Unit 7. Competition Economics

Part 2. Markets and Market Equilibria

Merger Antitrust Law

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Substitutes, Complements, and Elasticities

Substitutes/Complements

- Substitutes
  - *Definition*: Two products or services are *substitutes* if, when consumer demand increases for one product, it will decrease for the other product
    - Symbolically:

$$\frac{\Delta q_2}{\Delta q_1} < 0$$

  - Examples
    - Coke and Pepsi
    - iPhone and Galaxy S series mobile phones
    - Nike and Adidas shoes
    - Hertz and Avis rental cars
  - *Horizontal mergers* involve combinations of firms that offer substitute products

Substitutes/Complements

- Substitutes
  - Substitutes and prices
    - If products 1 and 2 are substitutes, then as the price of 1 increases, the demand for 2 increases
    - Proof:

$$\overset{(-)}{\frac{\Delta q_2}{\Delta q_1}}\ \overset{(-)}{\frac{\Delta q_1}{\Delta p_1}} = \overset{(+)}{\frac{\Delta q_2}{\Delta p_1}} > 0$$

      - $\frac{\Delta q_2}{\Delta q_1}$ is a negative number (by definition of a substitute)
      - $\frac{\Delta q_1}{\Delta p_1}$ is a negative number (it is the slope of the demand curve for product 1)
      - A negative number times a negative number is positive, so $\frac{\Delta q_2}{\Delta p_1}$ is positive
      - If Δp_1 is positive (i.e., the price of product 1 goes up), then Δq_2 must be positive (i.e., demand for product 2 goes up)

Substitutes/Complements

- Complements
  - *Definition*: Two products are *complements* if, when consumer demand increases for one product, consumer demand also will increase for the other product
  - Symbolically:

$$\frac{\Delta q_2}{\Delta q_1} > 0$$

  - Examples
    - *Vertical mergers* involve complements
      - Television LCD screens and TV sets
      - Car engines and cars
      - Cable TV programming and cable TV distribution (AT&T/Time Warner)
      - Drug manufacture and drug distribution
    - But many conglomerate mergers can also involve complements
      - Printers and ink cartridges
      - Razors and razor blades
      - Computers and computer software

Substitutes/Complements

- Complements
  - Complements and prices
    - If products 1 and 2 are complements, then as the price of 1 increases, the demand for 2 decreases
    - Proof:

$$\overset{(+)}{\frac{\Delta q_2}{\Delta q_1}}\ \overset{(-)}{\frac{\Delta q_1}{\Delta p_1}} = \overset{(-)}{\frac{\Delta q_2}{\Delta p_1}} < 0$$

  - $\frac{\Delta q_2}{\Delta q_1}$ is a positive number (by definition of a complement)
  - $\frac{\Delta q_1}{\Delta p_1}$ is a negative number (it is the slope of the demand curve for product 1)
  - A negative number times a positive number is negative, so $\frac{\Delta q_2}{\Delta p_1}$ is negative
  - If Δp_1 is positive (i.e., the price of product 1 goes up), then Δq_2 must be negative (i.e., demand for product 2 goes down)

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

The Greek letter epsilon (ε) is the usual symbol in economics for elasticity

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

Percentage change q_i in the quantity of product i demanded

Percentage change p_i in the price of product i

    - These are sometimes called *elasticity of demand* or *price elasticity of demand*
  - Examples:
    - If price increases by 5% and demand decreases by 10%, then the own-elasticity is -2 (= -10%/5%)
    - If price increases by 3% and demand deceases by 1%, then the own-elasticity is -1/3 (= -1%/3%)

Technically, these are called *arc elasticities* because they give percentage changes for discrete changes in prices and quantities

Elasticities

- Own-elasticity of demand
  - Conventions
    - Own-elasticities are often simply called *elasticities* or *price elasticities*
    - Technically, own-elasticities are always negative numbers (given downward-sloping demand)
      - But economists often drop the negative sign and use the absolute value
      - The idea is that everyone knows that own-elasticities are negative, so why bother saying it? Using absolute values are also more intuitive (substitutability increases as the absolute value increases)

Elasticities

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

For intuition only (NOT technically correct, but it is usually the intuition that is important)

- Some important definitions
  - *Inelastic demand*: Not very price sensitive

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

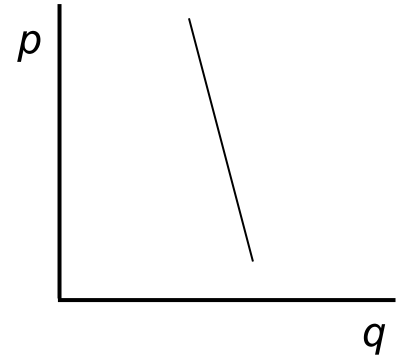
  - *Unit elasticity*:

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

  - *Elastic demand*: Price sensitive

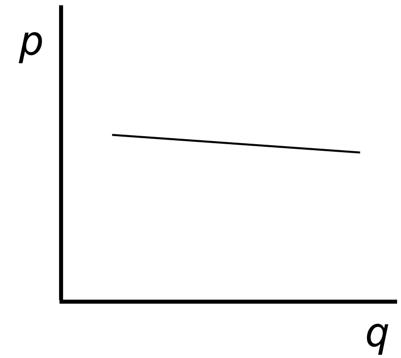
$$|\varepsilon| = \left| \frac{\text{\%change in quantity}}{\text{\%change in price}} \right| > 1$$

Inelastic demand



Little sensitivity to changes in price

Elastic demand



More sensitivity to changes in price

Note: |*x*| is the *absolute value* of *x*, which is the magnitude of *x* without the sign. So |3| = |-3| = 3.

Elasticities

- Own-elasticity of demand
  - The relation to the slope of the demand curve:

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

that is, the own-elasticity at a point on the demand curve is equal to the slope of the demand curve at that point times the ratio of price to quantity

- Proof

$$\varepsilon = \frac{\%\Delta q_i}{\%\Delta p_i} = \left(\frac{\frac{\Delta q_i}{q_i}}{\frac{\Delta p_i}{p_i}}\right)\left(\frac{\frac{q_i}{1}}{\frac{q_i}{1}}\right) = \left(\frac{\Delta q_i}{\Delta p_i}\right)\left(\frac{1}{\frac{q_i}{p_i}}\right) = \frac{\Delta q_i}{\Delta p_i}\frac{p_i}{q_i}$$

This fraction is equal to 1

Slope of the (residual) demand curve: Always negative

- Mathematical note (optional)
  - In calculus terms: $\varepsilon = \frac{dq_i}{dp_i}\frac{p_i}{q_i}$

Elasticities

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

- 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

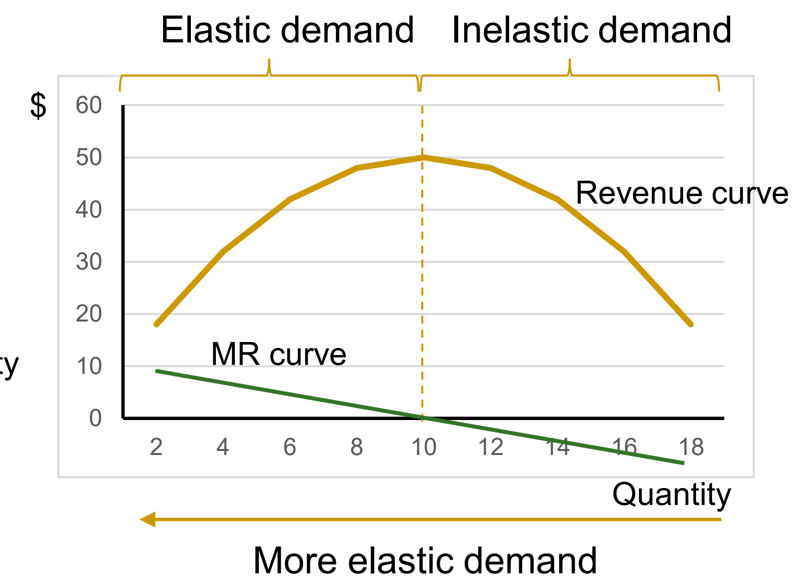
Inverse demand curve:
p = 20 – 2*q*

p	*q*	Slope	*p*/*q*	ε	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

Unit elasticity

Elastic demand



General rules:
Elasticity decreases as quantity increase and prices decrease
Elasticity increases as quantity decrease and prices increase

Elasticities

- *Proposition*
  - When a firm maximizes its revenues are maximized, the elasticity of its residual demand function is -1 (ε = -1)
    - We see this on the graph on the previous slide

- *Proof with linear demand* (optional)

Step 1. Solve for *q* and *p* at the revenue maximum

$$r(q) = p(q)q$$ Definition of revenue

$$= (a + bq)q$$
$$= aq + bq^2$$
Substituting the inverse demand function for *p*

$$mr(q) = a + 2bq = 0$$ FOC for a revenue maximum

$$q = \frac{-a}{2b}$$
$$p = \frac{a}{2}$$
Solving for *q* and *p*

Step 2. Substitute for the slope, *q* and *p* in the elasticity formula and simplify

$$\varepsilon = \frac{\Delta q}{\Delta p}\frac{p}{q}$$ Definition of elasticity

$$= \frac{1}{b}\frac{p}{q}$$ Substituting for the slope

$$= \frac{1}{b}\frac{\left(\frac{a}{2}\right)}{\left(\frac{-a}{2b}\right)}$$ Substituting for *p* and *q*

$$= -1$$ Simplifying

Q.E.D.

Elasticities

- *Proposition*
  - When a firm maximizes its revenues are maximized, the elasticity of its residual demand function is -1 (ε = -1)
    - We see this on the graph on the previous slide

- *Proof in the general case* (optional)

$$r(q) = p(q)q$$ Definition of revenues

$$\frac{dr}{dq} = p + q\frac{dp}{dq} = 0$$ First-order condition (FOC) for a revenue maximum

$$p = -q\frac{dp}{dq}$$ Rearranging FOC

$$\varepsilon = \frac{dq}{dp}\frac{p}{q}$$ Definition of elasticity

$$= \frac{dq}{dp}\frac{-q\frac{dp}{dq}}{q} = -1$$ Substituting for *p* and simplifying

Q.E.D.

Note: $\frac{dy}{dx} = \frac{1}{\frac{dx}{dy}}$ That is, the derivative of a function $y = f(x)$ is equal to the reciprocal of the derivative of the inverse function $x = g(y)$

Elasticities

- The *Lerner condition* for profit-maximizing firms
  - *Proposition*: When a firm maximizes its profits, at the profit-maximum levels of price and output the firm's own elasticity ε is equal to $1/m$:

$$\varepsilon = \frac{1}{m},$$

where m is the *gross margin*:

$$m = \frac{p-c}{p}$$

Proof (optional):

The firm's first order condition for a profit-maximum:

Marginal revenue = Marginal cost

Mathematically $$p + \frac{dp}{dq}q = c$$

Rearranging and dividing by p: $$\frac{p-c}{p} = -\frac{dp}{dq}\frac{q}{p}$$

$$m = \frac{1}{\varepsilon}$$ *Q.E.D.*

Elasticities

- Predicting quantity changes for a given price increase
  - An approximation
    - We can approximate a percentage quantity change $\%\Delta q$ for a given percentage price change %Δp by multiplying the own-elasticity ε by the percentage price change:

$$\varepsilon = \frac{\%\Delta q}{\%\Delta p} \Rightarrow \%\Delta q \approx \varepsilon\%\Delta p$$

      - The relationship is not exact since the elasticity can change over the discrete range of the price change (as it does on a linear demand function)
  - An exact relationship exists the unit quantity change Δp for linear demand curves:

$$\varepsilon = \frac{\frac{\Delta q}{q}}{\frac{\Delta p}{p}} = \frac{\Delta q}{\Delta p}\frac{p}{q} \Rightarrow \Delta q = \varepsilon\frac{q}{p}\Delta p$$

    - Or, if you know the slope b of the demand curve

$$b = \frac{\Delta q}{\Delta p} \Rightarrow \Delta q = b\Delta p$$

These relationships can be important when determining a quantity change associated with a price increase in the hypothetical monopolist test for market definition

Cross-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*.

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

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

Percentage change p_j in the price of product *j*

- With a little algebra (as before):

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

Positive for substitutes
Negative for complements

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

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- Mathematical note (optional)
  - In calculus terms:

$$\varepsilon_{ij} = \frac{dq_i}{dp_j}\frac{p_j}{q_i}$$

Cross-elasticities

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

Make sure you understand why!

    - *Think of it this way:*
      - In a two-firm market, a high cross-elasticity means a large number of *marginal customers* who will abandon product *i* when its price increases and will divert to product *j*
      - It also means a correspondingly smaller number of *inframarginal customers* who will stay with product *i* in the wake of a price increase)
  - *Low cross-elasticity of demand*:
    - A large change in the price of product *i* will cause only a small change of demand to product *j*
    - As a result, product *j* brings little competitive pressure on product *i*

Make sure you understand why!

An important relationship

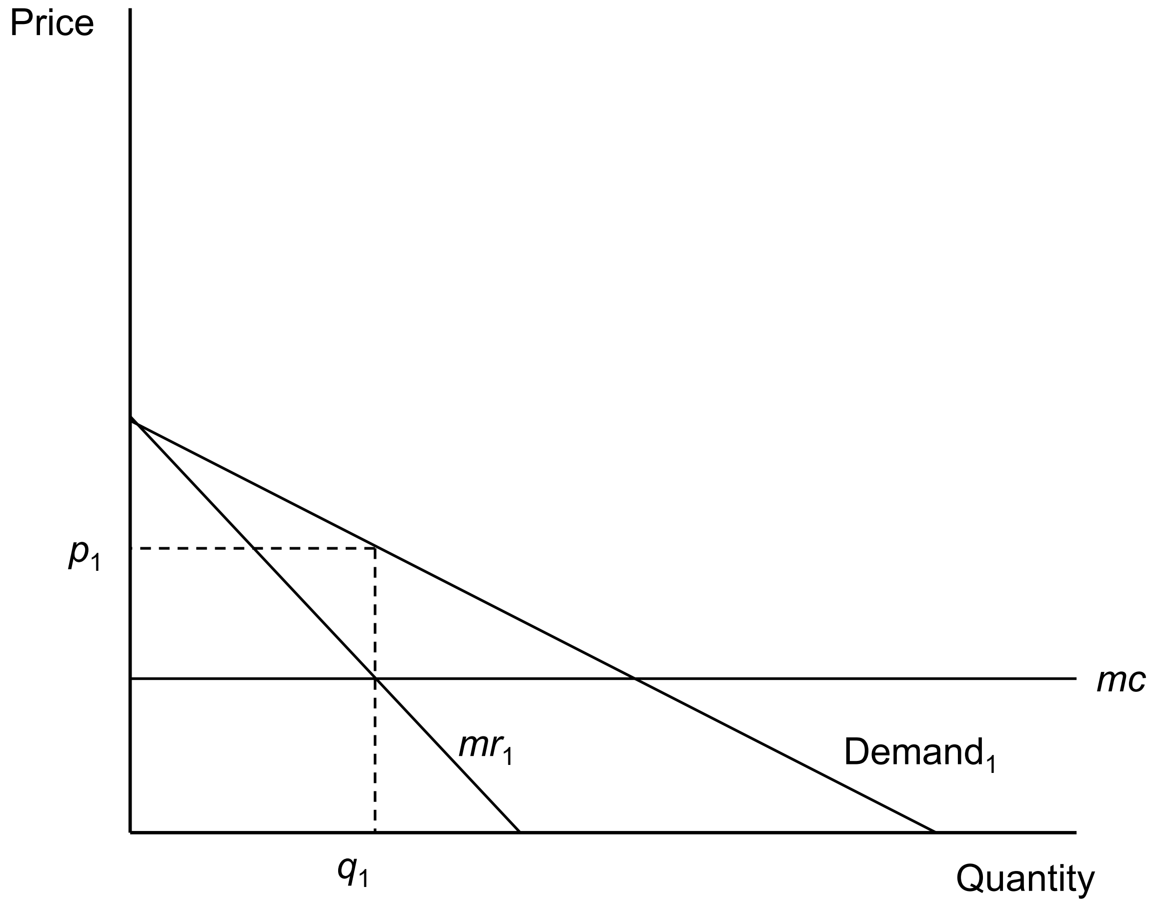
- Relationship of own-elasticities to cross-elasticities
  - Intuitively, the higher the cross-elasticities with the other products, the more elastic is the own-elasticity
  - Consequently, if a merger has the effect of decreasing the cross-elasticities of one or more substitute products, then the own-elasticity also decreases
  - *Key result*: All other things being equal, decreasing the cross-elasticity of demand of substitute products shifts the intersection of the marginal revenue curve and the marginal cost curve to the left, leading the firm to decrease output and increase prices

Let's look at the next two graphs to see why

An important relationship

- Relationship of own-elasticities to cross-elasticities

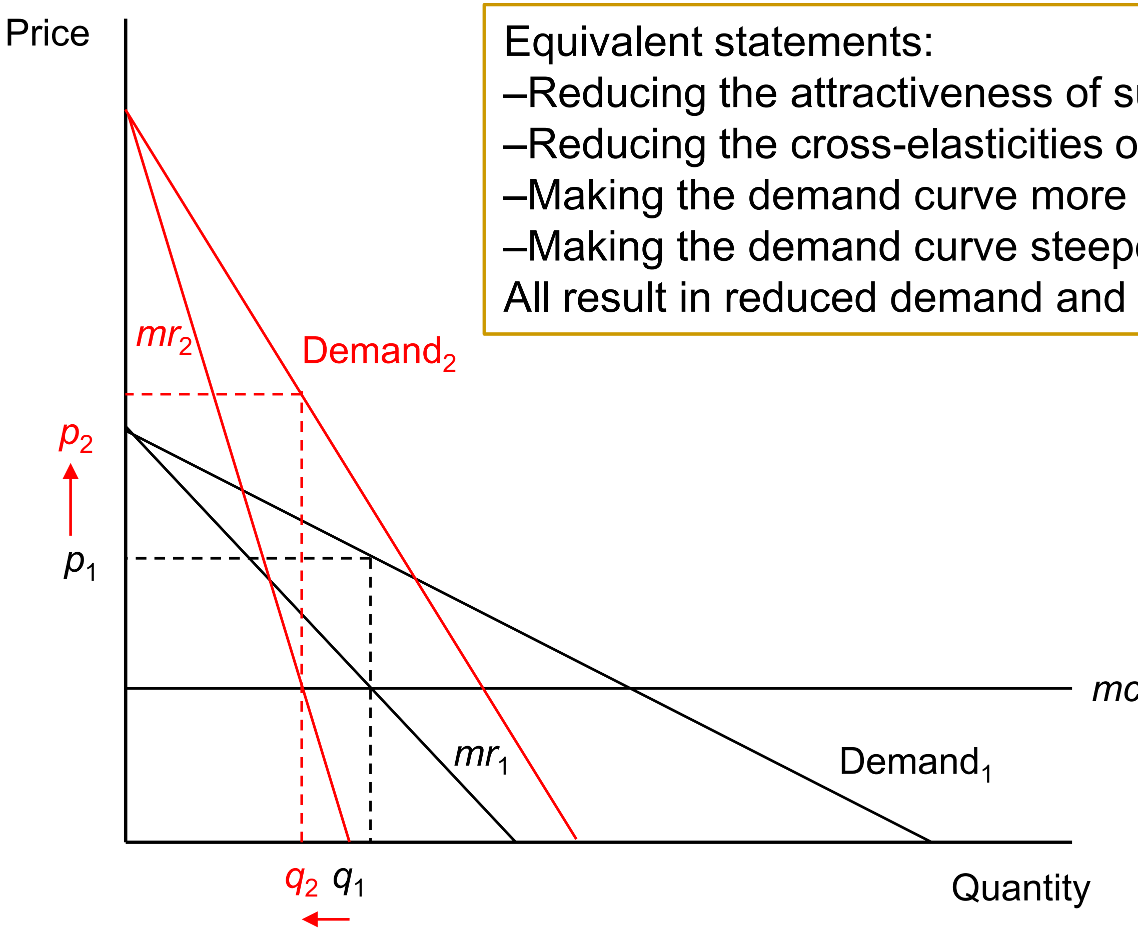
Suppose that this graph describes the initial equilibrium, with price p_1 and quantity q_1



An important relationship

- Relationship of own-elasticities to cross-elasticities

This graph describes the second equilibrium, with price p_2 and quantity q_2 after demand for the firm's product has become more inelastic



Equivalent statements:
–Reducing the attractiveness of substitutes
–Reducing the cross-elasticities of demand
–Making the demand curve more inelastic
–Making the demand curve steeper
All result in reduced demand and increased prices

An important relationship

- Relationship of own-elasticities to cross-elasticities
  - Technically:

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

You do not have to know this equation, but keep in the mind the relationship

where ε_{11} is the own-elasticity of product 1 and ε_{i1} is the cross-elasticity of product *i* with respect to product 1

  - Takeaways

This is important!

    - As the cross-elasticities on the right-hand side decrease, the demand for product 1 become more inelastic (|ε| becomes smaller)
      - This allows Firm 1 to exercise market power and charge higher prices
    - Competitors with larger market shares have more influence in constraining the price of Firm 1 for any given cross-elasticity

Diversion ratios

- *Definition*: Diversion ration (D)

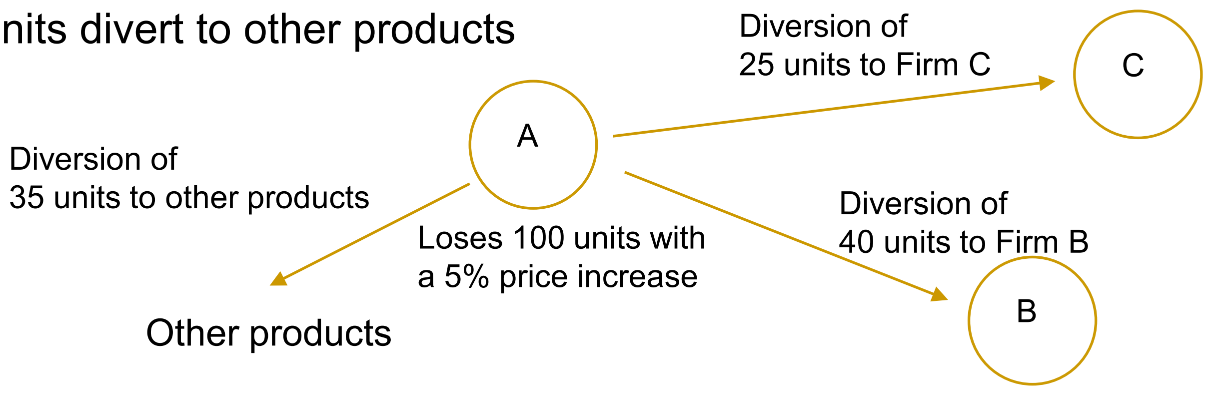
$$D_{12} = \frac{\text{Units captured by Firm 2 as a result of Firm 1's price increase}}{\text{Total units lost by Firm 1 as a result of Firm 1's price increase}} = \left| \frac{\Delta q_2}{\Delta q_1} \right|$$

  - NB: By convention, diversion ratios are *positive*. Since $\Delta q_1/\Delta p_1$ is negative (since the demand curve is downward sloping), we need to look at the absolute value

- Thinking about diversion ratios
  - Think of D_{12} as $D_{1\rightarrow 2}$, that is, the percentage of units lost by Firm 1 that are "diverted" to Firm 2 (which produces a substitute product) as a result of Firm 1's price increase when Firm 2's price stays constant
    - This heuristic assumes that there is a one-to-one switch between Firm 1's and Firm 2's products

Diversion ratios

- Example
  - Firm A raises its price by 5% and loses 100 units (all other firms hold their price constant)
    - 40 units divert to Firm B
    - 25 units divert to Firm C
    - 35 units divert to other products



  - Then:

$$D_{A\to B} = \frac{40}{100} = 0.40 \text{ or } 40\%$$

$$D_{A\to C} = \frac{25}{100} = 0.25 \text{ or } 25\%$$

Since $D_{A\to B} > D_{A\to C}$, B is generally regarded as a closer substitute to A than C

Diversion ratios

- Relation to cross-elasticities
  - Diversion ratios are closely related to cross-elasticities: both measure the degree of substitutability between two products when the relative prices change
    - Elasticities measure substitutability in terms of *percentages*: the percentage increase in Firm 2's unit sales for a percentage increase in Firm 1's price
    - Diversion ratios measure substantiality in terms of *units*: the unit increase in Firm 2's sales as a percentage of all units lost by Firm 1 as a result in Firm 1's price increase
  - Modern antitrust economics still speaks in terms of cross-elasticities when it often means diversion ratios
    - For example, products with high diversion ratios are said to have high cross-elasticity

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  - Technically (optional):

$$D_{12} = \left| \frac{dq_2 / dp_1}{dq_1 / dp_1} \right| = -\left(\frac{dq_2 / dp_1}{dq_1 / dp_1} \right) \overbrace{\left(\frac{p_1 / q_2}{p_1 / q_1} \, \frac{q_2 / 1}{q_1 / 1} \right)}^{=\,1} = \overbrace{-\left(\frac{\frac{dq_2}{dp_1} \, \frac{p_1}{q_2}}{\frac{dq_1}{dp_1} \, \frac{p_1}{q_1}} \right) \left(\frac{q_2}{q_1} \right)}^{\text{Rearranging terms}} = \overbrace{-\frac{e_{21}}{e_{11}} \, \frac{q_2}{q_1}}^{\text{Simplifying}}$$

Diversion ratios

- How are diversion ratios estimated?
  1. Data collected during the regular course of business (including win-loss data)
  2. Indications in the company documents
  3. Consumer surveys
     - But very sensitive to survey design and customer ability to accurately predict product choice in the presence of a price increase
  4. Switching shares as proxies
     - Where switching behavior is not limited to reactions to changes in relative price
     - *Example*: H&R Block/TaxACT (where the court accepted a diversion analysis based on IRS switching data only as corroborating other evidence)
  5. Demand system estimation/econometrics
     - Econometric estimation of all own- and cross-elasticities of all interacting firms
     - Very demanding data requirements—Usually possible only in retail deals where point-of-purchase scanner data is available

Diversion ratios

- How are diversion ratios estimated?
  6. Market shares as proxies: Relative market share method
     - Very popular method
     - Assumes that customers divert in proportion to the market shares of the competitor firms (after adjusting for any out-of-market diversion)
       - So that the largest competitors (by market share) get the highest diversions
     - When all diversion is to products within the candidate market:

$$D_{A \to B} = \frac{s_B}{1 - s_A},$$

where s_A and s_B are the market shares of firms A and B, respectively

- Example: Candidate market—
  - Firm A 40%
  - Firm B 30%
  - Firm C 24%
  - Firm D 6%
  - No diversion outside the candidate market

60% points to be allocated to three firms pro rata by their market shares

Then:

$$D_{A \to B} = \frac{0.30}{1 - 0.40} = 50.0\%$$

$$D_{A \to C} = \frac{0.24}{1 - 0.40} = 40.0\%$$

$$D_{A \to D} = \frac{0.06}{1 - 0.40} = 10.0\%$$

Adds to 100%, to account for 100% of the diverted sales

Diversion ratios

- How are diversion ratios estimated?
  6. Market shares as proxies: Relative market share method (con't)
     - When there is some diversion to products outside the candidate market:

$$D_{A\to B} = \left(1 - \frac{\Delta q_{outside}}{\Delta q_A}\right)\frac{s_B}{1-s_A},$$

where $\frac{\Delta q_{outside}}{\Delta q_A}$ is the percentage of Firm A's lost sales that are diverted to firms outside of the market

- Example: Candidate market—
  - Firm A 50%
  - Firm B 25%
  - Firm C 15%
  - Firm D 10%
  - Outside diversion: 15%

  (Firms A–D: Shares in the candidate market (= 100%))

  → 85% points to be allocated to the firms in the candidate market

Then:

$$D_{A\to B} = (1-0.15)\frac{0.25}{1-0.50} = 42.5\%$$

$$D_{A\to c} = (1-0.15)\frac{0.15}{1-0.50} = 25.5\%$$

$$D_{A\to D} = (1-0.15)\frac{0.10}{1-0.50} = 17.0\%$$

$$D_{A\to O} = 15\%$$

Total 85%
With outside diversion: 100%

Diversion ratios

Enough of diversion ratios for now. But keep them in mind. We will see them again in implementations of the hypothetical monopolist test and in the unilateral effects theory of anticompetitive harm

Markets and Market Equilibria

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 $\sum q_i = 10 + 7 + 5 = 22$.

Perfectly Competitive Markets

Perfectly competitive markets

- *Definition*: A market in which no single firm can affect price, meaning—
  - The firm perceives its residual demand curve as horizontal
  - The firm perceives that it can sell any amount of product without affecting the market price
  - $\frac{dp}{dq} = 0$ (as perceived by the firm)
  - $p = \frac{dc}{dq}$ (i.e., price = marginal cost)

These four bullets are just different ways of saying exactly the same thing

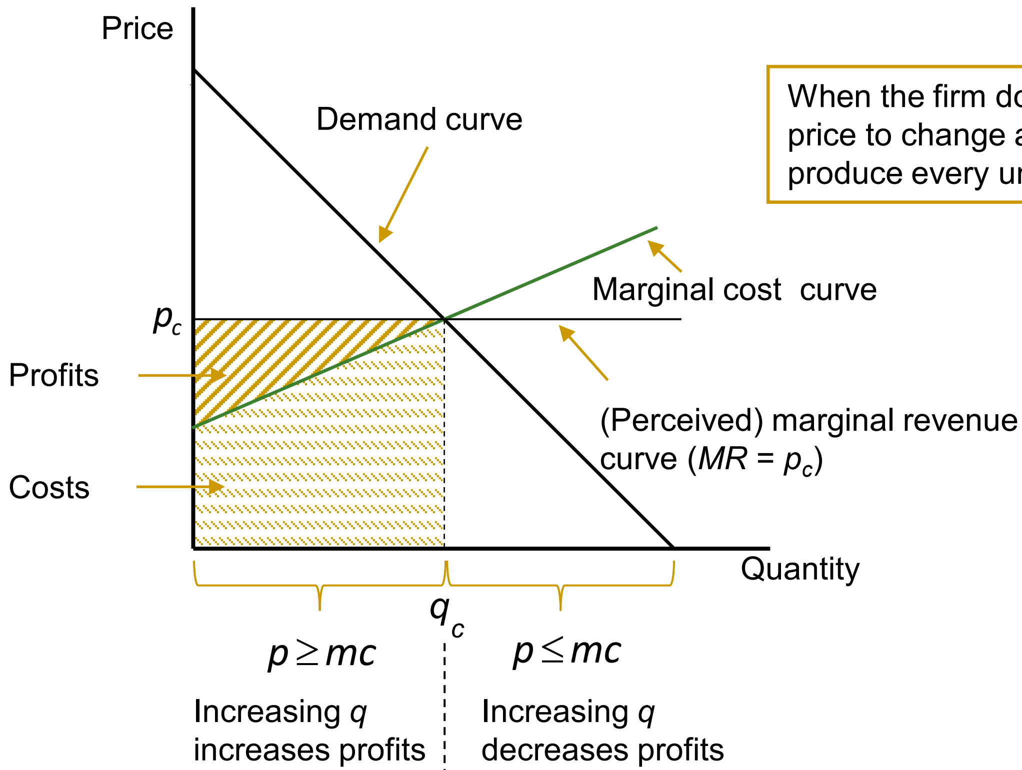
- Some more definitions
  - *"Price taking":* Competitive firms are called *price-takers*, that is, they take price as given and not something that they can affect
  - *Perfectly competitive equilibrium*: A market equilibrium where:
    - Aggregate supply equals aggregate demand, *and*
    - Each firm chooses its level of production so that the market-clearing price is equal to the firm's marginal cost of production

Perfectly competitive markets

- What could cause a market to be perfectly competitive?
  - *Traditional theory*: Each individual firm's production is very small compared to aggregate demand at any price, so that individual production changes cannot move significantly along the aggregate demand curve
    - This implies that there are a very large number of firms in the market
  - *Modern theory*: Competitors in the market place react strategically but non-collusively to price or quantity changes by a firm in ways that maintain the perfectly competitive equilibrium

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 $p \geq mc$

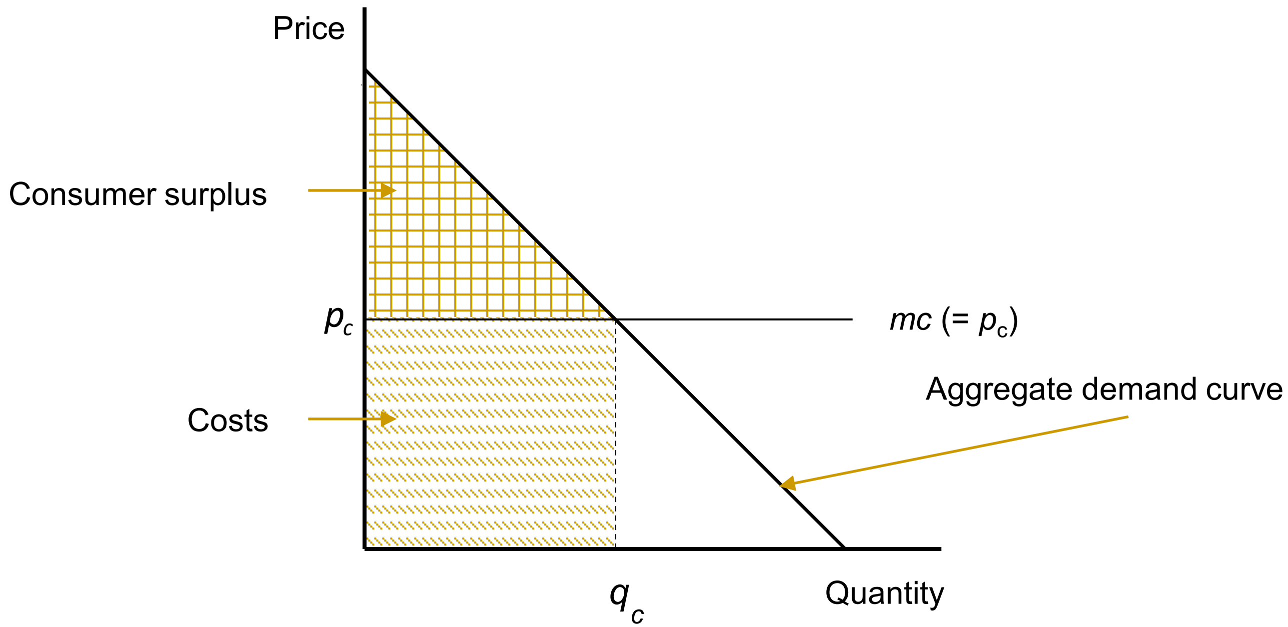
Rule: As always, the FOC is $mr = mc$. If the firm is competitive, then $mr = p_c$ and so FOC is $p_c = mc$.

Competitive firms

- Three take-aways
  1. Competitive firms do not perceive that their output decisions affect the market-clearing price
     - That is, they perceived that they face a horizontal demand curve
     - In fact, their output decisions do affect the market-clearing price but they do not perceive it
       - We know this since in the aggregate the output of all competitive firms does affect the market-clearing price
  2. Competitive firms chose their output so that $p = mc$
     - Competitive firms, like all other firms, choose output so that marginal revenue is equal to marginal cost ($mr = mc$)
     - Since a competitive firm does not perceive that its output decisions affect the market-clearing price, the firm does not perceive that there is any downward adjustment in market price when it expands its output.
     - Therefore, the firm perceives—and makes its output decision—on the premise that its marginal revenue is equal to the market price.
     - Hence, the firm selects an output level so that $p = mc$.

Competitive firms

- Three take-aways
  3. A competitive market maximizes consumer surplus[1]
     - A competitive market exhausts all gains from trade



[1] We are assuming a simple market where there is only one product that sells at a single uniform price (i.e., there is no price discrimination).

Perfectly Monopolized Markets

Perfect monopoly

- Basic concepts
  - In a perfect monopoly market, there is only one firm that supplies the product
    - This is an economic concept
    - In law, a monopolist need not control 100% of the market

> In economics and in law, a firm that faces a downward-sloping residual demand curve and therefore has some power to influence the market-clearing price for its product is said to have *market power*. In antitrust law, a firm that has very significant power over the market-clearing price is said to have *monopoly power*. In economics, a monopolist is the only firm in the market.

  - The aggregate demand curve defines the residual demand curve facing the firm
    - The demand curve is still downward-loping (as opposed to vertical), so that there are some substitutes for the monopolist's product—just not very good ones

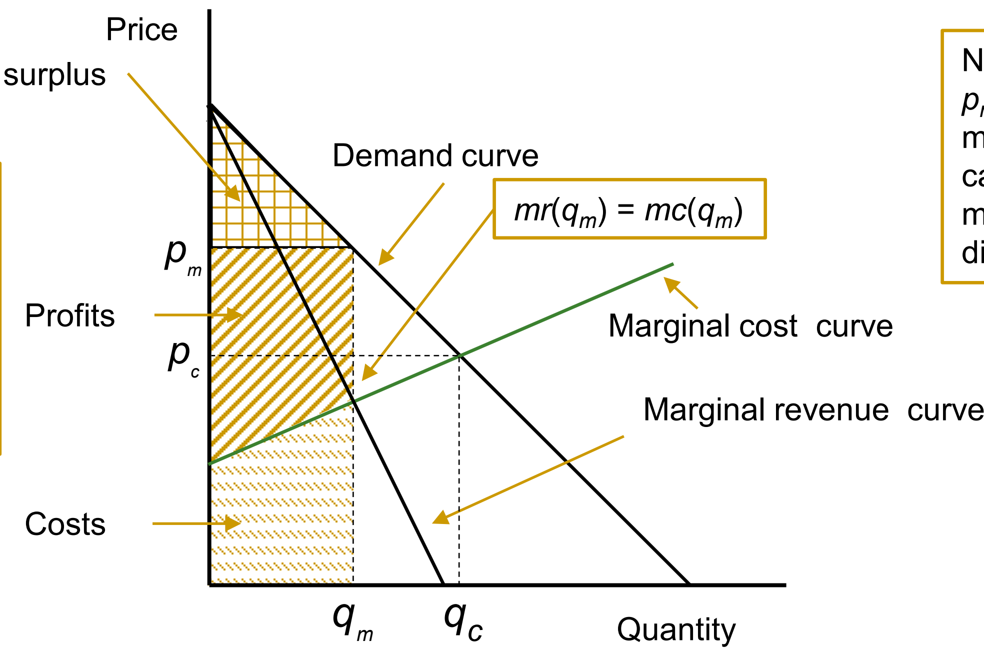
Monopolist firm

- A monopolist chooses output q_m so that $mr(q_m) = mc(q_m)$
  - A monopolist charges a higher price than a competitive firm

$$p_m > mr\left(q_m\right) = mc\left(q_m\right) = p_c$$

  - A monopolist produces a lower output than would a competitive firm facing the same residual demand curve ($q_m < q_c$)

NB: $q_m = ½\ q_c$, where the monopolist and the firms in the competitive market face the same aggregate demand curve and have the same constant marginal costs.



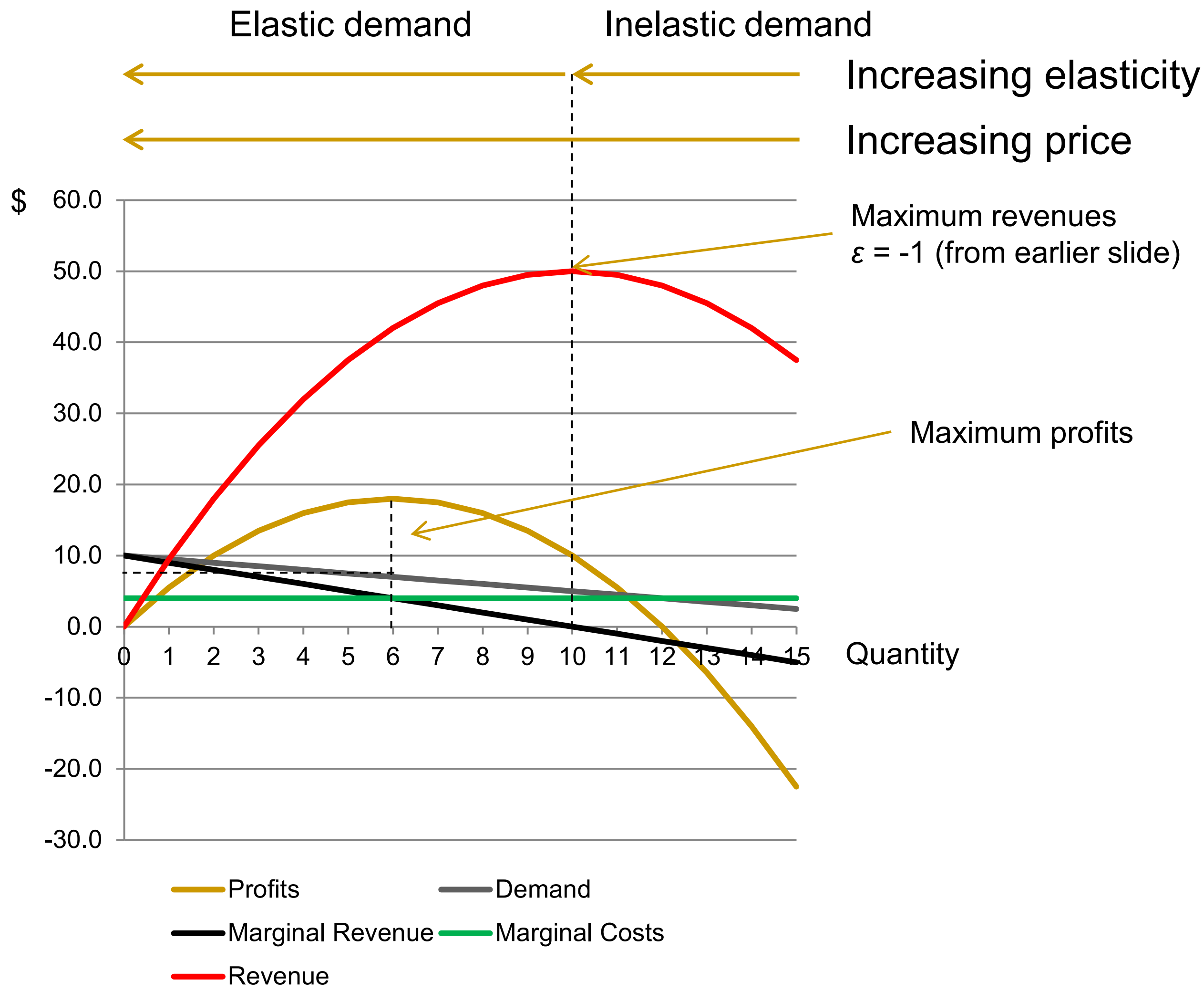
NB: The monopolist price p_m is the price at which the maximum available profits can be drawn from the market without price discrimination

Monopolists and elasticities

- Proposition
  - A monopolist will not operate in the inelastic portion of its demand curve

Remember:

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



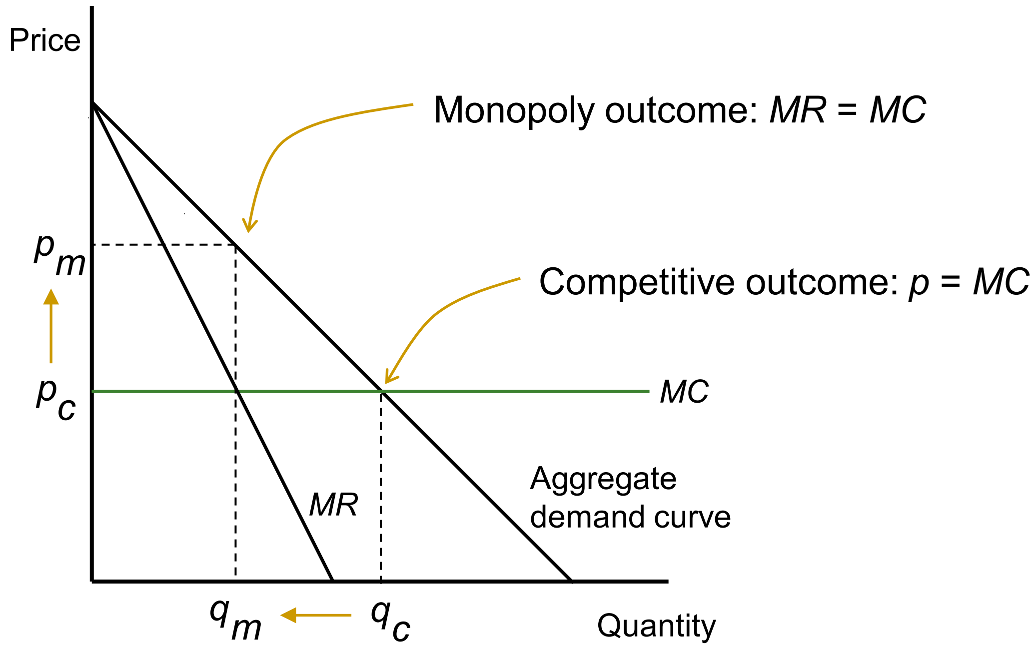
Review: Public policy on monopolies

- Modern view on why monopolies are bad:
  1. Increase price and decrease output
  2. Shift wealth from consumers to producers
  3. 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

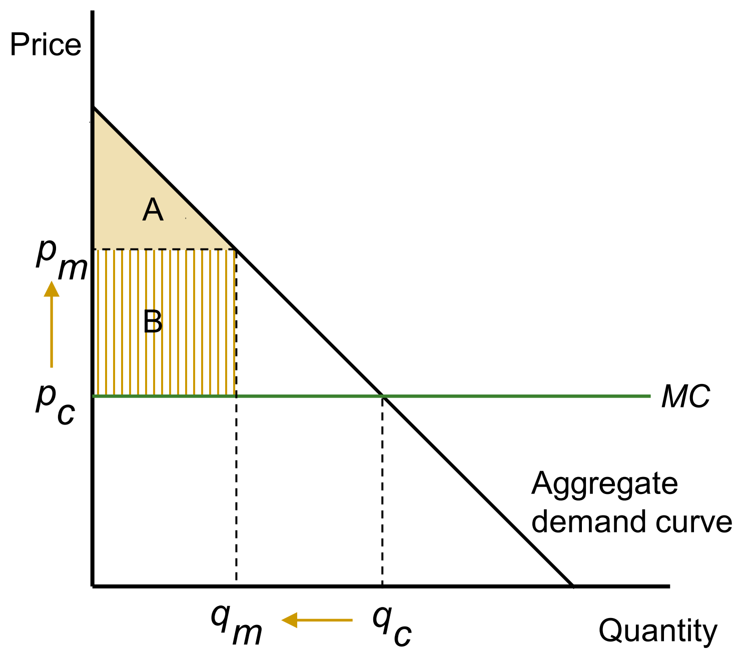
Review: Public policy on monopolies

1. Adverse effect on output and prices
   - Output decreases: $q_c > q_m$
   - Prices increase: $p_c < p_m$



Review: Public policy on monopolies

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

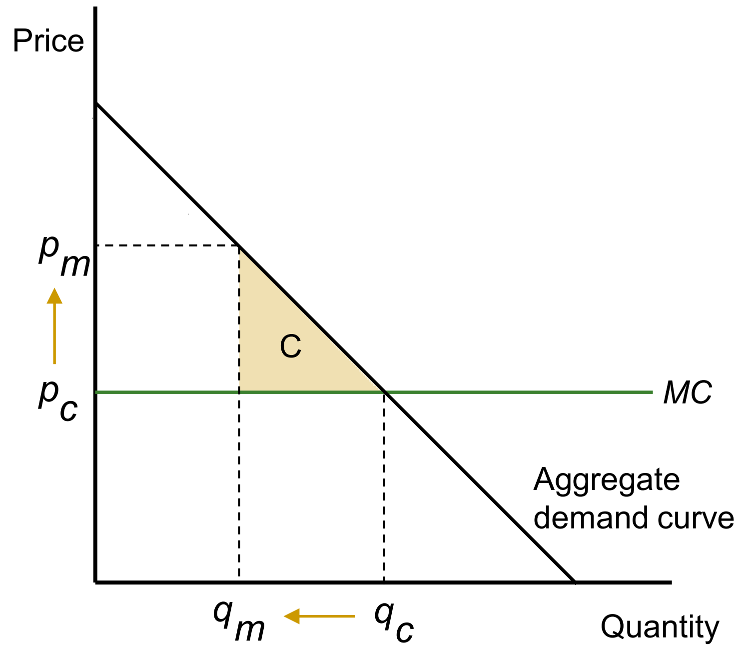


	Competitive	Monopoly
Consumers	A + B	A
Producers	0	B

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

Review: Public policy on monopolies

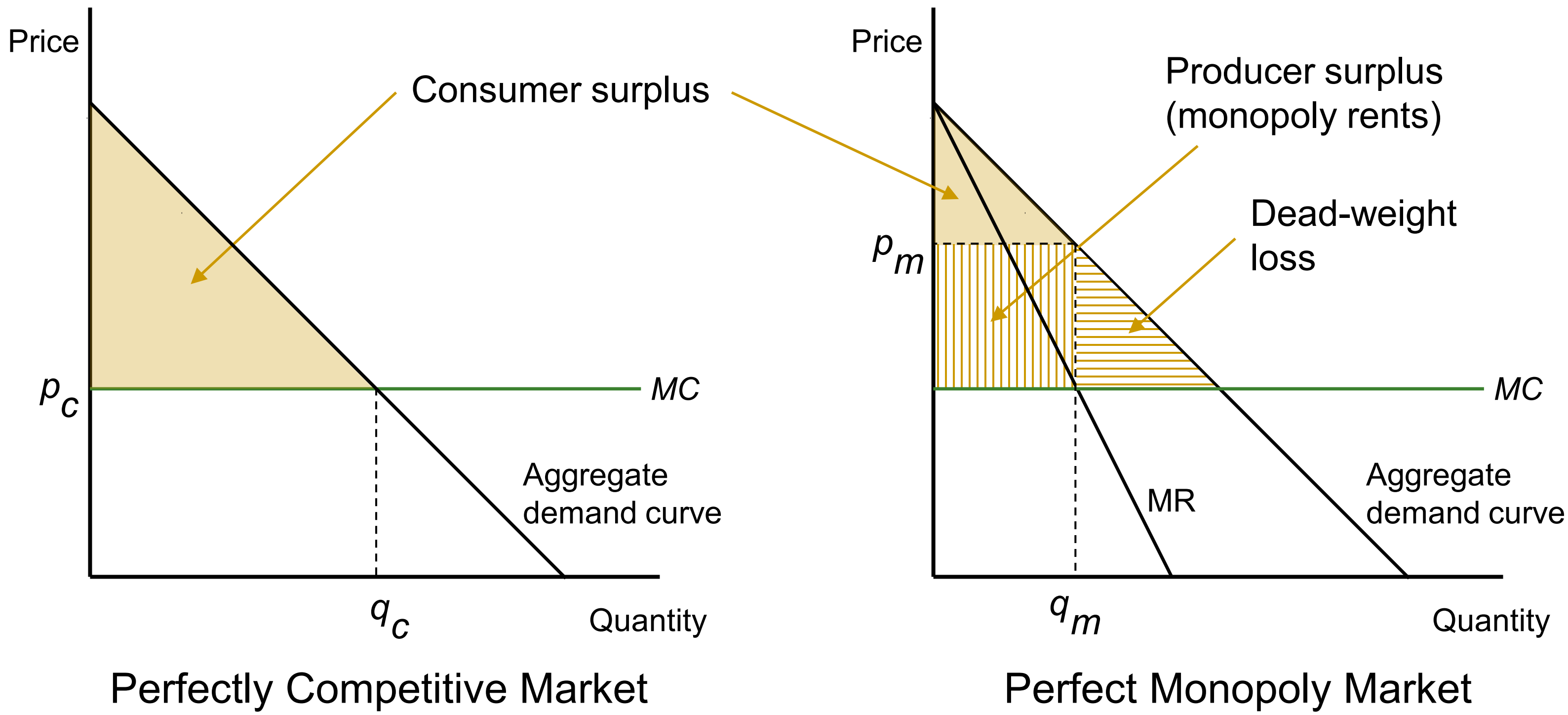
3. "Deadweight loss" of surplus of marginal customers*
   - Surplus C just disappears from the economy
   - Creates "allocative inefficiency" because it does not exhaust all gains from trade



* *Marginal customers* here means customers that would purchase at the competitive price but not the the monopoly price

Review: Public policy on monopolies

1. Increases prices and decreases output
2. Shifts wealth from consumers to producers
3. Creates a deadweight economic loss



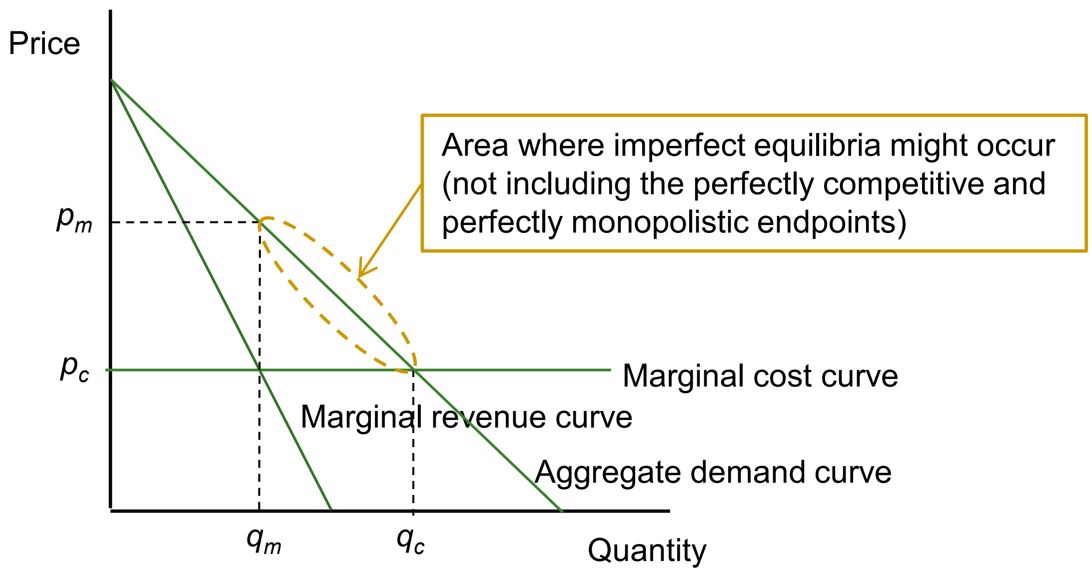
May also:

4. Decrease product or service quality
5. Decrease the rate of technological innovation or product improvement
6. Decrease product choice

Imperfectly Competitive Markets

Imperfectly Competitive Markets

- Range of imperfect equilibria
  - An imperfectly competitive equilibrium occurs when the equilibrium price and output on the demand curve falls strictly between the perfect monopoly equilibrium and the perfectly competitive equilibrium

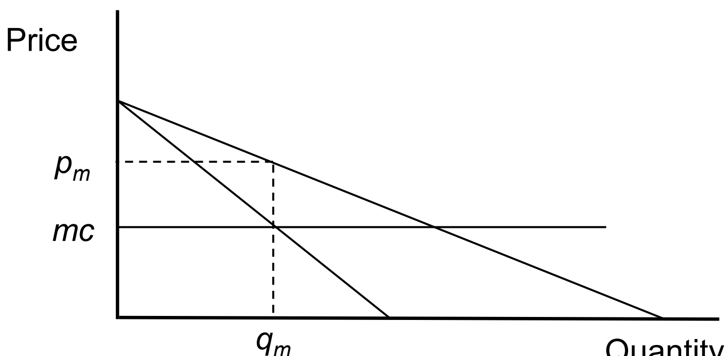


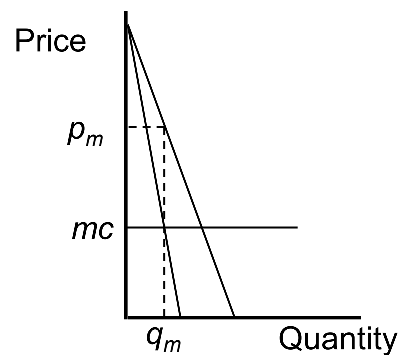
Market power

- Measuring market power
  - Economically, market power is the power of the firm to affect the market-clearing price through its choice of output level
  - The traditional economic 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 as a percentage of price:

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

    - In a competitive market, $L = 0$ since because $p = mc$
    - In a perfectly monopolized market, L increases as the aggregate demand curve becomes steeper (and so price increases)





Homogeneous product models

- Homogeneous product models
  - Characterized by products that 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

$$Q(p) = \sum q_i(p)$$

      - Adding all individual consumer demands at price *p* gives aggregate demand
      - Adding all individual firm outputs at price *p* gives aggregate supply

Cournot oligopoly models

- The setup
  - The standard homogenous product model is the *Cournot model*
  - 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

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

where there a n firms in the market

  - The profit equation for firm i is:

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

Each firm i choses its level of output q_i, but it is the aggregate level of output that determines the market price

  - First order condition:

$$m\pi_i\left(q_i\right) = mr_i\left(q_i\right) - mc_i\left(q_i\right) = 0$$

This generates n equations in n unknows and can be solved for each q_i

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 (n=2)	20	60
Perfect monopoly	27.5	45

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

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

$q_{competitive}$	90	90	90	90	90	90	90	90	90
n	9	8	7	6	5	4	3	2	1
$q_{cournot}$	81	80	78.8	77.1	75	72	67.5	60	45

Cournot oligopoly models

- Relationship of the Lerner index to the Herfindahl-Hirschman Index
  - The *Herfindahl-Hirschman Index (HHI),* which is the principal antitrust measure of market concentration, is the sum of the squares of the markets shares of the firms in the market. That is:

$$HHI = s_1^2 + s_2^2 + \cdots + s_N^2 = \sum_{i=1}^{N} s_i^2$$

1. Define the firm *i*'s Lerner index to be: $L_i = \dfrac{p - c_i}{p} = \dfrac{s_i}{\varepsilon}$

   where s_i is the market share of firm *i* and ε is the own-elasticity of demand of the aggregate demand curve and *p* is the market equilibrium price
2. Define the market Lerner index as the sum of the share-weighted individual firm Lerner indices. Then:

$$L \equiv \sum_{i=1}^{n} L_i s_i = \sum_{i=1}^{N} \left(\frac{s_i}{\varepsilon} \right) s_i = \sum_{i=1}^{N} \frac{s_i^2}{\varepsilon} = \frac{HHI}{\varepsilon}$$

   where *L* is the market-share weighted sum of the L_I of the individual firms in the market.
   - *Key result*: In a Cournot model, the degree of exercise of market power in the market is a function of market concentration as measured by the HHI

Cournot oligopoly models

- Price increases in Cournot oligopoly models with equal marginal costs
  - From the previous slides:

$$L \equiv \frac{p - mc}{p} = \frac{HHI}{\varepsilon},$$

where p is the single market-clearing price and mc is the marginal cost for all firms in the market

  - Then:

$$\frac{p_{Postmerger} - mc}{p_{Postmerger}} - \frac{p_{Premerger} - mc}{p_{Premerger}} = \frac{HHI_{Postmerger}}{\varepsilon_{Postmerger}} - \frac{HHI_{Premerger}}{\varepsilon_{Premerger}}$$

Generally

$$= \frac{\Delta HHI}{\varepsilon}$$

For constant elasticity

That is, the difference in the percentage markup resulting from the merger is $\Delta HHI/\varepsilon$

Bertrand oligopoly models

- The setup
  - In a Bertrand model, the firm's control variable is *price*
    - Compare with the Cournot model, where the firm's control variable is *quantity*
    - The (download-sloping) residual demand curve gives the relationship between the firms choice of price and the quantity consumers will demand from the firm at that price
  - The profit equation for firm *i* is:

This is the demand function

$$\pi_i(p_i) = p_i \underbrace{q_i(p_i)} - C_i(\underbrace{q_i(p_i)}), \quad i = 1, 2, \ldots, n$$

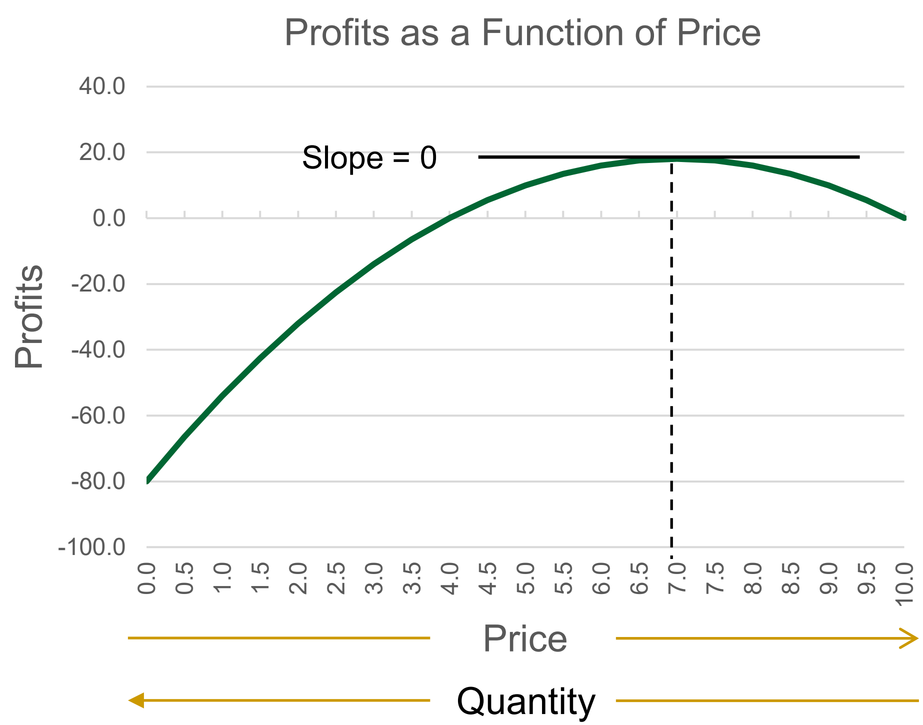
To see the first order conditions in operation, let's first look at profit-maximization for a monopolist whose control variable is price

Bertrand oligopoly models

- Profits as a function of price: Example for a monopolist

Price p	Quantity q	Revenues r	Costs C	Profits Π
0.0	20	0.0	80	-80.0
0.5	19	9.5	76	-66.5
1.0	18	18.0	72	-54.0
1.5	17	25.5	68	-42.5
2.0	16	32.0	64	-32.0
2.5	15	37.5	60	-22.5
3.0	14	42.0	56	-14.0
3.5	13	45.5	52	-6.5
4.0	12	48.0	48	0.0
4.5	11	49.5	44	5.5
5.0	10	50.0	40	10.0
5.5	9	49.5	36	13.5
6.0	8	48.0	32	16.0
6.5	7	45.5	28	17.5
7.0	6	42.0	24	18.0
7.5	5	37.5	20	17.5
8.0	4	32.0	16	16.0

Demand: $q = 20 - 2p$
Fixed costs = 0
Marginal costs = 4



Bertrand oligopoly models

- Observations
  - The profit curve as a function of price is a parabola
    - Although different in shape than the profit curve as a function of quantity
  - The profit maximum is when the slope of the profit curve is zero
  - So:

Marginal profits (as a function of price)	=	Marginal revenues (as a function of price)	-	Marginal costs (as a function of price)
	=	0 at the firm's profit maximum		

Bertrand oligopoly models

- Profit-maximization when a monopolist sets price: Example

Demand: $q = 20 - 2p$ Marginal costs ($mc(q)$) = 4
Fixed costs = 0

- Revenues:

$$\pi(p) = pq(p) = p(20-2p) = 20p - 2p^2$$

This describes the parabola on the prior slide

- Marginal revenues:

$$mr(p) = 20 - 4p$$

Remember, if $y = ax + bx^2$ is the function, then the marginal function is $a + 2bx$

- Cost

$$mc * q(p) = mc(20-2p) = 4(20-2p) = 80 - 8p$$

Constant marginal cost

Note: If $y = a + bx$ is the function, then the marginal function is b

- Marginal cost:

$$mc(p) = -8$$

NB: This is marginal cost as a function of p (not q). Why is it a negative number?

- FOC:

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

$$20 - 4p^* = -8$$

So $p^* = 7$ and $q^* = 6$

Bertrand oligopoly models

- Homogeneous products case with equal cost functions
  - Consider two firms producing homogeneous (identical) products at constant marginal cost *c* that use price as their control variable
  - Consumers purchase from the lower priced firm; if both firms charge the same price, they split equally consumer demand
  - Profit function for firm *i*:

$$\pi(p_i) \begin{cases} = p_i q_i(p_i) - c(q_i(p_i)) & \text{if } p_i < p_j \\ = \dfrac{p_i q_i(p_i) - c(q_i(p_i))}{2} & \text{if } p_i = p_j \\ = 0 & \text{if } p_i > p_j \end{cases}$$

    - That is, firm *i* gets 100% of market demand at price p_i if p_i is the lower price of the two firms, the two firms split the market demand if their prices are equal, and firm *i* gets nothing if it has the higher price
    - *Equilibrium*: $p_1 = p_2 = mc$, so that both firms price at marginal cost (i.e., the competitive price) and split equally market demand and total market profits

Bertrand oligopoly models

- Homogeneous products case with asymmetric cost functions
  - Now consider two firms producing homogeneous (identical) products but with different cost functions costs, with firm 1 have lower marginal costs than firm 2 (i.e., $mc(q(p(1)) < mc(q(p2)))$)
  - The profit function is the same as before:

$$\pi(p_i)\begin{cases} = p_i q_i(p_i) - c(q_i(p_i)) & \text{if } p_i < p_j \\ = \dfrac{p_i q_i(p_i) - c(q_i(p_i))}{2} & \text{if } p_i = p_j \\ = 0 & \text{if } p_i > p_j \end{cases}$$

  - *Equilibrium*: Firm 1 prices just below firm 2 and captures 100% of market demand
    - *Idea*: firm 1 and firm 2 compete the price down to firm 2's marginal cost as in the symmetric cost case. Then firm 1 just underprices firm 2 and captures 100% of the market demand

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 the same 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. It assumes that Firm 2' price is constant.

    - Solving for the Bertrand equilibrium:

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

You do not need to know this. What is important is how the model is set up.

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 its 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

Dominant firm with a competitive fringe

- Dominant oligopolies
  - The model can be extended to the case where the dominant firm is replaced by a dominant oligopoly
    - The key is to specify the solution concept for the choice of output by the firms in the oligopoly (e.g., Cournot). You then create a residual demand curve for the oligopoly and apply the solution concept to that demand curve.
- Fringe firms
  - As we saw in Unit 2, the DOJ and the FTC typically ignore fringe firms. The dominant oligopoly model with a competitive fringe provides a theoretical justification.