ANSWERS TO SELECTED EXERCISES

CHAPTER 1

1. a. *False*. There is little or no substitutability across geographical regions of the United States. A consumer in Los Angeles, for example, will not travel to Houston, Atlanta, or New York for lunch just because hamburger prices are lower in those cities. Likewise, a McDonald's or Burger King in New York cannot supply hamburgers in Los Angeles, even if prices were higher in Los Angeles. In other words, a fast-food price increase in New York will affect neither the quantity demanded nor the quantity supplied in Los Angeles or other parts of the country.

   b. *False*. Although consumers are unlikely to travel across the country to buy clothing, suppliers can easily move clothing from one part of the country to another. Thus if clothing prices were substantially higher in Atlanta than Los Angeles, clothing companies could shift supplies to Atlanta, which would reduce the price there.

   c. *False*. Although some consumers might be die-hard Coke or Pepsi loyalists, there are many consumers who will substitute one for the other based on price differences. Thus there is a single market for colas.

CHAPTER 2

2. a. With each price increase of \$20, the quantity demanded decreases by 2. Therefore, $(\Delta Q_D/\Delta P) = -2/20 = -0.1$. At $P = 80$, quantity demanded equals 20 and $E_D = (80/20)(-0.1) = -0.40$. Similarly, at $P = 100$, quantity demanded equals 18 and $E_D = (100/18)(-0.1) = -0.56$.

   b. With each price increase of \$20, quantity supplied increases by 2. Therefore, $(\Delta Q_S/\Delta P) = 2/20 = 0.1$. At $P = 80$, quantity supplied equals 16 and $E_S = (80/16)(0.1) = 0.5$. Similarly, at $P = 100$, quantity supplied equals 18 and $E_S = (100/18)(0.1) = 0.56$.

   c. The equilibrium price and quantity are found where the quantity supplied equals the quantity demanded at the same price. From the table, the $P^* = \$100$ and the $Q^* = 18$ million.

   d. With a price ceiling of \$80, consumers want 20 million, but producers supply only 16 million, for a shortage of 4 million.

3. If Brazil and Indonesia add 200 million bushels of wheat to U.S. wheat demand, the new demand curve will be $Q + 200$, or $Q_D = (3244 - 283P) + 200 = 3444 - 283P$.

   Equate supply and the new demand to find the new equilibrium price. $1944 + 207P = 3444 - 283P$, or $490P = 1500$, and thus $P = \$3.06$ per bushel. To find the equilibrium quantity, substitute the price into either the supply or demand equation. Using demand, $Q_D = 3444 - 283(3.06) = 2578$ million bushels.

5. a. Total demand is $Q = 3244 - 283P$; domestic demand is $Q_D = 1700 - 107P$; subtracting domestic demand from total demand gives export demand $Q_E = 1544 - 176P$. The initial market equilibrium price (as given in example) is $P^* = \$2.65$. With a 40-percent decrease in export demand, total demand becomes $Q = Q_D + 0.6Q_E = 1700 - 107P + 0.6(1544 - 176P) = 2626.4 - 212.6P$. Demand is equal to supply. Therefore:

   $$2626.4 - 212.6P = 1944 + 207P$$
   $$682.4 = 419.6P$$

   So $P = \dfrac{682.4}{419.6} = \$1.626$ or \$1.63. At this price, $Q = 2281$. Yes, farmers should be worried. With this drop in quantity and price, revenue goes from \$6609 million to \$3718 million.

   b. If the U.S. government supports a price of \$3.50, the market is not in equilibrium. At this support price, demand is equal to $2626.4 - 212.6(3.5) = 1882.3$ and supply is $1944 + 207(3.5) = 2668.5$. There is excess supply $(2668.5 - 1882.3 = 786.2)$ which the government must buy, costing $\$3.50(786.2) = \$2751.7$ million.

8. a. To derive the new demand curve, we follow the same procedure as in Section 2.6. We know that $E_D = -b\,(P^*/Q^*)$; substituting $E_D = -0.75$, $P^* = \$2$, and $Q^* = 12$ gives $-0.75 = -b(2/12)$ so that $b = 4.5$. Substituting this value into the equation for the linear demand curve, $Q_D = a - bP$, we have $12 = a - 4.5(2)$. So $a = 21$. The new demand curve is $Q_D = 21 - 4.5P$.

   b. To determine the effect of a 20-percent decline in copper demand, we note that the quantity demanded is 80 percent of what it would be otherwise for every price. Multiplying the right-hand side of the demand curve by 0.8, $Q_D = (0.8)(21 - 4.5P) = 16.8 - 3.6P$. Supply is still $Q_s = -6 + 9P$ and demand is equal to supply. Solving, $P^* = \$1.81$ per pound. A decline in demand of 20 percent, therefore, entails a drop in price of 19 cents per pound, or 9.5 percent.

10. a. First, considering non-OPEC supply: $S_C = Q^* = 20$. With $E_S = 0.10$ and $P^* = \$50$, $E_S = d(P^*/Q^*)$ implies $d = 0.04$. Substituting for d, $S_C = 20$, and $P = 50$ in the supply equation gives $20 = c + (0.04)(50)$, so that $c = 18$. Hence, the supply curve is $S_C = 18 + 0.04P$. Similarly, since $Q_D = 34$, $E_D = -b(P^*/Q^*) = -0.05$ and $b = 0.03$. Substituting for b, $Q_D = 34$, and $P = 50$ in the demand equation gives $34 = a - (0.03)(50)$, so that $a = 35.5$. Hence $Q_D = 35.5 - 0.03P$.

b. The long-run elasticities are: $E_S = 0.4$ and $E_D = -0.4$. As above, $E_S = d(P^*/Q^*)$ and $E_D = -b(P^*/Q^*)$, implying $0.4 = d(50/20)$ and $-0.4 = -b(50/34)$. So $d = 0.16$ and $b = 0.27$. Next solve for c and a: $S_C = c + dP$ and $Q_D = a - bP$, which implies that $20 = c + (0.16)(50)$ and $34 = a - (0.27)(50)$. Therefore, $c = 12$ and $a = 47.5$.

c. The discovery of new oil fields will increase OPEC supply by 2 bb/yr, so $S_C = 20$, $S_O = 16$, and $D = 36$. The new short-run total supply curve is $S_T = 34 + 0.04P$. Demand is unchanged: $D = 35.5 - 0.03P$. Since supply equals demand, $34 + 0.04P = 35.5 - 0.03P$. Solving, $P = \$21.43$ per barrel. An increase in OPEC supply entails a drop in price in \$ 28.57 or 57% in the short-run.

To analyze the long-run, use the new long-run supply curve, $S_T = 28 + 0.16P$. Setting this equal to the long-run demand gives: $28 + 0.16P = 47.5 - 0.27P$, so that $P = \$45.35$ per barrel, only \$4.65 per barrel (9%) less than the original long-run price.

CHAPTER 3

3. Not necessarily true. Suppose that she has convex preferences (a diminishing marginal rate of substitution), and has a lot of movie tickets. Even though she would give up movie tickets to get another basketball ticket, she does not necessarily like basketball better.

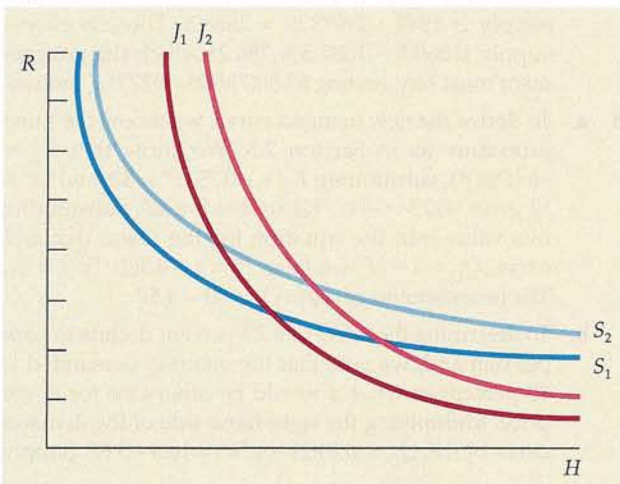

Figure 3(a)

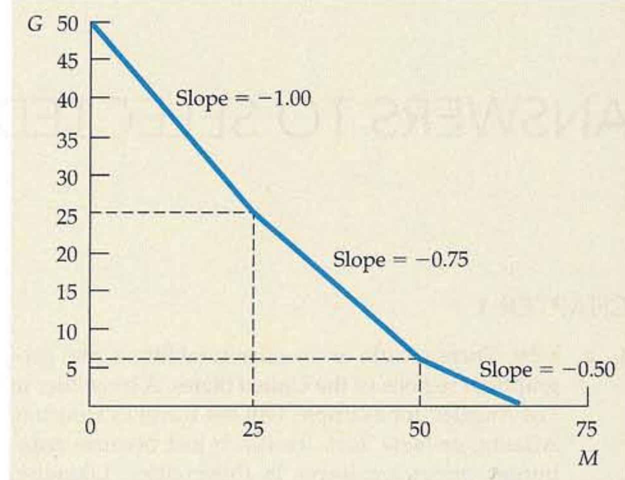

Figure 3(b)

6. a. See Figure 3(a), where R is the number of rock concerts, and H is the number of hockey games.

b. At any combination of R and H, Jones is willing to give up more of R to get some H than Smith is. Thus Jones has a *higher* MRS of R for H than Smith has. Jones' indifference curves are steeper than Smith's at any point on the graph.

8. In Figure 3(b) we plot miles flown, M, against all other goods, G, in dollars. The slope of the budget line is $-P_M/P_G$. The price of miles flown changes as number of miles flown changes, so the budget curve is kinked at 25,000 and 50,000 miles. Suppose P_M is \$1 per mile for ≤ 25,000 miles, then $P_M = \$0.75$ for $25{,}000 < M \leq 50{,}000$, and $P_M = \$.50$ for $M > 50{,}000$. Also, let $P_G = \$1$. Then the slope of the first segment is –1, the slope of the second segment is –0.75, and the slope of the last segment is –0.5.

CHAPTER 4

9. a. For computer chips, $E_P = -2$, so $-2 = \%\Delta Q/10$, and therefore $\%\Delta Q = -20$. For disk drives, $E_P = -1$, so a 10 percent increase in price will reduce sales by 10 percent. Sales revenue will decrease for computer chips because demand is elastic and price has increased. To estimate the change in revenue, let $TR_1 = P_1Q_1$ be revenue before the price change and $TR_2 = P_2Q_2$ be revenue after the price change. Therefore $\Delta TR = P_2Q_2 - P_1Q_1$, and thus $\Delta TR = (1.1P_1)(0.8Q_1) - P_1Q_1 = -0.12P_1Q_1$, or a 12 percent decline. Sales revenue for disk drives will remain unchanged because demand elasticity is -1.

b. Although we know the responsiveness of demand to change in price, we need to know the quantities and the prices of the products to determine total sales revenues.

11. a. With small changes in price, the point elasticity formula would be appropriate. But here, the price of food increases from \$2 to \$2.50, so arc elasticity should be used: $E_p = (\Delta Q/\Delta P)(\overline{P}/\overline{Q})$. We know that $E_p = -1$, $P = 2$, $\Delta P = .50$, and $Q = 5000$. So, if there is no change in income, we can solve for ΔQ: $-1 = (\Delta Q/.50)\ [((2 + .50)/2)/(5000 + \Delta Q/2)] = (\Delta Q \cdot 2.50)/(10{,}000 + \Delta Q)$. We find that $\Delta Q = -1000$: she decreases her consumption of food from 5000 to 4000 units.

b. A tax rebate of \$2500 implies an income increase of \$2500. To calculate the response of demand to the tax rebate, we use the definition of the arc income elasticity: $E_I = (\Delta Q / \Delta I)(\overline{I}/\overline{Q})$. We know that $E_I = 0.5$, $I = 25{,}000$, $\Delta I = 2500$, and $Q = 4000$. We solve for ΔQ: $0.5 = (\Delta Q/2500)[((25{,}000 + 27{,}500)/2)/(4000 + (\Delta Q/2)]$. Since $\Delta Q = 195$, she increases her consumption of food from 4000 to 4195 units.

c. Felicia is better off after the rebate. The amount of the rebate is enough to allow her to purchase her original bundle of food and other goods. Recall that originally she consumed 5000 units of food. When the price went up by fifty cents per unit, she needed an extra (5000)(\$0.50) = \$2500 to afford the same quantity of food without reducing the quantity of the other goods consumed. This is the exact amount of the rebate. However, she did not choose to return to her original bundle. We can therefore infer that she found a better bundle that gave her a higher level of utility.

13. a. The demand curve is a straight line with a vertical intercept of $P = 15$ and a horizontal intercept of $Q = 30$.

b. If there were no toll, the price P would be 0, so that $Q = 30$.

c. If the toll is \$5, $Q = 20$. The consumer surplus lost is the difference between consumer surplus when $P = 0$ and consumer surplus when $P = 5$, or \$125.

CHAPTER 4—APPENDIX

1. The first utility function can be represented as a series of straight lines; the second as a series of hyperbolas in the positive quadrant; and the third as a series of "L"s. Only the second utility function meets the definition of a strictly convex shape.

3. The Slutsky equation is $dX/dP_X = \partial X/\partial P^* |_{U=U^*} - X(\Delta X/\Delta I)$, where the first term represents the substitution effect and the second term represents the income effect. With this type of utility function the consumer does not substitute one good for the other when the price changes, so the substitution effect is zero.

CHAPTER 5

2. The four mutually exclusive states are given in Table 5 below.

4. The expected value is $EV = (0.4)(100) + (0.3)(30) + (0.3)(-30) = \$40$. The variance is $\sigma^2 = (0.4)(100 - 40)^2 + (0.3)(30 - 40)^2 + (0.3)(-30 - 40)^2 = 2{,}940$.

8. Calculate the expected utility of wealth under the three options. Wealth is equal to the initial \$250,000 plus whatever is earned on growing corn, or investing in the safe financial asset. Expected utility under the safe option, allowing for the fact that your initial wealth is \$250,000, is: $E(U) = (250{,}000 + 200{,}000(1 + 0.5))^{.5} = 678.23$. Expected utility with regular corn is:

$E(U) = .7(250{,}000 + (500{,}000 - 200{,}000))^{.5} + .3(250{,}000 + (50{,}000 - 200{,}000))^{.5} = 519.13 + 94.87 = 614$

Expected utility with drought-resistant corn is:

$E(U) = .7(250{,}000 + (500{,}000 - 250{,}000))^{.5} + .3(250{,}000 + (350{,}000 - 250{,}000))^{.5} = 494.975 + 177.482 = 672.46$

The option with the highest expected utility is the safe option of not planting corn.

CHAPTER 6

2. a. The average product of labor, AP, is equal to Q/L. The marginal product of labor, MP, is equal to $\Delta Q/\Delta L$. The relevant calculations are given in the following table.

L	Q	AP	MP
0	0	–	–
1	10	10	10
2	18	9	8
3	24	8	6
4	28	7	4
5	30	6	2
6	28	4.7	–2
7	25	3.6	–3

b. This production process exhibits diminishing returns to labor, which is characteristic of all production functions with one fixed input. Each additional unit of labor yields a smaller increase in output than the last unit of labor.

TABLE 5

	Congress Passes Tariff	Congress Does Not Pass Tariff
Slow growth rate	State 1: Slow growth with tariff	State 2: Slow growth without tariff
Fast growth rate	State 3: Fast growth with tariff	State 4: Fast growth without tariff

c. Labor's negative marginal product can arise from congestion in the chair manufacturer's factory. As more laborers are using a fixed amount of capital, they get in each other's way, decreasing output.

6. No. If the inputs are perfect substitutes, the isoquants will be linear. However, to calculate the slope of the isoquant, and hence the *MRTS*, we need to know the rate at which one input may be substituted for the other. Without the marginal product of each input, we cannot calculate the MRTS.

9. a. Let Q_1 be the output of DISK, Inc., Q_2 be the output of FLOPPY, Inc., and X be equal amounts of capital and labor for the two firms. Then, $Q_1 = 10X^{0.5}X^{0.5} = 10X^{(0.5+0.5)} = 10X$ and $Q_2 = 10X^{0.6}X^{0.4} = 10X^{(0.6+0.4)} = 10X$. Because $Q_1 = Q_2$, they both generate the same output with the same inputs.

b. With capital fixed at 9 machine units, the production functions become $Q_1 = 30L^{0.5}$ and $Q_2 = 37.37L^{0.4}$. Consider the following table:

L	Q Firm 1	MP Firm 1	Q Firm 2	MP Firm 2
0	0	–	0	–
1	30.00	30.00	37.37	37.37
2	42.43	12.43	49.31	11.94
3	51.96	9.53	57.99	8.69
4	60.00	8.04	65.07	7.07

For each unit of labor above 1 unit, the marginal product of labor is greater for DISK, Inc.

CHAPTER 7

4. a. Total cost, TC, is equal to fixed cost, FC, plus variable cost, VC. Since the franchise fee, FF, is a fixed sum, the firm's fixed costs increase by the fee. Then average cost, equal to (FC + VC)/Q, and average fixed cost, equal to (FC/Q), increase by the average franchise fee (FF/Q). Average variable cost is unaffected by the fee, as is marginal cost.

b. When a tax t is imposed, variable costs increase by tQ. Average variable cost increases by t (fixed cost is constant), as does average (total) cost. Because total cost increases by t with each additional unit, marginal cost increases by t.

5. It is probably referring to accounting profit; this is the standard concept used in most discussions of how firms are doing financially. In this case, the article points to a substantial difference between accounting and economic profits. It claims that, under the current labor contract, automakers must pay many workers even if they are not working. This implies that their wages are *sunk* for the life of the contract. Accounting profits would subtract wages paid; economic profits would not, since they are sunk costs. Therefore automakers may be earning economic profits on these sales, even if they have accounting losses.

10. If the firm can produce one chair with either 4 hours of labor or 4 hours of machinery or any combination, then the isoquant is a straight line with a slope of -1 and intercepts at $K = 4$ and $L = 4$. The isocost line, $TC = 30L + 15K$, has a slope of -2 and intercepts at $K = TC/15$ and $L = TC/30$. The cost-minimizing point is a corner solution, where $L = 0$ and $K = 4$, and TC = \$60.

CHAPTER 7—APPENDIX

1. a. Returns to scale refers to the relationship between output and proportional increases in all inputs. If $F(\lambda L,\lambda K) > \lambda F(L,K)$, there are increasing returns to scale; if $F(\lambda L,\lambda K) = \lambda F(L,K)$, there are constant returns to scale; if $F(\lambda L,\lambda K) < \lambda F(L,K)$, there are decreasing returns to scale. Applying this to $F(L,K) = K^2L$, $F(\lambda L,\lambda K) = (\lambda K)^2(\lambda L) = \lambda^3K^2L = \lambda^3F(L,K) > \lambda F(L,K)$. So, this production function exhibits increasing returns to scale.

b. $F(\lambda L,\lambda K) = 10\lambda K + 5\lambda L = \lambda F(L,K)$. The production function exhibits constant returns to scale.

c. $F(\lambda L,\lambda K) = (\lambda K\lambda L)^{0.5} = (\lambda^2)^{0.5} = (KL)^{0.5} = \lambda(KL)^{0.5} = \lambda F(L,K)$. The production function exhibits constant returns to scale.

2. The marginal product of labor is $100K$. The marginal product of capital is $100L$. The marginal rate of technical substitution is K/L. Set this equal to the ratio of the wage rate to the rental rate of capital: $K/L = 30/120$ or $L = 4K$. Then substitute for L in the production function and solve for a K that yields an output of 1000 units: $1000 = 100K \cdot 4K$. So, $K = 2.5^{0.5}$, $L = 4 \cdot 2.5^{0.5}$, and total cost is equal to \$379.20.

CHAPTER 8

4. a. Profit is maximized where marginal cost (MC) is equal to marginal revenue (MR). Here, MR is equal to \$100. Setting MC equal to 100 yields a profit-maximizing quantity of 25.

b. Profit is equal to total revenue (PQ) minus total cost. So profit $= PQ - 200 - 2Q^2$. At $P = 100$ and $Q = 25$, profit = \$1050.

c. The firm produces in the short run if its revenues are greater than its variable costs. The firm's short-run supply curve is its MC curve above minimum AVC. Here, AVC is equal to variable cost, $2Q^2$, divided by quantity, Q. So, AVC = $2Q$. Also, MC is equal to $4Q$. So, MC is greater than AVC for any quantity greater than 0. This means that the firm produces in the short run as long as price is positive.

11. The firm should produce where price is equal to marginal cost so that: $P = 115 = 15+4q = MC$ and $q = 25$.

Profit is \$800. Producer surplus is profit plus fixed cost, which is \$1250.

14. a. With the imposition of a \$1 tax on a single firm, all its cost curves shift up by \$1.

b. Because the firm is a price taker, the imposition of the tax on only one firm does not change the market price. Given that the firm's short-run supply curve is its marginal cost curve (above average variable cost), and that the marginal cost curve has shifted up (or inward), the firm supplies less to the market at every price.

c. If the tax is placed on a single firm, that firm will go out of business unless it was earning a positive economic profit before the tax.

CHAPTER 9

1. a. In free-market equilibrium, $L^S = L^D$. Solving, $w = \$4$ and $L^S = L^D = 40$. If the minimum wage is \$5, then $L^S = 50$ and $L^D = 30$. The number of people employed will be given by the labor demand. So employers will hire 30 million workers.

b. With the subsidy, only $w - 1$ is paid by the firm. The labor demand becomes $L^{D*} = 80 - 10(w - 1)$. So $w = \$4.50$ and $L = 45$.

4. a. Equating demand and supply, $28 - 2P = 4 + 4P \cdot P^* = 4$ and $Q^* = 20$.

b. The 25-percent reduction would imply that farmers produce 15 billion bushels. To encourage farmers to withdraw their land from cultivation, the government must give them 5 billion bushels that they can sell on the market. Since the total supply to the market is still 20 billion bushels, the market price remains at \$4 per bushel. Farmers gain because they incur no costs for the 5 billion bushels received from the government. We calculate these cost savings by taking the area under the supply curve between 15 and 20 billion bushels. The prices when $Q = 15$ and when $Q = 20$ are $P = \$2.75$ and $P = \$4.00$. The total cost of producing the last 5 billion bushels is therefore the area of a trapezoid with a base of $20 - 15 = 5$ billion and an average height of $(2.75 + 4.00)/2 = 3.375$. The area is $5(3.375) = \$16.875$ billion.

c. Taxpayers gain because the government does not have to pay to store the wheat for a year and then ship it to an underdeveloped country. The PIK Program can last only as long as wheat reserves last. But PIK assumes that the land removed from production can be restored to production at such time as the stockpiles are exhausted. If this cannot be done, consumers may eventually pay more for wheat-based products. Finally, farmers enjoy a windfall profit because they have no production costs.

10. a. To find the price of natural gas when the price of oil is \$60 per barrel, equate the quantity demanded and quantity supplied of natural gas, and solve for P_G. The relevant equations are: *Supply:* $Q = 15.90 + 0.72P_G + 0.05\,P_O$, *Demand:* $Q = 0.02 - 1.8P_G + 0.69P_O$. Using $P_O = \$60$, we get: $15.90 + 0.72P_G + 0.05(60) = 0.02 - 1.8P_G + 0.69(60)$, so the price of natural gas is $P_G = \$8.94$. Substituting into the supply or the demand curve gives a free-market quantity of 25.34 Tcf. If a maximum price of natural gas were set at \$3, the quantity supplied would be 21.06 Tcf and the quantity demanded would be 36.02 Tcf. To calculate the deadweight loss, we measure the area of triangles *B* and *C* (see Figure 9.4). To find area *B* we must first determine the price on the demand curve when quantity equals 21.1. From the demand equation, $21.1 = 41.42 - 1.8P_G$. Therefore, $P_G = \$11.29$. Area *B* equals $(0.5)(25.3 - 21.1)(11.29 - 8.94) = \$4.9$ billion, and area *C* is $(0.5)(25.3 - 21.1)(8.94 - 3) = \$12.5$ billion. The deadweight loss is $4.9 + 12.5 = \$17.4$ billion.

b. To find the price of oil that would yield a free market price of natural gas of \$3, we set the quantity demanded equal to the quantity supplied, use $P_G = \$3$, and solve for P_O. Therefore, $Q_S = 15.90 + 0.72(3) + 0.05P_O = 0.02 - 1.8(3) + 0.69P_O = Q_D$, or $18.06 + 0.05P_O = -5.38 + 0.69P_O$, so that $0.64P_O = 23.44$ and $P_O = \$36.63$. This yields a free market price of natural gas of \$3.

12. First, equate supply and demand to determine equilibrium quantity: $50 + Q = 200 - 2Q$, or $Q_{EQ} = 50$ (million pounds). Substitute $Q_{EQ} = 50$ into either the supply or demand equation to determine price: $P_S = 50 + 50 = 100$ and $P_D = 200 - (2)(50) = 100$. Thus, the equilibrium price *P* is \$1 (100 cents). However, the world market price is 60 cents. At this price, the domestic quantity supplied is $60 = 50 - Q_S$ or $Q_S = 10$, and domestic demand is $60 = 200 - 2Q_D$ or $Q_D = 70$. Imports equal the difference between domestic demand and supply, or 60 million pounds. If Congress imposes a tariff of 40 cents, the effective price of imports increases to \$1. At \$1, domestic producers satisfy domestic demand and imports fall to zero.

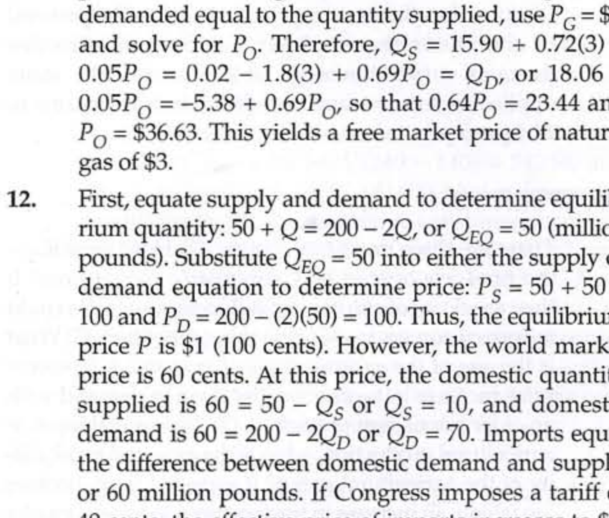

Figure 9

As shown in Figure 9, consumer surplus before the tariff is equal to area $a + b + c$, or (0.5)(200 + 60)(70) = 4,900 million cents or \$49 million. After the tariff, the price rises to \$1.00 and consumer surplus falls to area a, or (0.5)(200 – 100)(50) = \$25 million, a loss of \$24 million. Producer surplus increases by area b, or (100 – 60)(10) + (0.5)(100 – 60)(50 – 10) = \$12 million. Finally, because domestic production is equal to domestic demand at \$1, no hula beans are imported and the government receives no revenue. The difference between the loss of consumer surplus and the increase in producer surplus is deadweight loss which is \$12 million.

13. No, they would not. The clearest case is where labor markets are competitive. With either design of the tax, the wedge between supply and demand must total 12.4 percent of the wage paid. It does not matter whether the tax is imposed entirely on the workers (shifting the effective supply curve up by 12.4 percent) or entirely on the employers (shifting the effective demand curve down by 12.4 percent). The same applies to any combination of the two that sums to 12.4 percent.

CHAPTER 10

2. There are three important factors: (1) How similar are the products offered by Caterpillar's competitors? If they are close substitutes, a small increase in price could induce customers to switch to the competition. (2) What is the age of the existing stock of tractors? A 5-percent price increase induces a smaller drop in demand with an older population of tractors. (3) As a capital input in agricultural production, what is the expected profitability of the agricultural sector? If expected farm incomes are falling, an increase in tractor prices induces a greater decline in demand than one would estimate with information on past sales and prices.

4. a. Optimal production is found by setting marginal revenue equal to marginal cost. If the demand function is linear, $P = a - bQ$ (here, $a = 120$ and $b = 0.02$), so that $MR = a - 2bQ = 100 - 2(0.02)Q$.

Total cost = 25,000 + 60Q, so $MC = 60$. Setting $MR = MC$ implies $120 - 0.04Q = 60$, so $Q = 1500$. Substituting into the demand function, $P = 120 - (0.02)(1500) = 90$ cents. Total profit is (90)(1500) – (60)(1500) – 25,000, or \$200 per week.

b. Suppose initially that the consumers must pay the tax. Since the price (including the tax) that consumers would be willing to pay remains unchanged, the demand function can be written $P + t = 120 - 0.02Q - t$. Because the tax increases the price of each unit, total revenue for the monopolist increases by t, so $MR = 120 - 0.04Q - t$, where $t = 14$ cents. To determine the profit-maximizing output with tax, equate marginal revenue and marginal cost: $120 - 0.04Q - 14 = 60$, or $Q = 1150$ units.

From the demand function, average revenue = 120 – (0.02)(1150) – 14 = 83 cents. Total profit is 1450 cents or \$14.50 per week.

7. a. The monopolist's pricing rule is: $(P - MC)/P = -1/E_D$, using –2 for the elasticity and 40 for price, solve to find $MC = 20$.

b. In percentage terms, the mark-up is 50%, since marginal cost is 50% of price.

c. Total revenue is price times quantity, or (\$40)(800) = \$32,000. Total cost is equal to average cost times quantity, or (\$15)(800) = \$12,000, so profit is \$20,000. Producer surplus is profit plus fixed cost, or \$22,000.

10. a. **Pro:** Although Alcoa controlled about 90 percent of primary aluminum production in the United States, secondary aluminum production by recyclers accounted for 30 percent of the total aluminum supply. It should be possible for a much larger proportion of aluminum supply to come from secondary sources. Therefore the price elasticity of demand for Alcoa's primary aluminum is much higher than we would expect. In many applications, other metals, such as copper and steel, are feasible substitutes for aluminum. Here, the demand elasticity Alcoa faces may be lower than we would otherwise expect.

b. **Con:** The stock of potential supply is limited. Therefore, by keeping a stable high price, Alcoa could reap monopoly profits. Furthermore, since Alcoa had originally produced the metal reappearing as recycled scrap, it would have taken into account in its output decisions the effect of scrap reclamation on future prices. Hence, it exerted effective monopolistic control over the secondary metal supply.

c. Alcoa was not ordered to sell any of its U.S. production facilities. Rather, (1) it was barred from bidding for two primary aluminum plants constructed by the government during World War II; and (2) it was ordered to divest itself of its Canadian subsidiary, which became Alcan.

13. No, you should not. In a competitive market, a firm views price as being horizontal and equal to average revenue, which is equal to marginal revenue. If Connecticut's marginal cost increases, price will still be equal to Massachusetts's marginal cost, total marginal cost, and marginal revenue. Only Connecticut's quantity is reduced (which, in turn, reduces overall quantity), as shown in Figure 10.

CHAPTER 11

1. a. The Saturday-night requirement separates business travelers, who prefer to return home for the weekend, from tourists, who travel on the weekend.

b. By basing prices on the buyer's location, sorting is done by geography. Then prices can reflect transportation charges, which the customer pays for whether

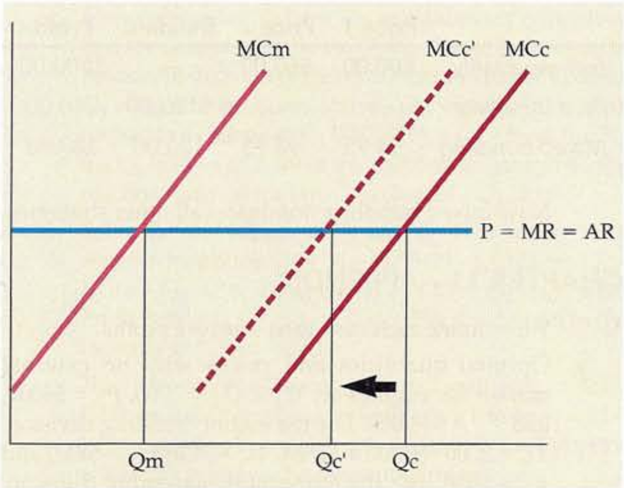

Figure 10

delivery is received at the buyer's location or at the cement plant.

c. Rebate coupons with food processors separate consumers into two groups: (1) customers who are less price sensitive (those who have a lower elasticity of demand) do not request the rebate; and (2) customers who are more price sensitive (those who have a higher demand elasticity) request the rebate.

d. A temporary price cut on bathroom tissue is a form of intertemporal price discrimination. Price-sensitive customers buy more tissue than they would otherwise during the price cut, while non-price-sensitive consumers buy the same amount.

e. The plastic surgeon can distinguish a high-income patient from a low-income patient by negotiation. Arbitrage is no problem because plastic surgery cannot be transferred from low-income patients to high-income patients.

8. a. A monopolist with two markets should pick quantities in each market so that the marginal revenues in both markets are equal to one another and equal to marginal cost. Marginal cost is the slope of the total cost curve, 40. To determine marginal revenues in each market, we solve for price as a function of quantity. Then we substitute this expression for price into the equation for total revenue. $P_{NY} = 240 - 4Q_{NY}$, and $P_{LA} = 200 - 2Q_{LA}$. Then total revenues are $TR_{NY} = Q_{NY}P_{NY} = Q_{NY}(240 - 4Q_{NY})$, and $TR_{LA} = Q_{LA}P_{LA} = Q_{LA}(200 - 2Q_{LA})$. The marginal revenues are the slopes of the total revenue curves: $MR_{NY} = 240 - 8Q_{NY}$ and $MR_{LA} = 200 - 4Q_{LA}$. Next, we set each marginal revenue to marginal cost (=40), implying $Q_{NY} = 25$ and $Q_{LA} = 40$. With these quantities, we solve for price in each market: $P_{NY} = 240 - (4)(25) = \$140$ and $P_{LA} = 200 - (2)(40) = \$120$.

b. With the new satellite, Sal can no longer separate the two markets. The total demand function is the horizontal summation of the two markets. Above a price of \$200, the total demand is just the New York demand function. Below a price of \$200, we add the two demands: $Q_T = 60 - 0.25P + 100 - 0.50P = 160 - 0.75P$. Sal maximizes profit by choosing a quantity so that MR = MC. Marginal revenue is $213.33 - 2.67Q$. Setting this equal to marginal cost implies a profit-maximizing quantity of 65 with a price of \$126.67. In the New York market, quantity is equal to $60 - 0.25(126.67) = 28.3$, and in the Los Angeles market, quantity is equal to $100 - 0.50(126.67) = 36.7$. Together, 65 units are purchased at a price of \$126.67.

c. Sal is better off in the situation with the highest profit, which occurs in part (a) with price discrimination. Under price discrimination, profit is equal to $\pi = P_{NY}Q_{NY} + P_{LA}Q_{LA} - [1000 + 40(Q_{NY} + Q_{LA})]$, or $\pi = \$140(25) + \$120(40) - [1000 + 40(25 + 40)] = \$4700$. Under the market conditions in part (b), profit is $\pi = PQ_T - [1000 + 40Q_T]$, or $\pi = \$126.67(65) - [1000 + 40(65)] = \$4633.33$. Therefore, Sal is better off when the two markets are separated. Under the market conditions in (a), the consumer surpluses in the two cities are $CS_{NY} = (0.5)(25)(240 - 140) = \$1250$, and $CS_{LA} = (0.5)(40)(200 - 120) = \$1600$. Under the market conditions in (b), the respective consumer surpluses are $CS_{NY} = (0.5)(28.3)(240 - 126.67) = \$1603.67$, and $CS_{LA} = (0.5)(36.7)(200 - 126.67) = \$1345.67$. New Yorkers prefer (b) because their price is \$126.67 instead of \$140, giving them a higher consumer surplus. Customers in Los Angeles prefer (a) because their price is \$120 instead of \$126.67, and their consumer surplus is greater in (a).

10. a. With individual demands of $Q_1 = 10 - P$, individual consumer surplus is equal to \$50 per week, or \$2600 per year. An entry fee of \$2600 captures all consumer surplus, even though no court fee would be charged, since marginal cost is equal to zero. Weekly profits would be equal to the number of serious players, 1000, times the weekly entry fee, \$50, minus \$10,000, the fixed cost, or \$40,000 per week.

b. When there are two classes of customers, the club owner maximizes profits by charging court fees above marginal cost and by setting the entry fee equal to the remaining consumer surplus of the consumer with the smaller demand—the occasional player. The entry fee, T, is equal to the consumer surplus remaining after the court fee is assessed: $T = (Q_2 - 0)(16 - P)(1/2)$, where $Q_2 = 4 - (1/4)P$, or $T = (1/2)(4 - (1/4)P)(16 - P) = 32 - 4P + P^2/8$. Entry fees for all players would be $2000(32 - 4P + P^2/8)$. Revenues from court fees equals $P(Q_1 + Q_2) = P[1000(10 - P) + 1000(4 - P/4)] = 14{,}000P - 1250P^2$. Then total revenue $= \text{TR} = 64{,}000 + 6000P - 1000P^2$. Marginal cost is zero and marginal revenue is given by the slope of the total revenue curve: $\Delta\text{TR}/\Delta P = 6000 - 2000P$. Equating marginal revenue and marginal cost implies a price of \$3.00 per hour. Total revenue is equal to \$73,000. Total cost is equal to fixed costs of \$10,000. So profit is \$63,000 per week, which is greater than the \$40,000 when only serious players become members.

c. An entry fee of \$50 per week would attract only serious players. With 3000 serious players, total revenues would be \$150,000, and profits would be \$140,000 per week. With both serious and occasional players, entry fees would be equal to 4000 times the consumer surplus of the occasional player: $T = 4000(32 - 4P + P^2/8)$. Court fees are $P[3000(10 - P) + 1000(4 - P/4)] = 34{,}000P - 3250P^2$. Then $\text{TR} = 128{,}000 + 18{,}000P - 2750P^2$. Marginal cost is zero, so setting $\Delta\text{TR}/\Delta P = 18{,}000 - 5500P = 0$ implies a price of \$3.27 per hour. Then total revenue is equal to \$157,455 per week, which is more than the \$150,000 per week with only serious players. The club owner should set annual dues at \$1053, charge \$3.27 for court time, and earn profits of \$7.67 million per year.

11. Mixed bundling is often the ideal strategy when demands are only somewhat negatively correlated and/or when marginal production costs are significant. The following tables present the reservation prices of the three consumers and the profits from the three strategies:

	Reservation Price		
	For 1	For 2	Total
Consumer A	\$ 3.25	\$ 6.00	\$ 9.25
Consumer B	8.25	3.25	11.50
Consumer C	10.00	10.00	20.00

	Price 1	Price 2	Bundled	Profit
Sell separately	\$ 8.25	\$6.00	—	\$28.50
Pure bundling	—	—	\$ 9.25	27.75
Mixed bundling	10.00	6.00	11.50	29.00

The profit-maximizing strategy is to use mixed bundling.

15. a. For each strategy, the optimal prices and profits are

	Price 1	Price 2	Bundled	Profit
Sell separately	\$80.00	\$80.00	—	\$320.00
Pure bundling	—	—	\$120.00	480.00
Mixed bundling	94.95	94.95	120.00	429.00

Pure bundling dominates mixed bundling because with marginal costs of zero, there is no reason to exclude purchases of both goods by all customers.

b. With marginal cost of \$30, the optimal prices and profits are

	Price 1	Price 2	Bundled	Profit
Sell separately	\$80.00	\$80.00	—	\$200.00
Pure bundling	—	—	\$120.00	240.00
Mixed bundling	94.95	94.95	120.00	249.90

Now mixed bundling dominates all other strategies.

CHAPTER 11—APPENDIX

1. We examine each case, then compare profits.

a. Optimal quantities and prices with no external market for engines are $Q_E = Q_A = 2000$, $P_E = \$8000$, and $P_A = \$18{,}000$. For the engine-building division, $\text{TR} = 2000 \cdot \$8000 = \$16\text{M}$, $\text{TC} = 2(2000)^2 = \$8\text{M}$, and $\pi_E = \$8\text{M}$. For the automobile-assembly division, $\text{TR} = 2000 \cdot \$18{,}000 = \$36\text{M}$, $\text{TC} = \$8000 \cdot 2000 + 16\text{M} = \$32\text{M}$, and $\pi_A = \$4\text{M}$. Total profits are \$12M.

b. Optimal quantities and prices with an external market for engines are $Q_E = 1500$, $Q_A = 3000$, $P_E = \$6000$, and $P_A = \$17{,}000$. For the engine-building division, $\text{TR} = 1500 \cdot \$6000 = \$9\text{M}$, $\text{TC} = 2(1500)^2 = \$4.5\text{M}$, and $\pi = \$4.5\text{M}$. For the automobile-assembly division, $\text{TR} = 3000 \cdot \$17{,}000 = \$51\text{M}$, $\text{TC} = (8000 + 6000)3000 = \$42\text{M}$, and $\pi = \$9\text{M}$. Total profits are \$13.5M.

c. Optimal quantities and prices with a monopoly market for engines are $Q_E = 2200$, $Q_A = 1600$, $P_E = \$8800$, and $P_A = \$18{,}400$, with 600 engines sold in the monopolized market for \$9400. For the engine-building division, $\text{TR} = 1600 \cdot \$8800 + 600 \cdot 9400 = \$19.72\text{M}$, $\text{TC} = 2(2200)^2 = \$9.68\text{M}$, and $\text{p} = \$10.04\text{M}$. For the automobile-assembly division, $\text{TR} = 1600 \cdot \$18{,}400 = \text{TR} = 1600 \cdot \$18{,}400 = \$29.44\text{M}$, $\text{TC} = (8000 + 8800)1600 = \$26.88\text{M}$, and $\text{p} = \$2.56\text{M}$. Total profits are \$12.6M.

The upstream division, building engines, earns the most profit when it has a monopoly on engines. The downstream division, building automobiles, earns the most when there is a competitive market for engines. Given the high cost of engines, the firm does best when engines are produced at the lowest cost with an external, competitive market for engines.

CHAPTER 12

1. Each firm earns economic profit by distinguishing its brand from all other brands. If these competitors merge into a single firm, the resulting monopolist would not produce as many brands as would have been produced before the merger. But, producing several brands with different prices and characteristics is one method of splitting the market into sets of customers with different price elasticities.

3. a. To maximize profit $\text{p} = 53Q - Q^2 - 5Q$, we find $\Delta\text{p}/\Delta Q = -2Q + 48 = 0$. $Q = 24$, so $P = 29$. Profit is equal to 576.

b. $P = 53\ Q_1 - Q_2$, $\text{p}_1 = PQ1 - C(Q) = 53Q1 - Q_1^2 - Q_1Q_2 - 5Q_1$ and $\text{p}_2 = PQ_2 - \text{C}(Q_2) = 53Q_2 - Q_1Q_2 - Q_2^2 - 5Q_2$.

c. The problem facing Firm 1 is to maximize profit, given that the output of Firm 2 will not change in reaction to the output decision of Firm 1. Therefore, Firm 1 chooses Q_1 to maximize π_1, as above. The change in π_1 with respect to a change in Q_1 is $53 - 2Q_1 - Q_2 - 5 = 0$, implying $Q_1 = 24 - Q_2/2$. Since the problem is symmetric, the reaction function for Firm 2 is $Q_2 = 24 - Q_1/2$.

d. Solve for the values of Q_1 and Q_2 that satisfy both reaction functions: $Q_1 = 24 - (1/2)(24 - Q_1/2)$. So, $Q_1 = 16$ and $Q_2 = 16$. The price is $P = 53 - Q_1 - Q_2 = 21$. Profit is $\pi_1 = \pi_2 = P \cdot Q_i - C(Q_i) = 256$. Total profit in the industry is $\pi_1 + \pi_2 = 512$.

5. *True*. The reaction curve of Firm 2 will be $q_2 = 7.5 - 1/2q_1$ and the reaction curve of Firm 1 will be $q_1 = 15 - 1/2q_2$. Substituting yields $q_2 = 0$ and $q_1 = 15$. The price will be 15, which is the monopoly price.

7. a. (i) In a Cournot equilibrium, when firm A has an increase in marginal cost, its reaction function shifts inwards. The quantity produced by firm A will decrease and the quantity produced by firm B will increase. Total quantity produced will decrease and price will increase. (ii) In a collusive equilibrium, the two firms will collectively act like a monopolist. When the marginal cost of Firm A increases, Firm A will reduce its production to zero, because Firm B can produce at a lower marginal coat. Because Firm B can produce the entire industry output at a marginal cost of \$50, there will be no change in output or price. However, the firms will have to come to some agreement on how to share the profit earned by B. (iii) Because the good is homogeneous, both produce where price equals marginal cost. Firm A increases price to \$80 and firm B raises its price to \$79.99. Assuming firm B can produce enough output, it will supply the entire market.

b. (i) The increase in the marginal cost of both firms shifts both reaction functions inwards. Both firms decrease output, and price will increase. (ii) When marginal cost increases, both firms will produce less and price will increase, as in the monopoly case. (iii) Price will increase and quantity produced will decrease.

c. (i) Both reaction functions shift outwards and both firms produce more. Price will increase. (ii) Both firms will increase output, and price will also increase. (iii) Both firms will produce more. Because marginal cost is constant, price will not change.

11. a. To determine the Nash equilibrium we calculate the reaction function for each firm, then simultaneously solve for price. *Assuming marginal cost is zero*, profit for Firm 1 is $P_1Q_1 = P_1(20 - P_1 + P_2) = 20P_1 + P_1^2 + P_2P_1$. $MR_1 = 20 - 2P_1 + P_2$. At the profit-maximizing price, $MR_1 = 0$. So, $P_1 = (20 + P_2)/2$. Because Firm 2 is symmetric to Firm 1, its profit-maximizing price is $P_2 = (20 + P_1)/2$. We substitute Firm 2's reaction function into that of Firm 1: $P_1 = [20 + (20 + P_1)/2]/2 = 15 + P_1/4$. $P_1 = 20$. By symmetry $P_2 = 20$. Then $Q_1 = 20$, and by symmetry $Q_2 = 20$. Profit for Firm 1 is $P_1Q_1 = 400$, and profit for Firm 2 is also 400.

b. If Firm 1 sets its price first, it takes Firm 2's reaction function into account. Firm 1's profit is $\pi_1 = P_1[20 - P_1 + (20 + P_1)/2]$. Then, $d\pi_1/dP_1 = 20 - 2P_1 + 10 + P_1$. Setting this expression equal to zero, $P_1 = 30$. We substitute for P_1 in Firm 2's reaction function, $P_2 = 25$. At these prices, $Q_1 = 20 - 30 + 25 = 15$ and $Q_2 = 20 + 30 - 25 = 25$. Profit is $\pi_1 = 30 \cdot 15 = 450$ and $\pi_2 = 25 \cdot 25 = 625$.

c. Your first choice should be (iii), and your second choice should be (ii). Setting prices above the Cournot equilibrium values is optional for both firms when Stackelberg strategies are followed. From the reaction functions, we know that the price leader provokes a price increase in the follower. But the follower increases price less than the price leader, and hence undercuts the leader. Both firms enjoy increased profits, but the follower does best, and both do better than they would in the Cournot equilibrium.

CHAPTER 13

1. If games are repeated indefinitely and all players know all payoffs, rational behavior will lead to apparently collusive outcomes. But, sometimes the payoffs of other firms can only be known by engaging in extensive information exchanges.

Perhaps the greatest problem to maintaining a collusive outcome is exogenous changes in demand and in the prices of inputs. When new information is not available to all players simultaneously, a rational reaction by one firm could be interpreted as a threat by another firm.

2. Excess capacity can arise in industries with easy entry and differentiated products. Because downward-sloping demand curves for each firm lead to outputs with average cost above minimum average cost, increases in output result in decreases in average cost. The difference between the resulting output and the output at minimum long-run average cost is excess capacity, which can be used to deter new entry.

4. a. There are two Nash equilibria: (100,800) and (900,600).

b. Both managers will follow a high-end strategy, and the resulting equilibrium will be (50,50), yielding less profit to both parties.

c. The cooperative outcome (900,600) maximizes the joint profit of the two firms.

d. Firm 1 benefits the most from cooperation. Compared to the next best opportunity, Firm 1 benefits by 900 − 100 = 800, whereas Firm 2 loses 800 − 600 = 200 under cooperation. Therefore, Firm 1 would need to offer Firm 2 at least 200 to compensate for Firm 2's loss.

6. a. Yes, there are two: (1) Given Firm 2 chooses *A*, Firm 1 chooses *C*; given Firm 1 chooses *C*, Firm 2 chooses *A*.

(2) Given Firm 2 chooses C, Firm 1 chooses A; given Firm 1 chooses A, Firm 2 chooses C.

b. If both firms choose according to maximin, Firm 1 will choose Product A and Firm 2 will choose Product A, resulting in -10 payoff for both.

c. Firm 2 will choose Product C in order to maximize payoffs at 10, 20.

12. Although antique auctions often have private-value elements, they are primarily common value because dealers are involved. Our antique dealer is disappointed in the nearby town's public auction because estimates of the value of the antiques vary widely and she has suffered from the winner's curse. At home, where there are fewer well-informed bidders, the winner's curse has not been a problem.

CHAPTER 14

2. With the new program, the budget line shifts up by the \$5000 government grant when the worker does no work at all and takes the maximum amount of leisure hours. As the number of hours worked increases (i.e., leisure decreases), the budget line has half the slope of the original budget line because earned income is taxed at 50 percent. When the after-tax income is \$10,000, the new budget line coincides with the original budget line. The result is that the new program will have no effect if the worker originally earned more than \$10,000 per year, but it will probably reduce the amount of time worked (i.e., increase leisure) if the worker earned less than \$10,000 originally.

6. The demand for labor is given by the marginal revenue product of labor; $\text{MRP}_L = \text{MR} \cdot \text{MP}_L$. In a competitive market, price is equal to marginal revenue, so MR = 10. The marginal product of labor is equal to the slope of the production function $Q = 12L - L^2$. This slope is equal to $12 - 2L$. The firm's profit-maximizing quantity of labor occurs where $\text{MRP}_L = w$, the wage rate. If $w = 30$, solving for L yields 4.5 hours per day. Similarly, if $w = 60$, solving for L yields 3 hours per day.

8. The equilibrium wage is where the quantity of labor supplied is equal to the quantity of labor demanded, or $20w = 1{,}200 - 10w$. Solving, $w = \$40$. Substituting into the labor supply equation, for example, the equilibrium quantity of labor is: $L_S = (20)(40) = 800$. Economic rent is the difference between the equilibrium wage and the wage given by the labor supply curve. Here, it is the area above the labor supply curve up to $L = 800$ and below the equilibrium wage. This area is (0.5)(800)(\$40) = \$16,000.

CHAPTER 15

3. The present discounted value of the first \$80 payment one year from now is $\text{PDV} = 80/(1 + 0.10)^1 = \$72.73$. The value of all these coupon payments can be found the same way: $\text{PDV} = 80[1/(1.10)^1 + 1/(1.10)^2 + 1/(1.10)^3 + 1/(1.10)^4 + 1/(1.10)^5] = \$303.26$. The present value of the final payment of \$1000 in the sixth year is $1000/1.1^6 = \$564.47$. So the present value of this bond is \$303.26 + \$564.47 = \$867.73. With an interest rate of 15 percent, PDV = \$700.49.

5. Using $R = 0.04$, we can substitute the appropriate values into Equation 15.5. We find that $NPV = -5 - 4.808 - 0.925 - 0.445 + 0.821 + 0.789 + 0.759 + 0.730 + 0.701 + 0.674 + 0.649 + 0.624 + 0.600 + 0.577 + 0.554 + 0.533 + 0.513 + 0.493 + 0.474 + 0.456 + 0.438 + 0.456 = -0.338$. The investment loses \$338,000 and is not worthwhile. However, were the discount rate 3%, the NPV = \$866,000, and the investment would be worth undertaking.

9. a. If we buy a bottle and sell it after t years, we pay \$100 now and receive $100t^{0.5}$ when it is sold. The NPV of this investment is $\text{NPV} = -100 + e^{-rt}100t^{0.5} = -100 + e^{-0.1t}100t^{0.5}$.

If we do buy a bottle, we will choose t to maximize the NPV. The necessary condition is $d\text{NPV}/dt = e^{-0.1t}(50 - t^{-0.5}) - 0.1e^{-0.1t} \cdot 100t^{0.5} = 0$. Solving, $t = 5$. If we hold the bottle 5 years, the NPV is $-100 + e^{-0.1 \cdot 5}100 \cdot 5^{0.5} = 35.62$. Since each bottle is a good investment, we should buy all 100 bottles.

b. You are offered \$130 for resale, so you would make an immediate profit of \$30. However, if you hold the wine for 5 years, the NPV of your profit is \$35.62 as shown in part (a). Therefore, the NPV if you sell immediately rather than hold for 5 years is \$30 − 35.62 = −\$5.62, and you should not sell.

c. If the interest rate changes from 10 percent to 5 percent the NPV calculation changes to $\text{NPV} = -100 + e^{-0.05t} \cdot 100t^{0.5}$. If we hold the bottle 10 years, the maximum NPV is $-100 + e^{-0.05 \cdot 10} \cdot 100 \cdot 10^{0.5} = \$91.80$.

11. a. Compare buying the car to leasing the car, with $r = 0.04$. The present value net cost of buying is $-20{,}000 + 12{,}000/(1 + 0.04)^6 = -10{,}516.22$. The present value cost of leasing the car is $-3600 - 3600/(1 + 0.04)^1 - 3600/(1 + 0.04)^2 = -10{,}389.94$. You are better off leasing the car if $r = 4$ percent.

b. Again, compare buying to leasing: $20{,}000 + 12{,}000/(1 + 0.12)^6 = -13{,}920.43$ with buying, versus $-3600 - 3600/(1 + 0.12)^1 - 3600/(1 + 0.12)^2 = -9{,}684.18$ with leasing. You are better off leasing the car if $r = 12$ percent.

c. Consumers will be indifferent when the present value cost of buying and later selling the car equals the present value cost of leasing: $-20{,}000 + 12{,}000/(1 + r)^6 = -3600 - 3600/(1 + r)^1 - 3600/(1 + r)^2$. This is true when $r = 3.8$ percent. You can solve this equation using a graphing calculator or computer spreadsheet, or by trial and error.

CHAPTER 16

6. Even with identical preferences, the contract curve may or may not be a straight line. This can easily be shown graphically. For example, when both individuals have utility functions $U = x^2y$, the marginal rate of substitution is given by $2y/x$. It is not difficult to show that the MRS's of both individuals are equal for all points on the contract curve $y = (Y/X)x$, where X and Y are the total quantities of both goods. One example in which the contract curve is not a straight line is when the two individuals have different incomes and one good is inferior.

7. The marginal rate of transformation is equal to the ratio of the marginal costs of producing the two goods. Most production possibilities frontiers are "bowed outward." However, if the two goods are produced with constant returns to scale production functions, the production possibilities frontier is a straight line.

10. A change from a constant-returns-to-scale production process to a sharply-increasing-returns-to-scale process does not imply a change in the shape of the isoquants. One can simply redefine the quantities associated with each isoquant such that proportional increases in inputs yield greater than proportional increases in outputs. Under this assumption, the marginal rate of technical substitution would not change, and there would be no change in the production contract curve.

CHAPTER 17

5. a. In the recent past, American automobiles appeared to customers to be of low quality. To reverse this trend, American companies invested in quality control, improving the potential repair records of their products. They signaled the improved quality of their products through improved warranties.

b. Moral hazard occurs when the party to be insured (the owner of an American automobile with an extensive warranty) can influence the probability or the magnitude of the event that triggers payment (the repair of the automobile). Covering all parts and labor associated with mechanical problems reduces the incentive to maintain the automobile. Hence, a moral hazard problem is created with extensive warranties.

7. Moral hazard problems arise with fire insurance when the insured party can influence the probability of a fire. The property owner can reduce the probability of a fire or its impact by inspecting and replacing faulty wiring, installing warning systems, etc. After purchasing complete insurance, the insured has little incentive to reduce either the probability or the magnitude of the loss, so the moral hazard problem can be severe. In order to compare a \$10,000 deductible and 90 percent coverage, we need information on the value of the potential loss. Both policies reduce the moral hazard problem of complete coverage. However, if the property is worth less (more) than \$100,000, the total loss will be less (more) with 90 percent coverage than with the \$10,000 deductible. As the value of the property increases above \$100,000, the owner is more likely to engage in fire prevention efforts under the policy that offers 90 percent coverage than under the one that offers the \$10,000 deductible.

CHAPTER 18

4. One needs to know the value to homeowners of swimming in the river, and the marginal cost of abatement. The choice of a policy tool will depend on the marginal benefits and costs of abatement. If firms are charged an equal rate effluent fee, the firms will reduce effluent to the point where the marginal cost of abatement is equal to the fee. If this reduction is not high enough to permit swimming, the fee could be increased.

The setting of a standard will be efficient only if the policy maker has complete information regarding the marginal costs and benefits of abatement. Further, the standard will not encourage firms to reduce effluent further if new filtering technologies become available. A transferable effluent permit system still requires the policymaker to determine the efficient effluent standard. Once the permits are distributed, a market will develop and firms with a higher cost of abatement will purchase permits from firms with lower abatement costs. However, unless permits are sold initially, no revenue will be generated.

9. a. Profit is maximized when marginal revenue is equal to marginal cost. With a constant marginal revenue of \$40 and a marginal cost of $10 + 5Q$, $Q = 6$.

b. If bees are not forthcoming, the farmer must pay \$10 per acre for artificial pollination. Since the farmer would be willing to pay up to \$10 to the beekeeper to maintain each additional hive, the marginal social benefit of each is \$50, which is greater than the marginal private benefit of \$40. Equating the marginal social benefit to the marginal cost, $Q = 80$.

c. The most radical change that would lead to more efficient operations would be the merger of the farmer's business with the beekeeper's business. This merger would internalize the positive externality of bee pollination. Short of a merger, the farmer and beekeeper should enter into a contract for pollination services.