BEE2017 Intermediate Microeconomics 2

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Organisation

- Lectures
  - Mon 14:00-15:00, STC/C
  - Wed 12:00-13:00, STC/D
- Tutorials
  - Mon 15:00-16:00, STC/106 (will run a week late)
  - Wed 14:00-15:00, AMO/219
  - Thu 10:00-11:00, STC/106
  - Thu 13:00-14:00, STC/106
- Teaching Experiments

Organisation

- Homework
  - Wiley Plus
    - Chapter summary
    - Review Question
    - Self-test
    - Exelets
    - Assignment (weekly)
- Assessment
  - Exam in June (90%)
    - Variants of homework assignments and self test used
    - Questions relating to experiments
    - … and tutorial exercises
  - Weekly homework assignment (10%)
    - do 8 out of 10 satisfactorily
    - satisfactorily: 30 % of marks

Textbook:

Microeconomics: 2nd Edition

David Besanko and Ronald Braeutigam

Microeconomics: 2nd Edition

David Besanko and Ronald Braeutigam

Chapter 11: Monopoly and Monopsony

Prepared by Katharine Rockett

+ DCB

Outline

1. Motivation: Brush Wellman

2. The Monopolist's Profit Maximization Problem
   - The Profit Maximization Condition
   - Equilibrium
   - The Inverse Elasticity Pricing Rule

3. Multi-plant Monopoly and Cartel Production

4. The Welfare Economics of Monopoly

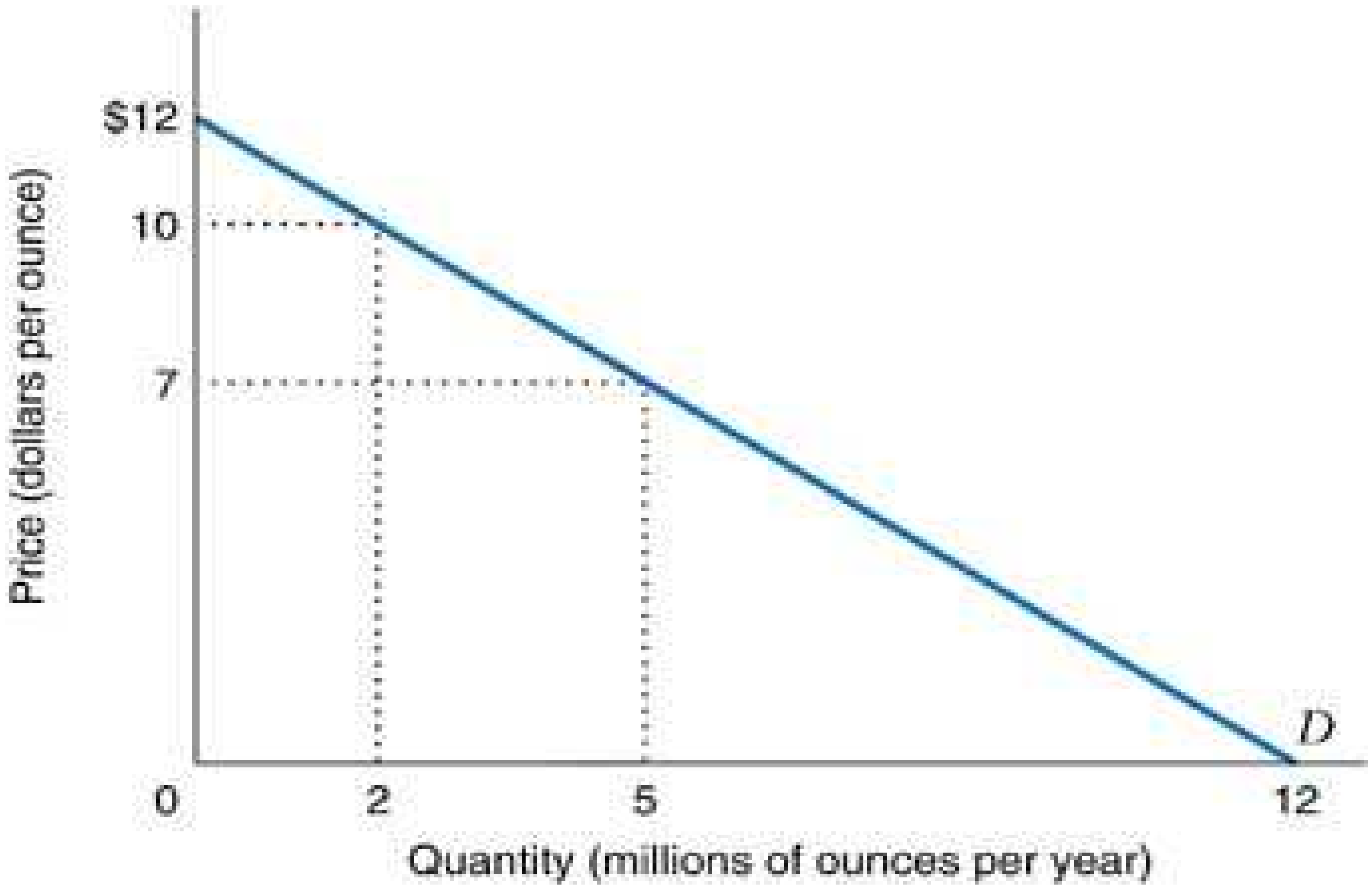
MONOPOLY

- Examples
- Do they exist?
- Do perfectly competitve markets exist?
- Protected by state.
- Airline industry, local monopoly.
- Natural monopoly.
- “temporal” monopoly.
- This chapter: price only instrument.
- Inefficiency: strawberries.

Monopolist producing a single output

- Revenue: $TR=P*Q=P*D(P)=D^{-1}(Q)*Q$
- $Q=D(P)$ demand function: what quantity will be sold at price P? (P independent variable)
- $P=D^{-1}(Q)$ inverse demand function: What price will the monopolist achieve if he brings Q units of output to the market? (Q independent variable)
- $D(D^{-1}(Q))=Q$; $D^{-1}(D(P))=P$

Downward sloping demand curve



Monopoly

- Costs: $TC(Q)$
- Profits: $\Pi(Q)=TR(Q)-TC(Q)$
- Profits: $\underline{\Pi}(P)=TR(P)-TC(D(P))$
- First-order condition (FOC) for an interior profit optimum:

$$\Pi\,'(Q)=MR(Q)-MC(Q)=0$$

Profit maximizing condition for a monopolist:

$$\Delta TR(Q)/\Delta Q = \Delta TC(Q)/\Delta Q$$

$$MR(Q) = MC(Q)$$

In other words,

The monopolist sets output so that marginal profit of *additional* production is just zero.

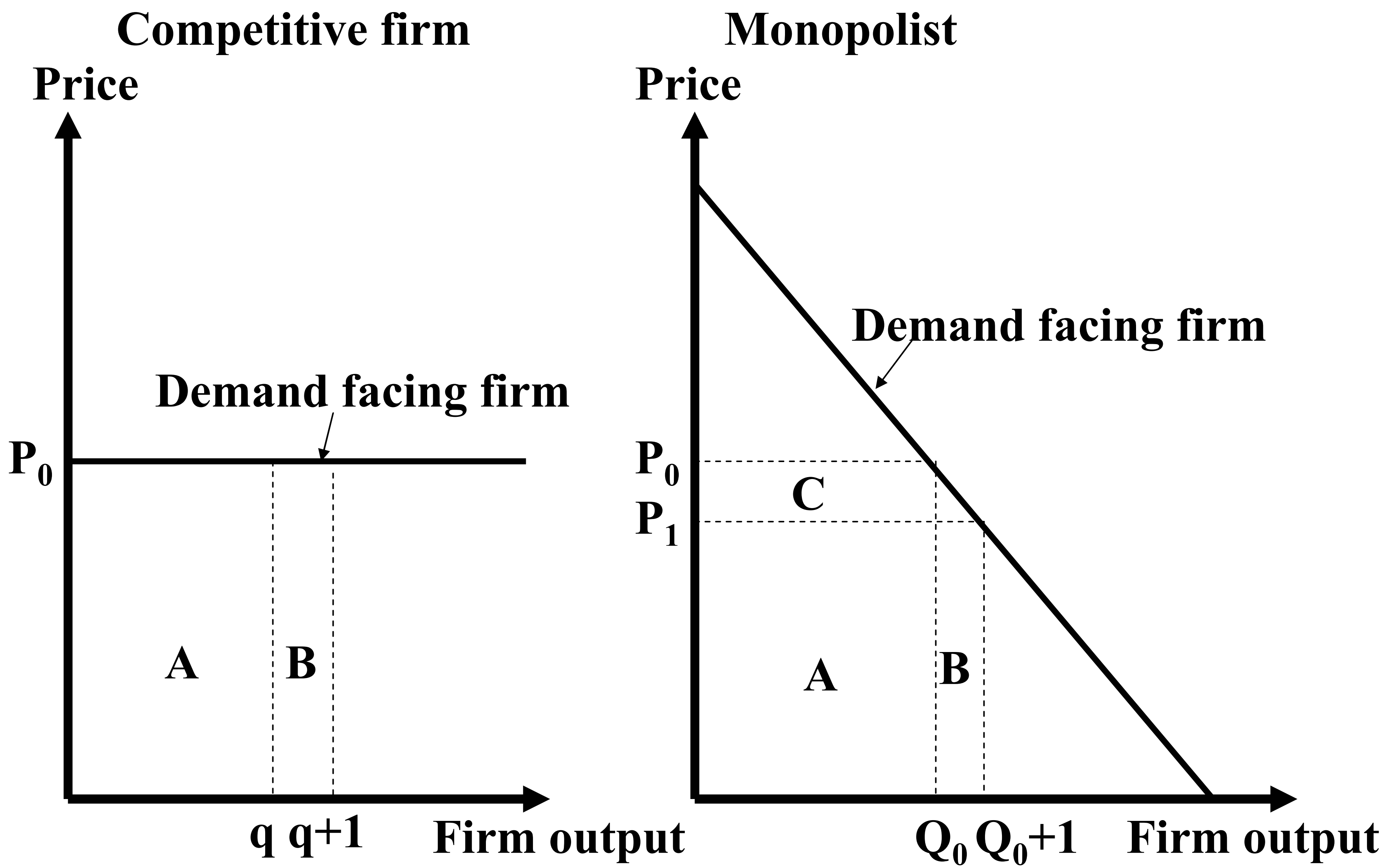
Recall:

A perfect competitor sets P = MC…in other words, marginal revenue equals price.

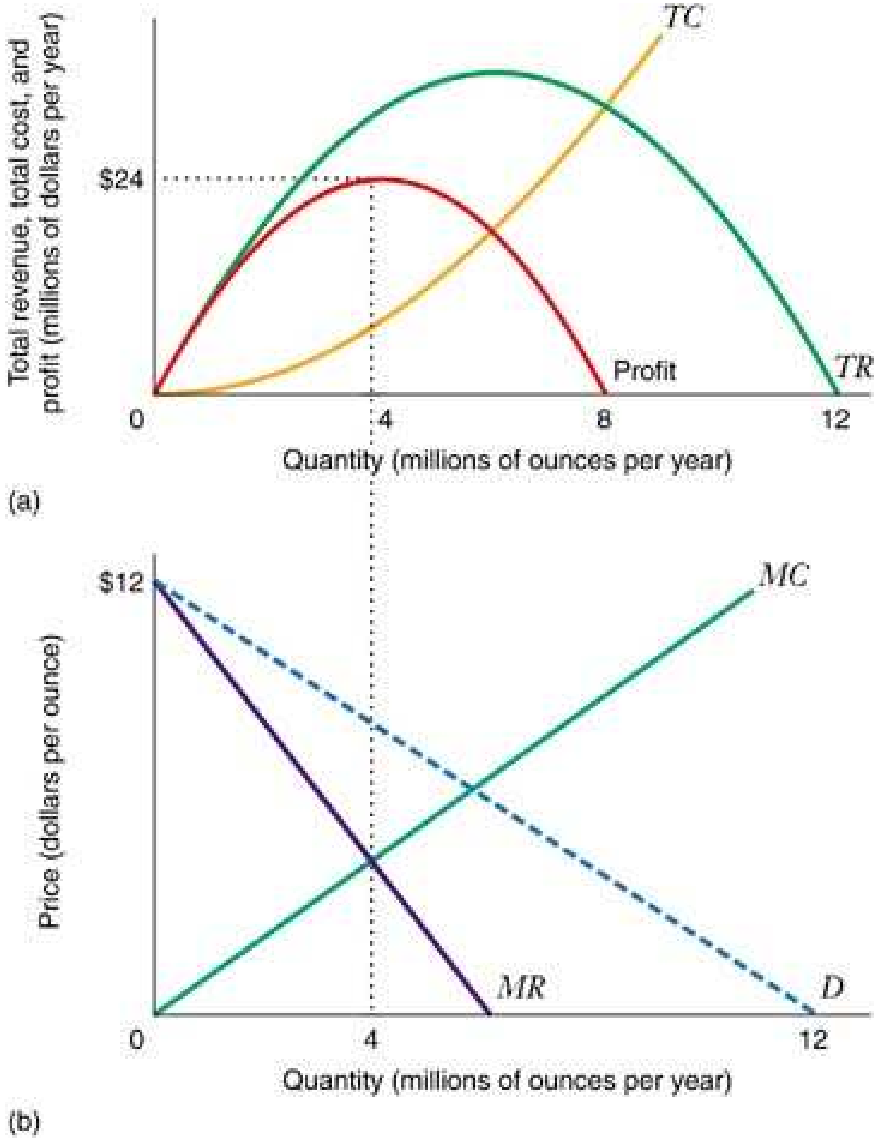
- *Why is this not so for the monopolist?*
- $\Delta TR = P1\Delta Q + Q0\Delta P$ =>
- $\Delta TR = P1\Delta Q + Q0\Delta P$ =>
- *and, as we let the change in output get very small, this approaches:*
- $MR(Q0) = P0 + Q0\Delta P/\Delta Q$

⇨ $MR(Q_0) < P_0$ for any $Q_0 > 0$
⇨ MR may be negative or positive
⇨ for a perfect competitor, demand was "flat" so MR = P

Example: Marginal Revenue



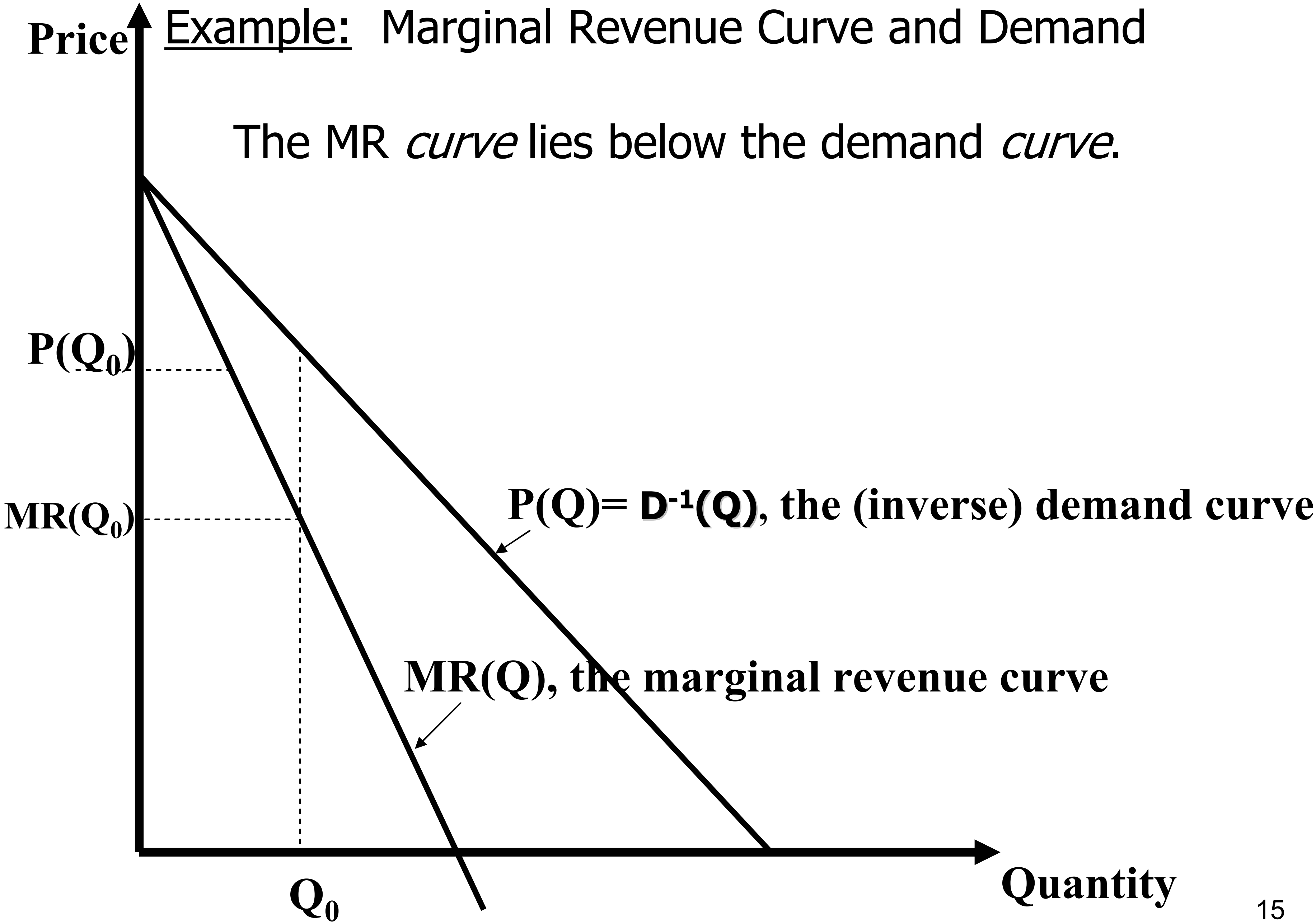
Monopoly



Total revenue, total cost, and profit (millions of dollars per year)
$24
TC
Profit
TR
0
4
8
12
Quantity (millions of ounces per year)
(a)
Price (dollars per ounce)
$12
MC
MR
D
0
4
12
Quantity (millions of ounces per year)
(b)

Example: Marginal Revenue Curve and Demand

The MR *curve* lies below the demand *curve*.



Definition: An agent has **Market Power** if s/he can affect, through his/her own actions, the price that prevails in the market. Sometimes this is thought of as the degree to which a firm can raise price above marginal cost.

Example

- $P(Q) = a - bQ$ …linear demand…

A) What is the equation of the marginal revenue curve?

- $\Delta P/\Delta Q = -b$
- $MR(Q) = P + Q\Delta P/\Delta Q$
- $\quad = a - bQ + Q(-b)$
- $\quad = a - 2bQ$
- **twice the slope of demand for linear demand**

Example

B) What is the equation of the average revenue curve?

- $AR(Q) = TR(Q)/Q = P = a - bQ$
- (you earn more on the average unit than on an additional unit…)

Example

C) What is the profit-maximizing output if:

- $TC(Q) = 100 + 20Q + Q^2$
- $MC(Q) = 20 + 2Q$
- $AVC(Q) = 20 + Q$
- $P(Q) = 100 – Q$
- MR = MC => 100 - 2Q = 20 + 2Q
- 4Q=80
- Q* = 20
- P* = 80

Shutdown Condition:

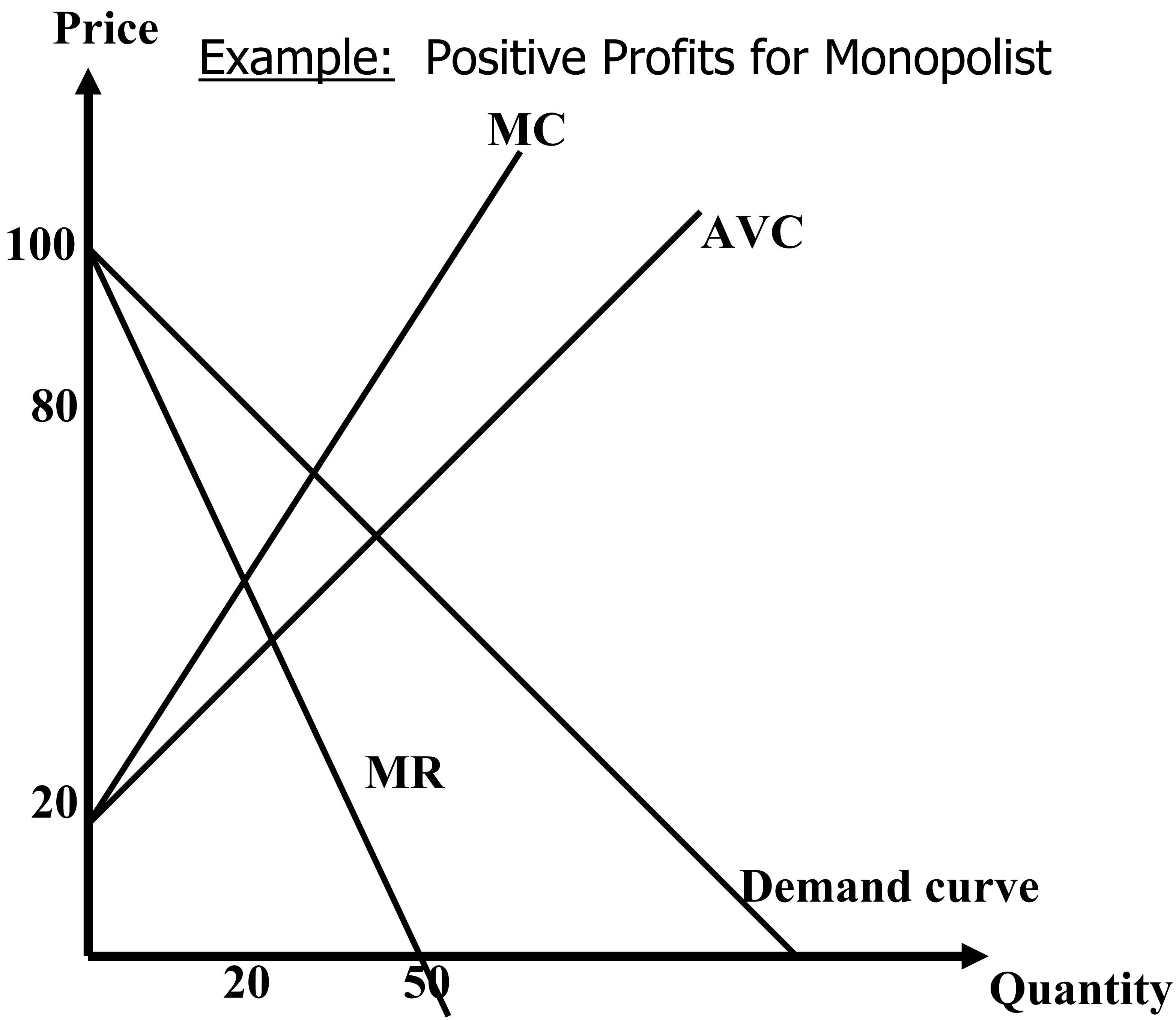
In the short run, the monopolist shuts down if the most profitable price does not cover AVC (or average non-sunk costs). In the long run, the monopolist shuts down if the most profitable price does not cover AC.
Here, P exceeds both AVC and AC.*

$$\pi^* = 700 \ (= Q^*P^* - 100 - 20(Q^*) - Q^{*2})$$

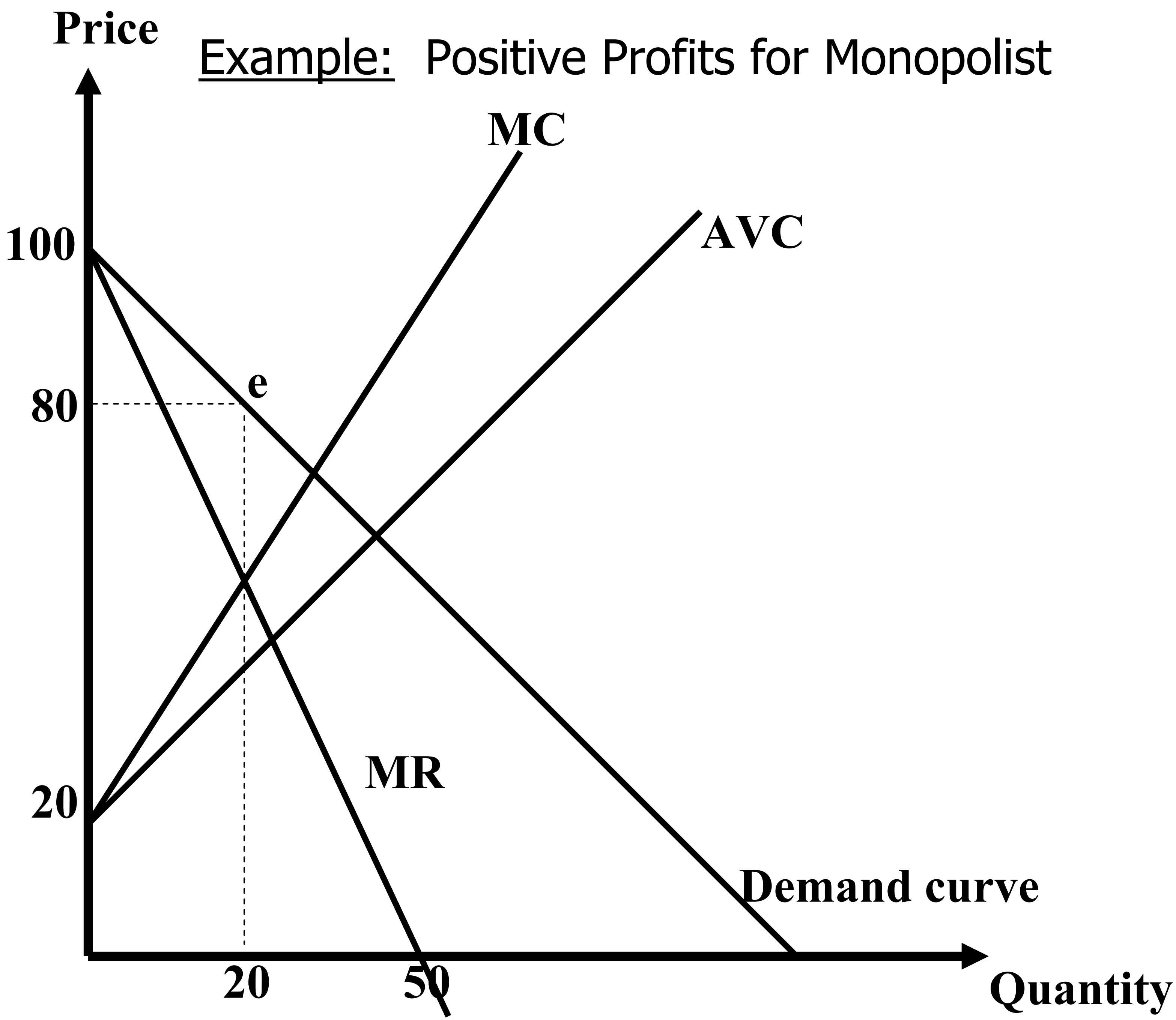
This profit is positive. *Why? Because the monopolist takes into account the price-reducing effect of increased output so that the monopolist has less incentive to increase output than the perfect competitor.*

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.*

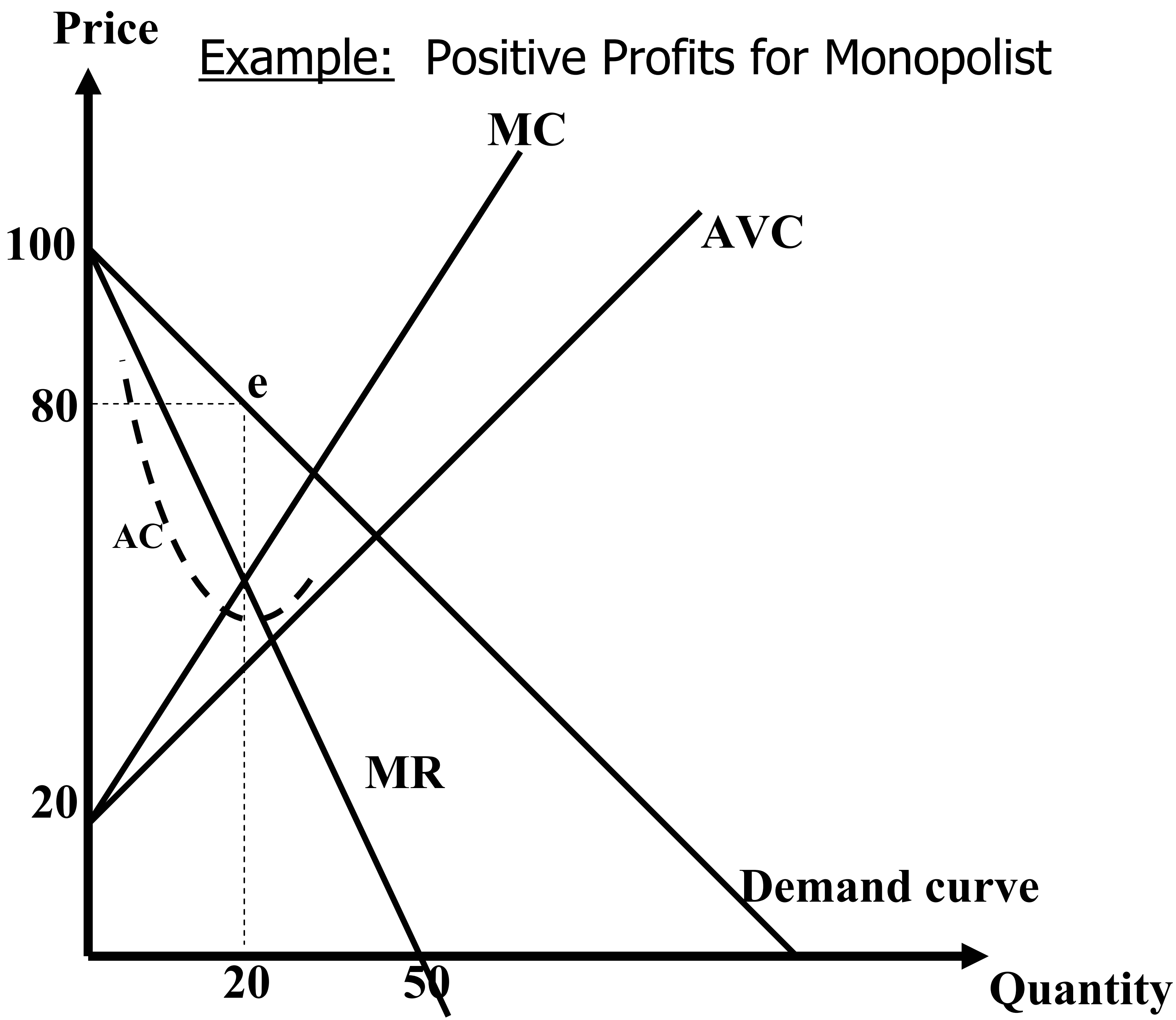
<u>Example:</u> Positive Profits for Monopolist



Example: Positive Profits for Monopolist



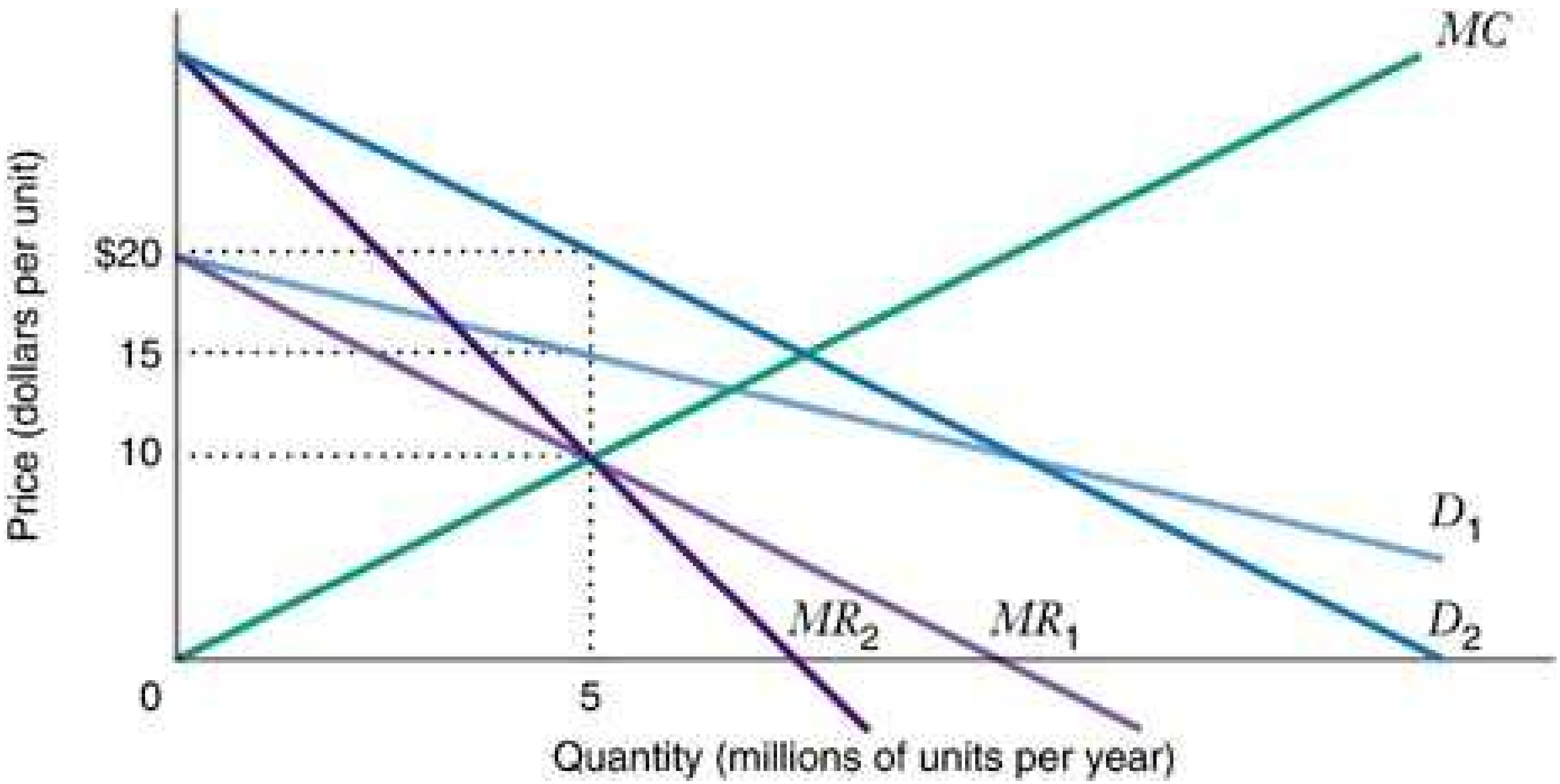
<u>Example:</u> Positive Profits for Monopolist



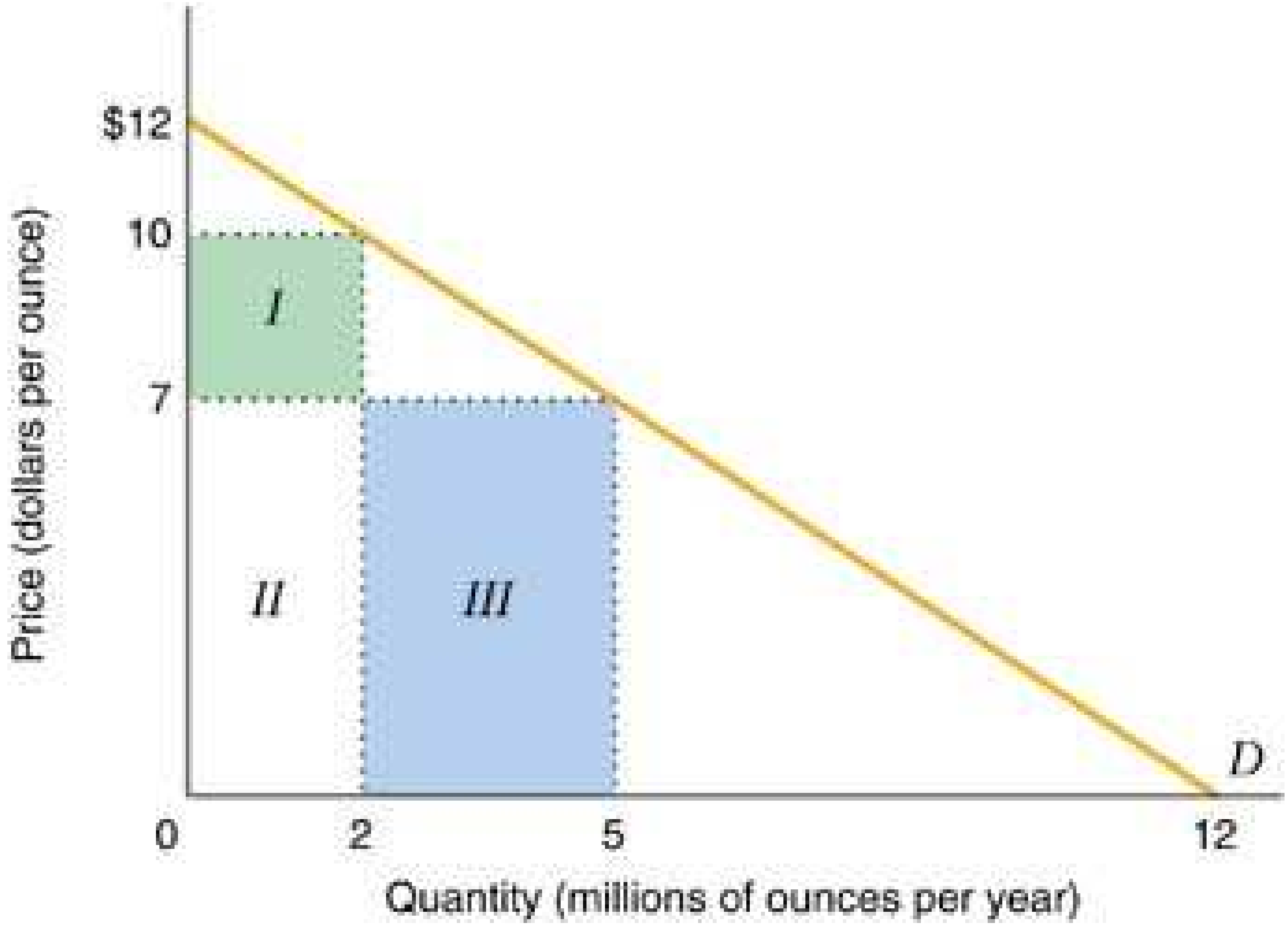
Equilibrium

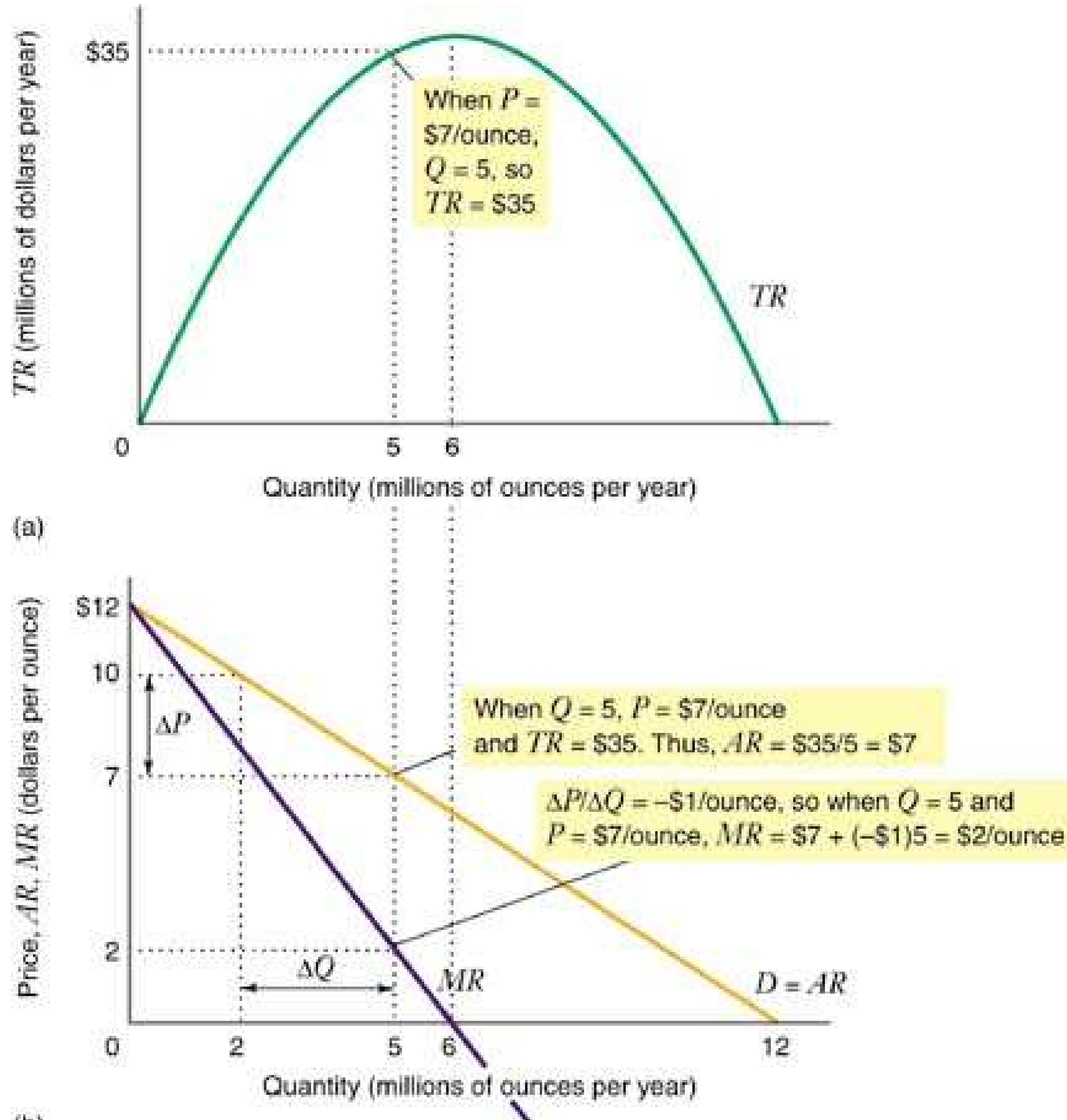
A monopolist does not have a supply curve (i.e., an optimal output for any exogenously-given price) because price is *endogenously-determined* by demand: the monopolist picks a preferred point on the demand curve.

One could also think of the monopolist choosing output to maximize profits subject to the *constraint* that price be determined by the demand curve.


MC
Price (dollars per unit)
$20
15
10
D1
MR2
MR1
D2
0
5
Quantity (millions of units per year)

Marginal Revenue





$35
When P = $7/ounce, Q = 5, so TR = $35
TR
TR (millions of dollars per year)
0
5
6
Quantity (millions of ounces per year)
(a)
$12
10
7
2
Price, AR, MR (dollars per ounce)
ΔP
ΔQ
When Q = 5, P = $7/ounce and TR = $35. Thus, AR = $35/5 = $7
$\Delta P/\Delta Q$ = −$1/ounce, so when Q = 5 and P = $7/ounce, MR = $7 + (−$1)5 = $2/ounce
MR
$D = AR$
0
2
5
6
12
Quantity (millions of ounces per year)
(b)

The Inverse Elasticity Pricing Rule

We can rewrite the MR curve as follows:

$MR = P + Q\Delta P/\Delta Q$

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

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

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

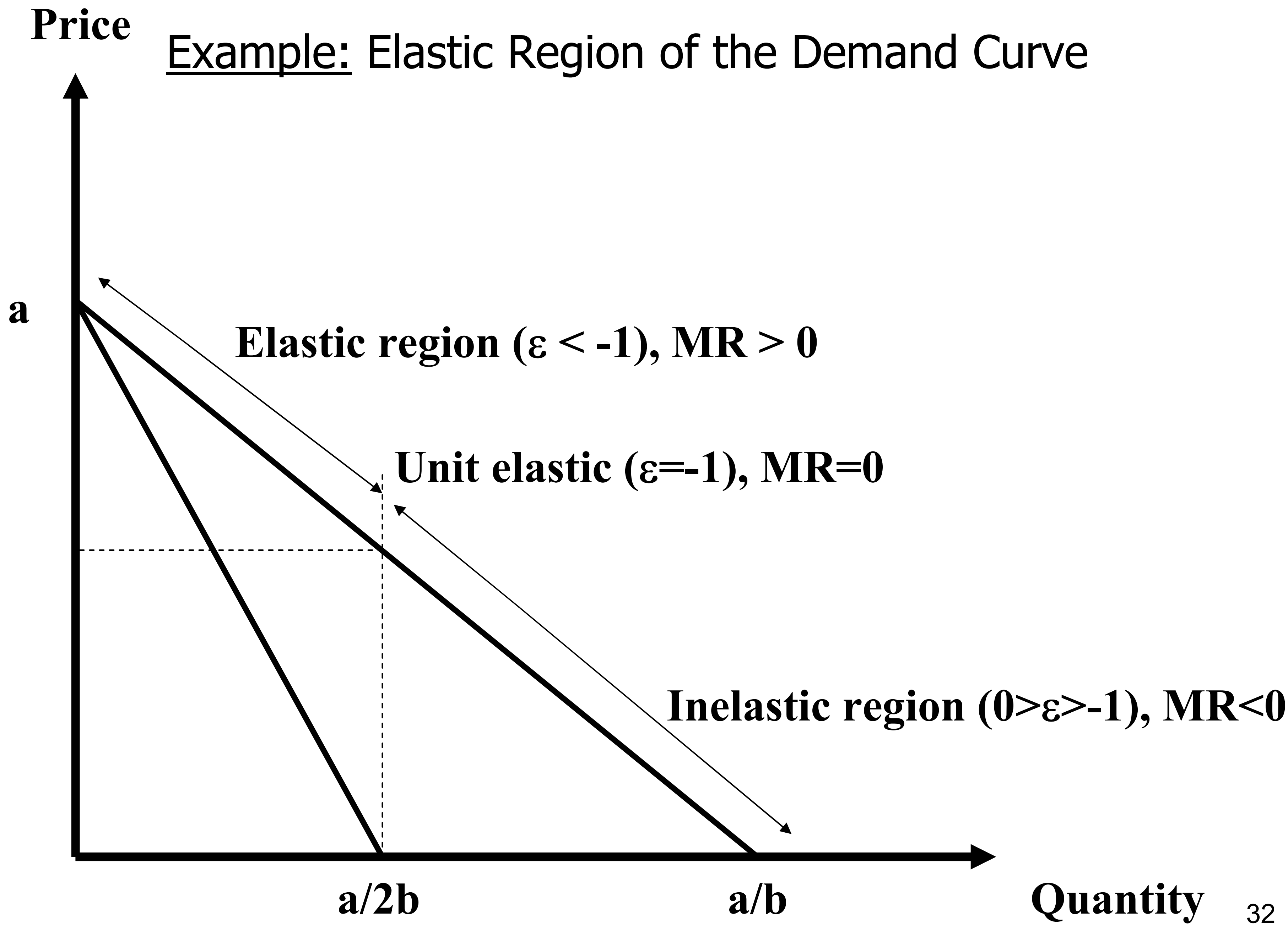
Elasticity

- When demand is elastic ($\varepsilon < -1$), MR > 0
- When demand is inelastic ($\varepsilon > -1$), MR < 0
- When demand is unit elastic ($\varepsilon = -1$), MR= 0

Using this formula:

- When demand is elastic ($\varepsilon < -1$), MR > 0
- When demand is inelastic ($\varepsilon > -1$), MR < 0
- When demand is unit elastic ($\varepsilon = -1$), MR= 0

<u>Example:</u> Elastic Region of the Demand Curve



Therefore,

The monopolist will always operate on the elastic region of the market demand curve

- As demand becomes more elastic at each point, marginal revenue approaches price

<u>Example:</u>

$Q^D = 100P^{-2}$
MC = \$50

a. *What is the monopolist's optimal price?*

$MR = MC \Leftrightarrow P(1+1/\varepsilon) = MC \Leftrightarrow$
$P(1+1/(-2)) = 50$
$P^* = 100$

- More generally: $P(1+1/\varepsilon) = MC$
- $P-MC=-P/\varepsilon$
- The FOC takes the form
- $(P-MC)/P=-1/\varepsilon$
- The markup equals the (negative of the) inverse elasticity

b. *Now, suppose that* $Q^D = 100P^{-b}$ *and* $MC = c$ *(constant). What is the monopolist's optimal price now?*

$$P(1+1/-b) = c$$
$$P^* = cb/(b-1)$$

- We need the assumption that b > 1 *("demand is everywhere elastic")* to get an interior solution.

- As b -> 1 *(demand becomes everywhere less elastic)*, P* -> infinity and P - MC, the "price-cost margin" also increases to infinity.

- As b -> ∞, the monopoly price approaches marginal cost.

The Lerner Index of Market Power

Restating the monopolist's profit maximization condition, we have:

$P^*(1 + 1/\varepsilon) = MC(Q^*)$ …or…

$[P^* - MC(Q^*)]/P^* = -1/\varepsilon$

In words, the monopolist's ability to price above marginal cost depends on the elasticity of demand.

Definition: The **Lerner Index of market power** is the price-cost margin, (P*-MC)/P*. This index ranges between 0 (for the competitive firm) and 1, for a monopolist facing a unit elastic demand.

Multi-plant Monopoly

Recall: In the perfectly competitive model, we could derive firm outputs that varied depending on the cost characteristics of the firms. The analogous problem here is to derive how a monopolist would allocate production across the plants under its management.

Assume:

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

Question: How should the monopolist allocate production across the two plants?

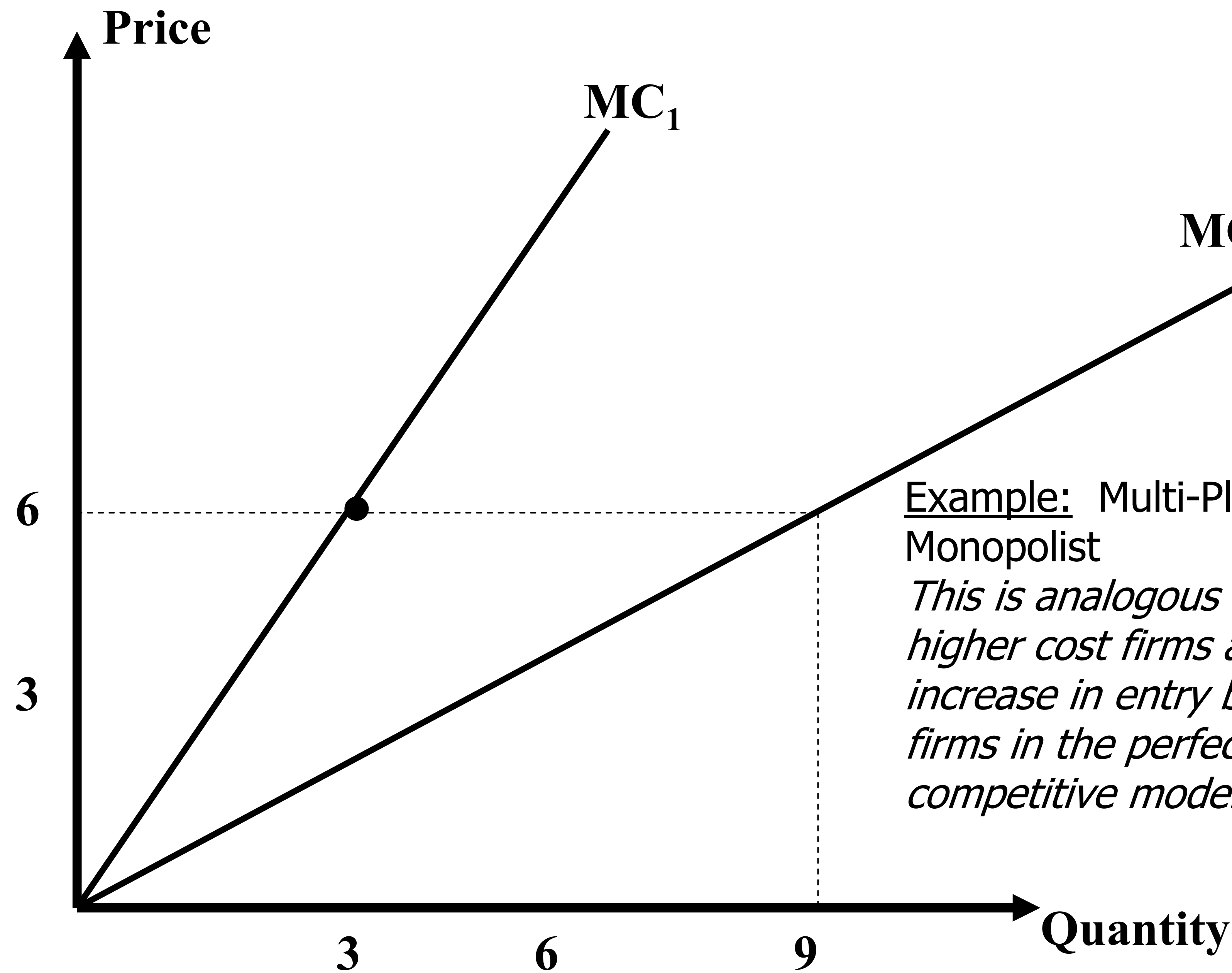
Whenever the marginal costs of the two plants are not equal, the firm can increase profits by reallocating production towards the lower marginal cost plant and away from the higher marginal cost plant.

Example:

Suppose the monopolist wishes to produce 6 units

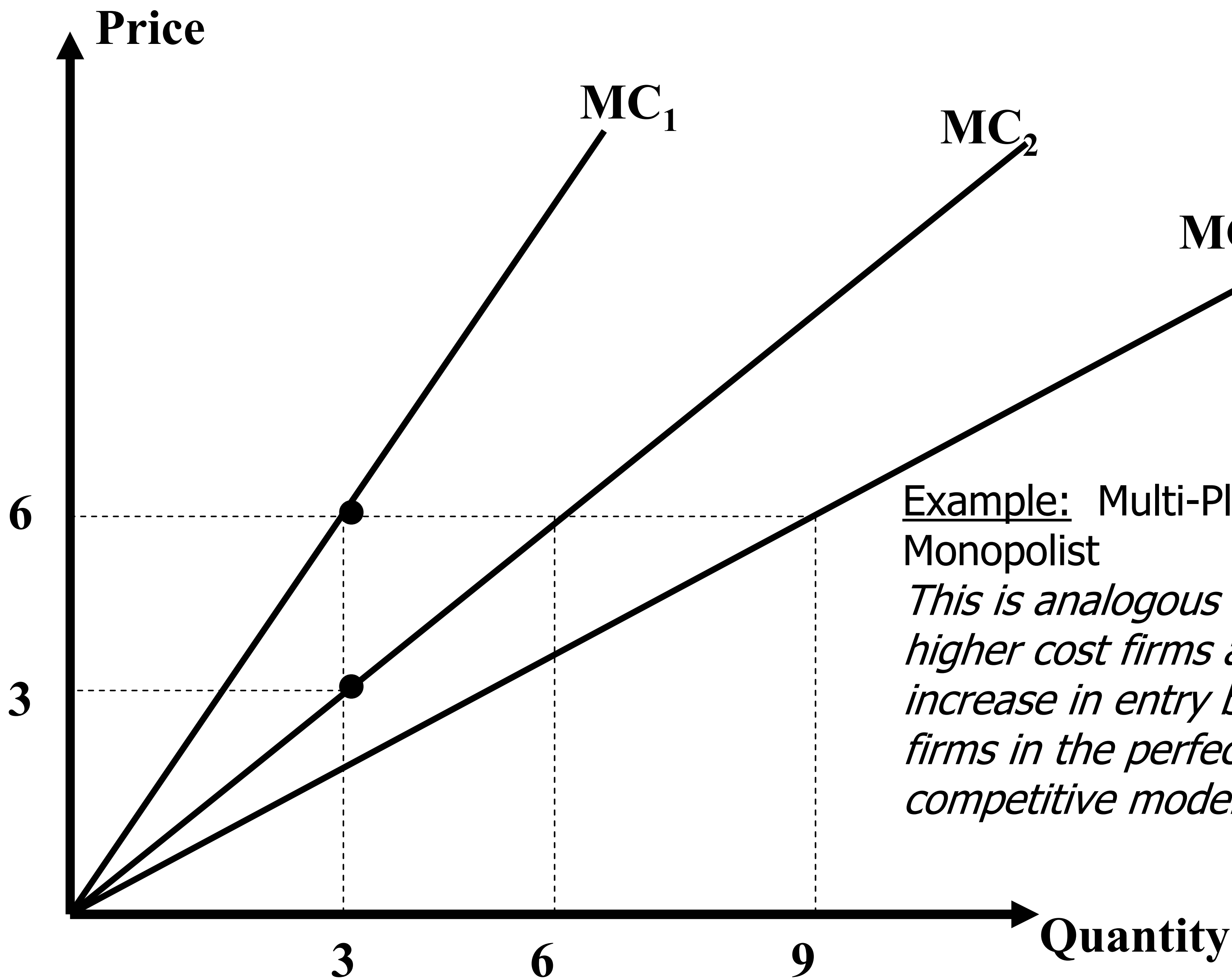
3 units per plant => $MC_1 = \$6$
$MC_2 = \$3$

Reducing plant 1's units and increasing plant 2's units raises profits



Example: Multi-Plant Monopolist

This is analogous to exit by higher cost firms and an increase in entry by low-cost firms in the perfectly competitive model.



Example: Multi-Plant Monopolist

This is analogous to exit by higher cost firms and an increase in entry by low-cost firms in the perfectly competitive model.

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

Definition: The **Multi-Plant Marginal Cost Curve** traces out the set of points generated when the marginal cost curves of the individual plants are horizontally summed (i.e. this curve shows the total output that can be produced at every level of marginal cost.)

Example:

For MC_1 = \$6, $Q_1 = 3$
MC_2 = \$6, $Q_2 = 6$

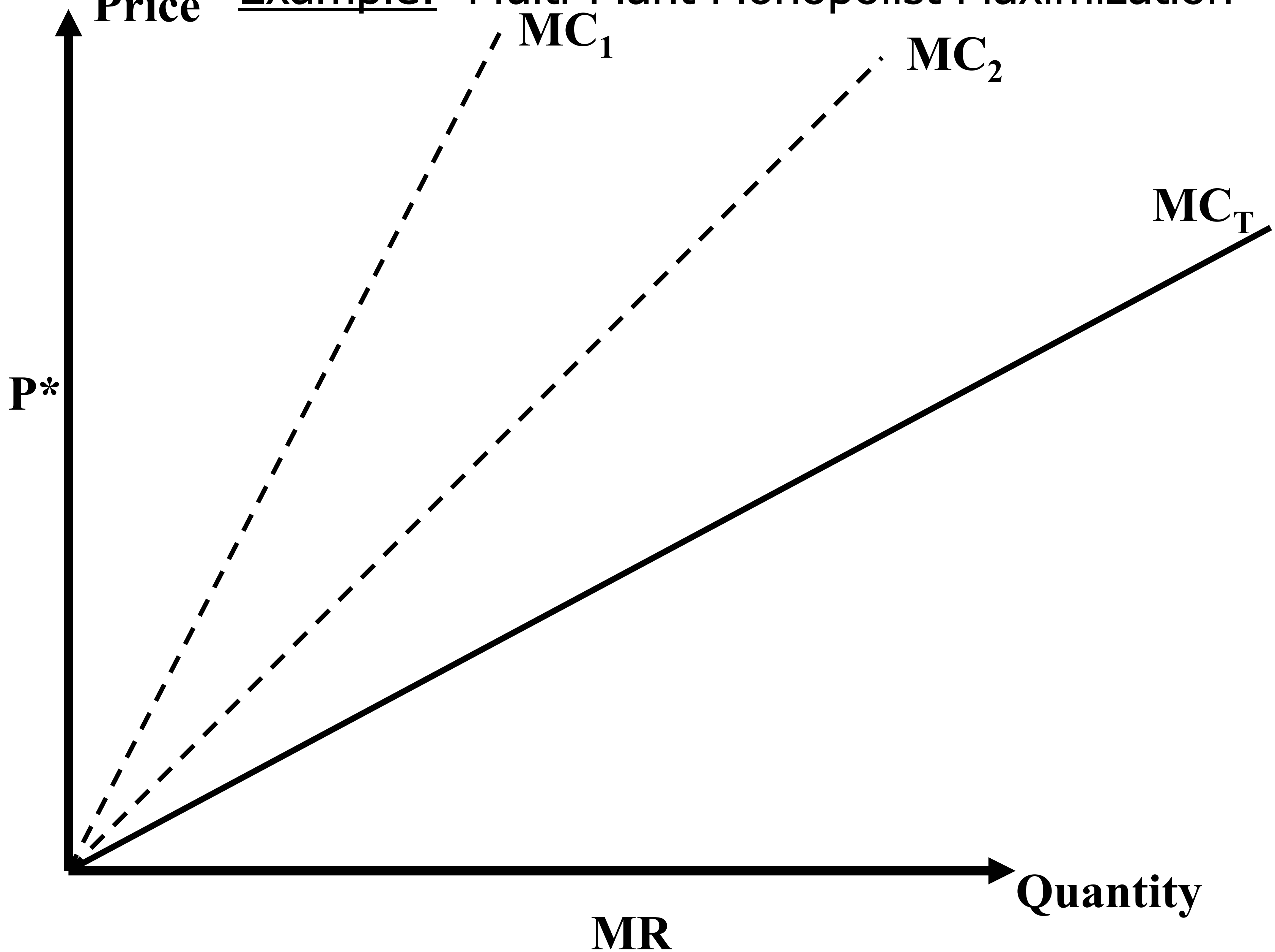
Therefore, for MC_T = \$6, $Q_T = Q_1 + Q_2 = 9$

The profit maximization condition that determines optimal total output is now:

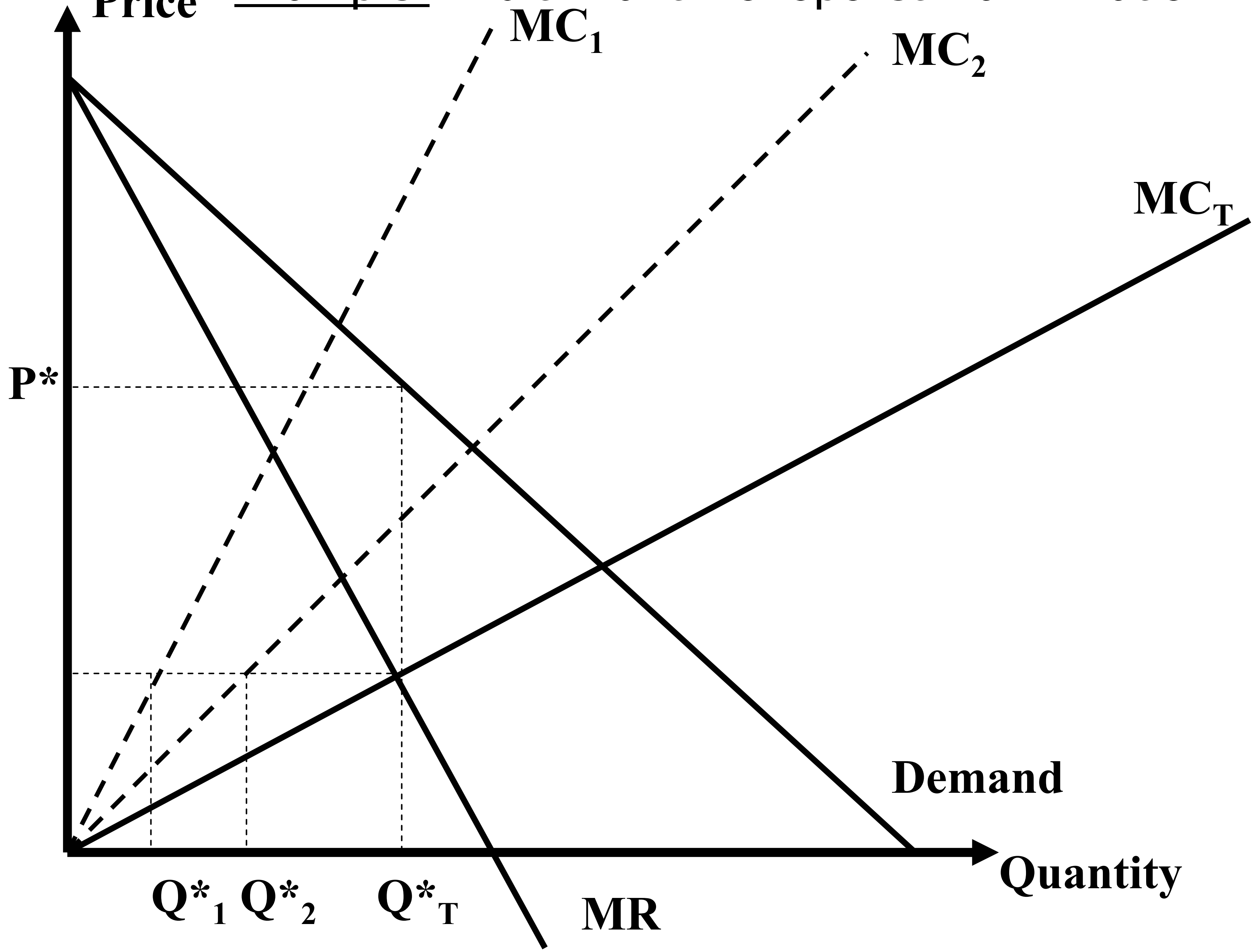
$$MR = MC_T$$

The marginal cost of a change in output for the monopolist is the change after all optimal adjustment has occurred in the distribution of production across plants.

<u>Example:</u> Multi-Plant Monopolist Maximization



Example: Multi-Plant Monopolist Maximization



Example

$P = 120 - 3Q$ *...demand...*

$MC_1 = 10 + 20Q_1$ *...plant 1...*
$MC_2 = 60 + 5Q_2$ *...plant 2...*

a. *What are the monopolist's optimal total quantity and price?*

Step 1: Derive MC_T as the horizontal sum of MC_1 and MC_2 Inverting marginal cost (to get Q as a function of MC), we have:

$Q_1 = -1/2 + (1/20)MC_T$
$Q_2 = -12 + (1/5)MC_T$

Let MC_T equal the common marginal cost level in the two plants. Then:

$$Q_T = Q_1 + Q_2 = -12.5 + .25MC_T$$

And, writing this as MC_T as a function of Q_T:

$$MC_T = 50 + 4Q_T$$

Using the monopolist's profit maximization condition:

$$MR = MC_T \Rightarrow 120 - 6Q_T = 50 + 4Q_T$$

$Q_T^* = 7$

$P^* = 120 - 3(7) = 99$

b. *What is the optimal division of output across the monopolist's plants?*

$MC_T^* = 50 + 4(7) = 78$

Therefore,

$Q_1^* = -1/2 + (1/20)(78) = 3.4$
$Q_2^* = -12 + (1/5)(78) = 3.6$

Applications

<u>Definition:</u> A **cartel** is a group of firms that collusively determine the price and output in a market. 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.

Therefore, a cartel does not necessarily divide up market shares equally among members: higher marginal cost firms produce less.

This gives us a benchmark against which we can compare actual industry and firm output to see how far the industry is from the collusive equilibrium.

The Welfare Economics of Monopoly

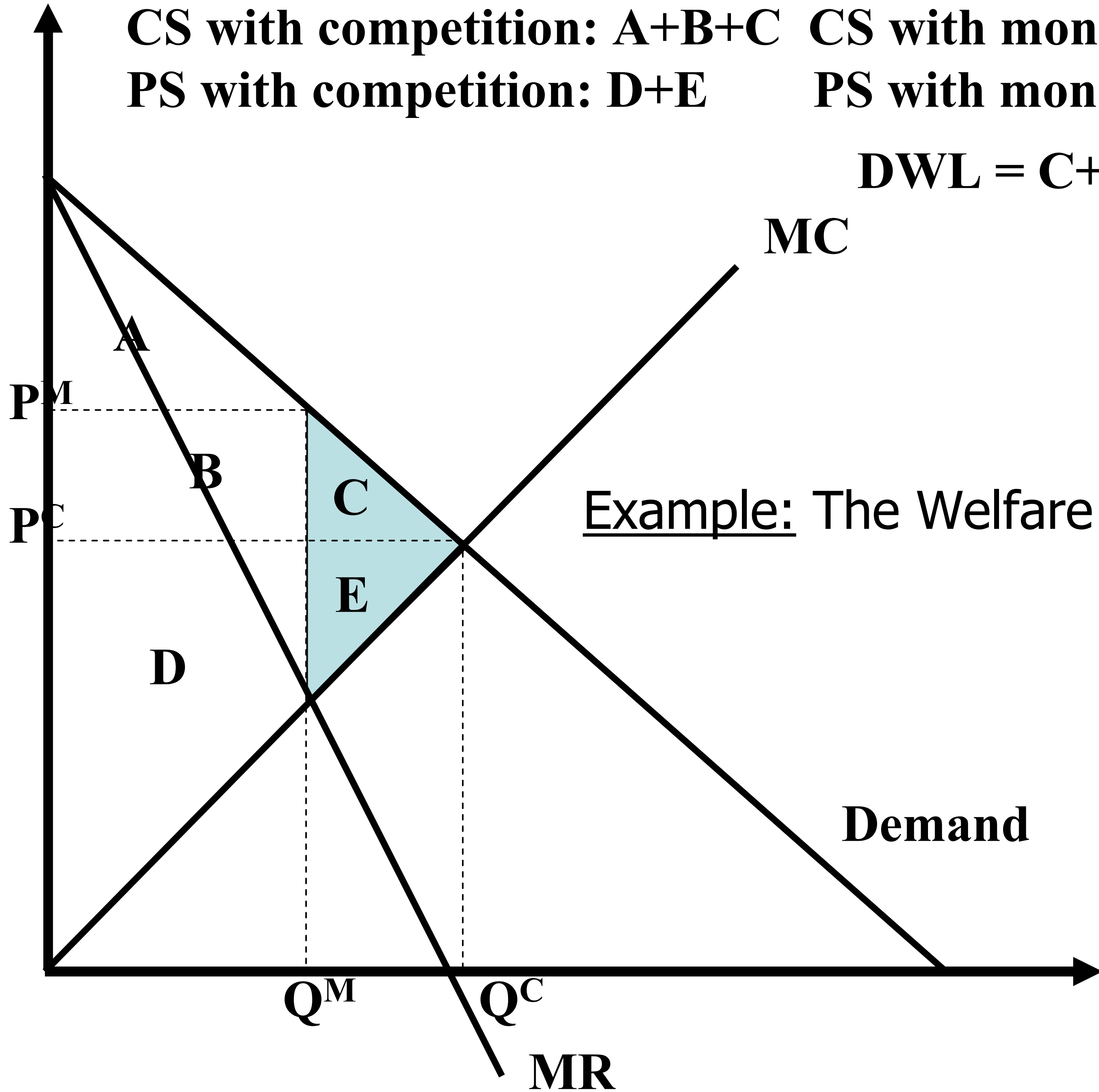
Since the monopoly equilibrium output does not, in general, correspond to the perfectly competitive equilibrium it entails a dead-weight loss.

1. Suppose that we compare a monopolist to a competitive market, where the supply curve of the competitors is equal to the marginal cost curve of the monopolist…

CS with competition: A+B+C CS with monopoly: A

PS with competition: D+E PS with monopoly:B+D

DWL = C+E

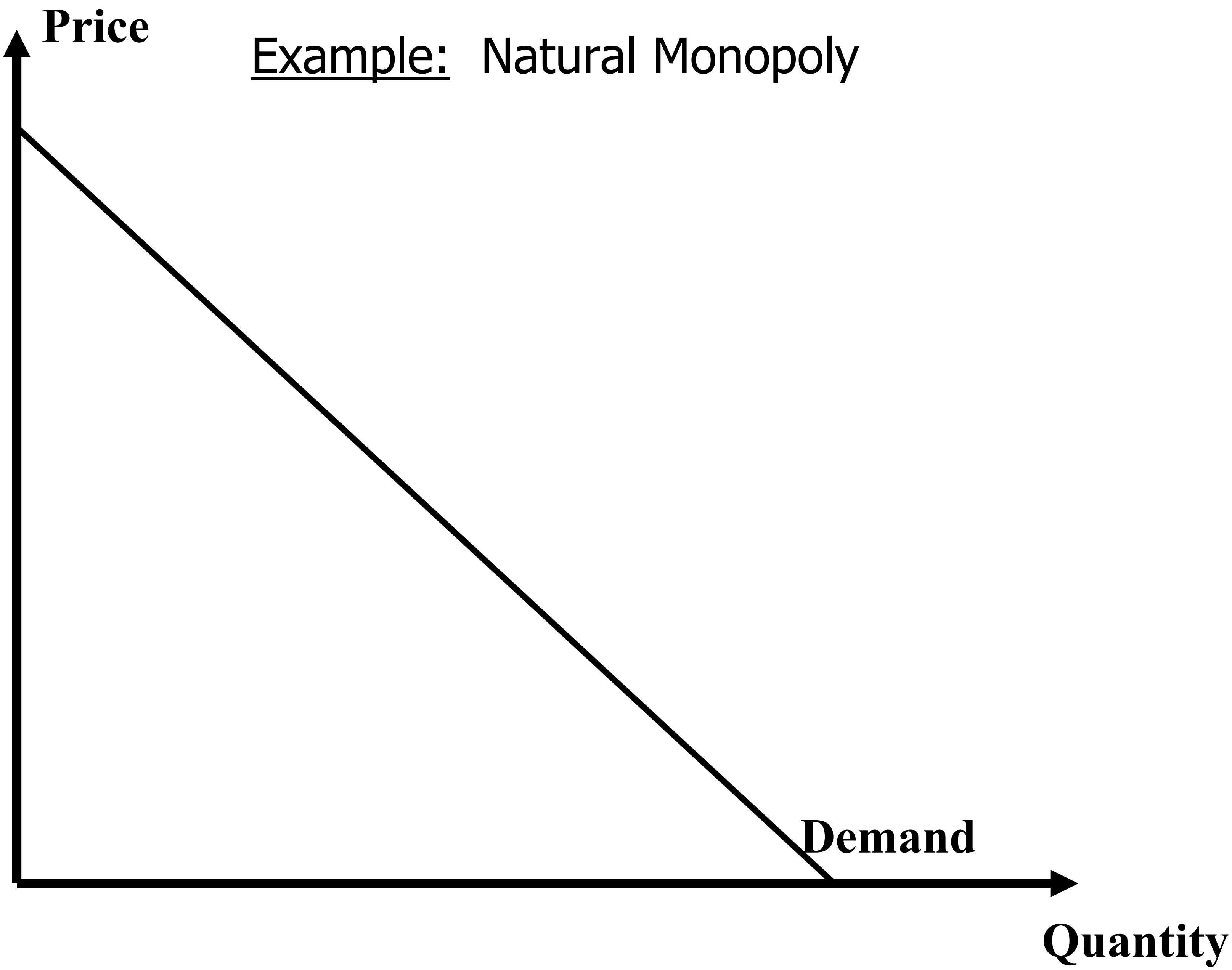


<u>Example:</u> The Welfare Effect of Monopoly

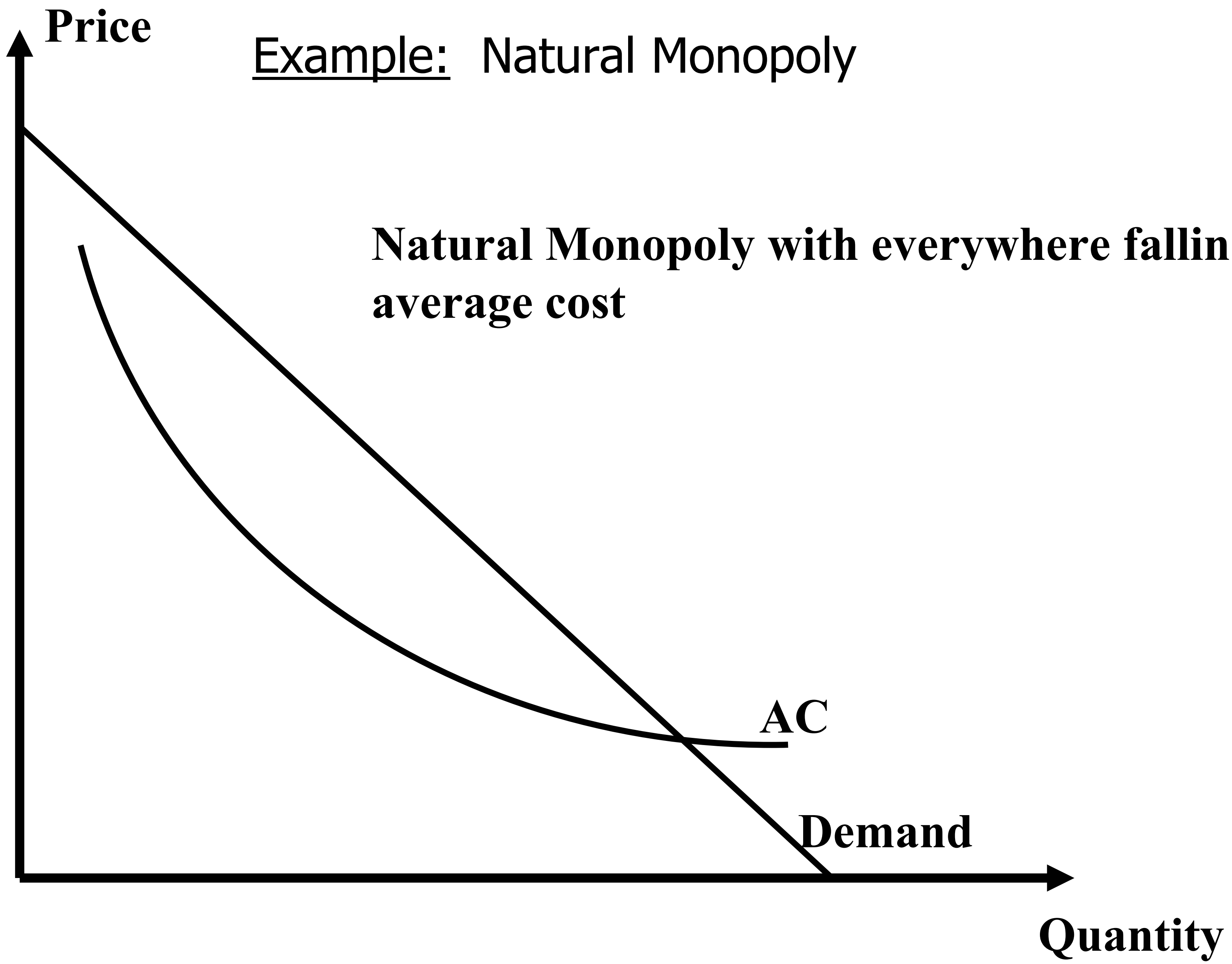
2.Dead-weight loss in a Natural Monopoly Market

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.

Benchmark: What would be the market outcome if the monopolist produced according to the same rule as a perfect competitor (i.e., P = MC)?


Price
Example: Natural Monopoly
Demand
Quantity

Example: Natural Monopoly

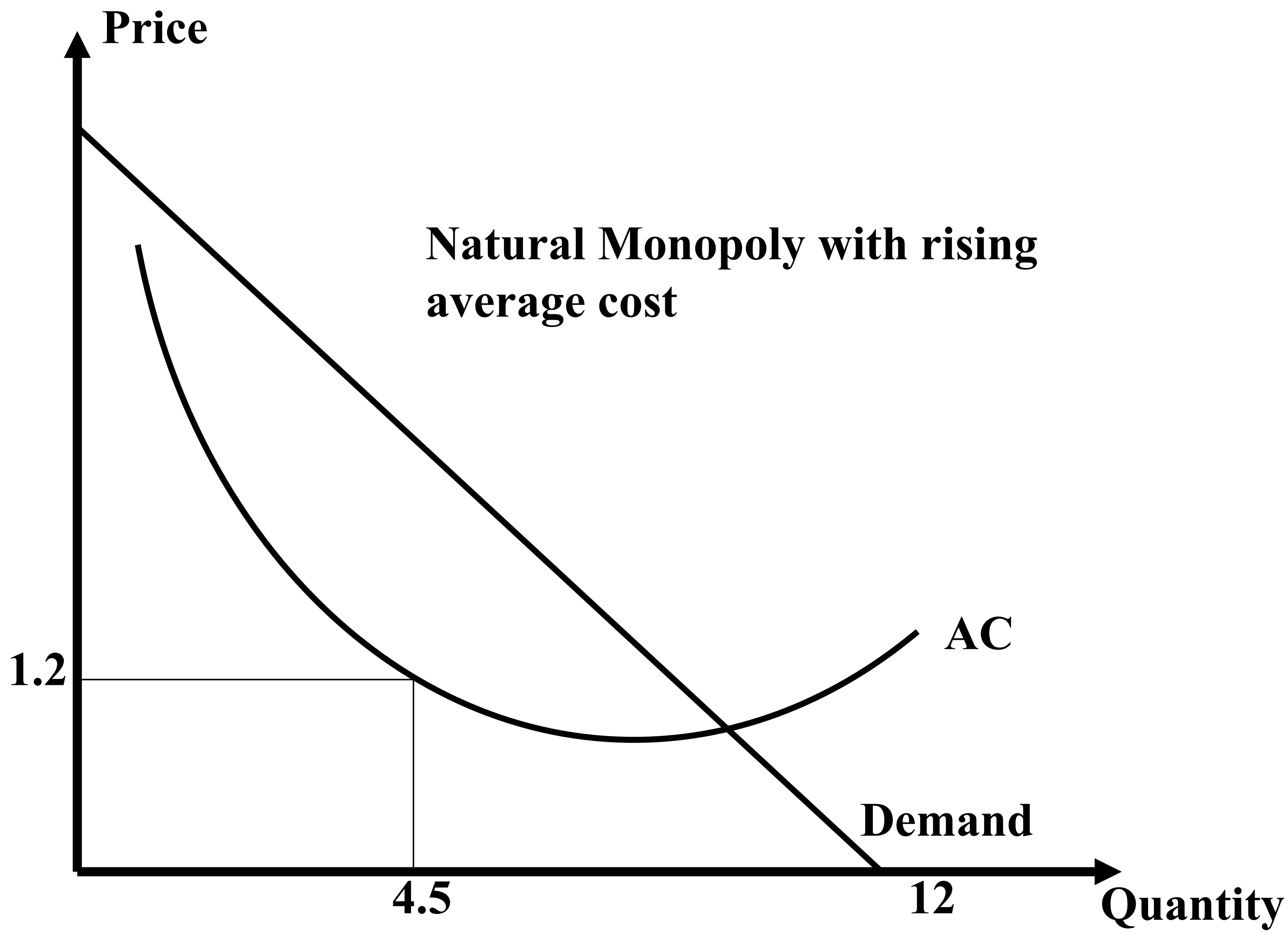


P = MC cannot be the appropriate benchmark here to calculate deadweight loss due to monopoly…P = AC may be a better benchmark…

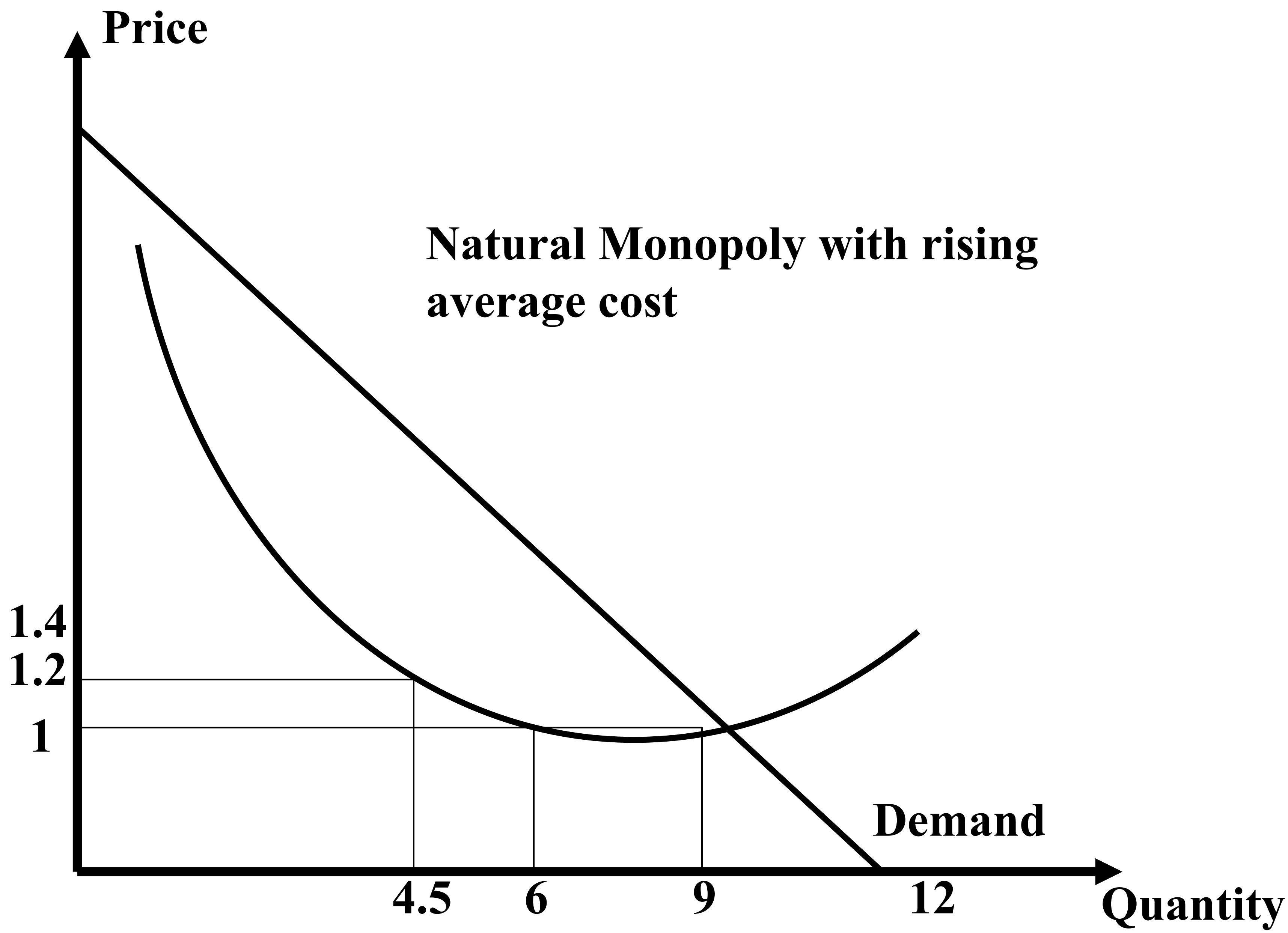
for small outputs, this *is* a natural monopoly…for large outputs, it is not…

P = MC is the appropriate benchmark for these types of natural monopolies.

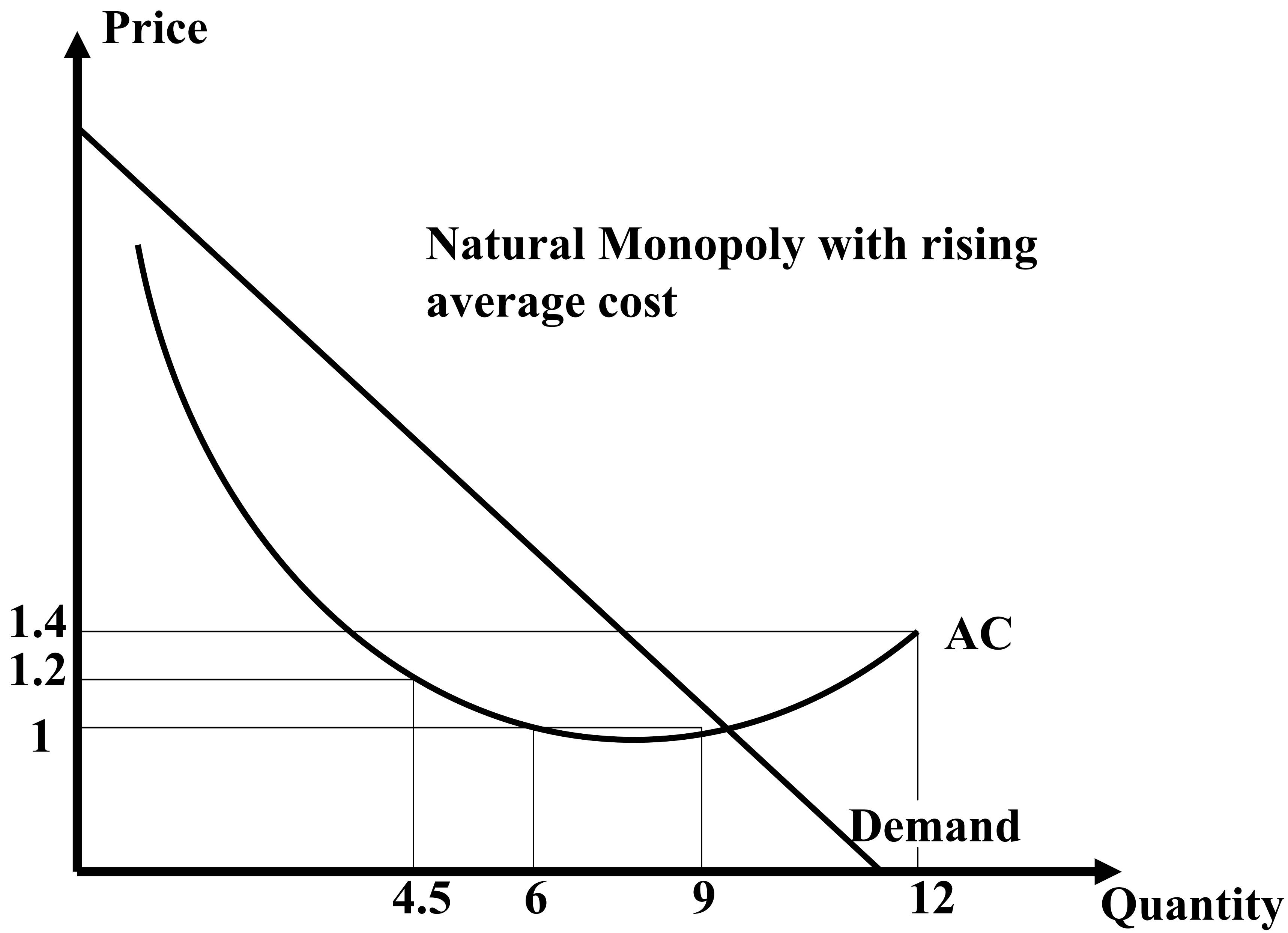
<u>Example:</u> Natural Monopoly with Rising Average Cost



Example: Natural Monopoly with Rising Average Cost



Example: Natural Monopoly with Rising Average Cost



Summary

1. A monopoly market consists of a single seller facing many buyers *(utilities, postal services)*.

2. A monopolist's profit maximization condition is to set the marginal revenue of additional output (or a change in price) equal to the marginal cost of additional output (or a change in price).

3. Marginal revenue generally is less than price. How much less depends on the elasticity of demand.

4. A monopolist generally never produces on the inelastic portion of demand since, in the inelastic region, raising price and reducing quantity make total revenues rise and total costs fall!

5. The Lerner Index is a measure of market power, often used in antitrust analysis.