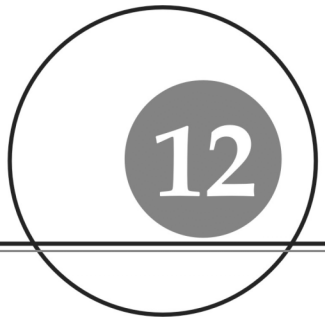


Managerial Decisions for Firms with Market Power

Learning Objectives

After reading Chapter 12 and working the problems for Chapter 12 in the textbook and in this Workbook, you should be able to:

- Define the concept of market power and distinguish between market power and monopoly.
- Explain how own-price and cross-price elasticities of demand and the Lerner index can be used to measure the degree of market power possessed by a firm.
- Explain why the existence of barriers to entry are necessary for market power in the long run, and list six types of entry barriers.
- Find the profit-maximizing output and price for a monopolist in both the short run and long run.
- Find the profit-maximizing level of input usage for firms with market power.
- Find the profit-maximizing price and output for a monopolistically competitive firm in both the short run and the long run.
- Find the profit-maximizing (or loss-minimizing) level of output for a monopoly, or any firm with market power, given estimates or forecasts of (i) the demand function, (ii) the average variable cost function, and (iii) the marginal cost function.
- How to choose individual production levels at multiple plants owned by a firm in order to minimize the total cost of producing a given amount of total output for a firm.

Essential Concepts

1. *Market power* is the ability of a firm to raise price without losing all its sales. Any firm that faces a downward sloping demand curve has market power. Market power gives the firm the ability to raise price above average cost and earn economic profit, if demand and cost conditions so permit.
2. A *monopoly* exists when a single firm produces and sells a particular good or service for which there are no good substitutes, and new firms are prevented from entering the market.
3. The degree to which a firm possesses market power is inversely related to the price elasticity of demand. The less (more) elastic the firm's demand, the greater (less)

its degree of market power. The fewer the number of close substitutes consumers can find for a firm's product, the smaller the elasticity of demand (in absolute value), and the greater the firm's market power. When demand is perfectly elastic (demand is horizontal), the firm possesses no market power.

4. The Lerner index measures the proportionate amount by which price exceeds marginal cost:

$$\text{Lerner index} = \frac{P - MC}{P}$$

Under perfect competition, the index is equal to zero, and the index increases in magnitude as market power increases.

5. When consumers view two goods to be substitutes, the cross-price elasticity of demand (E_{XY}) is positive. The higher the (positive) cross-price elasticity, the greater the substitutability between two goods, and the smaller the degree of market power possessed by the two firms.

6. A firm can possess a high degree of market power only when strong barriers to the entry of new firms exist. Six common types of entry barriers are:

   a. *Economies of scale.* When long-run average cost declines over a wide range of output relative to the demand for the product, there may not be room in the market for another large producer to enter the market—at least not without driving price below unit costs making it unprofitable to enter.

   b. *Barriers created by government*. Government barriers to entry, such as licenses and exclusive franchises, have been created in many industries. Patent laws also can, but need not, create strong barriers to entry.

   c. *Input barriers*. When one firm controls a crucial input in the production process, that firm can obviously block entry.

   d. *Brand loyalties*. Over time, firms may develop such strong customer allegiance that new firms cannot find enough buyers at a price that covers cost to make entry worthwhile.

   e. *Consumer lock-in*. For some products or services, consumers may find it costly to switch to another brand, which makes previous consumption decisions costly to change. Potential rivals can be deterred from entering if they believe high switching costs will make it difficult for them to induce many consumers to change brands.

   f. *Network externalities*. Network externalities occur when the value of a product increases as more consumers buy and use the product. Thus, entry of new firms can be deterred if network externalities make it very difficult for new firms to enter markets where firms have established a large base or network of buyers.

7. In the short run:

   a. A monopolist will produce a positive output if some price on the demand curve exceeds average variable cost.

   b. A monopolist maximizes profit or minimizes loss by producing the quantity for which $MR = MC$.

   c. If the price exceeds average total cost ($P > ATC$) the firm makes an economic profit.

   d. If price is less than average total cost but greater than average variable cost ($ATC > P \geq AVC$), the firm suffers an economic loss, but continues to produce in the short run.

   e. If demand falls below average variable cost at every level of output, the firm shuts down and loses only its fixed cost.

8. In the long run:

   a. A manager of a monopoly firm maximizes profit by choosing to produce the level of output where marginal revenue equals long-run marginal cost ($MR = LMC$) as long as $P \geq LAC$.

   b. A monopolist will exit the industry if $P < LAC$.

   c. The manager will adjust plant size to the optimal level, i.e., the plant with the ATC curve tangent to the LAC curve at the profit-maximizing output level.

8. *Marginal revenue product (MRP)* is the additional revenue attributable to hiring one additional unit of the input: $MRP =)TR/)L$. MRP is also equal to marginal revenue times marginal product: $MRP = MR \times MP$.

9. When producing with a single variable input, a firm with market power will maximize profit by employing that amount of the input for which marginal revenue product (MRP) equals the price of the input when input price is given. The relevant range of the MRP curve is the downward sloping, positive portion of MRP for which $ARP > MRP$.

10. For a firm with market power, the profit-maximizing condition that the marginal revenue product of the variable input must equal the price of the input ($MRP = w$) is equivalent to the profit-maximizing condition that marginal revenue must equal marginal cost ($MR = MC$). Thus, regardless of whether the manager chooses Q or L to maximize profit, the resulting levels of input usage, output, price and profit are the same in either case.

11. Under *monopolistic competition*, a large number of firms sell a differentiated product. The market is monopolistic in that product differentiation creates a degree of market power. It is competitive because of the large number of firms and easy entry.

12. Short-run equilibrium under monopolistic competition is exactly the same as it is for monopoly. Long-run equilibrium in a monopolistically competitive market is attained when the demand curve for each producer is tangent to the long-run average cost curve. Unrestricted entry and exit lead to this equilibrium. At the

equilibrium output, price equals long-run average cost, and marginal revenue equals long-run marginal cost.

13. Making profit-maximizing pricing and output decisions for firms with market power can be summarized in the following steps:

Step 1: *Estimate the demand equation.* Estimate demand for a price-setting firm using the OLS regression procedure, as set forth in Chapter 7.

Step 2: *Find the inverse demand equation.* The inverse demand function is derived by solving for P in the estimated demand equation:

$$P = \frac{-a'}{b} + \frac{1}{b}Q = A + BQ$$

where $a' = a + c\,\hat{M} + d\,\hat{P}_R$, $A = -a'/b$, and $B = 1/b$.

Step 3: *Solve for marginal revenue*. Marginal revenue is

$$MR = A + 2BQ = \frac{-a'}{b} + \frac{2}{b}Q$$

Step 4: *Estimate average variable cost (AVC) and short-run marginal cost (SMC)*. Estimate AVC and SMC functions, as set forth in Chapter 10:

$$AVC = a + bQ + cQ^2$$

$$SMC = a + 2bQ + 3cQ^2$$

Step 5: *Find the output level where MR = SMC*. To find the optimal level of output, the manager sets marginal revenue equal to marginal cost and solves for Q. The larger of the two roots or solutions is the profit-maximizing level of output—unless P (found in Step 6) is less than AVC, and then the optimal level of output is zero.

Step 6: *Find the profit-maximizing price*. Once the optimal quantity, Q^*, has been found, the profit-maximizing price is found by substituting Q^* into the inverse demand equation to obtain the optimal price, P^*:

Step 7: *Check the shutdown rule*. The manager can calculate the average variable cost at Q^* units by substituting Q^* into the estimated AVC function

$$AVC^* = a + bQ^* + cQ^{*2}$$

If $P^* \geq AVC^*$, then the firm produces Q^* units of output and sells each unit for P^*. If $P^* < AVC^*$, the monopolist shuts down in the short run.

Step 8: *Compute profit or loss*. To compute profit or loss, the manager makes the same calculation regardless of whether the firm operates in a monopoly, oligopoly, or perfectly competitive market

$$\text{Profit} = TR - TC = (P \times Q) - (AVC \times Q) - TFC$$

If $P < AVC$, the firm shuts down, and profit is $-TFC$.

14. If a firm produces in two plants, A and B, it should allocate production between the two plants so that $MC_A = MC_B$. The optimal total output for the firm is that output for which $MR = MC_T$. Hence, for profit maximization, the firm should produce the level of total output and allocate this total output between the two plants so that

$$MR = MC_T = MC_A = MC_B$$

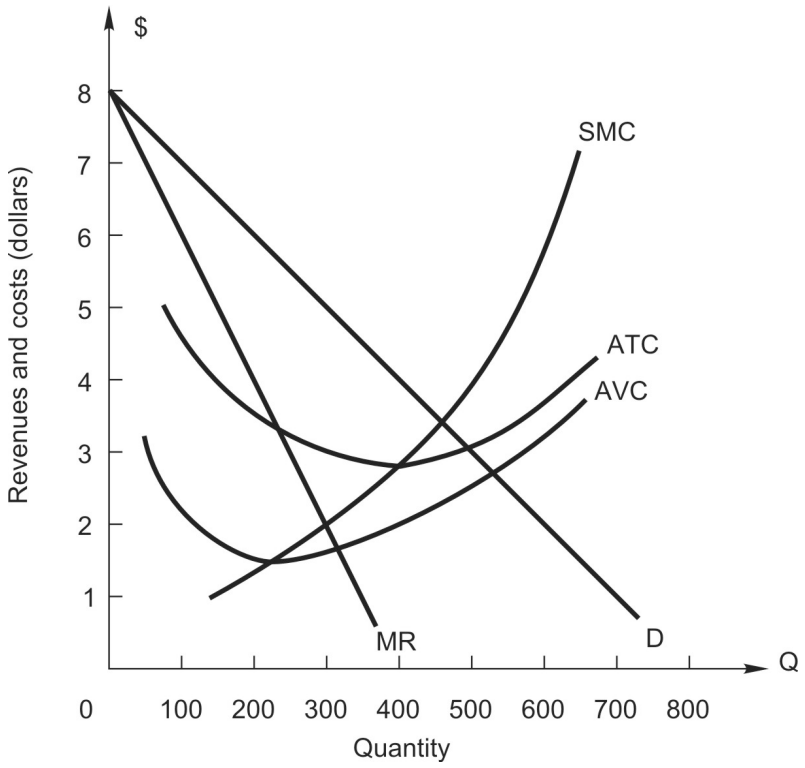
Matching Definitions

consumer lock-in
inverse demand function
Lerner index
marginal revenue product
market definition
market power
monopolistic competition
monopoly
network externalities
strong barrier to entry
switching costs

1. _____ Ability of a firm to raise price without losing all its sales.
2. _____ Firm that produces a good for which there are no close substitutes in a market that other firms are prevented from entering because of entry barriers.
3. _____ Market consisting of a large number of firms selling a differentiated product with low barriers to entry.
4. _____ The identification of the producers and products that compete for consumers in a particular area.
5. _____ A ratio that measures the proportionate amount by which price exceeds marginal cost.
6. _____ Condition that makes it difficult for new firms to enter a market in which economic profits are being earned.
7. _____ Costs consumers incur when they switch to new or different products or services.
8. _____ When high switching costs make previous consumption decisions very costly to change.
9. _____ When a product's value rises as more consumers use it.
10. _____ The additional revenue attributable to hiring an additional unit of a variable input.
11. _____ The demand function with demand price expressed as a function of output.

Study Problems

1. Suppose a monopolist faces the demand and cost curves shown in the figure below.



   a. The monopolist maximizes profit (minimizes loss) by producing _____ units of output.

   b. The monopolist will sell its output at a price of $_____ per unit.

   c. The monopolist earns a profit (loss) of $_____.

   d. Construct a new demand and marginal revenue curve such that the monopolist earns a loss in the short run but does not shut down.

   e. Construct a new demand such that the firm shuts down.

2. a. Explain carefully why firms with market power do not, in general, also maximize total revenue.

   b. Under what special condition would firms with market power be able to maximize both profit and total revenue at the same level of output?

3. A monopolist is producing a level of output, 80 units, at which price is $12, marginal revenue is $8, average total cost is $14, average variable cost is $5, and marginal cost is $2.

   a. Draw a graph of the demand and cost conditions facing the firm.

   b. Is the firm making the profit-maximizing decision? Why or why not? If not, what should the manager do?

4. A manager of a monopolistic competitor faces the following demand and cost schedules:

Quantity	*Price*	*Total Cost*
0	$25	$1,000
100	20	1,800
200	16	2,800
300	10	4,000
400	5	5,400
500	1	7,000

   a. The manager should produce _____ units.
   b. The manager should charge a price of _____ units.
   c. The maximum amount of profit that can be earned is $ _____.
   d. If total fixed cost doubles, the firm should produce _____ units. The maximum amount of profit that can be earned is $_____.

5. In the following table columns (1) and (2) show the short-run production function for a monopolist using a single variable input, labor. Columns (2) and (3) show the demand schedule. Total fixed cost is $1,800.

(1) *Labor / week*	(2) *Output / week*	(3) *Price*
0	0	xx
1	50	20
2	110	18
3	150	16
4	180	15
5	200	14
6	210	13

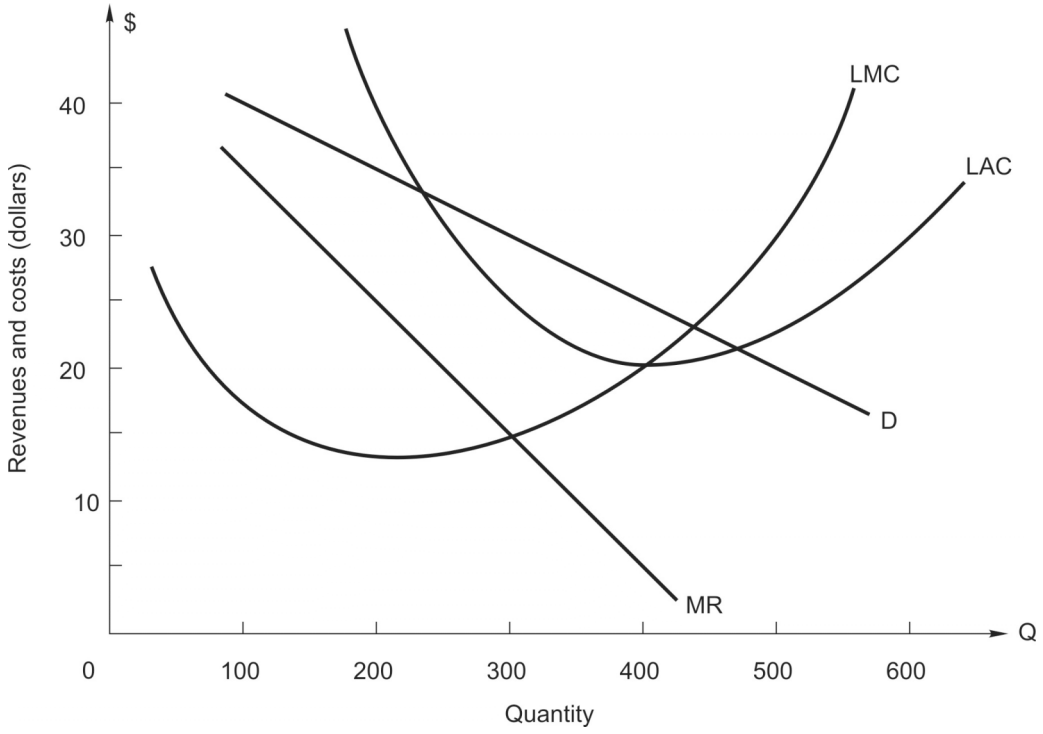
   a. Calculate the *MRP* and *ARP* for each level of labor usage.
   b. If the weekly wage is $150 how much labor will the firm use and how much will it produce? What is the firm's profit (loss)?
   c. If the wage rises to $350 how much labor will the firm use and how much will it produce? What is the firm's profit (loss)?

6. a. Compare short-run profit-maximizing equilibrium for a monopolistic competitor and a monopoly.

   b. Compare long-run equilibrium for a monopolistic competitor and a perfect competitor.

7. Explain why, in theory, a monopolist and a monopolistic competitor always sell an output and set a price on the elastic portion of demand.

8. The following figure shows demand, marginal revenue, and long-run costs for a monopolistic competitor.



   a. With the given demand, what output will the firm produce, what price will it charge, and how much profit (loss) will the firm make?

   b. Draw in possible demand and marginal revenue curves when the firm attains long-run equilibrium. What is the firm's economic profit?

   c. If these were the cost curves for a perfectly competitive firm in long-run competitive equilibrium, what would output, price, and economic profit be?

9. The demand function for a firm with market power is estimated to be

$$Q = 122{,}000 - 500P + 4M + 10{,}000P_R$$

   where Q is output, P is price per unit, M is income, and P_R the price of a related good. The manager estimates the values of M and P_R will be \$32,000 and \$4, respectively, in 2008. For 2008, find the following functions:

   a. Forecasted demand function

   b. Inverse demand function

   c. Marginal revenue function

The firm faces an average variable cost function estimated to be

$$AVC = 500 - 0.03Q + 0.000001Q^2$$

where AVC is measured in dollars per unit.

d. The estimated marginal cost function is

$SMC =$ _____.

e. The profit-maximizing level of output for 2008 is _____ units.

f. The profit-maximizing price for 2008 is $_____.

g. Should the manager produce or shut down?

h. If total fixed cost is expected to be $5 million in 2008, what is the firm's expected profit or loss in 2008?

Multiple Choice / True-False

1. If a firm with market power maximizes profit by producing at the unit elastic point on the demand curve, then
   a. it has no direct competitors.
   b. its marginal cost must be zero at the profit-maximizing level of output.
   c. demand must be perfectly elastic.
   d. it cannot be in long-run equilibrium.

2. Which of the following statements is not always true for a monopolist in short-run equilibrium?
   a. $|E| \geq 1$
   b. $TR > TVC$
   c. $MR = SMC$
   d. $P > MR$

3. If a firm with market power is not making enough profit (in equilibrium),
   a. it will lower price thereby increasing total revenue because demand is elastic.
   b. it will raise price thereby increasing total revenue because demand is inelastic.
   c. it will exit the industry in the long run if economic profit is negative.
   d. it will expand sales until it reaches the unit elastic point on demand.

4. If a monopolist can find buyers for 4 units at a price of $7, and if the marginal revenue due to the 5th unit is $2, the highest price at which the monopolist can find buyers for 5 units must be
   a. $2.
   b. $3.
   c. $4.
   d. $5.
   e. $6.

5. Market power
   a. is the capability to increase price without losing all sales.
   b. exists whenever the firm faces a downward-sloping demand curve.
   c. is greater the less elastic is demand.
   d. is smaller the more positive is the cross-price elasticity of demand.
   e. all of the above.

6. A monopoly is maximizing short-run profit at a point on demand where demand elasticity is –3. What is the Lerner index?
   a. 3
   b. 1/3
   c. 33.3
   d. –3/4

7. Monopolistic competition is similar to monopoly since both market structures have
   a. a small number of firms.
   b. downward-sloping demands for the firms.
   c. economic profit in long-run equilibrium.
   d. easy entry and exit.
   e. all of the above.

8. The *primary* difference between perfect and monopolistic competition is that for monopolistic competition
   a. there is product differentiation.
   b. entry is difficult.
   c. a large number of sellers exists.
   d. consumers have perfect information with respect to prices.

9. In long-run equilibrium under monopolistic competition,
   a. price equals minimum long-run average cost.
   b. price is higher than minimum long-run average cost.
   c. the firms earn less than a normal profit.
   d. firms have the incentive to enter the market.
   e. both *a* and *d*.

Use the following table showing a monopolist's demand schedule and short-run total cost schedule to answer questions 10–13.

Price	*Quantity*	*Total cost*
$11	0	$400
10	60	800
9	90	890
8	130	1,050
7	166	1,230
6	196	1,440
5	210	1,800

10. To maximize profit the firm will set a price of $_____ and sell _____ units output.
    a. $10; 60
    b. $9; 90
    c. $8; 130
    d. $7; 166
    e. $6; 196

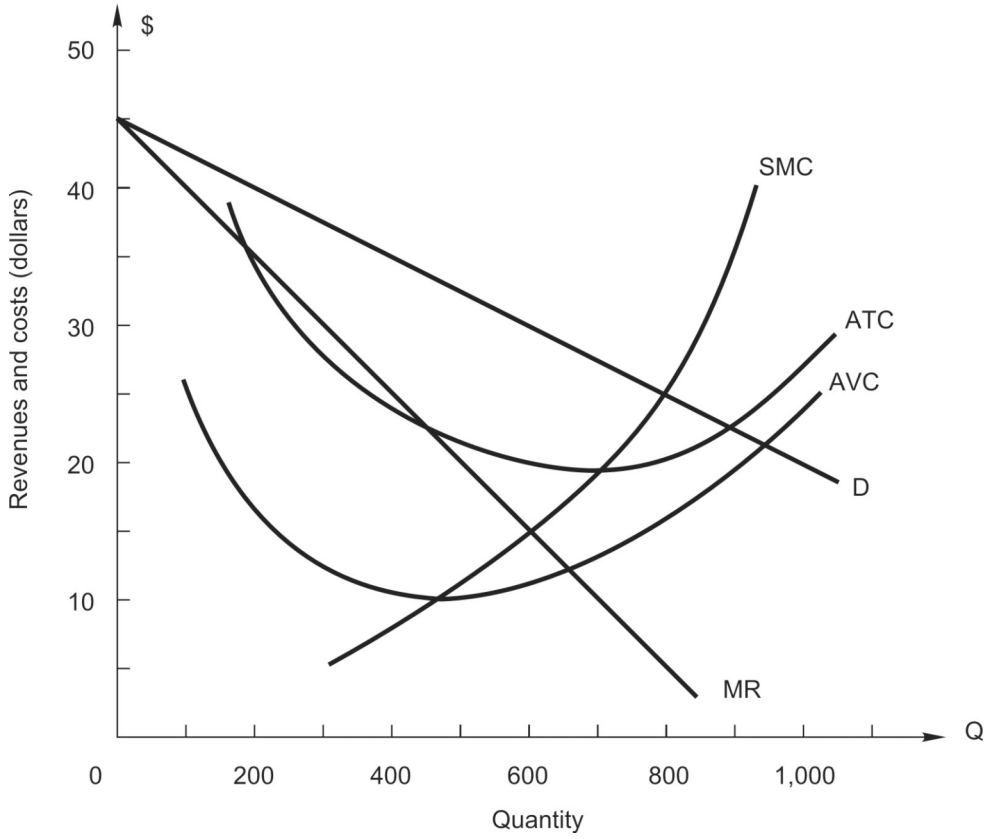
11. Profit (loss) at the profit-maximizing output is $_____.
    a. $90
    b. $300
    c. –$48
    d. –$10
    e. –$90

12. If the firm reduces price $1 from the profit-maximizing level, marginal revenue is $_____ and marginal cost is $_____.

    a. $0.47; $6
    b. $20; $4
    c. $7; $3
    d. $3.40; $5

13. If the firm reduces price $1 from the profit-maximizing level, profit (loss) will be $_____.
    a. –$48
    b. $62
    c. –$68
    d. –$264
    e. $400

Use the following figure showing cost, demand, and marginal revenue for a monopoly to answer questions 14–16.



14. What is the profit-maximizing level of output?
    a. 860
    b. 600
    c. 700
    d. 900
    e. 650

15. What is the profit-maximizing price?
    a. $15
    b. $20
    c. $25
    d. $30
    e. $23

16. What is the maximum amount of profit the firm can earn?
    a. $6,000
    b. $10,200
    c. $9,000
    d. $1,200
    e. $8,000

Questions 17–24 involve a profit-maximizing monopolist that produces a product using a single variable input–labor. Using time-series data, the demand function for the monopolist has been estimated as

$$Q = 15{,}000 - 50P + 0.5M - 300P_R$$

The estimated values for M and P_R in 2008 are \$22,000 and \$16, respectively. The average variable cost curve for this firm has been estimated as

$$AVC = 200 - 0.12Q + 0.0002Q^2$$

Total fixed costs were forecast to be \$100,000 in 2008.

17. The forecasted demand function for 2008 is
    a. $Q = 150{,}000 - 20P$.
    b. $Q = 20{,}000 - 0.02P$.
    c. $Q = 80{,}000 - 0.50P$.
    d. $Q = 21{,}200 - 50P$.
    e. $Q = 110{,}000 - 50P$.

18. The forecasted marginal revenue function for 2008 is
    a. $MR = 424 - 0.04Q$.
    b. $MR = 424 - 0.02Q$.
    c. $MR = 110{,}000 - 0.02Q$.
    d. $MR = 220{,}000 - 4Q$.
    e. $MR = 16{,}000 - 2Q$.

19. What is the marginal cost function?
    a. $SMC = 400 - 0.24Q + 0.0001Q^2$
    b. $SMC = 400 - 0.12Q + 0.0004Q^2$
    c. $SMC = 200 - 0.24Q + 0.0006Q^2$
    d. $SMC = 400 - 0.24Q + 0.0004Q^2$

20. What is the profit-maximizing (or loss-minimizing) level of production?
    a. 0 units
    b. 800 units
    c. 1,000 units
    d. 1,200 units
    e. 1,250 units

21. What is the value of average variable cost at the optimal level of output?
    a. \$76
    b. \$96
    c. \$112
    d. \$196
    e. \$232

22. What is the optimal price?
    a. This is irrelevant as the firm will not produce in the short run.
    b. $200
    c. $263
    d. $408
    e. $488

23. The firm's forecasted profit in 2008 is a
    a. loss of $100,000.
    b. loss of $48,000.
    c. profit of $40,800.
    d. profit of $400,000.
    e. profit of $565,000.

24. Now suppose total fixed cost doubles to $200,000 in 2008. The optimal price is now
    a. $408.
    b. $488.
    c. $512.
    d. $524.
    e. $600.

In questions 1 and 2, consider a firm with market power that produces in two plants (1 and 2) with the following marginal costs:

$$MC_1 = 2.0 + 0.001Q_1$$
$$MC_2 = 1.0 + 0.001Q_2$$
$$MC_T = 1.5 + 0.0005Q \quad (\text{for } Q_T > 1{,}000)$$

where cost is measured in dollars. The firm's demand function is estimated to be

$$Q = 22{,}000 - 4{,}000P$$

25. The manager maximizes profit by producing and selling
    a. 2,000 units at a price of $3.50 per unit.
    b. 2,500 units at a price of $3.75 per unit.
    c. 5,500 units at a price of $4.25 per unit.
    d. 3,000 units at a price of $4.00 per unit.
    e. 4,000 units at a price of $4.50 per unit.

26. To minimize the total cost of producing the profit-maximizing level of output, the manager allocates output between the two plants so that
    a. Q_1 = 1,000 and Q_2 = 2,000.
    b. Q_1 = 1,500 and Q_2 = 2,500.
    c. Q_1 = 2,000 and Q_2 = 3,000.
    d. Q_1 = 2,250 and Q_2 = 3,500.

27. T F A large negative cross-price elasticity of demand means two goods are easily substitutable, and market power is likely to be weak.

28. T F A monopolist always earns economic profit.

29. T F Like a perfectly competitive firm, a monopolist maximizes profit by producing the level of output for which $P = MC$.

30. T F A high Lerner index indicates a large degree of market power.

31. T F A monopoly should produce and sell on the elastic portion of demand.

32. T F At the output at which $MR = MC$, profit (loss) is the same as at the level of labor usage at which $w = MRP$.

Answers

MATCHING DEFINITIONS

1. market power
2. monopoly
3. monopolistic competition
4. market definition
5. Lerner index
6. strong barrier to entry
7. switching costs
8. consumer lock-in
9. network externalities
10. marginal revenue product
11. inverse demand function

STUDY PROBLEMS

1. a. *MR* intersects *SMC* at 300 units

   b. \$5 = *P* for 300 units.

   c. $ATC_{Q=300}$ = \$3, so profit is $(P - ATC)Q = (5 - 3) \times 300 = \$600$.

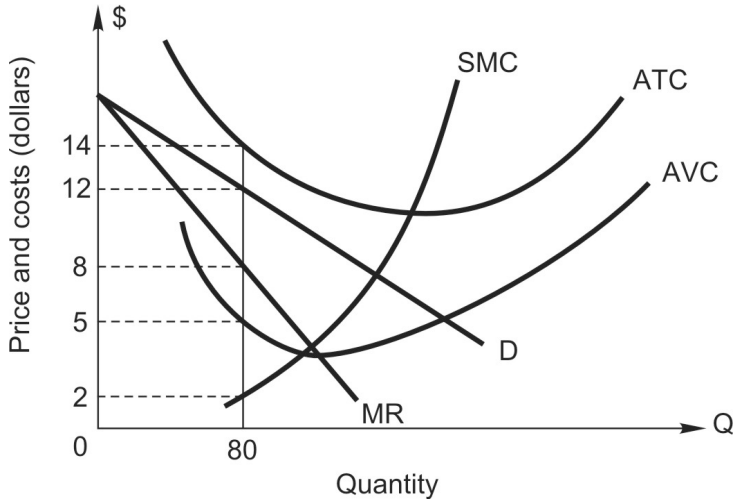
   d. Demand and marginal revenue should be drawn so that $ATC > P > AVC$.

   e. Draw a demand that lies below *AVC* at every output level.

2. a. Profit is maximized at the level of output for which *MR* = *MC*. Total revenue is maximized at the level of output for which *MR* = 0. Since *MC* is generally positive for all levels of output, the profit-maximizing point where *MR* equals *MC* occurs at a lower level of output than that which maximizes total revenue.

   b. If *MC* is constant and equal to zero, then both total revenue maximization and profit maximization occur at the same output level.

3. a. The following figure illustrates the demand and cost conditions facing the monopolist



   b. The manager is not minimizing loss. Output should be increased until *MR* = *SMC*.

4. a. $Q = 200$ units

   b. $P = \$16$

   c. Profit = \$400

   d. After doubling *TFC* to \$2,000, the profit-maximizing output is still 200 units. The maximum profit is now –\$600.

5. a.

L	*MRP* = *MR* × *MP*	*ARP* = *TR*/*L*
0	xx	xx
1	\$1,000	\$1,000
2	980	990
3	420	800
4	300	675
5	100	560
6	–70	455

   b. $L = 4$, $Q = 180$. Last unit at which $MRP > w$. $w = \$150 < ARP = \$675$. Profit $= PQ - wL - TFC = \$2,700 - \$600 - \$1,800 = \$300$

   c. $L = 3$, $Q = 150$. Last unit at which $MRP > w$. $w < ARP = 800$. Profit $= \$2,400 - \$1,050 - \$1,800 = -\$450$

6. a. In the short run the two are the same; *MR* = *SMC* and price given by demand.

   b. Both firms make zero economic profit, earn a normal profit, and produce an output at which price equals long-run average cost. For a perfect competitor this occurs where price equals minimum *LAC* equals *LMC*. For a monopolistic competitor this occurs at a lower output on the downward-sloping portion of *LAC* and $P > MR = LMC$.

7. Profit is maximized where *MC* = *MR*. Since *MC* is positive (in both the short run and the long run), *MR* must also be positive, and thus, demand must be elastic.

8. a. $Q = 300$ (where *LMC* = *MR*), *P* is \$30 (from demand), and profit is \$1,500 [= $(P - LAC)Q = (30 - 25) \times 300$].

   b. Draw a demand curve that is tangent to *LAC* on the downward-sloping portion of *LAC*. The associated *MR* should equal *LMC* at tangency quantity. Economic profit is zero since *P* = *LAC*.

   c. $Q = 400$, $P = \$20$ at minimum *LAC*. Profit is zero.

9. a. $Q = 122{,}000 - 500P + 4(32{,}000) + 10{,}000(4) = 290{,}000 - 500P$

   b. Solve the demand function for *P*: $Q - 290{,}000 = -500P \Rightarrow P = 580 - 0.002Q$

   c. $MR = 580 - 2(0.002)Q = 580 - 0.004Q$

   d. $SMC = 500 - 2(0.03)Q + 3(0.000001)Q^2 = 500 - 0.06Q + 0.000003Q^2$

   e. Set *MR* = *SMC* and solve for Q^*: $580 - 0.004Q = 500 - 0.06Q + 0.000003Q^2$. Solving using the quadratic formula $\Rightarrow Q^* = 20{,}000$ units

   f. $P^* = 580 - 0.002(20{,}000) = \$540$

   g. $AVC_{Q=20{,}000} = 500 - (0.03 \times 20{,}000) + 0.000001(20{,}000)^2 = \$300$. Since $P = \$540 > \$300 = AVC$, the monopolist should produce.

   h. Profit = *TR* – *TVC* – *TFC* = (\$540 × 20,000) – (\$300 × 20,000) – \$5,000,000 = –\$200,000

10. a. Take the inverses of the *MC* functions. [See Exercises 2*a* and 2*b* in the *Review of Fundamental Mathematics* at the beginning of this Workbook.]

$$Q_A = -200 + 20\,MC_A$$
$$Q_B = -2{,}000 + 100\,MC_B$$

b. After setting $MC_A = MC_B = MC_T$, which forces the manager to minimize total cost:

$$Q_T = Q_A + Q_B = (-200 + 20\,MC_T) + (-2{,}000 + 100\,MC_T) = -2{,}200 + 120\,MC_T$$

c. Taking the inverse of $Q_T = -2{,}200 + 120MC_T$:

$$MC_T = 18.33 + 0.00833Q_T$$

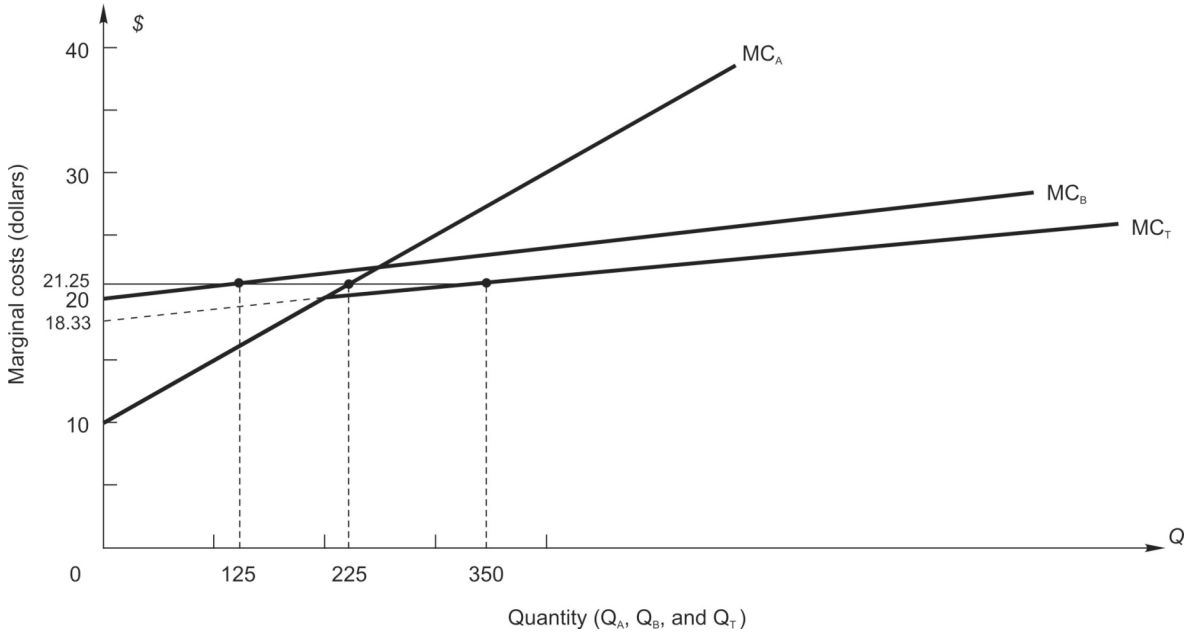
d. To find the kink point of MC_T, set *MC* in the low-cost plant equal to the minimum value of the marginal cost in the high-cost plant and solve for Q_{kink}:

$$10 + 0.05Q = 20$$
$$Q_{kink} = 10 / 0.05 = 200 \text{ units}$$

e. Since Q_T = 350, substitute 350 into the MC_T function to find MC_T = \$21.25 (= 18.33 + 0.00833×350). Then find Q_A^* and Q_B^* by substituting \$21.25 into the two inverse marginal cost functions

$$Q_A^* = 225 (= -200 + 20 \times 21.25)$$
$$Q_B^* = 125 (= -2{,}000 + 100 \times 21.25)$$

f. See MC_A, MC_B, and MC_T in the following figure. Note that at MC_T = \$21.25, $MC_A = MC_B$ and Q_A = 125, Q_B = 225, and Q_T = 350.



g. 100; 0 Since $Q_T < Q_{\text{kink}}$, all output is produced in the low-cost plant A and high-cost plant B is shut down.

h. $MR = 40 - 0.01875Q$

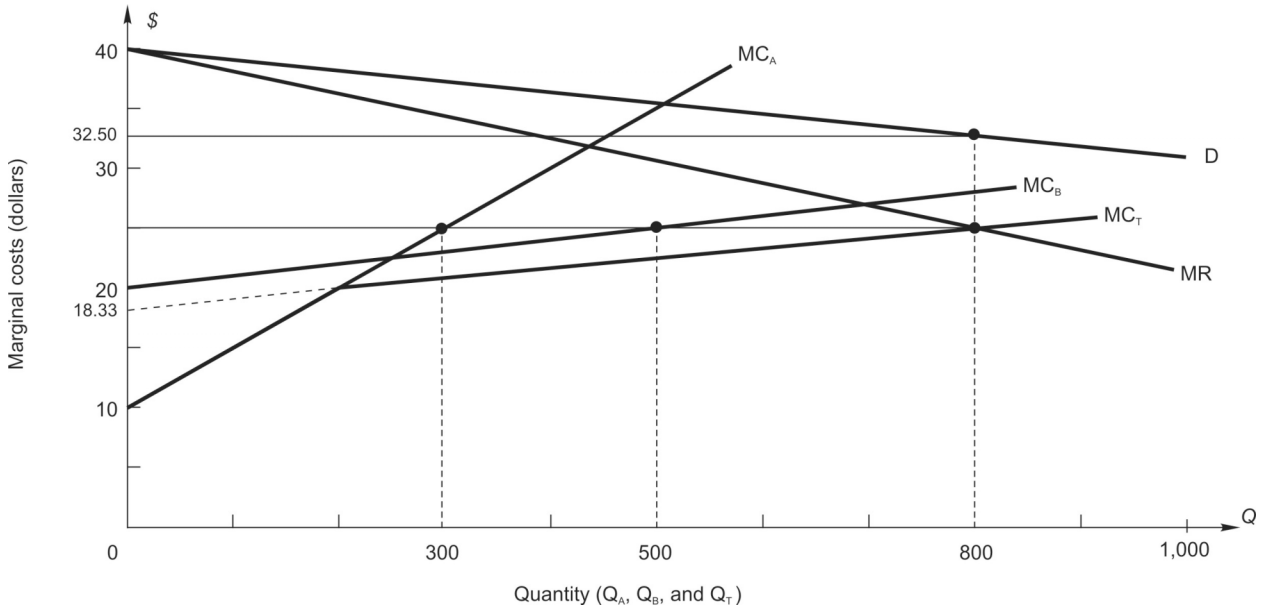
i. Set $MR = MC_T$ and solve for Q_T :

$$40 - 0.01875Q_T = 18.33 + 0.0083Q_T \Rightarrow Q_T^* = 800$$

j. $MC_T(800) = \$25;\ Q_A^* = 300\ (= -200 + 20 \times 25);\ Q_B^* = 500\ (= -2{,}000 + 100 \times 25)$

k. $P^* = \$32.50\ (= 40 - 0.009375 \times 800)$

l. See the figure below.



MULTIPLE CHOICE / TRUE-FALSE

1. b Since profit maximization requires $MR = MC$ and $MR = 0$ when demand is unitary elastic, MC must be zero.
2. b In short-run equilibrium, a monopolist may have to shut down, and in such a case, $TR < TVC$.
3. c The monopolist cannot increase profit in the short run because it is already in profit-maximizing equilibrium. In the long run, if profit is negative the monopolist will exit the industry.
4. e Total revenue for 4 units is \$28. Marginal revenue for the 5th unit is \$2, so total revenue for 5 units is \$30. Therefore, the price of 5 units must be \$6.
5. e All choices are correct.
6. b The Lerner index is equal to $-1/E$.
7. b Both have market power.
8. a In perfect competitive products are identical.
9. b $P = LAC$ where LAC slopes downward, rather than at LAC's minimum point.
10. c This is the last output for which $MR > SMC$.
11. d $TR(= \$8 \times 130) - TC = \$1{,}040 - \$1{,}050 = -\$10$.
12. d $MR = (\$1{,}162 - \$1{,}040)/36$; $SMC = (\$1{,}230 - \$1{,}050)/36$.
13. c $TR - TC = \$1{,}162 - 1{,}230 = -\$68$.
14. b $MR = SMC$ at 600.
15. d $P = \$30$ at $Q = 600$.
16. a Profit $= (P - ATC)Q = (30 - 20) \times 600$.
17. d $Q = 15{,}000 - 50\text{P} + 0.5(22{,}000) - 300(16) = 21{,}200 - 50P$

18. a Inverse demand is $P = 424 - 0.02Q$, so $MR = 424 - 0.04Q$.

19. c Since $AVC = 200 - 0.12Q + 0.0002Q^2$, $SMC = 200 - 0.24Q + 0.0006Q^2$.

20. b Setting $MR = SMC$ and solving for $Q \Rightarrow Q^* = 800$ units

21. e $AVC_{Q=800} = 200 - 0.12(800) + 0.0002(800)^2 = \$232$

22. d $P^* = 424 - 0.02(800) = \$408$

23. c Profit = $TR - TVC - TFC = (\$408 \times 800) - (\$232 \times 800) - 100{,}000 = \$40{,}800$.

24. a Fixed costs don't matter in making optimal decisions, so rising fixed costs have no effect on the profit-maximizing price. P^* remains \$408, while profit falls by the amount that total fixed cost rises (i.e., profit falls by \$100,000 in this case).

25. e Set $MR = MC_T$: $MR = 5.5 - 0.0005Q_T = 1.5 + 0.0005Q_T$. Solve for $Q^* = 4{,}000$ units

$P = 5.5 - 0.00025 \times 4{,}000 = \$4.50$

26. b $MC_T = 0.0005(4{,}000) + 1.5 = 3.5$. Set $MC_1 = MC_2 = 3.5$ in the inverse MC functions:

$$Q_1^* = 1{,}000 \times 3.5 - 2{,}000 = 1{,}500 \text{ units}$$

$$Q_2^* = 1{,}000 \times 3.5 - 1{,}000 = 2{,}500 \text{ units}$$

27. F E_{XY} is *positive* for substitutes.

28. F A monopolist may earn a loss in the short run but never in the long run.

29. F $MR = MC$ for both a perfectly competitive firm and a monopolist. But since $P > MR$ for a monopolist, $P \neq MC$ under monopoly.

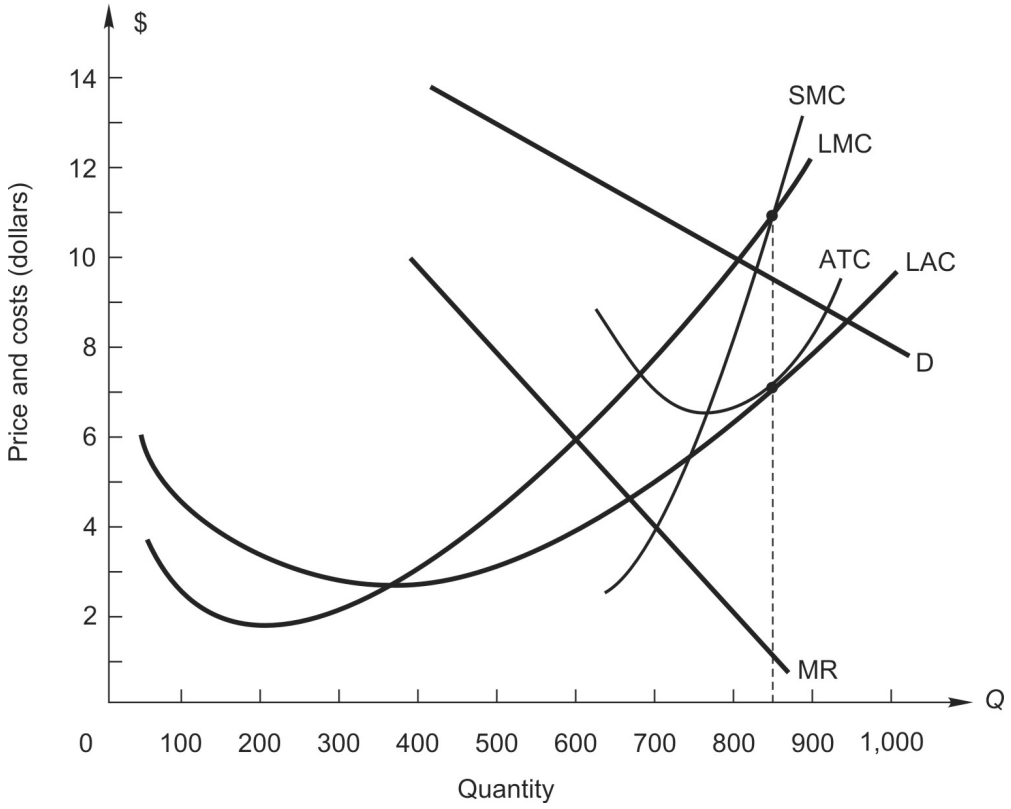
30. T Higher Lerner index indicates a less elastic demand.

31. T Profit-maximization requires $MR = MC$, and since $MC > 0$, MR must be > 0. And, since demand is elastic when $MR > 0$, profit-maximization occurs in the elastic region of demand.

32. T The two lead to equivalent outcomes.

Homework Exercises

1. Consider a monopoly that faces the demand and cost curves in the figure below. The firm operates in the short run using a plant designed to produce 850 units optimally.



a. In the short run, the manager maximizes profit (or minimizes loss) by producing _____ units.

b. The monopolist charges $_____ per unit for its output.

c. Monopoly profit is $_____.

d. In the long run, the monopolist produces _____ units and sells this output at $_____ per unit. The monopolist earns $_____ profit in the long run.

2. Cascade Enterprises has a patent on a water purifying device that is used mostly by restaurants to soften and purify tap water used in cooking food and cleaning dishes. Cascade Enterprises enjoys a substantial amount of market power in this rather specialized market. In the following table, columns 1 and 2 show a portion of Cascade's production function using a single variable input labor. Quantity and labor are measured in units per month. Columns 2 and 3 show the estimated demand for Cascade's water purifier. Cascade has fixed costs each month of $2,000.

(1) *Labor* (*L*)	(2) *Quantity* (*Q*)	(3) *Price* (*P*)	*Marginal Product* (*MP*)	*Marginal Revenue* (*MR*)	*Marginal Revenue Product* (*MRP*)
4	200	$50	xx	xx	xx
5	280	48	_____	_____	_____
6	340	46	_____	_____	_____
7	390	44	_____	_____	_____
8	430	42	_____	_____	_____
9	450	40	_____	_____	_____
10	460	38	_____	_____	_____

a. Calculate marginal product (*MP*), marginal revenue (*MR*), and marginal revenue product (*MRP*).

b. If Cascade Enterprises must pay a monthly wage rate of $3,000, what is the profit-maximizing levels of labor employment (*L**), output (*Q**), price (*P**), and profit (π^*)?

i. *L** = _____

ii. *Q** = _____

iii. *P** = _____

iv. π^* = _____

c. If the wage rate falls to $1,400 per month, what is the profit-maximizing levels of labor employment (*L**), output (*Q**), price (*P**), and profit (π^*)?

i. *L** = _____

ii. *Q** = _____

iii. *P** = _____

iv. π^* = _____

3. Gemini Robotics, Inc. is a monopoly firm in the market for home robots. The owner-manager of Gemini founded the home robot industry in 2009 on the basis of the following forecasted demand function for home robots in 2009:

$$Q = 9{,}000 - 0.2P + 0.2M + 56P_B$$

where Q is the number of robots sold, M is the average annual income of potential buyers, and P_B is the price of butlers (in dollars per day). The owner-manager of Gemini expects M_{2009} = \$50,000/year and P_B = \$125/day.

a. The forecasted demand function in 2009 is

$$Q = \_\_\_\_\_$$

b. The inverse demand function is

$$P = \_\_\_\_\_$$

c. The marginal revenue function is

$$MR = \_\_\_\_\_$$

Suppose Gemini Robotics faces the following estimated average variable cost function:

$$AVC = 40{,}000 - 200Q + Q^2$$

d. The estimated marginal cost function is

$$SMC = \_\_\_\_\_$$

e. The optimal level of output for 2009 is _____ units.

f. The price of a home robot in 2009 will be \$_____.

g. If Gemini Robotics expects fixed costs in 2009 to be \$15 million, then it can expect to earn a profit (loss) of \$_____.

4. Consider a firm with market power that produces its product in two plants, A and B. The marginal cost curves, as well as the demand and marginal revenue curves, are shown in the figure below.

   a. Construct the total marginal cost function in the figure. Label this curve MC_T.
   b. The profit-maximizing level of total output is _____ units. At this level of production, marginal cost = $_____ and marginal revenue = $_____.
   c. The manager minimizes the total cost of producing the total output in part *b* by producing _____ units in plant A and producing _____ units in plant B.
   d. The profit-maximizing price of the output is $_____ per unit.