

# Monopoly

# Monopoly

## Key Characteristics

- **One seller**
  - >>> the firm represents the whole industry
  - >>> industry's demand = firm's demand
- **Unique Product**
  - >>> the firm has its own group of buyers
  - >>> demand is downward-sloping
- **Barriers to Entry**
  - >>> the firm can make abnormal profit in the long run

# Why does Monopoly exist?

Definition: **Barriers to Entry** are factors that allow an incumbent firm to earn positive economic profits while making it unprofitable for newcomers to enter the industry.

1. **Structural Barriers to Entry** – occur when incumbent firms have cost or demand advantages that would make it unattractive for a new firm to enter the industry
2. **Legal Barriers to Entry** – exist when an incumbent firm is legally protected against competition
3. **Strategic Barriers to Entry** – result when an incumbent firm takes explicit steps to deter entry

# Monopoly

## Types of Monopoly

- Single-Price Monopolist  
Charges the same price for all units.
- Price-Discriminating Monopolist  
Charges different prices for different units.

**In this lecture, we will focus on the first type.**

# Monopoly vs Perfect Competition

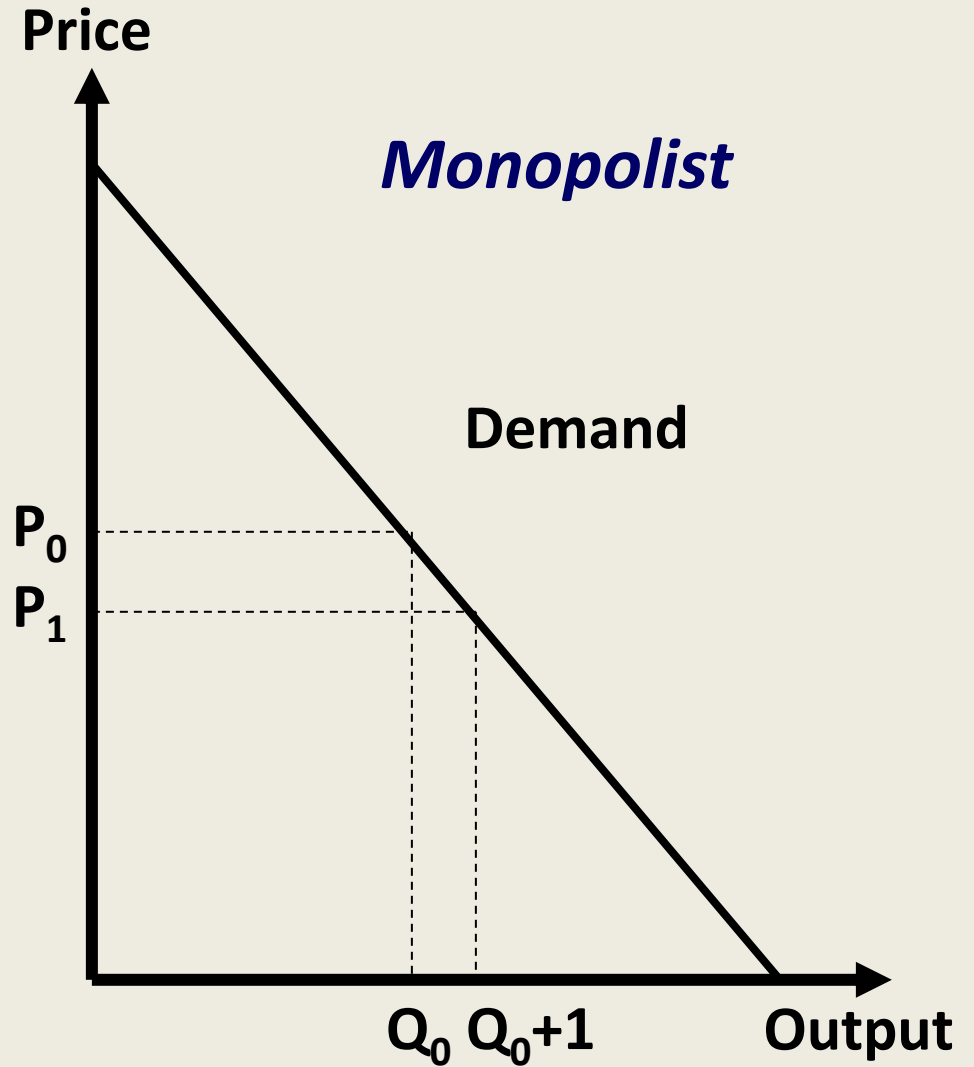
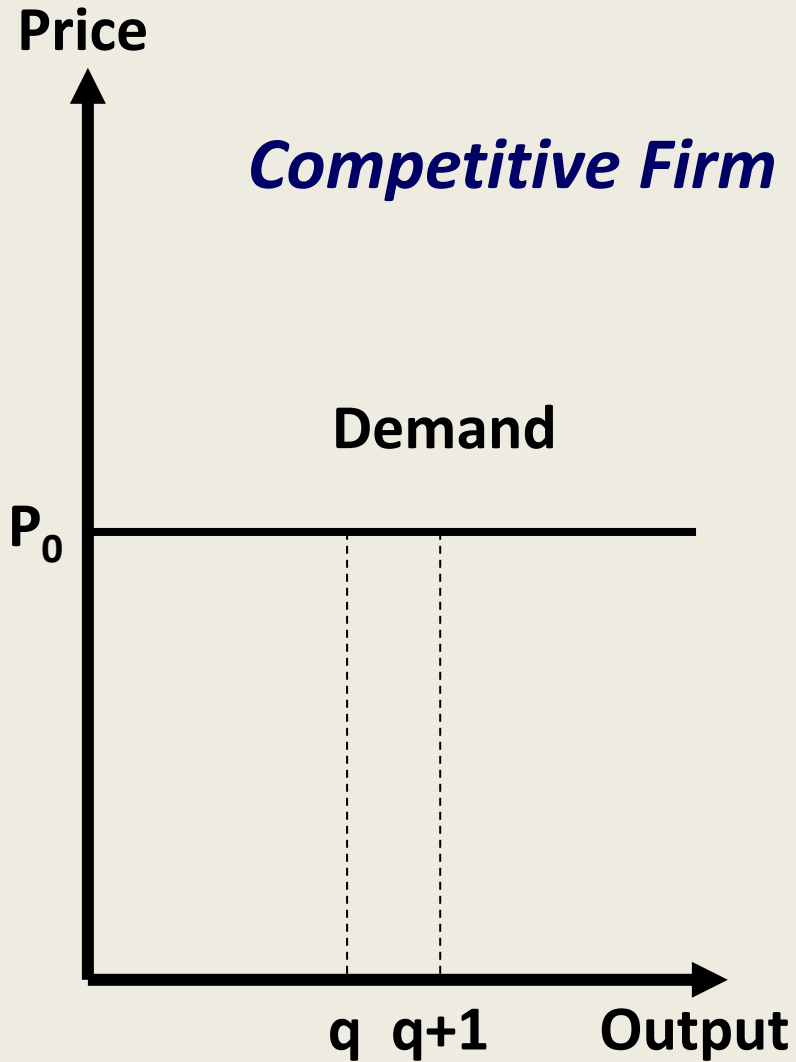
In perfect competition, there are infinitely many buyers and sellers, selling homogeneous products.

As a result, **perfectly competitive firms are price takers**: they take price as given, and face a perfectly elastic demand curve.

In contrast, **a monopolist is a price maker**. It sets the market price to maximize its profit.

However, we often state the monopolist's profit maximization problem in terms of setting quantity rather than price. This is because  $\pi(Q)$ ,  $TR(Q)$ , and  $TC(Q)$  are functions of Quantity.

# Demand Curve



# A Monopoly – Profit Maximizing

*The monopolist's profit maximization problem:*

$$\text{Max } \pi(Q) = \text{TR}(Q) - \text{TC}(Q)$$

*where:*  $\text{TR}(Q) = QP(Q)$  and  
 $P(Q)$  is the (*inverse*) market demand curve.

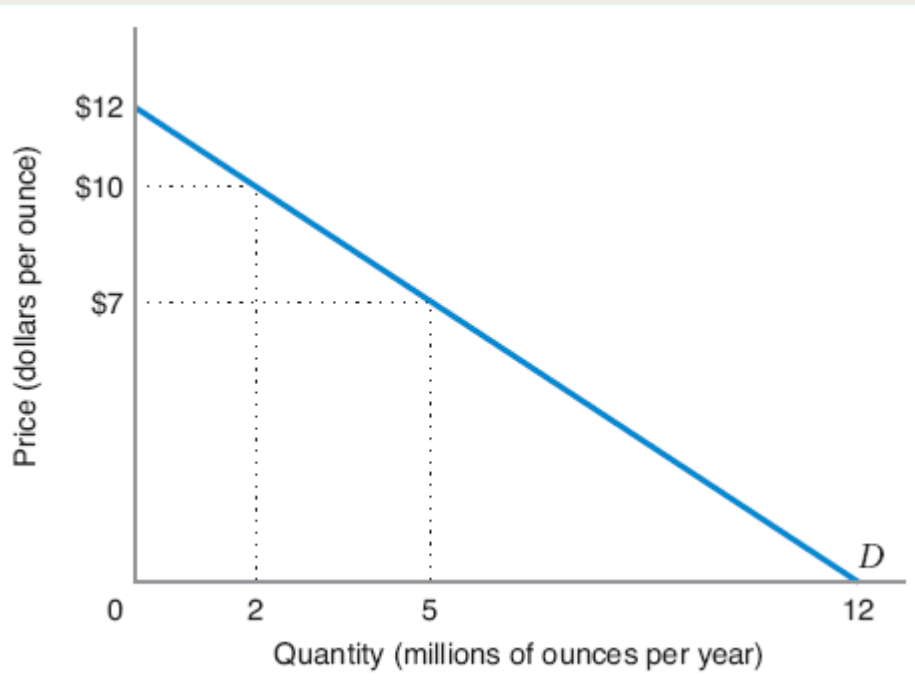
*The monopolist's profit maximization condition:*

$$\Delta \pi(Q) / \Delta Q = 0$$

$$\Delta \text{TR}(Q) / \Delta Q = \Delta \text{TC}(Q) / \Delta Q \quad \text{OR} \quad \text{MR}(Q) = \text{MC}(Q)$$

# A Monopoly – Profit Maximizing

The Monopolist's Demand Curve is downward-sloping: the higher P, the lower Q, and vice versa.



- Along the demand curve, different revenues for different quantities
- Profit maximization problem is **the optimal trade-off between volume** (number of units sold) **and margin** (the differential between price).

# A Monopoly – Profit Maximizing

- Demand Curve:  $P(Q) = 12 - Q$
- Total Revenue:  $TR(Q) = Q \times P(Q) = 12Q - Q^2$
- Total Cost:  $TC(Q) = \frac{1}{2}Q^2$
- Profit-Maximization:  $MR(Q) = MC(Q)$

# A Monopoly – Profit Maximizing

Given the inverse demand and MC, what is the profit maximizing Q and P for the monopolist?

$$P = 12 - Q$$

$$MC = Q$$

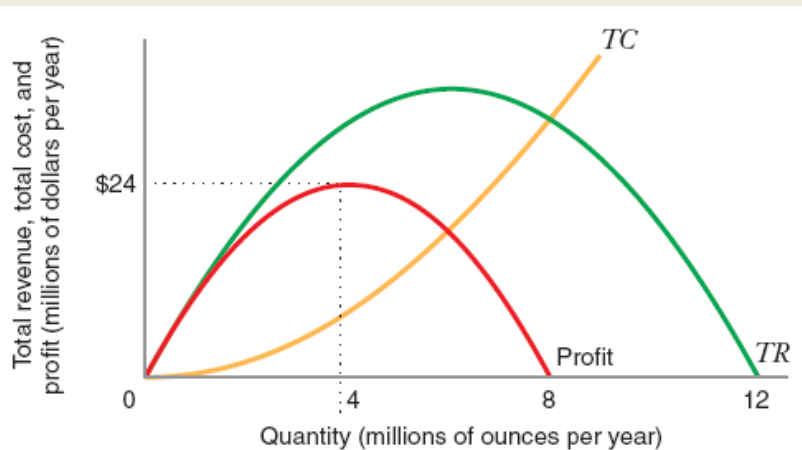
$$MR = 12 - 2Q$$

Setting  $MC = MR$  ;  $12 - 2Q = Q$

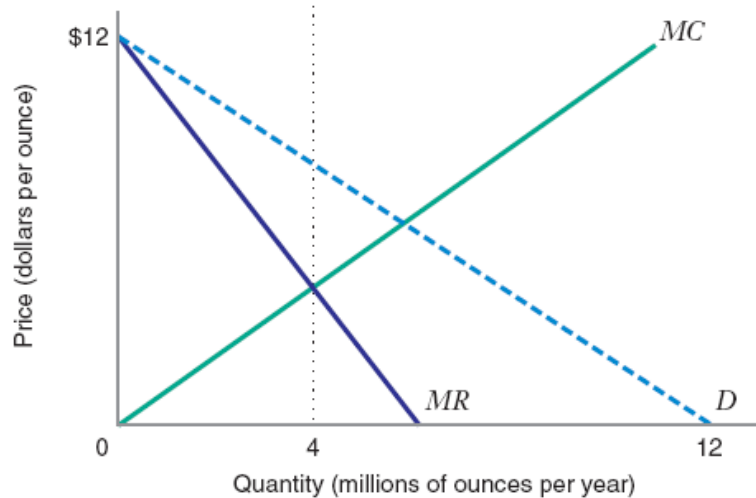
$$Q^* = 4$$

$$P^* = 12 - 4 = 8$$

# A Monopoly – Profit Maximizing



(a)



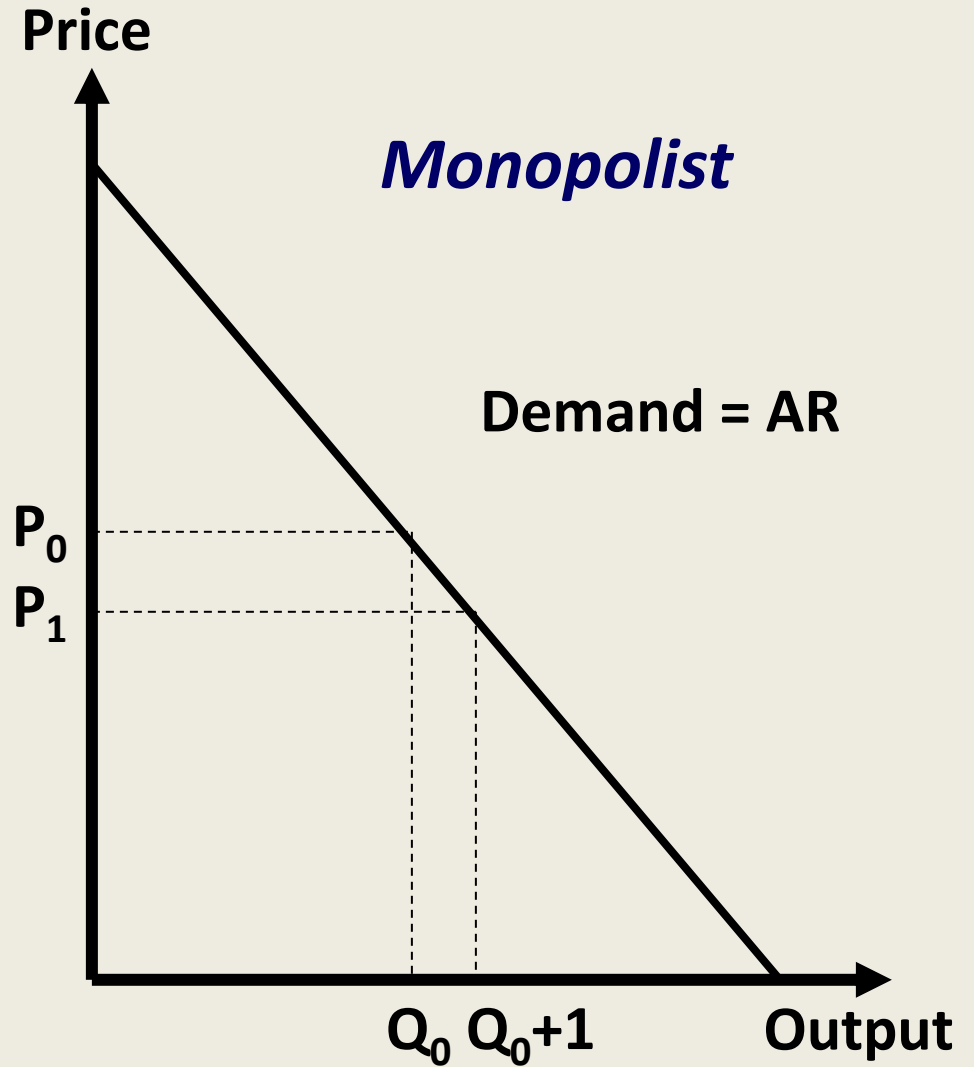
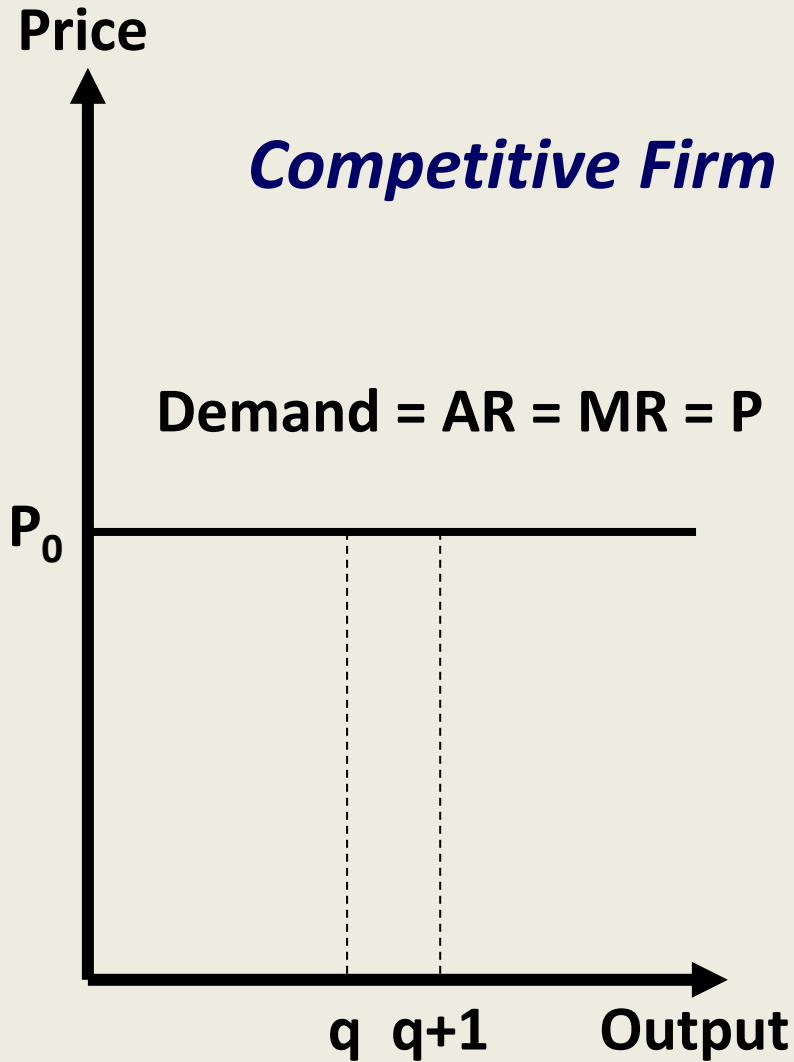
(b)

- As Q increases TC increases, TR increases first and then decreases.
- Profit Maximization is at  $MR = MC$ .

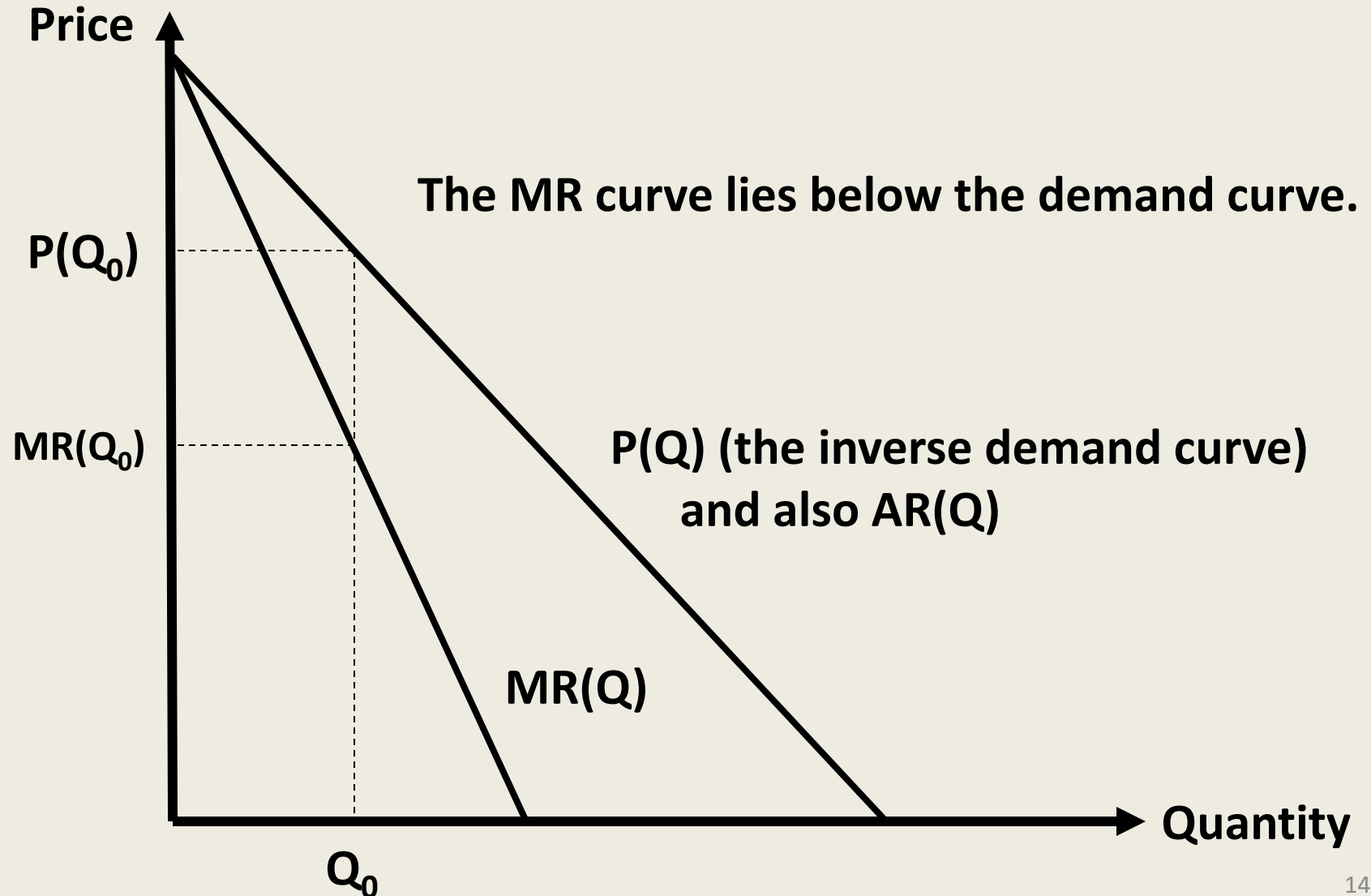
# A Monopoly – Profit Maximizing

- $MR > MC$ , firms can increase  $Q$  and increase profit. **Firms should sell as long as  $MR \geq MC$ .**
- $MR < MC$ , firms can decrease quantity and increase profit.
- $MR = MC$ , firms cannot increase profit. **In other words, the profit is maximized.**

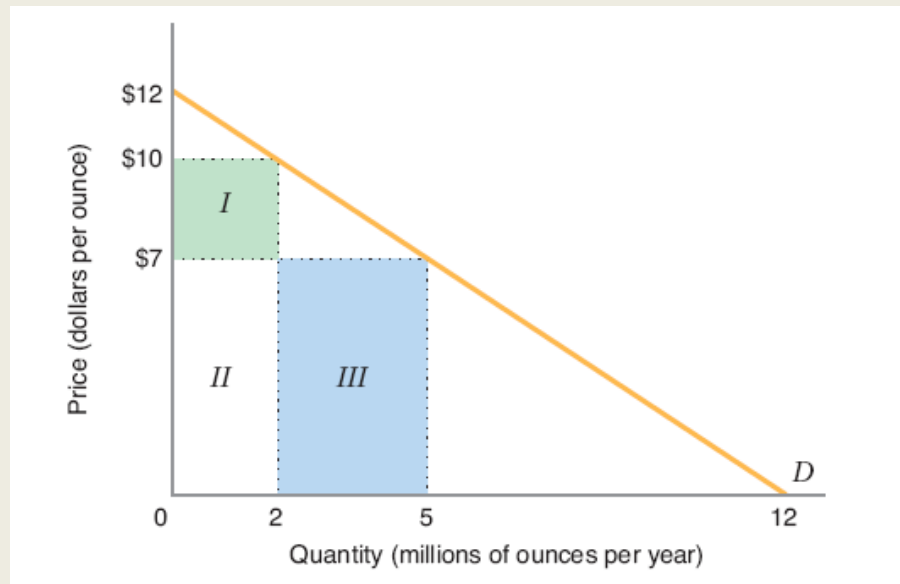
# MR and AR



# Marginal Revenue Curve and Demand



# Marginal Revenue Curve and Demand



- The firm faces a downward-sloping demand curve.
- To sell more units, a monopolist has to lower the price of all previous units sold.
- At a lower P, the increase in TR is Area III.
- The TR sacrificed is Area I.

# Marginal Revenue

$$MR = \frac{\Delta TR}{\Delta Q} = \frac{P\Delta Q + Q\Delta P}{\Delta Q} = P + Q \frac{\Delta P}{\Delta Q}$$

- $\Delta P/\Delta Q$  = slope of the inverse demand curve.
- Since  $\Delta P/\Delta Q < 0$ ,  $MR < P$ .
- **That is, if it produces one more unit, the extra revenue gained will be lower than the price charged for that unit.**

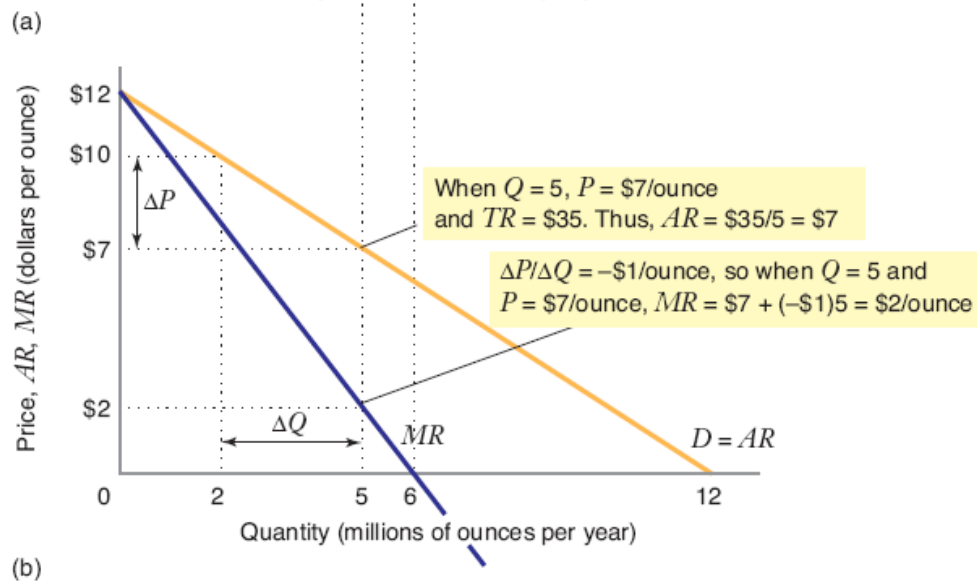
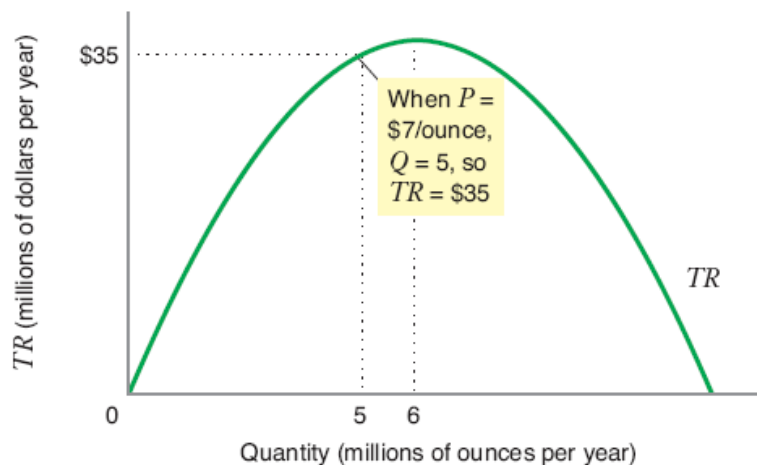
# Average Revenue

Since  $AR = \frac{TR}{Q} = \frac{P \times Q}{Q} = P$

the monopolist's AR curve coincides with the market inverse demand curve:

$$AR(Q) = P(Q)$$

# MR and AR



- The demand curve and the AR curve coincide.
- (For  $Q > 0$ )  
**Since  $MR < P$ , we have  $MR < AR$ , i.e. MR lies below the demand curve and AR curve.**

# MR and AR

When  $P$  decreases by \$3 per ounce (from \$10 to \$7),  
 $Q$  increases by 3 million ounces (from 2 million to 5 million).

$$\frac{\Delta P}{\Delta Q} = -1$$

$$TR = P \times Q = 7 \times 5 = \$35 \text{ million per year}$$

$$AR = \frac{TR}{Q} = \frac{35}{5} = \$7 \text{ per ounce}$$

$$MR = P + Q \frac{\Delta P}{\Delta Q} = 7 + 5(-1) = \$2 \text{ per ounce}$$

# MR and AR



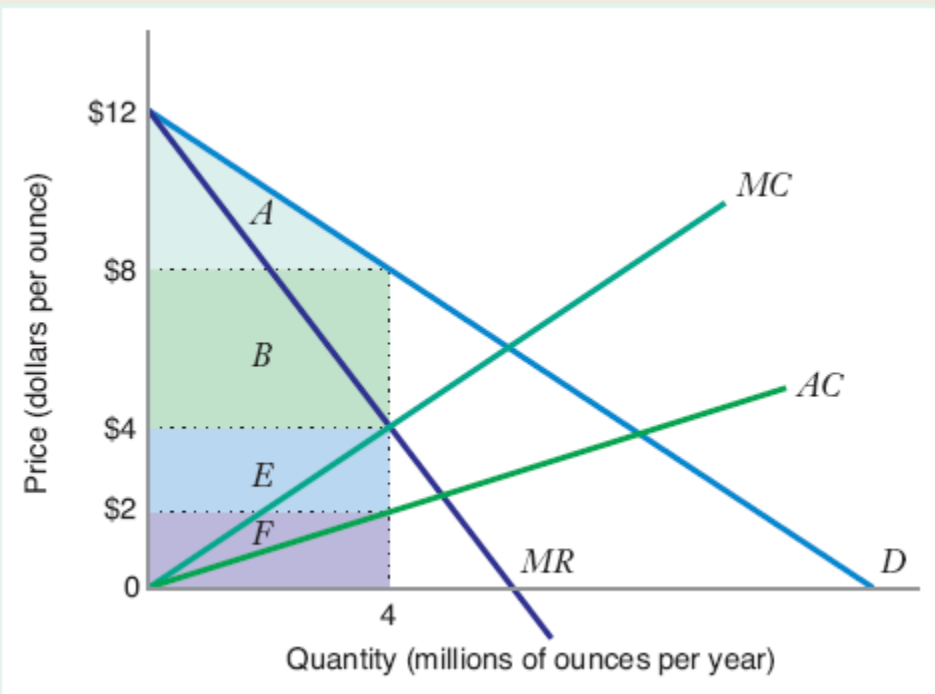
## LEARNING-BY-DOING EXERCISE 11.1

### Marginal and Average Revenue for a Linear Demand Curve

Suppose that the equation of the market demand curve is  $P = a - bQ$ .

**Problem** What are the expressions for the average and marginal revenues curves?

# Profit Maximization



- Profit-Maximizing output is at  $MR = MC$ .
- Monopolist will make 4 million ounces and sells at \$8 per ounce.
- $TR = \text{Areas } B + E + F$ .
- $TC = \text{Area } F$
- Profit ( $TR - TC$ ) is  $B + E$ .

# Positive Profits for Monopolist

**This profit is positive. Why?**

Because the monopolist takes into account the price-reducing effect of increased output so that the monopolist has less incentive to increase output too much.

**Profit can remain positive in the long run. Why?**

Because we are assuming that there is no possible entry in this industry, so profits are not competed away.

# Monopolist's Supply Curve

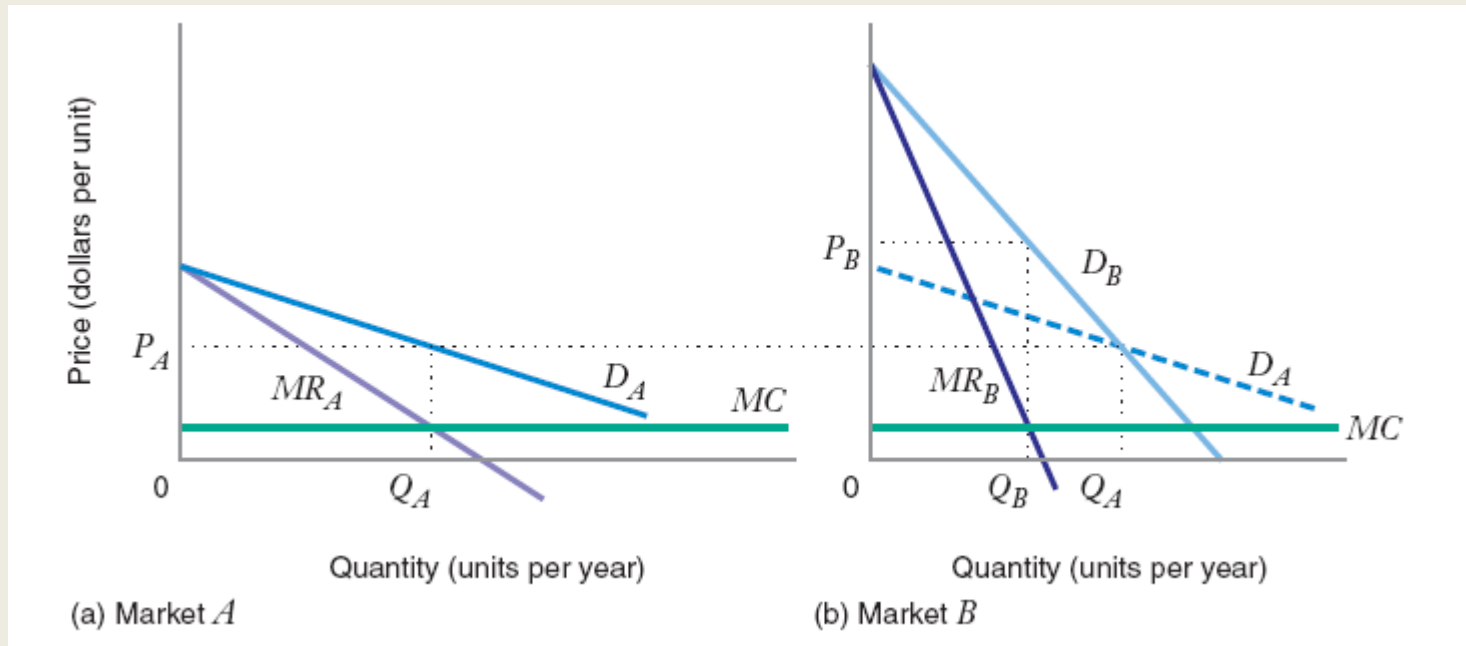
A supply curve shows a profit-maximizing quantity at each price. Only perfectly competitive firms have supply curve because they cannot set the price (which is set by the market).

**A monopolist does not have a supply curve** because it can set the price by choosing the quantity it produces.

In other words, the monopolist can pick a preferred point on the demand curve that maximizes its profit.

# Inverse Elasticity Pricing Rule

- Market A: profit-maximizing price is  $P_A$ .
- Market B: profit-maximizing price is  $P_B$ .
- Demand is less elastic in Market B.



# Inverse Elasticity Pricing Rule

*We can rewrite the MR curve as follows:*

$$MR = P + Q(\Delta P/\Delta Q) = P(1 + (Q/P)(\Delta P/\Delta Q))$$

$$MR = P(1 + 1/\varepsilon)$$

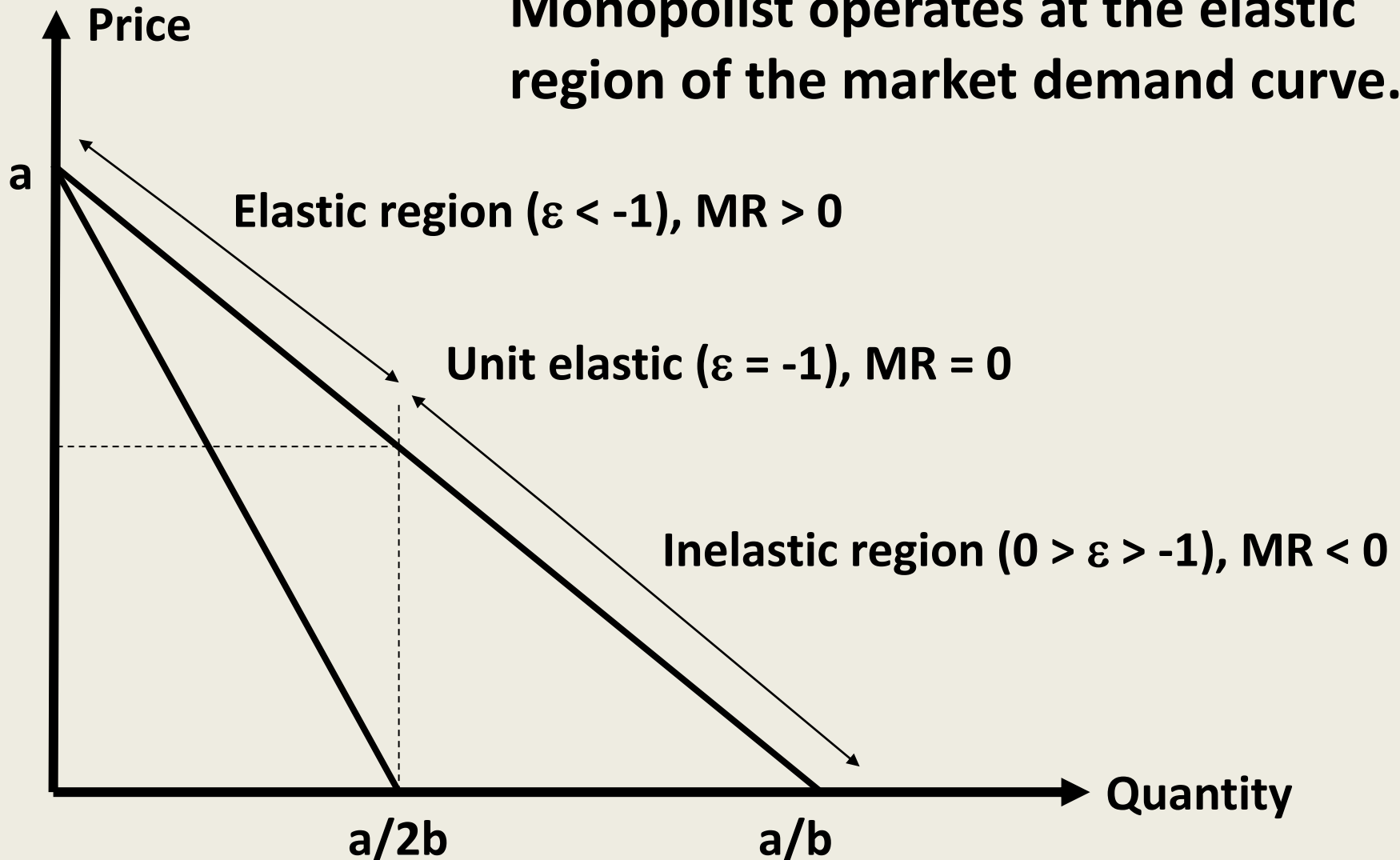
*where:*  $\varepsilon$  is the price elasticity of demand,  
 $(P/Q)(\Delta Q/\Delta P)$

# Inverse Elasticity Pricing Rule

Region of Demand Curve	Relationship between	
	Marginal Revenue and $\epsilon_{Q,P}$	Total Revenue and Price
Elastic ( $-\infty < \epsilon_{Q,P} < -1$ )	$MR > 0$ [because $1 + (1/\epsilon_{Q,P}) > 0$ ]	The monopolist can increase total revenue by decreasing price (and thereby increasing quantity) by a small amount.
Unitary elastic ( $\epsilon_{Q,P} = -1$ )	$MR = 0$ [because $1 + (1/\epsilon_{Q,P}) = 0$ ]	The monopolist's total revenue will not change when price (or quantity) is changed by a small amount.
Inelastic ( $-1 < \epsilon_{Q,P} < 0$ )	$MR < 0$ [because $1 + (1/\epsilon_{Q,P}) < 0$ ]	The monopolist can increase total revenue by increasing price (and thereby decreasing quantity) by a small amount.

# Elasticity Region of the Demand Curve

Monopolist operates at the elastic region of the market demand curve.



# Inverse Elasticity Pricing Rule

- Profit maximizing condition:

$$MR(Q^*) = MC(Q^*)$$

$$MC(Q^*) = P^* \left( 1 + \frac{1}{\varepsilon_{Q,P}} \right)$$

- Rearranging:

$$\frac{P^* - MC^*}{P^*} = -\frac{1}{\varepsilon_{Q,P}}$$

# Inverse Elasticity Pricing Rule

## Inverse Elasticity Pricing Rule (IEPR)

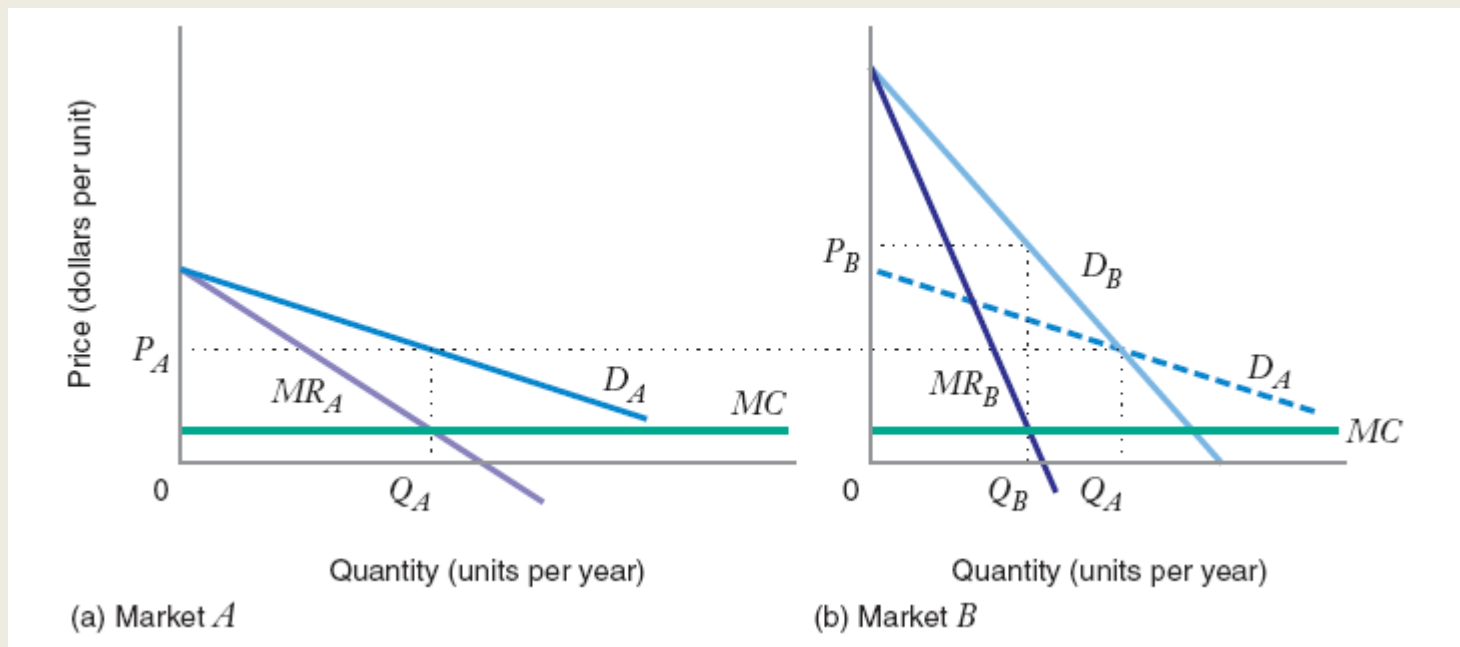
- Monopolist's optimal markup of price above marginal cost expressed as a percentage of price is equal to minus the inverse of the price elasticity of demand.

$$\frac{P^* - MC^*}{P^*} = -\frac{1}{\epsilon_{Q,P}}$$

- IEPR tells us about how much  $P^*$  the monopolist should charge, given the PED.
- **High PED implies that  $P^*$  should be low.**

# Inverse Elasticity Pricing Rule

- In Market A,  $P^* = P_A$ . In Market B,  $P^* = P_B$ .
- According to IEPR, since Mkt A is more elastic, it should charge lower price.



# Inverse Elasticity Pricing Rule



## LEARNING-BY-DOING EXERCISE 11.3

### Computing the Optimal Monopoly Price for a Constant Elasticity Demand Curve

The general form of a constant elasticity demand curve is  $Q = aP^{-b}$ . At every point on such a curve, the price elasticity of demand equals  $-b$ .<sup>5</sup> Suppose a monopolist has a constant marginal cost  $MC = \$50$ .

#### Problem

- What is the monopolist's optimal price if its constant elasticity demand curve is  $Q = 100P^{-2}$ ?
- What is the monopolist's optimal price if its constant elasticity demand curve is  $Q = 100P^{-5}$ ?

# The Lerner Index of Market Power

Definition: An agent has **Market Power** if he can affect the market price.

Sometimes, this is thought of as the degree to which a firm can raise price above marginal cost.

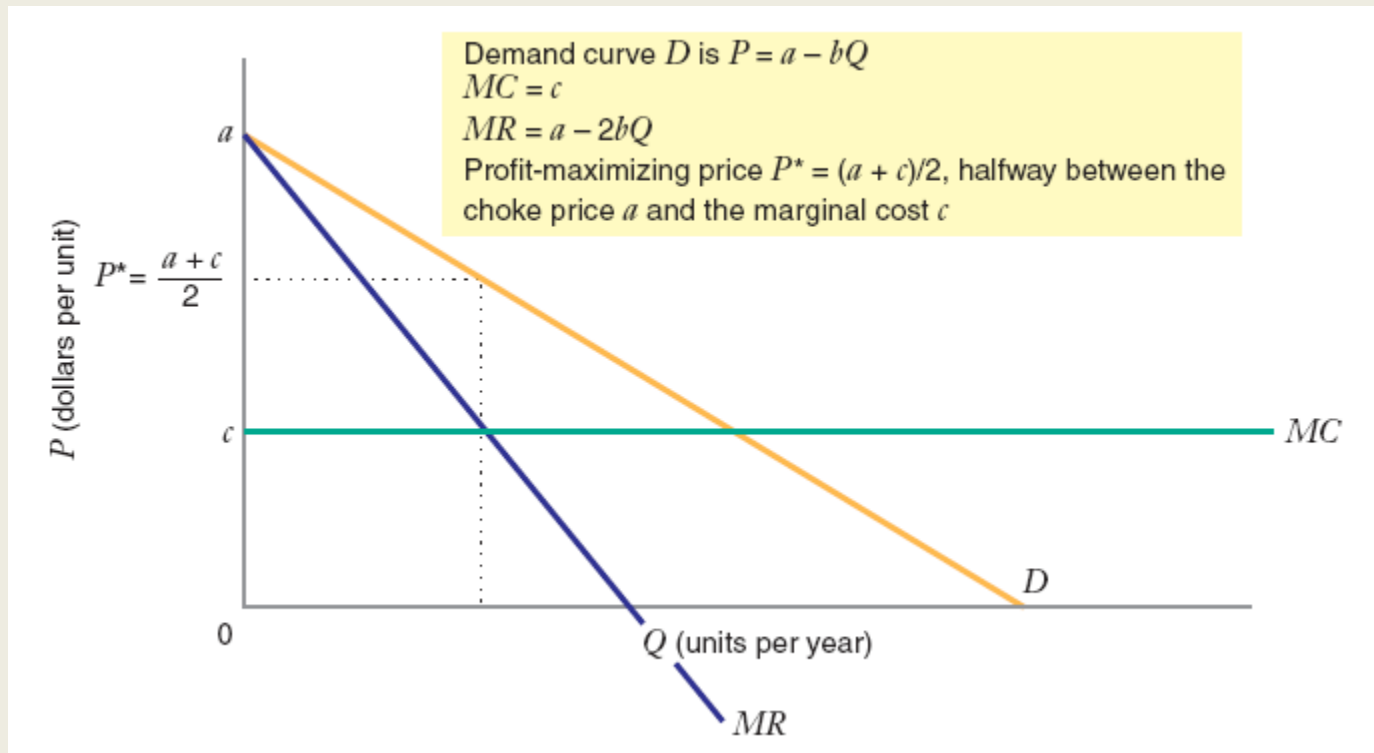
Definition: The **Lerner Index of market power** is the price-cost margin,  $(P^* - MC) / P^*$ .

This index ranges between 0 (for competitive firms) and 1 (for a monopolist facing a unit-elastic demand).

# Midpoint Rule to Maximize Profit

For a constant MC,  $P^*$  is found using the midpoint rule:

**$P^*$  is halfway between the vertical intercept of the demand curve  $a$  (choke price) and vertical intercept of the MC curve  $c$ .**



# Midpoint Rule to Maximize Profit

## LEARNING-BY-DOING EXERCISE 11.5

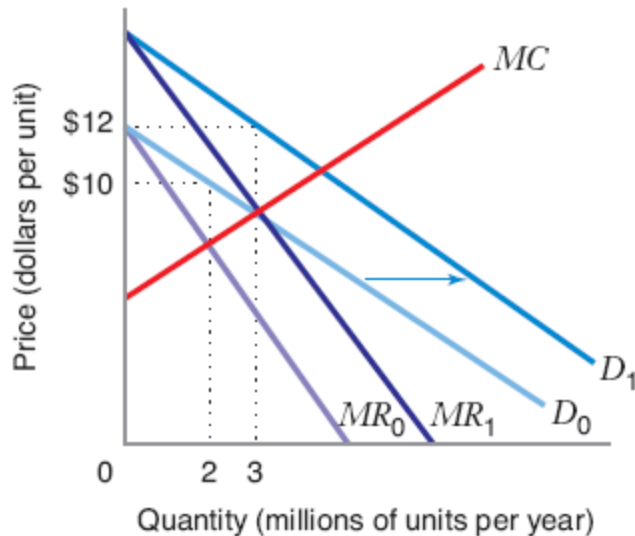
### Computing the Optimal Price Using the Monopoly Midpoint Rule



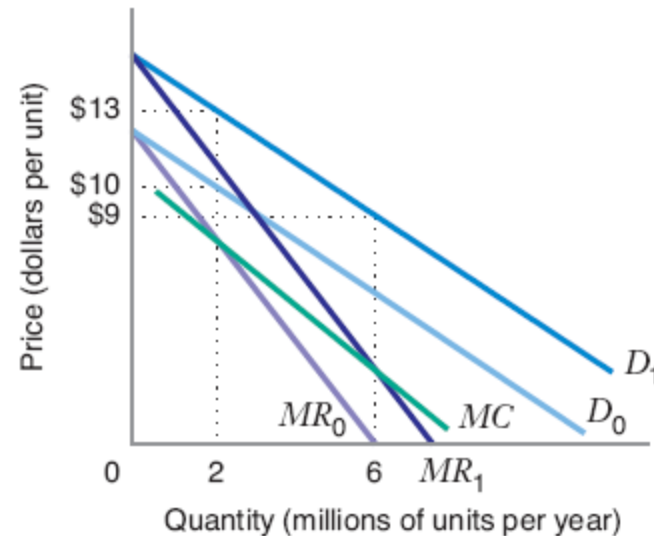
Suppose a monopolist faces a linear market demand curve  $P = a - bQ$  and has a constant marginal cost  $MC = c$  (as illustrated in Figure 11.11).

**Problem** What is the monopolist's profit-maximizing quantity and price?

# Comparative Statics – Shifts in Demand



(a)



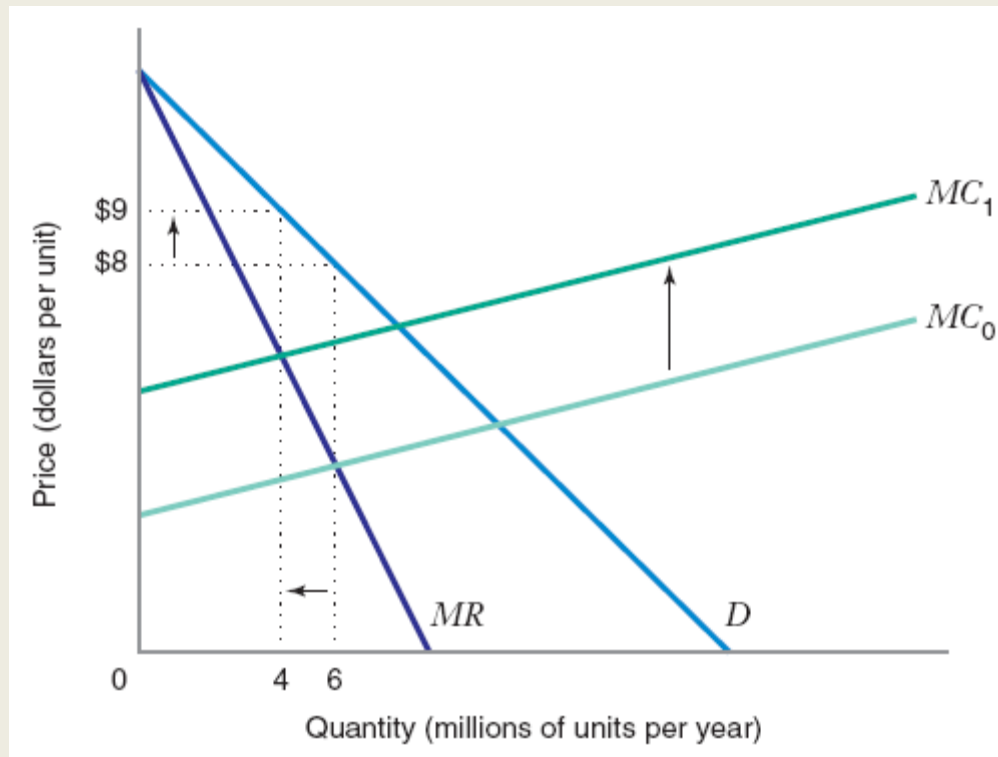
(b)

**Rightward shift in the demand curve causes an increase in profit-maximizing quantity.**

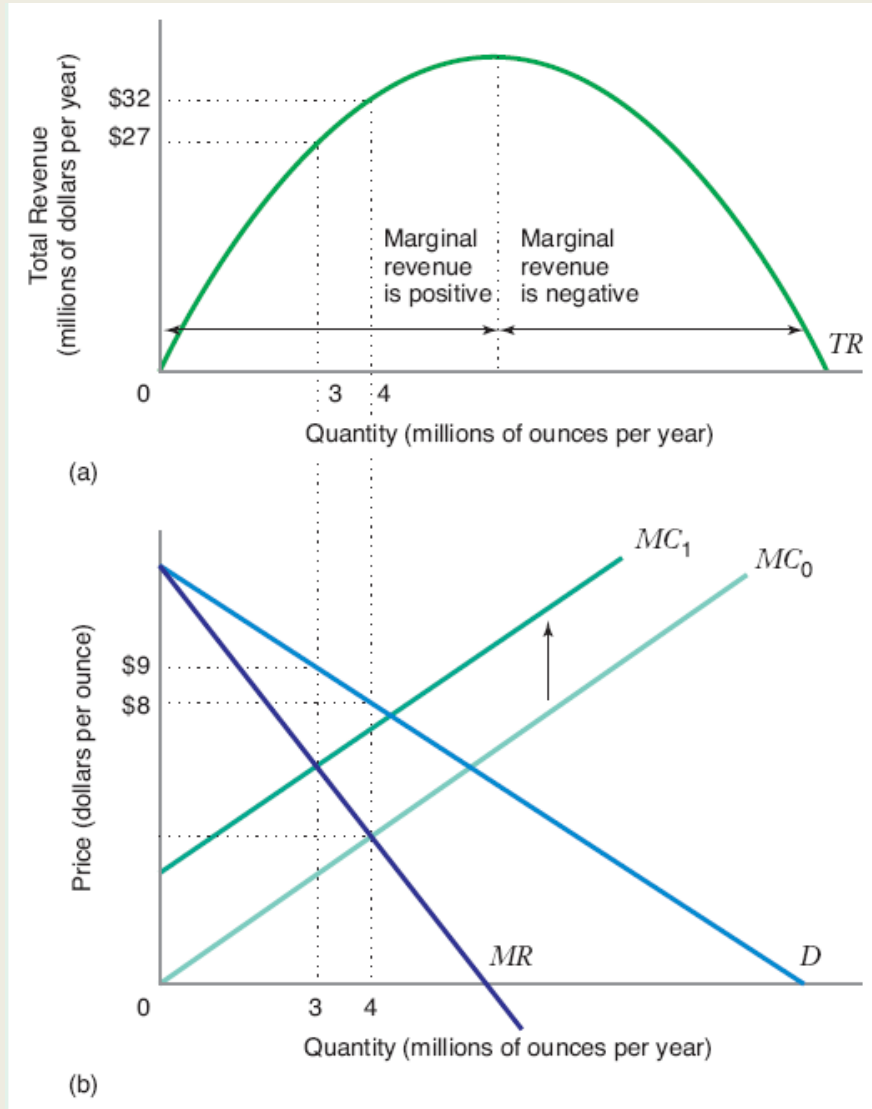
- (a)  $MC$  increases as  $Q$  increases
- (b)  $MC$  decreases as  $Q$  increases

# Comparative Statics – Shifts in MC

When MC shifts up,  $Q^*$  falls and  $P^*$  increases.



# Comparative Statics – Shifts in MC



- Upward shift of MC decreases the profit maximizing monopolist's total revenue.
- Downward shift of MC increases the profit maximizing monopolist's total revenue.

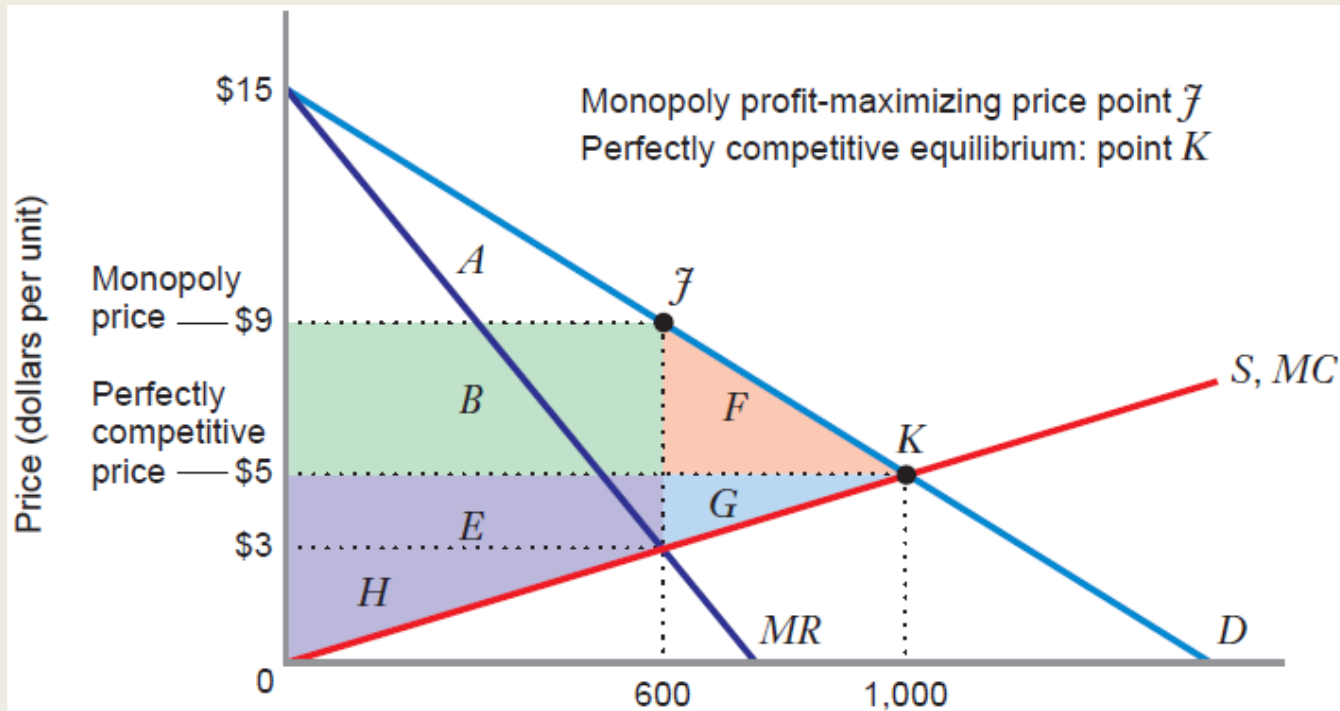
# The Welfare Economies of Monopoly

Since the monopoly equilibrium output does not, in general, correspond to the perfectly competitive equilibrium, **it entails a deadweight loss.**

This is because at the profit-maximizing quantity ( $Q^*$ ) set by the monopolist, there is underallocation of resources:  $P = MB(Q^*) > MC(Q^*)$ .

**Why?**

# The Welfare Economies of Monopoly



	Perfect Competition	Monopoly	Impact of Monopoly
Consumer surplus	$A + B + F$	$A$	$-B - F$
Producer surplus	$E + G + H$	$B + E + H$	$B - G$
Net economic benefit	$A + B + E + F + G + H$	$A + B + E + H$	$-F - G$

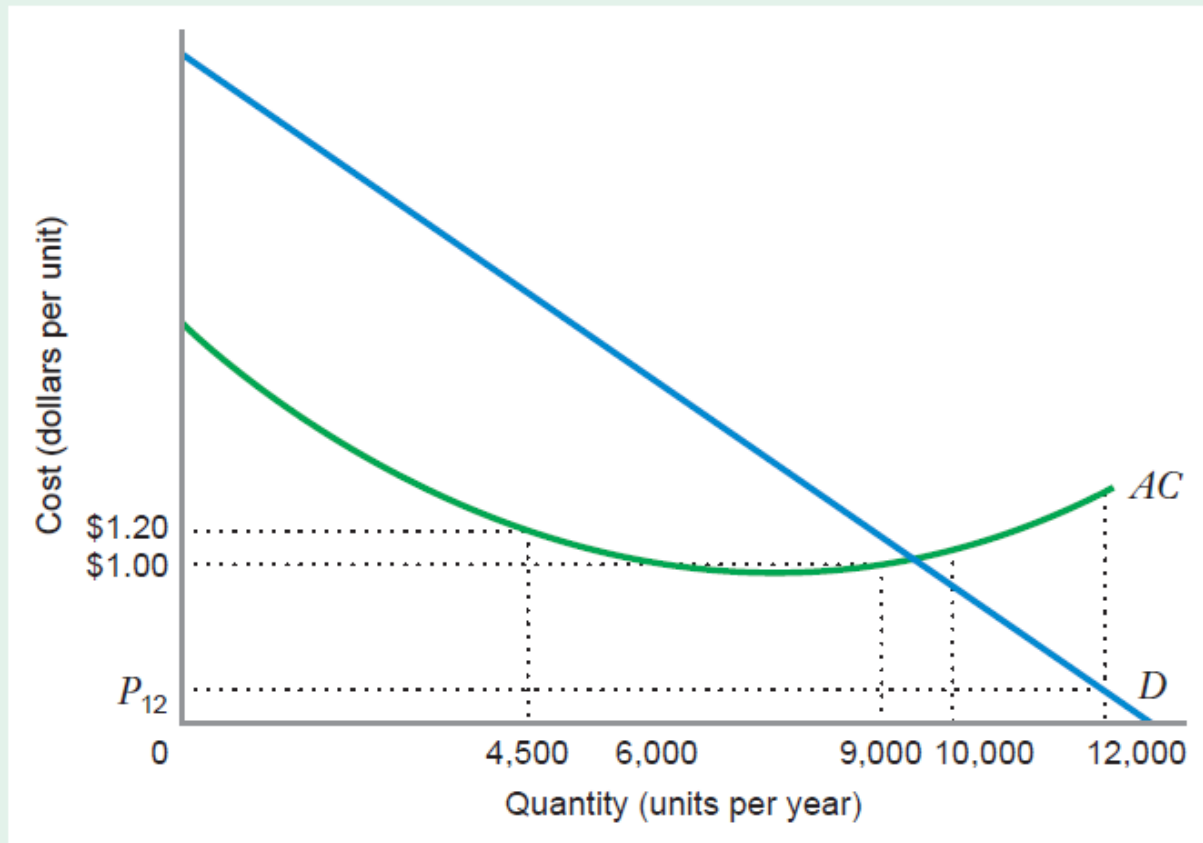
# Natural Monopoly

*Definition:* A market is a **natural monopoly** if the total cost incurred by a single firm producing output is less than the combined total cost of two or more firms producing this same level of output among them.

# Natural Monopoly

**FIGURE 11.17** Natural Monopoly Market

Any output level less than 10,000 units per year can be produced most cheaply by a single firm. For example, a single firm can produce an output of 9,000 units for an average cost of \$1 per unit. Two firms, each producing 4,500 units, would incur an average cost of \$1.20 per unit. Two firms could produce 12,000 units at a lower total cost than one firm could. However, this level of output would not be profitable because the price  $P_{12}$  at which 12,000 units would be demanded is less than the minimum level of average cost.



# Multi-Plant Monopoly

**Suppose the monopolist has two plants:** one plant has marginal cost  $MC_1(Q)$  and the other has marginal cost  $MC_2(Q)$ .

The problem here is how a monopolist would allocate production across the plants under its management.

**Whenever the marginal costs of the two plants are not equal, the firm can increase profits by reallocating production towards the lower marginal cost plant and away from the higher marginal cost plant.**

Thus, if  $MC_2 > MC_1$ , more output should be produced at Plant 1.

# Multi-Plant Monopoly

*Question: How much should the monopolist produce in total?*

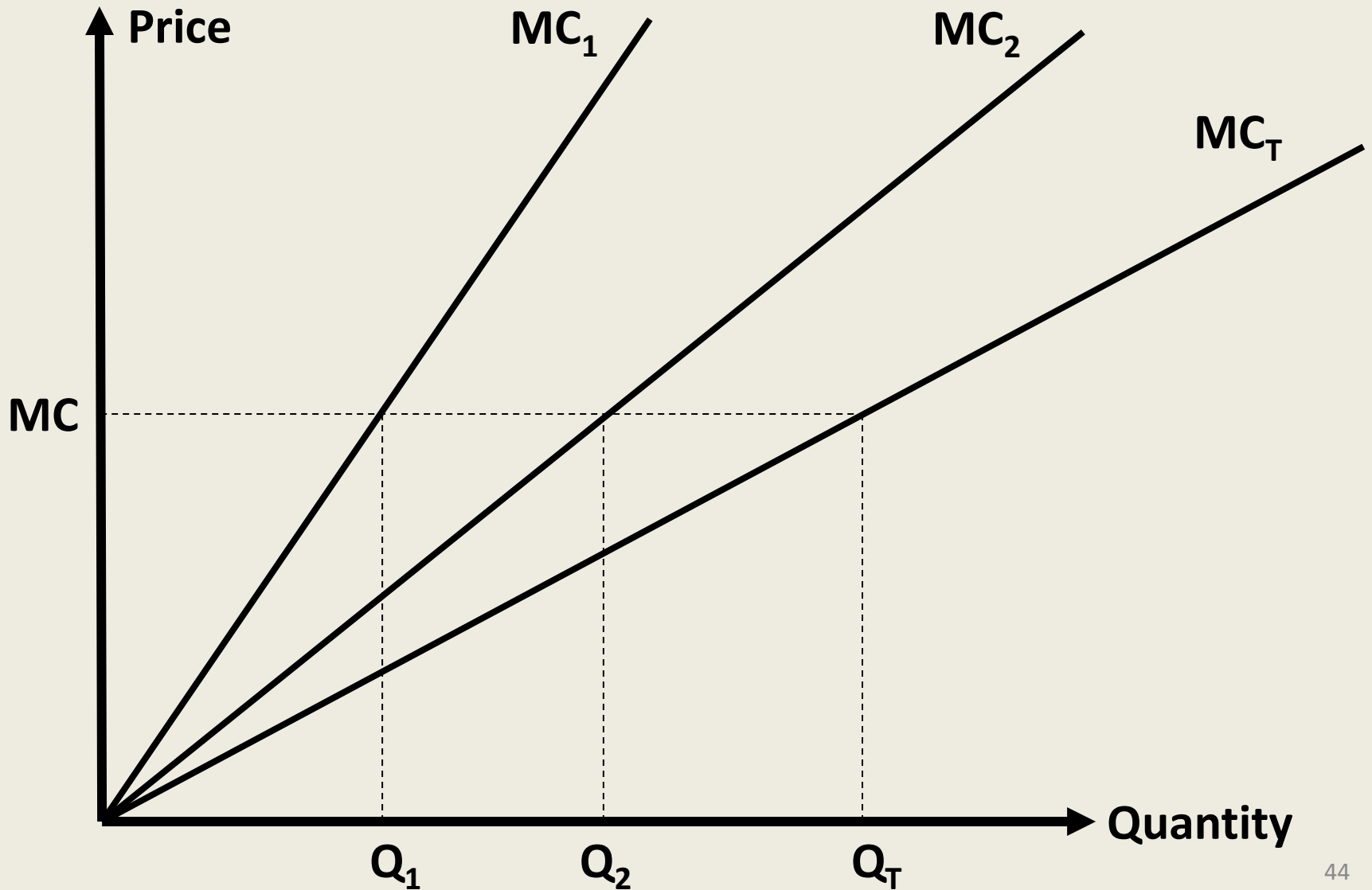
Definition: The **Multi-Plant Marginal Cost Curve ( $MC_T$ )** is the horizontal sum of the marginal cost curves of the individual plants (i.e. this curve shows the total output that can be produced at every level of marginal cost.)

**Answer:**

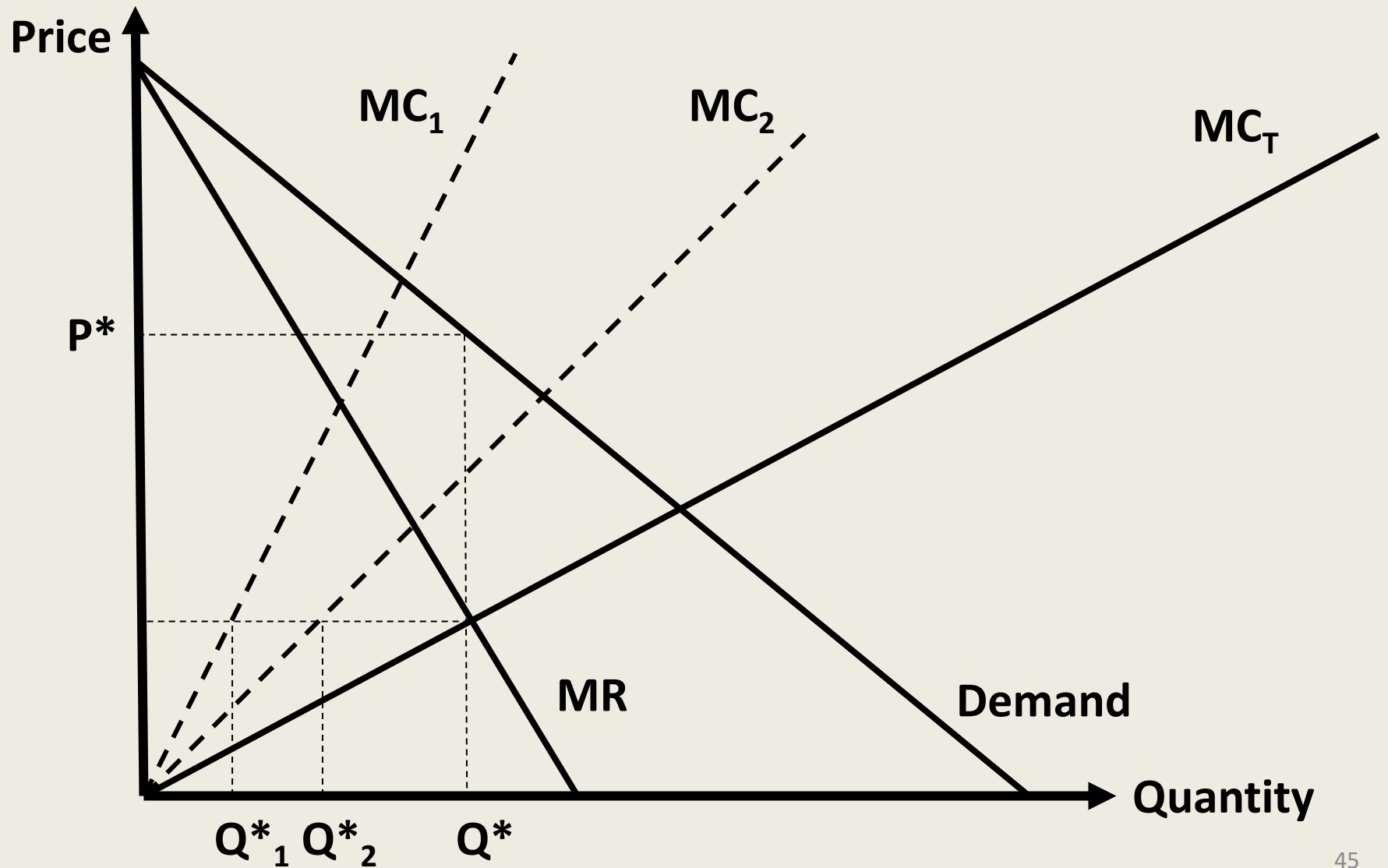
The monopolist produces where  $MR = MC_T$ . This will give the profit-maximizing quantity  $Q^*$ .

The output production between two plants is determined by  $MR(Q^*) = MC_1(Q_1^*) = MC_2(Q_2^*)$  with  $Q_1^* + Q_2^* = Q^*$ .

# Multi-Plant Marginal Cost Curve



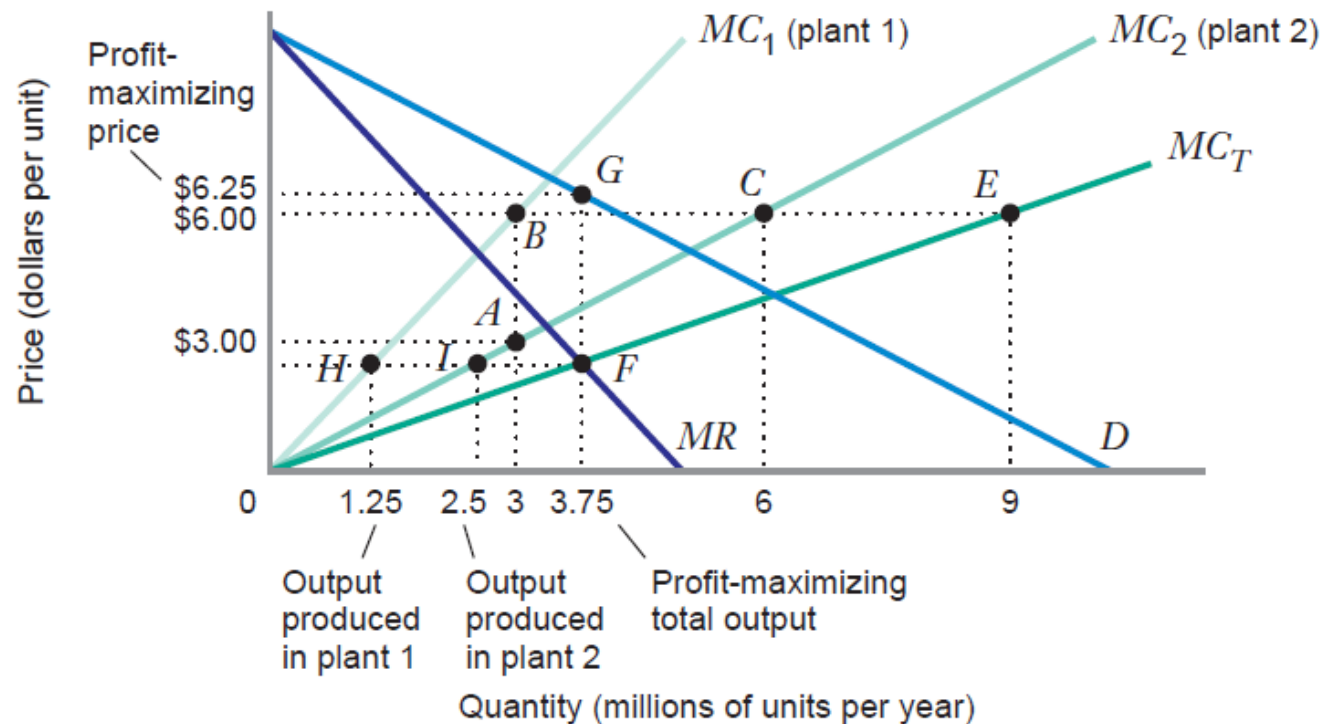
# Multi-Plant Monopoly



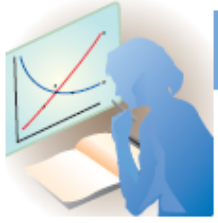
# Multi-Plant Monopoly

**FIGURE 11.14** Profit Maximization by a Multiplant Monopolist

The monopolist's multiplant marginal cost curve  $MC_T$  is the horizontal sum of the individual plant's marginal cost curves  $MC_1$  and  $MC_2$ . The monopolist's optimal total output of 3.75 million units per year occurs at  $MR = MC_T$ , where the optimal price is \$6.25 per unit. Plant 1 produces 1.25 million units of the total output, and plant 2 produces 2.5 million units.



# Multi-Plant Monopoly



## LEARNING-BY-DOING EXERCISE 11.6

### Determining the Optimal Output, Price, and Division of Production for a Multiplant Monopolist

Suppose a monopolist faces a demand curve given by  $P = 120 - 3Q$ . The monopolist has two plants. The first has a marginal cost curve given by  $MC_1 = 10 + 20Q_1$ , and the second plant's marginal cost curve is given by  $MC_2 = 60 + 5Q_2$ .

#### Problem

- Find the monopolist's optimal total quantity and price.
- Find the optimal division of the monopolist's quantity between its two plants.

**HINT: To find  $MC_T$ , you must first invert  $MC(Q)$  to  $Q(MC)$ .**

# Cartel

Definition: A **cartel** is a group of firms that collusively determine the price and output in a market, e.g. OPEC countries controlling oil price and production.

In other words, a **cartel acts as a single monopoly firm** that maximizes total industry profit.

**The problem of optimally allocating output across cartel members is identical to the monopolist's problem of allocating output across individual plants.**

A cartel does not necessarily divide up market shares equally among members: **firms with higher marginal cost produce less.**