Chapter 11
Monopoly

■ Chapter Outline

■ Teaching Tips

Chapter 11 begins the study of monopoly and concentrated markets. You might want to maintain a running connection to the material in Chapters 8 and 9 by comparing the competitive solution or assumption to that of monopoly throughout the early portion of the chapter. This will be helpful in the later stages when evaluating deadweight loss and the comparison of efficient levels to competitive output and price levels.

Before beginning the material on profit maximization, it is worth the time to discuss the concept of market edges. Because monopolies only exist when a product has no close substitutes, the class should see that a monopoly on Ford pickup trucks is not meaningful. This will provide context for the discussion of elasticity and market power that begins with the relationship among price, marginal revenue, and elasticity, and continues in Section 11.2. The United States Postal Service is a great example to discuss, as most students are very familiar with the changes that have occurred in communication technology. Students with free access to e-mail through the campus network are likely to have highly elastic demand for first class instant messaging and mail.

In the presentation on profit maximization, two points tend to slow students down. The first is the relationship between marginal revenue and price. If you are restricting your demand curves to be linear, the price–marginal revenue relationship is greatly simplified. Although memorization is generally to be discouraged, if students remember the "same intercept, twice the slope" relationship between linear demand curves and their associated marginal revenue curves, it might prevent a silly mistake on an exam. The shut-down point is the other point that occasionally throws students, as it implies that a monopolist might not earn profits. When students think of monopolies, they usually associate them with high prices and profits, not the need to shut down. It is also worth using a graph to show a comparison to the shutdown rule for the competitive firm.

Section 11.3, which covers the measurement of welfare loss, is extremely important. In order for students to be able to assess monopoly effects at more than the most superficial level (price is higher, output is lower), they must understand the concept of deadweight loss. You might use a current event, such as the introduction of competition to the residential electricity industry, to discuss the relationship among the inelasticity of demand, the magnitude of the welfare loss, and the importance of substitutes. As demand elasticity decreases, loss of consumer surplus increases. Because consumers have historically had no alternatives for commodities such as electricity and local telephone service, demand was highly inelastic.

Further, scale economies have made breakups unwise, with the result that utilities have been heavily regulated to reduce welfare loss. Recent changes in technology have created the opportunity to replace regulation with competition, which would increase the elasticity of demand faced by individual firms, thus creating incentives for lower prices and increased efficiency.

The discussion of entry barriers in the text, with the exception of patents, is limited mostly to exogenous barriers such as cost advantages due to scale economies and government actions such as the postal service or licensing laws. Strategic actions such as advertising, product tie-ins, and raising rival's costs are discussed in Chapter 12. If you will not have time to cover all of Chapter 12 later in the course, you might want to spend a few minutes discussing how firms can try to create barriers to entry, and give some examples. If you have Internet access in your classroom you could log on to the major breakfast cereal manufacturer websites and discuss product proliferation as an entry barrier. You may be able to generate a good class discussion on the subject of patents. I present them as the classic example of a double-edged sword—creating the incentive to innovate on the one hand, but at the same time creating a legal monopoly. Students often will give the quick response of "too expensive" if asked about pharmaceuticals. This is likely because they have not considered the alternatives, which are less research and development, and fewer new medicines. The line between too much protection for firm innovations and not enough protection is difficult to determine. Recent changes in patent law such as the Drug Price Competition and Patent Term Restoration Act in 1984 have moved this line toward more protection in the short run, and increased competition in the long run. This new law reduces the time required to approve generic equivalent drugs, decreasing the time lag between the expiration of a patent and the introduction of substitutes. It also allows for the extension of patents by up to five years to replace time lost in the FDA approval process, increasing the incentive for firms to innovate.

The chapter concludes with the problems of regulation and monopoly decisions over time. The discussion of regulation is brief and deals largely with the issue of deadweight losses with average cost pricing. Of course, there are many other issues relating to monopoly regulation; students often wish to discuss these at this point, although these can also be deferred to the strategic issues dealt with in later chapters. Finally, the concept of network externalities is introduced, with a simple two-period model of profit maximization over time.

■ Additional Applications

The Creation and Destruction of an Aluminum Monopoly[1]

Cost advantages and government actions allowed the Aluminum Company of America (Alcoa) to maintain a monopoly in aluminum in the United States. Eventually, however, government and judicial action destroyed Alcoa's monopoly.

In 1893, Alfred Hall invented and patented a new process that allowed his firm, Pittsburgh Reduction (which became Alcoa) to produce aluminum at much lower cost than his competitors. Over time, this firm obtained control of most domestic and many international sources of bauxite ore, which is necessary to produce aluminum. As a result, Alcoa was the only American producer of aluminum. Alcoa did face some competition from foreign producers; however, the United States established high tariffs on aluminum imports, which reduced this threat to Alcoa's market power.

During World War I, when foreign competitors were unable to effectively produce and sell in other countries, Alcoa became an exporter. It continued to export after the war. Between the two world wars, Alcoa remained the only aluminum smelter (producer) in the United States due to its technological advantages and economies of scale. The demand for aluminum increased substantially with the start of World War II. Aluminum was used to produce planes and other manufactured products for military use.

[1]Adele Hast, ed., *International Directory of Company Histories,* Vol. IV, Chicago and London: St. James Press.

Because of its important role in the production of military products, the government financed new plants during World War II that were built and run by Alcoa, and encouraged the development of other aluminum producers.

In 1945, the U.S. Supreme Court ruled that Alcoa should be broken up because it had a monopoly, which is a violation of U.S. law under the Sherman Antitrust Act (1890). With the end of the war, the Supreme Court decision was enforced by the sale of government-financed Alcoa plants at low prices to Reynolds Metals Company, and Permanente Metals Corporation, owned by Henry Kaiser. By 1950, these government sales created an oligopoly, where Alcoa made 50.9% of all sales, Reynolds 30.9%, and Kaiser Aluminum and Chemical Corporation (the renamed Permanente Metals) 18.2%.

1. Based on your knowledge of general equilibrium from Chapter 10, what other markets do you believe were affected by the Alcoa monopoly?

2. Are consumers necessarily better off with three producers rather than one? Why, or why not?

Playmobil USA Was Not Playing Around When It Came to Market Power[2]

When a powerful seller exerts pressure on firms that make up its customer base, the result can be reduced competition among those firms. Manufacturers often list suggested retail prices. In the case of Playmobil, however, the U.S. Department of Justice (USDOJ) believes that the manufacturer of children's toys did more than suggest. Playmobil was accused of threatening to discontinue retailers for violating rules on discounting its products. Although the law does allow a manufacturer to drop a retailer for excessive discounting, it does not allow for bullying. In the end, the case was settled through a consent decree, which means that the firm agrees to alter its behavior subject to court mandates, without admitting guilt.

1. Why would retailers who carry Playmobil products object to standardized pricing mandated by the manufacturer?

2. Should the government allow firms to refuse to even sell their products to discounters?

■ Discussion Questions

1. Is it feasible to prohibit monopolies in all markets?

2. Patents provide an incentive to invest. The government could provide other incentives such as government grants or prizes for major discoveries. Why do you think patents are more commonly used than these other approaches, even though patents lead to monopoly problems?

3. How many monopolies can you list? List them and identify which markets they serve.

4. How many of the monopolies identified in Question 3 are unregulated?

5. Which of the monopolies identified in Question 3 are likely to be natural monopolies?

6. If the government regulates the price a monopoly may charge, how will that affect a firm's Lerner Index? When should we distinguish between an actual Lerner Index and a potential Lerner Index?

7. Sometimes a local convenience store is said to have "local monopoly power." What is meant by this phrase?

8. Would you expect monopolies to be more common in small countries or large ones? Why?

9. Is the Internet a monopoly? Can this change?

[2] http://www.usdoj.gov/atr/cases/f0000/0058.htm. and http://www.usdoj.gov/atr/cases/f0000/0059.htm.

■ Additional Questions and Problems

1. Use Equation 11.4 to prove that a monopolist would never choose to price in the inelastic range of demand.

2. Assume a monopolist faces a market demand curve $P = 100 - 2Q$, and has the short-run total cost function $C = 640 + 20Q$. What is the profit-maximizing level of output? What are profits? Graph the marginal revenue, marginal cost, and demand curves, and show the area that represents deadweight loss on the graph.

3. In Question 2, what would price and output be if the firm priced at socially efficient (competitive) levels? What is the magnitude of the deadweight loss caused by monopoly pricing?

4. Show that if a firm is a natural monopoly, a government policy that forces marginal cost pricing will result in losses for the firm.

5. Suppose a change in technology available to fringe firms increases their elasticity of supply, altering the total fringe supply curve from $p = 5 + Q$ to $p = 5 + 2Q$. If market demand is $Q = 20 - p$, show the change in the residual demand curve using a graph. Is the dominant firm better off or worse off after the change?

6. If a monopolist has constant marginal cost $MC = 20$, and faces demand $p = 80 - Q$, what is the effect on consumer surplus of a $5-per-unit tax on sellers? Is the tax revenue collected less than, equal to, or greater than the consumer surplus loss plus the reduction in profits?

7. Suppose a legislator introduced a bill that would decrease patent life for new drugs from 17 years to 10 years, based on the argument that it would reduce deadweight loss through lower prices. What argument could you make against such a change?

8. Suppose a monopoly is for sale. What specifically must be purchased by the buyer in order to retain its market position? How much would it be worth?

9. Suppose a monopolist faces a market demand curve $Q = 50 - p$. If marginal cost is constant and equal to zero, what is the magnitude of the welfare loss? If marginal cost increases to $MC = 10$, does welfare loss increase or decrease? Use a graph to explain your answer.

10. The chapter notes that one possible alternative to regulation is for the government to encourage competition. Would this be an efficient mechanism to increase efficiency in an industry where the incumbent firm is a natural monopoly?

11. If a monopoly firm sells a product with price $100, whose marginal cost is $30, what is the price/marginal cost ratio? What is the Lerner Index? And what is the demand elasticity the firm believes it faces?

12. Suppose a monopoly firm with a constant marginal cost 10 faces an inverse linear demand function $p = 50 - Q$. What would be the profit-maximizing price and quantity if its marginal cost doubles? How does it compare to the outcome with original cost?

■ Answers to Additional Questions and Problems

1. In Equation 11.4 whenever demand is inelastic, *MR* is negative, indicating that the last unit sold decreased total revenue. By increasing prices, the monopolist will reach the elastic portion of the demand curve, at which point *MR* becomes positive.

2. First, derive the *MR* and *MC* functions; then set $MC = MR$ and solve. See Figure 11.1. Deadweight loss is equal to area *abc*.

$$\begin{aligned} P &= 100 - 2Q \\ R &= 100Q - 2Q^2 \\ MR &= dR/dQ = 100 - 4Q \\ MC &= 20 \\ 100 - 4Q &= 20 \\ Q^* &= 20 \\ p^* &= 60 \\ \pi &= 1200 - 1040 = 160. \end{aligned}$$

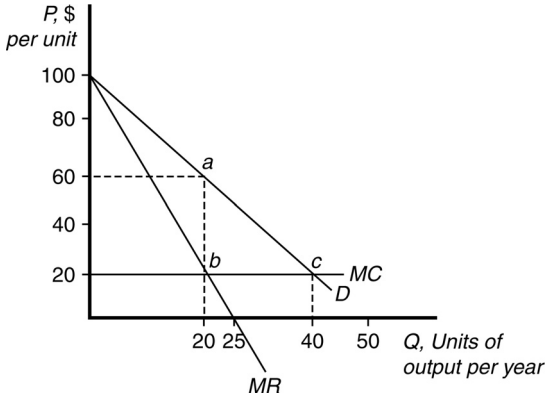

Figure 11.1

3. To solve for the competitive price and output, set $MC = p$.

$$\begin{aligned} 20 &= 100 - 2Q \\ Q_C^* &= 40 \\ p_C^* &= 20 \end{aligned}$$

The magnitude of the deadweight loss is $400, which is the area of triangle *abc* in Figure 11.1.

4. See Figure 11.2. If the firm is a natural monopoly, *AC* falls throughout the range of demand. When *AC* is falling, *MC* is below *AC*. By forcing the firm to price at marginal cost, revenue would be less than cost, and the firm would incur losses equal to area *abcd*.

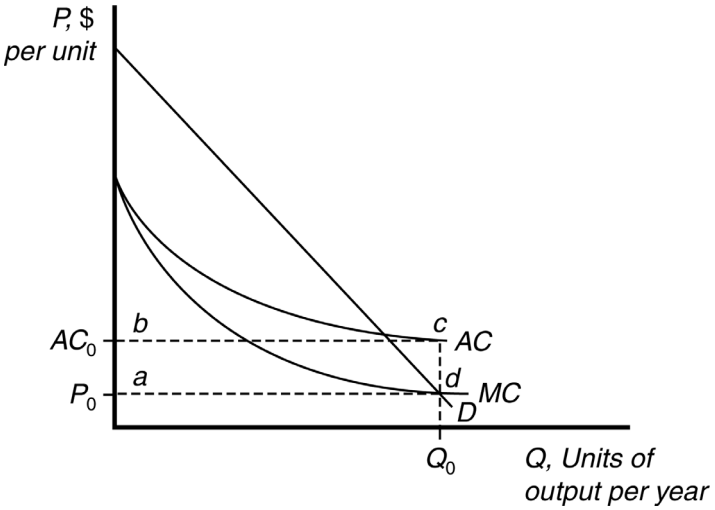

Figure 11.2

5. See Figure 11.3. The change in technology reduces the slope of the fringe firm supply curve, allowing them to supply more of the total demand at all prices above $5, making the dominant firm worse off.

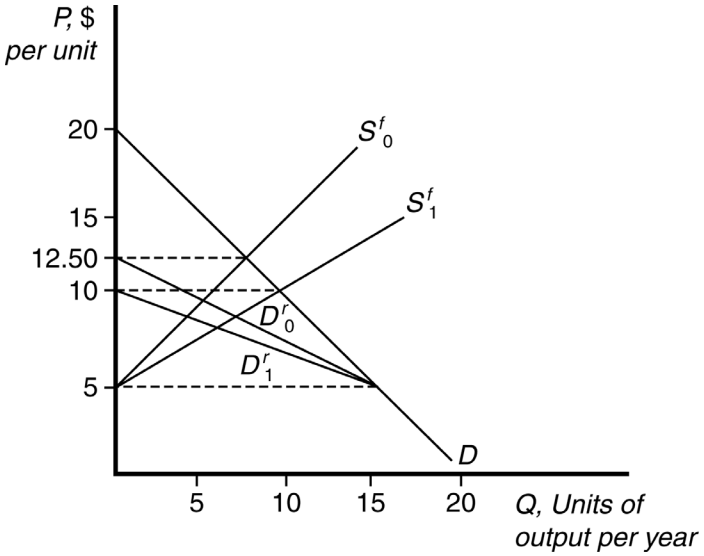

Figure 11.3

6. The $5 tax increases *MC* to $25. Quantity falls from 30 to 27.5, and price increases from $50 to $52.50. Consumer surplus falls by $71.875 (from $450 to $378.125). Profits fall by $143.75 (from $900 to $756.25). Tax revenue collected is $137.50 ($5 × 27.5 = $137.50). See Figure 11.4.

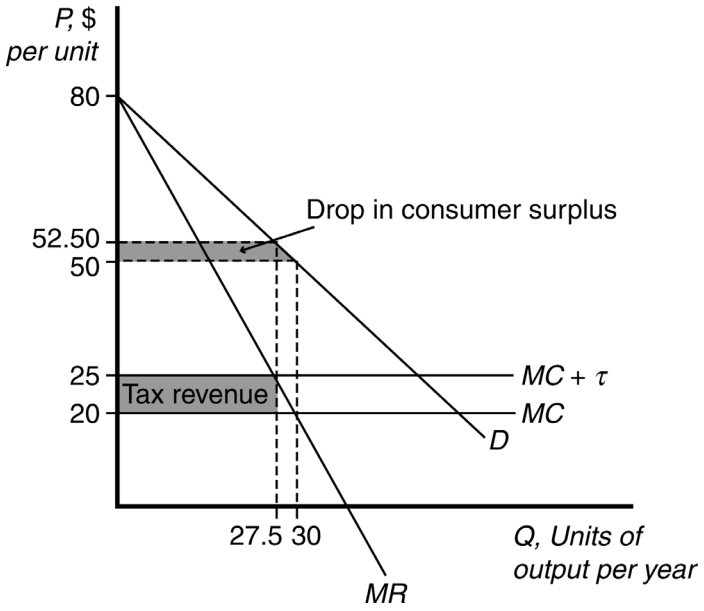

Figure 11.4

7. In order for the legislation to have a net positive effect, any social cost must be more than offset by the lower prices when the patent expires. Firms would engage in less research and development. If a firm believed that a project could only become profitable in the 11th through 17th year of the patent, it would not be funded, or may be funded at a less than efficient level. The reduction in health that occurs as a result represents the social cost of the policy.

8. The buyer would have to purchase whatever the source is of the monopolist's barrier to entry, for example, a patent, or the control of a resource needed for production. The value of a barrier to entry is the discounted stream of profits that a monopolist could expect to earn from that monopoly. In the case of a patent it would be the discounted stream of profits that could be earned in the remaining years before the patent expires.

9. See Figure 11.5. When marginal cost is zero, the firm sells 25 units of output for $25 per unit. The welfare loss is equal to the area of triangle *abc*, or $312.50. When marginal cost increases to $10, the firm reduces output to 20, and the new welfare loss is *def*, or $250.00.

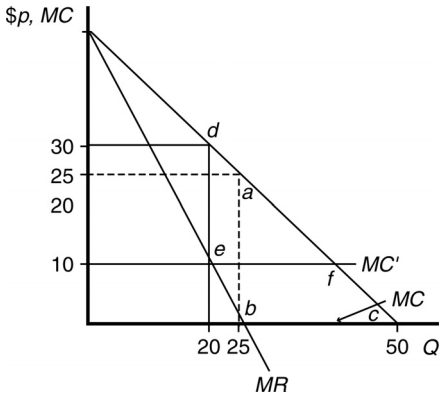

Figure 11.5

10. No. If the incumbent firm is a natural monopoly, to encourage entry through any form of assistance or subsidy will reduce overall efficiency and lead to increased prices, because cost increases as per-firm output decreases.

11. The price/marginal cost ratio will be 100/30 = 3.33. Its Lerner Index is 70/100 = 0.7 and the firm believes it faces a demand elasticity of −1.43.

12. Under $MC = 10$, we have $10 = 50 - 2Q$, hence $Q = 20$ and $p = 30$. With the new marginal cost, we have $20 = 50 - 2Q$. Hence $Q = 15$ and $p = 35$.

■ Answers to Questions and Problems in the Text

1. See Figure 11.6. Because there is no supply curve, if the demand curve shifts from D^0 to D^1, output increases from Q_0 to Q_1, but price remains unchanged.

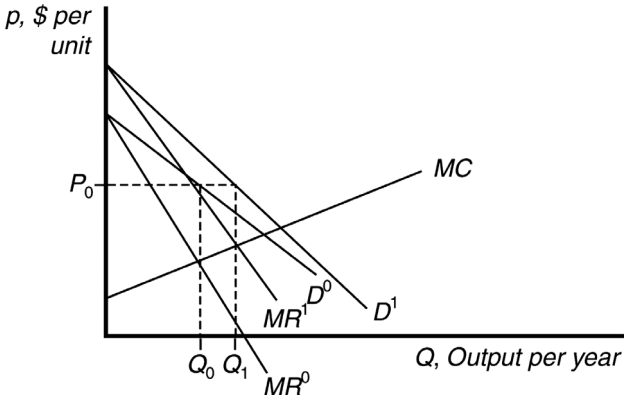

Figure 11.6

2. The effect of a franchise tax or lump sum tax on a monopoly is to reduce profits by the amount of the tax. Because there is no change in marginal cost, the profit-maximizing/loss-minimizing output and price remain unchanged, with one exception. If the tax is large enough, losses may exceed variable costs. If that is the case, the firm will shut down (produce no output) in order to minimize losses.

3. When the average total cost curve lies above the demand curve at all output levels, the monopolist cannot earn positive profits.

4. See Figure 11.7. The values of price and quantity depend on the demand curve drawn by the student. In the given graph, profit-maximizing quantity is 4 and profit-maximizing price is 8. Profits are area *abcd* and the deadweight loss is area *bef*.

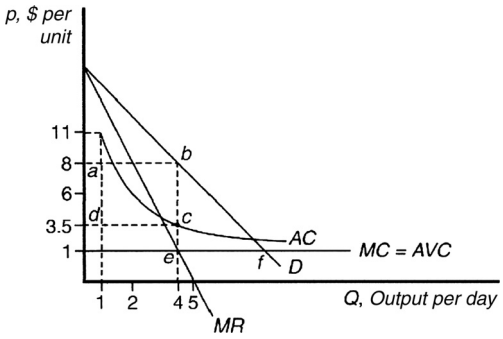

Figure 11.7

5. Yes. As the "Electric Power Utilities" application illustrates, the demand curve could cut the average cost curve only in its downward-sloping section. Consequently, the average cost is strictly downward sloping in the relevant region.

6. No. In order for a firm to be a natural monopoly, its production must exhibit economies of scale; that is, firm's average cost curve must be downward sloping. If the firm operates in the upward sloping region of its average cost curve, it is possible that two or more firms could produce in the same industry more efficiently than one firm.

7. Utilities are often government-created monopolies. In addition, the government essentially creates monopolies through patents and copyrights.

8. See Figure 11.8. A competitive firm maximizes long-run profits by setting $LMC = p$, as long as price exceeds average cost (it should shut down if $p < LAC$). Because marginal cost is above average cost only where AC slopes up, the firm will never operate in an area where average cost is falling. A monopolist maximizes profit by setting $MR = MC$, which can occur on either the upward- or downward-sloping portion of the LAC curve. In the graph, D_M represents the demand curve faced by the monopolist, and d_C represents the demand curve faced by a competitive firm.

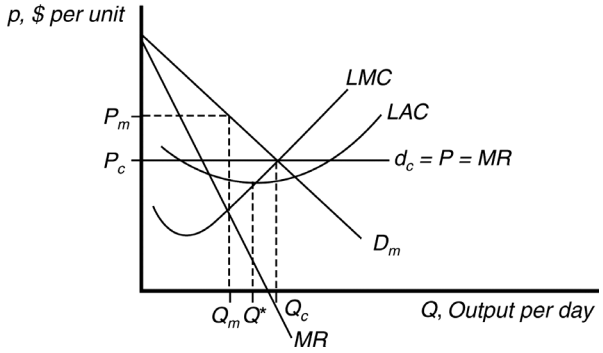

Figure 11.8

9. A monopolist may set price equal to marginal cost if other firms can enter costlessly. If there is free entry, any price above marginal cost will attract other firms. Thus even though the firm has no current competitors, it sets price equal to marginal cost to deter entry of potential competitors. Also, if not all customers are charged the same price (price discrimination), the firm may want to sell the last unit where price equals marginal cost (Chapter 12).

10. See Figure 11.9. If the government sets a price cap between the monopoly price and the socially optimal price, output increases from Q_M to Q_R, and deadweight loss is reduced from area abc to cdf.

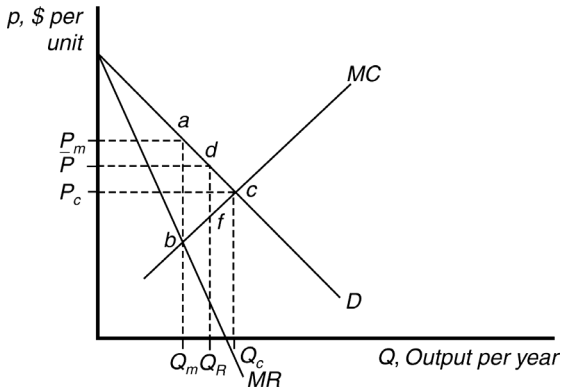

Figure 11.9

11. See Figure 11.10. To be on the contract curve (Pareto efficiency) requires that all goods be traded at competitive prices. Because Jane is a monopolist, she sets the price of wood above the competitive price. At this higher price, she receives more candy bars per unit of wood than with competitive prices, and consumers end up with less wood than with competitive prices. The monopoly price line in the graph depicts this higher price ratio. Instead of reaching the Pareto-optimal solution at *a*, Jane is able to use her market power to force the solution at *b*, which is off the contract curve and Pareto inferior.

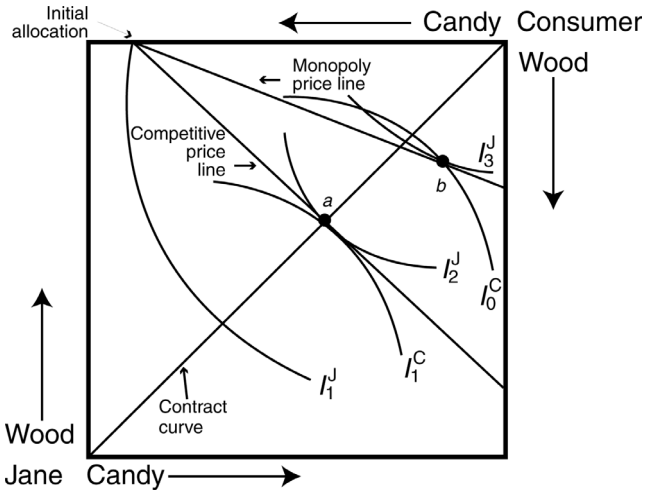

Figure 11.10

12. See Figure 11.11. In this case, *MR* curve coincides with the demand curve. Equilibrium quantity is 100 and equilibrium price is \$100. Consumer surplus is zero and producer surplus is (\$100 − \$10) ∗ 100 = \$9000. If a price ceiling of \$30 is imposed, consumer surplus increases and producer surplus decreases by area *abcd*. There is no deadweight loss.

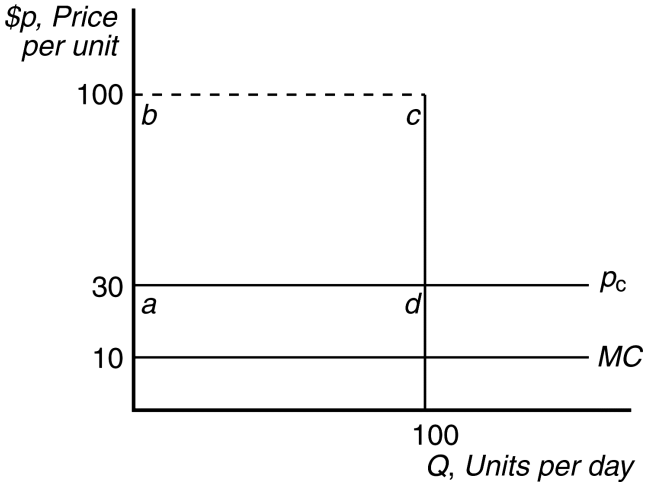

Figure 11.11

13. The wholesale price of milk represents the marginal cost for retailers, who sell to consumers. In Figure 11.12, suppose prices at the wholesale level fall 30.3% from \$2.00 to \$1.394 per gallon, or \$0.606 per gallon. That is, for retailers, marginal cost shifts from *MC* to *MC′*. If the original retail price were \$3.00 per gallon, a 30.3% price decrease would mean the new price of \$2.09, a drop of \$0.91 per gallon. However, the negative slope of the demand curve results in a price decrease that is less than \$0.91. The new retail price, for the given demand curve, is \$2.50. In other words, price at the retail level may not fall by the same percentage as the wholesale level due to the slope of the demand curve.

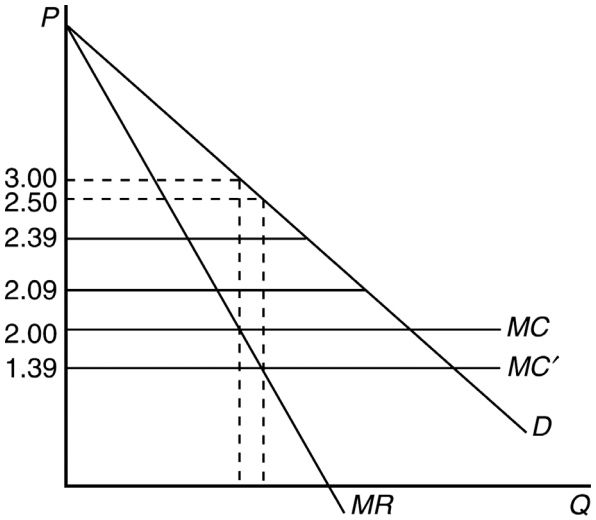

Figure 11.12

14. See Figure 11.13. Summing the demand curves horizontally yields the market demand curve. Once the price is set, quantity in each market is determined from the individual product demand curves. If the firm charged different prices in each market, physicians could simply prescribe the lower-priced version of the product.

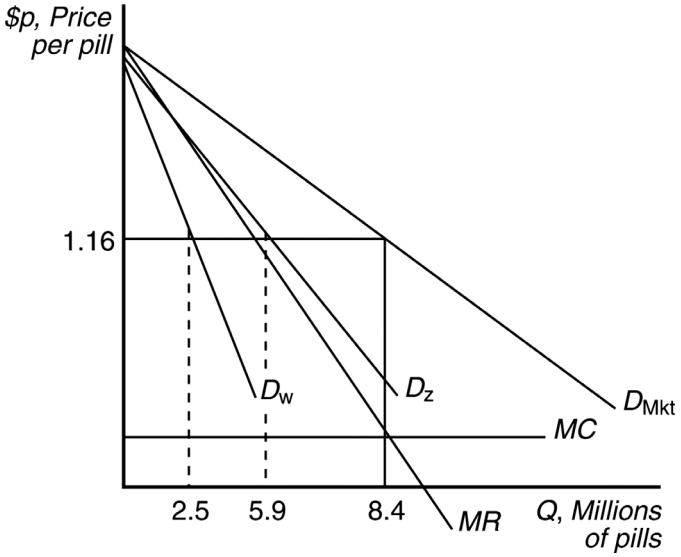

Figure 11.13

15. Once a book is online, it is available to consumers for free. As a result, the publisher may lose some consumers after the copyright expires. Limiting the length of a copyright (in the United States or elsewhere) would encourage the publisher to charge a higher price for the novel, as the publisher attempts to recoup the cost of publishing the novel and earn profit in a shorter period before the copyright expires. After the copyright runs out, the publisher may lower the price of the novel to stay competitive with the online version.

16. This test is relevant because if the club were maximizing revenue, it would be operating at the level $MR = 0$, where the elasticity is -1.

17. Consider a small hotel where the jammer would cost $25,000. If the expected profit from room phone service is $\$A$ per day per room and the number of rooms in the hotel is B. Then if $\$365AB > \$25{,}000$, it is profitable to install a jammer.

18. See Figure 11.14. Assume that Bleyer Industries Inc. has a production process described by the marginal cost curve MC_1. As a monopoly, Bleyer Industries Inc. can charge price P_1, while selling Q_1 plastic Easter eggs. Since P_1 is above Bleyer's average total cost AC at the level of Q_1, Bleyer is profitable. The Chinese firms have lower production cost; we can denote their marginal cost as MC_2. Once the Chinese firms start competing with Bleyer, they can charge a price as low as P_2. Such a low price would force Bleyer to exit the market because P_2 is below AC and Bleyer cannot make positive profit.

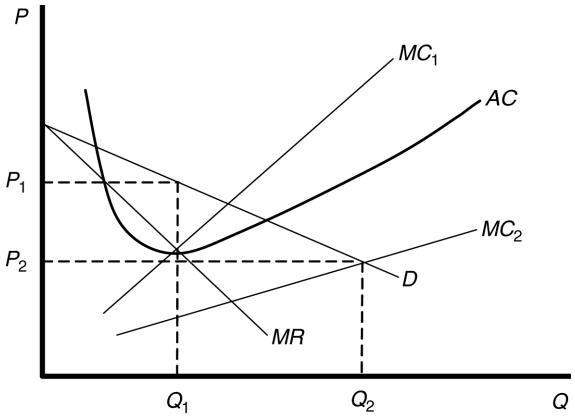

Figure 11.14

19. a. Assume demand is D_1. Then, the consumer surplus is $a + d + h$, the producer surplus is $b + i$, and social deadweight loss is $c + e$. If the monopoly behaves like a price taker, the quantity will be Q_c, as shown in the figure.

    b. When the new demand curve, D_2, is tangent to the original one at (Q^*, P^*), as shown in Figure 11.15, the price and quantity will not change. However, the quantity if the monopoly behaves like a price taker will change to Q_2. Consumer surplus will decrease and will be the area $a + h$ under the concave demand curve; producer surplus will remain as $b + i$; deadweight loss will decrease to c.

c. Under the convex demand curve, D_3, the price and quantity will be the same as in the linear case. But under the price-taker assumption, the quantity supplied will be Q_3. Consumer surplus will increase and will be the area $a + d + h + f$; producer surplus will remain as $b + i$; deadweight loss will increase to $c + e + g$.

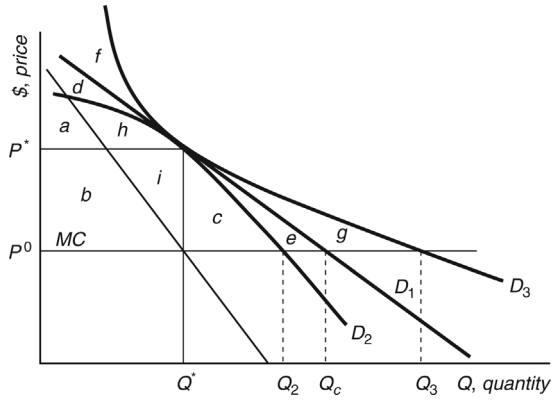

Figure 11.15

20. See Figure 11.16. After the remove of the tariff, the former monopoly will sell its products at the world price p_w. The new quantity Q_w is determined by the intersection of its *MC* and world price. The consumer benefits from removal of the tariff, and the former monopoly suffers losses.

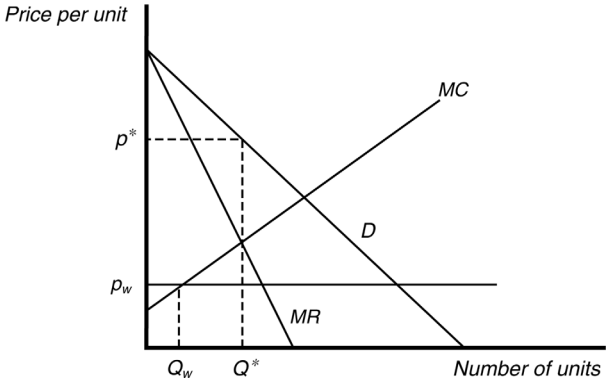

Figure 11.16

21. When the hoi polloi buy the chocolate, the snobs won't buy. So the monopoly is facing a relatively flat demand curve, which suggests a low price, high quantity outcome. On the contrary, if the hoi polloi do not buy the chocolate, the snobs will buy. In this situation, the monopoly will face a steep demand curve, resulting in a high price, low quantity outcome. If the demand curve for the snobs is substantially steeper than that for the hoi polloi such that the profit from the former is larger than that from the latter, the monopoly will choose to cater to the snobs.

22. For a general linear inverse demand function, $p(Q) = a - bQ$, $\mathrm{d}Q/\mathrm{d}p = -1/b$, so the elasticity is $\varepsilon = -p/(bQ)$. The demand curve hits the horizontal (quantity) axis at a/b. At half that quantity (the midpoint of the demand curve), the quantity is $a/(2b)$, and the price is $a/2$. Thus the elasticity of demand is $\varepsilon = -p/(bQ) = -(a/2)/[ab/(2b)] = -1$ at the midpoint of any linear demand curve. As the chapter shows, a monopoly will not operate in the inelastic section of its demand curve, so a monopoly will not operate in the right half of its linear demand curve.

23. Set $MC = MR$ and solve:

$$\begin{aligned} MR &= 100 - 2Q \\ MC &= 5 \\ 5 &= 100 - 2Q \\ Q^* &= 47.5 \\ p^* &= 52.5 \end{aligned}$$

If $C(Q) = 100 + 5Q,$ the answer does not change because marginal cost is still $MC = 5,$ and therefore the profit-maximizing condition is still the same.

24. Set $MC = MR$ and solve:

$$\begin{aligned} MR &= \frac{dR}{dQ} = \frac{d}{dQ}(10Q^{-1/2} \cdot Q) = \frac{d}{dQ}(10Q^{1/2}) = 5Q^{-1/2} \\ MC &= 5 \\ Q^* &= 1 \\ p^* &= 10 \end{aligned}$$

25. The total profit is total revenue minus total cost and tax.

$$\pi = TR - (TC + tQ) = P(Q)Q - (C(Q) + tQ)$$

The first-order condition is

$$\frac{d\pi}{dQ} = \frac{d}{dQ}(TR - (TC + tQ)) = MR - (MC + t) = 0.$$

Imposing tax is equivalent to increasing the marginal cost, i.e. $MC' = MC + t.$ Hence after tax is imposed, output will drop, price will increase, and profit will be smaller.

26. When the demand curve is linear, the marginal revenue curve will always be linear with twice the slope of the demand curve. This is true because when multiplying the demand curve by Q to obtain total revenue, we always obtain a squared term in the revenue function, which then doubles the slope when we take the derivative to obtain marginal revenue. For example, if the demand curve is

$$\begin{aligned} P &= a - bQ \\ TR &= aQ - bQ^2 \\ MR &= \frac{dTR}{dQ} = a - 2bQ. \end{aligned}$$

Because the slope of MR is double of the slope of the linear demand curve, MR curve always crosses the MC segment in the middle between the y-axis and point e_c (see figure in the Botox application). Hence triangles A and C have one equal side and three equal angles, which implies that these triangles are equal.

27. The inverse demand function is $p = 775 - 375Q$. Imposing a specific tax of \$75 will be equivalent to shifting the demand curve to $p = 700 - 375Q$. With $MC = 25,$ profit-maximizing quantity and price are $Q = 0.9$ and $p = 437.5$. The new deadweight loss will be $(437.5 - 25)(2 - 0.9)$\$226.875 million.

28. With a price ceiling of \$200, the monopoly will produce $Q = (775 - 200)/375 = 1.53$ million vials and the deadweight loss will be $(200 - 25) \times (2 - 1.53)/2 = \$41.1$ million.

29. Audio-PowerPoint answer by James Dearden is also available (11A State Wine Stores).
    a. Setting $MR = MC$ we get $5 - 2 \times 0.001Q = 2$. Solving the equation we get $Q^* = 1500$. Plugging the quantity back in the inverse demand function we get $P^* = 3.50$. The profit is $(3.5 - 2) \times 1500 = \$2250$.
    b. Setting $P = MC$ we get $5 - 0.001Q = 2$. Solving the equation we get $Q^* = 3000$. The competitive price will be $P^* = 2$.
    c. The supply function in New Jersey is perfectly elastic, thus any tax will be paid by suppliers. A specific tax of \$1.50 will raise the supply curve up to \$3.50. The price buyers pay will be \$3.50, the price received by sellers will be \$2, and the quantity exchanged will be 1500. The tax revenue is $1500 \times 1.5 = 2250$. The State of New Jersey's tax revenue is equal to Pennsylvania's monopoly profit.

30. Audio-PowerPoint answer by James Dearden is also available (11B iPod).
    a. Setting $MR = MC$ we get $1.98 - 2 \times 0.00198Q = 0$. Solving the equation we get $Q^* = 500$. Plugging the quantity back in the inverse demand function we get $P^* = 0.99$.
    b. Setting $MR = MC$ we get $2.58 - 2 \times 0.0129Q = 0$. Solving the equation we get $Q^* = 100$. Plugging the quantity back in the inverse demand function we get $P^* = 1.29$.

31. The price/marginal cost ratio is $99/45.37 = 2.18$. Lerner Index is $P - MC/P = 99 - 45.37/99 = 0.542$. Using the formula for the Lerner Index, the elasticity is -1.85.

32. See MyEconLab Chapter 11, "Humana Hospitals," for more examples. For saline solution, $p/MC \approx 55.4$ and the Lerner Index is $(p - MC)/p \approx 0.98$. From Equation 11.9, we know that $(p - MC)/p \approx 0.98 = -1/\varepsilon$, so $\varepsilon \approx 1.02$.

33. The Lerner Index is $(1840.8 - 100)/1840.8 = 0.95$. Hence Tenet believes that the elasticity it faces is -1.06.

34. The price/marginal cost ratio is $5000/2000 = 2.5$. The Lerner Index is $(5000 - 2000)/5000 = 0.6$. Hence Segway believes it faces a demand elasticity of -1.67.

35. The price/marginal cost ratio is $499/258 = 1.93$. The Lerner Index is $(499 - 258)/499 = 0.48$, and the elasticity Apple believes it faces is -2.08.

36. The Lerner Index is $(84.95 - 37)/84.95 = 0.56$. Hence Stamps.com believes that it faces a demand elasticity of -1.79.

37. A profit tax (of less than 100%) has no effect on a firm's profit-maximizing behavior. Suppose the government's share of the profit is β. Then the firm wants to maximize its after-tax profit, which is $(1 - \gamma)\pi$. However, whatever choice of Q (or p) maximizes π will also maximize $(1 - \gamma)\pi$. Figure 19.3 gives a graphical example where $\gamma = 1/3$. Consequently, the tribe's behavior is unaffected by a change in the share that the government receives. We can also answer this problem using calculus. The before-tax profit is $\pi_B = R(Q) - C(Q)$, and the after-tax profit is $\pi_A = (1 - \gamma)[R(Q) - C(Q)]$. For both, the first-order condition is marginal revenue equals marginal cost: $dR(Q)/dQ = dC(Q)/dQ$.

38. In the competitive case, equilibrium is found by equating supply and demand curves, $D = S$:

$$1.787 - 0.0004641Q = -0.496 + 0.00020165Q.$$

Then

$$Q_C^* = 3429.2151 \text{ lb}$$
$$P_C^* = 0.19550 \quad \$/\text{lb}.$$

Once the specific tax $\tau = \$0.01$ is imposed, the supply curve, which is also *MC*, shifts up (see Figure 11.17a). To find the after-tax equilibrium, we solve

$$D = S' = S + \tau$$
$$1.787 - 0.0004641Q = -0.496 + 0.00020165Q + 0.01$$
$$Q_C' = 3414.1945 \quad \text{lb}$$
$$P_C' = 0.20247 \quad \$/\text{lb}.$$

This suggests that tax incidence in the case of competition is

$$\frac{\Delta p}{\Delta \tau} = \frac{P_C' - P_C^*}{\Delta \tau} = \frac{0.20247 - 0.19550}{0.01} = 0.7 = 70\%.$$

In the monopoly case, pretax profit-maximizing output and price levels are found by equating *MC* and *MR* (see Figure 11.17b). Marginal revenue is

$$MR = \frac{dR}{dQ} = \frac{d}{dQ}(P(Q)Q) = \frac{d}{dQ}((1.787 - 0.0004641Q)Q)$$
$$= 1.787 - 0.0009282Q.$$

Marginal cost is the same as in the competitive case. Then, $MR = MC$ means that

$$1.787 - 0.009282Q = -0.496 + 0.00020165Q$$
$$Q_M^* = 2020.71 lb$$
$$P_M^* = 1.787 - 0.0004641 \times 2020.71 = 0.8492\$ / lb.$$

After specific tax τ is imposed, *MC* shifts to *MC*′ and monopoly chooses output that satisfies the following condition

$$MR = MC' = MC + \tau.$$

Then

$$1.787 - 0.0009282Q = -0.496 + 0.00020165Q + 0.01$$
$$Q_M' = 2011.7714 \quad \text{lb}$$
$$Q_M' = 1.787 - 0.0004641 \cdot 2011.7714 \simeq 0.8533 \quad \$/\text{lb}.$$

Tax incidence on consumers in the case of monopoly is

$$\frac{\Delta p}{\Delta \tau} = \frac{P'_M - P^*_M}{\Delta \tau} = \frac{0.8533 - 0.8492}{0.01} = 0.41 \equiv 41\%.$$

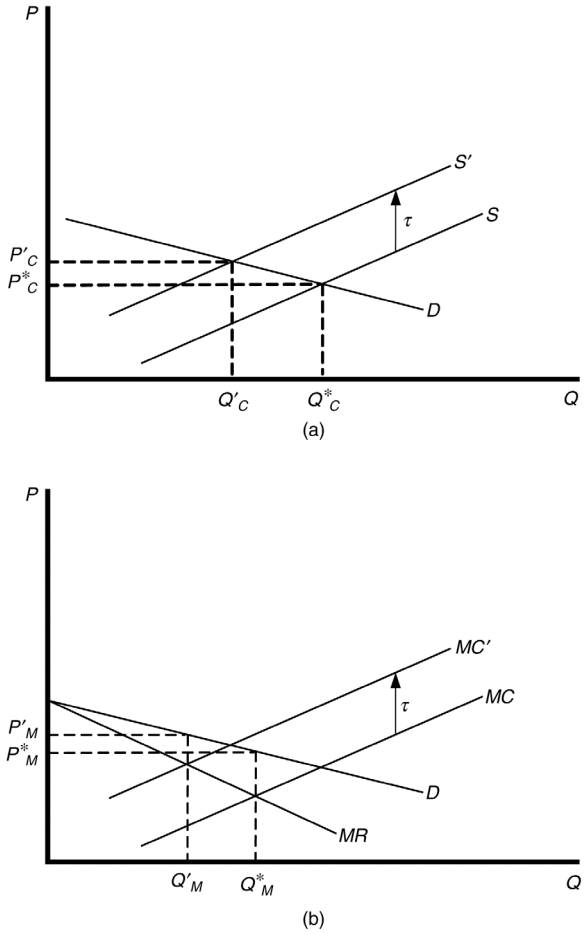

Figure 11.17

39. Consider constant marginal cost and suppose the monopoly is facing a linear demand function with inverse demand function $p = a - bQ$. The monopoly will produce $Q = (a - MC)/2b$, where MC is the lower of two marginal costs at the factory with lower MC, and zero units at the factory with higher MC. Suppose both factories have increasing marginal cost, the monopoly will produce at two factories Q_1 and Q_2 such that $MC(Q_1) = MC(Q_2) = MR(Q)$.

40. a. If the consumer cannot steal music, the total demand function function will be $p = 120 - Q/2$. The monopoly will set $MR = 120 - Q = 20$, such that $Q = 100$ and $p = 70$. Consumer surplus will be 2500, profit and producer surplus will be 5000, and deadweight loss will be 2500.

    b. If the dishonest customer can steal music, then the total demand function will be $p = 120 - Q$. The monopoly will set $MR = 120 - 2Q = 20$, such that $Q = 50$ and $p = 70$.

    c. When dishonest customers can pirate the music, consumer surplus will consist of consumer surplus of honest and dishonest customers. Consumer surplus of dishonest customers will be 7200 and consumer surplus of honest customers will be 1250; therefore, total consumer surplus will be 7200 + 1250 = 8450. Producer will receive profit and surplus only by selling to the honest customers. Profit and producer surplus will be 2500. Deadweight loss will be 1250.

41. Given that the demand curve is $p = 10 - Q$, its marginal revenue curve is $MR = 10 - 2Q$. Thus the output that maximizes the monopoly's profit is determined by $MR = 10 - 2Q = 2 = MC$, or $Q^* = 4$. At that output level, its price is $p^* = 6$ and its profit is $\pi^* = 16$. If the monopoly chooses to sell 8 units in the first period (it has no incentive to sell more), its price is 2 and it makes no profit. Given that the firm sells 8 units in the first period, its demand curve in the second period is $p = 10 - Q/\beta$, so its marginal revenue function is $MR = 10 - 2Q/\beta$. The output that leads to its maximum profit is determined by $MR = 10 - 2Q/\beta = 2 = MC$, or its output is 4β. Thus its price is 6 and its profit is 16β. It pays for the firm to set a low price in the first period if the lost profit, 16, is less than the extra profit in the second period, which is $16(\beta - 1)$. Thus it pays to set a low price in the first period if $16 < 16(\beta - 1)$, or $2 < \beta$.

42. a. To solve for the expansion path, set the ratio of the marginal products equal to the ratio of the input prices (see Appendix 7C).

$$\frac{MP_L}{MP_K} = \frac{\omega}{r}$$

This gives the equation for the expansion path $K = \frac{\omega}{r}L = 0.25L$. See Figure 11.18.

b. Substituting the expansion path into the production function yields $L = 2Q$, and $K = 0.5Q$. Thus $C(Q) = wL + rK = w2Q + r\,0.5Q = 1(2)Q + 4(0.5)Q = 4Q$.

c. Long-run profit-maximizing output is where $LMC = MR$.

$$LMC = \frac{dC}{dQ} = 4$$

$$MR = \frac{dR}{dQ} = \frac{d}{dQ}(P(Q)\cdot Q) = \frac{d}{dQ}(100Q - Q^2) = 100 - 2Q$$

$$Q^* = 48$$

$$p^* = 52$$

d. To solve, plug the capital labor ratio $K = 0.25L$ and the output level (48) into the production function.

$$48 = L^{1/2}K^{1/2} = L^{1/2}(0.25L)^{1/2} = 0.5L$$

$$L^* = 96$$

$$K^* = 0.25 \times 96 = 24$$

See Figure 11.18.

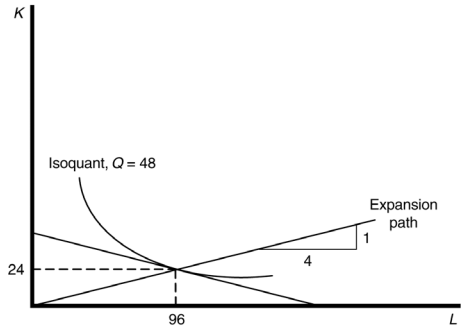

Figure 11.18

43. Solution also provided in Jim Dearden's audio presentation.

a. Total revenue is: $TR(Q) = p \cdot Q = (9 - \frac{Q}{20})Q = 9Q - \frac{Q^2}{20}$, therefore marginal revenue is:

$$MR(Q) = \frac{dTR(Q)}{dQ} = 9 - \frac{Q}{10}.$$

Marginal cost function is: $m(Q) = \frac{dC(Q)}{dQ} = 10 - 8Q + 2Q^2$.

Marginal revenue curve (MR) and marginal cost curve ($m(Q)$) are shown in Figure 11.19.

$$MR(Q) = m(Q) \quad \Rightarrow \quad Q_1^* = \frac{79 + \sqrt{5441}}{40},\ Q_2^* = \frac{79 - \sqrt{5441}}{40}.$$

b. Profit function is: $\pi(Q) = TR(Q) - C(Q) = 9Q - \frac{Q^2}{20} - (10 + 10Q - 4Q^2 + \frac{2}{3}Q^3)$; the F.O.C. is:

$$\frac{d\pi(Q)}{dQ} = 9 - \frac{Q}{10} - 10 + 8Q - 2Q^2 = -1 + \frac{79}{10}Q - 2Q^2 = 0 \quad \Rightarrow \quad \begin{cases} Q_1^* = \dfrac{79 + \sqrt{5441}}{40} > 0 \\ Q_2^* = \dfrac{79 - \sqrt{5441}}{40} > 0. \end{cases}$$

The S.O.C. is:

$$\frac{d^2\pi(Q_1^*)}{dQ^2} = \frac{79}{10} - 4Q_1^* = -\frac{\sqrt{5441}}{10} < 0,\ \frac{d^2\pi(Q_2^*)}{dQ^2} = \frac{79}{10} - 4Q_2^* = \frac{\sqrt{5441}}{10} > 0.$$

Therefore the S.O.C. is satisfied at $Q_2^* = \frac{79 - \sqrt{5441}}{40}$, i.e. the profit-maximizing output is

$$Q_2^* = \frac{79 - \sqrt{5441}}{40}.$$

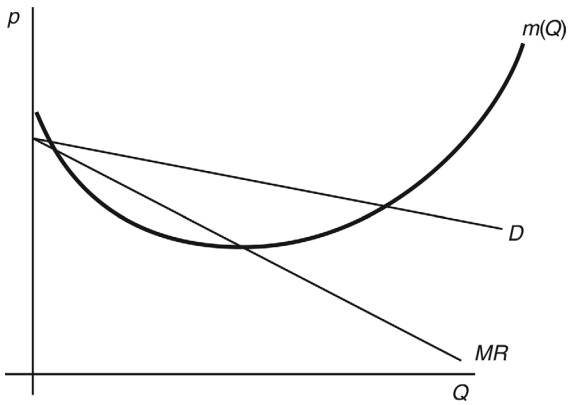

Figure 11.19

44. Solution also provided in Jim Dearden's audio presentation.

a. The revenue function is: $R(Q) = p \cdot Q = (10 - \frac{Q}{1000})Q$; then the F.O.C. is:

$$\frac{dR(Q)}{dQ} = 10 - \frac{Q}{500} = 0 \quad \Rightarrow \quad Q^* = 5000 \quad \Rightarrow \quad p^* = 10 - \frac{Q^*}{1000} = 5.$$

The revenue-maximizing price is \$5.

b. The sum of the cable car revenues and the economic impact is:

$$S(Q) = R(Q) + EI(Q) = \left(10 - \frac{Q}{1000}\right)Q + 4Q = \left(14 - \frac{Q}{1000}\right)Q.$$

The F.O.C. is:

$$\frac{dS(Q)}{dQ} = 14 - \frac{Q}{500} = 0 \quad \Rightarrow \quad Q^* = 7000 \quad \Rightarrow \quad p^* = 10 - \frac{Q^*}{1000} = 3.$$

The optimal price is \$3.