9 The Analysis of Competitive Markets

Read Pindyck and Rubinfeld (2009), Chapter 9
CHAPTER 9 OUTLINE

9.1 Evaluating the Gains and Losses from Government Policies—Consumer and Producer Surplus

9.2 The Efficiency of a Competitive Market

9.3 Minimum Prices

9.4 Price Supports and Production Quotas

9.5 Import Quotas and Tariffs

9.6 The Impact of a Tax or Subsidy
Review of Consumer and Producer Surplus

Consumer A would pay $10 for a good whose market price is $5 and therefore enjoys a benefit of $5. Consumer B enjoys a benefit of $2, and Consumer C, who values the good at exactly the market price, enjoys no benefit.

**Consumer surplus**, which measures the total benefit to all consumers, is the yellow-shaded area between the demand curve and the market price.
9.1 Review of Consumer and Producer Surplus

Figure 9.1

**Producer surplus** measures the total profits of producers, plus rents to factor inputs.

It is the benefit that lower-cost producers enjoy by selling at the market price, shown by the green-shaded area between the supply curve and the market price.

Together, consumer and producer surplus measure the welfare benefit of a competitive market.
9.1 Application of Consumer and Producer Surplus

- **welfare effects** Gains and losses to consumers and producers.

**Figure 9.2**

Change in Consumer and Producer Surplus from Price Controls

The price of a good has been regulated to be no higher than $P_{\text{max}}$, which is below the market-clearing price $P_0$.

The gain to consumers is the difference between rectangle $A$ and triangle $B$.

The loss to producers is the sum of rectangle $A$ and triangle $C$.

Triangles $B$ and $C$ together measure the deadweight loss from price controls.

- **deadweight loss** Net loss of total (consumer plus producer) surplus.
9.1

EVALUATING THE GAINS AND LOSSES FROM GOVERNMENT POLICIES—CONSUMER AND PRODUCER SURPLUS

• Application of Consumer and Producer Surplus

Figure 9.3

Effect of Price Controls When Demand Is Inelastic

If demand is sufficiently inelastic, triangle $B$ can be larger than rectangle $A$. In this case, consumers suffer a net loss from price controls.
EXAMPLE 9.1  PRICE CONTROLS AND NATURAL GAS SHORTAGES

Supply: $Q^S = 15.90 + 0.72P_G + 0.05P_O$
Demand: $Q^D = 0.02 - 1.8P_G + 0.69P_O$

**Figure 9.4**  EFFECTS OF NATURAL GAS PRICE CONTROLS

The market-clearing price of natural gas was $6.40 per mcf, and the (hypothetical) maximum allowable price is $3.00.

A shortage of $29.1 - 20.6 = 8.5$ Tcf results.

The gain to consumers is rectangle $A$ minus triangle $B$,
and the loss to producers is rectangle $A$ plus triangle $C$.

The deadweight loss is the sum of triangles $B$ plus $C$. 
EXAMPLE 9.1  PRICE CONTROLS AND NATURAL GAS SHORTAGES

**Figure 9.4** (supplement)

**EFFECTS OF NATURAL GAS PRICE CONTROLS**

\[ A = (20.6 \text{ billion mcf}) \times ($3.40/\text{mcf}) = $70.04 \text{ billion} \]

\[ B = (1/2) \times (2.4 \text{ billion mcf}) \times ($1.33/\text{mcf}) = $1.60 \text{ billion} \]

\[ C = (1/2) \times (2.4 \text{ billion mcf}) \times ($3.40/\text{mcf}) = $4.08 \text{ billion} \]

The annual change in consumer surplus that would result from these hypothetical price controls would therefore be \( A - B = 70.04 - 1.60 = $68.44 \text{ billion} \).

The change in producer surplus would be \(-A - C = -70.04 - 4.08 = -$74.12 \text{ billion} \).

And finally, the annual deadweight loss would be \(-B - C = -1.60 - 4.08 = -$5.68 \text{ billion} \).
E10. 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.

Supply: \( Q^s = 15.90 + 0.72P_G + 0.05P_O \)  
Demand: \( Q^D = 0.02 - 1.8P_G + 0.69P_O \)

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?

b) What price of oil would yield a free-market price of natural gas of $3?
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?

Supply: \( Q_S = 15.90 + 0.72P_G + 0.05P_O \)
Demand: \( Q_D = 0.02 - 1.8P_G + 0.69P_O \)

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

\[
Q_S = 18.90 + 0.72P_G \\
Q_D = 41.42 - 1.8P_G
\]

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

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

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 \( 18.90 + 0.72(3) = 21.1 \) 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

\[
0.64P_O = 15.88 + 2.52(3), \quad \text{or} \quad P_O = \$36.63.
\]
THE EFFICIENCY OF A COMPETITIVE MARKET

- **economic efficiency**  Maximization of aggregate consumer and producer surplus.

- **Market Failure**

  - **market failure**  Situation in which an unregulated competitive market is inefficient because prices fail to provide proper signals to consumers and producers.

There are two important instances in which market failure can occur:

1. Externalities
2. Lack of Information

- **externality**  Action taken by either a producer or a consumer which affects other producers or consumers but is not accounted for by the market price.
EXAMPLE 8.2 THE MARKET FOR HUMAN KIDNEYS

Even at a price of zero (the effective price under the law), donors supply about 16,000 kidneys per year. It has been estimated that 8000 more kidneys would be supplied if the price were $20,000.

We can fit a linear supply curve to this data—i.e., a supply curve of the form \( Q = a + bP \). When \( P = 0 \), \( Q = 16,000 \), so \( a = 16,000 \). If \( P = 20,000 \), \( Q = 24,000 \), so \( b = (24,000 - 16,000)/20,000 = 0.4 \).

Thus the supply curve is \( Supply: Q^S = 16,000 + 0.4P \)

Note that at a price of $20,000, the elasticity of supply is 0.33. It is expected that at a price of $20,000, the number of kidneys demanded would be 24,000 per year. Like supply, demand is relatively price inelastic; a reasonable estimate for the price elasticity of demand at the $20,000 price is –0.33. This implies the following linear demand curve:

\[ Demand: Q^D = 32,000 - 0.4P \]
Economics, the dismal science, shows us that human organs have economic value that cannot be ignored, and prohibiting their sale imposes a cost on society that must be weighed against the benefits.
When price is regulated to be no lower than $P_2$, only $Q_3$ will be demanded.

If $Q_3$ is produced, the deadweight loss is given by triangles $B$ and $C$.

At price $P_2$, producers would like to produce more than $Q_3$. If they do, the deadweight loss will be even larger.
Price Minimum

Price is regulated to be no lower than $P_{\text{min}}$.
Producers would like to supply $Q_2$, but consumers will buy only $Q_3$.
If producers indeed produce $Q_2$, the amount $Q_2 - Q_3$ will go unsold and the change in producer surplus will be $A - C - D$. In this case, producers as a group may be worse off.
9.3 MINIMUM PRICES

Figure 9.8

The Minimum Wage

Although the market-clearing wage is $w_0$,
firms are not allowed to pay less than $w_{\text{min}}$.
This results in unemployment of an amount $L_2 - L_1$
and a deadweight loss given by triangles $B$ and $C$. 
9.4 PRICE SUPPORTS AND PRODUCTION QUOTAS

- Price Supports
  - **price support** Price set by government above free market level and maintained by governmental purchases of excess supply.

Figure 9.10

**Prince Supports**

To maintain a price $P_s$ above the market-clearing price $P_0$, the government buys a quantity $Q_g$.

The gain to producers is $A + B + D$. The loss to consumers is $A + B$.

The cost to the government is the speckled rectangle, the area of which is $P_s(Q_2 - Q_1)$.

Total change in welfare: $\Delta CS + \Delta PS - \text{Cost to Govt.} = D - (Q_2 - Q_1)P_s$
• Production Quotas/Financial Incentive

Figure 9.11

Supply Restrictions

To maintain a price $P_s$ above the market-clearing price $P_0$, the government can restrict supply to $Q_1$, either by imposing production quotas (as with taxicab medallions) or by giving producers a financial incentive to reduce output (as with acreage limitations in agriculture).

For an incentive to work, it must be at least as large as $B + C + D$, which would be the additional profit earned by planting, given the higher price $P_s$. The cost to the government is therefore at least $B + C + D$.

$\Delta CS = -A - B$

$\Delta PS = A - C + \text{Payments for not producing (or at least } B + C + D)$

$\Delta Welfare = -A - B + A + B + D - B - C - D = -B - C$
EXAMPLE 9.4  SUPPORTING THE PRICE OF WHEAT

1981 Supply: \( Q_S = 1800 + 240P \)

1981 Demand: \( Q_D = 3550 - 266P \)

**Figure 9.12**

**THE WHEAT MARKET IN 1981**

To increase the price to $3.70, the government must buy a quantity of wheat \( Q_g \).

By buying 122 million bushels of wheat, the government increased the market-clearing price from $3.46 per bushel to $3.70.

1981 Total demand: \( Q_D = 3550 - 266P + Q_g \)

\( Q_g = 506P - 1750 \)

\( Q_g = (506)(3.70) - 1750 = 112 \) million bushels

Loss to consumers = \(-A - B = $624 \) million

Cost to the government = $3.70 \times 122 \) million = $451.4 \) million

Total cost of the program = $624 million + $451.4 million = $1075 million

Gain to producers = \( A + B + C = $638 \) million
EXAMPLE 9.4 SUPPORTING THE PRICE OF WHEAT

In 1996, the U.S. Congress passed a new farm bill, nicknamed the “Freedom to Farm” law. The law eliminated production quotas (for wheat, corn, rice, and other products) and gradually reduced government purchases and subsidies through 2003.

In Example 2.5, we saw that the market-clearing price of wheat in 2007 had increased to about $6.00 per bushel. The supply and demand curves in 2007 were as follows:

\[
\text{Supply: } Q_S = 2900 + 125P \\
\text{Demand: } Q_D = 1460 - 115P
\]

You can check to see that the market-clearing quantity is 2150 million bushels.

In 2002, the Farm Security and Rural Investment Act reinstated subsidies for most crops, in particular grain and cotton. It called for the government to issue “fixed direct payments” to producers. Congress revisited agricultural subsidies in 2007, and the subsidies were either maintained or increased, thus making the burden on U.S. taxpayers even higher.

Recently, however, the pendulum has swung back toward eliminating subsidies, and new cuts were approved as part of the deal to resolve the 2011 budget crisis.
E4. 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.

1. 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.

2. 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?

3. 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?
E4. 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.

**ANS.** 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?

ANS. 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.
E4. 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.

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?

**ANS.** 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.
9.5 IMPORT QUOTAS AND TARIFFS

- **import quota**  Limit on the quantity of a good that can be imported.
- **tariff**  Tax on an imported good.

In a free market, the domestic price equals the world price $P_w$.

A total $Q_d$ is consumed, of which $Q_s$ is supplied domestically and the rest imported.

When imports are eliminated, the price is increased to $P_0$.

The gain to producers is trapezoid $A$.

The loss to consumers is $A + B + C$, so the deadweight loss is $B + C$.
When imports are reduced, the domestic price is increased from $P_w$ to $P^*$. This can be achieved by a quota, or by a tariff $T = P^* - P_w$. Trapezoid $A$ is again the gain to domestic producers. The loss to consumers is $A + B + C + D$.

If a tariff is used, the government gains $D$, the revenue from the tariff. The net domestic loss is $B + C$. If a quota is used instead, rectangle $D$ becomes part of the profits of foreign producers, and the net domestic loss is $B + C + D$. 

Figure 9.15

Import Tariff or Quota (General Case)
EXAMPLE 9.6  THE SUGAR QUOTA

In recent years, the world price of sugar has been between 10 and 28 cents per pound, while the U.S. price has been 30 to 40 cents per pound. Why?

By restricting imports, the U.S. government protects the $4 billion domestic sugar industry, which would virtually be put out of business if it had to compete with low-cost foreign producers. This policy has been good for U.S. sugar producers, but bad for consumers.

<table>
<thead>
<tr>
<th>U.S. production:</th>
<th>15.9 billion pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. consumption:</td>
<td>22.8 billion pounds</td>
</tr>
<tr>
<td>U.S. price:</td>
<td>36 cents per pound</td>
</tr>
<tr>
<td>World price</td>
<td>24 cents per pound</td>
</tr>
</tbody>
</table>

\[ Q_S = -7.95 + 0.66P \]
\[ Q_D = 29.73 - 0.19P \]

At the 24-cent world price, U.S. production would have been only about 7.9 billion pounds and U.S. consumption about 25.2 billion pounds, of which 25.2 - 7.9 = 17.3 billion pounds would have been imported. But fortunately for U.S. producers, imports were limited to only 6.9 billion pounds.
EXAMPLE 9.6  THE SUGAR QUOTA

FIGURE 9.16  SUGAR QUOTA IN 2010

At the world price of 24 cents per pound, about 25.2 billion pounds of sugar would have been consumed of which all but 17.3 billion pounds would have been imported. Restricting imports to 6.9 billion pounds caused the U.S. price to go up by 12 cents. The cost to consumers, \( A + B + C + D \), was about $2.9 billion. The gain to domestic producers was trapezoid \( A \), about $1.4 billion. Rectangle \( D \), $836 million, was a gain to those foreign producers who obtained quota allotments. Triangles \( B \) and \( C \) represent the deadweight loss of about $614 million.
E12. The domestic supply and demand curves for hula beans are as follows:

Supply:  \[ P = 50 + Q \]
Demand: \[ P = 200 - 2Q \]

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 \( (0.5)(70)(200 - 60) = 4900 \text{ million cents or }$49 \text{ million.} \) After the tariff, the price rises to $1.00 and consumer surplus falls to area \( a \), or \( (0.5)(50)(200 - 100) = $25 \text{ million, a loss of }$24 \text{ million.} \) Producer surplus increases by area \( b \), or \( (10)(100 - 60) + (.5)(50 - 10)(100 - 60) = $12 \text{ million.} \)

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 \( $24 - 12 = $12 \text{ million (area } c). \)
9.6 THE IMPACT OF A TAX OR SUBSIDY

**specific tax** Tax of a certain amount of money per unit sold.

*Figure 9.17*

**Incidence of a Tax**

$P_b$ is the price (including the tax) paid by buyers. $P_s$ is the price that sellers receive, less the tax.

Here the burden of the tax is split evenly between buyers and sellers.

**Buyers lose** $A + B$.

**Sellers lose** $D + C$.

The government earns $A + D$ in revenue.

The **deadweight loss** is $B + C$.

Market clearing requires four conditions to be satisfied after the tax is in place:

\[ Q^D = Q^D(P_b) \]  
(9.1a)

\[ Q^S = Q^S(P_s) \]  
(9.1b)

\[ Q^D = Q^S \]  
(9.1c)

\[ P_b - P_s = t \]  
(9.1d)
If demand is very inelastic relative to supply, the burden of the tax falls mostly on buyers.

If demand is very elastic relative to supply, it falls mostly on sellers.
The Effects of a Subsidy

- **subsidy** Payment reducing the buyer’s price below the seller’s price; i.e., a negative tax.

Conditions needed for the market to clear with a subsidy:

\[
\begin{align*}
Q^D &= Q^D(P_b) \\
Q^S &= Q^S(P_s) \\
Q^D &= Q^S \\
P_s - P_b &= s
\end{align*}
\]

(9.2a) (9.2b) (9.2c) (9.2d)

A subsidy can be thought of as a negative tax. Like a tax, the benefit of a subsidy is split between buyers and sellers, depending on the relative elasticities of supply and demand.
EXAMPLE 9.7  A TAX ON GASOLINE

\[ Q^D = 150 - 25P_b \]  (Demand)
\[ Q^S = 60 + 20P_s \]  (Supply)
\[ Q^D = Q^S \]  (Supply must equal demand)
\[ P_b - P_s = 1.00 \]  (Government must receive $1.00/gallon)

\[ 150 - 25P_b = 60 + 20P_s \]
\[ P_b = P_s + 1.00 \]
\[ 150 - 25P_b = 60 + 20P_s \]
\[ 20P_s + 25P_s = 150 - 25 - 60 \]
\[ 45P_s = 65, \text{ or } P_s = 1.44 \]
\[ Q^D = 150 - (25)(2.44) = 150 - 61, \text{ or } Q = 89 \text{ bg/yr} \]

Annual revenue from the tax \( tQ = (1.00)(89) = $89 \text{ billion per year} \)

Deadweight loss: \( (1/2) \times ($1.00/gallon) \times (11 \text{ billion gallons/year} = $5.5 \text{ billion per year} \)
**EXAMPLE 9.7 A TAX ON GASOLINE**

**Figure 9.20**

**IMPACT OF $1 GASOLINE TAX**

The price of gasoline at the pump increases from $2.00 per gallon to $2.44, and the quantity sold falls from 100 to 89 bg/yr.

Annual revenue from the tax is \((1.00)(89) = 89\) billion (areas \(A + D\)).

The two triangles show the deadweight loss of $5.5 billion per year.
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 \( L^D = 80 - 10w \).

1. 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?

2. 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?
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?

ANS. 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?

**ANS.** 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

\[
L^D(w_b) = L^S(w_s), \quad \text{and}
\]

\[
w_s - w_b = 1.
\]

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.
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?

ANS. 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.
Recap CHAPTER 9

9.1 Evaluating the Gains and Losses from Government Policies—Consumer and Producer Surplus

9.2 The Efficiency of a Competitive Market

9.3 Minimum Prices

9.4 Price Supports and Production Quotas

9.5 Import Quotas and Tariffs

9.6 The Impact of a Tax or Subsidy