REVIEW SESSION SLIDES

# 8. Basic Competition Economics

Merger Antitrust Law

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# Central questions

1. How does a firm price its product and choose its level of production?
2. What are the social welfare implications of these determinations?
3. How can firms coordinate their behavior—through a price-fixing agreement or a merger—to increase their aggregate profits?
4. Why is competitive pricing socially better than monopoly pricing?

# Price formation models

- Standard assumptions in the neo-classical model
  - Consumers
    - Individually maximize preferences (utility) subject to their individual budget constraints
    - Yields a consumer demand function, which gives the quantity demanded $q_i^{demanded}$ by consumer *i* for a given market price *p*
  - Firms
    - Individually maximize profits subject to their available production technology (production possibility sets)
    - Yields a production function that gives the quantity produced $q_j^{produced}$ by firm *j* for a given market price *p*
  - Equilibrium condition
    - No price discrimination (all purchases are made at the single market price)
    - Market clears at the market price (i.e., demand equals supply):

$$\sum_i q_i^{demanded} = \sum_j q_j^{produced}$$

> $\sum$ simply means to add up the *q*'s. So if $q_1 = 10$. $q_2 = 7$, and $q_3 = 5$, then $\sum q_i = 10 + 7 + 5 = 22$.

# Consumers

- Consumers and demand curves
  - Demand curves
    - At a price $p_1$ for product 1 a given consumer will demand a quantity $q_1$ of that product
    - A consumer's individual *demand curve* for product 1 is the collection of the pair of points ($p_1$, $q_1$) that is generated by varying the price of product 1 while holding the prices of all other products constant gives the demand $q_1$ for product 1 at that price
    - *Law of demand*. A consumer will demand less of a product as that product's price increase, which results in a downward sloping demand curve
    - *The aggregate demand curve* is the sum of the demand curves of the individual consumers. Aggregate demand curves are downward sloping
      - A *demand function* is the mathematical relationship that describes the demand curve
      - The aggregate demand functions we will use in this course will be linear: $q = a + bp$

# Demand curves

- Demand curves and inverse demand curves
  - An *inverse demand curve* gives price as a function of quantity
  - So if the demand curve is $q = a + bp$, the inverse demand curve can be derived by solving for $p$:
    - *Example*: If the demand curve is $q = 20 - 2p$, the inverse demand curve is:

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

  - Think about the inverse demand curve as the price necessary to *clear the market* given production level $q$
    - "Clear the market" means that consumers demand no more and no less than $q$ at price $p$

# Demand curves

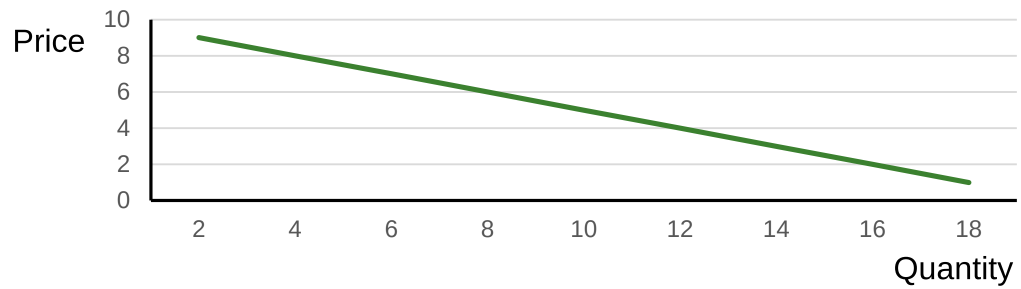
*Demand*: The total quantity $q$ customers are willing to purchase at a price $p$
*Demand curve*: Traces the relationship between $q$ and $p$

Demand Curve

$$q = 20 - 2p$$


Inverse Demand Curve

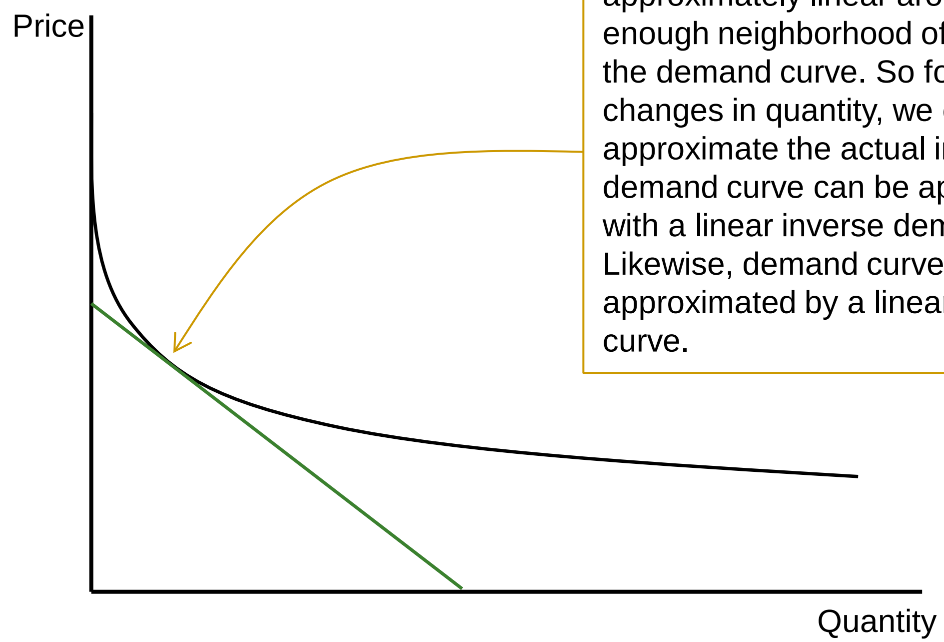
$$p = \frac{20-2q}{2} = 10 - \frac{1}{2}q$$




*Query*: Why is the demand curve downward sloping?

# Demand curves

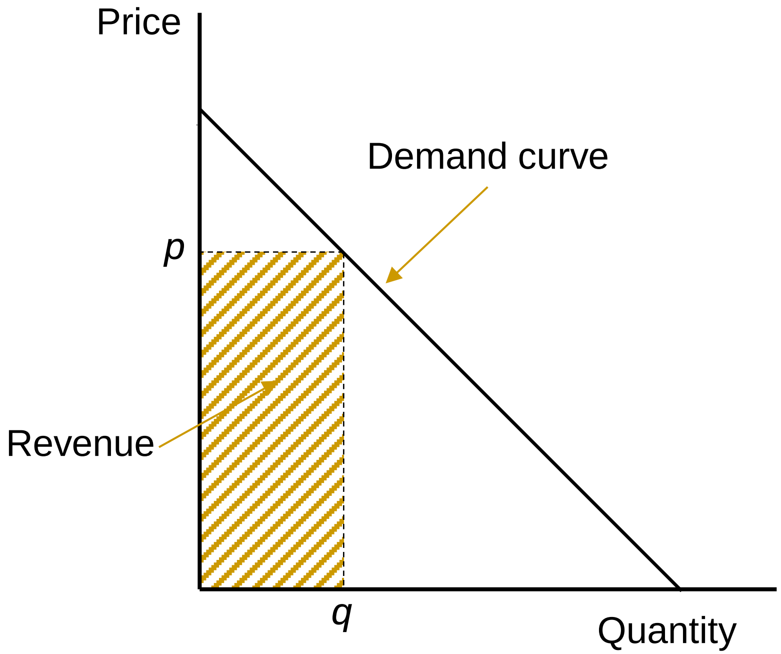
- Example: Nonlinear inverse demand curve with no x-axis intercept




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 (= $pq$)



# Revenues and marginal revenues

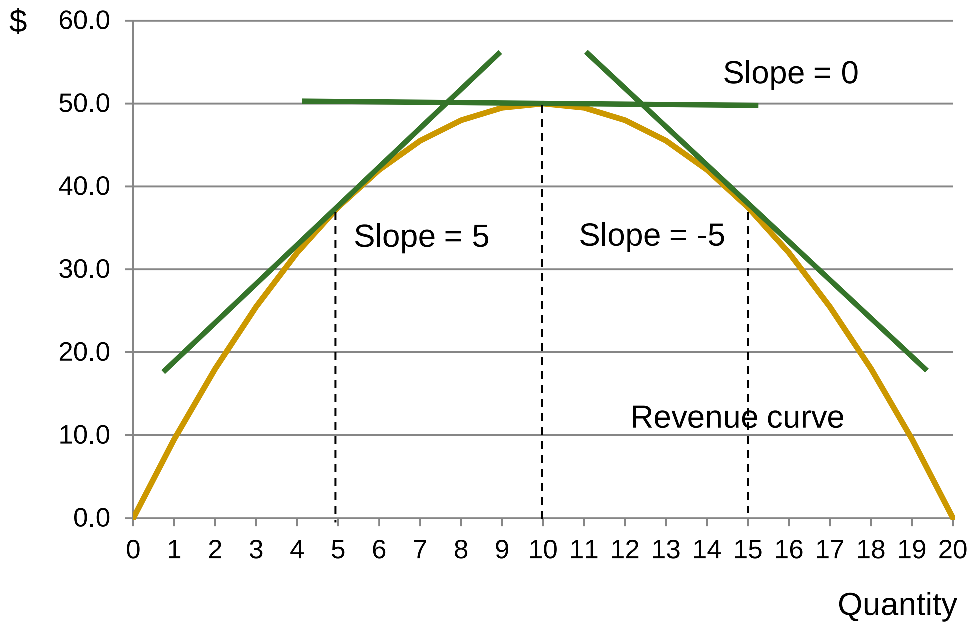
- *Marginal revenue*: The net additional revenue the firms earns by increasing its output by one unit
  - *Note*: If the firm faces a downward sloping demand curve, marginal revenue will be less than price—the market price will have to decrease after adding the incremental output in order to clear the market
    - This lower price will apply to preexisting sales as well as incremental sales

# Revenues and marginal revenues

- *Example:*
  - Demand curve: $q = 20 - p$
  - 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




  - Marginal revenue at *q* is simply the slope of the demand curve at *q*

# Marginal revenues

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

or equivalently

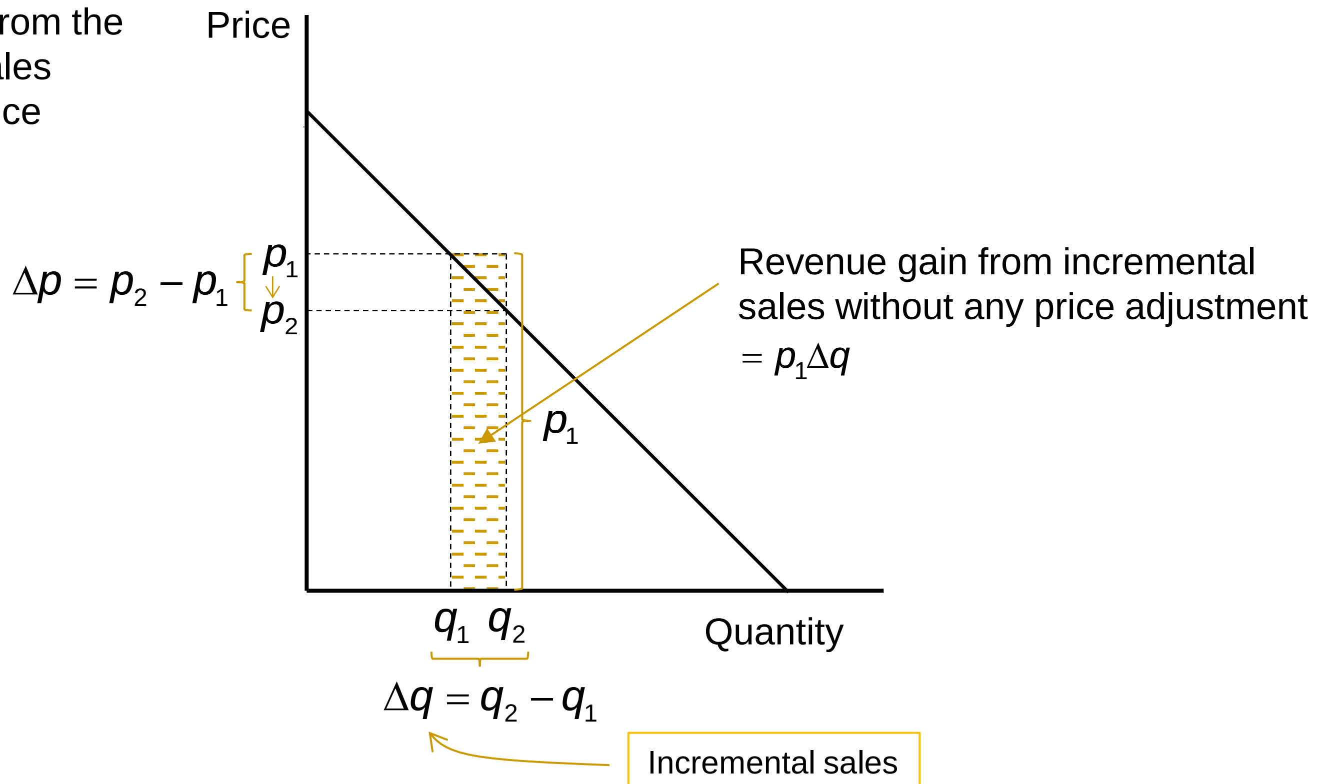
= the revenue gain from incremental sales (the sale of one additional unit)
– revenue loss from lower price on preexisting sales

The next three slides demonstrate this

# Marginal revenues

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

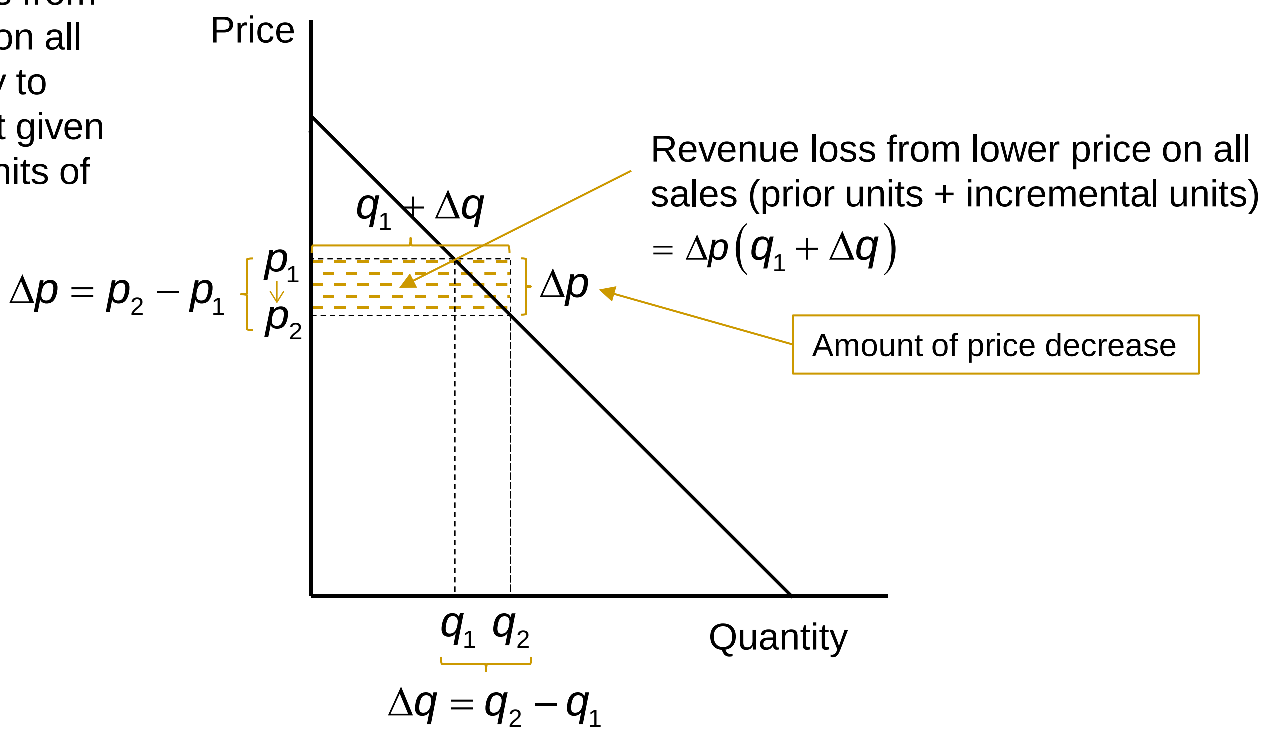
**Step 1.** Look first at the revenue gain from the incremental sales without any price adjustment:



# Marginal revenues

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

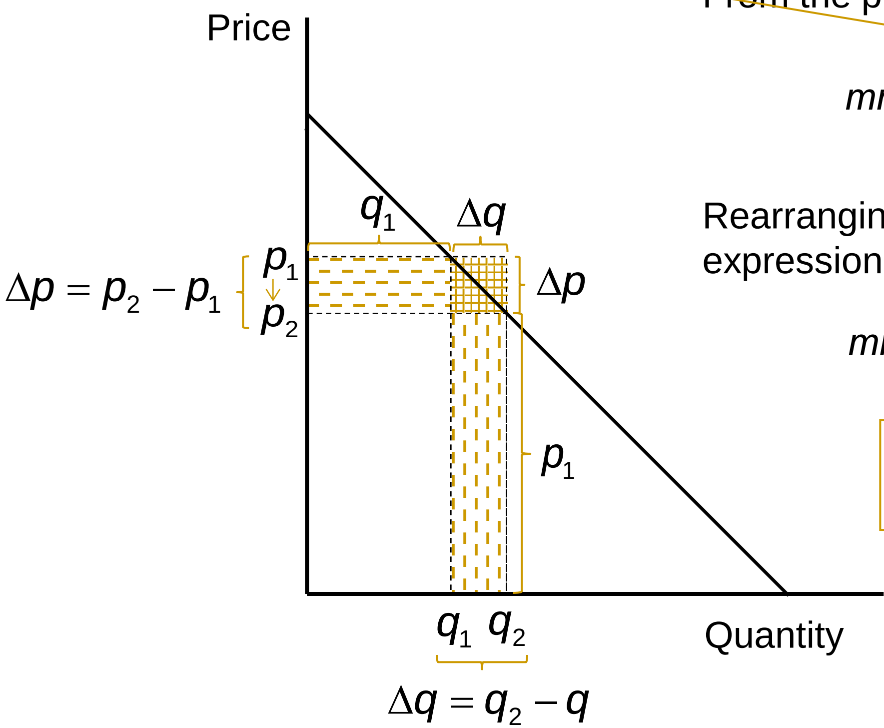
**Step 2**. Now look at the revenue loss from decrease price on all sales necessary to clear the market given the additional units of output



# Marginal revenues

*Marginal revenue (mr)* = The revenue gain from the incremental sales without any price adjustment
– the revenue loss from decrease 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:

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

Rearranging for an alternative but equivalent expression:

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

Revenue gain from lower price on *incremental* sales

Revenue loss from lower price on *preexisting* sales

# 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

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

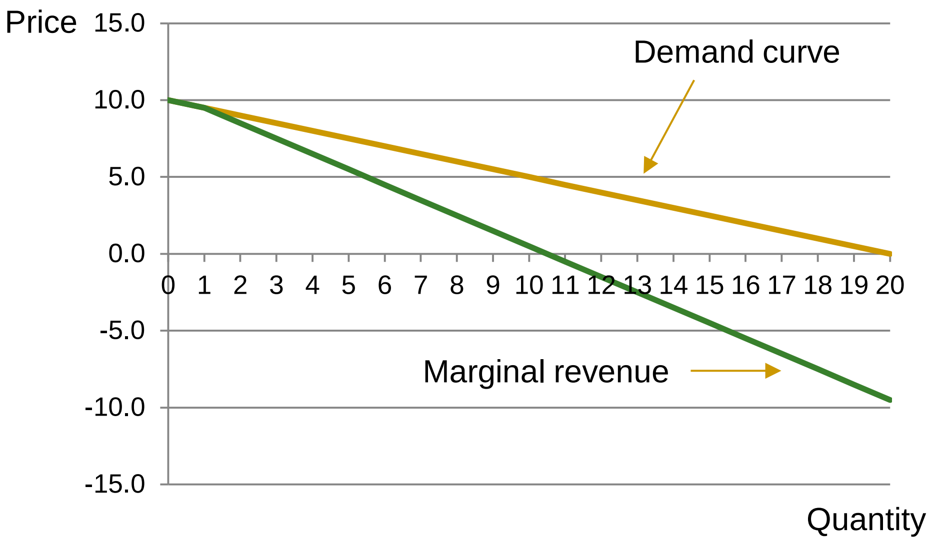
# Revenues and marginal revenues

- Linear (inverse) demand curves
  - If $p = a + bq$ is the inverse demand curve, then
  - $R = pq = (a + bq)q = aq + bq^2$
  - *Rule*: Marginal revenue is then $mr = a + 2bq$
    - If you know calculus, marginal revenue is the derivative of the revenue function
    - If you do not know calculus, you should just memorize the result

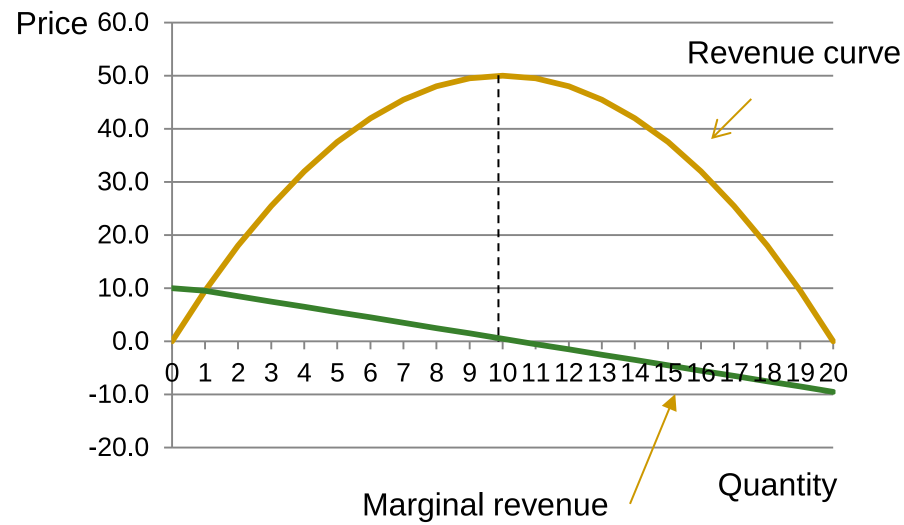
# Revenues

- Graphing revenue and marginal revenue curves
  - Inverse demand: $p = 10 - \frac{1}{2}q$

Demand and Marginal Revenue




Revenue and Marginal Revenue




Notes:

1. When demand is linear, the slope of the marginal revenue curve is twice as steep as the demand curve. This means that marginal revenue crosses the *x*-axis at half of the distant to where the demand curve crosses the *x*-axis. In the first chart, the marginal revenue curve crosses the x-axis at 10, half of the distance to where the demand crosses the *x*-axis at 20.
2. When marginal revenue equals zero (here, a $q$ = 10), revenues are at their maximum.

# Costs

- Some basic terms
  - *Revenues* (*R*(*q*))
    - Price (*p*) times quantity (*q*) sold
    - Evaluated at a production level *q*
  - *Marginal revenue (mr)*: The net additional revenues that would be earned if the firm produced an additional unit
    - If the firm faces a downward-sloping demand curve for its product, the production of an additional unit will require a decrease in price in order to clear the market of the larger volume
    - Marginal revenue may be positive or negative

# Costs

- Some basic terms
  - *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
    - $mc(q) = C(q+1) + C(q)$

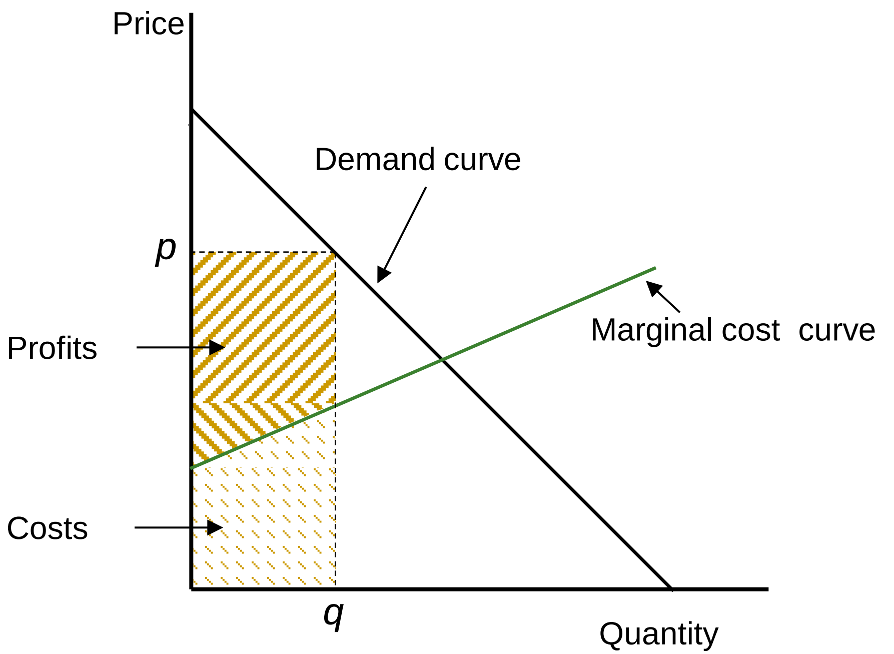
# Costs

- 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:

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

# Marginal costs

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




$$c(q) = \sum_{i=1}^{n} mc_i$$

+ *f* if there are fixed costs

*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

- A firm maximizes its profits when it sets its production level so that its marginal revenues equal its marginal costs
  - The idea
    - A firm maximizes its profits at a production level $q^*$ when its profits decrease when it either produces more or less units than $q^*$
    - Let $\Delta q$ be a change in the firm's production level from $q^*$. Then:

$$\pi(p^*) > \pi(p^* + \Delta q)$$

where $\Delta q$ may be either positive or negative

    - Let $m\pi(\Delta q)$ be the incremental profits the firm earns by changing its production level by $\Delta q$. Then:

$$\pi(q^* + \Delta q) = \pi(q^*) + m\pi(q^* + \Delta q)$$

    - These two equations imply:

$$\pi(q^* + \Delta q) - \pi(q^*) = m\pi(q^* + \Delta q) < 0$$

# Profit maximization

- A firm maximizes its profits when it sets its production level so that its marginal revenues equal its marginal costs
  - The idea
    - Now profits equal revenues minus costs, so marginal profits equal marginal revenues minus marginal costs:

$$m\pi(q^* + \Delta q) = mr(q^* + \Delta q) - mc(q^* + \Delta q) < 0$$

The inequality comes from the prior equation

    - The only time when this inequality does not hold is when $\Delta q = 0$, so that:

$$mr(q^*) = mc(q^*)$$

  - The calculus version
    - The firm's profit maximization function:

$$\max_q \pi(q) = R(q) - C(q)$$

Where $p(q)$ is function that expresses $p$ as a function of $q$ (i.e., the inverse demand function)

    - Obtain the first order condition by setting the derivative of the profit function to zero:

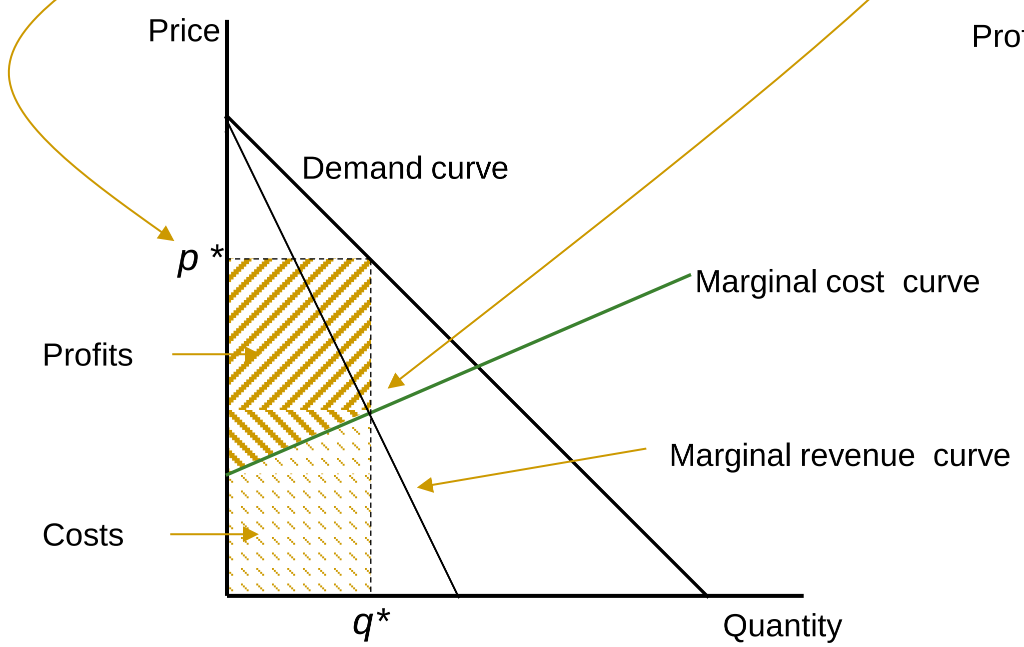
$$\frac{d\pi}{dq} = \frac{dR}{dq} - \frac{dC}{dq} = 0 \Rightarrow mr(q^*) = mc(q^*)$$

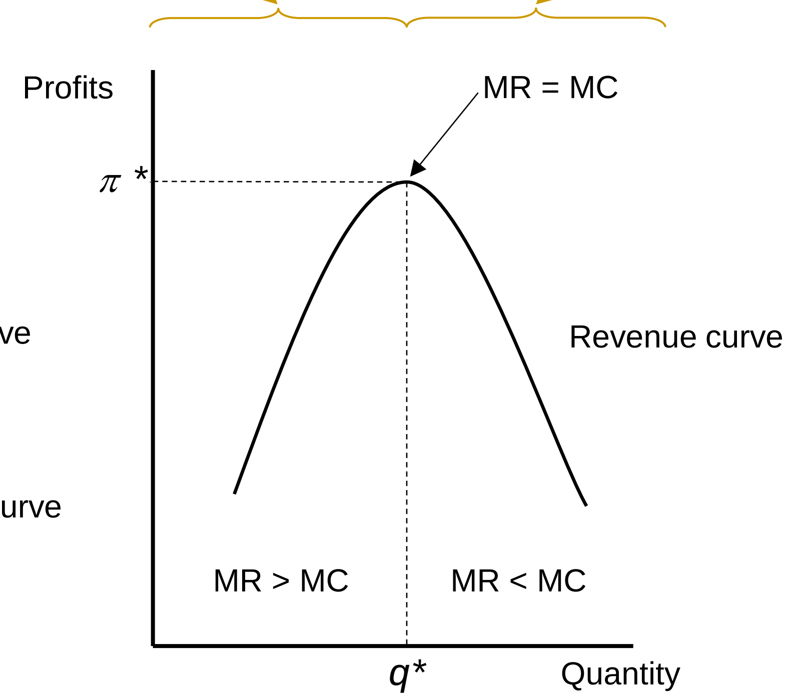
# Profit maximization

- Firms maximize profits when *mr = mc*
  - *Step 1*: Find the q* where marginal revenue equals marginal cost
  - *Step 2*: find p* for q* from the inverse demand curve

Firm can make more profits by increasing *q*, since incremental revenue gains exceed incremental costs

Firm can make more profits by decreasing *q*, since incremental costs exceed incremental revenue gains



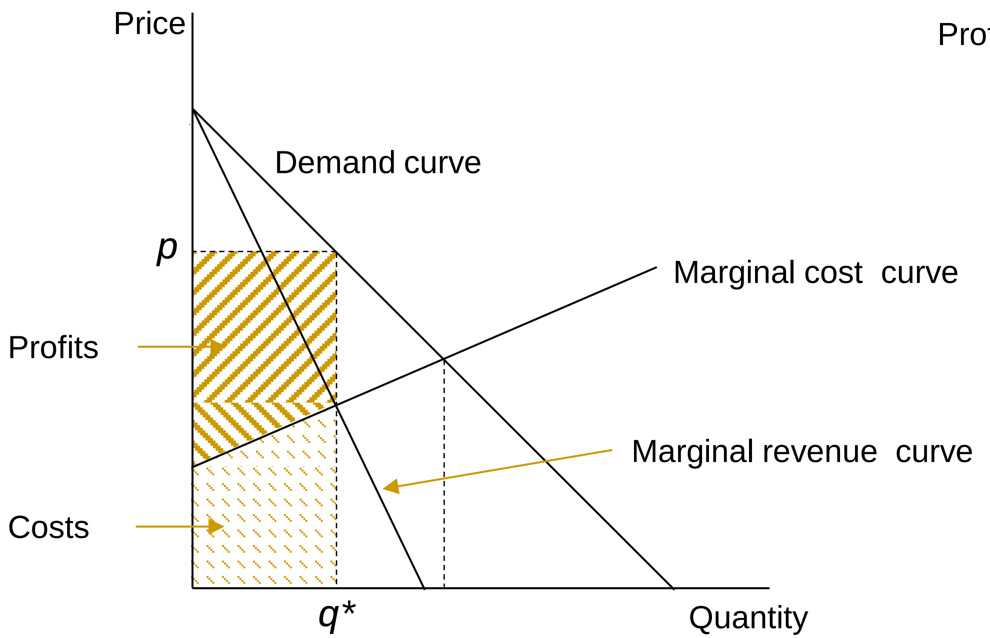
# Profit maximization

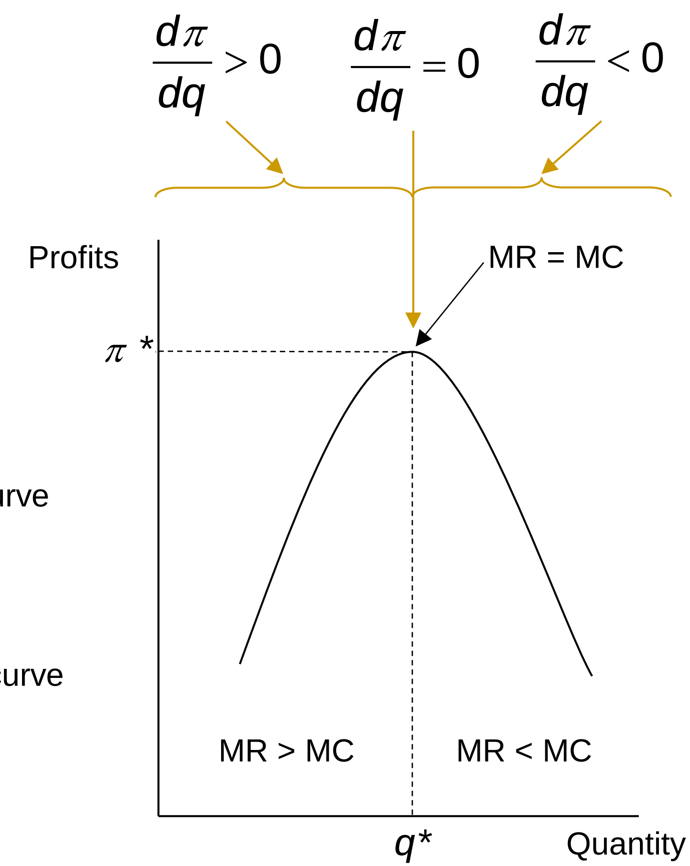
- The calculus version

Profits = Revenues - Costs

$$\max_q \pi(q) = R(q) - C(q)$$

$$\frac{d\pi}{dq} = \frac{dR}{dq} - \frac{dC}{dq} = 0$$

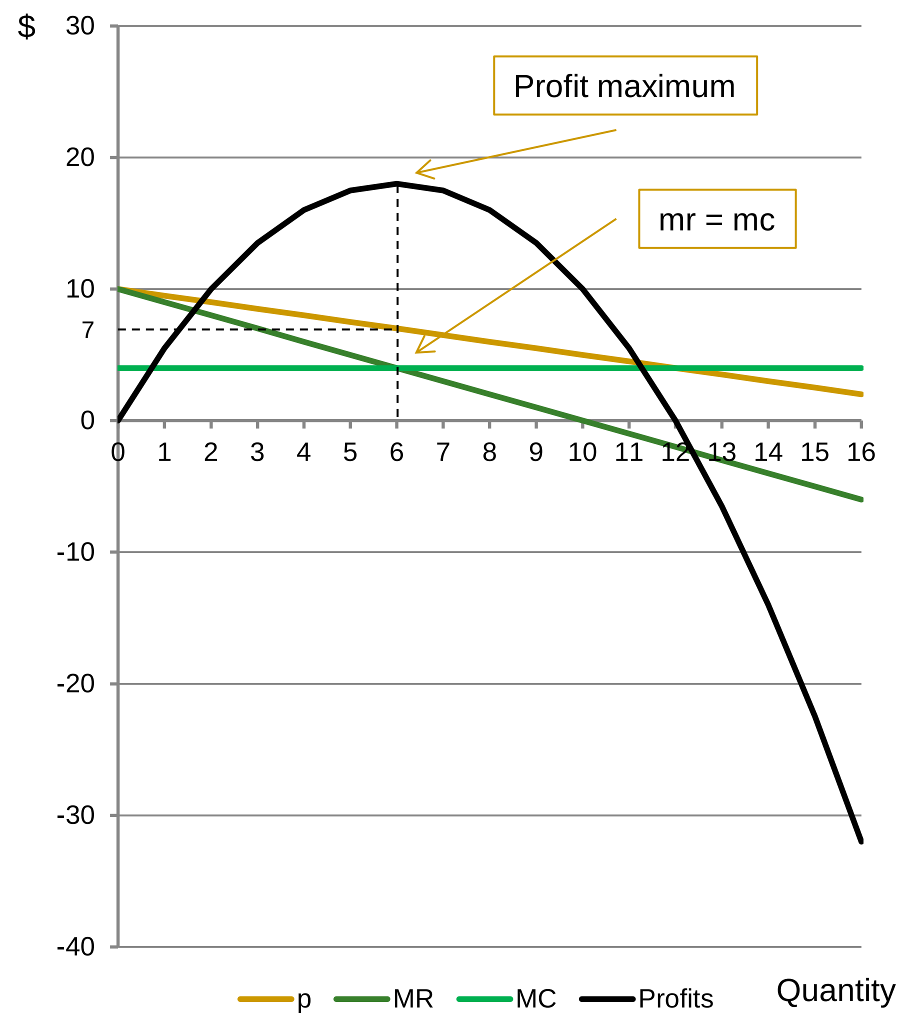


# Profit maximization

- 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 |



# Profit maximization

- Example (calculus version):

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

Revenue: $r = pq = 10q - \frac{1}{2}q^2$

Marginal revenue: $mr = \frac{dr}{dq} = 10 - q$

Marginal cost: $mc = 4$

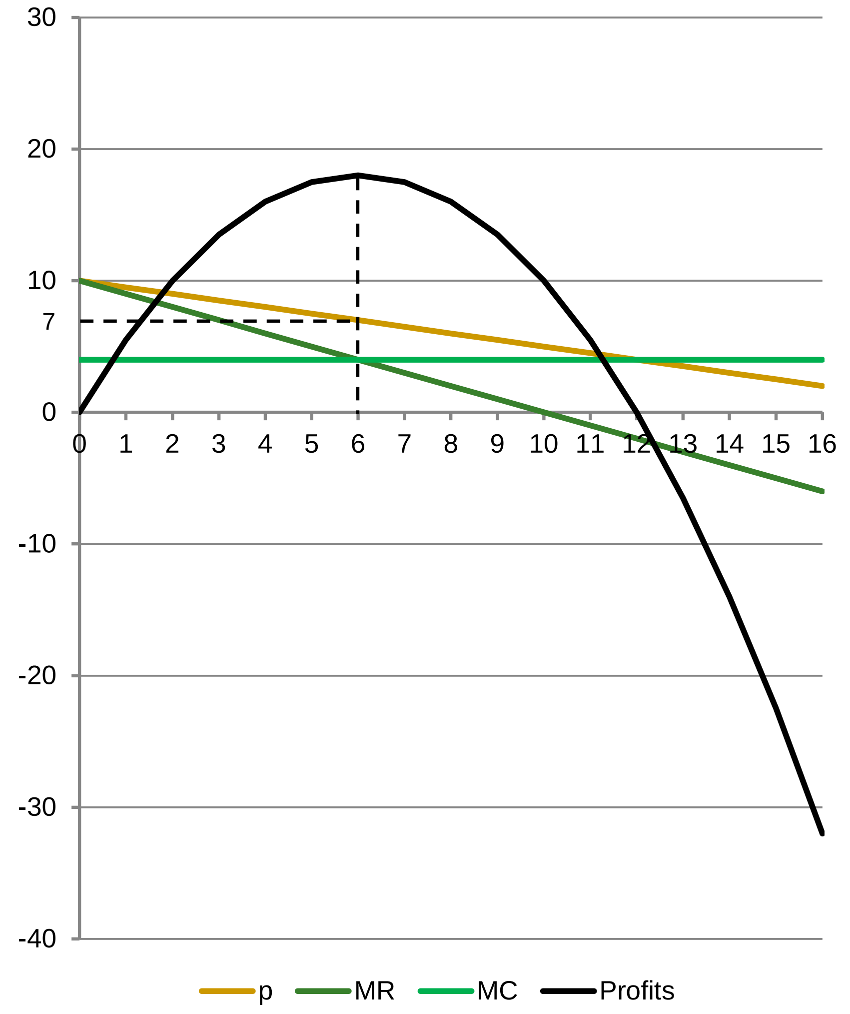
Profit max: $mr = mc$

$$10 - q = 4$$

$$q = 6$$

$$p = 7$$

Profits: $\pi = r - (mc)q = 42 - (4)6 = 18$

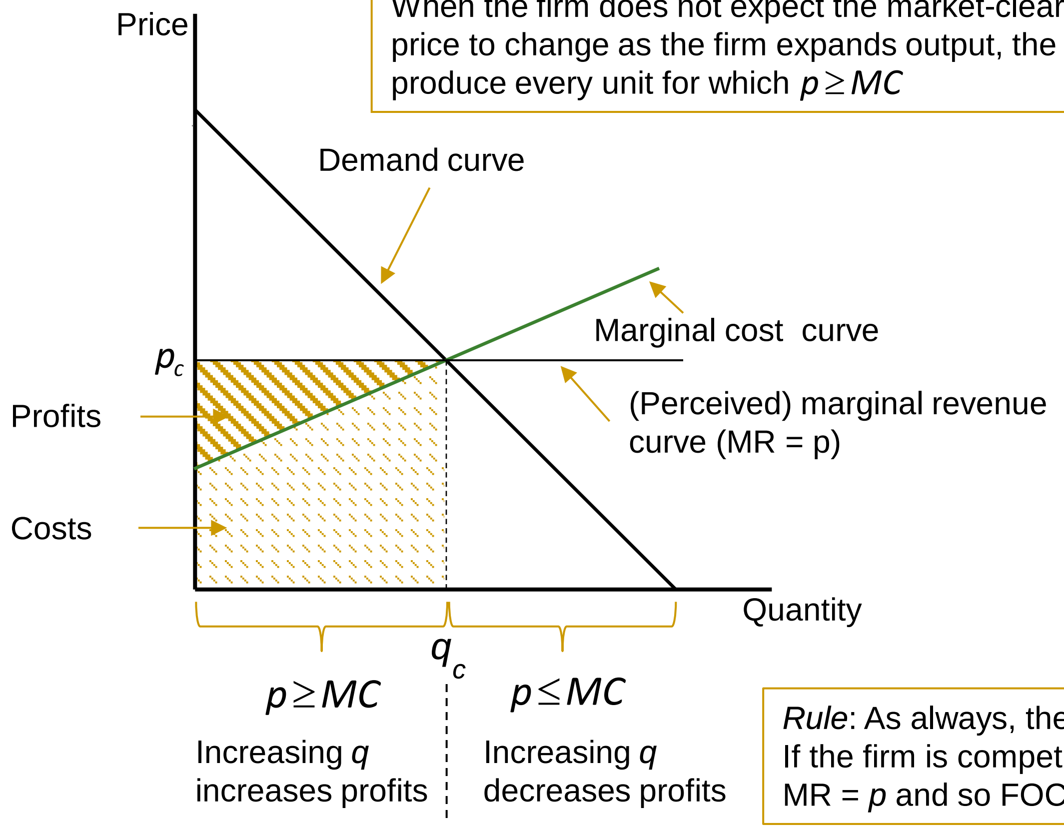


# Perfect Market Equilibria

# Competitive firms

- Competitive firms take prices as given
  - → Individual output decisions do not affect the market-clearing price

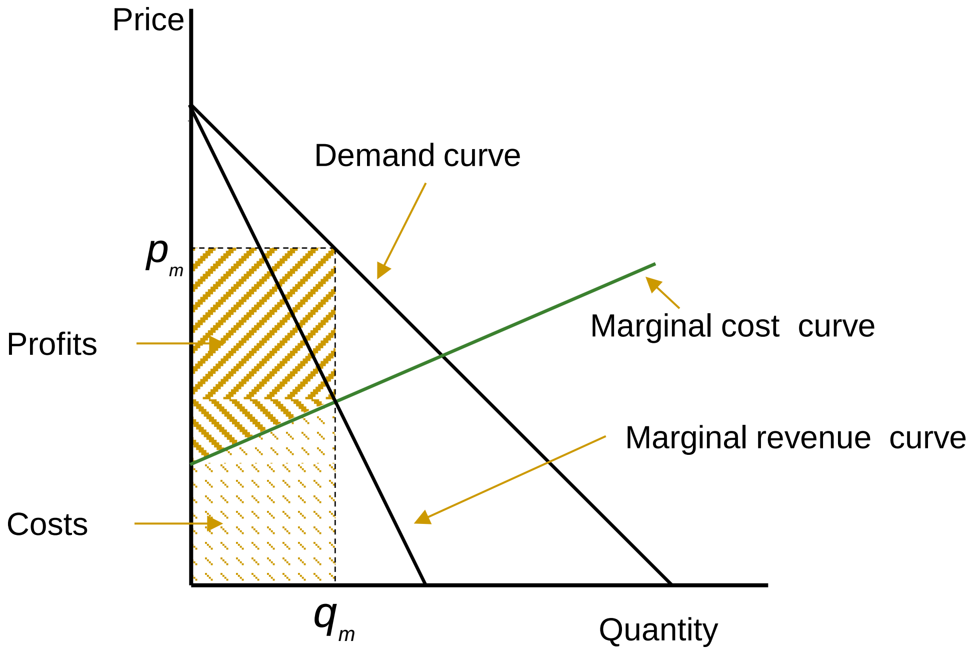
When the firm does not expect the market-clearing price to change as the firm expands output, the firm will produce every unit for which $p \geq MC$




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

# Monopolist Firm

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




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

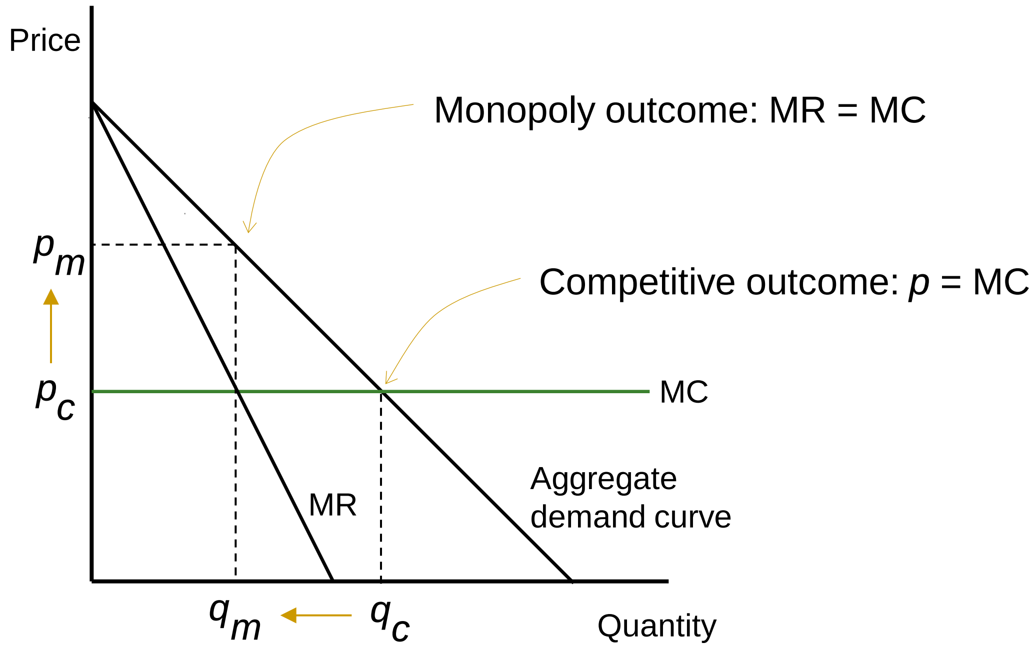
# Public policy on monopolies

- 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

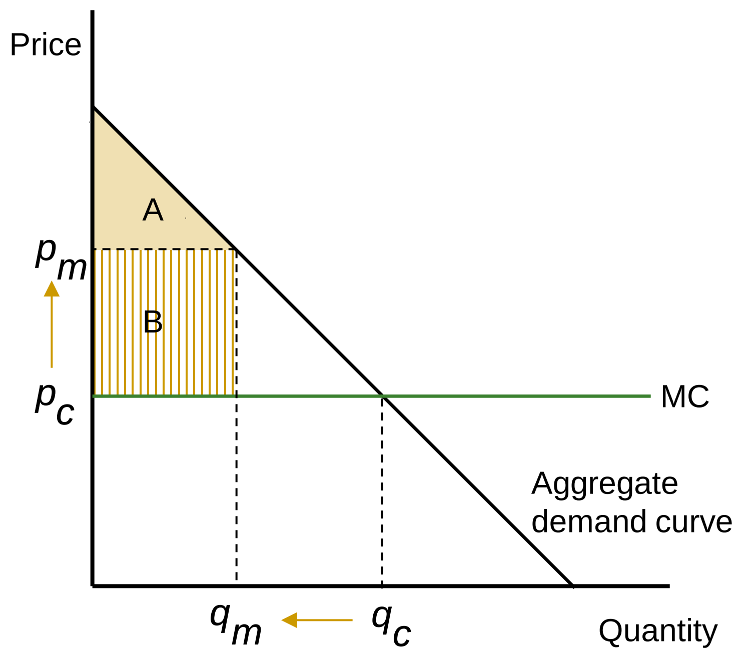
# Public policy on monopolies

- Output decreases: $q_c \searrow q_m$
- Prices increase: $p_c \nearrow p_m$



# Public policy on monopolies

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

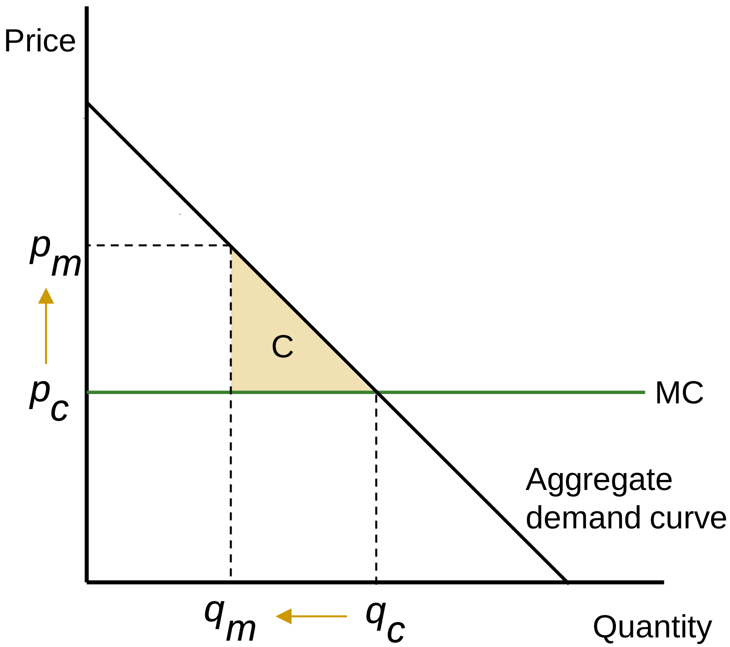



| | Competitive | Monopoly |
|---|---|---|
| Consumers | A + B | A |
| Producers | 0 | B |

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

# Public policy on monopolies

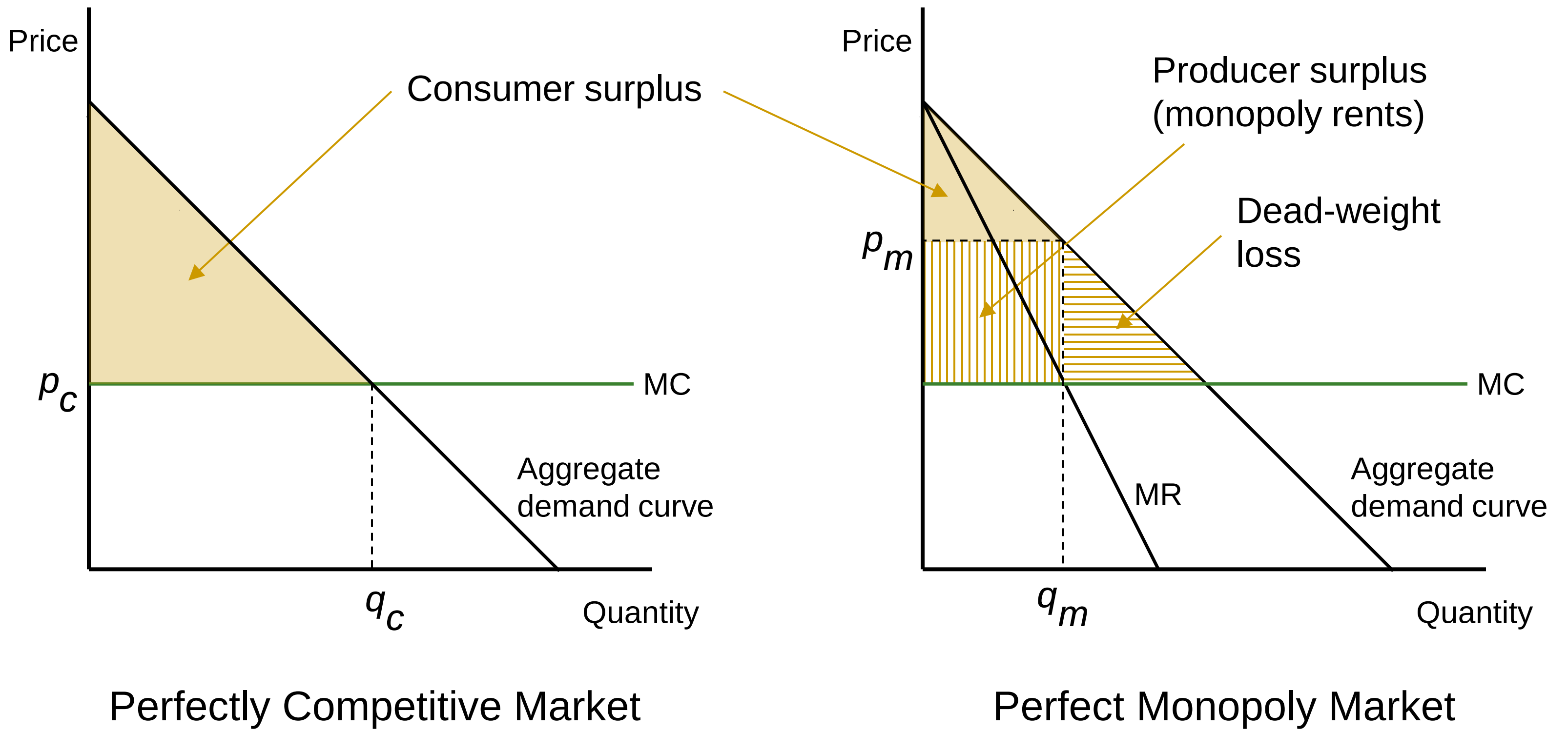
- "Deadweight loss" of surplus of marginal customers*
  - Surplus C just disappears from the economy
  - Creates "allocative inefficiency" because it does not exhaust all gains from trade




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

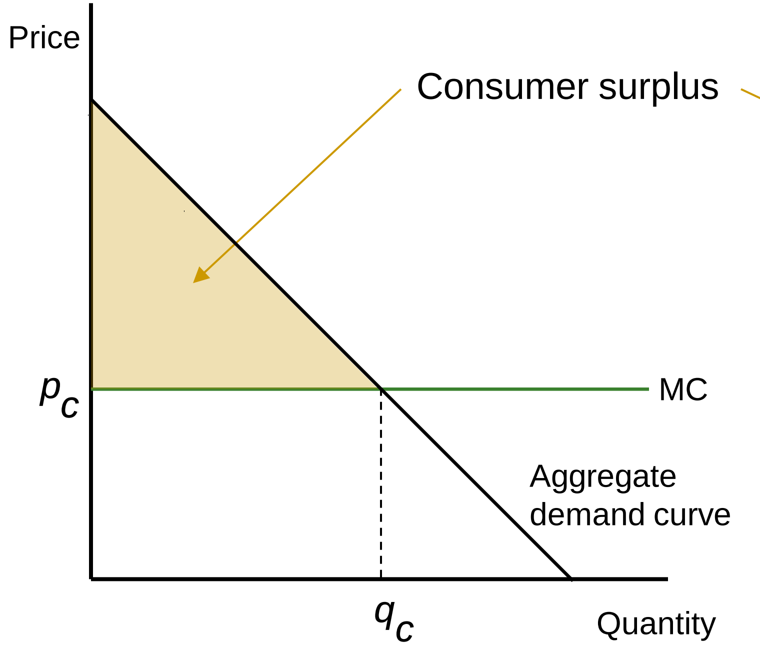
# Public policy on monopolies

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

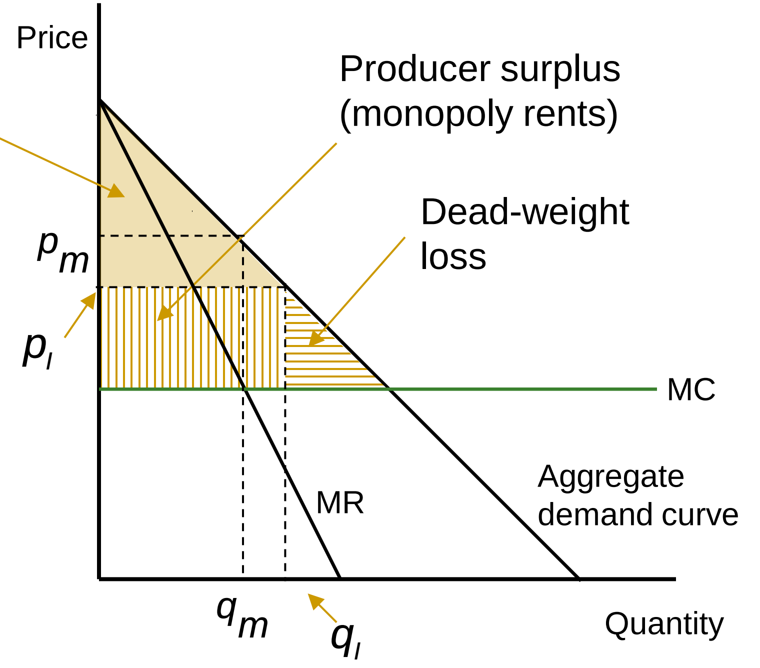


# Oligopolies

- 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

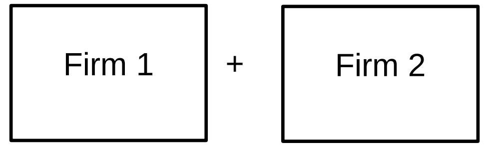



Oligopolistic Market

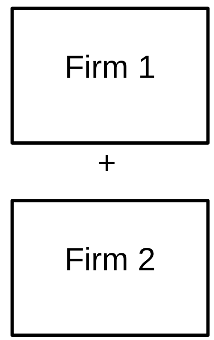
# Merger Typology, Substitutes and Complements, and Elasticities

# Merger typology

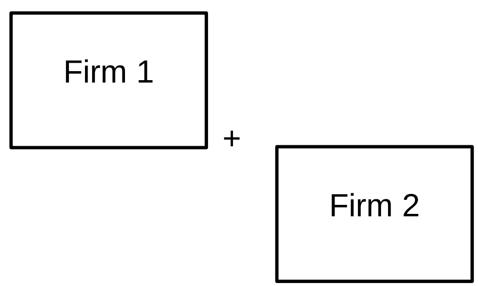
- Horizontal mergers




- 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:

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

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

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

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

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

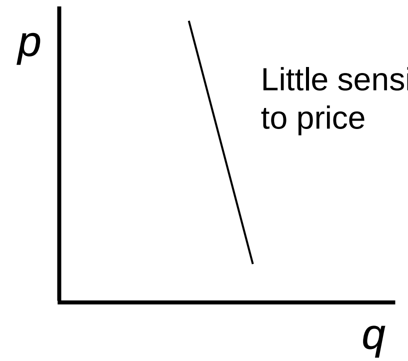
  - *Unit elasticity*:

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

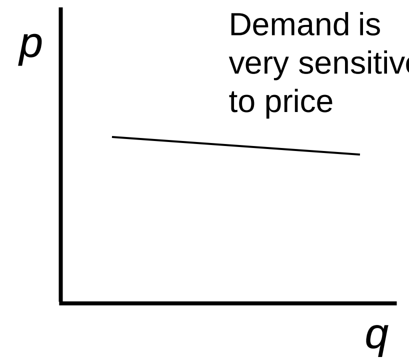
  - *Elastic demand*: Price sensitive.

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

Very inelastic demand




Very elastic demand



# 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

$$\varepsilon = \frac{\text{\% change in quanity demanded}}{\text{\% change in price}} = \frac{\dfrac{\Delta q}{q}}{\dfrac{\Delta p}{p}} = \frac{\Delta q}{\Delta p}\frac{p}{q}$$

This is the slope of the demand curve

  - Although a linear demand curve has a constant slope $\Delta q/\Delta p$, since $p$ and $q$ change going up or down the demand curve, the elasticity of demand is *not* constant
  - Assume that the slope of the demand curve is some constant $b$. Then:

$$\varepsilon = b\frac{p}{q}$$

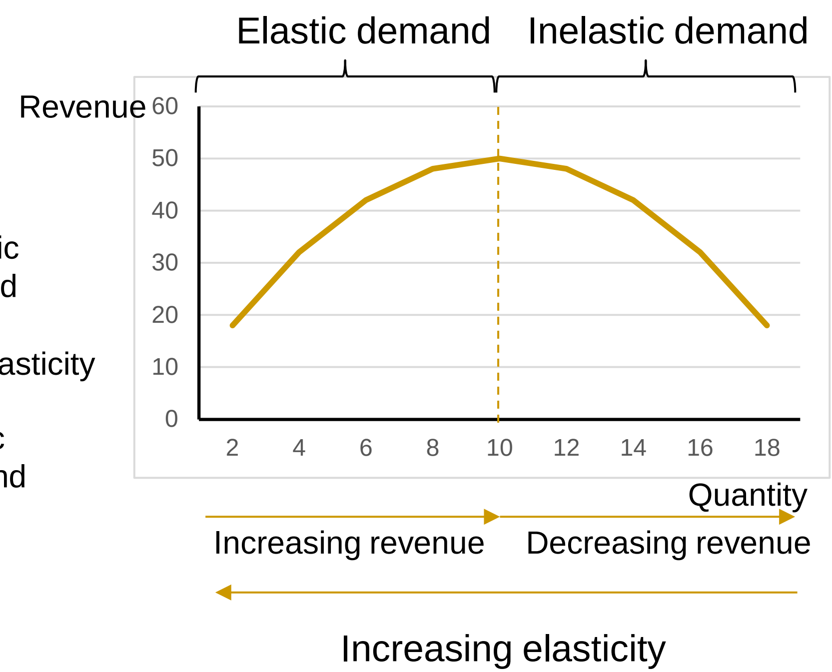
    - Given that the demand curve is downward sloping, as $q$ increases in magnitude $p$ decreases, so that $p/q$ get smaller. This means
      - Demand is inelastic $\left(|\varepsilon| > 1\right)$ at high prices and low quantities, and
      - Becomes more elastic (becomes a smaller number in absolute value) as $q$ increases and $p$ decreases.

# Elasticities

- Elasticity of demand and the slope of the demand curve

Demand curve:
$p = 20 - 2q$

| $p$ | $q$ | Slope | $p/q$ | $\varepsilon$ | 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 | |



# Elasticities

- Elasticity of demand and the slope of the demand curve

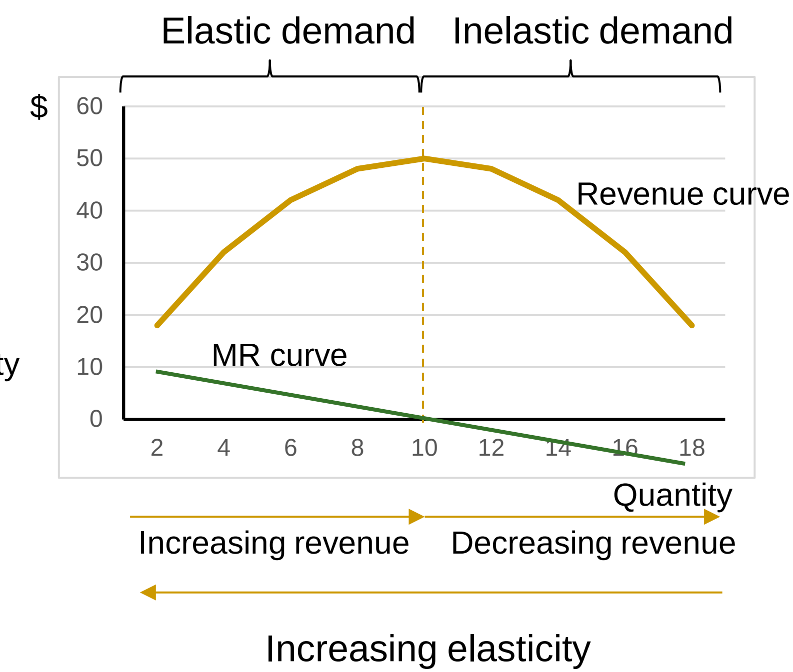
Demand curve:
*p* = 20 – 2*q*

| *p* | *q* | Slope | *p*/*q* | $\varepsilon$ | Total revenue |
|---|---|---|---|---|---|
| 1 | 18 | -2 | 0.0556 | -0.1111 | 18 |
| 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 |
| 6 | 8 | -2 | 0.7500 | -1.5000 | 48 |
| 7 | 6 | -2 | 1.1667 | -2.3333 | 42 |
| 8 | 4 | -2 | 2.0000 | -4.0000 | 32 |
| 9 | 2 | -2 | 4.5000 | -9.0000 | 18 |

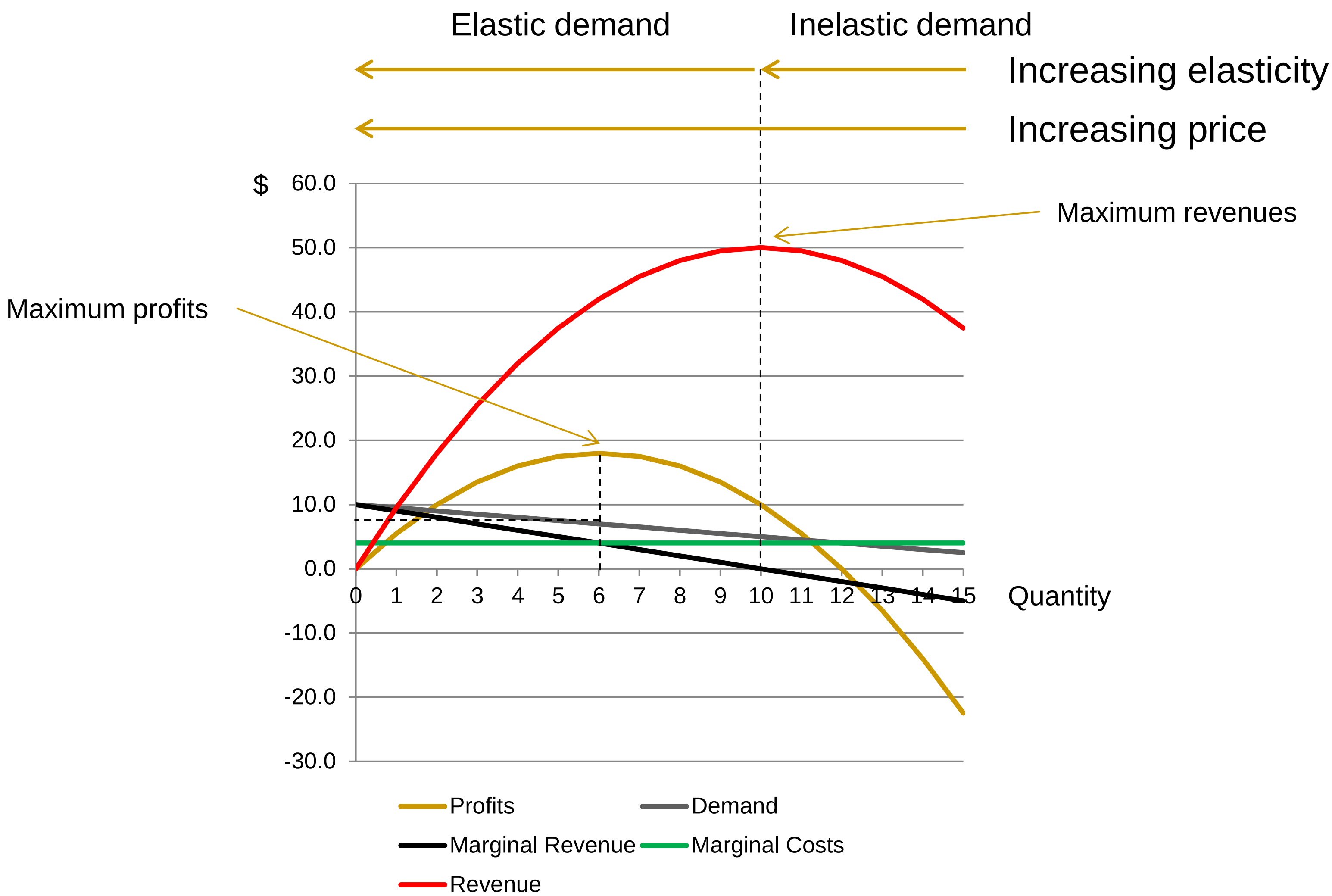
Inelastic demand (rows 1–4)

Unit elasticity (row 5)

Elastic demand (rows 6–9)



# 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

$$\varepsilon = n\varepsilon_i,$$

where $\varepsilon$ is the market elasticity and $\varepsilon_i$ 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

# Introduction

- The basic concept
  - An imperfectly competitive market exhibits—
    - A degree of competition, but not to the extent of a perfectly competitive market
    - A degree of market power, but not to the extent of perfect monopoly market
  - Characteristics of imperfectly competitive markets
    - Some or all firms exercise some degree of market power
      - One way of things about this is that they each face a downward-sloping residual demand curve, so that changes in a firm's output level will have an effect on the firm's market-clearing price
    - Multiple firms, but few enough that each firm recognizes its optimal control variables (e.g., price, output, quality) depends on the choices
    - Firms are differentiated
      - Product differentiation (e.g., various makes and models of automobiles)
      - Spatial differentiation (e.g., gasoline stations located at different locations)

      NB: In both cases, firms are "close enough" to one another to exhibit significant cross-elasticities of demand

# 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:

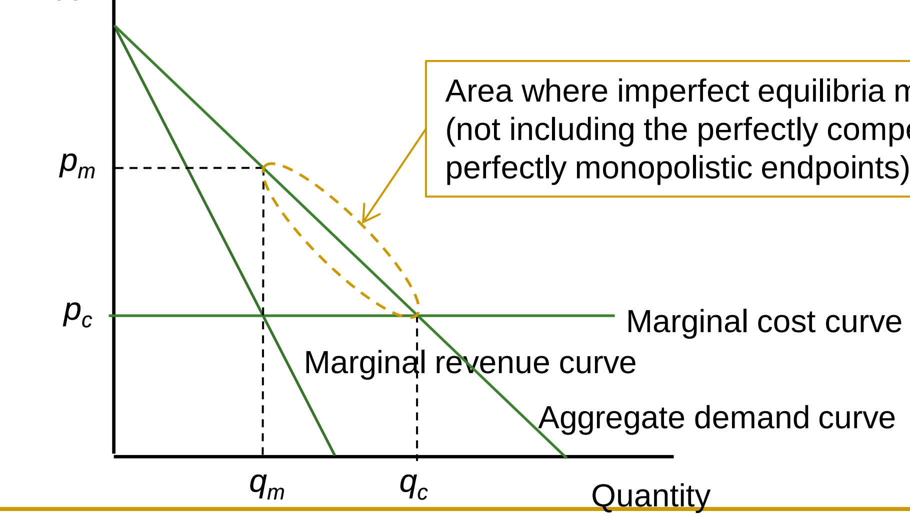
$$L = \frac{p - mc}{p}$$

  - Note that in a competitive market $L = 0$ 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 and the market-clearing price
    - When their a multiple firms each producing some output, the market-clearing price is a function of all of their outputs
  - Assume that each firm produced an identical (homogeneous) product. Then the market-clearing price $p$ is a function of the sum of the outputs of all of the firms in the market:

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

    and where $q_i$ is the output of the $i$th firm
  - The profit equation for firm I is:

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

# Cournot oligopoly models

- Two 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 $\lambda$ is the market-share weighted sum of the $\lambda_I$ 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 customer
    - 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