Market equilibrium is defined as $Q_D = Q_S$. Substituting the supply and demand to equations into the equilibrium condition, we obtain

$$15{,}100 - 100P = 1{,}350 + 450P$$

$$P^* = \$25$$

$$Q^* = 15{,}100 - 100(25) = 12{,}600$$

c. Substituting the new information into the demand equation yields

$$\begin{aligned} Q_D &= 500 - 100P + 50(255) + 20(80) + 30(100) \\ &= 500 - 100P + 12{,}750 + 1{,}600 + 3{,}000 = 17{,}850 - 100P \end{aligned}$$

Substituting this into the equilibrium condition, we write

$$17{,}850 - 100P = 1{,}350 + 450P$$

$$P^* = \$30$$

$$Q^* = 17{,}850 - 100(30) = 14{,}850$$

It is interesting to note that the increase in per-capita income is represented diagrammatically as an increase in the intercept Q from 15,100 to 17,850, with no change in the slope of the demand curve. The student should verify diagrammatically that an increase in the Q intercept will result in right-shift of the demand curve, which is exactly what we would expect for a normal good given an increase in per capita income.

CHANGES IN SUPPLY AND DEMAND: THE ANALYSIS OF PRICE DETERMINATION

Now let us use the analytical tools of supply and demand to analyze the effects of a change in demand and/or a change in supply on the equilibrium price and quantity. Consider first the case of a change in demand.

DEMAND SHIFTS

Suppose, for example, that medical research finds that hamburgers have highly desirable health characteristics, triggering an increase in the public's preference for hamburgers. Other things remaining constant, this would result in a right-shift in the demand curve for hamburgers. This results in an increase in the equilibrium price and quantity demanded for hamburgers. Consider Figure 3.15.

If medical research, on the other hand had discovered that hamburgers exhibited highly undesirable health properties, one could have predicted a reduction in the demand for hamburgers, or a left-shift in the demand curve,

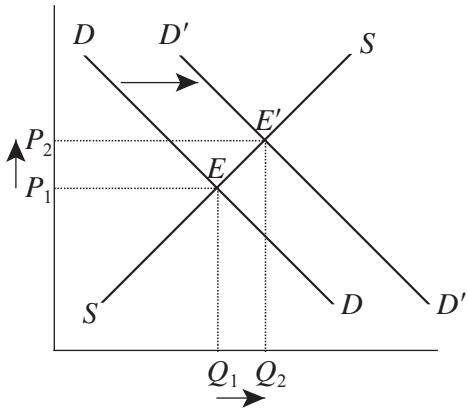

FIGURE 3.15 A rise in the equilibrium price and quantity resulting from an increase in demand.

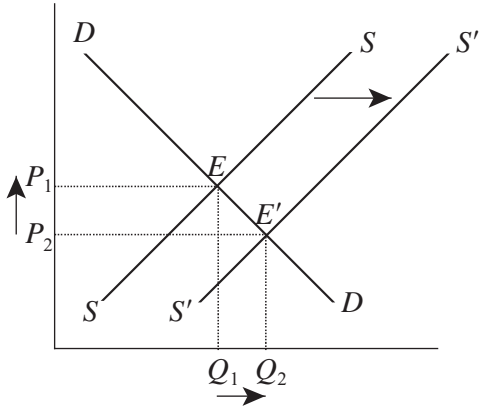

FIGURE 3.16 A fall in the equilibrium price and a rise in the equilibrium quantity resulting from an increase in supply.

resulting, in turn, in a decline in both equilibrium price and quantity demanded.

SUPPLY SHIFTS

Suppose there is a sharp decline in the price of cattle feed. The result will be an increase in the supply of hamburgers at every price, other things remaining the same. This, of course, would result in a right-shift of the supply function. The result, which is illustrated in Figure 3.16, is a decline in the equilibrium price and an increase in quantity supplied. Conversely, a

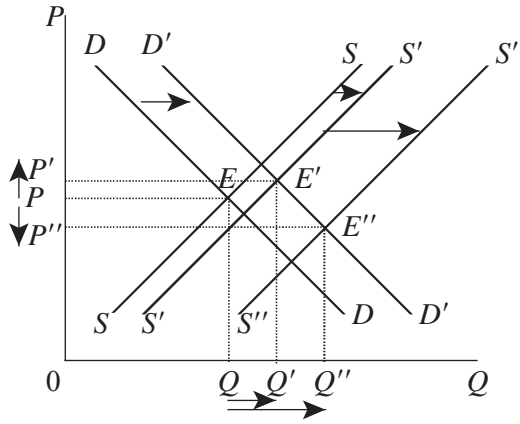

FIGURE 3.17 An increase in demand and supply may result in an unambiguous rise in the equilibrium quantity and an ambiguous change in the equilibrium price.

left-shift in the supply curve would have raised the equilibrium price and lowered the equilibrium quantity. In either the case of a demand shift or a supply shift, the effect on the equilibrium price and quantity is unambiguous. Can as much be said if both the demand curve and the supply curve shift simultaneously?

DEMAND AND SUPPLY SHIFTS

As illustrated in Figure 3.16, a shift in the demand curve or a shift in the supply curve resulted in unambiguous changes in equilibrium price and quantity demanded. When changes in both demand and supply occur simultaneously, however, it is more difficult to predict the effect on price and quantity demanded. This can be illustrated by considering four possible cases.

Case 1: An Increase in Demand and an Increase in Supply

As illustrated in Figure 3.17, a right-shift in both the demand and supply curves yields an unambiguous increase in quantity demanded. The effect on the equilibrium price, however, is indeterminate.

As shown earlier, if the increase in supply is relatively less than the increase in demand, the result will be a net increase in price. This is seen in Figure 3.17 by comparing the market clearing price at E with E'. On the other hand, if there occurs a large increase in supply, relative to the increase in demand, the result will be a net decrease in the equilibrium price. This is seen by comparing the market clearing price at E with E'' in Figure 3.17.

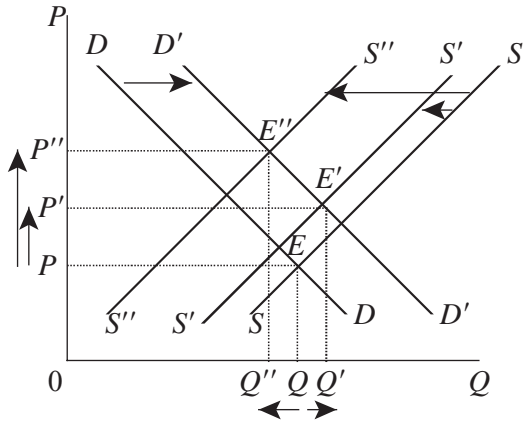

FIGURE 3.18 An increase in demand and a decrease in supply may result in an unambiguous rise in the equilibrium price and an ambiguous change in the equilibrium quantity.

Case 2: An Increase in Demand and a Decrease in Supply

As illustrated in Figure 3.18, a right-shift in the demand curve and a left-shift in The supply curve result in an unambiguous increase in the equilibrium price, although the effect on the equilibrium quantity is indeterminate.

If the decrease in supply is relatively less than the increase in demand, the result will be an increase in equilibrium price and quantity. This is seen in Figure 3.18 by comparing the equilibrium price and quantity at E with E'. If, however, the decrease in supply is relatively more than the increase in demand, the result will be an increase in the equilibrium price but a decrease in the equilibrium quantity. This can be seen by comparing the equilibrium price and quantity at E with E'' in Figure 3.18.

Case 3: A Decrease in Demand and a Decrease in Supply

As can be seen in Figure 3.19, a left-shift in both the demand and supply curves will result in an unambiguous decline in the equilibrium quantity and an indeterminate change in the equilibrium price.

If the decrease in supply is relatively less than the decrease in demand, the result will be a decrease in the equilibrium price and quantity. This is seen by comparing equilibrium price and quantity at E with E' in Figure 3.19. If, however, the decrease in supply is relatively greater than the decrease in demand, the result will be a decrease in the equilibrium quantity, but an increase in the equilibrium price. This can be seen by comparing the equilibrium price and quantity at E with E'' in Figure 3.19.

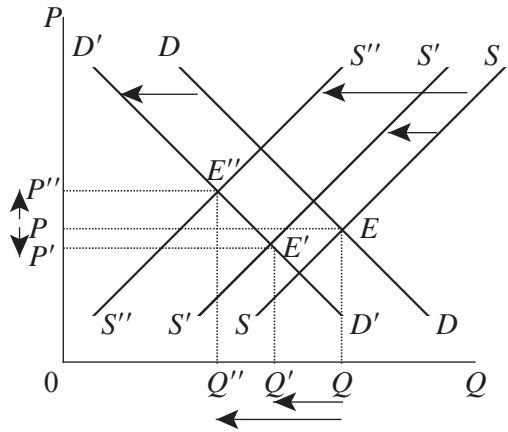

FIGURE 3.19 A decrease in both demand and supply may result in an unambiguous fall in the equilibrium quantity but an ambiguous change in the equilibrium price.

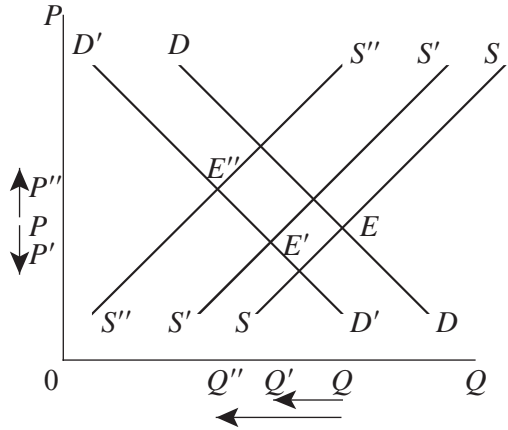

FIGURE 3.20 A decrease in demand and an increase in supply may result in an unambiguous fall in the equilibrium quantity and an ambiguous change in the equilibrium price.

Case 4: A Decrease in Demand and an Increase in Supply

In our final case, a left-shift in the demand curve and a right-shift in the supply curve will result in an unambiguous decline in the equilibrium price, but an indeterminate change in the equilibrium quantity. This situation is depicted in Figure 3.20.

If the increase in supply is relatively less than the decrease in demand, the result will be a decrease in the equilibrium price and quantity. This is seen by comparing the equilibrium price and quantity at E with E' in

Figure 3.20. If, however, the increase in supply is relatively greater than the decrease in demand, the result will be an increase in the equilibrium quantity and a decrease in the equilibrium price. This can be seen by comparing the equilibrium price and quantity at E with E'' in Figure 3.20.

Problem 3.8. The market supply and demand equations for a given product are given by the expressions

$$Q_D = 200 - 50P$$

$$Q_S = -40 + 30P$$

a. Determine the equilibrium price and quantity.
b. Suppose that there is an increase in demand to

$$Q_D = 300 - 50P$$

Suppose further that there is an increase in supply to

$$Q_S = -20 + 30P$$

What are the new equilibrium price and quantity?
c. Suppose that the increase in supply had been

$$Q_S = 140 + 30P$$

Given the demand curve in part b, what are the equilibrium price and quantity?
d. Diagram your results.

Solution

a. Equilibrium is characterized by the condition $Q_D = Q_S$. Substituting, we have

$$200 - 50P = -40 + 30P$$

$$P^* = 3$$

$$Q^* = 200 - 50(3) = -40 + 30(3) = 50$$

b. Substituting the new demand and supply equations into the equilibrium equations yields

$$300 - 50P = -20 + 30P$$

$$P^* = 4$$

$$Q^* = 300 - 50(4) = -20 + 30(4) = 100$$

c.
$$300 - 50P = 140 + 30P$$

$$P^* = 2$$

$$Q^* = 300 - 50(2) = 140 + 30(2) = 200$$

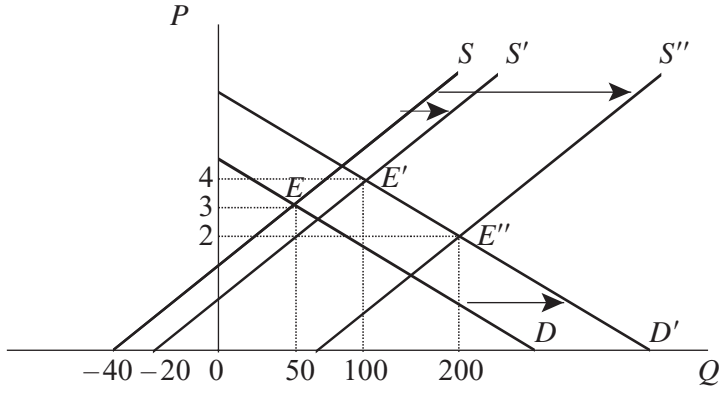

FIGURE 3.21 Diagrammatic solution to problem 3.8.

d. Figure 3.21 diagrams the foregoing results.

THE RATIONING FUNCTION OF PRICES

How realistic is the assumption of market equilibrium? In a dynamic economy it is unrealistic to presume that markets adjust instantaneously to demand and supply disturbances. Although temporary shortages and surpluses are inevitable, it is important to realize that unfettered markets are stable in the sense that the prices tend to converge toward equilibrium following an exogenous shock. The converse would be to assume that markets are inherently unstable and that prices diverge or spiral away from equilibrium, which would be a recipe for market disintegration on a regular basis. The fact that we do not observe this kind of chaos should reinforce our faith in the underlying logic and stability of the free market process.

The system of markets and prices performs two closely related, and very important, functions. In Figure 3.12 we observed that when the market price of a good or service is above or below the equilibrium price, surpluses or shortages arise. The question confronting any economy when the quantity demanded exceeds the quantity supplied is how to allocate available supplies among competing consumers. In free-market economies, this task is typically accomplished by an increase in prices. The process by which shortages are eliminated by allocating available goods and services to consumers willing and able to pay higher prices calls on control the *rationing function* of prices. Price rationing means that whenever there is a need to distribution of a good or service that is in limited supply, the price will rise until the quantity demanded equals the quantity supplied and equilibrium in the market is restored.

Definition: The rationing function of prices refers to the increase or a decrease in the market price to eliminate a surplus or a shortage of a good or service. The rationing function is considered to be a short-run phenomenon because other demand determinants are assumed to be constant.

As we observed earlier, shortages set into motion a process whereby consumers effectively bid among themselves for available goods and services. As the price is bid up, suppliers make more goods and services available for sale, while some consumers drop out of the bidding process. Fundamental to this bidding process is the notion of willingness and ability to pay. The ideal of "willingness and ability to pay" is fundamental to the allocation of available goods and services. The willingness and ability of a consumer to pay for a good or service is fundamentally a function of consumers' tastes and preferences, and income and wealth. What all this implies, of course, is that in market economies the more well-to-do participants have greater command over goods and services than consumers of more modest means.

While price rationing is a fundamental characteristic of market economies, it is not the only way to allocate goods and services that are in short supply. Alternative rationing mechanisms are necessary when the market is constrained from performing this function. Under what circumstances might the market price fail to increase to eliminate a shortage?

PRICE CEILINGS

At various times, and under a variety of circumstances, state and federal governments have found it necessary to "interfere" in the market. This interference has sometimes involved measures that short-circuit the price-rationing function of markets. Government officials accomplish this by prohibiting price increases to eliminate shortages when they arise. A ban on price increases above a certain level is called a *price ceiling*. The rationale underlying the imposition of a price ceiling typically revolves around the issue of "fairness." Sometimes such interference is justified, but more often than not price ceilings result in unintended negative consequences. To understand what is involved, consider Figure 3.21.

Definition: A price ceiling is a maximum price for a good or service that has been legally imposed on firms in an industry.

Figure 3.21 depicts the situation of excess demand $Q_1' - Q_1''$ at price P_1 arising from a decrease in the supply. Of course, the excess demand might also have arisen from an increase in the demand for a good or service. Figure 3.21 might be used to illustrate the market for consumer goods and services in the United States during World War II. As resources were shifted into the production of military goods and services to prosecute the war effort, fewer commodities were available for domestic consumption. If the

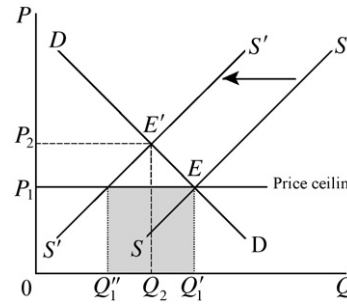

FIGURE 3.22 Market intervention: the effects of price ceilings in times of shortage.

government had done nothing, prices on a wide range of consumer goods (gasoline, meat, sugar, butter, automobile tires, etc.) would have risen sharply from P_1 to P_2. Without price controls, the equilibrium quantity would have fallen from Q_1' to Q_2. Thus, the rationing function of prices would have guaranteed that only the well-to-do had access to available, nonmilitary commodities. In the interest of "fairness," and to maintain morale on the home front, the government imposed *price ceilings*, such as P_1 in Figure 3.21, on a wide range of consumer goods.

The imposition of a price ceiling means shortages will not be automatically eliminated by increases in price. With price ceilings, the price-rationing mechanism is not permitted to operate. Some other mechanism for allocating available supplies of consumer goods is required. When shortages were created by the imposition of price ceilings during World War II, the federal government instituted a program of *ration coupons* to distribute available supplies of consumer goods. Ration coupons are coupons or tickets that entitle the holder to purchase a given amount of a particular good or service during a given time period. During World War II, families were issued ration coupons monthly to purchase a limited quantities of gasoline, meat, butter, and so on.

Definition: Ration coupons are coupons or tickets that entitle the holder to purchase a given amount of a particular good or service during a given time period.

It should be noted that the use of ration coupons to bypass the price-rationing mechanism of the market will be effective as long as no trading in ration coupons is all owed. If transactions in trading coupons are not effectively prohibited, the results will be almost identical to a market-driven outcome. Illegal transactions are referred to as "black markets." Individuals who are willing and able to pay will simply bid up the price of coupons and eliminate the price differential between the market and ceiling prices.

In addition to ration coupons, there are a variety of other non–price rationing mechanisms. Perhaps the most common of all such non–price rationing mechanisms is *queuing*, or waiting in line. This was the

non–price rationing mechanism that arose in response to the decision by Congress to impose a price ceiling of 57¢ per gallon of unleaded gasoline following the 1973–74 OPEC embargo on shipments of crude oil to the United States.

Definition: Queuing is a non–price rationing mechanism that involves waiting in line.

Analytically, higher crude oil prices resulted in a left-shift in the supply of curve of gasoline (why?). Without the price ceiling, the result would have been a sharp increase of gasoline prices at the pump, which the Congress deemed to be "unfair." As a result, shortages of gasoline developed. Since the price rationing mechanism was not permitted to operate, there were very long lines at gas stations. Under the circumstances, gasoline still went to drivers willing and able to pay the price, which in this case, in addition to the pump price, included the opportunity cost of waiting in line for hours on end.

Another version of queuing is the *waiting list*. Waiting lists are prevalent in metropolitan areas with rent control laws. Rent control is a price ceiling on residential apartments. When controlled rents are below market clearing rents, a shortage of rent-controlled apartments is created. Prospective tenants are placed on a waiting list to obtain apartments as housing units become available. Rent controls were initially imposed during World War II. With the end of the war and the return of the GIs, and the subsequent baby boom, the demand curve for rental housing units soared. Elected politicians, sensing the pulse of their constituency, decided to continue with rent controls in some form, no doubt intoning the "fairness" mantra."

The initial result was a serious housing shortage in urban centers. Applicants were placed on waiting lists, but the next available rental units were slow to materialize. Other non–price rationing mechanisms included so-called *key money* (bribes paid by applicants to landlords to move up on the waiting list), the requirement that prospective tenants purchase worthless furniture at inflated prices, exorbitant, non refundable *security deposits*, and, of course, so-called *favored customers* or individuals who receive special treatment. One of the more despicable incarnations of the favored customer relates to racial, religious, and other forms of group discrimination.

Definition: A favored customer is an individual who receives special treatment.

Rent controls tend to create housing shortages that become more severe over time. Population growth shifts the demand for rental units to the right, which tends to exacerbate shortages in the rental housing market. What is more, if permitted rent increases do not keep pace with rising maintenance costs, fuel bills, and taxes, the supply of rental units may actually decline as landlords abandoned unprofitable buildings. This was particularly notable in New York City in the 1960s and 1970s, when apartment buildings abandoned by landlords in the face of rising operating costs transformed the

South Bronx into an area reminiscent of war-ravaged Berlin in 1945. Rent stabilization in the cities encouraged the development of suburban communities, which ultimately led to "urban sprawl."

Another tactic for dealing with the economic problems associated with rent controls was the genesis, at least in New York City, of the cooperative. "Co-ops," which are not subject to rent controls, are former rental units in apartment buildings. Ownership of shares in the corporation convey the right to occupy an apartment. The prices of these shares are market determined. Unfortunately, the transformation of rental units into co-ops and office space further exacerbated New York City's housing shortage.

Just why rent controls in New York City have persisted for so long is understandable. To begin with, landlords are a particularly unlikable lot. Second, there are many more tenants than landlords, and each tenant has a vote. Pleasing this population is a lure not easily overlooked by politicians, whose planning horizon tends to extend only as far as the next election.

But there is some good news. Having recognized the fundamental flaws associated with interfering in the housing market, newer generations of politicians, obliged to deal with the problems of inner-city blight in part created by rent controls have undertaken to revitalize urban centers. Among these measures has been the elimination or dramatic reduction in the number of rental units subject to price ceilings. The result has been a resurgence in new rental housing construction, which has put downward pressure on rents (why?).

Problem 3.9. The market demand and supply equations for a product are

$$Q_D = 300 - 3P$$

$$Q_S = 100 + 5P$$

where Q is quantity and P is price.

a. What are the equilibrium price and quantity for this product?
b. Suppose that an increase in consumer income resulted in the new demand equation

$$Q_D = 420 - 3P$$

What are the new equilibrium price and quantity for this product?
c. Suppose the government enacts legislation that imposes a price ceiling equivalent to the original equilibrium price. What is the result of this legislation?

Solution

a. Equilibrium is characterized by the condition $Q_D = Q_S$ Substituting, we have

$$300 - 3 = 100 + 5P$$

$$P^* = \$25$$

$$Q^* = 300 - 3(25) = 100 + 5(25) = 225$$

b. Substituting the new demand and supply equations into the equilibrium equations yields

$$420 - 3P = 100 + 5P$$

$$P^* = 40$$

$$Q^* = 420 - 3(40) = 100 + 5(40) = 300$$

c. At the price ceiling of $P = \$25$ the quantity demand is

$$Q_D = 420 - 3P = 420 - 3(25) = 345$$

At the price ceiling the quantity supplied is

$$Q_S = 100 + 5P = 100 + 5(25) = 225$$

Based on these results, there is a shortage in this market of

$$Q_D - Q_S = 345 - 225 = 120$$

PRICE FLOORS

The counterpart to price ceilings is the price floor. Whereas price ceilings are designed to keep prices from rising above some legal maximum, price floors are designed to keep prices from falling below some legal minimum. Perhaps the most notable examples of prices floors are agricultural price supports and minimum wages. This situation is depicted in Figure 3.22.

The situation depicted in Figure 3.22 is that of an excess supply (surplus) for a commodity, say tobacco, resulting from an increase in supply. Of course, the excess supply might also have arisen from a decrease in the demand. Here, the government is committed to maintaining a minimum tobacco price at P_1, perhaps for the purpose of assuring tobacco farmers a minimum level of income. The result of a price floor is to create an excess supply of tobacco of $Q_1'' - Q_1'$. In the absence of a price floor, the equilibrium price of tobacco would have fallen from P_1 to P_2 and the equilibrium quantity would have increased from Q_1' to Q_2. In the labor market, price floors in the form of minimum wage legislation are ostensibly designed to provide unskilled workers with a "living wage," although the result is usually an increase in the unemployment rate of unskilled labor.

Definition: A price floor is a legally imposed minimum price that may be charged for a good or service.

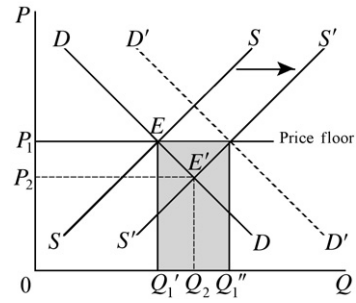

FIGURE 3.23 Market intervention: the effects of price floors in times of surplus.

The problem with price floors is that they create surpluses, which ultimately have to be dealt with. In the case of agricultural price supports, to maintain the price of the product at P_1 in Figure 3.22 the government has two policy options: either pay certain farmers not to plant, thereby keeping the supply curve from shifting from SS to $S'S'$, or enter the market and effectively buy up the surplus produce, which is analytically equivalent to shifting the demand curve from DD to $D'D'$. In either case, the taxpayer picks up the bill for subsidizing the income of the farmers for whose benefit the price floor has been imposed.

Actually, the tobacco farmer case illustrates the often schizophrenic nature of government policies. On the one hand, the federal government goes to great lengths to extol the evils of smoking, while at the same time subsidizing tobacco production.

Minimum wage legislation also impacts the taxpayer. Suppose, for example, that there is an increase in unskilled labor in a particular industry because of immigration. This results in a shift to the right of the labor supply curve, which could drive the wage rate below the mandated minimum. A surplus of unskilled labor leads to unemployment. This is a serious result, since not only would many unskilled workers be willing to accept a wage below the minimum (as opposed to no wage at all), but these workers now are hard put to obtain on-the-job experience needed to enable them to earn higher wages and income in the future. The taxpayer picks up the bill for many of these unemployed workers, who show up on state welfare rolls.

Problem 3.10. Consider the following demand and supply equations for the product of a perfectly competitive industry:

$$Q_D = 25 - 3P$$

$$Q_S = 10 + 2P$$

a. Determine the market equilibrium price and quantity algebraically.

TABLE 3.2 Impacts on Supply Arising from Changes in Supply Determinants

Determinant	Change	Supply shift
Resource prices, P_L	$\Delta\uparrow$	$\leftarrow$
	$\Delta\downarrow$	$\rightarrow$
Technology, E	$\Delta\uparrow$	$\rightarrow$
	$\Delta\downarrow$	$\leftarrow$
Taxes and subsidies, R	$\Delta\uparrow$	$\leftarrow$
	$\Delta\downarrow$	$\rightarrow$
Price of substitutes, P_s	$\Delta\uparrow$	$\leftarrow$
	$\Delta\downarrow$	$\rightarrow$
Price of complements, P_c	$\Delta\uparrow$	$\rightarrow$
	$\Delta\downarrow$	$\leftarrow$
Price expectations, P_e	$\Delta\uparrow$	$\leftarrow$
	$\Delta\downarrow$	$\rightarrow$
Number of firms, F	$\Delta\uparrow$	$\rightarrow$
	$\Delta\downarrow$	$\leftarrow$

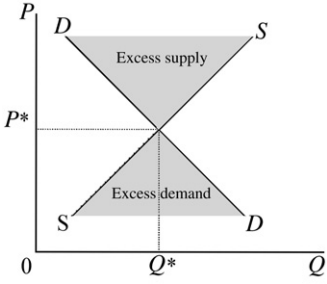

FIGURE 3.12 Market equilibrium.

THE MARKET MECHANISM: THE INTERACTION OF DEMAND AND SUPPLY

We can now use the concepts of demand and supply to explain the functioning of the market mechanism. Consider Figure 3.12, which brings together the market demand and supply curves. In our hypothetical market, the market equilibrium price is P^*. At that price, the quantity of a good or service that buyers are able and willing to buy is precisely equal to Q^*, the amount that firms are willing to supply. At a price below P^*, the quantity demanded exceeds the quantity supplied. In this situation, consumers will bid among themselves for the available supply of Q, which will drive up the selling price. Buyers who are unable or unwilling to pay the higher price will drop out of the bidding process. At the higher price, profit-maximizing producers will increase the quantity supplied. As long as the selling price is

below P^*, excess demand for the product will persist and the bidding process will continue. The bidding process will come to an end when, at the equilibrium price, excess demand is eliminated. In other words, at the equilibrium price, the quantity demanded by buyers is equal to the quantity supplied.

It is important to note that in the presence of excess demand, the adjustment toward equilibrium in the market emanates from the demand side. That is, prices are bid up by consumers eager to obtain a product that is in relatively short supply. Suppliers, on the other hand, are, in a sense, passive participants, taking their cue to increase production as prices rise.

On the other side of the market equilibrium price is the situation of excess supply. At a price above P^*, producers are supplying amounts of Q in excess of what consumers are willing to purchase. In this case, producers' inventories will rise above optimal levels as unwanted products go unsold. Since holding inventories is costly, producers will lower price in an effort to move their product. At the lower price, the number of consumers who are willing and able to purchase, say, hamburgers increases. Producers, on the other hand, will adjust their production schedules downward to reflect the reduced consumer demand.

In this case, where the quantity supplied exceeds the quantity demanded, producers become active players in the market adjustment process. That is, in the presence of excess supply, producers provide the impetus for lower product prices in an effort to avoid unwanted inventory accumulation. Consumers, on the other hand, are passive participants, taking their cue to increase consumption in response to lower prices initiated by the actions of producers but having no direct responsibility for the lower prices.

Problem 3.4. The market demand and supply equations for a product are

$$Q_D = 25 - 3P$$

$$Q_S = 10 + 2P$$

where Q is quantity and P is price. What are the equilibrium price and quantity for this product?

Solution. Equilibrium is characterized by the condition $Q_D = Q_S$. Substituting the demand and supply equations into the equilibrium condition, we obtain

$$25 - 3P = 10 + 2P$$

$$P^* = 3$$

$$Q^* = 25 - 3(3) = 10 + 2(3) = 16$$

Problem 3.5. Adam has an extensive collection of *Flash* and *Green Lantern* comic books. Adam is planning to attend a local community college

in the fall and wishes to sell his collection to raise money for textbooks. Three local comic book collectors have expressed an interest in buying Adam's collection. The individual demand equation for each of these three individuals is

$$Q_{D,1} = Q_{D,2} = Q_{D,3} = 550 - 2.5P$$

where P is measured in dollars per comic book.

a. What is the market demand equation for Adam's comic books?
b. How many more comic books can Adam sell for each dollar reduction in price?
c. If Adam has 900 comic books in all, what price should he charge to sell his entire collection?

Solution

a. The market demand for Adam's comic books is equal to the sum of the individual demands, that is,

$$\begin{aligned} Q_{D,M} &= Q_{D,1} + Q_{D,2} + Q_{D,3} = (55 - 2.5P) + (55 - 2.5P) + (55 - 2.5P) \\ &= 165 - 7.5P \end{aligned}$$

b. Since price is measured in dollars, each one-dollar reduction in the price of comic books will result in an increase in quantity demanded of 7.5 comic books.
c. Since Adam is offering his entire comic book collection for sale, the total quantity supplied of comic books is 90, that is,

$$Q_S = 90$$

To determine the price Adam must charge to sell his entire collection, equate market demand to market supply and solve:

$$Q_D = Q_S$$

$$165 - 7.5P = 90$$

$$P^* = 75/7.5 = \$10$$

That is, in order for Adam to sell his entire collection, he should sell his comic books for \$10 each. Consider Figure 3.13.

Problem 3.6. Consider, again, the market demand curve in Figure 3.5.

a. Suppose that the total market supply is given by the equation

$$Q_S = -16 + 2P$$

What are the market equilibrium price and quantity?
b. Suppose that because of a decline in labor costs, market supply increases to

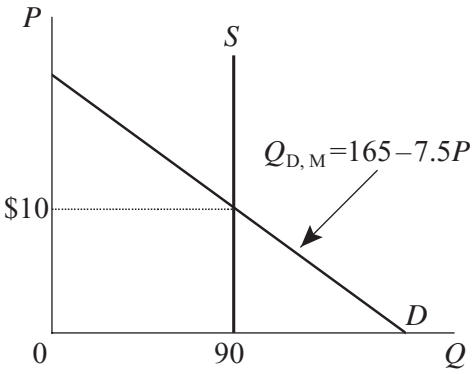

FIGURE 3.13 Diagrammatic solution to problem 3.5.

$$Q_S' = 6 + 2P$$

What are the new equilibrium price and quantity?

c. Diagram your answers to parts a and b.

Solution

a. Equilibrium is characterized by the condition $Q_D = Q_S$. Recall from Problem 3.2 that the market demand curve for $Q \le 6$ is $Q_{D,1} = 20 - 2P$ and $Q_{D,M} = Q_{D,1} + Q_{D,2} = 60 - 7P$ for $Q \ge 4$. The equilibrium price and quantity are

$$-16 + 2P = 20 - 2P$$

$$P^* = 9$$

$$Q^* = 20 - 2(9) = -16 + 2(9) = 2$$

b. The new equilibrium price and quantity are

$$6 + 2P = 60 - 7P$$

$$P^* = 6$$

$$Q^* = 60 - 7(6) = 6 + 2(6) = 18$$

c. Figure 3.14 shows the old and new market equilibrium price and quantity.

Problem 3.7. Universal Exports has estimated the following monthly demand equation for its new brand of gourmet French pizza, Andrew's Appetizer:

$$Q_D = 500 - 100P + 50I + 20P_r + 30A$$

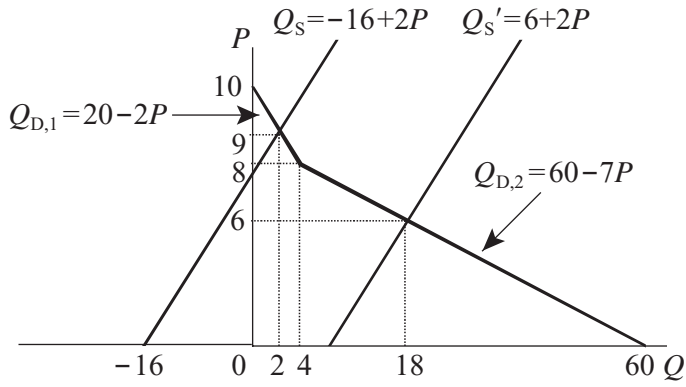

FIGURE 3.14 Diagrammatic solution to problem 3.6.

where Q_D = quantity demanded per month
P = price per unit
I = per-capita income (thousands of dollars)
P_r = price of another gourmet product, François's Frog Legs
A = monthly advertising expenditures (thousands of dollars) of U niversal Exports

The supply equation for Andrew's Appetizer is

$$Q_S = 1{,}350 + 450P$$

a. What is the relationship between Andrew's Appetizer and François's Frog Legs?
b. Suppose that $I = 200$, $P_r = 80$, and $A = 100$. What are the equilibrium price and quantity for this product?
c. Suppose that per-capita income increases by 55 (i.e., $I = 255$). What are the new equilibrium price and quantity for this product?

Solution

a. By the law of demand, an increase in the price of a product will result in a decrease in the quantity demanded of that product, other things being equal. In this case, an increase in the price of François's Frog Legs would result in a decrease in the quantity demanded of frogs legs, other things equal. Since this results in an increase in the demand for Andrew's Appetizer, we would conclude that Andrew's Appetizer and François's Frog Legs are substitutes.
b. Substituting the information from the problem statement into the demand equation yields

$$\begin{aligned} Q_D &= 500 - 100P + 50(200) + 20(80) + 30(100) \\ &= 500 - 100P + 10{,}000 + 1{,}600 + 3{,}000 = 15{,}100 - 100P \end{aligned}$$

Market equilibrium is defined as $Q_D = Q_S$. Substituting the supply and demand to equations into the equilibrium condition, we obtain

$$15{,}100 - 100P = 1{,}350 + 450P$$

$$P^* = \$25$$

$$Q^* = 15{,}100 - 100(25) = 12{,}600$$

c. Substituting the new information into the demand equation yields

$$\begin{aligned} Q_D &= 500 - 100P + 50(255) + 20(80) + 30(100) \\ &= 500 - 100P + 12{,}750 + 1{,}600 + 3{,}000 = 17{,}850 - 100P \end{aligned}$$

Substituting this into the equilibrium condition, we write

$$17{,}850 - 100P = 1{,}350 + 450P$$

$$P^* = \$30$$

$$Q^* = 17{,}850 - 100(30) = 14{,}850$$

It is interesting to note that the increase in per-capita income is represented diagrammatically as an increase in the intercept Q from 15,100 to 17,850, with no change in the slope of the demand curve. The student should verify diagrammatically that an increase in the Q intercept will result in right-shift of the demand curve, which is exactly what we would expect for a normal good given an increase in per capita income.

CHANGES IN SUPPLY AND DEMAND: THE ANALYSIS OF PRICE DETERMINATION

Now let us use the analytical tools of supply and demand to analyze the effects of a change in demand and/or a change in supply on the equilibrium price and quantity. Consider first the case of a change in demand.

DEMAND SHIFTS

Suppose, for example, that medical research finds that hamburgers have highly desirable health characteristics, triggering an increase in the public's preference for hamburgers. Other things remaining constant, this would result in a right-shift in the demand curve for hamburgers. This results in an increase in the equilibrium price and quantity demanded for hamburgers. Consider Figure 3.15.

If medical research, on the other hand had discovered that hamburgers exhibited highly undesirable health properties, one could have predicted a reduction in the demand for hamburgers, or a left-shift in the demand curve,