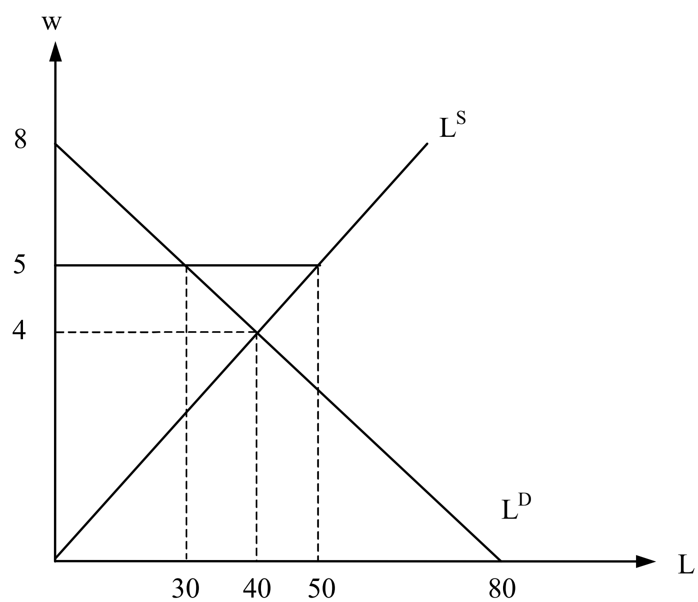
Solution to Selected Questions: CHAPTER 9
THE ANALYSIS OF COMPETITIVE MARKETS

E1. In 1996, Congress raised the minimum wage from \$4.25 per hour to \$5.15 per hour, and then raised it again in 2007. (See Example 1.3 [page 13].) Some people suggested that a government subsidy could help employers finance the higher wage. This exercise examines the economics of a minimum wage and wage subsidies. Suppose the supply of low-skilled labor is given by $L^S = 10w$, where L^S is the quantity of low-skilled labor (in millions of persons employed each year), and w is the wage rate (in dollars per hour). The demand for labor is given by $L^D = 80 - 10w$.

a. What will be the free-market wage rate and employment level? Suppose the government sets a minimum wage of \$5 per hour. How many people would then be employed?

In a free-market equilibrium, $L^S = L^D$. Solving yields $w = \$4$ 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 only 30 million workers.



b. Suppose that instead of a minimum wage, the government pays a subsidy of \$1 per hour for each employee. What will the total level of employment be now? What will the equilibrium wage rate be?

Let w_s denote the wage received by the sellers (i.e., the employees), and w_b the wage paid by the buyers (the firms). The new equilibrium occurs where the vertical difference between the supply and demand curves is \$1 (the amount of the subsidy). This point can be found where

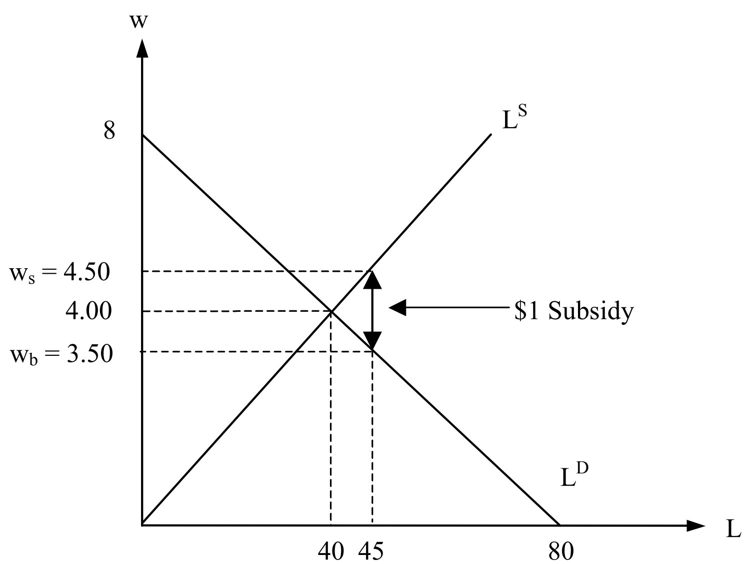
$$L^D(w_b) = L^S(w_s), \text{ and}$$

$$w_s - w_b = 1.$$

Write the second equation as $w_b = w_s - 1$. This reflects the fact that firms pay \$1 less than the wage received by workers because of the subsidy. Substitute for w_b in the demand equation: $L^D(w_b) = 80 - 10(w_s - 1)$, so

$$L^D(w_b) = 90 - 10w_s.$$

Note that this is equivalent to an upward shift in demand by the amount of the \$1 subsidy. Now set the new demand equal to supply: $90 - 10w_s = 10w_s$. Therefore, $w_s = \$4.50$, and $L^D = 90 - 10(4.50) = 45$. Employment increases to 45 (compared to 30 with the minimum wage), but wage drops to \$4.50 (compared to \$5.00 with the minimum wage). The net wage the firm pays falls to \$3.50 due to the subsidy.



4. In 1983, the Reagan Administration introduced a new agricultural program called the Payment-in-Kind Program. To see how the program worked, let's consider the wheat market.

a. Suppose the demand function is $Q^D = 28 - 2P$ and the supply function is $Q^S = 4 + 4P$, where P is the price of wheat in dollars per bushel, and Q is the quantity in billions of bushels. Find the free-market equilibrium price and quantity.

Equating demand and supply, $Q^D = Q^S$,

$$28 - 2P = 4 + 4P, \text{ or } P = \$4.00 \text{ per bushel.}$$

To determine the equilibrium quantity, substitute $P = 4$ into either the supply equation or the demand equation:

$$Q^S = 4 + 4(4) = 20 \text{ billion bushels,}$$

or

$$Q^D = 28 - 2(4) = 20 \text{ billion bushels.}$$

b. Now suppose the government wants to lower the supply of wheat by 25 percent from the free-market equilibrium by paying farmers to withdraw land from production. However, the payment is made in wheat rather than in dollars – hence the name of the program. The wheat comes from vast government reserves accumulated from previous price support programs. The amount of wheat paid is equal to the amount that could have been harvested on the land withdrawn from production. Farmers are free to sell this wheat on the market. How much is now produced by farmers? How much is indirectly supplied to the market by the government? What is the new market price? How much do farmers gain? Do consumers gain or lose?

► **Note**: The answer at the end of the book (first printing) calculates the farmers' gain incorrectly. The correct cost saving and gain is given below.

Because the free-market supply by farmers is 20 billion bushels, the 25-percent reduction required by the new Payment-In-Kind (PIK) Program means that the farmers now produce 15 billion bushels. To encourage farmers to withdraw their land from cultivation, the government must give them 5 billion bushels of wheat, which they sell on the market.

Because the total quantity supplied to the market is still 20 billion bushels, the market price does not change; it remains at \$4 per bushel. Farmers gain because they incur no costs for the 5 billion bushels received from the government. We can calculate these cost savings by taking the area under the supply curve between 15 and 20 billion bushels. These are the variable costs of producing the last 5 billion bushels that are no longer grown under the PIK Program. To find this area, first determine the prices when $Q = 15$ and when $Q = 20$. These values 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.

The PIK program does not affect consumers in the wheat market, because they purchase the same amount at the same price as they did in the free-market case.

c. Had the government not given the wheat back to the farmers, it would have stored or destroyed it. Do taxpayers gain from the program? What potential problems does the program create?

Taxpayers gain because the government does not incur costs to store or destroy the wheat. Although everyone seems to gain from the PIK program, it can only last while there are government wheat reserves. The PIK program assumes that the land removed from production may be restored to production when stockpiles of wheat are exhausted. If this cannot be done, consumers may eventually pay more for wheat-based products.

10. In Example 9.1 (page 314), we calculated the gains and losses from price controls on natural gas and found that there was a deadweight loss of \$5.68 billion. This calculation was based on a price of oil of \$50 per barrel.

a. If the price of oil were \$60 per barrel, what would be the free-market price of gas? How large a deadweight loss would result if the maximum allowable price of natural gas were \$3.00 per thousand cubic feet?

► **Note**: The answer at the end of the book (first printing) used the wrong equilibrium price and quantity to calculate deadweight loss. The correct values are used to calculate deadweight loss below.

From Example 9.1, we know that the supply and demand curves for natural gas can be approximated as follows:

$$Q_S = 15.90 + 0.72P_G + 0.05P_O$$

and

$$Q_D = 0.02 - 1.8P_G + 0.69P_O,$$

where P_G is the price of natural gas in dollars per thousand cubic feet (\$/mcf) and P_O is the price of oil in dollars per barrel (\$/b).

With the price of oil at \$60 per barrel, these curves become,

$$Q_S = 18.90 + 0.72P_G$$

and

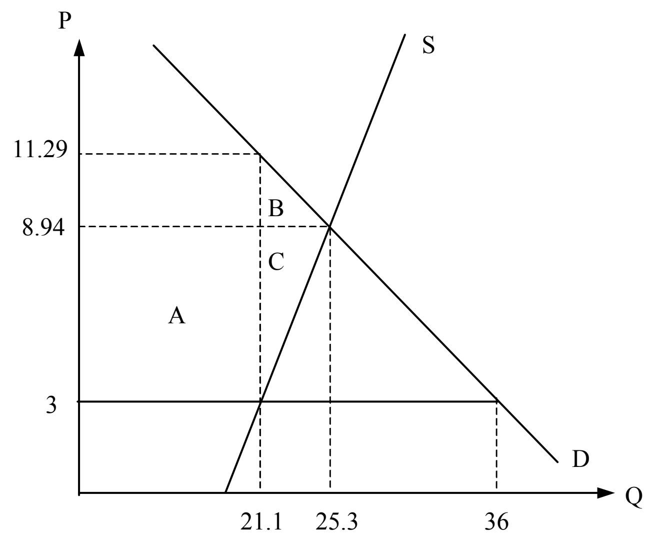
$$Q_D = 41.42 - 1.8P_G.$$

Setting quantity demanded equal to quantity supplied, find the free-market equilibrium price:

$$18.90 + 0.72P_G = 41.42 - 1.8P_G\text{, or } P_G = \$8.94.$$

At this price, the equilibrium quantity is 25.3 trillion cubic feet (Tcf).

If a price ceiling of \$3 is imposed, producers would supply only 18.9 + 0.72(3) = 21.1 Tcf, although consumers would demand 36.0 Tcf. See the diagram below. Area A is transferred from producers to consumers. The deadweight loss is B + C. 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. What price of oil would yield a free-market price of natural gas of $3?

Set the original supply and demand equal to each other, and solve for P_O.

$$15.90 + 0.72P_G + 0.05P_O = 0.02 - 1.8P_G + 0.69P_O$$

$$0.64P_O = 15.88 + 2.52P_G$$

Substitute $3 for the price of natural gas. Then

$$0.64P_O = 15.88 + 2.52(3), \text{ or } P_O = \$36.63.$$

12. The domestic supply and demand curves for hula beans are as follows:

Supply*: *P* = 50 + *Q ***Demand*: *P* = 200 – 2*Q***

where *P* is the price in cents per pound and *Q* is the quantity in millions of pounds. The U.S. is a small producer in the world hula bean market, where the current price (which will not be affected by anything we do) is 60 cents per pound.

Congress is considering a tariff of 40 cents per pound. Find the domestic price of hula beans that will result if the tariff is imposed. Also compute the dollar gain or loss to domestic consumers, domestic producers, and government revenue from the tariff.

To analyze the influence of a tariff on the domestic hula bean market, start by solving for domestic equilibrium price and quantity. First, equate supply and demand to determine equilibrium quantity without the tariff:

$$50 + Q = 200 - 2Q, \text{ or } Q_{EQ} = 50.$$

Thus, the equilibrium quantity is 50 million pounds. Substituting Q_{EQ} of 50 into either the supply or demand equation to determine price, we find:

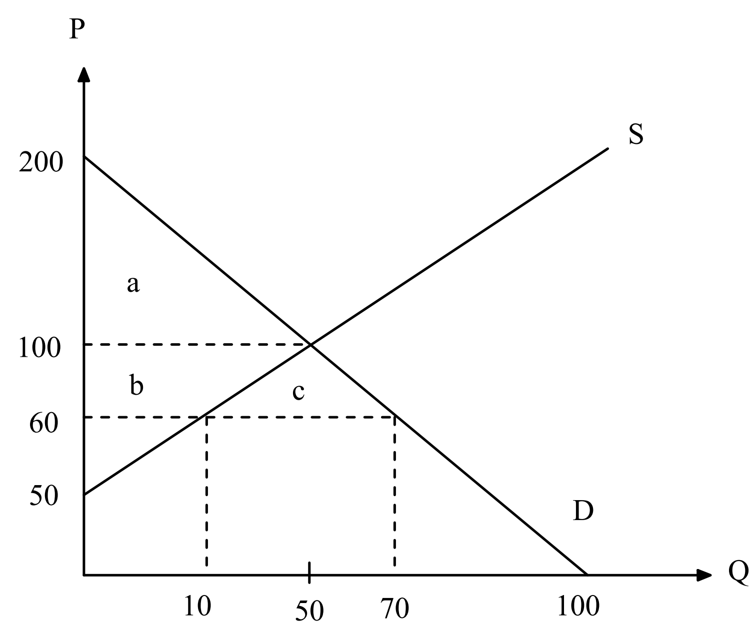
$$P_S = 50 + 50 = 100 \text{ and } P_D = 200 - (2)(50) = 100.$$

The equilibrium price P is thus $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 similarly, domestic demand at the world price is $60 = 200 -$

$2Q_D$, or $Q_D = 70$. Imports are equal to 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.

As shown in the figure below, consumer surplus before the imposition of the tariff is equal to area a + b + c, or (0.5)(70)(200–60) = 4900 million cents or \$49 million. After the tariff, the price rises to \$1.00 and consumer surplus falls to area a, or (0.5)(50)(200–100) = \$25 million, a loss of \$24 million. Producer surplus increases by area b, or (10)(100–60) + (.5)(50–10)(100–60) = \$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 in this case is equal to \$24 – 12 = \$12 million (area c).



13. Currently, the social security payroll tax in the United States is evenly divided between employers and employees. Employers must pay the government a tax of 6.2 percent of the wages they pay, and employees must pay 6.2 percent of the wages they receive. Suppose the tax were changed so that employers paid the full 12.4 percent and employees paid nothing. Would employees then be better off?

If the labor market is competitive (i.e., both employers and employees take the wage as given), then shifting all the tax onto employers will have no effect on the amount of labor employed or on employees' after tax wages. We know this because the incidence of a tax is the same regardless of who officially pays it. As long as the total tax doesn't change, the same amount of labor will be employed, and the wages paid by employers and received by the employee (after tax) will not change. Hence, employees would be no better or worse off if employers paid the full amount of the social security tax.