instituting a higher minimum wage? Or were the opponents correct to claim that a higher minimum wage could end up hurting more people than it helped? In this chapter, we look at more sophisticated aspects of the supply and demand model that are helpful in understanding policy debates, like the minimum-wage increase. We first look at how to use the supply and demand model in situations in which government policies do not allow price to be freely determined in a market. These interventions can take the form of a price ceiling, a maximum price imposed by the government when it feels that the equilibrium price is “too high,” or a price floor, a minimum price imposed by the government when it feels that the equilibrium price is “too low,” as in the case of the minimum wage. This extension of the supply and demand model also will be helpful in solidifying your understanding of the important role played by prices in the allocation of resources.

We then move on to discussing an elegant, and remarkably useful, economic concept called elasticity that economists use when they work with the supply and demand model. In economics, elasticity is a measure of how sensitive one variable is to another. In the case of the supply and demand model, elasticity measures how sensitive the quantity of a good that people demand, or that firms supply, is to the price of the good. In this chapter, we show how the concept of elasticity can be used to answer the question raised earlier about how much unemployment is caused when the minimum wage is raised. You will learn a formula that shows how elasticity is calculated and then learn how to work with and talk about elasticity.

**Interference with Market Prices**

Thus far, we have used the supply and demand model in situations in which the price is freely determined without government control. But at many times throughout history, and around the world in the twenty-first century, governments have attempted to control market prices. The usual reasons are that government leaders were not happy with the outcome of the market or were pressured by groups who would benefit from price controls.

**Price Ceilings and Price Floors**

In general, the government imposes two broad types of price controls. Controls can stipulate either a price ceiling, a maximum price at which a good can be bought and sold, or a price floor, a minimum price at which a good can be bought and sold. Why would a government choose to intervene in the market and put in a price floor or a price ceiling? What happens when such an intervention is made?

Ostensibly, the primary purpose of a price ceiling is to help consumers in situations in which the government thinks that the equilibrium price is “too high” or is inundated with consumer complaints that the equilibrium price is too high. For example, the U.S. government controlled oil prices in the early 1970s, stipulating that firms could not charge more than a stated maximum price of $5.25 per barrel of crude oil at a time when the equilibrium price was well over $10 per barrel. As another example, some cities in the United States place price controls on rental apartments; landlords are not permitted to charge a rent higher than the maximum stipulated by the rent control law in these

**price control**
a government law or regulation that sets or limits the price to be charged for a particular good.

**price ceiling**
a government price control that sets the maximum allowable price for a good.

**price floor**
a government price control that sets the minimum allowable price for a good.

**rent control**
a government price control that sets the maximum allowable rent on a house or apartment.
cities. Tenants living in rent-controlled units pay less than the market equilibrium rent that would prevail in the absence of the price ceiling.

Conversely, governments impose price floors to help the suppliers of goods and services in situations in which the government feels that the equilibrium price is “too low” or is influenced by complaints from producers that the equilibrium price is too low. For example, the U.S. government requires that the price of sugar in the United States not fall below a certain amount. Another example can be found in the labor market, in which the U.S. government requires that firms pay workers a wage of at least a given level, called the minimum wage.

Side Effects of Price Ceilings

Even though price ceilings typically are implemented with the idea of helping consumers, they often end up having harmful side effects that hurt the consumers that the ceiling was put in place to help. If the price ceiling that the government puts in place to prevent firms from charging more than a certain amount for their products is lower than the equilibrium price, then a shortage is likely to result, as illustrated in Figure 4-1. The situation of a persistent shortage, in which sellers are unwilling to supply as much as buyers want to buy, is illustrated for the general case of any good in the top graph in Figure 4-1 and for the specific case of rent control in the bottom graph.

Dealing with Persistent Shortages

Because higher prices are not allowed, the shortage must be dealt with in other ways. Sometimes the government issues a limited amount of ration coupons, which do not exceed the quantity supplied at the restricted maximum price, to people to alleviate the shortage. This was done in World War II when people had to present these ration coupons at stores to buy certain goods, and only those individuals who had ration coupons could buy those goods. If the price ceiling had not been in place, the shortage would have driven prices higher, and those who were willing and able to pay the higher price would have been able to buy the goods without the need for a ration coupon.

Alternatively, if ration coupons are not issued, then the shortage might result in long waiting lines. In the past, in centrally planned economies, long lines for bread frequently were observed because of price controls on bread. Sometimes black markets develop, in which people buy and sell goods outside the watch of the government and charge whatever price they want. In the past, this was typical in command economies. In the twenty-first century, black markets are common in less-developed countries when the governments in these countries impose price controls.

Another effect of price ceilings is a reduction in the quality of the good sold. By lowering the quality of the good, the producer can reduce the costs of producing it. A frequent criticism of rent control is that it can lower the quality of housing—landlords are more reluctant to paint the walls or to repair the elevator because they are prevented from charging a higher rent.

Making Things Worse

Although the stated purpose of price ceilings is to help people who have to pay high prices, the preceding examples indicate how price ceilings can make things worse. Issuing ration coupons raises difficult problems about who gets the coupons. In the case of a price ceiling on gasoline, for example, should the government give more coupons to those who use a lot of gasoline because they drive vehicles with poor gas mileage than to those who use less gasoline because they drive more fuel-efficient cars or use public transportation for their daily commute? Rationing by waiting in line also is an undesirable outcome. People who are waiting in line could be doing more enjoyable or more useful things. Similarly, black markets, being illegal, encourage
The General Case of a Price Ceiling

Equilibrium price
Maximum price or price ceiling

This is the quantity supplied.
This is the quantity demanded.

The Case of Rent Control

Equilibrium rent
Rent controls stipulate this maximum rent.

Number of apartments supplied
Number of apartments demanded

Effects of a Maximum-Price Law
The top diagram shows the general case when the government prevents the market price from rising above a particular maximum price, or sets a price ceiling below the equilibrium price. The lower diagram shows a particular example of a price ceiling, rent controls on apartment units. The supply and demand model predicts a shortage. The shortage occurs because the quantity supplied is less than consumers are willing to buy at that price. The shortage leads to rationing, black markets, or lower product quality.
people to go outside the law. People transacting in black markets also may be more vulnerable to theft or fraud. Lowering the quality of the good is also a bad way to alleviate the problem of a high price. This simply eliminates the higher-quality good from production; both consumers and producers lose. Price ceilings also are not particularly well targeted. Even though the goal of a price ceiling may be to ensure that someone who cannot afford to pay the equilibrium price still can purchase the good, there is no way to guarantee that only those who cannot afford to pay the equilibrium price end up purchasing the good. For instance, many people who end up living in rent-controlled apartments may not be poor at all.

**Side Effects of Price Floors**

Price floors typically are enacted with the goal of helping producers who are facing low market equilibrium prices, but, as with price ceilings, they often end up having harmful side effects that hurt the people that the policy was put in place to help. If the price floor that the government imposes exceeds the equilibrium price, then a surplus will occur. The situation of a persistent surplus, in which sellers are willing to supply more output than buyers want to buy, is illustrated for the general case of any good in the top graph of Figure 4-2 and for the specific case of the minimum wage in the bottom graph.

**Dealing with Persistent Surpluses**  How is this surplus dealt with in actual markets? In markets for farm products, the government usually has to buy the surplus and, perhaps, put it in storage. Buying farm products above the equilibrium price costs taxpayers money, and the higher price raises costs to consumers. For this reason, economists argue against price floors on agricultural goods. As an alternative, the government sometimes reduces the supply by telling farms to plant fewer acres or to destroy crops. But government requirements that land be kept idle or crops destroyed in exchange for taxpayer’s money are particularly repugnant to most people.

When the supply and demand model is applied to labor markets, the price is the price of labor (or the wage) and a minimum wage is a price floor. What does the supply and demand model predict about the effects of a minimum wage? The lower diagram in Figure 4-2 shows that a minimum wage can cause unemployment. If the minimum wage exceeds the equilibrium wage, the number of workers demanded at that wage is less than the number of workers who are willing to work. Even though some workers would be willing to work for less than the minimum wage, employers are not permitted to pay them less than the minimum wage. Therefore, there is a surplus of unemployed workers at the minimum wage.

**Making Things Worse**  Even though the stated purpose of price floors is to help sellers by paying them a higher price, the preceding examples indicate how price floors can make things worse. The resources allocated to building grain silos to store surplus grain could have been used to hire doctors or teachers or to build low-income houses. The land that farmers are encouraged to keep in an undeveloped yet unfarmed state could have been used for a housing development or as a high school athletic field. Price floors, like price ceilings, also are not particularly well targeted. Even though the goal of a price floor may be to ensure that a poor farmer does not suffer because crop prices are too low, the benefits of the higher price typically will accrue to extremely wealthy farmers and large agricultural businesses with lots of resources. In the case of the minimum wage, teenagers from relatively well-off families may end up earning a higher salary as a result of the minimum wage, but a poor parent may end up losing his or her job and joining the ranks of the unemployed.
**Figure 4-2**

**Effects of a Minimum-Price Law**

The top diagram shows the general case when the government prevents the market price from falling below a particular minimum price, or sets a price floor above the equilibrium price. The lower diagram shows a particular example when the price of labor—the wage—cannot fall below the minimum wage. The supply and demand model predicts that sellers are willing to sell a greater quantity than buyers are willing to buy at that price. Thus, there is a surplus of the good or, in the case of labor, unemployment for some of those who would be hired only at a lower wage.
Elasticity of Demand

Defining the Price Elasticity of Demand

The price elasticity of demand is a measure of the sensitivity of the quantity demanded of a good to the price of the good. “Price elasticity of demand” is sometimes shortened to “elasticity of demand,” the “demand elasticity,” or even simply “elasticity” when the meaning is clear from the context. The price elasticity of demand always refers to a particular demand curve or demand schedule, such as the world demand for oil or the U.S. demand for bicycles. The price elasticity of demand is a measure of how much the quantity demanded changes when the price changes.

For example, when economists report that the price elasticity of demand for contact lenses is high, they mean that the quantity of contact lenses demanded by people changes by a large amount when the price changes. Or if they report that the price elasticity of demand for bread is low, they mean that the quantity of bread demanded changes by only a small amount when the price of bread changes.

We can define the price elasticity of demand clearly with a formula: Price elasticity of demand is the percentage change in the quantity demanded divided by the percentage change in the price. That is,

\[
\text{Price elasticity of demand} = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in price}}
\]

We emphasize that the price elasticity of demand refers to a particular demand curve; thus, the numerator of this formula is the percentage change in quantity demanded when the price changes by the percentage amount shown in the denominator. All the other factors that affect demand are held constant when we compute the price elasticity of demand. This expression will have a negative sign because the numerator and denominator are of opposite signs. Because the demand curve slopes downward, as the price increases, the quantity demanded by consumers declines, and as the price decreases, the quantity demanded by consumers increases, all else held equal. The convention is to ignore the negative sign or, alternatively, take the negative sign for granted when we discuss the elasticity of demand.

For example, if the price elasticity of demand for gasoline is said to be about 0.2, that means that if the price of gasoline increases by 10 percent, the quantity of gasoline
demanded will fall by 2 percent \((0.2 \times 10)\). If the price elasticity of demand for alcoholic beverages is said to be about 1.5, that means that when the price of alcoholic beverages rises by 10 percent, the quantity demanded will fall by 15 percent \((1.5 \times 10)\). As you can see from these examples, knowing the elasticity of demand enables us to determine how much the quantity demanded changes when the price changes.

The Size of the Elasticity: High versus Low

The two graphs in Figure 4-3 each show a different possible demand curve for oil in the world. We want to show why it is important to know which of these two demand curves gives a better description of economic behavior in the oil market. Each graph has the price of oil on the vertical axis (in dollars per barrel) and the quantity of oil demanded on the horizontal axis (in millions of barrels of oil a day).

**Figure 4-3**

Comparing Different Sizes of the Price Elasticity of Demand

Both sets of axes have exactly the same scale. In the top graph, the quantity demanded is sensitive to the price; the elasticity is high. In the bottom graph, the quantity demanded is not sensitive to the price; the elasticity is low. Thus, the same increase in price ($2, or 10 percent) reduces the quantity demanded much more when the elasticity is high (top graph) than when it is low (bottom graph).
Both of the demand curves pass through the same point $A$, where the price of oil is $20 per barrel and the quantity demanded is 60 million barrels per day. But observe that the two curves show different degrees of sensitivity of the quantity demanded to the price. In the top graph, where the demand curve is relatively flat, the quantity demanded of oil is sensitive to the price; in other words, the demand curve has a high elasticity. For example, consider a change from point $A$ to point $B$: When the price rises by $2, from $20 to $22, the quantity demanded falls by 12 million, from 60 million to 48 million barrels a day. In percentage terms, when the price rises by 10 percent ($2/20 = 0.10$, or 10 percent), the quantity demanded falls by 20 percent ($12/60 = 0.20$, or 20 percent).

On the other hand, in the bottom graph, the quantity demanded is not quite as sensitive to the price; in other words, the demand curve has a low elasticity. It is relatively steep. When the price rises by $2 from point $A$ to point $C$, the quantity demanded falls by

**Figure 4-4**

*The Importance of the Size of the Price Elasticity of Demand*

The impact on the oil price of a reduction in oil supply is shown for two different demand curves. The reduction in supply is the same for both graphs. When the price elasticity of demand is high (top graph), there is only a small increase in the price. When the price elasticity of demand is low (bottom graph), the price rises by much more.
3 million barrels. In percentage terms, the same 10 percent increase in price reduces the quantity demanded by only 5 percent ($3/60 = 0.05$, or 5 percent). Thus, the sensitivity of the quantity to the price, or the size of the elasticity, is what distinguishes these two graphs.

**The Impact of a Change in Supply on the Price of Oil**

Now consider what happens when there is a decline in supply in the world oil market. In Figure 4-4, we combine the supply curve for oil with the two demand curves for oil from Figure 4-3. Initially the oil market is in equilibrium in Figure 4-4; in both graphs, the quantity demanded equals the quantity supplied. The equilibrium price is $20 per barrel, and the equilibrium quantity is 60 million barrels a day, just like at point $A$ in Figure 4-3. A reduction in the supply of oil—perhaps because of the reduction in Iraqi oil production or the shutdown of refineries following Hurricane Katrina—is also shown. The exact same leftward shift in supply is shown in the top and bottom graphs of Figure 4-4.

Now, observe how the equilibrium price changes in the two graphs. Recall that this change is our prediction—using the supply and demand model—of what would happen to the price of oil if the supply declined. We know that a decrease in supply will lead to an increase in the equilibrium price and a decrease in the equilibrium quantity. As the two graphs show, however, there is a huge difference in the size of the predicted price increase. In the top graph, the oil price increases only a little. If the elasticity is very high, then even a small increase in the price is enough to get people to reduce their use of oil and thereby bring the quantity demanded down to the lower quantity supplied. On the other hand, in the bottom diagram, the price rises by much more. Here the elasticity is very low, and thus a large increase in price is needed to get people to reduce their use of oil and bring the quantity demanded down to the quantity supplied.

Thus, to determine how much the price will rise in response to a shift in oil supply, we need to know how sensitive the quantity demanded is to the price, or the size of the elasticity of demand.

**REVIEW**

- We know that an increase in price will lower the quantity demanded, whereas a decrease in price will increase the quantity demanded. The price elasticity of demand is a number that tells us by how much the quantity demanded changes when the price changes.
- The price elasticity of demand, which we also refer to as “elasticity of demand” or just as “elasticity,” is defined as the percentage change in the quantity demanded divided by the percentage change in the price.
- A given change in price has a larger impact on quantity demanded when the elasticity of demand is higher.
- A given shift of the supply curve will have a larger impact on equilibrium quantity (and a smaller impact on equilibrium price) when the elasticity of demand is higher.

**Working with Demand Elasticities**

Having demonstrated the practical importance of elasticity, let us examine the concept in more detail and show how to use it. Some symbols will be helpful.

If we let the symbol $e_d$ represent the price elasticity of demand, then we can write the definition as

$$e_d = \frac{\Delta Q_d}{Q_d} \times \frac{\Delta P}{P} = \frac{\Delta Q_d/Q_d}{\Delta P/P}$$