Chapter 9
Properties and Applications of the Competitive Model

■ Chapter Outline

■ Teaching Tips

The material in Chapter 9 represents a series of applications of the competitive model to government policies that alter the equilibrium and so also reduce overall welfare. Many of the concepts presented here, such as deadweight loss, are needed later in the course. Thus the time spent here will pay dividends later.

While the concept of consumer surplus is straightforward because all students are consumers, you may need to spend a bit more time on the concept of producer surplus. The advantage here is the direct link between producer surplus and profit; the disadvantage is that they are not equal in the short run.

It is important to cover the section on deadweight loss for two reasons. First, it drives home the point that competitive markets are efficient, and that any divergence from the competitive equilibrium results in some level of inefficiency. Second, looking ahead to monopoly, the introduction of deadweight loss due to prices above equilibrium levels will be important in future chapters. To ensure that these concepts are clear, you may want to walk the class through Figures 9.3 and 9.4. Students weak in geometry are likely to struggle with the graphs in this chapter, and may need extra help sorting out which areas are transferred from consumers to firms, which are part of deadweight loss, and which are not.

The remainder of the chapter is devoted to the three fundamental ways in which government intervention affects welfare restrictions on the number of firms (entry and/or exit barriers); taxes and tariffs; and quotas, floors, and ceilings. Begin this section by asking students which of these government policies are beneficial. Although most students will accept the fact that at an individual level it depends on who you are, it often leads to a good discussion on the merits of protectionism, or of preserving the family farm through price supports. When discussing the welfare effects of taxes, you may want to emphasize the point made in the text that the source of the welfare loss is not the tax revenue itself. Even if all of the tax revenue is used to increase welfare in other markets with no administrative cost, there is still a deadweight loss in the taxed market due to the divergence from a competitive equilibrium. This point underscores the normative nature of taxation. The text has several good examples of agricultural price supports in the United States and in Europe that are worth spending some class time discussing. American students are usually surprised at the levels of agricultural subsidies in Europe.

The previous discussion of tariffs and price floors is a good lead-in to the final section on rent-seeking behavior. In Ross Perot's 1996 unsuccessful presidential bid, he routinely addressed this issue, noting that large corporations spent huge sums of money to walk the halls of Congress lobbying for their causes, since the gains are concentrated. Yet consumers have no such representation because the gains are small for an individual consumer.

As an additional example of government's limiting entry, there is the case of street food vendors in Philadelphia. These vendors set up food carts on corners throughout the downtown section of the city. Turf battles between cart owners over prime locations became such a problem that the city government considered instituting a lottery to reallocate vacated corners among competing carts, rather than allow more than one cart to attempt to occupy the same location (economic competition).

■ Additional Applications

Milk Prices—Reducing a Price Floor[1]

Every month, the Pennsylvania Milk Marketing Board sets prices to farmers for milk. These prices are based on costs of transportation, packaging, shipping, and other costs. The final calculated price becomes the minimum that farmers are guaranteed per hundred pounds of milk. This method of setting price floors has been in place for over 60 years, and in some ways has very little to do with the supply and demand for milk in Pennsylvania. For example, the formula price is based partly on the price of cheese in Wisconsin. The final price does, however, include some level of market input, as it reflects input from local milk retailers. Milk Marketing Board spokesperson Tracey Jackson indicates that it's done through a hearing process. Testimony is given by dealers and stores and the Milk Marketing Board. We take into account packaging, processing, union contracts—anything that is necessary for the processing of milk. The set price is the wholesale price, not the one paid by consumers. Consumers are charged retail prices that fluctuate based on local demand.

[1]Chris Peter, "Milk Prices Make Buyers Smile and Farmers Fume," *The Morning Call,* March 21, 1999, B1 and B10. Also, Letters to the Editor, *The Morning Call,* from April 14, 1999 and May 8, 1999.

The existence of price floors means that many farmers who could not survive at competitive market wholesale prices are able to remain profitable. In April 1999, the price floor was decreased over 30%. The change in prices sparked anger and frustration among some local dairy farmers, and resignation among others. One Pennsylvania farmer, Russell Dietrich, said, "(T)he whole farm economy is going in the same direction. Grain prices were the first to go, then pork. I think it's supply and demand that's doing it." But dairy farmer Hubert Sell observed, "You have to be ready to weather the low points. You have to save when times are good."

The reduction in price prompted state legislators to consider increasing the minimum price to reduce the uncertainty faced by farmers. Two letters to the editor of *The Morning Call* are indicative of the widely divergent opinions and understanding of the economics of price supports. One stated in part, "(W)ith even higher prices, farmers will increase the size of their herds. This will produce an even larger glut of milk on the market. . . . " Another read, "I don't know why the government, or whoever, is lowering milk prices. Dairy farmers and potato farmers, as well as other farmers, are always picked on. . . . Now they are about to take their profit margin away. I think it's a disgrace."

1. If the price falls to the new minimum, what does that imply about the true equilibrium price (the unsupported price)?

2. How might the Milk Board change its pricing formula to reflect cost more accurately?

■ Discussion Questions

1. What are the strengths and weaknesses of the measure of welfare used by many economists: consumer welfare plus producer surplus?

2. Why might a society prefer a government policy that lowers our standard measure of welfare? Give some examples.

3. Give some examples of products that are likely to have little if any consumer surplus and explain why.

4. Give some examples of products that are likely to have little if any producer surplus and explain why.

5. Should the government subsidize farmers? What do you predict would happen if all subsidies were eliminated?

6. Sales taxes cause a deadweight loss. Are there other taxes that could raise as much revenue but cause less harm?

7. How important is rent seeking in your country? Do you think rent seeking is more or less important in developing countries or developed countries? Why?

■ Additional Questions and Problems

1. Demand in Market 1 for X is $Q_d = 80 - p$. Demand in Market 2 is $Q_d = 120 - 2p$. At a price of \$20, which has a larger consumer surplus?

2. True or false; explain your answer. Producer surplus and profits are always equal, since they mean the same thing.

3. Suppose instead of a minimum wage, the government instituted a maximum wage (set below the equilibrium) in the unskilled labor market. Show the welfare effects of this cap on the market using a graph.

4. If demand in the cake market is $Q_d = 500 - 10p$, and unrestricted supply is $Q_s = 100 + 10p$, what is the effect on price, quantity, producer, and consumer surplus of a baker's license that reduces cake supply to $Q_s' = 10p$?

5. True or false; explain your answer. I bought three identical hats because the price was \$10 each and that's how much each is worth to me.

6. Philadelphia Flyers games are frequently sold out, and a waiting list exists for the right to purchase season tickets. What would be the welfare effects of a \$1 tax on tickets? Explain.

7. Suppose that by coincidence two markets for separate products had the same demand and supply functions. In each market, $Q_d = 50 - p$, and $Q_s = p$. The government decides to discourage consumption in both markets. It institutes a \$4 per unit tax in one market, and a quota of 23 units in the other market. Are the welfare effects of these policies equal? Explain.

8. If marginal cost is constant at \$5 for all firms, what is the value of producer surplus?

9. Suppose the government decides to subsidize exercise by \$2 for every mile (Q) consumers run at a health club that charges by the mile. The current demand for running is $Q = 12 - 2P$. The supply of miles available by the track owners is $S = 2P$. What is the initial equilibrium price and quantity? How does the subsidy affect the total number of miles run? What is the new price, including the subsidy?

10. The NFL's championship game, called The Super Bowl, is played at a neutral site. Home team fans must put their names into a lottery for a chance to buy tickets to the game. Winners then purchase tickets at the stated price. Explain why this allocation mechanism does not maximize total fan welfare.

11. In the application Deadweight Loss of Christmas Presents, explain how giving gifts with a gift receipt changes the welfare.

12. Suppose the demand curve for a good is $Q = 9 - p$ and the supply curve is $Q = 2p$. The government imposes a specific tax of $\tau = 1$ per unit. What would be the equilibrium? What effect does the tax have on consumer surplus, producer surplus, and deadweight loss?

■ Answers to Additional Questions and Problems

1. Surplus in Market 1 is \$180, but only \$160 in Market 2.

2. This statement is true in the long run when there are no fixed costs, but false in the short run since $PS = R - VC$.

3. See Figure 9.1. When the maximum wage is imposed, employment falls from N^* to N', producer surplus falls from $C + D + B$, to D, and consumer surplus changes from $E + A$ to $E + C$. The welfare change is $-(A + B)$.

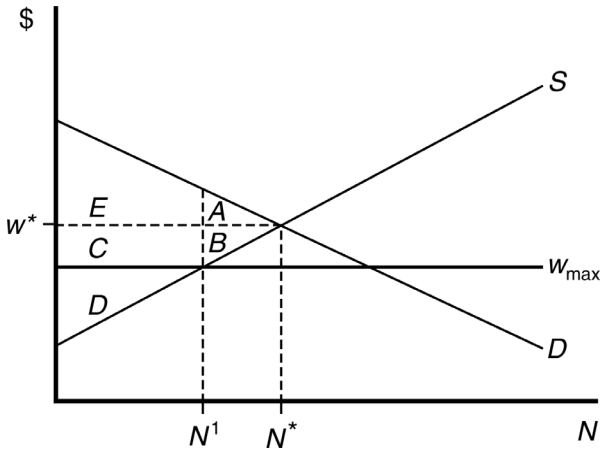

Figure 9.1

4. When the baker's license is instituted, the supply curve shifts upwards by \$100. Quantity falls from 300 to 250, price increases from \$20 to \$25, and consumer and producer surplus each fall from \$4500 to \$3125. See Figure 9.2. Initially, consumer surplus is $A + B + D + E$, and producer surplus is $C + F + G + H$. After the policy goes into effect, consumer surplus is A, and producer surplus is $B + C$.

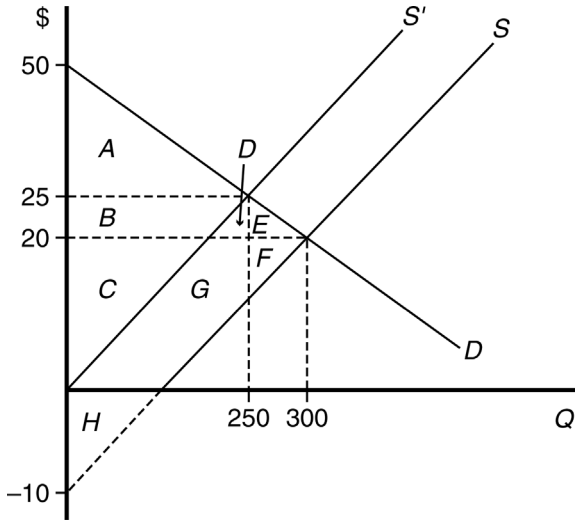

Figure 9.2

5. This is false unless the consumer's demand is perfectly elastic. Under normal circumstances, the first unit is worth more than the marginal unit. If the marginal utility (as revealed by the demand curve) of the first hat was \$20, and the marginal utility of the second hat was \$15, and the third hat, \$10, consumer surplus would be \$15. If the marginal utility of each hat were \$10, the consumer would be indifferent between purchasing them and not purchasing them.

6. Because the demand curve crosses the supply curve in its perfectly inelastic range at current prices, a $1 per seat tax on tickets (which is a small percentage increase for even the least expensive seats) would reduce consumer welfare by the amount of the tax times the capacity of the building. If the tax revenues are used for lump-sum grants, the loss becomes a transfer from the consumers that pay the tax to the consumers that receive the grants. If the building seats 20,000, then consumer welfare falls by $20,000. See Figure 9.3.

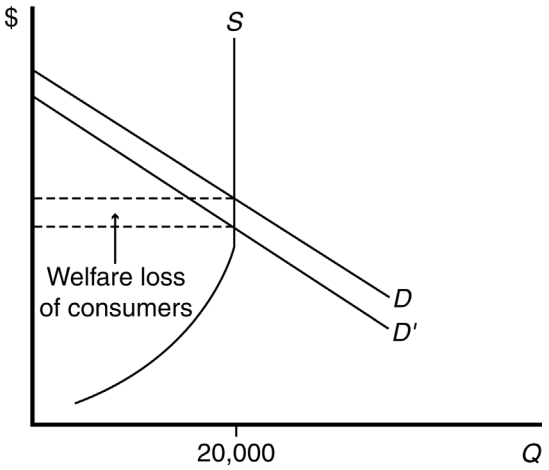

Figure 9.3

7. Refer to Figure 9.4. The effect of a $4 per-unit tax is shown as a shift upwards of the supply curve by $4 to S''. The effect of the quota is to make the supply curve vertical at 23 units, shown as S^Q. In either case, the new equilibrium quantity is 23 units. With the tax, consumer surplus falls in Figure 9.4 from $A + B + F + J$ to A, and producer surplus falls from $C + D + E + G + H$ to $E + H$. Area $B + D + C + J$ is collected in tax revenue, and $F + G$ is the deadweight loss. With the quota, no tax revenue is collected. Deadweight loss is unchanged at $F + G$, consumer surplus falls to area A as before. The new producer surplus with the quota is $B + J + D + C + H + E$. The difference is that firms now keep as producer surplus what was tax revenue with the unit tax.

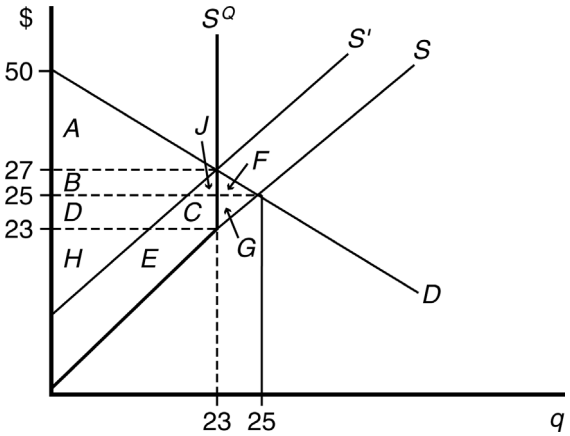

Figure 9.4

8. When marginal cost is constant, the supply curve is horizontal and consumer surplus is equal to zero.

9. By setting demand equal to supply, we discover that the initial equilibrium price is \$3, and the quantity of miles run is 6. With the subsidy, the new demand curve is $P = 8 - {}_1\acute{U}_2\, Q$, or $Q = 16 - 2P$. The new equilibrium quantity is 8 miles, and the price including the subsidy is \$4.

10. The allocation mechanism is inefficient because the there is no guarantee that the fans who value the tickets the most will receive them. Suppose the winning fans may purchase tickets for \$100 each. If a fan that is just willing to pay the \$100 receives a ticket, they purchase one, with a net consumer surplus of \$0. If the ticket had instead gone to another fan who values the ticket at \$500, overall welfare increases by \$400. The problem is, with a lottery, there is no way to ensure that the fans who value the tickets most will get one. Thus, just as in the Bruce Springsteen concert in Philadelphia that was described it the text, scalpers emerge and create a secondary market for resold tickets.

11. If people think the gifts they receive are not worth of its price, they can return them and receive a full refund. In this sense, their giving gifts with gift receipt amounts to giving cash and there is no deadweight loss.

12. The equilibrium without the tax is $p = 3$ and $Q = 6$. With the tax, the new equilibrium will be $p = 11/3$ and $Q = 16/3$. Consumer surplus decreases by $(9 - 3) \times 6/2 - (9 - 11/3) \times 16/3/2 = 34/9$. Producer surplus decreases by $3 \times 6/2 - 8/3 \times 16/3 \times 2 = 17/9$. The social deadweight loss is 51/9.

■ Answers to Questions and Problems in the Text

1. See Figure 9.5. As demand becomes more elastic, the welfare effect of specific tax becomes larger because there is a larger change in the equilibrium quantity. In the graph, D^0 is more elastic than D^1 at point *a*. When a specific tax shifts the supply curve upwards, the welfare loss with the more elastic demand curve is *abc*. With D^1, the welfare loss is only *adf*.

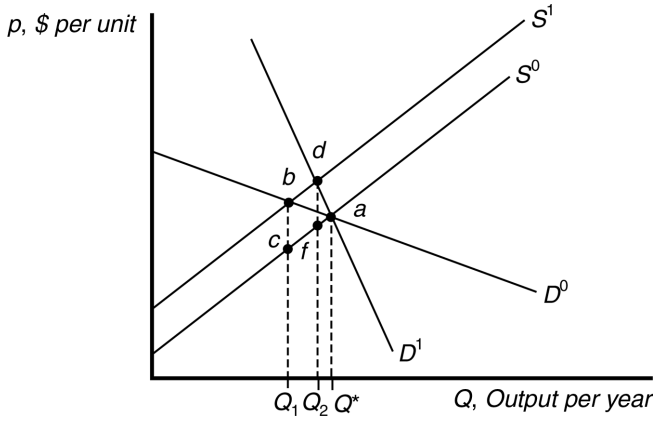

Figure 9.5

2. See Figure 9.6. The price ceiling (p_c) on gasoline reduces welfare by the areas $abd + bcd$. The new consumer surplus is area $gacf$, and producer surplus falls to area fch.

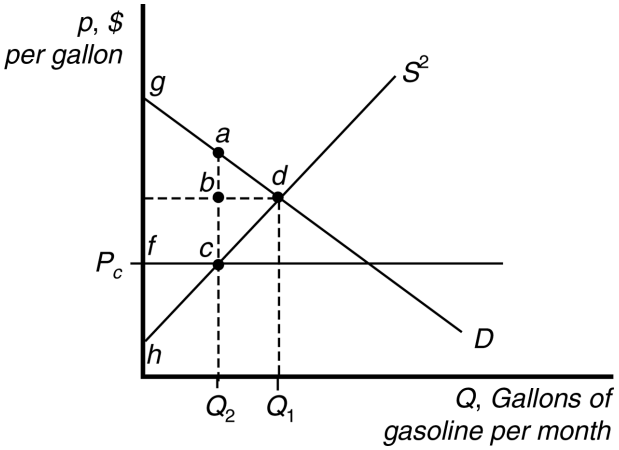

Figure 9.6

3. See Figure 9.7. An individual receiving a gift valued at G increases his or her utility from U^0 to U^1 (at point b). The same individual receiving cash in an amount equal to the cost of G increases his or her utility to U^2 (at point c). The reason for the lower utility in the case of the gift is that it limits the individual's ability to substitute between the gift good and other commodities (i.e., in the figure, the individual cannot reach point c, where the marginal rate of substitution equals the price ratio).

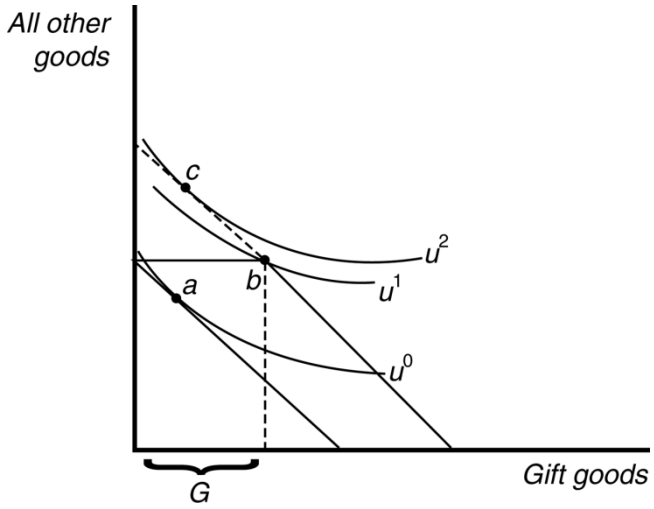

Figure 9.7

4. If the tax is based on *economic* profit, the tax has no long-run effect because the firms make zero economic profit. If the tax is based on *business* profit and business profit is greater than economic profit, the profit tax raises firms' after-tax costs and results in fewer firms in the market. The exact effect of the tax depends on why business profit is greater than economic profit. For example, if the government ignores opportunity labor cost but includes all capital cost in computing profit, firms will substitute toward labor and away from capital.

5. See Figure 9.8. The welfare loss from the tax is equal to area *abc*. If the ad valorem tax is levied on firms, then the supply curve will shift leftward. Also note that it is not a parallel shift—as the price goes up, the original supply curve and the new supply curve will get farther apart, creating a cone shape (narrower near the origin of the graph and wider as you move farther away from the origin).

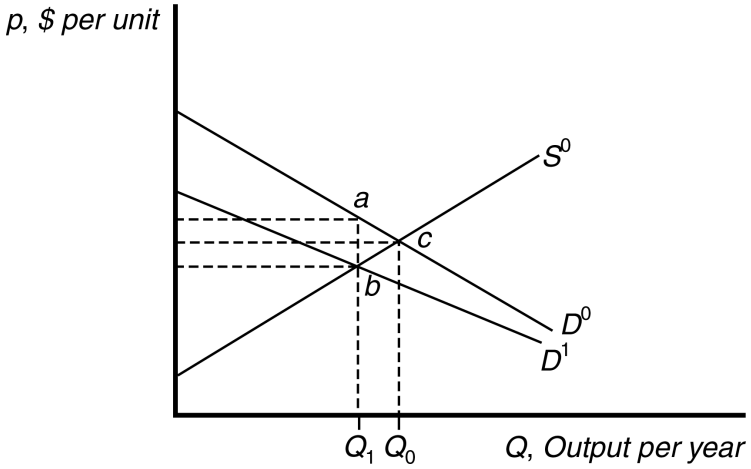

Figure 9.8

6. See Figure 9.9. The welfare loss due to the minimum wage is area *abc*. When the minimum is instituted, employment falls to L_1 from L_0. Because labor supply at the new higher wage increases to L_2, unemployment is increased by the institution of the minimum. Because of the excess supply, less experienced workers are likely to be losers with the new policy. In addition, if discrimination exists on the basis of age, gender, or race, those workers in the less desired group are also likely to be hurt by the minimum wage.

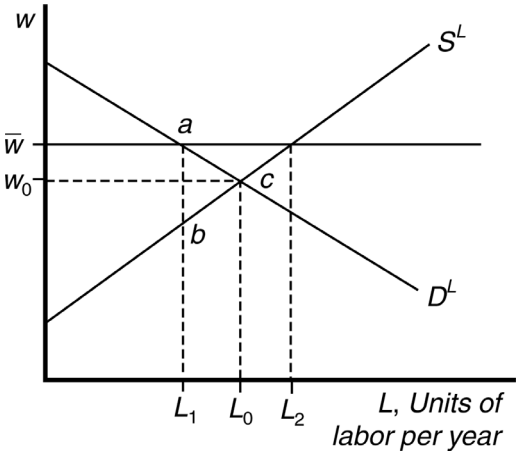

Figure 9.9

7. Solved Problem 8.5 shows the long-run effect of a lump-sum tax in a competitive market. Consumer surplus falls by more than tax revenue increases, and producer surplus remains zero, so welfare falls.

8. Owners of existing billboards would not oppose the ban because it creates an entry barrier and so also market power for existing sellers. Producers would then be able to set prices above marginal cost, and transfer some of the consumer surplus to producers. Exclusive of external effects, welfare will fall, as a deadweight loss is created. The consumers are the purchasers of billboard space. The producers are billboard owners. Welfare is improved if the increase in billboards was creating a negative externality by making the scenery less enjoyable.

9. See Figure 9.10. With the price increase, producers gain A but lose D. The payment x must be enough to compensate producers for their net loss from the price increase ($x = D - A$). With this payment, producer welfare is unchanged but consumer welfare falls by $A + B$. With a price support program, consumer surplus would be the same as with the lump-sum payment program, but producer surplus would be $A + B + C + D + E + F$. A quota set at Q_1 producer surplus is $A + B + C + D + E$. With the quota set at Q_2, producer surplus is $A + C$.

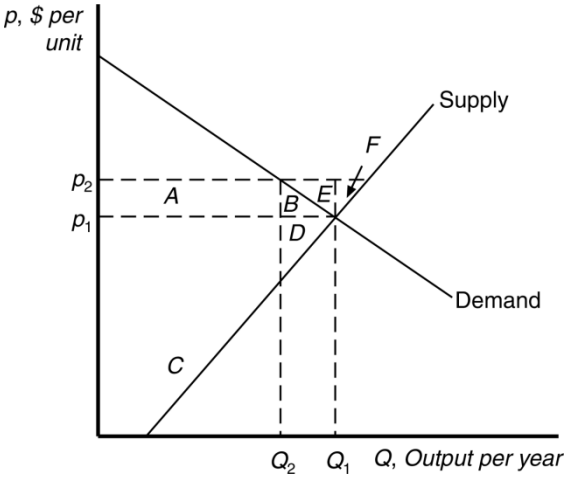

Figure 9.10

10. See Figure 9.11. At the original price, P_0, consumer surplus is $A + B + C$, and producer surplus is $E + F$. If officials want to reduce the number of visits to Q^*, they can either increase the price to P_1, which reduces consumer surplus by $B + C$, or they can institute a quota and leave the price unchanged. With the quota, consumers retain area $A + B$, and area C is deadweight loss. Area F is eliminated under either scenario. Assuming the park is charging marginal cost for admission, which is constant, there are no welfare effects from the change in area F.

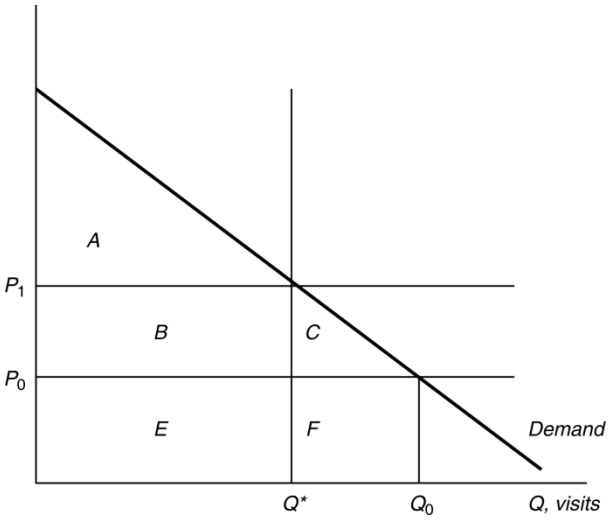

Figure 9.11

11. See Figures 9.12(a) and (b). In the sugar market, the quota increases price, reduces output, and causes a deadweight loss of A. In the corn sweetener market, demand is increased due to the increased cost of the substitute, raising prices from p_1 to p_2.

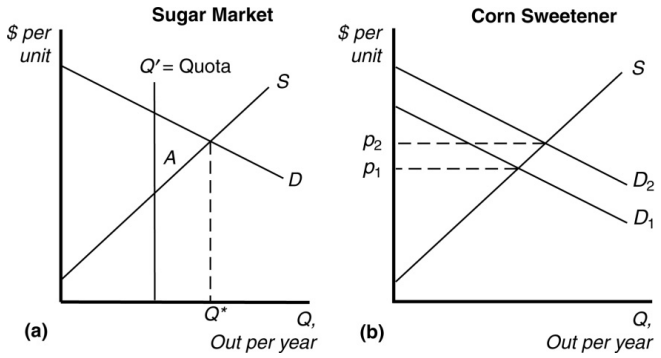

Figure 9.12

12. See Figure 9.13. The government prefers the tariff. In either case, consumer surplus is reduced to area A. With the quota, the government collects no revenue. With the tariff, the government collects $B + C + D + E$ as revenue.

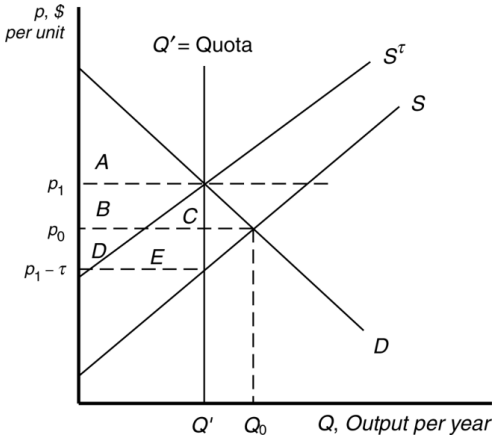

Figure 9.13

13. See Figure 9.14. The subsidy increases consumer welfare by $B + C$, but costs the government $B + C + D$. The net change in welfare is $-D$.

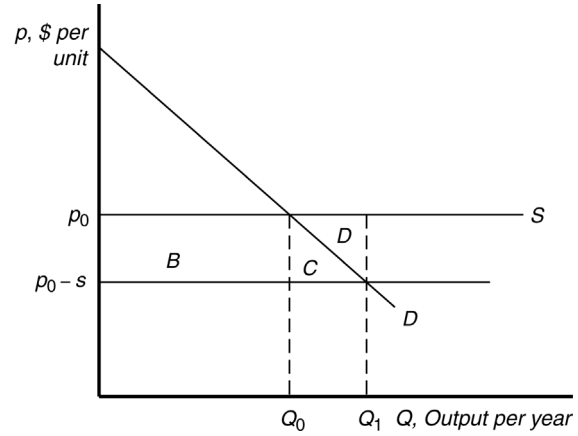

Figure 9.14

14. If we assume that the Canadian supply curve is perfectly elastic (horizontal) at the open-market price, there would be no welfare effects in Canada. Figure 9.15 shows the effects on the U.S. markets. If the open market supply curve (U.S. plus Canadian) is S^0, and the U.S. only supply curve is S^{US}, then the effect of the import restriction is to increase the price to U.S. water users from p to p'. Consumer surplus falls from $A + B + C + D$ to D only. U.S. producers gain A, but $B + C$ represent deadweight loss.

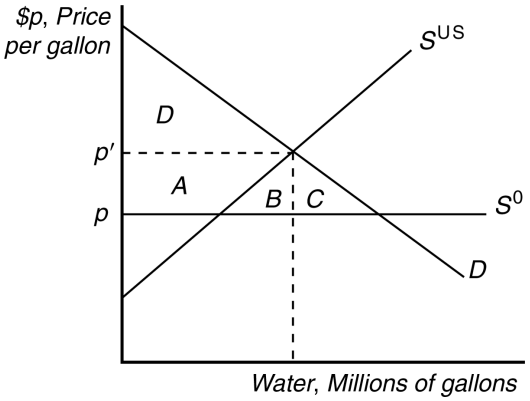

Figure 9.15

15. With the subsidy, consumers benefit, but taxpayers (including those same consumers) bear the burden of the subsidy, and a deadweight loss results, as the number of apartments rented exceeds the unregulated quantity. The price ceiling is analogous to the figure shown in Solved Problem 9.3 (in the text). In this case consumers who are still able to find an apartment gain, but fewer apartments are available. With the price ceiling, the good is underprovided, which again leads to a deadweight loss, although in this case there is no tax burden as there is no government expenditure. The supply and demand elasticities are important determinants of the size of the deadweight loss, as in both cases, the loss is created by the wedge between supply and demand at the new quantity. The relative slopes of the curves (which are directly related to the elasticities) determine the size of the wedge.

16. Audio-PowerPoint answer by James Dearden is also available (9A New York Wine).
    a. The new equilibrium price will be lower and will be set equal to the U.S. price.
    b. The consumer surplus will increase.
    c. As demand becomes more elastic (at the equilibrium point), the consumer surplus increases.

17. Audio-PowerPoint answer by James Dearden is also available (9B Ethanol).
    a. Denote the price of ethanol and gasoline with P_e and P_g, respectively. Demand for ethanol is:
    $Q = 0$, if $P_e > P_g$
    = anything between 0 up to market demand for gasoline at P_g, if $P_e = P_g$
    = the whole market demand for gasoline.
    b. Demand for ethanol in case of legislation is:
    $Q = 5\%$ of gasoline market, if $P_e > P_g$
    = anything between 0 up to market demand for gasoline at P_g, if $P_e = P_g$
    = the whole market demand for gasoline.
    c. The inelastic part of market demand in part (b) is further to the right compared to part (a).
    d. Since the *MC* of ethanol is higher than the *MC* of gasoline at all output levels, and the *MC* is the firm's supply curve, there is a price below which only gasoline will be produced, unless there is a federal mandate.

18. Audio-PowerPoint answer by James Dearden is also available (9C Water Price Elasticity).
    a. According to the problem, when price doubles, the agricultural water use decreases by 30%. Therefore the price elasticity of demand is –0.3/1 = –0.3.
    b. The more elastic the demand, the more responsive will be the quantity consumed to price changes. An increase in the price will lead to a larger decrease in the quantity demanded.

19. Audio-PowerPoint answer by James Dearden is also available (9D Click Fraud).
    a. Saving = $nxzp_c$.
    b. The maximum willingness to pay for a click-fraud detective is equal to the savings.
    For the first 200 advertisers the savings is = $600 \times 0.3 \times 0.8 \times 9 = 1296$. For the next 500 advertisers the savings is = $700 \times 0.2 \times 0.8 \times 5 = 560$. For the next 300 advertisers the savings is = $100 \times 0.1 \times 0.7 \times 12 = \$84$.
    c. Consumer surplus = $200(1296 – 500) + 500(560 – 500) = 159{,}200 + 30{,}000 = 189{,}200$.

20. See Figure 9.16. Panel (a) shows the impacts of medallions or annual licenses. The long run supply curve changes from S^1 to S^2. The area C is the deadweight loss. With medallions, the producer surplus B goes to the medallion owner; while with annual licenses, the surplus goes to government. Panel (b) shows the case of daily tax. The area C is the deadweight loss and the area B is the tax revenue.

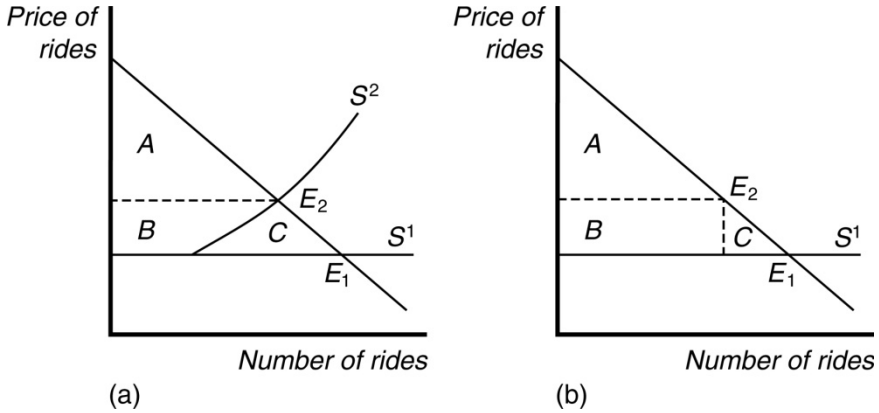

Figure 9.16

21. As shown in Figure 9.17, the ban of self-serve shifts the supply curve from S^1 to S^2. As a result, consumer surplus decreases by area $(A + B)$, the social deadweight loss is $(B + C)$, and gas stations get extra producer surplus equal to area $(A - C)$.

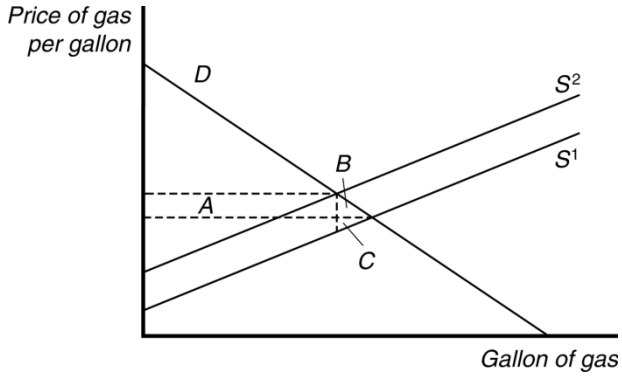

Figure 9.17

22. As shown in Figure 9.18, the USDA recommendation shifts the demand curve from D^1 to D^2. As the result, the consumer surplus increases from area $(A + B)$ to area $(B + C)$.

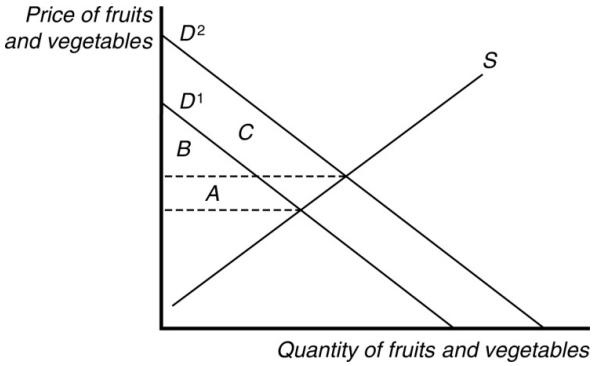

Figure 9.18

23. As shown in Figure 9.19, the government subsidy shifts the supply curve from S^1 to S^2. As a result, consumer surplus changes from $(A + B)$ to $(A + B + C + E)$, producer surplus changes from $(C + G)$ to $(C + G + B + D)$, and government expense changes from zero to $(B + C + D + E + F)$.

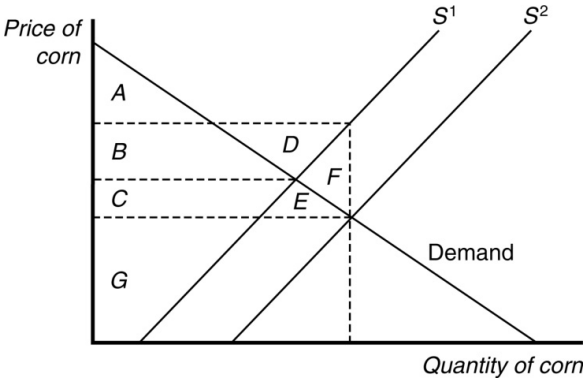

Figure 9.19

24. As shown in Figure 9.20, under the subsidy, consumer surplus increases from A to $(A + B + C)$, and produce surplus decreases from $B + D$ to D. If the government imposes a large tariff such that the domestic price is raised to the level without the subsidy, then the consumer and produce surpluses will return to the levels without the subsidy.

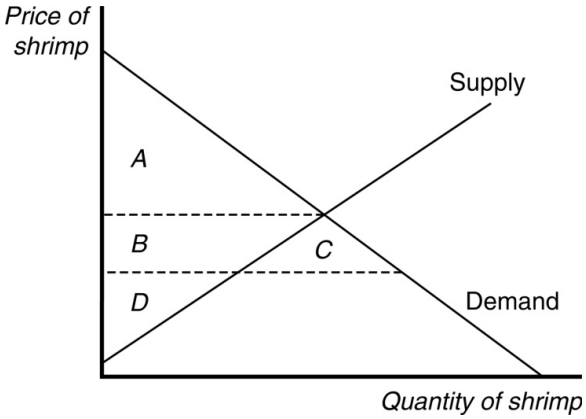

Figure 9.20

25. As shown in Figure 9.21, the government subsidy to the cotton producers shifts the supply curve from S^1 to S^2, and the subsidy to the buyers further lowers the price from p_2 to p_3. As a result, consumer (buyer) surplus increases by $(C + D + G + H + I)$ and producer surplus increases by $(L + H - C)$. The government expense increases from zero to $(C + D + E + F + G + H + I + J)$.

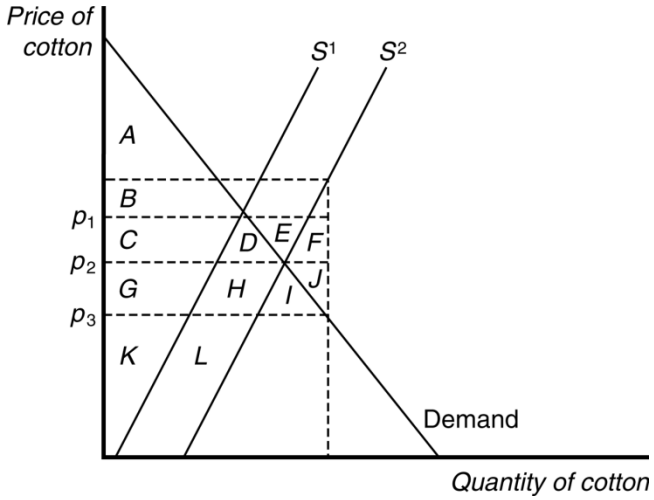

Figure 9.21

26. As shown in Figure 9.22, the tax on wireless service creates deadweight loss equal to area *B*. On the other hand, demand for landline service is almost perfectly inelastic; therefore this is virtually no deadweight loss.

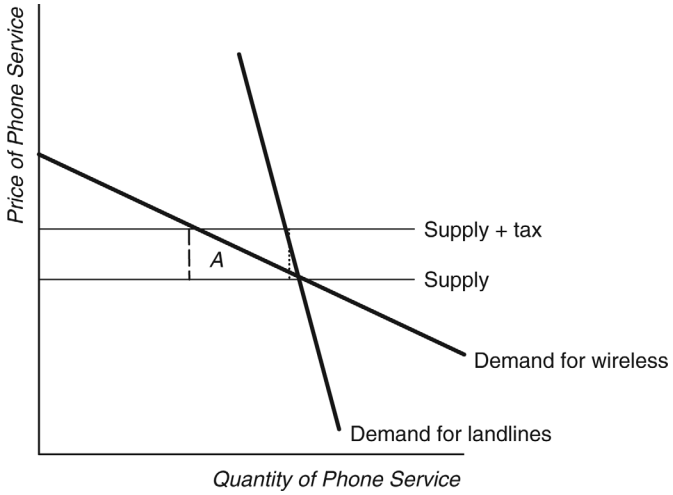

Figure 9.22

27. See Figure 9.23. Consider an imported good first. With the embargo, the consumer surplus decreases by $(B + C)$, and producer surplus increases by B. On the other hand, for an exported good, the consumer surplus increases by $(B + C)$ and producer surplus decreases by B.

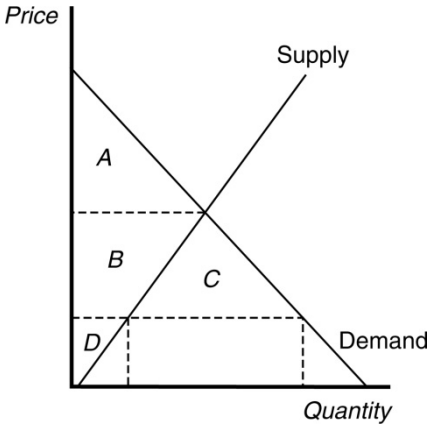

Figure 9.23

28. As shown in Figure 9.24, the tariff will decrease consumer surplus by the area $(A + B)$, while the tariff revenue is equal to area $(A + C)$. If $C > B$, the welfare in the importing country improves.

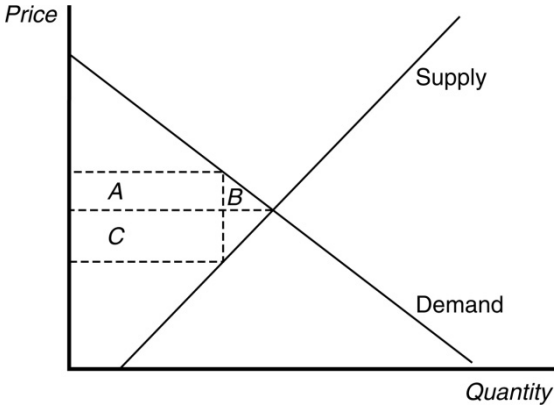

Figure 9.24

29. The specific subsidy shifts the supply curve, S in the figure on the next page, down by $s = 11¢$, to the curve labeled $S - 11¢$. Consequently, the equilibrium shifts from e_1 to e_2, so the quantity sold increases (from 1.25 to 1.34 billion rose stems per year), the price that consumers pay falls (from 30¢ to 28¢ per stem), and the amount that suppliers receive, including the subsidy, rises (from 30¢ to 39¢), so that the differential between what the consumers pay and what the producers receive is 11¢. Consumers and producers of roses are delighted to be subsidized by other members of society. Because the price to customers drops, consumer surplus rises from $A + B$ to $A + B + D + E$. Because firms receive more per stem after the subsidy, producer surplus rises from $D + G$ to $B + C + D + G$ (the area under the price they receive and above the original supply curve). Because the government pays a subsidy of 11¢ per stem for each stem sold, the government's expenditures go from zero to the rectangle $B + C + D + E + F$. Thus the new welfare is the sum of the new consumer surplus and producer surplus minus the government's expenses. Welfare falls from $A + B + D + G$ to $A + B + D + G - F$. The deadweight loss, this drop in welfare $\Delta W = -F$, results from producing too much: The marginal cost to producers of the last stem, 39¢, exceeds the marginal benefit to consumers, 28¢.

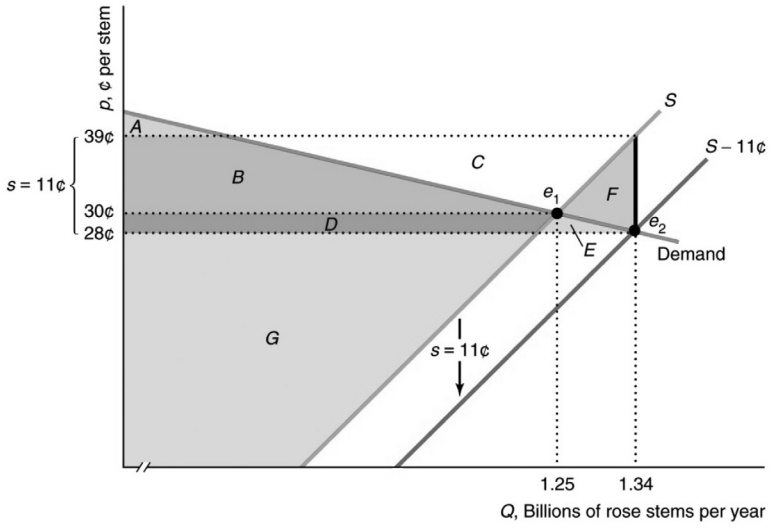

Figure 9.25

30. At the price of 30, the quantity demanded is 30, so the consumer surplus is $\frac{1}{2}(30 \times 30) = 450$, because the demand curve is linear.

31. $CS = 0.5(a/2)(a/2b) = a^2/8b$.

32. $PS = Ap^{*(\eta+1)} - \int_0^{Ap^{*\eta}} (Q/A)^{1/\eta}\, dQ = \dfrac{Ap^{*(\eta+1)}}{\eta+1}$.

33. The initial equilibrium is $Q^* = 30$, $p^* = 30$. The tax reduces output to 29. Consumers pay \$31 and producers receive \$29. Tax revenue is \$58, and deadweight loss is \$1.

34. a. The initial equilibrium is determined by equating the quantity demanded to the quantity supplied: $100 - 10p = 10p$. That is, the equilibrium is $p = 5$ and $Q = 50$. At the support price, the quantity supplied is $Q_s = 60$. The market clearing price is $p = 4$. The deficiency payment was $D = (\underline{p} - p)Q_s = (6-4)60 = 120$.

    b. Consumer surplus rises from $CS_1 = \frac{1}{2}(10-5)50 = 125$ to $CS_2 = \frac{1}{2}(10-4)60 = 180$. Producer surplus rises from $PS_1 = \frac{1}{2}(5-0)50 = 125$ to $PS_2 = \frac{1}{2} \times (6-0)60 = 180$. Welfare falls from $CS_1 + PS_1 = 125 + 125 = 250$ to $CS_2 + PS_2 - D = 180 + 180 - 120 = 240$. Thus the deadweight loss is 10.

35. a. The equilibrium price and quantity without the tax is $p = 5$ and $Q = 50$. With the tax, the demand function will be $Q = 100 - 10(p + 1)$ and the supply function remains the same. Hence the equilibrium will be $p = 5.5$ and $q = 45$.

    b. Consumer surplus decreases by $(50 + 45) \times 0.5/2 = 23.75$, producer surplus decreases by the same amount. Government tax revenue is 45. Hence the deadweight loss is $23.75^*2 - 45 = 2.5$.

36. a. With the price ceiling, the equilibrium will be $p = 3$ and $Q = 30$.

    b. The consumer surplus increases by $2^*30 - 2^*(50 - 30)/2 = 40$, producer surplus decreases by $2^*(50 + 30)/2 = 80$. So the social deadweight loss is 40.

37. Without the tariff, the U.S. supply curve of oil is horizontal at a price of \$14.70 (S^1 in Figure 9.9), and the equilibrium is determined by the intersection of this horizontal supply curve with the demand curve. With a new, small tariff of τ, the U.S. supply curve is horizontal at \$14.70 + τ, and the new equilibrium quantity is determined by substituting $p = 14.70 + \tau$ into the demand function: $Q = 35.41(14.70 + \tau)p^{-0.37}$. Evaluated at $\tau = 0$, the equilibrium quantity remains at 13.1. The deadweight loss is the area to the right of the domestic supply curve and to the left of the demand curve between \$14.70 and \$14.70 + τ (area $C + D + E$ in Figure 9.9) minus the tariff revenues (area D):

$$\begin{aligned} DWL &= \int_{14.70}^{14.70+\tau} [D(P) - S(p)]dp - \tau[D(p+\tau) - S(p+\tau)] \\ &= \int_{14.70}^{14.70+\tau} [3.54p^{-0.67} - 3.35p^{0.33}]dp \\ &\quad -\tau[3.54(p+\tau)^{-0.67} - 3.35(p+\tau)^{0.33}]. \end{aligned}$$

To see how a change in τ affects welfare, we differentiate DWL with respect to τ:

$$\begin{aligned} \frac{dDWL}{d\tau} &= \frac{d}{d\tau}\left\{\int_{14.70}^{14.70+\tau} [D(p) - S(p)]dp - \tau[D(14.70+\tau) - S(14.70+\tau)]\right\} \\ &= [D(14.70+\tau) - S(14.70+\tau)] - [D(14.70+\tau) \\ &\quad -S(14.70+\tau)] - \tau\left[\frac{dD(14.70+\tau)}{d\tau} - \frac{dS(14.70+\tau)}{d\tau}\right] \\ &= -\tau\left[\frac{dD(14.70+\tau)}{d\tau} - \frac{dS(14.70+\tau)}{d\tau}\right]. \end{aligned}$$

If we evaluate this expression at $\tau = 0$, we find that $dDWL/d\tau = 0$. In short, applying a small tariff to the free-trade equilibrium has a negligible effect on quantity and deadweight loss. Only if the tariff is larger—as in Figure 9.9—do we see a measurable effect.

38. Solution provided in Jim Dearden's audio presentation.
    a. The equilibrium price and quantity are:

$$\begin{cases} \boldsymbol{p}^* = \dfrac{25}{14} + \dfrac{3}{28}\boldsymbol{p}_N \\ \boldsymbol{Q}^* = -\dfrac{125}{7} + \dfrac{125}{14}\boldsymbol{p}_N \end{cases}$$

$$\Rightarrow \frac{\boldsymbol{dp}^*}{\boldsymbol{dp}_N} = \frac{3}{28}.$$

b. If $p_N = \$30$, the equilibrium price and quantity are:

$$\begin{cases} p^* = 5 \\ Q^* = 250. \end{cases}$$

The consumer surplus is:

$$CS = \int_5^{30} 10 \cdot (30 - p)dp = 3125.$$

The producer surplus is:

$$PS = \int_2^5 \frac{(p-2)}{0.012} dp = 375.$$

39. Solution provided in Jim Dearden's audio presentation.

The equilibrium price and quantity are:

$$\begin{cases} p^* = 6.44 \\ Q^* = 6743. \end{cases}$$

The consumer surplus is:

$$CS = \int_{6.44}^{\infty} 50{,}000\, p^{-1.076} dp = 571{,}059.14.$$

The producer surplus is:

$$PS = \int_0^{6.44} 0.01 p^{7.208} dp = 5301.04.$$