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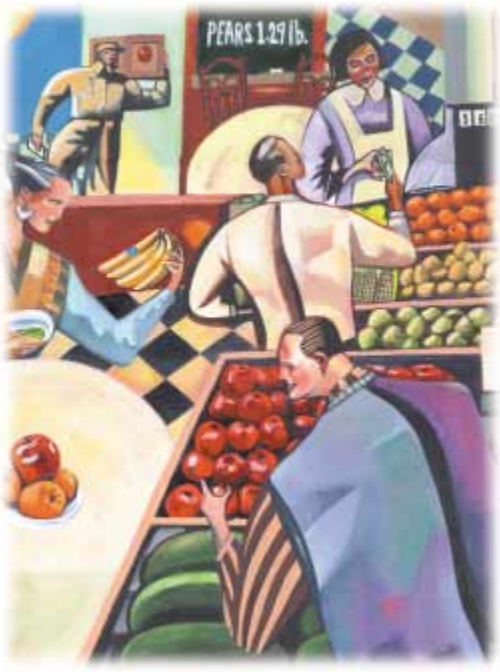


ELASTICITY AND ITS APPLICATION

Imagine yourself as a Kansas wheat farmer. Because you earn all your income from selling wheat, you devote much effort to making your land as productive as it can be. You monitor weather and soil conditions, check your fields for pests and disease, and study the latest advances in farm technology. You know that the more wheat you grow, the more you will have to sell after the harvest, and the higher will be your income and your standard of living.

One day Kansas State University announces a major discovery. Researchers in its agronomy department have devised a new hybrid of wheat that raises the amount farmers can produce from each acre of land by 20 percent. How should you react to this news? Should you use the new hybrid? Does this discovery make you better off or worse off than you were before? In this chapter we will see that these questions can have surprising answers. The surprise will come from

IN THIS CHAPTER YOU WILL . . .

- ***Learn the meaning of the elasticity of demand***
- ***Examine what determines the elasticity of demand***
- ***Learn the meaning of the elasticity of supply***
- ***Examine what determines the elasticity of supply***
- ***Apply the concept of elasticity in three very different markets***

applying the most basic tools of economics—supply and demand—to the market for wheat.

The previous chapter introduced supply and demand. In any competitive market, such as the market for wheat, the upward-sloping supply curve represents the behavior of sellers, and the downward-sloping demand curve represents the behavior of buyers. The price of the good adjusts to bring the quantity supplied and quantity demanded of the good into balance. To apply this basic analysis to understand the impact of the agronomists' discovery, we must first develop one more tool: the concept of *elasticity*. Elasticity, a measure of how much buyers and sellers respond to changes in market conditions, allows us to analyze supply and demand with greater precision.

THE ELASTICITY OF DEMAND

When we discussed the determinants of demand in Chapter 4, we noted that buyers usually demand more of a good when its price is lower, when their incomes are higher, when the prices of substitutes for the good are higher, or when the prices of complements of the good are lower. Our discussion of demand was qualitative, not quantitative. That is, we discussed the direction in which the quantity demanded moves, but not the size of the change. To measure how much demand responds to changes in its determinants, economists use the concept of **elasticity.**

elasticity
a measure of the responsiveness of quantity demanded or quantity supplied to one of its determinants

THE PRICE ELASTICITY OF DEMAND AND ITS DETERMINANTS

The law of demand states that a fall in the price of a good raises the quantity demanded. The **price elasticity of demand** measures how much the quantity demanded responds to a change in price. Demand for a good is said to be *elastic* if the quantity demanded responds substantially to changes in the price. Demand is said to be *inelastic* if the quantity demanded responds only slightly to changes in the price.

price elasticity of demand
a measure of how much the quantity demanded of a good responds to a change in the price of that good, computed as the percentage change in quantity demanded divided by the percentage change in price

What determines whether the demand for a good is elastic or inelastic? Because the demand for any good depends on consumer preferences, the price elasticity of demand depends on the many economic, social, and psychological forces that shape individual desires. Based on experience, however, we can state some general rules about what determines the price elasticity of demand.

Necessities versus Luxuries Necessities tend to have inelastic demands, whereas luxuries have elastic demands. When the price of a visit to the doctor rises, people will not dramatically alter the number of times they go to the doctor, although they might go somewhat less often. By contrast, when the price of sailboats rises, the quantity of sailboats demanded falls substantially. The reason is that most people view doctor visits as a necessity and sailboats as a luxury. Of course, whether a good is a necessity or a luxury depends not on the intrinsic properties of the good but on the preferences of the buyer. For an avid sailor with

little concern over his health, sailboats might be a necessity with inelastic demand and doctor visits a luxury with elastic demand.

Availability of Close Substitutes Goods with close substitutes tend to have more elastic demand because it is easier for consumers to switch from that good to others. For example, butter and margarine are easily substitutable. A small increase in the price of butter, assuming the price of margarine is held fixed, causes the quantity of butter sold to fall by a large amount. By contrast, because eggs are a food without a close substitute, the demand for eggs is probably less elastic than the demand for butter.

Definition of the Market The elasticity of demand in any market depends on how we draw the boundaries of the market. Narrowly defined markets tend to have more elastic demand than broadly defined markets, because it is easier to find close substitutes for narrowly defined goods. For example, food, a broad category, has a fairly inelastic demand because there are no good substitutes for food. Ice cream, a more narrow category, has a more elastic demand because it is easy to substitute other desserts for ice cream. Vanilla ice cream, a very narrow category, has a very elastic demand because other flavors of ice cream are almost perfect substitutes for vanilla.

Time Horizon Goods tend to have more elastic demand over longer time horizons. When the price of gasoline rises, the quantity of gasoline demanded falls only slightly in the first few months. Over time, however, people buy more fuel-efficient cars, switch to public transportation, and move closer to where they work. Within several years, the quantity of gasoline demanded falls substantially.

COMPUTING THE PRICE ELASTICITY OF DEMAND

Now that we have discussed the price elasticity of demand in general terms, let's be more precise about how it is measured. Economists compute the price elasticity of demand as the percentage change in the quantity demanded divided by the percentage change in the price. That is,

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}.$$

For example, suppose that a 10-percent increase in the price of an ice-cream cone causes the amount of ice cream you buy to fall by 20 percent. We calculate your elasticity of demand as

$$\text{Price elasticity of demand} = \frac{20 \text{ percent}}{10 \text{ percent}} = 2.$$

In this example, the elasticity is 2, reflecting that the change in the quantity demanded is proportionately twice as large as the change in the price.

Because the quantity demanded of a good is negatively related to its price, the percentage change in quantity will always have the opposite sign as the

percentage change in price. In this example, the percentage change in price is a *positive* 10 percent (reflecting an increase), and the percentage change in quantity demanded is a *negative* 20 percent (reflecting a decrease). For this reason, price elasticities of demand are sometimes reported as negative numbers. In this book we follow the common practice of dropping the minus sign and reporting all price elasticities as positive numbers. (Mathematicians call this the *absolute value*.) With this convention, a larger price elasticity implies a greater responsiveness of quantity demanded to price.

THE MIDPOINT METHOD: A BETTER WAY TO CALCULATE PERCENTAGE CHANGES AND ELASTICITIES

If you try calculating the price elasticity of demand between two points on a demand curve, you will quickly notice an annoying problem: The elasticity from point A to point B seems different from the elasticity from point B to point A. For example, consider these numbers:

Point A:	Price = $4	Quantity = 120
Point B:	Price = $6	Quantity = 80

Going from point A to point B, the price rises by 50 percent, and the quantity falls by 33 percent, indicating that the price elasticity of demand is 33/50, or 0.66. By contrast, going from point B to point A, the price falls by 33 percent, and the quantity rises by 50 percent, indicating that the price elasticity of demand is 50/33, or 1.5.

One way to avoid this problem is to use the *midpoint method* for calculating elasticities. Rather than computing a percentage change using the standard way (by dividing the change by the initial level), the midpoint method computes a percentage change by dividing the change by the midpoint of the initial and final levels. For instance, $5 is the midpoint of $4 and $6. Therefore, according to the midpoint method, a change from $4 to $6 is considered a 40 percent rise, because $(6 - 4)/5 \times 100 = 40$. Similarly, a change from $6 to $4 is considered a 40 percent fall.

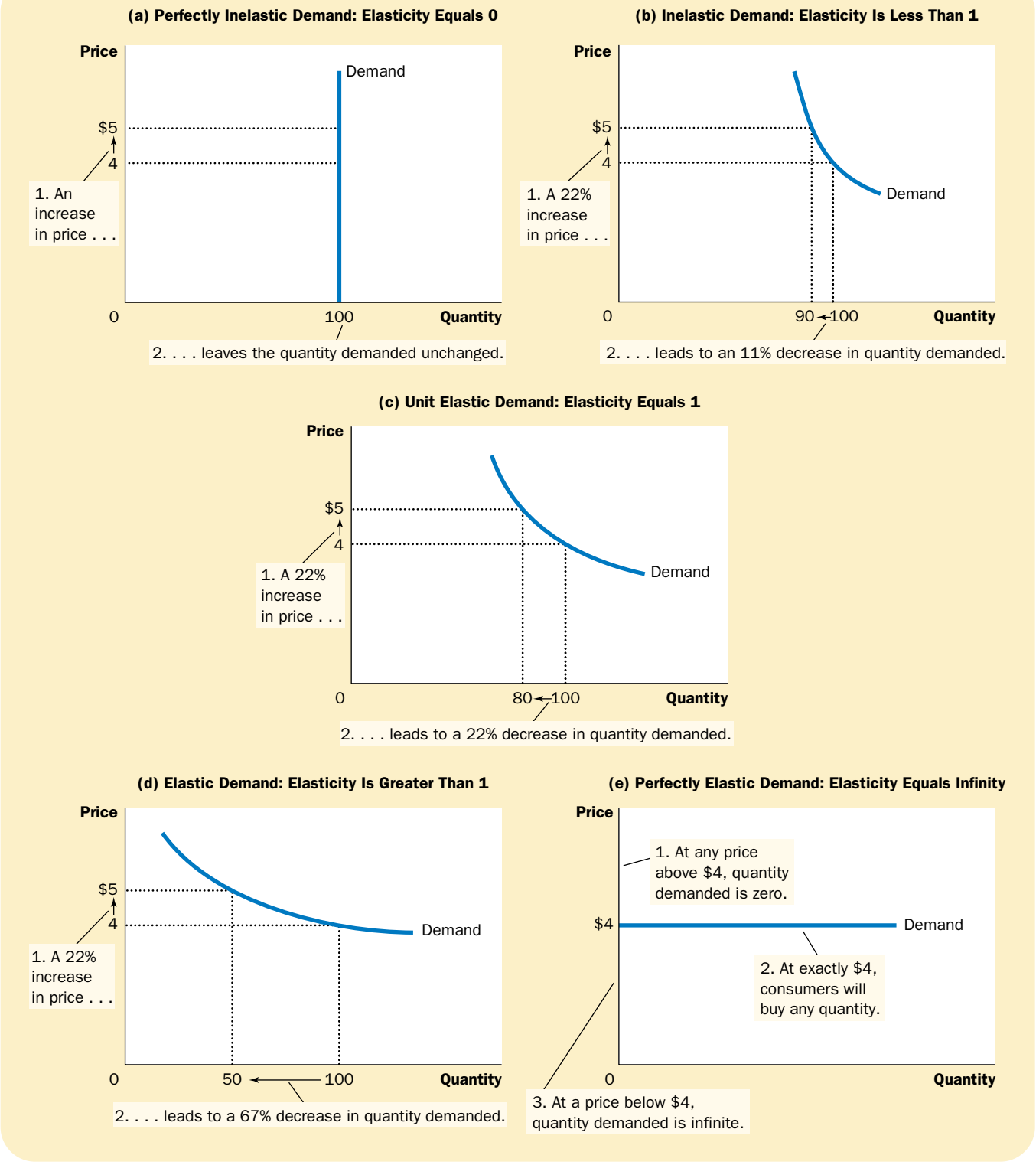
Because the midpoint method gives the same answer regardless of the direction of change, it is often used when calculating the price elasticity of demand between two points. In our example, the midpoint between point A and point B is:

Midpoint:	Price = $5	Quantity = 100

According to the midpoint method, when going from point A to point B, the price rises by 40 percent, and the quantity falls by 40 percent. Similarly, when going from point B to point A, the price falls by 40 percent, and the quantity rises by 40 percent. In both directions, the price elasticity of demand equals 1.

We can express the midpoint method with the following formula for the price elasticity of demand between two points, denoted (Q_1, P_1) and (Q_2, P_2):

$$\text{Price elasticity of demand} = \frac{(Q_2 - Q_1)/[(Q_2 + Q_1)/2]}{(P_2 - P_1)/[(P_2 + P_1)/2]}.$$



THE PRICE ELASTICITY OF DEMAND. The price elasticity of demand determines whether the demand curve is steep or flat. Note that all percentage changes are calculated using the midpoint method.

Figure 5-1

The numerator is the percentage change in quantity computed using the midpoint method, and the denominator is the percentage change in price computed using the midpoint method. If you ever need to calculate elasticities, you should use this formula.

Throughout this book, however, we only rarely need to perform such calculations. For our purposes, what elasticity represents—the responsiveness of quantity demanded to price—is more important than how it is calculated.

THE VARIETY OF DEMAND CURVES

Economists classify demand curves according to their elasticity. Demand is *elastic* when the elasticity is greater than 1, so that quantity moves proportionately more than the price. Demand is *inelastic* when the elasticity is less than 1, so that quantity moves proportionately less than the price. If the elasticity is exactly 1, so that quantity moves the same amount proportionately as price, demand is said to have *unit elasticity.*

Because the price elasticity of demand measures how much quantity demanded responds to changes in the price, it is closely related to the slope of the demand curve. The following rule of thumb is a useful guide: The flatter is the demand curve that passes through a given point, the greater is the price elasticity of demand. The steeper is the demand curve that passes through a given point, the smaller is the price elasticity of demand.

Figure 5-1 shows five cases. In the extreme case of a zero elasticity, demand is *perfectly inelastic,* and the demand curve is vertical. In this case, regardless of the price, the quantity demanded stays the same. As the elasticity rises, the demand curve gets flatter and flatter. At the opposite extreme, demand is *perfectly elastic.* This occurs as the price elasticity of demand approaches infinity and the demand curve becomes horizontal, reflecting the fact that very small changes in the price lead to huge changes in the quantity demanded.

Finally, if you have trouble keeping straight the terms *elastic* and *inelastic,* here's a memory trick for you: Inelastic curves, such as in panel (a) of Figure 5-1, look like the letter *I.* Elastic curves, as in panel (e), look like the letter *E.* This is not a deep insight, but it might help on your next exam.

TOTAL REVENUE AND THE PRICE ELASTICITY OF DEMAND

total revenue
the amount paid by buyers and received by sellers of a good, computed as the price of the good times the quantity sold

When studying changes in supply or demand in a market, one variable we often want to study is **total revenue,** the amount paid by buyers and received by sellers of the good. In any market, total revenue is $P \times Q$, the price of the good times the quantity of the good sold. We can show total revenue graphically, as in Figure 5-2. The height of the box under the demand curve is P, and the width is Q. The area of this box, $P \times Q$, equals the total revenue in this market. In Figure 5-2, where $P = \$4$ and $Q = 100$, total revenue is $\$4 \times 100$, or \$400.

How does total revenue change as one moves along the demand curve? The answer depends on the price elasticity of demand. If demand is inelastic, as in Figure 5-3, then an increase in the price causes an increase in total revenue. Here an increase in price from \$1 to \$3 causes the quantity demanded to fall only from 100

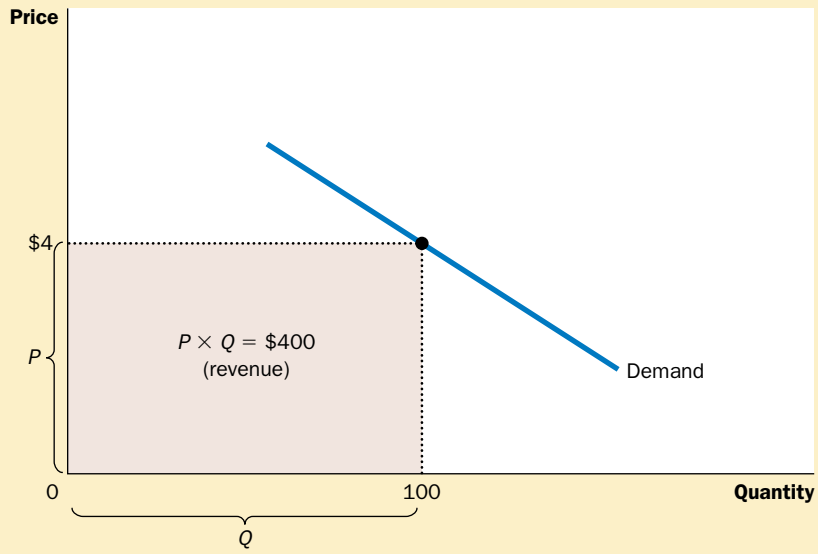


Figure 5-2

TOTAL REVENUE. The total amount paid by buyers, and received as revenue by sellers, equals the area of the box under the demand curve, $P \times Q$. Here, at a price of $4, the quantity demanded is 100, and total revenue is $400.

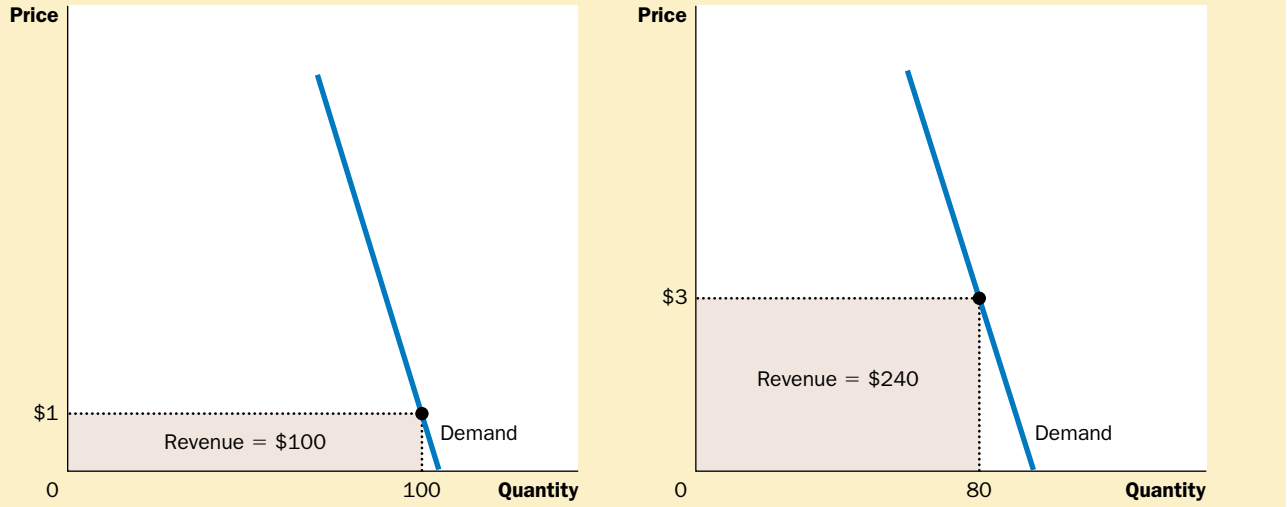


Figure 5-3

HOW TOTAL REVENUE CHANGES WHEN PRICE CHANGES: INELASTIC DEMAND. With an inelastic demand curve, an increase in the price leads to a decrease in quantity demanded that is proportionately smaller. Therefore, total revenue (the product of price and quantity) increases. Here, an increase in the price from $1 to $3 causes the quantity demanded to fall from 100 to 80, and total revenue rises from $100 to $240.

to 80, and so total revenue rises from $100 to $240. An increase in price raises $P \times Q$ because the fall in Q is proportionately smaller than the rise in P.

We obtain the opposite result if demand is elastic: An increase in the price causes a decrease in total revenue. In Figure 5-4, for instance, when the price rises from $4 to $5, the quantity demanded falls from 50 to 20, and so total revenue falls from $200 to $100. Because demand is elastic, the reduction in the quantity demanded is so great that it more than offsets the increase in the price. That is, an increase in price reduces $P \times Q$ because the fall in Q is proportionately greater than the rise in P.

Although the examples in these two figures are extreme, they illustrate a general rule:

- When a demand curve is inelastic (a price elasticity less than 1), a price increase raises total revenue, and a price decrease reduces total revenue.
- When a demand curve is elastic (a price elasticity greater than 1), a price increase reduces total revenue, and a price decrease raises total revenue.
- In the special case of unit elastic demand (a price elasticity exactly equal to 1), a change in the price does not affect total revenue.

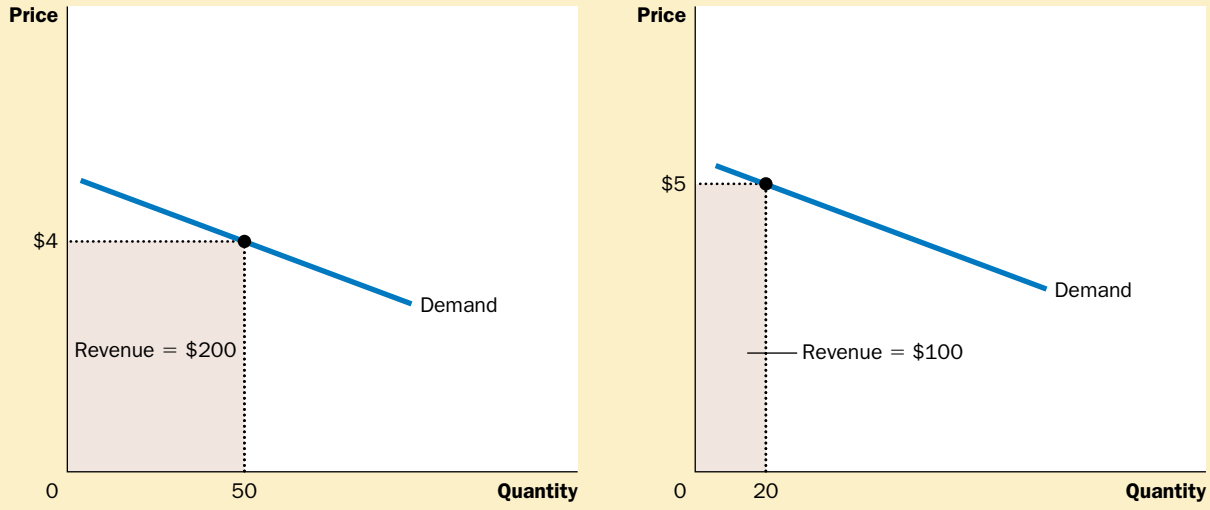


Figure 5-4

HOW TOTAL REVENUE CHANGES WHEN PRICE CHANGES: ELASTIC DEMAND. With an elastic demand curve, an increase in the price leads to a decrease in quantity demanded that is proportionately larger. Therefore, total revenue (the product of price and quantity) decreases. Here, an increase in the price from $4 to $5 causes the quantity demanded to fall from 50 to 20, so total revenue falls from $200 to $100.

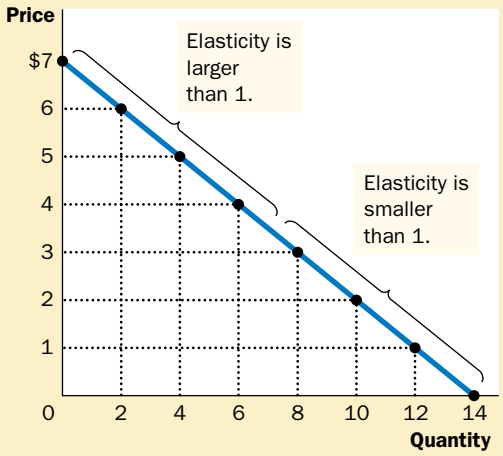


Figure 5-5

A LINEAR DEMAND CURVE. The slope of a linear demand curve is constant, but its elasticity is not.

PRICE	QUANTITY	TOTAL REVENUE (PRICE × QUANTITY)	PERCENT CHANGE IN PRICE	PERCENT CHANGE IN QUANTITY	ELASTICITY	DESCRIPTION
$7	0	$ 0				
			15	200	13.0	Elastic
6	2	12				
			18	67	3.7	Elastic
5	4	20				
			22	40	1.8	Elastic
4	6	24				
			29	29	1.0	Unit elastic
3	8	24				
			40	22	0.6	Inelastic
2	10	20				
			67	18	0.3	Inelastic
1	12	12				
			200	15	0.1	Inelastic
0	14	0				

COMPUTING THE ELASTICITY OF A LINEAR DEMAND CURVE

NOTE: Elasticity is calculated here using the midpoint method.

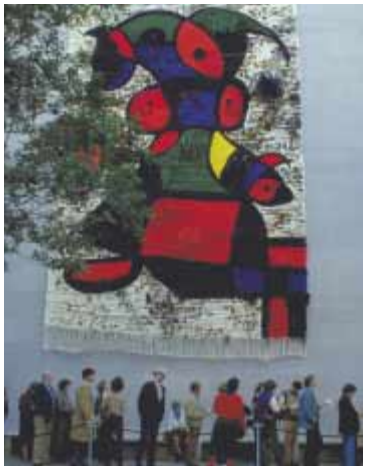
Table 5-1

ELASTICITY AND TOTAL REVENUE ALONG A LINEAR DEMAND CURVE

Although some demand curves have an elasticity that is the same along the entire curve, that is not always the case. An example of a demand curve along which elasticity changes is a straight line, as shown in Figure 5-5. A linear demand curve has a constant slope. Recall that slope is defined as "rise over run," which here is the ratio of the change in price ("rise") to the change in quantity ("run"). This particular demand curve's slope is constant because each $1 increase in price causes the same 2-unit decrease in the quantity demanded.

Even though the slope of a linear demand curve is constant, the elasticity is not. The reason is that the slope is the ratio of *changes* in the two variables, whereas the elasticity is the ratio of *percentage changes* in the two variables. You can see this most easily by looking at Table 5-1. This table shows the demand schedule for the linear demand curve in Figure 5-5 and calculates the price elasticity of demand using the midpoint method discussed earlier. At points with a low price and high quantity, the demand curve is inelastic. At points with a high price and low quantity, the demand curve is elastic.

Table 5-1 also presents total revenue at each point on the demand curve. These numbers illustrate the relationship between total revenue and elasticity. When the price is $1, for instance, demand is inelastic, and a price increase to $2 raises total revenue. When the price is $5, demand is elastic, and a price increase to $6 reduces total revenue. Between $3 and $4, demand is exactly unit elastic, and total revenue is the same at these two prices.



IF THE PRICE OF ADMISSION WERE HIGHER, HOW MUCH SHORTER WOULD THIS LINE BECOME?

CASE STUDY PRICING ADMISSION TO A MUSEUM

You are curator of a major art museum. Your director of finance tells you that the museum is running short of funds and suggests that you consider changing the price of admission to increase total revenue. What do you do? Do you raise the price of admission, or do you lower it?

The answer depends on the elasticity of demand. If the demand for visits to the museum is inelastic, then an increase in the price of admission would increase total revenue. But if the demand is elastic, then an increase in price would cause the number of visitors to fall by so much that total revenue would decrease. In this case, you should cut the price. The number of visitors would rise by so much that total revenue would increase.

To estimate the price elasticity of demand, you would need to turn to your statisticians. They might use historical data to study how museum attendance varied from year to year as the admission price changed. Or they might use data on attendance at the various museums around the country to see how the admission price affects attendance. In studying either of these sets of data, the statisticians would need to take account of other factors that affect attendance—weather, population, size of collection, and so forth—to isolate the effect of price. In the end, such data analysis would provide an estimate of the price elasticity of demand, which you could use in deciding how to respond to your financial problem.

OTHER DEMAND ELASTICITIES

income elasticity of demand
a measure of how much the quantity demanded of a good responds to a change in consumers' income, computed as the percentage change in quantity demanded divided by the percentage change in income

In addition to the price elasticity of demand, economists also use other elasticities to describe the behavior of buyers in a market.

The Income Elasticity of Demand Economists use the **income elasticity of demand** to measure how the quantity demanded changes as consumer income changes. The income elasticity is the percentage change in quantity demanded divided by the percentage change in income. That is,

IN THE NEWS

On the Road with Elasticity

HOW SHOULD A FIRM THAT OPERATES A private toll road set a price for its service? As the following article makes clear, answering this question requires an understanding of the demand curve and its elasticity.

For Whom the Booth Tolls, Price Really Does Matter

BY STEVEN PEARLSTEIN

All businesses face a similar question: What price for their product will generate the maximum profit?

The answer is not always obvious: Raising the price of something often has the effect of reducing sales as price-sensitive consumers seek alternatives or simply do without. For every product, the extent of that sensitivity is different. The trick is to find the point for each where the ideal tradeoff between profit margin and sales volume is achieved.

Right now, the developers of a new private toll road between Leesburg and Washington-Dulles International Airport are trying to discern the magic point. The group originally projected that it could charge nearly $2 for the 14-mile one-way trip, while attracting 34,000 trips on an average day from overcrowded public roads such as nearby Route 7. But after spending $350 million to build their much heralded "Greenway," they discovered to their dismay that only about a third that number of commuters were willing to pay that much to shave 20 minutes off their daily commute. . . .

It was only when the company, in desperation, lowered the toll to $1 that it came even close to attracting the expected traffic flows.

Although the Greenway still is losing money, it is clearly better off at this new point on the demand curve than it was when it first opened. Average daily revenue today is $22,000, compared with $14,875 when the "special introductory" price was $1.75. And with traffic still light even at rush hour, it is possible that the owners may lower tolls even further in search of higher revenue.

After all, when the price was lowered by 45 percent last spring, it generated a 200 percent increase in volume three months later. If the same ratio applies again, lowering the toll another 25 percent would drive the daily volume up to 38,000 trips, and daily revenue up to nearly $29,000.

The problem, of course, is that the same ratio usually does not apply at every price point, which is why this pricing business is so tricky. . . .

Clifford Winston of the Brookings Institution and John Calfee of the American Enterprise Institute have considered the toll road's dilemma. . . .

Last year, the economists conducted an elaborate market test with 1,170 people across the country who were each presented with a series of options in which they were, in effect, asked to make a personal tradeoff between less commuting time and higher tolls.

In the end, they concluded that the people who placed the highest value on reducing their commuting time already had done so by finding public transportation, living closer to their work, or selecting jobs that allowed them to commute at off-peak hours.

Conversely, those who commuted significant distances had a higher tolerance for traffic congestion and were willing to pay only 20 percent of their hourly pay to save an hour of their time.

Overall, the Winston/Calfee findings help explain why the Greenway's original toll and volume projections were too high: By their reckoning, only commuters who earned at least $30 an hour (about $60,000 a year) would be willing to pay $2 to save 20 minutes.

SOURCE: *The Washington Post,* October 24, 1996, p. E1.

$$\text{Income elasticity of demand} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in income}}.$$

As we discussed in Chapter 4, most goods are *normal goods:* Higher income raises quantity demanded. Because quantity demanded and income move in the same direction, normal goods have positive income elasticities. A few goods, such as bus

rides, are *inferior goods:* Higher income lowers the quantity demanded. Because quantity demanded and income move in opposite directions, inferior goods have negative income elasticities.

Even among normal goods, income elasticities vary substantially in size. Necessities, such as food and clothing, tend to have small income elasticities because consumers, regardless of how low their incomes, choose to buy some of these goods. Luxuries, such as caviar and furs, tend to have large income elasticities because consumers feel that they can do without these goods altogether if their income is too low.

cross-price elasticity of demand
a measure of how much the quantity demanded of one good responds to a change in the price of another good, computed as the percentage change in quantity demanded of the first good divided by the percentage change in the price of the second good

The Cross-Price Elasticity of Demand

Economists use the **cross-price elasticity of demand** to measure how the quantity demanded of one good changes as the price of another good changes. It is calculated as the percentage change in quantity demanded of good 1 divided by the percentage change in the price of good 2. That is,

$$\text{Cross-price elasticity of demand} = \frac{\text{Percentage change in quantity demanded of good 1}}{\text{Percentage change in the price of good 2}}.$$

Whether the cross-price elasticity is a positive or negative number depends on whether the two goods are substitutes or complements. As we discussed in Chapter 4, substitutes are goods that are typically used in place of one another, such as hamburgers and hot dogs. An increase in hot dog prices induces people to grill hamburgers instead. Because the price of hot dogs and the quantity of hamburgers demanded move in the same direction, the cross-price elasticity is positive. Conversely, complements are goods that are typically used together, such as computers and software. In this case, the cross-price elasticity is negative, indicating that an increase in the price of computers reduces the quantity of software demanded.

QUICK QUIZ: Define the *price elasticity of demand*. ◆ Explain the relationship between total revenue and the price elasticity of demand.

THE ELASTICITY OF SUPPLY

When we discussed the determinants of supply in Chapter 4, we noted that sellers of a good increase the quantity supplied when the price of the good rises, when their input prices fall, or when their technology improves. To turn from qualitative to quantitative statements about supply, we once again use the concept of elasticity.

price elasticity of supply
a measure of how much the quantity supplied of a good responds to a change in the price of that good, computed as the percentage change in quantity supplied divided by the percentage change in price

THE PRICE ELASTICITY OF SUPPLY AND ITS DETERMINANTS

The law of supply states that higher prices raise the quantity supplied. The **price elasticity of supply** measures how much the quantity supplied responds to changes in the price. Supply of a good is said to be *elastic* if the quantity supplied

responds substantially to changes in the price. Supply is said to be *inelastic* if the quantity supplied responds only slightly to changes in the price.

The price elasticity of supply depends on the flexibility of sellers to change the amount of the good they produce. For example, beachfront land has an inelastic supply because it is almost impossible to produce more of it. By contrast, manufactured goods, such as books, cars, and televisions, have elastic supplies because the firms that produce them can run their factories longer in response to a higher price.

In most markets, a key determinant of the price elasticity of supply is the time period being considered. Supply is usually more elastic in the long run than in the short run. Over short periods of time, firms cannot easily change the size of their factories to make more or less of a good. Thus, in the short run, the quantity supplied is not very responsive to the price. By contrast, over longer periods, firms can build new factories or close old ones. In addition, new firms can enter a market, and old firms can shut down. Thus, in the long run, the quantity supplied can respond substantially to the price.

COMPUTING THE PRICE ELASTICITY OF SUPPLY

Now that we have some idea about what the price elasticity of supply is, let's be more precise. Economists compute the price elasticity of supply as the percentage change in the quantity supplied divided by the percentage change in the price. That is,

$$\text{Price elasticity of supply} = \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}.$$

For example, suppose that an increase in the price of milk from \$2.85 to \$3.15 a gallon raises the amount that dairy farmers produce from 9,000 to 11,000 gallons per month. Using the midpoint method, we calculate the percentage change in price as

$$\text{Percentage change in price} = (3.15 - 2.85)/3.00 \times 100 = 10 \text{ percent}.$$

Similarly, we calculate the percentage change in quantity supplied as

$$\begin{aligned}\text{Percentage change in quantity supplied} &= (11{,}000 - 9{,}000)/10{,}000 \times 100 \\ &= 20 \text{ percent}.\end{aligned}$$

In this case, the price elasticity of supply is

$$\text{Price elasticity of supply} = \frac{20 \text{ percent}}{10 \text{ percent}} = 2.0.$$

In this example, the elasticity of 2 reflects the fact that the quantity supplied moves proportionately twice as much as the price.

THE VARIETY OF SUPPLY CURVES

Because the price elasticity of supply measures the responsiveness of quantity supplied to the price, it is reflected in the appearance of the supply curve. Figure 5-6 shows five cases. In the extreme case of a zero elasticity, supply is *perfectly inelastic*,

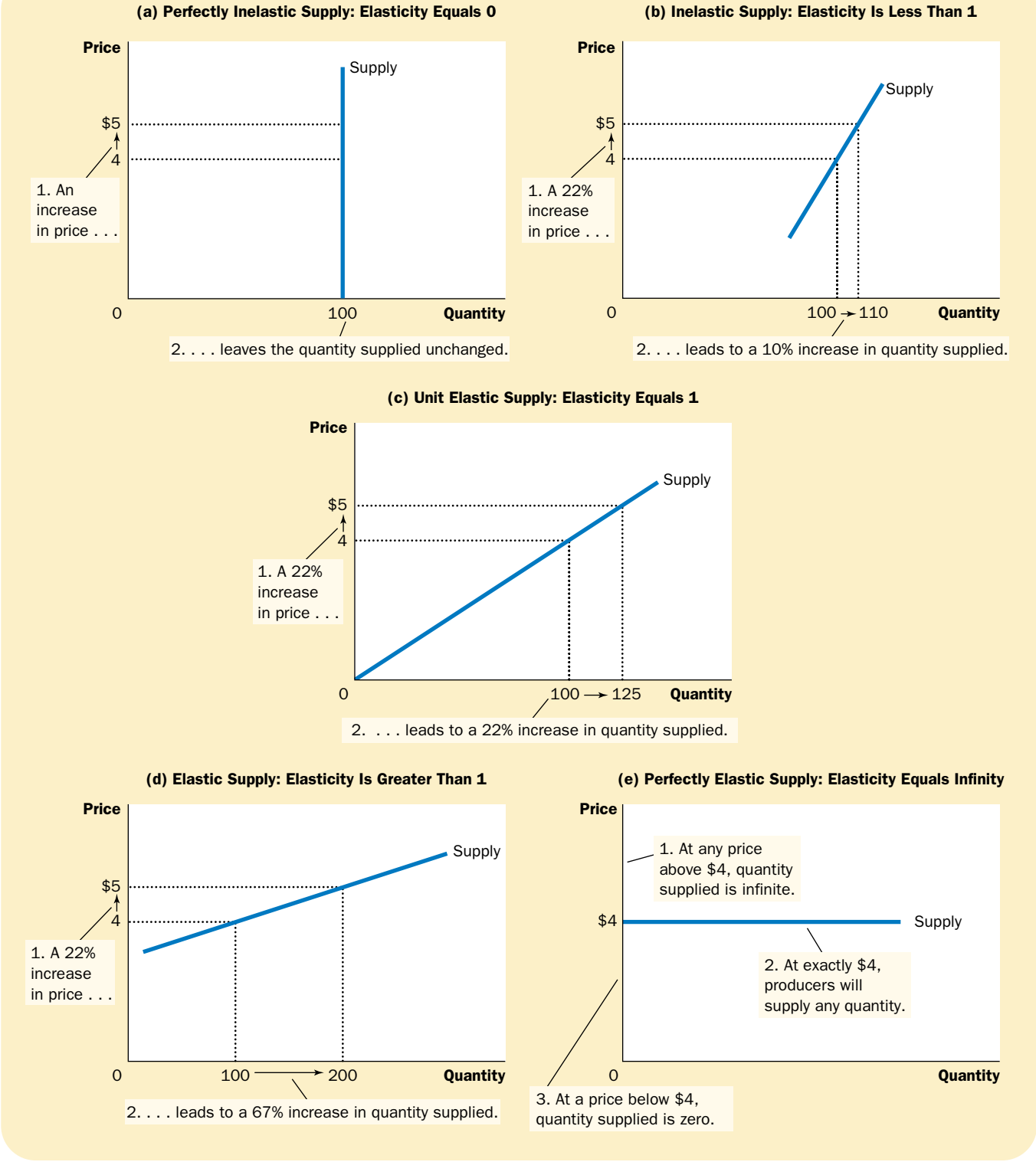


Figure 5-6

THE PRICE ELASTICITY OF SUPPLY. The price elasticity of supply determines whether the supply curve is steep or flat. Note that all percentage changes are calculated using the midpoint method.

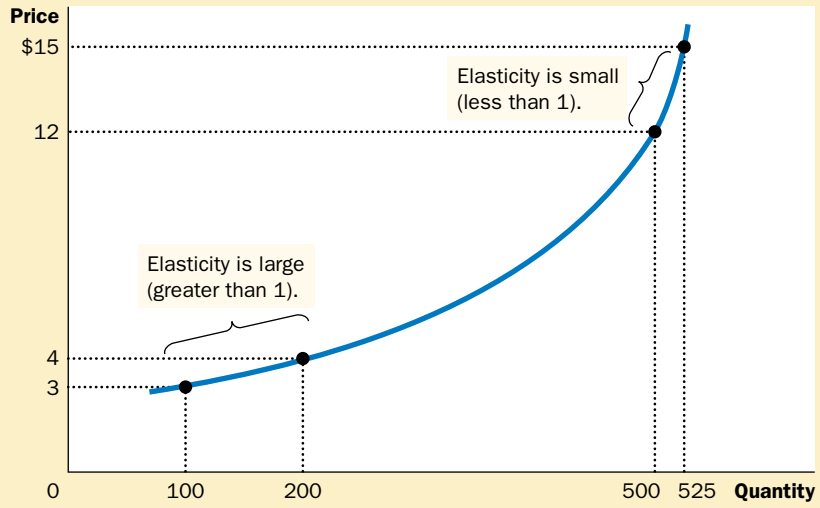


Figure 5-7

HOW THE PRICE ELASTICITY OF SUPPLY CAN VARY. Because firms often have a maximum capacity for production, the elasticity of supply may be very high at low levels of quantity supplied and very low at high levels of quantity supplied. Here, an increase in price from $3 to $4 increases the quantity supplied from 100 to 200. Because the increase in quantity supplied of 67 percent is larger than the increase in price of 29 percent, the supply curve is elastic in this range. By contrast, when the price rises from $12 to $15, the quantity supplied rises only from 500 to 525. Because the increase in quantity supplied of 5 percent is smaller than the increase in price of 22 percent, the supply curve is inelastic in this range.

and the supply curve is vertical. In this case, the quantity supplied is the same regardless of the price. As the elasticity rises, the supply curve gets flatter, which shows that the quantity supplied responds more to changes in the price. At the opposite extreme, supply is *perfectly elastic.* This occurs as the price elasticity of supply approaches infinity and the supply curve becomes horizontal, meaning that very small changes in the price lead to very large changes in the quantity supplied.

In some markets, the elasticity of supply is not constant but varies over the supply curve. Figure 5-7 shows a typical case for an industry in which firms have factories with a limited capacity for production. For low levels of quantity supplied, the elasticity of supply is high, indicating that firms respond substantially to changes in the price. In this region, firms have capacity for production that is not being used, such as plants and equipment sitting idle for all or part of the day. Small increases in price make it profitable for firms to begin using this idle capacity. As the quantity supplied rises, firms begin to reach capacity. Once capacity is fully used, increasing production further requires the construction of new plants. To induce firms to incur this extra expense, the price must rise substantially, so supply becomes less elastic.

Figure 5-7 presents a numerical example of this phenomenon. When the price rises from $3 to $4 (a 29 percent increase, according to the midpoint method), the quantity supplied rises from 100 to 200 (a 67 percent increase). Because quantity supplied moves proportionately more than the price, the supply curve has elasticity greater than 1. By contrast, when the price rises from $12 to $15 (a 22 percent increase), the quantity supplied rises from 500 to 525 (a 5 percent increase). In this case, quantity supplied moves proportionately less than the price, so the elasticity is less than 1.

QUICK QUIZ: Define the *price elasticity of supply.* ◆ Explain why the the price elasticity of supply might be different in the long run than in the short run.

THREE APPLICATIONS OF SUPPLY, DEMAND, AND ELASTICITY

Can good news for farming be bad news for farmers? Why did the Organization of Petroleum Exporting Countries (OPEC) fail to keep the price of oil high? Does drug interdiction increase or decrease drug-related crime? At first, these questions might seem to have little in common. Yet all three questions are about markets, and all markets are subject to the forces of supply and demand. Here we apply the versatile tools of supply, demand, and elasticity to answer these seemingly complex questions.

CAN GOOD NEWS FOR FARMING BE BAD NEWS FOR FARMERS?

Let's now return to the question posed at the beginning of this chapter: What happens to wheat farmers and the market for wheat when university agronomists discover a new wheat hybrid that is more productive than existing varieties? Recall from Chapter 4 that we answer such questions in three steps. First, we examine whether the supply curve or demand curve shifts. Second, we consider which direction the curve shifts. Third, we use the supply-and-demand diagram to see how the market equilibrium changes.

In this case, the discovery of the new hybrid affects the supply curve. Because the hybrid increases the amount of wheat that can be produced on each acre of land, farmers are now willing to supply more wheat at any given price. In other words, the supply curve shifts to the right. The demand curve remains the same because consumers' desire to buy wheat products at any given price is not affected by the introduction of a new hybrid. Figure 5-8 shows an example of such a change. When the supply curve shifts from S_1 to S_2, the quantity of wheat sold increases from 100 to 110, and the price of wheat falls from \$3 to \$2.

But does this discovery make farmers better off? As a first cut to answering this question, consider what happens to the total revenue received by farmers. Farmers' total revenue is $P \times Q$, the price of the wheat times the quantity sold. The discovery affects farmers in two conflicting ways. The hybrid allows farmers to produce more wheat (Q rises), but now each bushel of wheat sells for less (P falls).

Whether total revenue rises or falls depends on the elasticity of demand. In practice, the demand for basic foodstuffs such as wheat is usually inelastic, for these items are relatively inexpensive and have few good substitutes. When the demand curve is inelastic, as it is in Figure 5-8, a decrease in price causes total revenue to fall. You can see this in the figure: The price of wheat falls substantially, whereas the quantity of wheat sold rises only slightly. Total revenue falls from \$300 to \$220. Thus, the discovery of the new hybrid lowers the total revenue that farmers receive for the sale of their crops.

If farmers are made worse off by the discovery of this new hybrid, why do they adopt it? The answer to this question goes to the heart of how competitive markets work. Because each farmer is a small part of the market for wheat, he or she takes the price of wheat as given. For any given price of wheat, it is better to

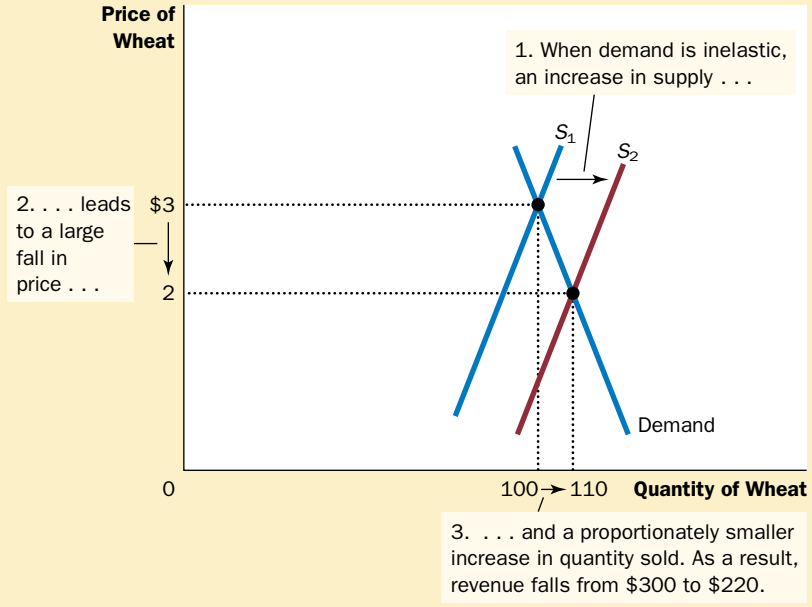


Figure 5-8

AN INCREASE IN SUPPLY IN THE MARKET FOR WHEAT. When an advance in farm technology increases the supply of wheat from S_1 to S_2, the price of wheat falls. Because the demand for wheat is inelastic, the increase in the quantity sold from 100 to 110 is proportionately smaller than the decrease in the price from $3 to $2. As a result, farmers' total revenue falls from $300 ($3 × 100) to $220 ($2 × 110).

use the new hybrid in order to produce and sell more wheat. Yet when all farmers do this, the supply of wheat rises, the price falls, and farmers are worse off.

Although this example may at first seem only hypothetical, in fact it helps to explain a major change in the U.S. economy over the past century. Two hundred years ago, most Americans lived on farms. Knowledge about farm methods was sufficiently primitive that most of us had to be farmers to produce enough food. Yet, over time, advances in farm technology increased the amount of food that each farmer could produce. This increase in food supply, together with inelastic food demand, caused farm revenues to fall, which in turn encouraged people to leave farming.

A few numbers show the magnitude of this historic change. As recently as 1950, there were 10 million people working on farms in the United States, representing 17 percent of the labor force. In 1998, fewer than 3 million people worked on farms, or 2 percent of the labor force. This change coincided with tremendous advances in farm productivity: Despite the 70 percent drop in the number of farmers, U.S. farms produced more than twice the output of crops and livestock in 1998 as they did in 1950.

This analysis of the market for farm products also helps to explain a seeming paradox of public policy: Certain farm programs try to help farmers by inducing them not to plant crops on all of their land. Why do these programs do this? Their purpose is to reduce the supply of farm products and thereby raise prices. With inelastic demand for their products, farmers as a group receive greater total revenue if they supply a smaller crop to the market. No single farmer would choose to leave his land fallow on his own because each takes the market price as given. But if all farmers do so together, each of them can be better off.

When analyzing the effects of farm technology or farm policy, it is important to keep in mind that what is good for farmers is not necessarily good for society as a whole. Improvement in farm technology can be bad for farmers who become increasingly unnecessary, but it is surely good for consumers who pay less for food. Similarly, a policy aimed at reducing the supply of farm products may raise the incomes of farmers, but it does so at the expense of consumers.

WHY DID OPEC FAIL TO KEEP THE PRICE OF OIL HIGH?

Many of the most disruptive events for the world's economies over the past several decades have originated in the world market for oil. In the 1970s members of the Organization of Petroleum Exporting Countries (OPEC) decided to raise the world price of oil in order to increase their incomes. These countries accomplished this goal by jointly reducing the amount of oil they supplied. From 1973 to 1974, the price of oil (adjusted for overall inflation) rose more than 50 percent. Then, a few years later, OPEC did the same thing again. The price of oil rose 14 percent in 1979, followed by 34 percent in 1980, and another 34 percent in 1981.

Yet OPEC found it difficult to maintain a high price. From 1982 to 1985, the price of oil steadily declined at about 10 percent per year. Dissatisfaction and disarray soon prevailed among the OPEC countries. In 1986 cooperation among OPEC members completely broke down, and the price of oil plunged 45 percent. In 1990 the price of oil (adjusted for overall inflation) was back to where it began in 1970, and it has stayed at that low level throughout most of the 1990s.

This episode shows how supply and demand can behave differently in the short run and in the long run. In the short run, both the supply and demand for oil are relatively inelastic. Supply is inelastic because the quantity of known oil reserves and the capacity for oil extraction cannot be changed quickly. Demand is inelastic because buying habits do not respond immediately to changes in price. Many drivers with old gas-guzzling cars, for instance, will just pay the higher

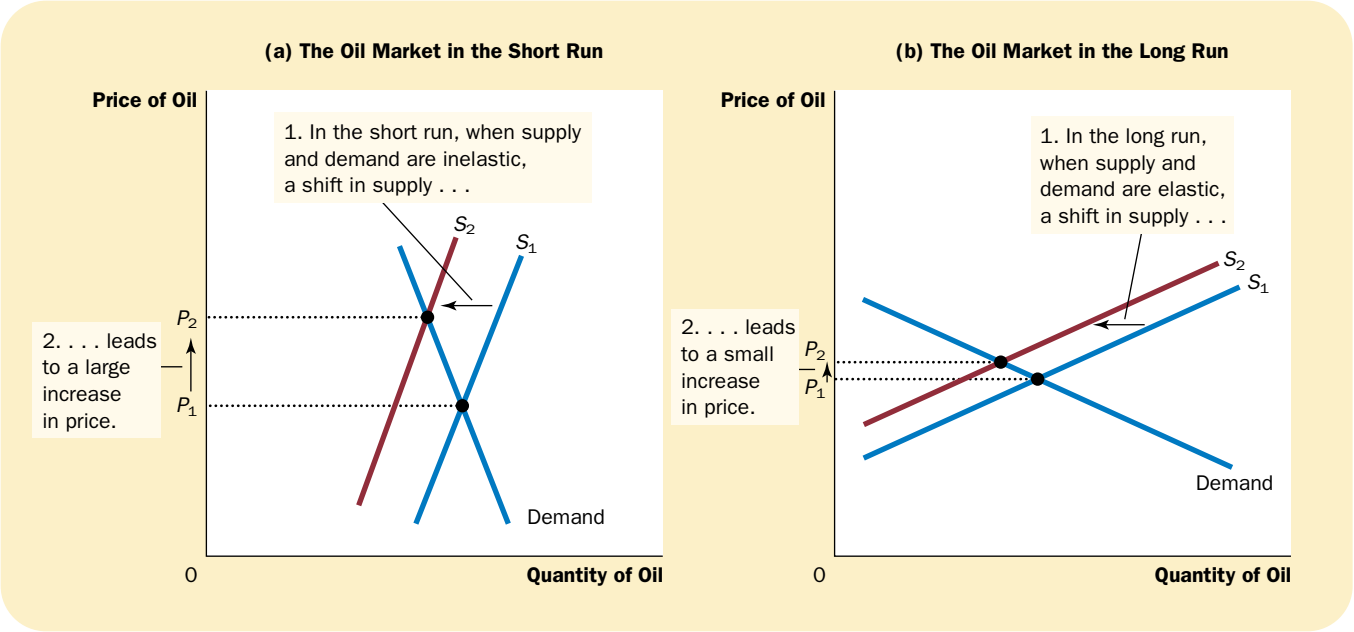


Figure 5-9

A REDUCTION IN SUPPLY IN THE WORLD MARKET FOR OIL. When the supply of oil falls, the response depends on the time horizon. In the short run, supply and demand are relatively inelastic, as in panel (a). Thus, when the supply curve shifts from S_1 to S_2, the price rises substantially. By contrast, in the long run, supply and demand are relatively elastic, as in panel (b). In this case, the same size shift in the supply curve (S_1 to S_2) causes a smaller increase in the price.

price. Thus, as panel (a) of Figure 5-9 shows, the short-run supply and demand curves are steep. When the supply of oil shifts from S_1 to S_2, the price increase from P_1 to P_2 is large.

The situation is very different in the long run. Over long periods of time, producers of oil outside of OPEC respond to high prices by increasing oil exploration and by building new extraction capacity. Consumers respond with greater conservation, for instance by replacing old inefficient cars with newer efficient ones. Thus, as panel (b) of Figure 5-9 shows, the long-run supply and demand curves are more elastic. In the long run, the shift in the supply curve from S_1 to S_2 causes a much smaller increase in the price.

This analysis shows why OPEC succeeded in maintaining a high price of oil only in the short run. When OPEC countries agreed to reduce their production of oil, they shifted the supply curve to the left. Even though each OPEC member sold less oil, the price rose by so much in the short run that OPEC incomes rose. By contrast, in the long run when supply and demand are more elastic, the same reduction in supply, measured by the horizontal shift in the supply curve, caused a smaller increase in the price. Thus, OPEC's coordinated reduction in supply proved less profitable in the long run.

OPEC still exists today, and it has from time to time succeeded at reducing supply and raising prices. But the price of oil (adjusted for overall inflation) has

never returned to the peak reached in 1981. The cartel now seems to understand that raising prices is easier in the short run than in the long run.

DOES DRUG INTERDICTION INCREASE OR DECREASE DRUG-RELATED CRIME?

A persistent problem facing our society is the use of illegal drugs, such as heroin, cocaine, and crack. Drug use has several adverse effects. One is that drug dependency can ruin the lives of drug users and their families. Another is that drug addicts often turn to robbery and other violent crimes to obtain the money needed to support their habit. To discourage the use of illegal drugs, the U.S. government devotes billions of dollars each year to reduce the flow of drugs into the country. Let's use the tools of supply and demand to examine this policy of drug interdiction.

Suppose the government increases the number of federal agents devoted to the war on drugs. What happens in the market for illegal drugs? As is usual, we answer this question in three steps. First, we consider whether the supply curve or demand curve shifts. Second, we consider the direction of the shift. Third, we see how the shift affects the equilibrium price and quantity.

Although the purpose of drug interdiction is to reduce drug use, its direct impact is on the sellers of drugs rather than the buyers. When the government stops some drugs from entering the country and arrests more smugglers, it raises the cost of selling drugs and, therefore, reduces the quantity of drugs supplied at any given price. The demand for drugs—the amount buyers want at any given price—is not changed. As panel (a) of Figure 5-10 shows, interdiction shifts the supply curve to the left from S_1 to S_2 and leaves the demand curve the same. The equilibrium price of drugs rises from P_1 to P_2, and the equilibrium quantity falls from Q_1 to Q_2. The fall in the equilibrium quantity shows that drug interdiction does reduce drug use.

But what about the amount of drug-related crime? To answer this question, consider the total amount that drug users pay for the drugs they buy. Because few drug addicts are likely to break their destructive habits in response to a higher price, it is likely that the demand for drugs is inelastic, as it is drawn in the figure. If demand is inelastic, then an increase in price raises total revenue in the drug market. That is, because drug interdiction raises the price of drugs proportionately more than it reduces drug use, it raises the total amount of money that drug users pay for drugs. Addicts who already had to steal to support their habits would have an even greater need for quick cash. Thus, drug interdiction could increase drug-related crime.

Because of this adverse effect of drug interdiction, some analysts argue for alternative approaches to the drug problem. Rather than trying to reduce the supply of drugs, policymakers might try to reduce the demand by pursuing a policy of drug education. Successful drug education has the effects shown in panel (b) of Figure 5-10. The demand curve shifts to the left from D_1 to D_2. As a result, the equilibrium quantity falls from Q_1 to Q_2, and the equilibrium price falls from P_1 to P_2. Total revenue, which is price times quantity, also falls. Thus, in contrast to drug interdiction, drug education can reduce both drug use and drug-related crime.

Advocates of drug interdiction might argue that the effects of this policy are different in the long run than in the short run, because the elasticity of demand may depend on the time horizon. The demand for drugs is probably inelastic over

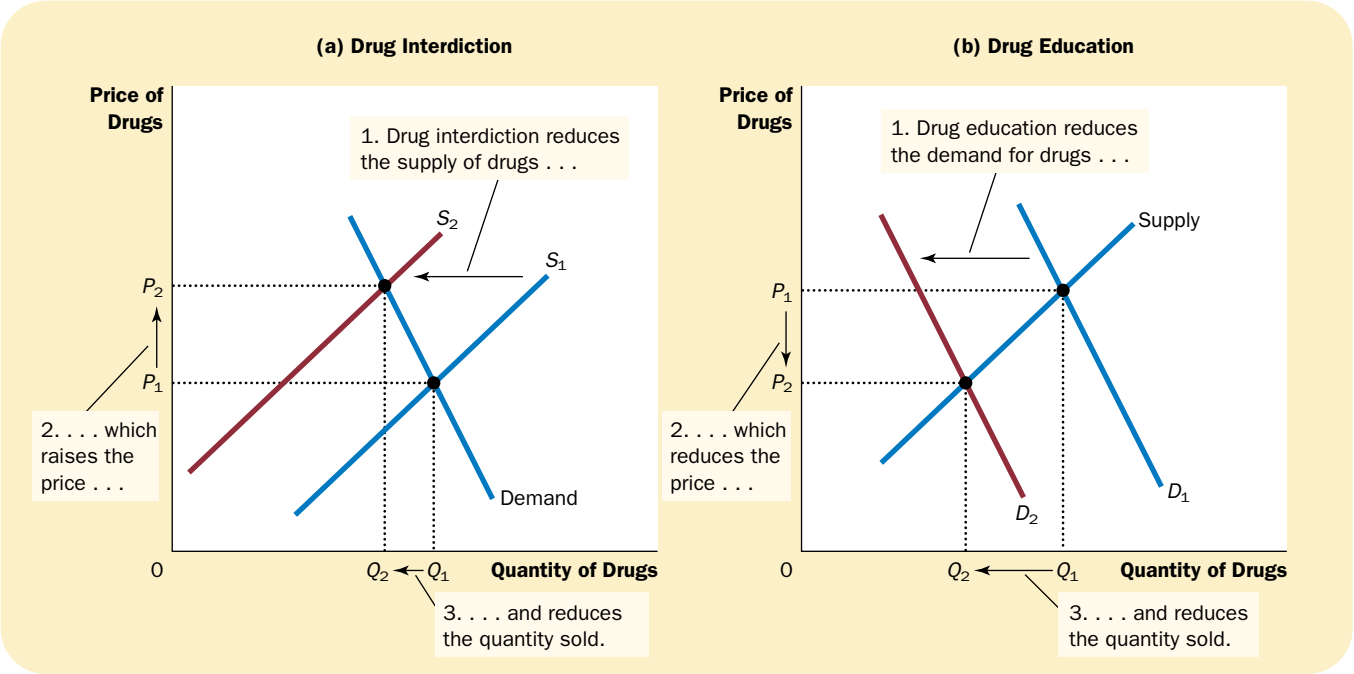


Figure 5-10

POLICIES TO REDUCE THE USE OF ILLEGAL DRUGS. Drug interdiction reduces the supply of drugs from S_1 to S_2, as in panel (a). If the demand for drugs is inelastic, then the total amount paid by drug users rises, even as the amount of drug use falls. By contrast, drug education reduces the demand for drugs from D_1 to D_2, as in panel (b). Because both price and quantity fall, the amount paid by drug users falls.

short periods of time because higher prices do not substantially affect drug use by established addicts. But demand may be more elastic over longer periods of time because higher prices would discourage experimentation with drugs among the young and, over time, lead to fewer drug addicts. In this case, drug interdiction would increase drug-related crime in the short run while decreasing it in the long run.

QUICK QUIZ: How might a drought that destroys half of all farm crops be good for farmers? If such a drought is good for farmers, why don't farmers destroy their own crops in the absence of a drought?

CONCLUSION

According to an old quip, even a parrot can become an economist simply by learning to say "supply and demand." These last two chapters should have convinced you that there is much truth in this statement. The tools of supply and demand allow you to analyze many of the most important events and policies that shape

the economy. You are now well on your way to becoming an economist (or, at least, a well-educated parrot).

Summary

- The price elasticity of demand measures how much the quantity demanded responds to changes in the price. Demand tends to be more elastic if the good is a luxury rather than a necessity, if close substitutes are available, if the market is narrowly defined, or if buyers have substantial time to react to a price change.
- The price elasticity of demand is calculated as the percentage change in quantity demanded divided by the percentage change in price. If the elasticity is less than 1, so that quantity demanded moves proportionately less than the price, demand is said to be inelastic. If the elasticity is greater than 1, so that quantity demanded moves proportionately more than the price, demand is said to be elastic.
- Total revenue, the total amount paid for a good, equals the price of the good times the quantity sold. For inelastic demand curves, total revenue rises as price rises. For elastic demand curves, total revenue falls as price rises.
- The income elasticity of demand measures how much the quantity demanded responds to changes in consumers' income. The cross-price elasticity of demand measures how much the quantity demanded of one good responds to the price of another good.
- The price elasticity of supply measures how much the quantity supplied responds to changes in the price. This elasticity often depends on the time horizon under consideration. In most markets, supply is more elastic in the long run than in the short run.
- The price elasticity of supply is calculated as the percentage change in quantity supplied divided by the percentage change in price. If the elasticity is less than 1, so that quantity supplied moves proportionately less than the price, supply is said to be inelastic. If the elasticity is greater than 1, so that quantity supplied moves proportionately more than the price, supply is said to be elastic.
- The tools of supply and demand can be applied in many different kinds of markets. This chapter uses them to analyze the market for wheat, the market for oil, and the market for illegal drugs.

Key Concepts

elasticity, p. 94
price elasticity of demand, p. 94
total revenue, p. 98
income elasticity of demand, p. 102
cross-price elasticity of demand, p. 104
price elasticity of supply, p. 104

Questions for Review

1. Define the price elasticity of demand and the income elasticity of demand.
2. List and explain some of the determinants of the price elasticity of demand.
3. If the elasticity is greater than 1, is demand elastic or inelastic? If the elasticity equals 0, is demand perfectly elastic or perfectly inelastic?
4. On a supply-and-demand diagram, show equilibrium price, equilibrium quantity, and the total revenue received by producers.
5. If demand is elastic, how will an increase in price change total revenue? Explain.
6. What do we call a good whose income elasticity is less than 0?
7. How is the price elasticity of supply calculated? Explain what this measures.
8. What is the price elasticity of supply of Picasso paintings?
9. Is the price elasticity of supply usually larger in the short run or in the long run? Why?
10. In the 1970s, OPEC caused a dramatic increase in the price of oil. What prevented it from maintaining this high price through the 1980s?

Problems and Applications

1. For each of the following pairs of goods, which good would you expect to have more elastic demand and why?
   a. required textbooks or mystery novels
   b. Beethoven recordings or classical music recordings in general
   c. heating oil during the next six months or heating oil during the next five years
   d. root beer or water
2. Suppose that business travelers and vacationers have the following demand for airline tickets from New York to Boston:

Price	Quantity Demanded (business travelers)	Quantity Demanded (vacationers)
$150	2,100	1,000
200	2,000	800
250	1,900	600
300	1,800	400

   a. As the price of tickets rises from $200 to $250, what is the price elasticity of demand for (i) business travelers and (ii) vacationers? (Use the midpoint method in your calculations.)
   b. Why might vacationers have a different elasticity than business travelers?
3. Suppose that your demand schedule for compact discs is as follows:

Price	Quantity Demanded (income = $10,000)	Quantity Demanded (income = $12,000)
$ 8	40	50
10	32	45
12	24	30
14	16	20
16	8	12

   a. Use the midpoint method to calculate your price elasticity of demand as the price of compact discs increases from $8 to $10 if (i) your income is $10,000, and (ii) your income is $12,000.
   b. Calculate your income elasticity of demand as your income increases from $10,000 to $12,000 if (i) the price is $12, and (ii) the price is $16.
4. Emily has decided always to spend one-third of her income on clothing.
   a. What is her income elasticity of clothing demand?
   b. What is her price elasticity of clothing demand?
   c. If Emily's tastes change and she decides to spend only one-fourth of her income on clothing, how does her demand curve change? What are her income elasticity and price elasticity now?
5. *The New York Times* reported (Feb. 17, 1996, p. 25) that subway ridership declined after a fare increase: "There were nearly four million fewer riders in December 1995, the first full month after the price of a token increased 25 cents to $1.50, than in the previous December, a 4.3 percent decline."
   a. Use these data to estimate the price elasticity of demand for subway rides.
   b. According to your estimate, what happens to the Transit Authority's revenue when the fare rises?
   c. Why might your estimate of the elasticity be unreliable?
6. Two drivers—Tom and Jerry—each drive up to a gas station. Before looking at the price, each places an order. Tom says, "I'd like 10 gallons of gas." Jerry says, "I'd like $10 worth of gas." What is each driver's price elasticity of demand?
7. Economists have observed that spending on restaurant meals declines more during economic downturns than does spending on food to be eaten at home. How might the concept of elasticity help to explain this phenomenon?
8. Consider public policy aimed at smoking.
   a. Studies indicate that the price elasticity of demand for cigarettes is about 0.4. If a pack of cigarettes currently costs $2 and the government wants to reduce smoking by 20 percent, by how much should it increase the price?
   b. If the government permanently increases the price of cigarettes, will the policy have a larger effect on smoking one year from now or five years from now?
   c. Studies also find that teenagers have a higher price elasticity than do adults. Why might this be true?
9. Would you expect the price elasticity of *demand* to be larger in the market for all ice cream or the market for vanilla ice cream? Would you expect the price elasticity of *supply* to be larger in the market for all ice cream or the market for vanilla ice cream? Be sure to explain your answers.
10. Pharmaceutical drugs have an inelastic demand, and computers have an elastic demand. Suppose that

technological advance doubles the supply of both products (that is, the quantity supplied at each price is twice what it was).

a. What happens to the equilibrium price and quantity in each market?
b. Which product experiences a larger change in price?
c. Which product experiences a larger change in quantity?
d. What happens to total consumer spending on each product?

11. Beachfront resorts have an inelastic supply, and automobiles have an elastic supply. Suppose that a rise in population doubles the demand for both products (that is, the quantity demanded at each price is twice what it was).

a. What happens to the equilibrium price and quantity in each market?
b. Which product experiences a larger change in price?
c. Which product experiences a larger change in quantity?
d. What happens to total consumer spending on each product?

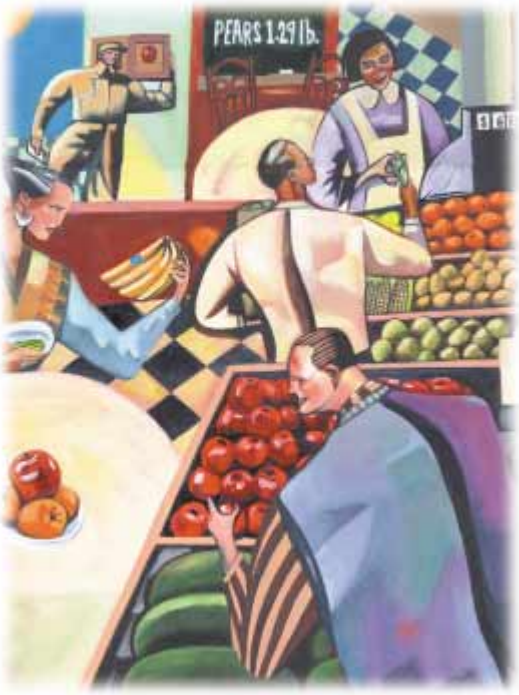
12. Several years ago, flooding along the Missouri and Mississippi rivers destroyed thousands of acres of wheat.

a. Farmers whose crops were destroyed by the floods were much worse off, but farmers whose crops were not destroyed benefited from the floods. Why?
b. What information would you need about the market for wheat in order to assess whether farmers as a group were hurt or helped by the floods?

13. Explain why the following might be true: A drought around the world raises the total revenue that farmers receive from the sale of grain, but a drought only in Kansas reduces the total revenue that Kansas farmers receive.

14. Because better weather makes farmland more productive, farmland in regions with good weather conditions is more expensive than farmland in regions with bad weather conditions. Over time, however, as advances in technology have made all farmland more productive, the price of farmland (adjusted for overall inflation) has fallen. Use the concept of elasticity to explain why productivity and farmland prices are positively related across space but negatively related over time.

6



SUPPLY, DEMAND, AND GOVERNMENT POLICIES

Economists have two roles. As scientists, they develop and test theories to explain the world around them. As policy advisers, they use their theories to help change the world for the better. The focus of the preceding two chapters has been scientific. We have seen how supply and demand determine the price of a good and the quantity of the good sold. We have also seen how various events shift supply and demand and thereby change the equilibrium price and quantity.

This chapter offers our first look at policy. Here we analyze various types of government policy using only the tools of supply and demand. As you will see, the analysis yields some surprising insights. Policies often have effects that their architects did not intend or anticipate.

We begin by considering policies that directly control prices. For example, rent-control laws dictate a maximum rent that landlords may charge tenants. Minimum-wage laws dictate the lowest wage that firms may pay workers. Price controls are

IN THIS CHAPTER YOU WILL . . .

Examine the effects of government policies that place a ceiling on prices

Examine the effects of government policies that put a floor under prices

Consider how a tax on a good affects the price of the good and the quantity sold

Learn that taxes levied on buyers and taxes levied on sellers are equivalent

See how the burden of a tax is split between buyers and sellers

usually enacted when policymakers believe that the market price of a good or service is unfair to buyers or sellers. Yet, as we will see, these policies can generate inequities of their own.

After our discussion of price controls, we next consider the impact of taxes. Policymakers use taxes both to influence market outcomes and to raise revenue for public purposes. Although the prevalence of taxes in our economy is obvious, their effects are not. For example, when the government levies a tax on the amount that firms pay their workers, do the firms or the workers bear the burden of the tax? The answer is not at all clear—until we apply the powerful tools of supply and demand.

CONTROLS ON PRICES

To see how price controls affect market outcomes, let's look once again at the market for ice cream. As we saw in Chapter 4, if ice cream is sold in a competitive market free of government regulation, the price of ice cream adjusts to balance supply and demand: At the equilibrium price, the quantity of ice cream that buyers want to buy exactly equals the quantity that sellers want to sell. To be concrete, suppose the equilibrium price is $3 per cone.

Not everyone may be happy with the outcome of this free-market process. Let's say the American Association of Ice Cream Eaters complains that the $3 price is too high for everyone to enjoy a cone a day (their recommended diet). Meanwhile, the National Organization of Ice Cream Makers complains that the $3 price—the result of "cutthroat competition"—is depressing the incomes of its members. Each of these groups lobbies the government to pass laws that alter the market outcome by directly controlling prices.

Of course, because buyers of any good always want a lower price while sellers want a higher price, the interests of the two groups conflict. If the Ice Cream Eaters are successful in their lobbying, the government imposes a legal maximum on the price at which ice cream can be sold. Because the price is not allowed to rise above this level, the legislated maximum is called a **price ceiling.** By contrast, if the Ice Cream Makers are successful, the government imposes a legal minimum on the price. Because the price cannot fall below this level, the legislated minimum is called a **price floor.** Let us consider the effects of these policies in turn.

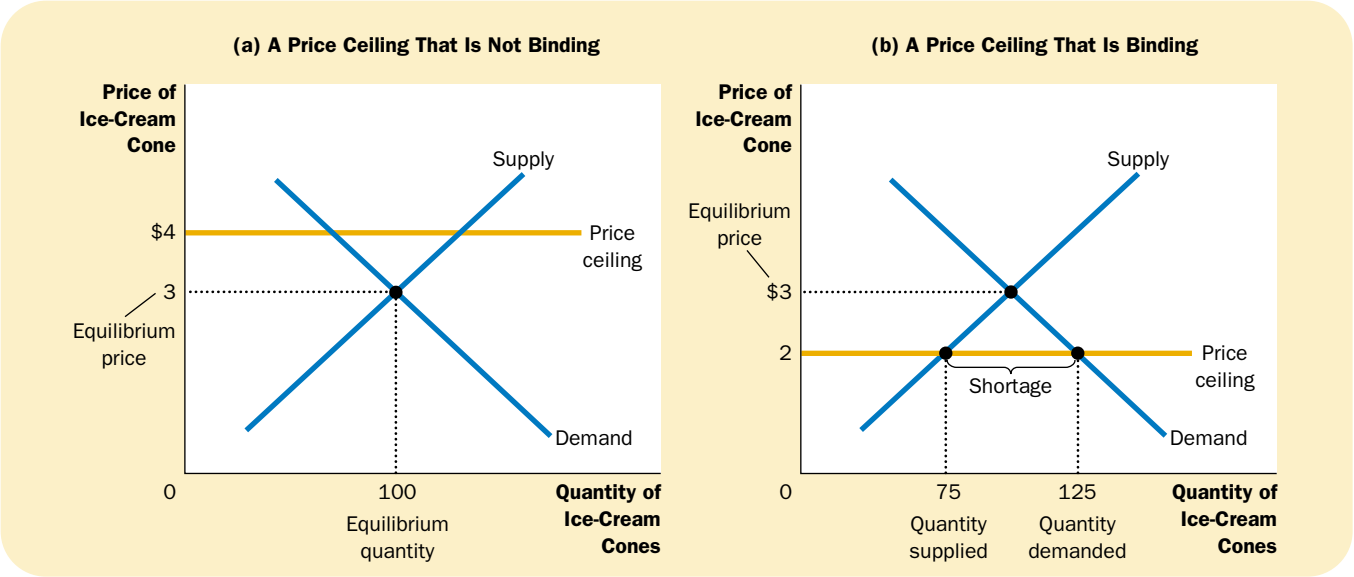
price ceiling
a legal maximum on the price at which a good can be sold

price floor
a legal minimum on the price at which a good can be sold

HOW PRICE CEILINGS AFFECT MARKET OUTCOMES

When the government, moved by the complaints of the Ice Cream Eaters, imposes a price ceiling on the market for ice cream, two outcomes are possible. In panel (a) of Figure 6-1, the government imposes a price ceiling of $4 per cone. In this case, because the price that balances supply and demand ($3) is below the ceiling, the price ceiling is *not binding*. Market forces naturally move the economy to the equilibrium, and the price ceiling has no effect.

Panel (b) of Figure 6-1 shows the other, more interesting, possibility. In this case, the government imposes a price ceiling of $2 per cone. Because the equilibrium price of $3 is above the price ceiling, the ceiling is a *binding constraint* on the market.



A MARKET WITH A PRICE CEILING. In panel (a), the government imposes a price ceiling of $4. Because the price ceiling is above the equilibrium price of $3, the price ceiling has no effect, and the market can reach the equilibrium of supply and demand. In this equilibrium, quantity supplied and quantity demanded both equal 100 cones. In panel (b), the government imposes a price ceiling of $2. Because the price ceiling is below the equilibrium price of $3, the market price equals $2. At this price, 125 cones are demanded and only 75 are supplied, so there is a shortage of 50 cones.

Figure 6-1

The forces of supply and demand tend to move the price toward the equilibrium price, but when the market price hits the ceiling, it can rise no further. Thus, the market price equals the price ceiling. At this price, the quantity of ice cream demanded (125 cones in the figure) exceeds the quantity supplied (75 cones). There is a shortage of ice cream, so some people who want to buy ice cream at the going price are unable to.

When a shortage of ice cream develops because of this price ceiling, some mechanism for rationing ice cream will naturally develop. The mechanism could be long lines: Buyers who are willing to arrive early and wait in line get a cone, while those unwilling to wait do not. Alternatively, sellers could ration ice cream according to their own personal biases, selling it only to friends, relatives, or members of their own racial or ethnic group. Notice that even though the price ceiling was motivated by a desire to help buyers of ice cream, not all buyers benefit from the policy. Some buyers do get to pay a lower price, although they may have to wait in line to do so, but other buyers cannot get any ice cream at all.

This example in the market for ice cream shows a general result: *When the government imposes a binding price ceiling on a competitive market, a shortage of the good arises, and sellers must ration the scarce goods among the large number of potential buyers.* The rationing mechanisms that develop under price ceilings are rarely desirable. Long lines are inefficient, because they waste buyers' time. Discrimination according to seller bias is both inefficient (because the good does not go to the buyer who values it most highly) and potentially unfair. By contrast, the rationing mechanism

WHO IS RESPONSIBLE FOR THIS—OPEC OR U.S. LAWMAKERS?

in a free, competitive market is both efficient and impersonal. When the market for ice cream reaches its equilibrium, anyone who wants to pay the market price can get a cone. Free markets ration goods with prices.

CASE STUDY LINES AT THE GAS PUMP

As we discussed in the preceding chapter, in 1973 the Organization of Petroleum Exporting Countries (OPEC) raised the price of crude oil in world oil markets. Because crude oil is the major input used to make gasoline, the higher oil prices reduced the supply of gasoline. Long lines at gas stations became commonplace, and motorists often had to wait for hours to buy only a few gallons of gas.

What was responsible for the long gas lines? Most people blame OPEC. Surely, if OPEC had not raised the price of crude oil, the shortage of gasoline would not have occurred. Yet economists blame government regulations that limited the price oil companies could charge for gasoline.

Figure 6-2 shows what happened. As shown in panel (a), before OPEC raised the price of crude oil, the equilibrium price of gasoline P_1 was below the price ceiling. The price regulation, therefore, had no effect. When the price of crude oil rose, however, the situation changed. The increase in the price of crude

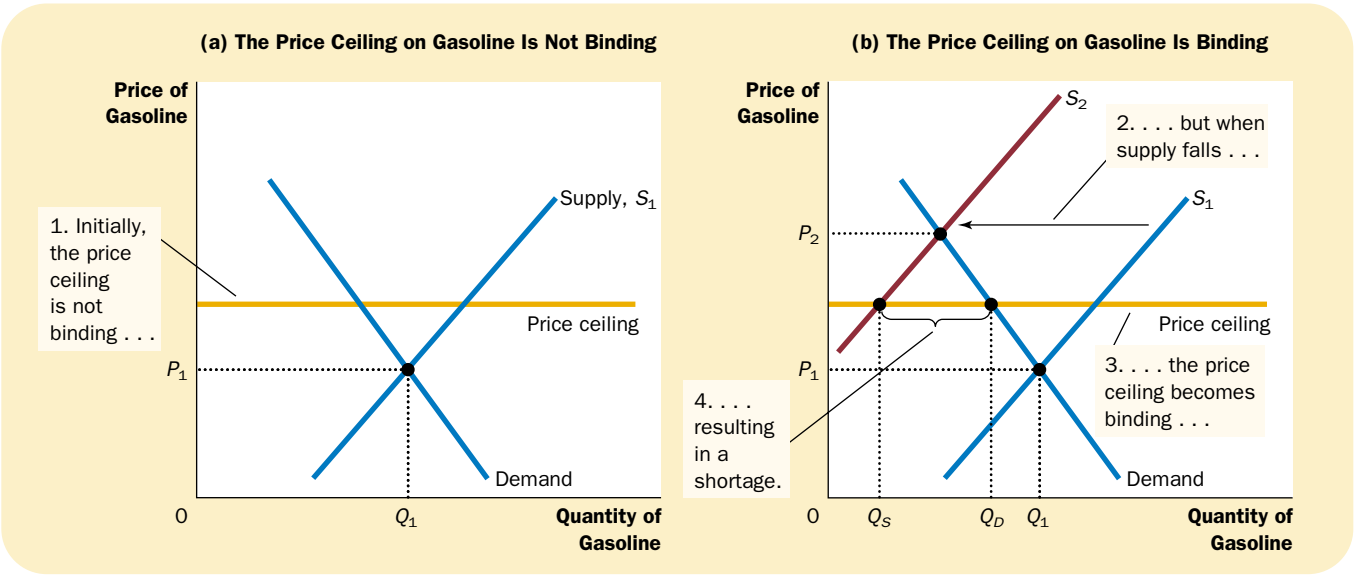


Figure 6-2

THE MARKET FOR GASOLINE WITH A PRICE CEILING. Panel (a) shows the gasoline market when the price ceiling is not binding because the equilibrium price, P_1, is below the ceiling. Panel (b) shows the gasoline market after an increase in the price of crude oil (an input into making gasoline) shifts the supply curve to the left from S_1 to S_2. In an unregulated market, the price would have risen from P_1 to P_2. The price ceiling, however, prevents this from happening. At the binding price ceiling, consumers are willing to buy Q_D, but producers of gasoline are willing to sell only Q_S. The difference between quantity demanded and quantity supplied, $Q_D - Q_S$, measures the gasoline shortage.

IN THE NEWS

Does a Drought Need to Cause a Water Shortage?

DURING THE SUMMER OF 1999, THE EAST coast of the United States experienced unusually little rain and a shortage of water. The following article suggests a way that the shortage could have been averted.

Trickle-Down Economics

BY TERRY L. ANDERSON AND CLAY J. LANDRY

Water shortages are being blamed on the drought in the East, but that's giving Mother Nature a bum rap. Certainly the drought is the immediate cause, but the real culprit is regulations that don't allow markets and prices to equalize demand and supply.

The similarity between water and gasoline is instructive. The energy crisis of the 1970s, too, was blamed on nature's niggardly supply of oil, but in fact it was the actions of the Organization of Petroleum Exporting Countries, combined with price controls, that was the main cause of the shortages. . . .

Once again, regulators are responding to shortages—in this case of water—with controls and regulations rather than allowing the market to work. Cities are restricting water usage; some have even gone so far as to prohibit restaurants from serving water except if the customer asks for a glass. But although cities initially saw declines in water use, some are starting to report increases in consumption. This has prompted some police departments to collect lists of residents suspected of wasting water.

There's a better answer than sending out the cops. Market forces could ensure plentiful water availability even in drought years. Contrary to popular belief, the supply of water is no more fixed than the supply of oil. Like all resources, water supplies change in response to economic growth and to the price. In developing countries, despite population growth, the percentage of people with access to safe drinking water has increased to 74 percent in 1994 from 44 percent in 1980. Rising incomes have given those countries the wherewithal to supply potable water.

Supplies also increase when current users have an incentive to conserve their surplus in the marketplace. California's drought-emergency water bank illustrates this. The bank allows farmers to lease water from other users during dry spells. In 1991, the first year the bank was tried, when the price was $125 per acre-foot (326,000 gallons), supply exceeded demand by two to one. That is, many more people wanted to sell their water than wanted to buy.

Data from every corner of the world show that when cities raise the price of water by 10 percent, water use goes down by as much as 12 percent. When the price of agricultural water goes up 10 percent, usage goes down by 20 percent. . . .

Unfortunately, Eastern water users do not pay realistic prices for water. According to the American Water Works Association, only 2 percent of municipal water suppliers adjust prices seasonally. . . .

Even more egregious, Eastern water laws bar people from buying and selling water. Just as tradable pollution permits established under the Clean Air Act have encouraged polluters to find efficient ways to reduce emissions, tradable water rights can encourage conservation and increase supplies. It is mainly a matter of following the lead of Western water courts that have quantified water rights and Western legislatures that have allowed trades.

By making water a commodity and unleashing market forces, policymakers can ensure plentiful water supplies for all. New policies won't make droughts disappear, but they will ease the pain they impose by priming the invisible pump of water markets.

SOURCE: *The Wall Street Journal,* August 23, 1999, p. A14.

oil raised the cost of producing gasoline, and this reduced the supply of gasoline. As panel (b) shows, the supply curve shifted to the left from S_1 to S_2. In an unregulated market, this shift in supply would have raised the equilibrium price of gasoline from P_1 to P_2, and no shortage would have resulted. Instead, the price ceiling prevented the price from rising to the equilibrium level. At the

price ceiling, producers were willing to sell Q_S, and consumers were willing to buy Q_D. Thus, the shift in supply caused a severe shortage at the regulated price.

Eventually, the laws regulating the price of gasoline were repealed. Lawmakers came to understand that they were partly responsible for the many hours Americans lost waiting in line to buy gasoline. Today, when the price of crude oil changes, the price of gasoline can adjust to bring supply and demand into equilibrium.

CASE STUDY RENT CONTROL IN THE SHORT RUN AND LONG RUN

One common example of a price ceiling is rent control. In some cities, the local government places a ceiling on rents that landlords may charge their tenants. The goal of this policy is to help the poor by making housing more affordable. Economists often criticize rent control, arguing that it is a highly inefficient way to help the poor raise their standard of living. One economist called rent control "the best way to destroy a city, other than bombing."

The adverse effects of rent control are less apparent to the general population because these effects occur over many years. In the short run, landlords have a fixed number of apartments to rent, and they cannot adjust this number quickly as market conditions change. Moreover, the number of people searching

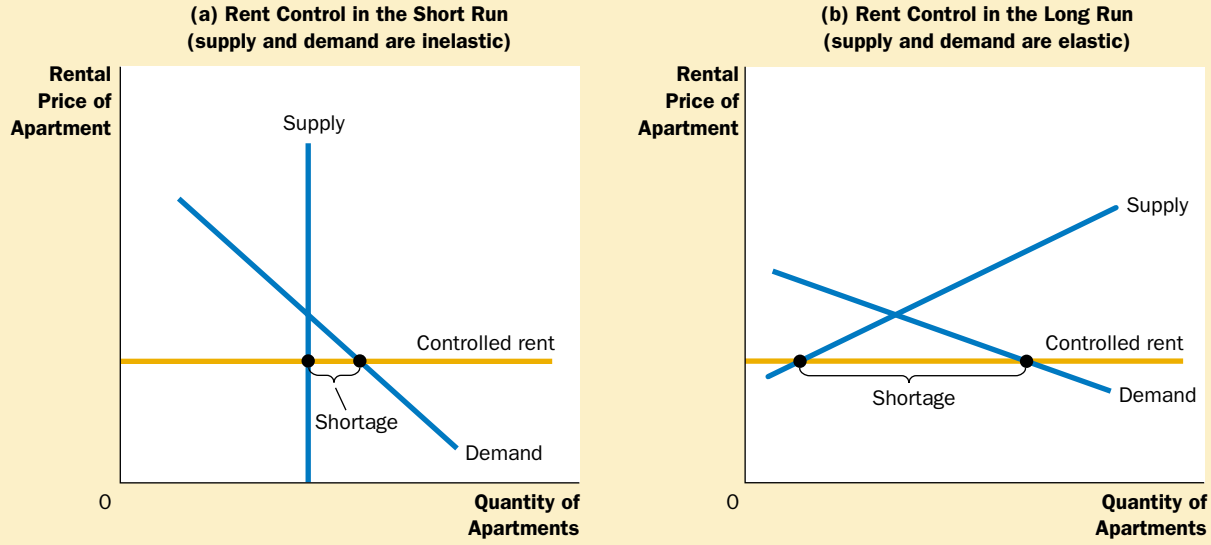


Figure 6-3

RENT CONTROL IN THE SHORT RUN AND IN THE LONG RUN. Panel (a) shows the short-run effects of rent control: Because the supply and demand for apartments are relatively inelastic, the price ceiling imposed by a rent-control law causes only a small shortage of housing. Panel (b) shows the long-run effects of rent control: Because the supply and demand for apartments are more elastic, rent control causes a large shortage.

for housing in a city may not be highly responsive to rents in the short run because people take time to adjust their housing arrangements. Therefore, the short-run supply and demand for housing are relatively inelastic.

Panel (a) of Figure 6-3 shows the short-run effects of rent control on the housing market. As with any price ceiling, rent control causes a shortage. Yet because supply and demand are inelastic in the short run, the initial shortage caused by rent control is small. The primary effect in the short run is to reduce rents.

The long-run story is very different because the buyers and sellers of rental housing respond more to market conditions as time passes. On the supply side, landlords respond to low rents by not building new apartments and by failing to maintain existing ones. On the demand side, low rents encourage people to find their own apartments (rather than living with their parents or sharing apartments with roommates) and induce more people to move into a city. Therefore, both supply and demand are more elastic in the long run.

Panel (b) of Figure 6-3 illustrates the housing market in the long run. When rent control depresses rents below the equilibrium level, the quantity of apartments supplied falls substantially, and the quantity of apartments demanded rises substantially. The result is a large shortage of housing.

In cities with rent control, landlords use various mechanisms to ration housing. Some landlords keep long waiting lists. Others give a preference to tenants without children. Still others discriminate on the basis of race. Sometimes, apartments are allocated to those willing to offer under-the-table payments to building superintendents. In essence, these bribes bring the total price of an apartment (including the bribe) closer to the equilibrium price.

To understand fully the effects of rent control, we have to remember one of the *Ten Principles of Economics* from Chapter 1: People respond to incentives. In free markets, landlords try to keep their buildings clean and safe because desirable apartments command higher prices. By contrast, when rent control creates shortages and waiting lists, landlords lose their incentive to be responsive to tenants' concerns. Why should a landlord spend his money to maintain and improve his property when people are waiting to get in as it is? In the end, tenants get lower rents, but they also get lower-quality housing.

Policymakers often react to the effects of rent control by imposing additional regulations. For example, there are laws that make racial discrimination in housing illegal and require landlords to provide minimally adequate living conditions. These laws, however, are difficult and costly to enforce. By contrast, when rent control is eliminated and a market for housing is regulated by the forces of competition, such laws are less necessary. In a free market, the price of housing adjusts to eliminate the shortages that give rise to undesirable landlord behavior.

HOW PRICE FLOORS AFFECT MARKET OUTCOMES

To examine the effects of another kind of government price control, let's return to the market for ice cream. Imagine now that the government is persuaded by the pleas of the National Organization of Ice Cream Makers. In this case, the government might institute a price floor. Price floors, like price ceilings, are an attempt by the government to maintain prices at other than equilibrium levels. Whereas a price ceiling places a legal maximum on prices, a price floor places a legal minimum.

IN THE NEWS

Rent Control in New York City

RENT CONTROL REMAINS A TOPIC OF HEATED debate in New York City, as the following article describes.

Threat to End Rent Control Stirs Up NYC

BY FRED KAPLAN

NEW YORK—One recent lunch hour at Shopsin's, a neighborhood diner in Manhattan's West Village, conversation turned to the topic of the state Senate majority leader, Joseph L. Bruno. "If he ever shows his face around here, we'll string him up," a customer exclaimed. "The guy deserves death," another said matter-of-factly.

Rarely has so much venom been aimed at a figure so obscure as an Albany legislator, but all over New York City, thousands of otherwise fairly civilized citizens are throwing similar fits. For Bruno is threatening to take away their one holy fringe benefit—the eternal right to a rent-controlled apartment.

Massachusetts and California have abolished or scaled back their rent-control laws in recent years, but New York remains the last holdout, and on a scale that dwarfs that of the other cities.

About 2 million residents—more than a quarter of New York City's population—live in apartments covered by regulations that severely limit how much a landlord can raise the rent and under what conditions a tenant or even a tenant's relatives can be evicted.

Tales are legion of wealthy movie stars, doctors, and stock brokers paying a pittance for palatial dwellings in the more fashionable neighborhoods of Manhattan.

Some of these tales were knocked off the books in 1993, when the state Legislature passed what many called "the Mia Farrow law"—in reference to the actress who was paying one-fifth the market price for a 10-room apartment on Central Park West. Still, the bill did not affect too many people. It lifted rent controls only from apartments going for more than $2,000 a month, and only if the tenants's annual household income exceeded $250,000 two years in a row.

Far more plentiful are the unaffected cases. An investment banker, who earns more than $400,000 a year, pays $1,500 a month for a three-bedroom apartment near Lincoln Center. A securities trader, making well over $100,000 a year, pays $800 a month for a one-bedroom on the Upper West Side. In both cases, the units would fetch at least three times as much if placed on the open market. . . .

But rent control helps more than the rich. A study by the city concludes that the average tenant of a rent-controlled apartment in New York City earns only $20,000 a year. Tenants' groups say that ending controls would primarily raise the rents of those who can least afford to pay, resulting in wholesale eviction.

However, Paul Grogan, president of the Local Initiatives Support Corp., a private organization that finances low-income housing, said, "In many poor neighborhoods, the landlord can't even get rents as high as the regulations allow." . . .

Few economists and policy analysts, even liberal ones, support rent control—not so much because it lets rich people pay far less than they can afford, but because it distorts the marketplace for everyone.

Frank Roconi, director of the Citizens Housing and Planning Council, a public-policy research organization that supports some government intervention in the real-estate market, spelled out "the classic case" of this distortion:

"There is an elderly couple, their kids are gone, they have a three-bedroom apartment, and they are paying $400 a month. Down the hall, there is a young family with two kids living in a one-bedroom for $1,000 a month. In a rational price system, the elderly couple would have an incentive to move to a smaller, cheaper apartment, leaving vacant a larger space for the young family."

Under the current system, though, if the elderly couple moves away, their children can claim the apartment at the same rent. Or, if it is left vacant, the landlord, by law, can charge only a few percentage points more than if the tenant had stayed.

Therefore, Roconi noted, "the landlord isn't going to let just anybody in. He's going to let his brother-in-law have the apartment or his accountant or someone willing to give him a bribe. There's a tremendous incentive for that apartment never to hit the open market."

SOURCE: *The Boston Globe,* April 28, 1997, p. A1.

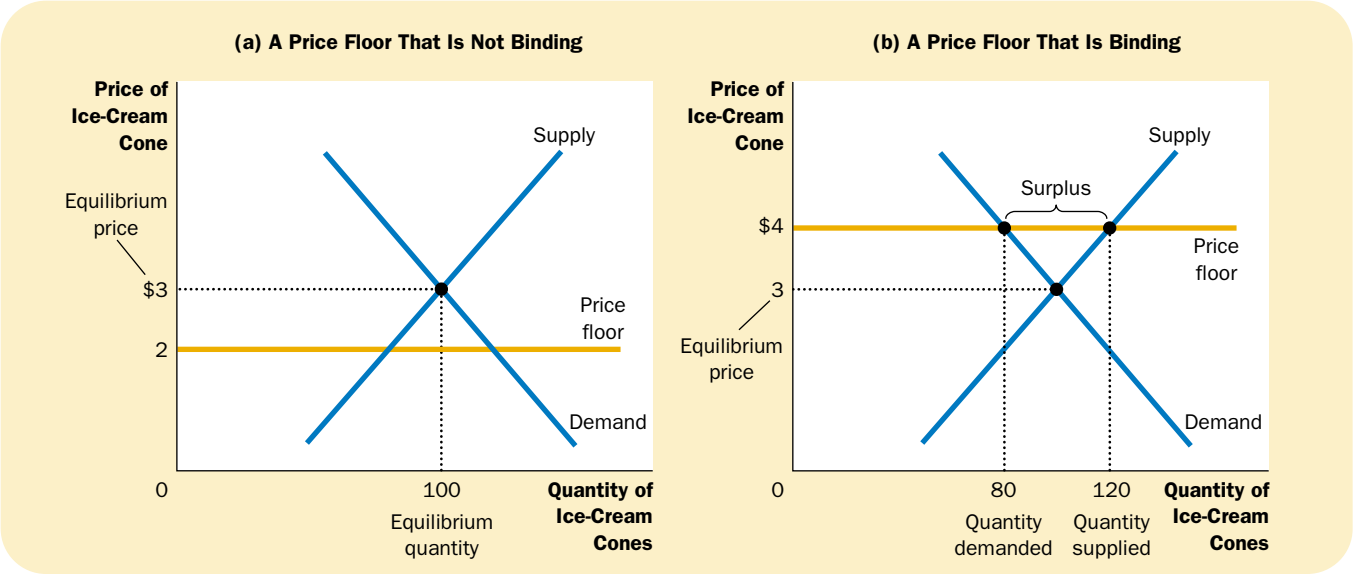


Figure 6-4

A MARKET WITH A PRICE FLOOR. In panel (a), the government imposes a price floor of $2. Because this is below the equilibrium price of $3, the price floor has no effect. The market price adjusts to balance supply and demand. At the equilibrium, quantity supplied and quantity demanded both equal 100 cones. In panel (b), the government imposes a price floor of $4, which is above the equilibrium price of $3. Therefore, the market price equals $4. Because 120 cones are supplied at this price and only 80 are demanded, there is a surplus of 40 cones.

When the government imposes a price floor on the ice-cream market, two outcomes are possible. If the government imposes a price floor of $2 per cone when the equilibrium price is $3, we obtain the outcome in panel (a) of Figure 6-4. In this case, because the equilibrium price is above the floor, the price floor is not binding. Market forces naturally move the economy to the equilibrium, and the price floor has no effect.

Panel (b) of Figure 6-4 shows what happens when the government imposes a price floor of $4 per cone. In this case, because the equilibrium price of $3 is below the floor, the price floor is a binding constraint on the market. The forces of supply and demand tend to move the price toward the equilibrium price, but when the market price hits the floor, it can fall no further. The market price equals the price floor. At this floor, the quantity of ice cream supplied (120 cones) exceeds the quantity demanded (80 cones). Some people who want to sell ice cream at the going price are unable to. *Thus, a binding price floor causes a surplus.*

Just as price ceilings and shortages can lead to undesirable rationing mechanisms, so can price floors and surpluses. In the case of a price floor, some sellers are unable to sell all they want at the market price. The sellers who appeal to the personal biases of the buyers, perhaps due to racial or familial ties, are better able to sell their goods than those who do not. By contrast, in a free market, the price serves as the rationing mechanism, and sellers can sell all they want at the equilibrium price.

CASE STUDY THE MINIMUM WAGE

An important example of a price floor is the minimum wage. Minimum-wage laws dictate the lowest price for labor that any employer may pay. The U.S. Congress first instituted a minimum wage with the Fair Labor Standards Act of 1938 to ensure workers a minimally adequate standard of living. In 1999 the minimum wage according to federal law was $5.15 per hour, and some state laws imposed higher minimum wages.

To examine the effects of a minimum wage, we must consider the market for labor. Panel (a) of Figure 6-5 shows the labor market which, like all markets, is subject to the forces of supply and demand. Workers determine the supply of labor, and firms determine the demand. If the government doesn't intervene, the wage normally adjusts to balance labor supply and labor demand.

Panel (b) of Figure 6-5 shows the labor market with a minimum wage. If the minimum wage is above the equilibrium level, as it is here, the quantity of labor supplied exceeds the quantity demanded. The result is unemployment. Thus, the minimum wage raises the incomes of those workers who have jobs, but it lowers the incomes of those workers who cannot find jobs.

To fully understand the minimum wage, keep in mind that the economy contains not a single labor market, but many labor markets for different types of workers. The impact of the minimum wage depends on the skill and experience of the worker. Workers with high skills and much experience are not affected, because their equilibrium wages are well above the minimum. For these workers, the minimum wage is not binding.

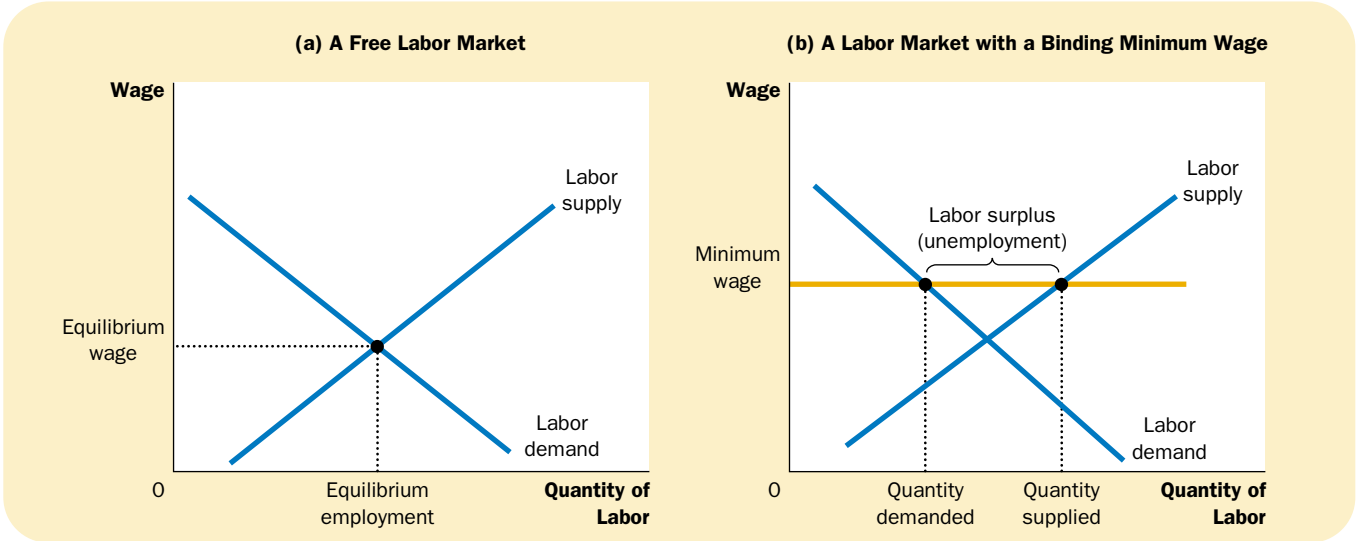


Figure 6-5

HOW THE MINIMUM WAGE AFFECTS THE LABOR MARKET. Panel (a) shows a labor market in which the wage adjusts to balance labor supply and labor demand. Panel (b) shows the impact of a binding minimum wage. Because the minimum wage is a price floor, it causes a surplus: The quantity of labor supplied exceeds the quantity demanded. The result is unemployment.

The minimum wage has its greatest impact on the market for teenage labor. The equilibrium wages of teenagers are low because teenagers are among the least skilled and least experienced members of the labor force. In addition, teenagers are often willing to accept a lower wage in exchange for on-the-job training. (Some teenagers are willing to work as "interns" for no pay at all. Because internships pay nothing, however, the minimum wage does not apply to them. If it did, these jobs might not exist.) As a result, the minimum wage is more often binding for teenagers than for other members of the labor force.

Many economists have studied how minimum-wage laws affect the teenage labor market. These researchers compare the changes in the minimum wage over time with the changes in teenage employment. Although there is some debate about how much the minimum wage affects employment, the typical study finds that a 10 percent increase in the minimum wage depresses teenage employment between 1 and 3 percent. In interpreting this estimate, note that a 10 percent increase in the minimum wage does not raise the average wage of teenagers by 10 percent. A change in the law does not directly affect those teenagers who are already paid well above the minimum, and enforcement of minimum-wage laws is not perfect. Thus, the estimated drop in employment of 1 to 3 percent is significant.

In addition to altering the quantity of labor demanded, the minimum wage also alters the quantity supplied. Because the minimum wage raises the wage that teenagers can earn, it increases the number of teenagers who choose to look for jobs. Studies have found that a higher minimum wage influences which teenagers are employed. When the minimum wage rises, some teenagers who are still attending school choose to drop out and take jobs. These new dropouts displace other teenagers who had already dropped out of school and who now become unemployed.

The minimum wage is a frequent topic of political debate. Advocates of the minimum wage view the policy as one way to raise the income of the working poor. They correctly point out that workers who earn the minimum wage can afford only a meager standard of living. In 1999, for instance, when the minimum wage was $5.15 per hour, two adults working 40 hours a week for every week of the year at minimum-wage jobs had a total annual income of only $21,424, which was less than half of the median family income. Many advocates of the minimum wage admit that it has some adverse effects, including unemployment, but they believe that these effects are small and that, all things considered, a higher minimum wage makes the poor better off.

Opponents of the minimum wage contend that it is not the best way to combat poverty. They note that a high minimum wage causes unemployment, encourages teenagers to drop out of school, and prevents some unskilled workers from getting the on-the-job training they need. Moreover, opponents of the minimum wage point out that the minimum wage is a poorly targeted policy. Not all minimum-wage workers are heads of households trying to help their families escape poverty. In fact, fewer than a third of minimum-wage earners are in families with incomes below the poverty line. Many are teenagers from middle-class homes working at part-time jobs for extra spending money.

EVALUATING PRICE CONTROLS

One of the *Ten Principles of Economics* discussed in Chapter 1 is that markets are usually a good way to organize economic activity. This principle explains why

economists usually oppose price ceilings and price floors. To economists, prices are not the outcome of some haphazard process. Prices, they contend, are the result of the millions of business and consumer decisions that lie behind the supply and demand curves. Prices have the crucial job of balancing supply and demand and, thereby, coordinating economic activity. When policymakers set prices by legal decree, they obscure the signals that normally guide the allocation of society's resources.

Another one of the *Ten Principles of Economics* is that governments can sometimes improve market outcomes. Indeed, policymakers are led to control prices because they view the market's outcome as unfair. Price controls are often aimed at helping the poor. For instance, rent-control laws try to make housing affordable for everyone, and minimum-wage laws try to help people escape poverty.

Yet price controls often hurt those they are trying to help. Rent control may keep rents low, but it also discourages landlords from maintaining their buildings and makes housing hard to find. Minimum-wage laws may raise the incomes of some workers, but they also cause other workers to be unemployed.

Helping those in need can be accomplished in ways other than controlling prices. For instance, the government can make housing more affordable by paying a fraction of the rent for poor families. Unlike rent control, such rent subsidies do not reduce the quantity of housing supplied and, therefore, do not lead to housing shortages. Similarly, wage subsidies raise the living standards of the working poor without discouraging firms from hiring them. An example of a wage subsidy is the *earned income tax credit*, a government program that supplements the incomes of low-wage workers.

Although these alternative policies are often better than price controls, they are not perfect. Rent and wage subsidies cost the government money and, therefore, require higher taxes. As we see in the next section, taxation has costs of its own.

QUICK QUIZ: Define *price ceiling* and *price floor*, and give an example of each. Which leads to a shortage? Which leads to a surplus? Why?

TAXES

All governments—from the federal government in Washington, D.C., to the local governments in small towns—use taxes to raise revenue for public projects, such as roads, schools, and national defense. Because taxes are such an important policy instrument, and because they affect our lives in many ways, the study of taxes is a topic to which we return several times throughout this book. In this section we begin our study of how taxes affect the economy.

To set the stage for our analysis, imagine that a local government decides to hold an annual ice-cream celebration—with a parade, fireworks, and speeches by town officials. To raise revenue to pay for the event, it decides to place a $0.50 tax on the sale of ice-cream cones. When the plan is announced, our two lobbying groups swing into action. The National Organization of Ice Cream Makers claims that its members are struggling to survive in a competitive market, and it argues that *buyers* of ice cream should have to pay the tax. The American Association of Ice Cream Eaters claims that consumers of ice cream are having trouble making ends meet, and it argues that *sellers* of ice cream should pay the tax. The town mayor, hoping to reach a compromise, suggests that half the tax be paid by the buyers and half be paid by the sellers.

To analyze these proposals, we need to address a simple but subtle question: When the government levies a tax on a good, who bears the burden of the tax? The people buying the good? The people selling the good? Or, if buyers and sellers share the tax burden, what determines how the burden is divided? Can the government simply legislate the division of the burden, as the mayor is suggesting, or is the division determined by more fundamental forces in the economy? Economists use the term **tax incidence** to refer to these questions about the distribution of a tax burden. As we will see, we can learn some surprising lessons about tax incidence just by applying the tools of supply and demand.

tax incidence
the study of who bears the burden of taxation

HOW TAXES ON BUYERS AFFECT MARKET OUTCOMES

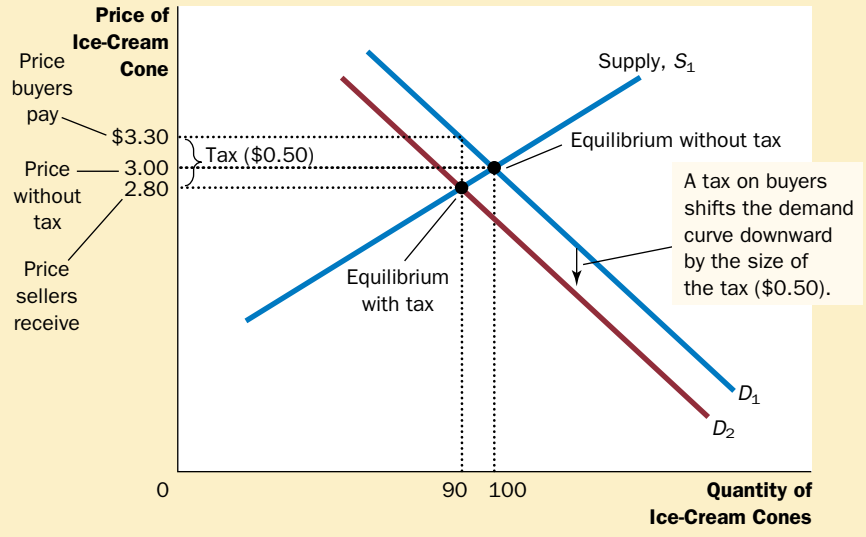
We first consider a tax levied on buyers of a good. Suppose, for instance, that our local government passes a law requiring buyers of ice-cream cones to send $0.50 to the government for each ice-cream cone they buy. How does this law affect the buyers and sellers of ice cream? To answer this question, we can follow the three steps in Chapter 4 for analyzing supply and demand: (1) We decide whether the law affects the supply curve or demand curve. (2) We decide which way the curve shifts. (3) We examine how the shift affects the equilibrium.

The initial impact of the tax is on the demand for ice cream. The supply curve is not affected because, for any given price of ice cream, sellers have the same incentive to provide ice cream to the market. By contrast, buyers now have to pay a tax to the government (as well as the price to the sellers) whenever they buy ice cream. Thus, the tax shifts the demand curve for ice cream.

The direction of the shift is easy to determine. Because the tax on buyers makes buying ice cream less attractive, buyers demand a smaller quantity of ice cream at every price. As a result, the demand curve shifts to the left (or, equivalently, downward), as shown in Figure 6-6.

Figure 6-6

A TAX ON BUYERS. When a tax of $0.50 is levied on buyers, the demand curve shifts down by $0.50 from D_1 to D_2. The equilibrium quantity falls from 100 to 90 cones. The price that sellers receive falls from $3.00 to $2.80. The price that buyers pay (including the tax) rises from $3.00 to $3.30. Even though the tax is levied on buyers, buyers and sellers share the burden of the tax.



We can, in this case, be precise about how much the curve shifts. Because of the $0.50 tax levied on buyers, the effective price to buyers is now $0.50 higher than the market price. For example, if the market price of a cone happened to be $2.00, the effective price to buyers would be $2.50. Because buyers look at their total cost including the tax, they demand a quantity of ice cream as if the market price were $0.50 higher than it actually is. In other words, to induce buyers to demand any given quantity, the market price must now be $0.50 lower to make up for the effect of the tax. Thus, the tax shifts the demand curve *downward* from D_1 to D_2 by exactly the size of the tax ($0.50).

To see the effect of the tax, we compare the old equilibrium and the new equilibrium. You can see in the figure that the equilibrium price of ice cream falls from $3.00 to $2.80 and the equilibrium quantity falls from 100 to 90 cones. Because sellers sell less and buyers buy less in the new equilibrium, the tax on ice cream reduces the size of the ice-cream market.

Now let's return to the question of tax incidence: Who pays the tax? Although buyers send the entire tax to the government, buyers and sellers share the burden. Because the market price falls from $3.00 to $2.80 when the tax is introduced, sellers receive $0.20 less for each ice-cream cone than they did without the tax. Thus, the tax makes sellers worse off. Buyers pay sellers a lower price ($2.80), but the effective price including the tax rises from $3.00 before the tax to $3.30 with the tax ($2.80 + $0.50 = $3.30). Thus, the tax also makes buyers worse off.

To sum up, the analysis yields two general lessons:

- Taxes discourage market activity. When a good is taxed, the quantity of the good sold is smaller in the new equilibrium.
- Buyers and sellers share the burden of taxes. In the new equilibrium, buyers pay more for the good, and sellers receive less.

HOW TAXES ON SELLERS AFFECT MARKET OUTCOMES

Now consider a tax levied on sellers of a good. Suppose the local government passes a law requiring sellers of ice-cream cones to send $0.50 to the government for each cone they sell. What are the effects of this law?

In this case, the initial impact of the tax is on the supply of ice cream. Because the tax is not levied on buyers, the quantity of ice cream demanded at any given price is the same, so the demand curve does not change. By contrast, the tax on sellers raises the cost of selling ice cream, and leads sellers to supply a smaller quantity at every price. The supply curve shifts to the left (or, equivalently, upward).

Once again, we can be precise about the magnitude of the shift. For any market price of ice cream, the effective price to sellers—the amount they get to keep after paying the tax—is $0.50 lower. For example, if the market price of a cone happened to be $2.00, the effective price received by sellers would be $1.50. Whatever the market price, sellers will supply a quantity of ice cream as if the price were $0.50 lower than it is. Put differently, to induce sellers to supply any given quantity, the market price must now be $0.50 higher to compensate for the effect of the tax. Thus, as shown in Figure 6-7, the supply curve shifts *upward* from S_1 to S_2 by exactly the size of the tax ($0.50).

When the market moves from the old to the new equilibrium, the equilibrium price of ice cream rises from $3.00 to $3.30, and the equilibrium quantity falls from

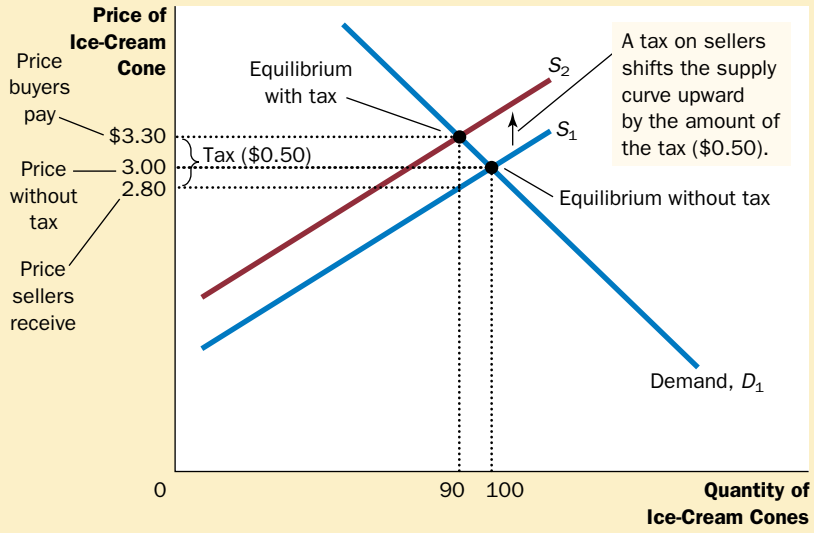


Figure 6-7

A TAX ON SELLERS. When a tax of $0.50 is levied on sellers, the supply curve shifts up by $0.50 from S_1 to S_2. The equilibrium quantity falls from 100 to 90 cones. The price that buyers pay rises from $3.00 to $3.30. The price that sellers receive (after paying the tax) falls from $3.00 to $2.80. Even though the tax is levied on sellers, buyers and sellers share the burden of the tax.

100 to 90 cones. Once again, the tax reduces the size of the ice-cream market. And once again, buyers and sellers share the burden of the tax. Because the market price rises, buyers pay $0.30 more for each cone than they did before the tax was enacted. Sellers receive a higher price than they did without the tax, but the effective price (after paying the tax) falls from $3.00 to $2.80.

Comparing Figures 6-6 and 6-7 leads to a surprising conclusion: *Taxes on buyers and taxes on sellers are equivalent*. In both cases, the tax places a wedge between the price that buyers pay and the price that sellers receive. The wedge between the buyers' price and the sellers' price is the same, regardless of whether the tax is levied on buyers or sellers. In either case, the wedge shifts the relative position of the supply and demand curves. In the new equilibrium, buyers and sellers share the burden of the tax. The only difference between taxes on buyers and taxes on sellers is who sends the money to the government.

The equivalence of these two taxes is perhaps easier to understand if we imagine that the government collects the $0.50 ice-cream tax in a bowl on the counter of each ice-cream store. When the government levies the tax on buyers, the buyer is required to place $0.50 in the bowl every time a cone is bought. When the government levies the tax on sellers, the seller is required to place $0.50 in the bowl after the sale of each cone. Whether the $0.50 goes directly from the buyer's pocket into the bowl, or indirectly from the buyer's pocket into the seller's hand and then into the bowl, does not matter. Once the market reaches its new equilibrium, buyers and sellers share the burden, regardless of how the tax is levied.

CASE STUDY CAN CONGRESS DISTRIBUTE THE BURDEN OF A PAYROLL TAX?

If you have ever received a paycheck, you probably noticed that taxes were deducted from the amount you earned. One of these taxes is called FICA, an

acronym for the Federal Insurance Contribution Act. The federal government uses the revenue from the FICA tax to pay for Social Security and Medicare, the income support and health care programs for the elderly. FICA is an example of a *payroll tax*, which is a tax on the wages that firms pay their workers. In 1999, the total FICA tax for the typical worker was 15.3 percent of earnings.

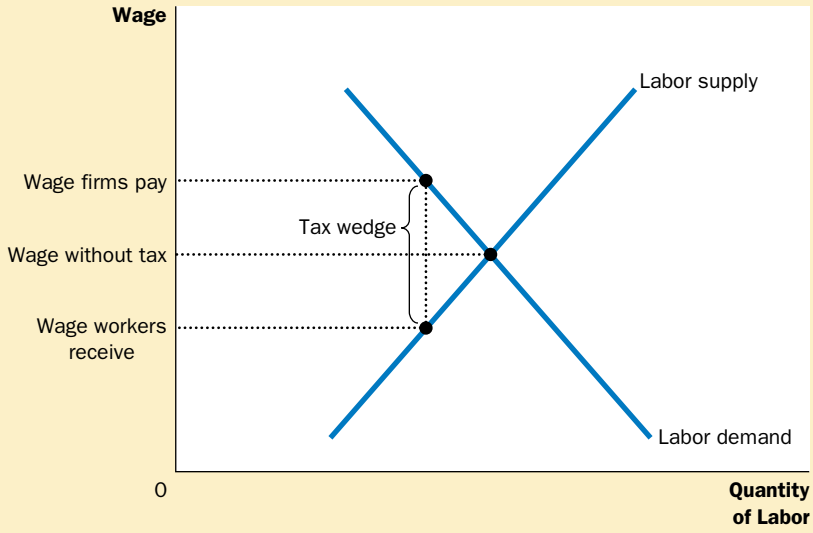
Who do you think bears the burden of this payroll tax—firms or workers? When Congress passed this legislation, it attempted to mandate a division of the tax burden. According to the law, half of the tax is paid by firms, and half is paid by workers. That is, half of the tax is paid out of firm revenue, and half is deducted from workers' paychecks. The amount that shows up as a deduction on your pay stub is the worker contribution.

Our analysis of tax incidence, however, shows that lawmakers cannot so easily distribute the burden of a tax. To illustrate, we can analyze a payroll tax as merely a tax on a good, where the good is labor and the price is the wage. The key feature of the payroll tax is that it places a wedge between the wage that firms pay and the wage that workers receive. Figure 6-8 shows the outcome. When a payroll tax is enacted, the wage received by workers falls, and the wage paid by firms rises. In the end, workers and firms share the burden of the tax, much as the legislation requires. Yet this division of the tax burden between workers and firms has nothing to do with the legislated division: The division of the burden in Figure 6-8 is not necessarily fifty-fifty, and the same outcome would prevail if the law levied the entire tax on workers or if it levied the entire tax on firms.

This example shows that the most basic lesson of tax incidence is often overlooked in public debate. Lawmakers can decide whether a tax comes from the buyer's pocket or from the seller's, but they cannot legislate the true burden of a tax. Rather, tax incidence depends on the forces of supply and demand.

Figure 6-8

A PAYROLL TAX. A payroll tax places a wedge between the wage that workers receive and the wage that firms pay. Comparing wages with and without the tax, you can see that workers and firms share the tax burden. This division of the tax burden between workers and firms does not depend on whether the government levies the tax on workers, levies the tax on firms, or divides the tax equally between the two groups.



ELASTICITY AND TAX INCIDENCE

When a good is taxed, buyers and sellers of the good share the burden of the tax. But how exactly is the tax burden divided? Only rarely will it be shared equally. To see how the burden is divided, consider the impact of taxation in the two markets in Figure 6-9. In both cases, the figure shows the initial demand curve, the initial supply curve, and a tax that drives a wedge between the amount paid by buyers and the amount received by sellers. (Not drawn in either panel of the figure is the new supply or demand curve. Which curve shifts depends on whether the tax is levied on buyers or sellers. As we have seen, this is irrelevant for the incidence of

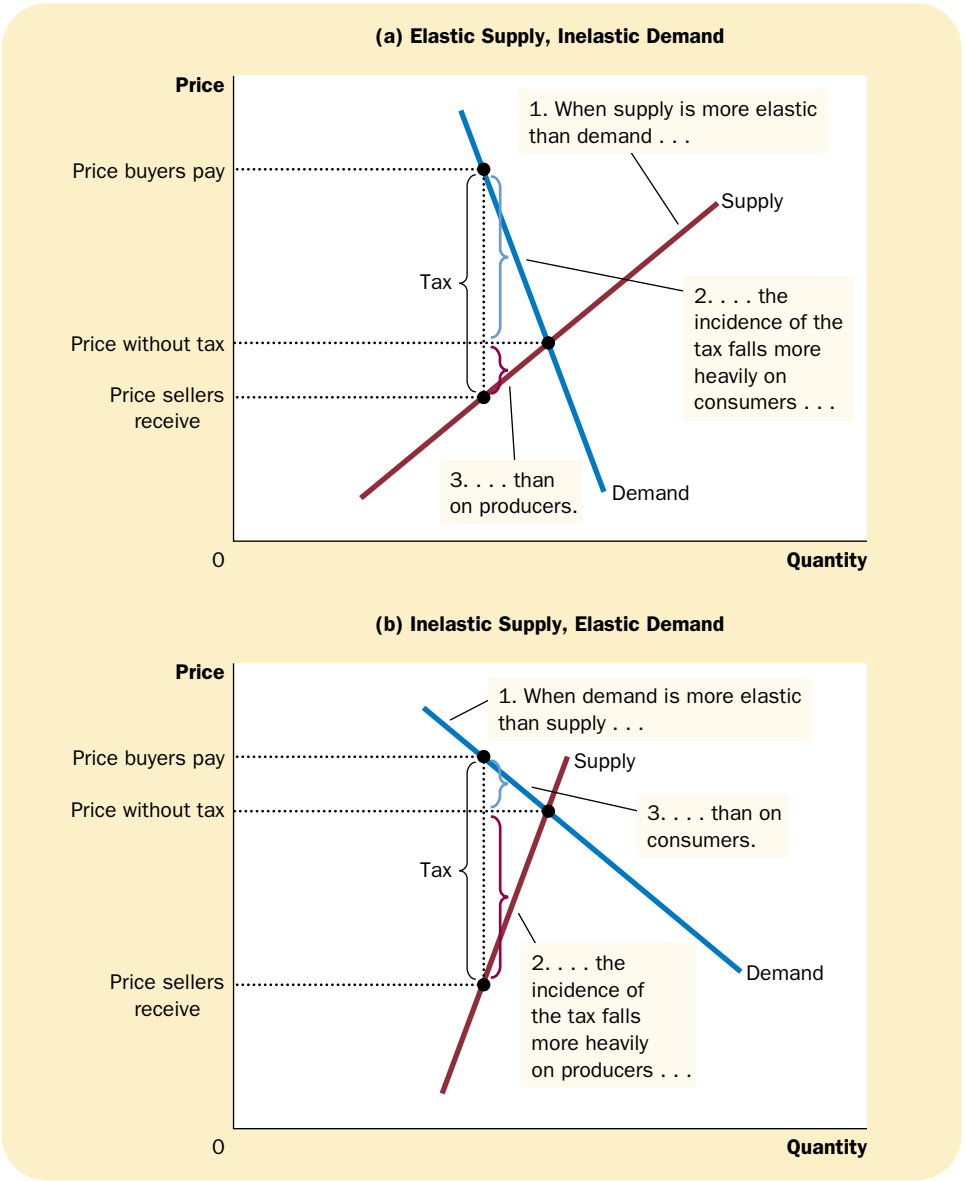


Figure 6-9

HOW THE BURDEN OF A TAX IS DIVIDED. In panel (a), the supply curve is elastic, and the demand curve is inelastic. In this case, the price received by sellers falls only slightly, while the price paid by buyers rises substantially. Thus, buyers bear most of the burden of the tax. In panel (b), the supply curve is inelastic, and the demand curve is elastic. In this case, the price received by sellers falls substantially, while the price paid by buyers rises only slightly. Thus, sellers bear most of the burden of the tax.

the tax.) The difference in the two panels is the relative elasticity of supply and demand.

Panel (a) of Figure 6-9 shows a tax in a market with very elastic supply and relatively inelastic demand. That is, sellers are very responsive to the price of the good, whereas buyers are not very responsive. When a tax is imposed on a market with these elasticities, the price received by sellers does not fall much, so sellers bear only a small burden. By contrast, the price paid by buyers rises substantially, indicating that buyers bear most of the burden of the tax.

Panel (b) of Figure 6-9 shows a tax in a market with relatively inelastic supply and very elastic demand. In this case, sellers are not very responsive to the price, while buyers are very responsive. The figure shows that when a tax is imposed, the price paid by buyers does not rise much, while the price received by sellers falls substantially. Thus, sellers bear most of the burden of the tax.

The two panels of Figure 6-9 show a general lesson about how the burden of a tax is divided: *A tax burden falls more heavily on the side of the market that is less elastic.* Why is this true? In essence, the elasticity measures the willingness of buyers or sellers to leave the market when conditions become unfavorable. A small elasticity of demand means that buyers do not have good alternatives to consuming this particular good. A small elasticity of supply means that sellers do not have good alternatives to producing this particular good. When the good is taxed, the side of the market with fewer good alternatives cannot easily leave the market and must, therefore, bear more of the burden of the tax.

We can apply this logic to the payroll tax, which was discussed in the previous case study. Most labor economists believe that the supply of labor is much less elastic than the demand. This means that workers, rather than firms, bear most of the burden of the payroll tax. In other words, the distribution of the tax burden is not at all close to the fifty-fifty split that lawmakers intended.

"IF THIS BOAT WERE ANY MORE EXPENSIVE, WE WOULD BE PLAYING GOLF."

CASE STUDY WHO PAYS THE LUXURY TAX?

In 1990, Congress adopted a new luxury tax on items such as yachts, private airplanes, furs, jewelry, and expensive cars. The goal of the tax was to raise revenue from those who could most easily afford to pay. Because only the rich could afford to buy such extravagances, taxing luxuries seemed a logical way of taxing the rich.

Yet, when the forces of supply and demand took over, the outcome was quite different from what Congress intended. Consider, for example, the market for yachts. The demand for yachts is quite elastic. A millionaire can easily not buy a yacht; she can use the money to buy a bigger house, take a European vacation, or leave a larger bequest to her heirs. By contrast, the supply of yachts is relatively inelastic, at least in the short run. Yacht factories are not easily converted to alternative uses, and workers who build yachts are not eager to change careers in response to changing market conditions.

Our analysis makes a clear prediction in this case. With elastic demand and inelastic supply, the burden of a tax falls largely on the suppliers. That is, a tax on yachts places a burden largely on the firms and workers who build yachts because they end up getting a lower price for their product. The workers, however, are not wealthy. Thus, the burden of a luxury tax falls more on the middle class than on the rich.

The mistaken assumptions about the incidence of the luxury tax quickly became apparent after the tax went into effect. Suppliers of luxuries made their congressional representatives well aware of the economic hardship they experienced, and Congress repealed most of the luxury tax in 1993.

QUICK QUIZ: In a supply-and-demand diagram, show how a tax on car buyers of $1,000 per car affects the quantity of cars sold and the price of cars. In another diagram, show how a tax on car sellers of $1,000 per car affects the quantity of cars sold and the price of cars. In both of your diagrams, show the change in the price paid by car buyers and the change in price received by car sellers.

CONCLUSION

The economy is governed by two kinds of laws: the laws of supply and demand and the laws enacted by governments. In this chapter we have begun to see how these laws interact. Price controls and taxes are common in various markets in the economy, and their effects are frequently debated in the press and among policymakers. Even a little bit of economic knowledge can go a long way toward understanding and evaluating these policies.

In subsequent chapters we will analyze many government policies in greater detail. We will examine the effects of taxation more fully, and we will consider a broader range of policies than we considered here. Yet the basic lessons of this chapter will not change: When analyzing government policies, supply and demand are the first and most useful tools of analysis.

Summary

- A price ceiling is a legal maximum on the price of a good or service. An example is rent control. If the price ceiling is below the equilibrium price, the quantity demanded exceeds the quantity supplied. Because of the resulting shortage, sellers must in some way ration the good or service among buyers.
- A price floor is a legal minimum on the price of a good or service. An example is the minimum wage. If the price floor is above the equilibrium price, the quantity supplied exceeds the quantity demanded. Because of the resulting surplus, buyers' demands for the good or service must in some way be rationed among sellers.
- When the government levies a tax on a good, the equilibrium quantity of the good falls. That is, a tax on a market shrinks the size of the market.
- A tax on a good places a wedge between the price paid by buyers and the price received by sellers. When the market moves to the new equilibrium, buyers pay more for the good and sellers receive less for it. In this sense, buyers and sellers share the tax burden. The incidence of a tax does not depend on whether the tax is levied on buyers or sellers.
- The incidence of a tax depends on the price elasticities of supply and demand. The burden tends to fall on the side of the market that is less elastic because that side of the market can respond less easily to the tax by changing the quantity bought or sold.

Key Concepts

price ceiling, p. 118 price floor, p. 118 tax incidence, p. 129

Questions for Review

1. Give an example of a price ceiling and an example of a price floor.
2. Which causes a shortage of a good—a price ceiling or a price floor? Which causes a surplus?
3. What mechanisms allocate resources when the price of a good is not allowed to bring supply and demand into equilibrium?
4. Explain why economists usually oppose controls on prices.
5. What is the difference between a tax paid by buyers and a tax paid by sellers?
6. How does a tax on a good affect the price paid by buyers, the price received by sellers, and the quantity sold?
7. What determines how the burden of a tax is divided between buyers and sellers? Why?

Problems and Applications

1. Lovers of classical music persuade Congress to impose a price ceiling of $40 per ticket. Does this policy get more or fewer people to attend classical music concerts?
2. The government has decided that the free-market price of cheese is too low.
   a. Suppose the government imposes a binding price floor in the cheese market. Use a supply-and-demand diagram to show the effect of this policy on the price of cheese and the quantity of cheese sold. Is there a shortage or surplus of cheese?
   b. Farmers complain that the price floor has reduced their total revenue. Is this possible? Explain.
   c. In response to farmers' complaints, the government agrees to purchase all of the surplus cheese at the price floor. Compared to the basic price floor, who benefits from this new policy? Who loses?
3. A recent study found that the demand and supply schedules for Frisbees are as follows:

Price per Frisbee	Quantity Demanded	Quantity Supplied
$11	1 million	15 million
10	2	12
9	4	9
8	6	6
7	8	3
6	10	1

   a. What are the equilibrium price and quantity of Frisbees?
   b. Frisbee manufacturers persuade the government that Frisbee production improves scientists' understanding of aerodynamics and thus is important for national security. A concerned Congress votes to impose a price floor $2 above the equilibrium price. What is the new market price? How many Frisbees are sold?
   c. Irate college students march on Washington and demand a reduction in the price of Frisbees. An even more concerned Congress votes to repeal the price floor and impose a price ceiling $1 below the former price floor. What is the new market price? How many Frisbees are sold?
4. Suppose the federal government requires beer drinkers to pay a $2 tax on each case of beer purchased. (In fact, both the federal and state governments impose beer taxes of some sort.)
   a. Draw a supply-and-demand diagram of the market for beer without the tax. Show the price paid by consumers, the price received by producers, and the quantity of beer sold. What is the difference between the price paid by consumers and the price received by producers?
   b. Now draw a supply-and-demand diagram for the beer market with the tax. Show the price paid by consumers, the price received by producers, and

the quantity of beer sold. What is the difference between the price paid by consumers and the price received by producers? Has the quantity of beer sold increased or decreased?

5. A senator wants to raise tax revenue and make workers better off. A staff member proposes raising the payroll tax paid by firms and using part of the extra revenue to reduce the payroll tax paid by workers. Would this accomplish the senator's goal?
6. If the government places a $500 tax on luxury cars, will the price paid by consumers rise by more than $500, less than $500, or exactly $500? Explain.
7. Congress and the president decide that the United States should reduce air pollution by reducing its use of gasoline. They impose a $0.50 tax for each gallon of gasoline sold.
   a. Should they impose this tax on producers or consumers? Explain carefully using a supply-and-demand diagram.
   b. If the demand for gasoline were more elastic, would this tax be more effective or less effective in reducing the quantity of gasoline consumed? Explain with both words and a diagram.
   c. Are consumers of gasoline helped or hurt by this tax? Why?
   d. Are workers in the oil industry helped or hurt by this tax? Why?
8. A case study in this chapter discusses the federal minimum-wage law.
   a. Suppose the minimum wage is above the equilibrium wage in the market for unskilled labor. Using a supply-and-demand diagram of the market for unskilled labor, show the market wage, the number of workers who are employed, and the number of workers who are unemployed. Also show the total wage payments to unskilled workers.
   b. Now suppose the secretary of labor proposes an increase in the minimum wage. What effect would this increase have on employment? Does the change in employment depend on the elasticity of demand, the elasticity of supply, both elasticities, or neither?
   c. What effect would this increase in the minimum wage have on unemployment? Does the change in unemployment depend on the elasticity of demand, the elasticity of supply, both elasticities, or neither?
   d. If the demand for unskilled labor were inelastic, would the proposed increase in the minimum wage raise or lower total wage payments to unskilled workers? Would your answer change if the demand for unskilled labor were elastic?
9. Consider the following policies, each of which is aimed at reducing violent crime by reducing the use of guns. Illustrate each of these proposed policies in a supply-and-demand diagram of the gun market.
   a. a tax on gun buyers
   b. a tax on gun sellers
   c. a price floor on guns
   d. a tax on ammunition
10. The U.S. government administers two programs that affect the market for cigarettes. Media campaigns and labeling requirements are aimed at making the public aware of the dangers of cigarette smoking. At the same time, the Department of Agriculture maintains a price support program for tobacco farmers, which raises the price of tobacco above the equilibrium price.
    a. How do these two programs affect cigarette consumption? Use a graph of the cigarette market in your answer.
    b. What is the combined effect of these two programs on the price of cigarettes?
    c. Cigarettes are also heavily taxed. What effect does this tax have on cigarette consumption?
11. A subsidy is the opposite of a tax. With a $0.50 tax on the buyers of ice-cream cones, the government collects $0.50 for each cone purchased; with a $0.50 subsidy for the buyers of ice-cream cones, the government pays buyers $0.50 for each cone purchased.
    a. Show the effect of a $0.50 per cone subsidy on the demand curve for ice-cream cones, the effective price paid by consumers, the effective price received by sellers, and the quantity of cones sold.
    b. Do consumers gain or lose from this policy? Do producers gain or lose? Does the government gain or lose?