Unit 8. Competition Economics

Part 2. Markets and Market Equilibria

Merger Antitrust Law
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Terms to know

Other things	Substitutes	How Substitutes and Complements Affect Demand
	Complements	
	Elasticity	Basics of Elasticities
		Elasticity of Demand
		Calculating Elasticity of Demand
		Elasticity and its Applications
	Cross elasticity	Cross elasticity of demand
		Calculating the Elasticity of Demand
	Monopolists	Intuition for Monopoly and Elasticity

Terms to know

Market models	Market equilibrium	The Equilibrium Price and Quantity Exploring Equilibrium
	Perfect competition	Introduction to the Competitive Firm Maximizing Profit Under Competition
	Perfect monopoly	Maximizing Profit Under Monopoly Monopoly Basics
	Lerner index	The Monopoly Markup
	Imperfectly competitive equilibrium	
	Cournot model	Cournot Competition Cournot oligopoly
	Bertrand model	Bertrand Competition Cournot versus Bertrand Basics
	Dominant firm model	

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
    - *Horizontal mergers* involve combinations of firms that offer substitute products

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

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

  - Examples
    - Coke and Pepsi
    - iPhone and Galaxy S series mobile phones
    - Nike and Adidas shoes
    - Hertz and Avis rental cars
    - Cars and oil
  - In each case, as the price of product A increases—
    - The demand for product A decreases (from the downward-sloping demand curve), and
    - The demand for the substitute product B increases

Substitutes/Complements

- Complements
  - *Definition*: 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

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

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

    - Examples
      - Printers and ink cartridges
      - Razors and razor blades
      - Computers and computer software
  - In each case, as the price of product A increases—
    - The demand for product A decreases (from the downward-sloping demand curve), and
    - The demand for the complement product B also 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.

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

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

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:

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

This fraction is equal to 1

Slope of the (residual) demand curve: Always negative

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

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* (that is, without regard to whether they are positive or negative)
- Some important definitions
  - *Inelastic demand*: Not very price sensitive

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

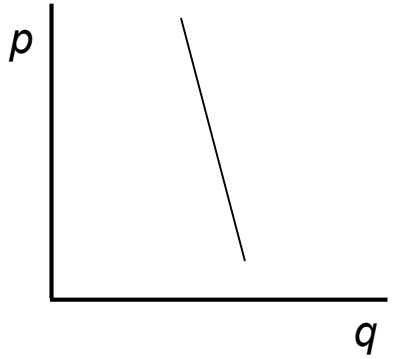
  - *Unit elasticity*:

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

  - *Elastic demand*: Price sensitive

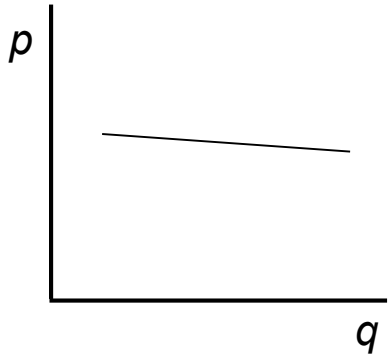
$$|\varepsilon| = \frac{\%\text{change in quantity}}{\%\text{change in price}} > 1$$

Very inelastic demand



Little sensitivity to price

Very elastic demand



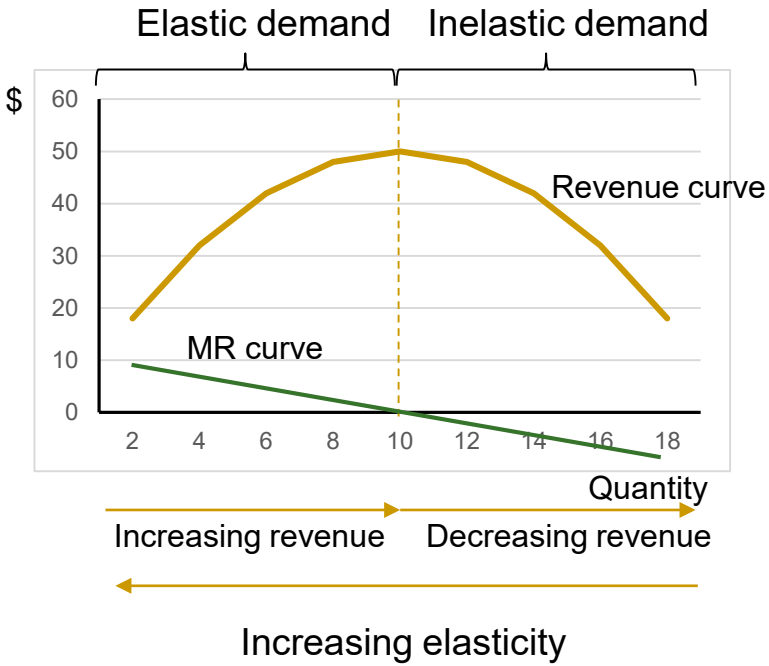
Demand is very sensitive to price

Elasticities

- Elasticity of demand 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	
2	16	-2	0.1250	-0.2500	32	Inelastic demand
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	
7	6	-2	1.1667	-2.3333	42	Elastic demand
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

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*.

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

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

Percentage change p_i in the price of product *i*

  - 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

Cross-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 (optional)

- 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 (optional)

- 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)

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

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

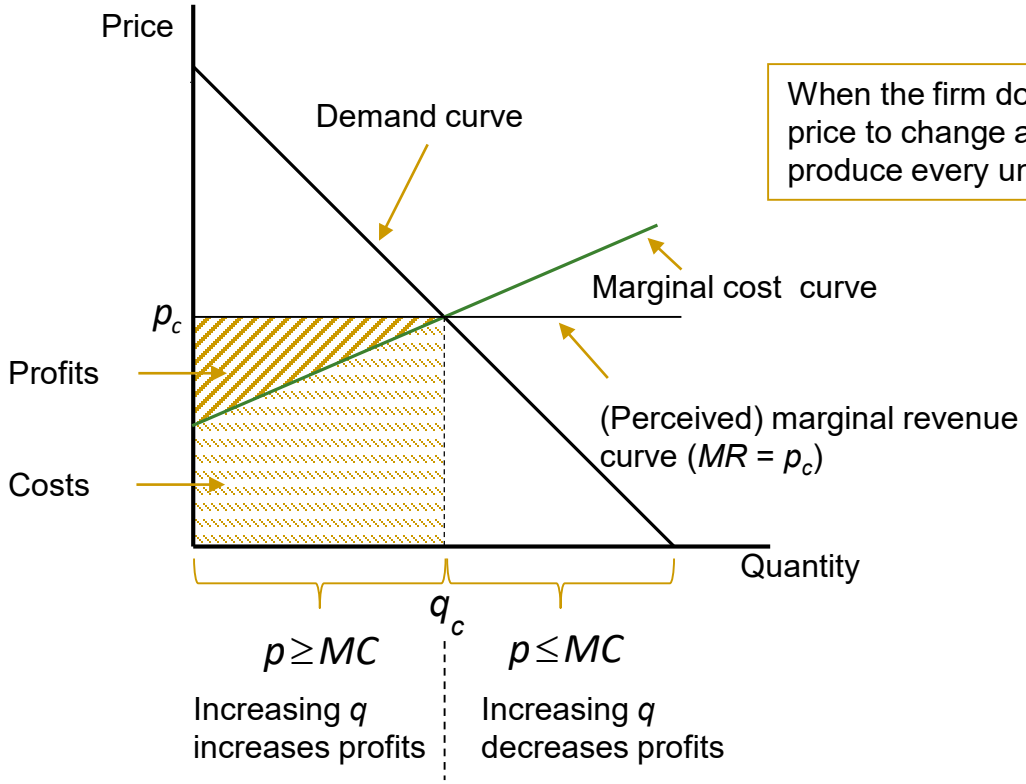
- *Definition*: A market in which no single firm can effect price, meaning:
  - The firm's residual demand curve is horizontal,
  - The firm can sell any amount of product without affecting the market price,
  - $\frac{dp}{dq} = 0$, or
  - $p = \frac{dc}{dq}$ (i.e., price = marginal cost)

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

- 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 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 $p \geq MC$

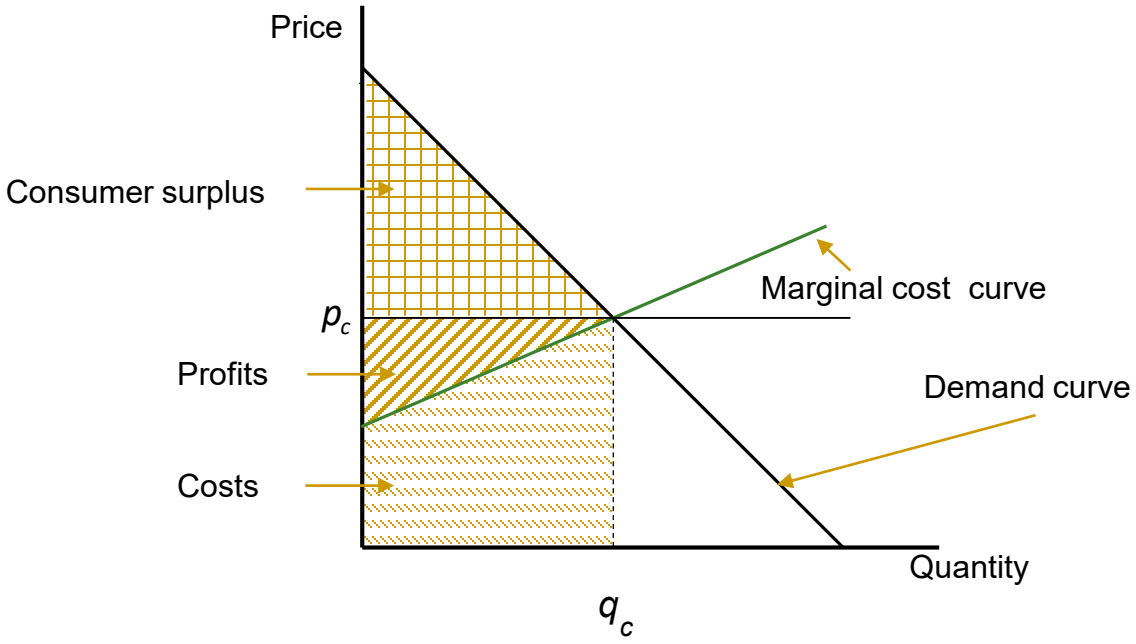
Rule: As always, the FOC is $MR = MC$. If the firm is competitive, then $MR = p_c$ and so FOC is $p_c = MC$.

Competitive firms

- Take-aways
  1. Competitive firms do not perceive that their output decisions affects 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 firm, 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 it output decision—on the premise that its marginal revenue is equal to the market price.
     - Hence, the firm select an output level so that $p = mc$.

Competitive firms

- 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
  - The aggregate demand curve from consumers defines the residual demand curve facing the firm
  - The monopolist firm, like all other profit-maximizing firms, selects output so that marginal revenue is equal to marginal cost ($mr = mc$)
    - Since the aggregate demand curve (and hence the monopolist's residual demand curve) is downward sloping, an increase in the monopolist's output requires a downward adjustment in the price to clear the market
    - Therefore, the market-clearing price p_m for a monopolist at its profit-maximizing level of output q_m is greater than the firm's marginal revenue, which in turn is equal to the firm's marginal cost:

$$p_m > mr(q_m) = mc(q_m)$$

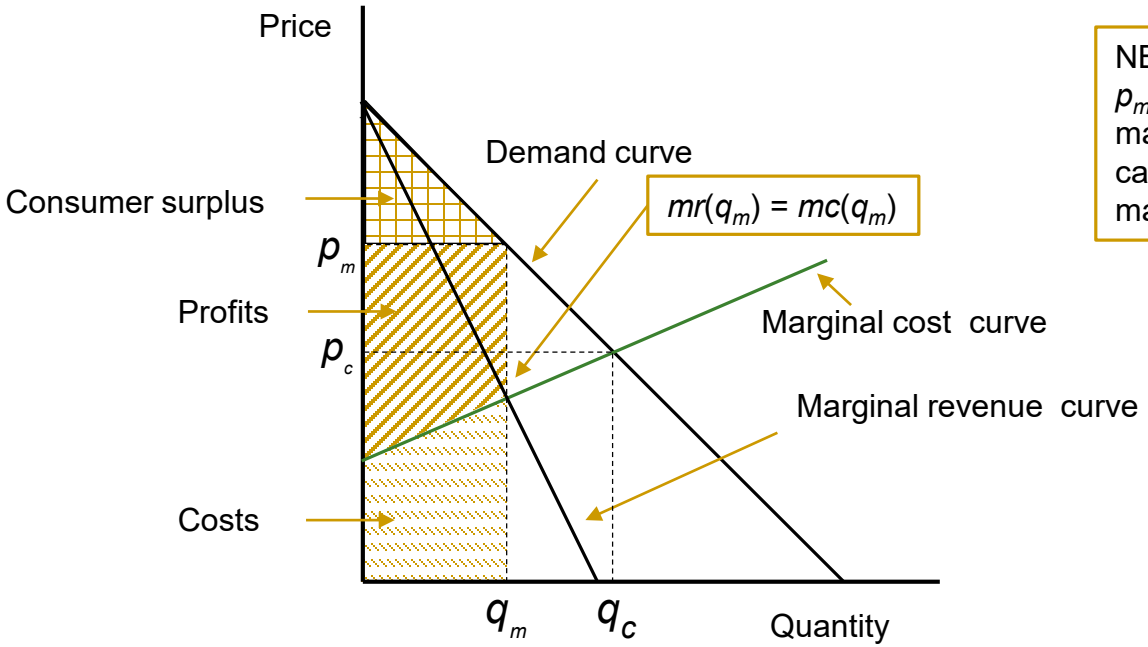
      - This means that there are consumers willing to pay a price that covers the monopolist's marginal cost of production, so that all gains from trade are not exhausted

Monopolist firm

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

$$p_m > mr(q_m) = mc(q_m) = p_c$$

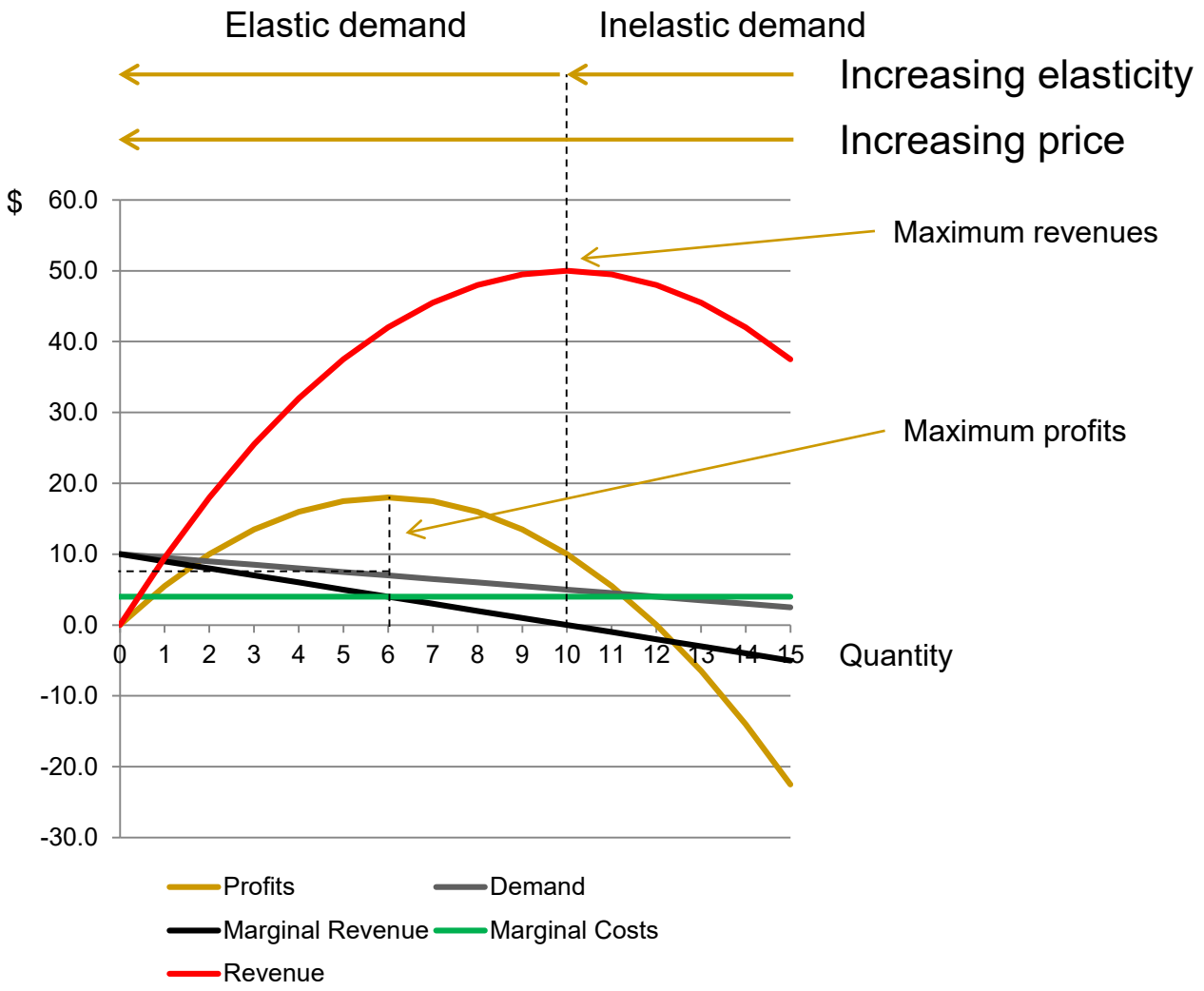
  - A monopolist produces a lower output than would a competitive firm facing the same residual demand curve



NB: The monopolist price p_m is the price at which the maximum available profits can be drawn from the market.

Monopolists and elasticities

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



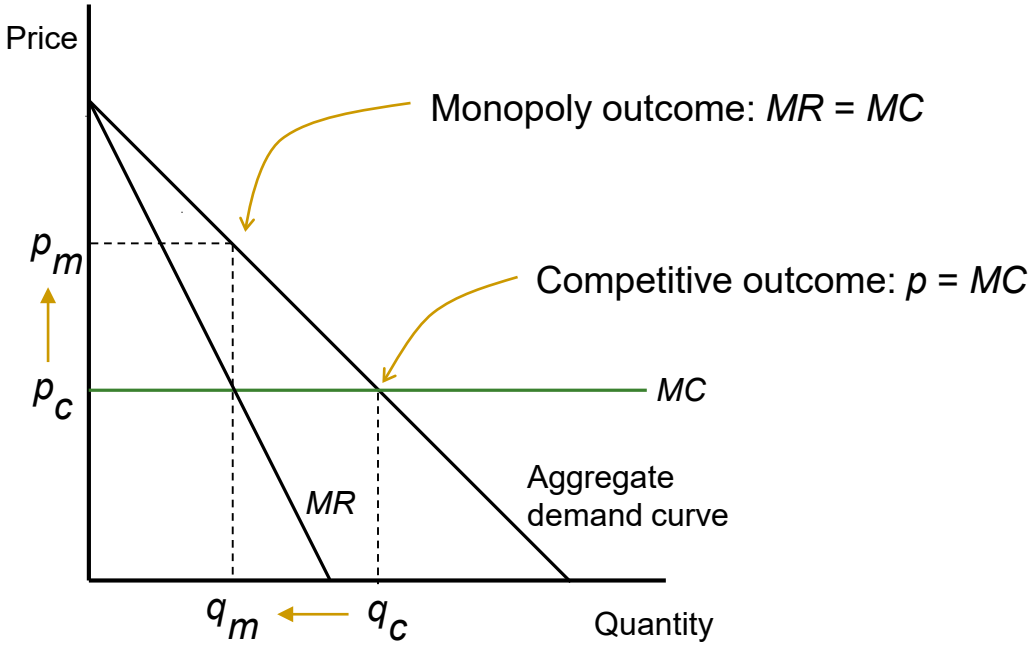
Review: Public policy on monopolies

- 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

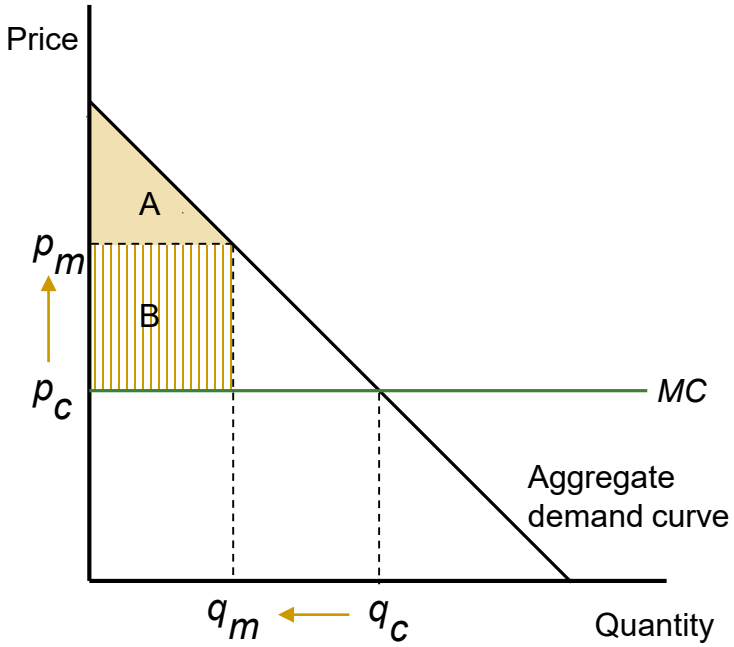
Review: Public policy on monopolies

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



Review: Public policy on monopolies

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

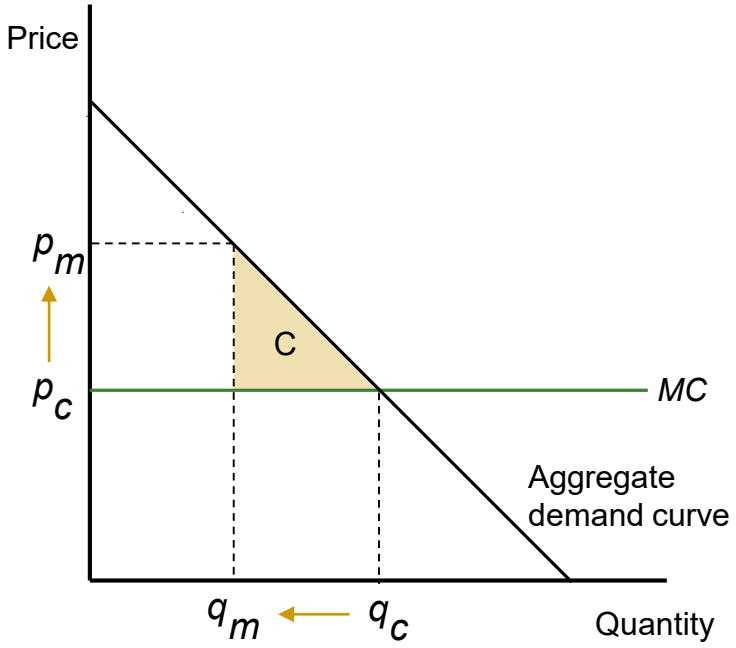


	Competitive	Monopoly
Consumers	A + B	A
Producers	0	B

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

Review: Public policy on monopolies

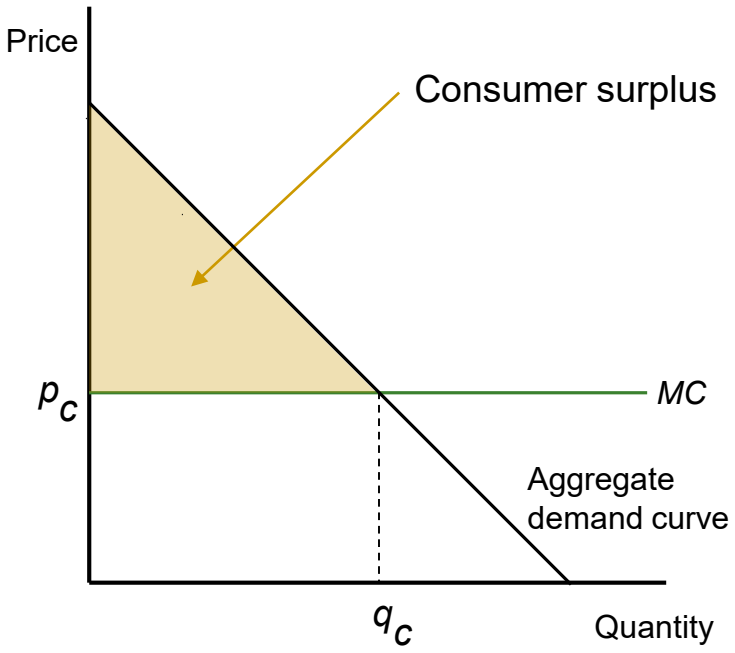
- "Deadweight loss" of surplus of marginal customers*
  - Surplus C just disappears from the economy
  - Creates "allocative inefficiency" because it does not exhaust all gains from trade



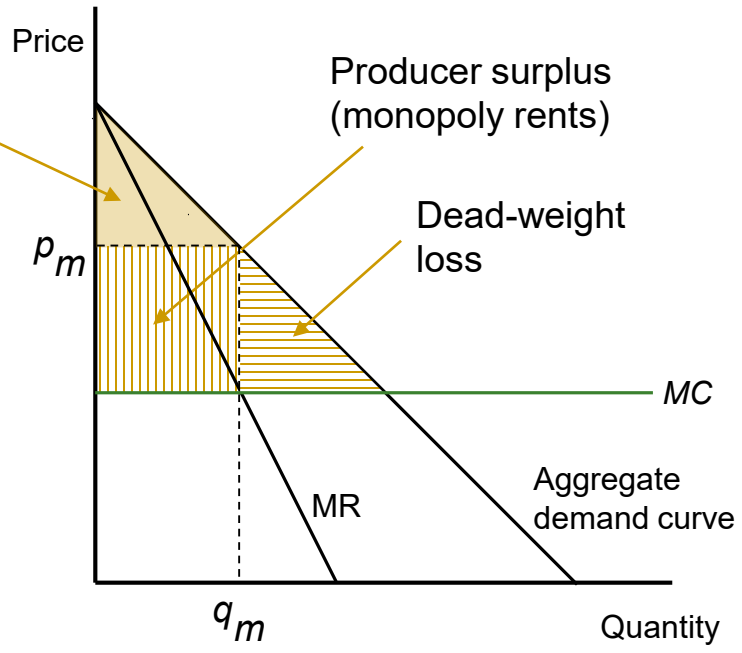
* Marginal customers here means customers that would purchase at both the competitive price and the monopoly price

Review: Public policy on monopolies

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



Perfectly Competitive Market



Perfect Monopoly Market

Imperfectly Competitive Markets

Market power

- Some legal 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]

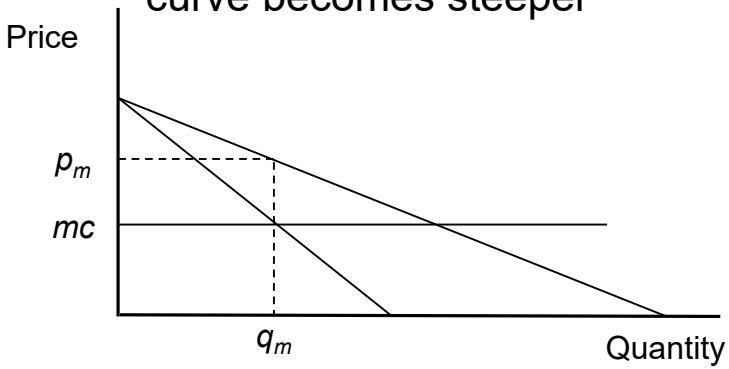
[1] Jefferson Parish Hosp. Dist. No. 2 v. Hyde, 466 U.S. 2, 27 n.46 (1984); *accord* NCAA v. Board of Regents, 468 U.S. 85, 109 n.38 (1984); Copperweld Corp. v. Independence Tube Corp., 467 U.S. 752, 789 n.19 (1984).
[2] Fortner Enters., Inc. v. United States Steel Corp., 394 U.S. 495, 503 (1969)
[3] 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).

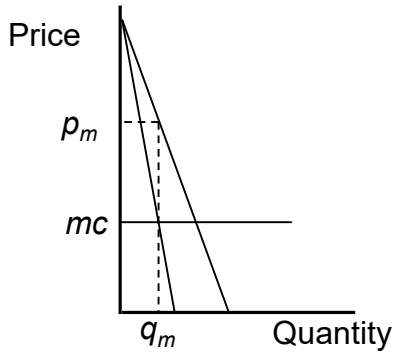
Market power

- Measuring market power
  - 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:

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

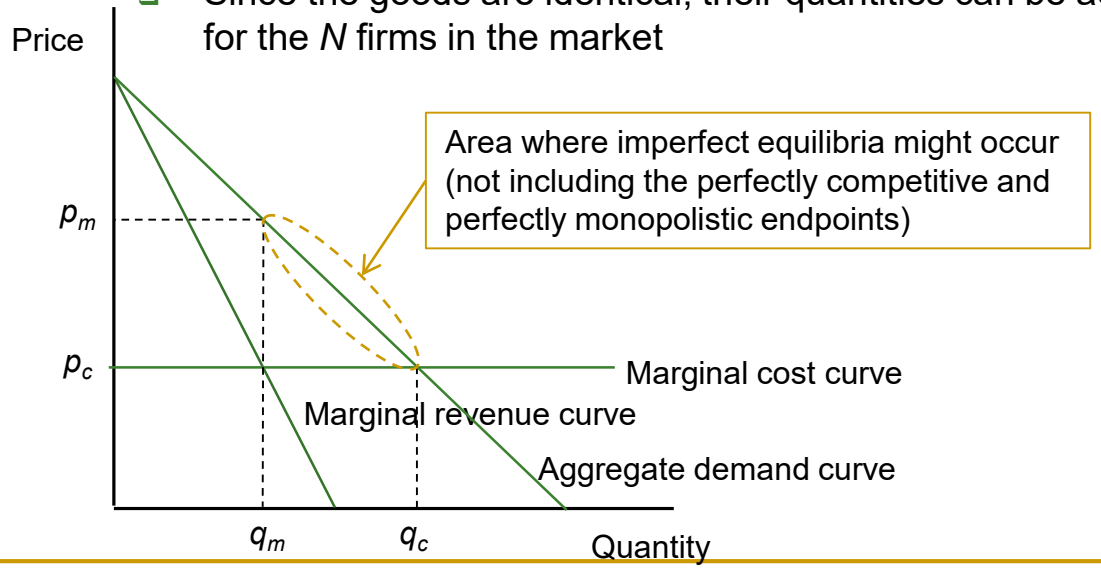
    - In a competitive market, $L = 0$ since because $p = mc$
    - In a perfectly monopolized market, L increases as the aggregate demand curve becomes steeper





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*
  - 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:

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

Each firm i choses its level of output q_i, but the aggregate level of output determines the market prices

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 $n = 1$:

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

Cournot oligopoly models (optional)

- 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* and ε is the own-elasiticity of demand of the aggregate demand curve and the market equilibrium price

  - So the market Lerner index is:

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

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

    - The Herfindahl-Hirschman Index (HHI), which is the principal measure of market concentration, is the sum of the squares of the markets shares of the firms in the market. That is,

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

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(i.e., the competitive price) 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

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.