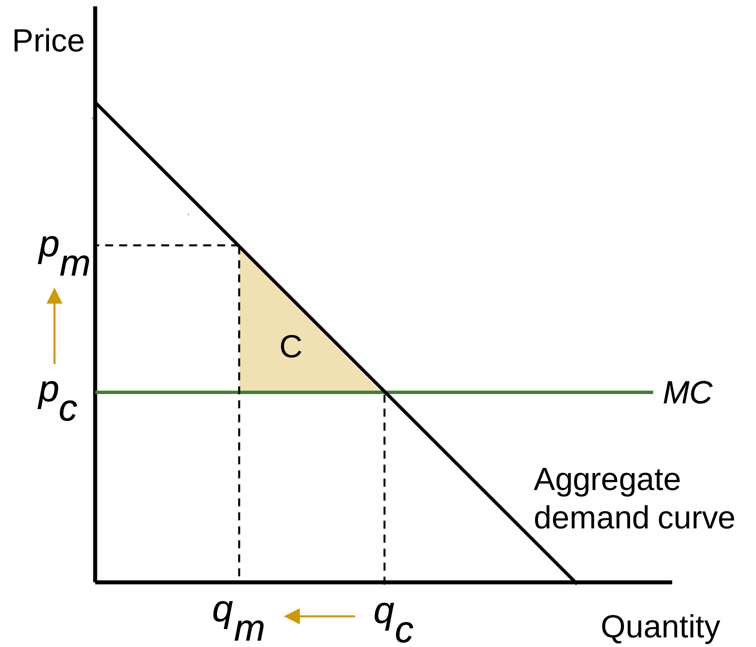


	Competitive	Monopoly
Consumers	A + B	A
Producers	0	B

* Inframarginal customers here means customers that would purchase at both the competitive price and the monopoly price

Public policy on monopolies

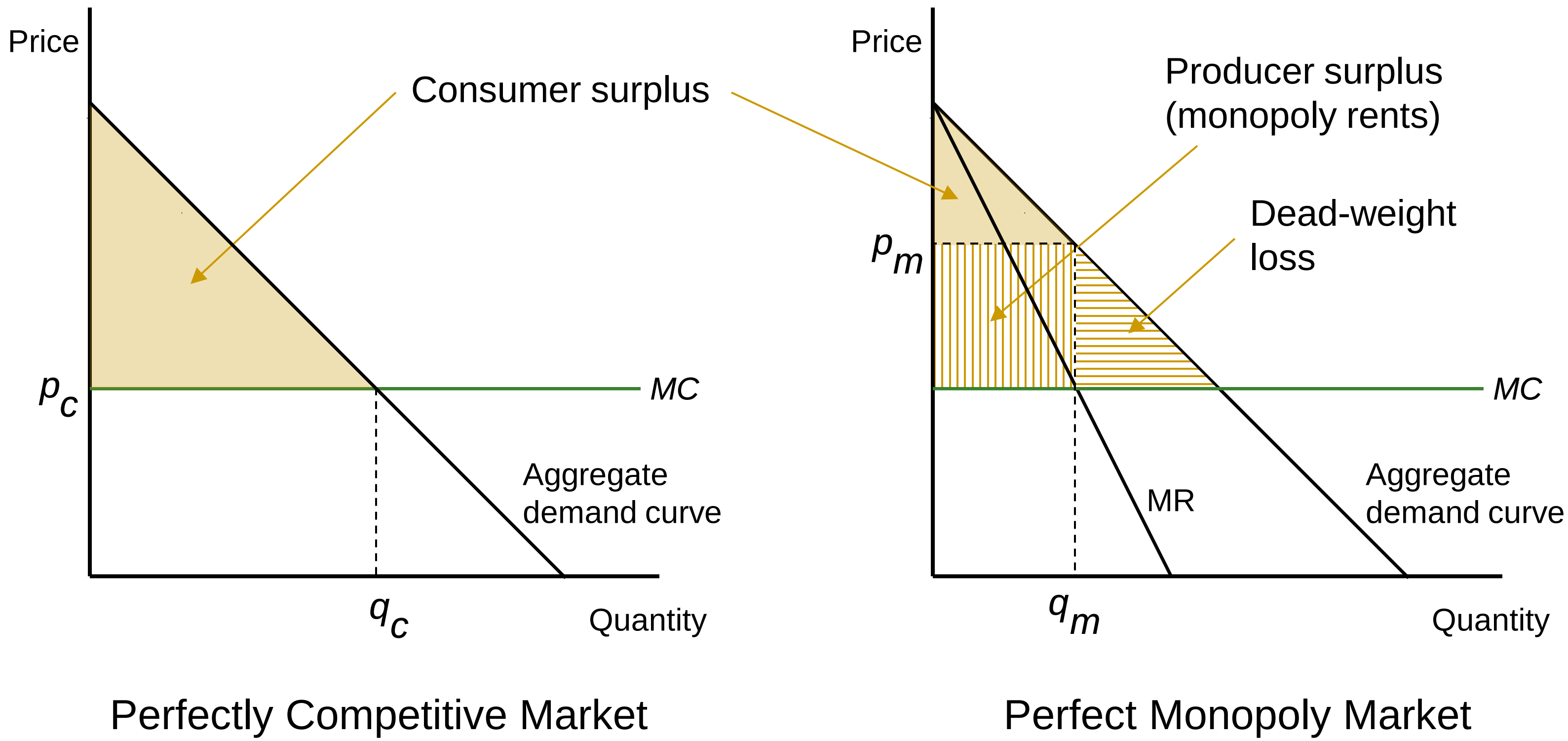
- “Deadweight loss” of surplus of marginal customers*
  - Surplus C just disappears from the economy
  - Creates “allocative inefficiency” because it does not exhaust all gains from trade



* Marginal customers here means customers that would purchase at both the competitive price and the monopoly price

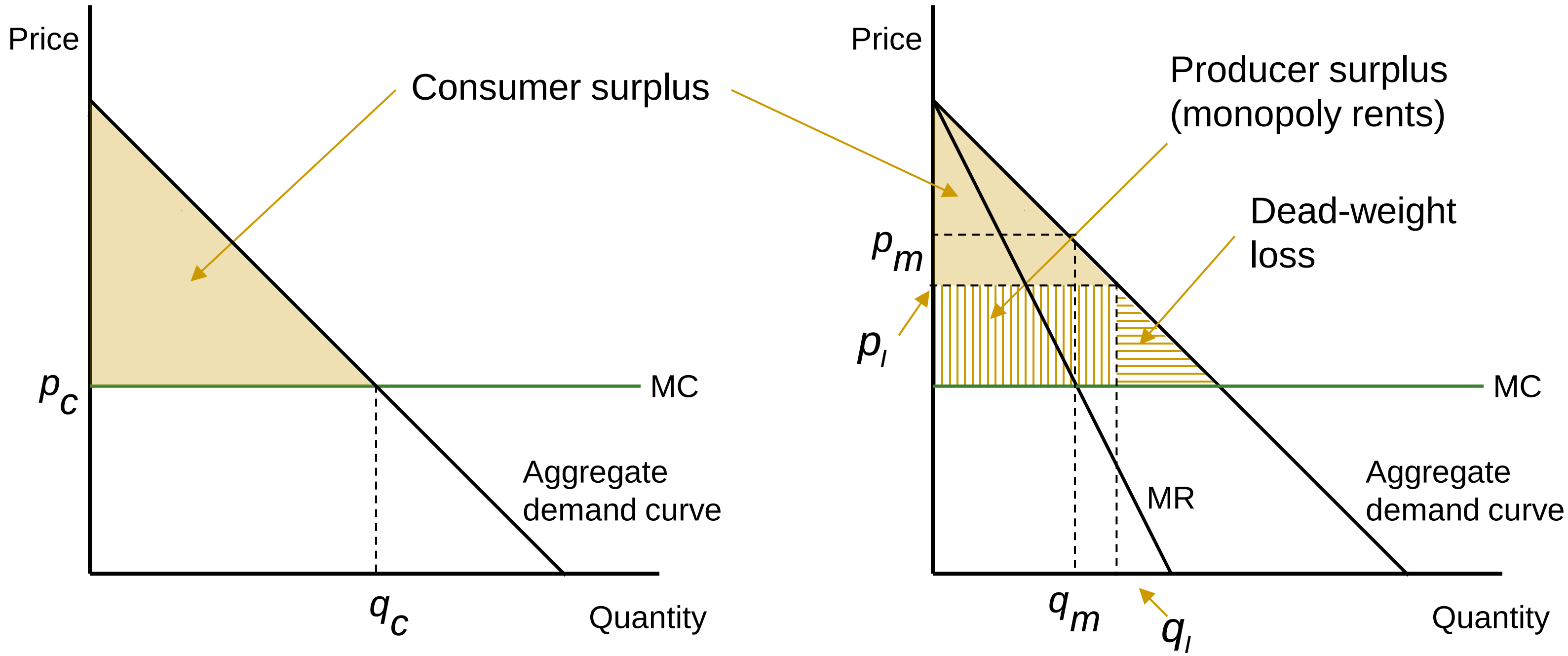
Public policy on monopolies

1. Shift in wealth from consumers to producers
2. Deadweight loss
3. May retard innovation



Oligopolies

- What if the merger does yields something less than a monopoly?
  - Can result in the shift of wealth and deadweight loss, only smaller in magnitude



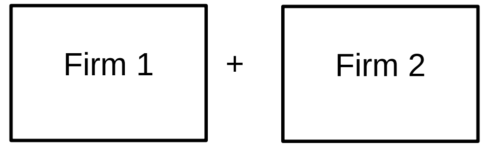
Perfectly Competitive Market

Oligopolistic Market

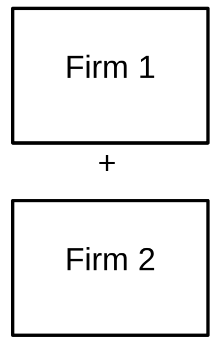
Merger Typology, Substitutes and Complements, and Elasticities

Merger typology

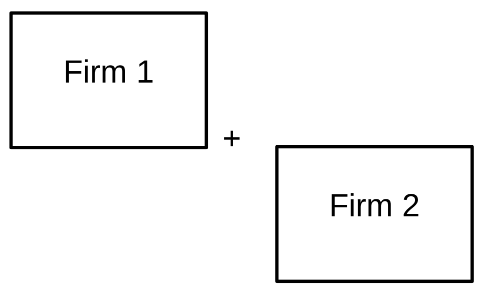
- Horizontal mergers



- Vertical mergers



- Conglomerate mergers



Substitutes/Complements

- Substitutes
  - Two products or services are *substitutes* if, when consumer demand increases for one product, it will decrease for the other product
    - *Horizontal mergers* involve combinations of firms that offer substitute products

$$\frac{\Delta q_2}{\Delta q_1} < 0 \qquad \text{So} \quad \overset{(-)}{\frac{\Delta q_2}{\Delta q_1}}\,\overset{(-)}{\frac{\Delta q_1}{\Delta p_1}} = \frac{\Delta q_2}{\Delta p_1} > 0$$

As price of product 1 increases, demand for product 2 increases

- Complements
  - Two products are *complements* if, when a consumer demand increases for one product, consumer demand also will increase for the other product
    - *Vertical mergers* involve complements
    - But some conglomerate mergers can also involve complements

$$\frac{\Delta q_2}{\Delta q_1} > 0 \qquad \text{So} \quad \overset{(+)}{\frac{\Delta q_2}{\Delta q_1}}\,\overset{(-)}{\frac{\Delta q_1}{\Delta p_1}} = \frac{\Delta q_2}{\Delta p_1} < 0$$

As price of product 1 increases, demand for product 2 decreases

Elasticities

- Elasticity of demand
  - *Problem*: Changes in the absolute quantities demanded can vary with changes in the unit of measure
    - *Example*: You get different numbers for the change in demand for razor blades with an increase in demand for razor if razor blades are measured in (a) units or (b) ounces
  - *Solution*: Find a measure of change that is dimensionless (free of units)
    - The percentage change in the quantity demanded for a given percentage change in price will do this. This is called an *elasticity of demand*.
    - The elasticity of demand will not change with a change in the unit of measure of either prices or quantities

Elasticities

- Own-elasticity of demand
  - *Definition*: The percentage change in the quantity demanded divided by the percentage change in the price of that *same* product.

$$\varepsilon = \frac{\dfrac{\Delta q_i}{q_i}}{\dfrac{\Delta p_i}{p_i}}$$

Percentage change q_i in the quantity of product *i* demanded

Percentage change p_i in the price of product *i*

- Using a little algebra:

$$\varepsilon = \frac{\dfrac{\Delta q_i}{q_i}}{\dfrac{\Delta p_i}{p_i}} = \frac{\Delta q_i}{\Delta p_i}\frac{p_i}{q_i}$$

1. Slope of the (residual) demand curve: Always negative

2. *Roughly* the change in revenues resulting from a quantity change

3. *Roughly* the change in revenues resulting from a price change

- Own-elasticities are *negative*, due to the downward-sloping nature of the demand curve

Elasticities

- Cross-elasticity of demand
  - *Definition*: The percentage change in the quantity demanded for product *j* divided by the percentage change in the price of product *i*.

$$\varepsilon_{ij} = \frac{\dfrac{\Delta q_j}{q_j}}{\dfrac{\Delta p_i}{p_i}}$$

Percentage change q_j in the quantity of product *j* demanded

Percentage change p_i in the price of product *i*

- Cross-elasticities are positive for substitutes and negative for complements

$$\varepsilon_{ij} = \frac{\dfrac{\Delta q_i}{q_i}}{\dfrac{\Delta p_j}{p_j}} = \frac{\Delta q_i}{\Delta p_j}\frac{p_j}{q_i}$$

Positive for substitutes
Negative for complements

Elasticities

NB: While helpful to guide the intuitions, these graphs are NOT correct for reasons explained below

- A convention
  - By convention, economists speak of elasticities in terms of their absolute values
- Some important definitions
  - *Inelastic demand*: Not very price sensitive

$$|\varepsilon| = \frac{\text{\%change in quantity}}{\text{\%change in price}} < 1$$

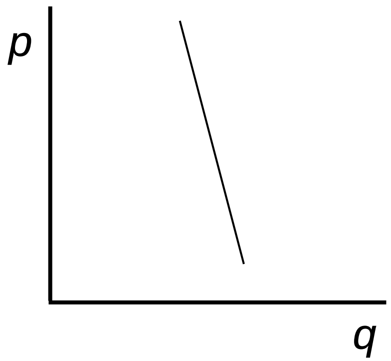
  - *Unit elasticity*:

$$|\varepsilon| = \frac{\text{\%change in quantity}}{\text{\%change in price}} = 1$$

  - *Elastic demand*: Price sensitive.

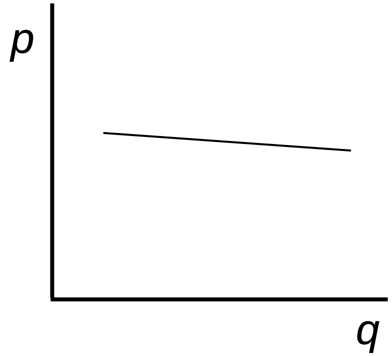
$$|\varepsilon| = \frac{\text{\%change in quantity}}{\text{\%change in price}} > 1$$

Very inelastic demand



Little sensitivity to price

Very elastic demand



Demand is very sensitive to price

Elasticities

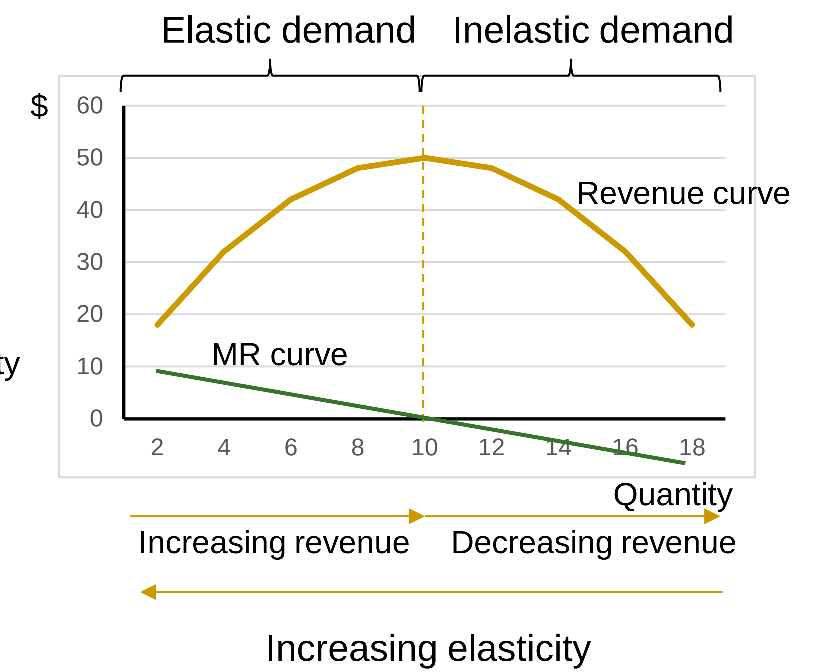
- Elasticity of demand—More definitions
  - Cross-elasticities
    - *High cross-elasticity of demand*:
      - A small change in the price of product *i* will cause a large shift of demand to product *j*
      - As a result, product *j* brings a lot of competitive pressure on product *i*
    - *Low cross-elasticity of demand*:
      - A large change in the price of product *i* will cause only a small shift of demand to product *j*
      - As a result, product *j* brings little competitive pressure on product *i*

Elasticities

- Elasticity of demand and the slope of the demand curve
  - Even when the demand curve is linear (so that the slope is constant), elasticity varies along the demand curve

Demand curve:
$p = 20 - 2q$

p	q	Slope	p/q	ε	Total revenue	
1	18	-2	0.0556	-0.1111	18	Inelastic demand
2	16	-2	0.1250	-0.2500	32	
3	14	-2	0.2143	-0.4286	42	
4	12	-2	0.3333	-0.6667	48	
5	10	-2	0.5000	-1.0000	50	Unit elasticity
6	8	-2	0.7500	-1.5000	48	Elastic demand
7	6	-2	1.1667	-2.3333	42	
8	4	-2	2.0000	-4.0000	32	
9	2	-2	4.5000	-9.0000	18	

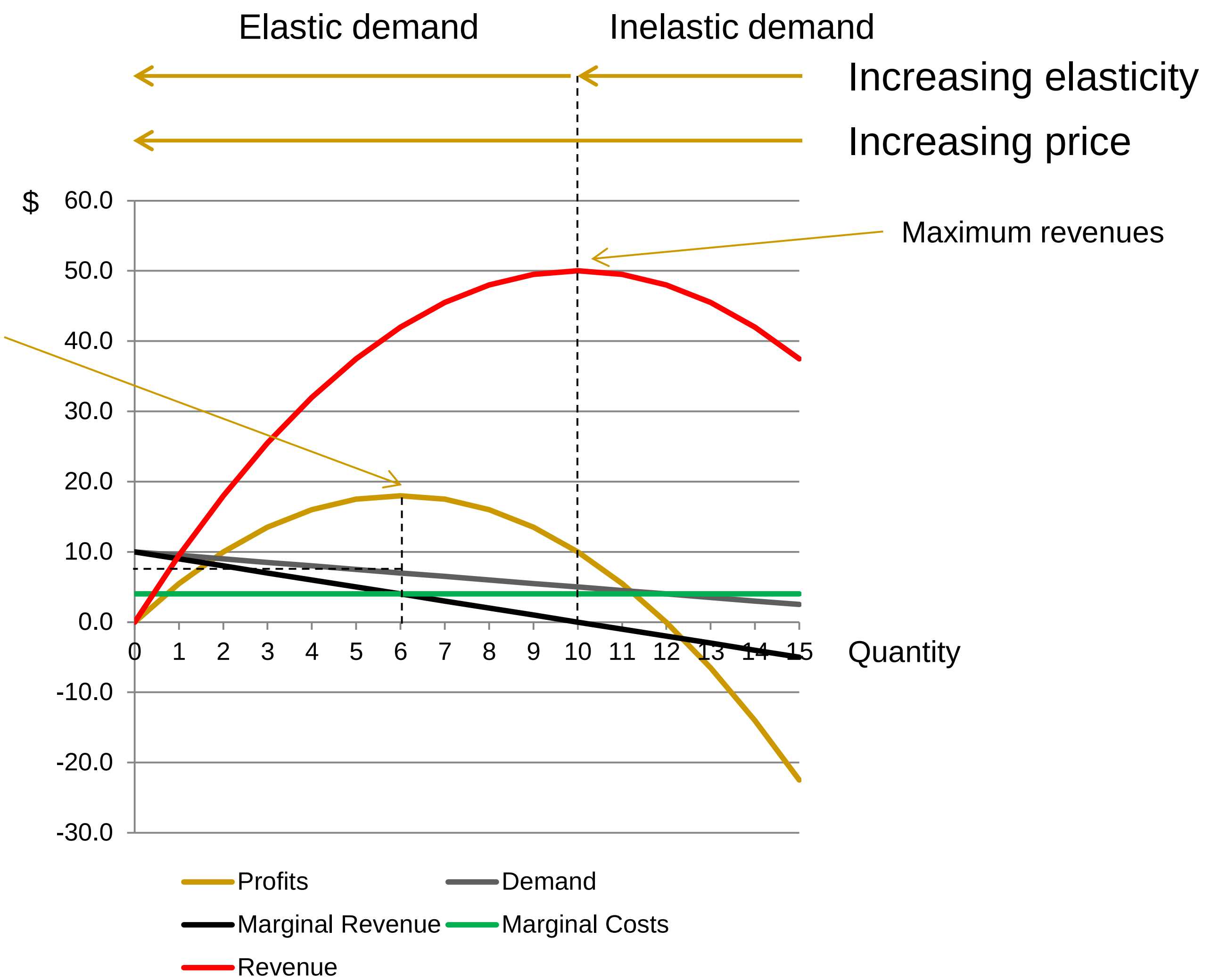


General rules:

Elasticity decreases as quantiles increase and prices decrease

Elasticity increases as quantities decrease and prices increase

Elasticities



Elasticities

- Relation of the residual demand elasticity to the aggregate demand elasticity
  - *Rule*: In a market of n identical firms, a single firm's own-price elasticity is equal to n times the aggregate demand own-elasticity

$$\varepsilon_i = n\varepsilon,$$

where ε is the market elasticity and ε_i is the firm i's residual own-elasticity

Elasticities

- Relationship between own- and cross-elasticities
  - *Rule*: The own-elasticity of demand for product *i* is a function of the sum of the cross-elasticities of all of the other products weighted by their relative market shares (measured by revenue)

$$-\varepsilon_{11} = 1 + \sum_{i=2}^{n} \varepsilon_{i1} \frac{s_i}{s_1}$$

Market Power

Market power

- Some definitions
  - Market power
    - "As an economic matter, market power exists whenever prices can be raised above the levels that would be charged in a competitive market."[1]
    - "Market power is usually stated to be the ability of a single seller to raise price and restrict output, for reduced output is the almost inevitable result of higher prices."[2]
    - "Market power generally is defined as the power of a firm to restrict output and thereby increase the selling price of its goods in the market."[3]
    - Market power means "by definition, means that the defendant can produce anticompetitive effects."[4]
    - "A merger enhances market power if it is likely to encourage one or more firms to raise price, reduce output, diminish innovation, or otherwise harm customers as a result of diminished competitive constraints or incentives."[5]

[1] Jefferson Parish Hosp. Dist. No. 2 v. Hyde, 466 U.S. 2, 27 n.46 (1984); *accord* NCAA v. Board of Regents, 468 U.S. 85, 109 n.38 (1984); Copperweld Corp. v. Independence Tube Corp., 467 U.S. 752, 789 n.19 (1984).
[2] Fortner Enters., Inc. v. United States Steel Corp., 394 U.S. 495, 503 (1969)
[3] Ryko Mfg. Co. v. Eden Servs., 823 F.2d 1215, 1232 (8th Cir. 1987).
[4] Agnew v. National Collegiate Athletic Ass'n 683 F.3d 328, 337 (7th Cir. 2012)
[5] U.S. Dept. of Justice & Fed. Trade Comm'n, Horizontal Merger Guidelines § 1 (rev. 2010).

Market power

- Measuring market power
  - Recall that in a competitive market, firms set price equal to marginal cost
  - The traditional measure of market power is the *price-cost margin* or *Lerner index L*, which is a measure of how much price has been marked up:

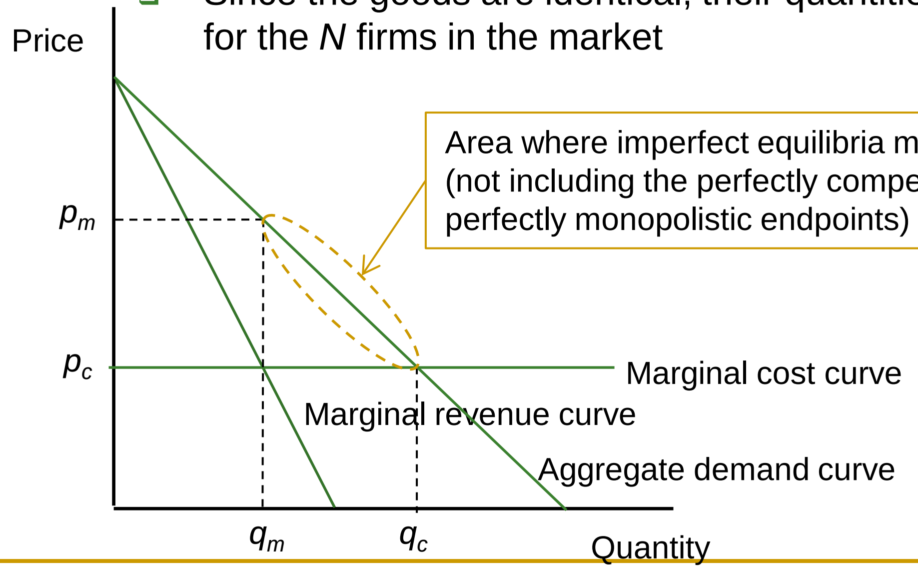
$$L = \frac{p - MC}{p}$$

  - Note that in a competitive market $L = 0$ (because *p* = *MC*)and that *L* increases as price increases relative to marginal cost

Imperfectly Competitive Market Equilibria

Homogeneous product models

- Range of imperfect equilibria in homogeneous product models
  - Assumes that products are undifferentiated (that is, *fungible* or *homogeneous*) in the eyes of the customer
    - *Common examples*: Ready-mix concrete, winter wheat, West Texas Intermediate (WTI) crude oil, wood pulp
    - Two properties of homogeneous products
      - Customers purchase from the lowest cost supplier → This forces all suppliers in the market to charge the same price
      - Since the goods are identical, their quantities can be added: Aggregate demand $Q = \sum_{i=1}^{N} q_i$ for the N firms in the market



Cournot oligopoly models

- The setup
  - The standard homogenous product model is the *Cournot model*
  - Recall that in a Cournot model the firm's control variable is *quantity*
    - The (download sloping) demand curve gives the relationship between the aggregate quantity produced Q and the market-clearing price p

$$p = p(Q), \text{ where } Q = \sum_{i=1}^{N} q_i,$$

  - The profit equation for firm I is:

$$\pi_i = p(Q)q_i - c_i(q_i), \quad i = 1,2,...N$$

Cournot oligopoly models

- Two important results
  - The firm's Lerner index

$$\lambda_i = \frac{p - mc_i}{p} = \frac{s_i}{\varepsilon}$$

where s_i is the market share of firm i

  - The market Lerner index:

$$\lambda = \sum_{i=1}^{N} \frac{p - c_i'}{p} s_i = \sum_{i=1}^{N} \frac{s_i^2}{\varepsilon} = \frac{HHI}{\varepsilon}$$

where λ is the market-share weighted sum of the λ_I of the individual firms in the market

Cournot oligopoly models

- Production levels in Cournot models
  - A simple example
    - Compare the competitive, Cournot, and monopoly outcomes in this example
      Demand curve: $Q = 100 - 2p$

	Price	Quantity
Perfectly competitive	5 (= mc)	90
Cournot	20	60
Perfect monopoly	27.5	45

  - When demand is linear and there are n identical firms in a Cournot model, then:

$$Q_{Cournot} = \frac{n}{n+1} Q_{Competitive}$$

  - When $n = 1$:

$$Q_{Cournot} = \frac{Q_{Competitive}}{2} = Q_{Monopoly}$$

Bertrand oligopoly models

- Homogeneous products case
  - Consider two firms producing homogeneous (identical) products at constant marginal cost *c* and use price as their control variable
  - Consumers also purchase from the lower priced firm; if both firms charge the same price, they split equally consumer demand
  - Consumer demand *Q* is a function of $\underline{p}$, the lowest price offered by a firm in the market
  - So if—
    - $p_1 < p_2$, , then $p_1 = \underline{p}$ and firm 1 sells all of consumer demand $Q(\underline{p})$ and firm 2 sells nothing and earns zero profits

$$\pi_1 = \underline{p}Q - C(Q),$$

    - $p_1 = p_2$, then $p_1 = p_2 = \underline{p}$ firm 1 and firm 2 each sell one-half of consumer demand $Q(p)$ for profits

$$\pi_i = \frac{\underline{p}Q - C(Q)}{2}.$$

  - *Equilibrium*: $p_1 = p_2 = \underline{p} = mc$, so that both firms price at marginal cost and split equally market demand and total market profits

Bertrand oligopoly models

- Differentiated products case
  - When products are differentiated, a lower price charged by one firm will not necessarily move all of the market demand to that firm
    - Consider a market with only red cars and blue cars.
    - Some consumers like blue cars so much that even if the price of red cars is lower than the price of blue cars there will still be positive demand for blue cars
    - Moreover, if the price of blue cars increases, some (inframarginal) blue car customers will purchase blue cars at the higher price while some (marginal) customers will switch to red cars
    - This means that the demand for red cars (and separately for blue cars) is a function both of the price of red cars and the price of blue cars
    - It also means that the price of blue cars may not equal the price of red cars in equilibrium

Bertrand oligopoly models

- Differentiated products case
  - Simple linear model
    - Firms 1 and 2 produce differentiated products and face the following residual demand curves:

$$q_1 = a - b_1 p_1 + b_2 p_2$$
$$q_2 = a - b_1 p_2 + b_2 p_1$$

NB: Each firm's demand decreases with increase in its own price and increases with increases in the price of the other firm

Assume that $b_1 > b_2$, so that each firm's residual demand is more sensitive to its own price than to the other firm's price

    - Assume each firm has a cost function with no fixed costs and constant marginal costs:

$$c_i(q_i) = cq_i$$

    - Firm 1's profit-maximization problem:

$$\max_{p_1} \pi_1 = (p_1 - c)(a - b_1 p_1 + b_2 p_2)$$

NB: This formulation does not take into account firm 2's reaction to a change in firm 1's price

    - Bertrand equilibrium:

$$p_1^* = p_2^* = \frac{a + cb_1}{2b_1 - b_2}$$

Dominant firm with a competitive fringe

- The setup
  - Consider a homogeneous product market with
    - a dominant firm, which sees its output decisions as affecting price and so sets output so that $mr = mc$, and
    - a fringe of firms that are small and act as price takers, that is, they do not see their individual choices of output levels as affecting price and therefore price as competitive firms (i.e., $p = mc$)
  - Choice question for the dominant firm: Pick the profit-maximizing level for its output given the competitive fringe
    - The model requires some constraint on the ability of the competitive fringe to expand it output. Otherwise, the competitive fringe will take over the market.
    - The constraint usually is either limited production capacity or increasing marginal costs

Dominant firm with a competitive fringe

- The model
  - At market price p, let $Q(p)$ be the industry demand function and $q_f(p)$ be the output of the competitive fringe. Then the residual demand $q_d(p)$ for the dominant firm is $Q(p) - q_f(p)$.
  - The dominant firm's profit maximization problem:

$$\max_p \pi_D = p \times \left[Q(p) - q_f(p) \right] - C\left(q(p) \right)$$

The dominant firm does not control market price directly, it in this model it can determine the price at which it would maximize its profits, and then back out the quantity it should produce using the aggregate demand function