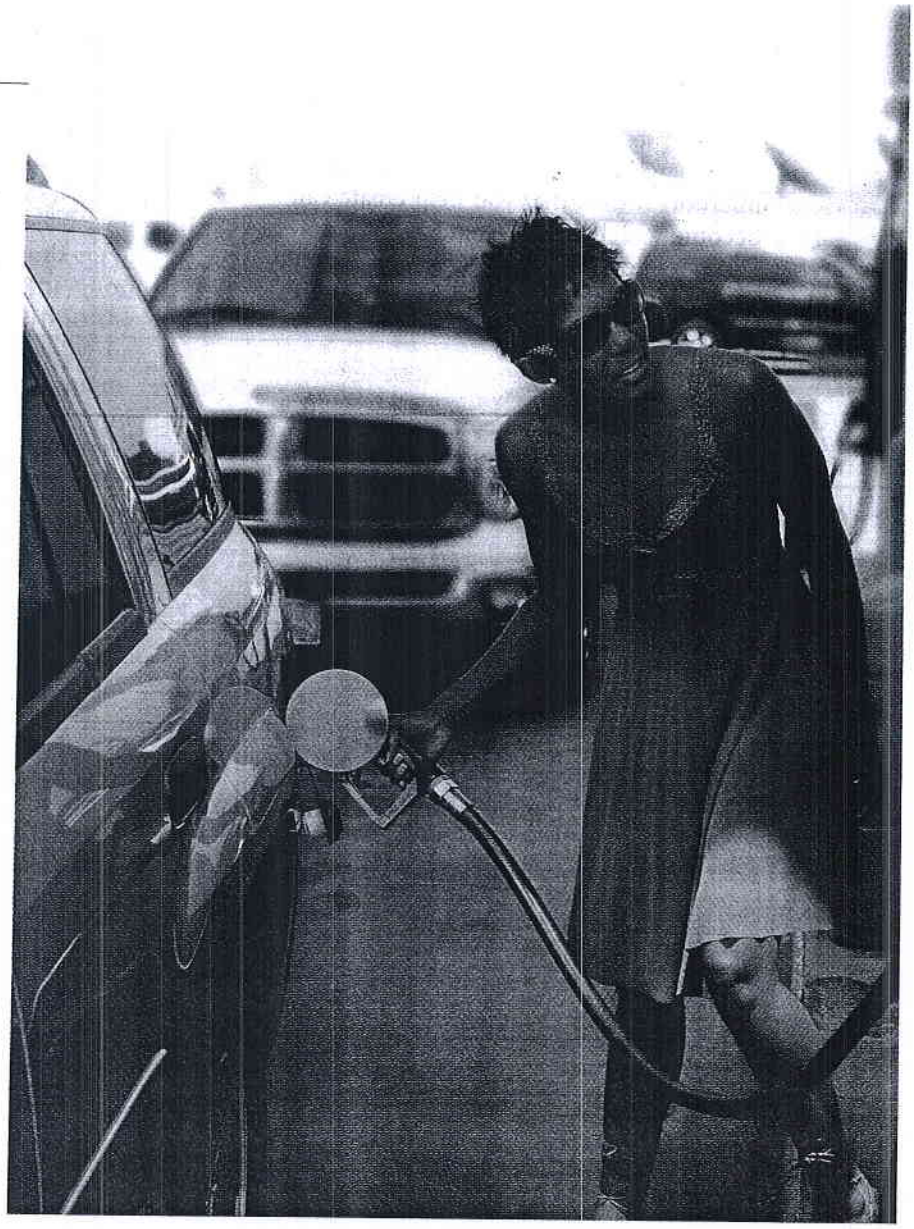
CHAPTER 6

Elasticity:
The Responsiveness of Demand and Supply

Chapter Outline and Learning Objectives



>> Do People Respond to Changes in the Price of Gasoline?

Some people have argued that consumers don't vary the quantity of gas they buy as the price changes because the number of miles they need to drive to get to work or school or to run errands is roughly constant. During the spring and summer of 2008, however, as the price of gasoline soared to $4.00 per gallon in many parts of the country, consumers certainly responded. For instance, during July 2008, when the average price of gasoline was $4.09, U.S. consumers bought nearly 6 percent less gasoline than they had during July 2007, when the average price of gasoline had been $2.96 per gallon.

Service station owners were definitely aware that consumers were responding to higher gas prices. In the spring of 2008, a service station owner on Staten Island, New York, was trying to avoid losing customers by keeping his price below $4.00 per gallon, even if it meant making very little profit. A newspaper article quoted him as saying:

> That gasoline costs me $3.78 cents. . . . If you take the $3.78 and you pay with an American Express card [the charge to the service station owner is] about 11 cents. Plus there's a 2 or 3 cents . . . sales tax extra that we don't charge. So now you're talking a cost of about $3.92 to me. And I'm charging $3.99.

But he was afraid that raising his prices would cause the quantity of gasoline he sold to fall by so much that he would be in an even worse situation.

In this chapter, we will explore what determines the responsiveness of the quantity demanded and the quantity supplied to changes in the market price. **AN INSIDE LOOK** on **page 192** discusses the effect of higher gas prices on the demand for public transportation.

Sources: Glenn Collins, "Gas Station Owners Try to Hold a Psychological Line," *New York Times*, May 3, 2008; and data on gasoline prices and consumption from the U.S. Energy Information Administration.

Economics in YOUR LIFE!

How Much Do Gas Prices Matter to You?

What factors would make you more or less responsive to price when purchasing gasoline? Have you responded differently to price changes during different periods of your life? Why do consumers seem to respond more to changes in gas prices at a particular service station but seem less sensitive when gas prices rise or fall at all service stations? As you read the chapter, see if you can answer these questions. You can check your answers against those we provide at the end of the chapter.

▶ Continued on page 190

Whether you are managing a service station, a bookstore, or a coffee shop, you need to know how an increase or a decrease in the price of your products will affect the quantity consumers are willing to buy. We saw in Chapter 3 that cutting the price of a good increases the quantity demanded and that raising the price reduces the quantity demanded. But the critical question is this: *How much* will the quantity demanded change as a result of a price increase or decrease? Economists use the concept of **elasticity** to measure how one economic variable—such as the quantity demanded—responds to changes in another economic variable—such as the price. For example, the responsiveness of the quantity demanded of a good to changes in its price is called the *price elasticity of demand.* Knowing the price elasticity of demand allows you to compute the effect of a price change on the quantity demanded.

Elasticity A measure of how much one economic variable responds to changes in another economic variable.

We also saw in Chapter 3 that the quantity of a good that consumers demand depends not just on the price of the good but also on consumer income and on the prices of related goods. As a manager, you would also be interested in measuring the responsiveness of demand to these other factors. As we will see, we can use the concept of elasticity here as well. We are also interested in the responsiveness of the quantity supplied of a good to changes in its price, which is called the *price elasticity of supply.*

Elasticity is an important concept not just for business managers but for policymakers as well. If the government wants to discourage teenage smoking, it can raise the price of cigarettes by increasing the tax on them. If we know the price elasticity of demand for cigarettes, we can calculate how many fewer packs of cigarettes will be demanded at a higher price. In this chapter, we will also see how policymakers use the concept of elasticity.

6.1 LEARNING OBJECTIVE

Define price elasticity of demand and understand how to measure it.

The Price Elasticity of Demand and its Measurement

We know from the law of demand that when the price of a product falls, the quantity demanded of the product increases. But the law of demand tells firms only that the demand curves for their products slope downward. More useful is a measure of the responsiveness of the quantity demanded to a change in price. This measure is called the **price elasticity of demand.**

Price elasticity of demand The responsiveness of the quantity demanded to a change in price, measured by dividing the percentage change in the quantity demanded of a product by the percentage change in the product's price.

Measuring the Price Elasticity of Demand

We might measure the price elasticity of demand by using the slope of the demand curve because the slope of the demand curve tells us how much quantity changes as price changes. Using the slope of the demand curve to measure price elasticity has a drawback, however: The measurement of slope is sensitive to the units chosen for quantity and price. For example, suppose a $1 per gallon decrease in the price of gasoline leads to an increase in the quantity demanded from 10.1 million gallons to 10.2 million gallons per day. The change in quantity is 0.1 million gallons, and the change in price is −$1, so the slope is 0.1/−1 = −0.1. But if we measure price in cents, rather than dollars, the slope is 0.1/−100 = −0.001. If we measure price in dollars and gallons in thousands, instead of millions, the slope is 100/−1 = −100. Clearly, the value we compute for the slope can change dramatically, depending on the units we use for quantity and price.

To avoid this confusion over units, economists use *percentage changes* when measuring the price elasticity of demand. Percentage changes are not dependent on units of measurement. (For a review of calculating percentage changes, see the appendix to Chapter 1.) No matter what units we use to measure the quantity of gasoline, 10 percent

more gasoline is 10 percent more gasoline. Therefore, the price elasticity of demand is measured by dividing the percentage change in the quantity demanded by the percentage change in the price. Or:

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

It's important to remember that *the price elasticity of demand is not the same as the slope of the demand curve.*

If we calculate the price elasticity of demand for a price cut, the percentage change in price will be negative, and the percentage change in quantity demanded will be positive. Similarly, if we calculate the price elasticity of demand for a price increase, the percentage change in price will be positive, and the percentage change in quantity demanded will be negative. Therefore, the price elasticity of demand is always negative. In comparing elasticities, though, we are usually interested in their relative size. So, we often drop the minus sign and compare their *absolute values.* In other words, although −3 is actually a smaller number than −2, a price elasticity of −3 is larger than a price elasticity of −2.

Elastic Demand and Inelastic Demand

If the quantity demanded is responsive to changes in price, the percentage change in quantity demanded will be *greater* than the percentage change in price, and the price elasticity of demand will be greater than 1 in absolute value. In this case, demand is **elastic.** For example, if a 10 percent decrease in the price of bagels results in a 20 percent increase in the quantity of bagels demanded, then:

$$\text{Price elasticity of demand} = \frac{20\%}{-10\%} = -2,$$

and we can conclude that the demand for bagels is elastic.

Elastic demand Demand is elastic when the percentage change in quantity demanded is *greater* than the percentage change in price, so the price elasticity is *greater* than 1 in absolute value.

When the quantity demanded is not very responsive to price, however, the percentage change in quantity demanded will be *less* than the percentage change in price, and the price elasticity of demand will be less than 1 in absolute value. In this case, demand is **inelastic.** For example, if a 10 percent decrease in the price of wheat results in a 5 percent increase in the quantity of wheat demanded, then:

$$\text{Price elasticity of demand} = \frac{5\%}{-10\%} = -0.5,$$

and we can conclude that the demand for wheat is inelastic.

Inelastic demand Demand is inelastic when the percentage change in quantity demanded is *less* than the percentage change in price, so the price elasticity is *less* than 1 in absolute value.

In the special case in which the percentage change in the quantity demanded is equal to the percentage change in price, the price elasticity of demand equals −1 (or 1 in absolute value). In this case, demand is **unit elastic.**

Unit-elastic demand Demand is unit elastic when the percentage change in quantity demanded is *equal to* the percentage change in price, so the price elasticity is equal to 1 in absolute value.

An Example of Computing Price Elasticities

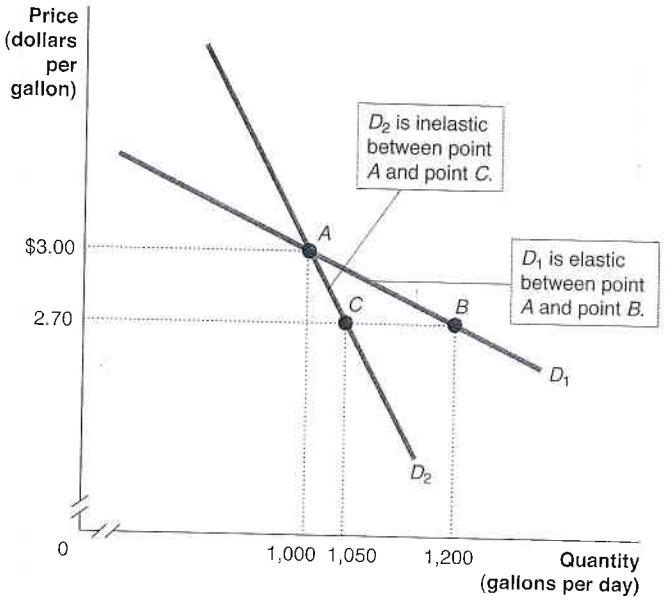
Suppose you own a service station and you are trying to decide whether to cut the price you are charging for a gallon of gas. You are currently at point *A* in Figure 6-1: selling 1,000 gallons per day at a price of $3.00 per gallon. How many more gallons you will sell by cutting the price to $2.70 depends on the price elasticity of demand for gasoline at your service station. Let's consider two possibilities: If D_1 is the demand curve for gasoline at your station, your sales will increase to 1,200 gallons per day, point *B.* But if D_2 is your demand curve, your sales will increase only to 1,050 gallons per day, point *C.* We might expect—correctly, as we will see—that between these points, demand curve D_1 is *elastic,* and demand curve D_2 is *inelastic.*

To confirm that D_1 is elastic between these points and that D_2 is inelastic, we need to calculate the price elasticity of demand for each curve. In calculating price elasticity between two points on a demand curve, though, we run into a problem because we get a different value for price increases than for price decreases. For example, suppose we

Figure 6-1

Elastic and Inelastic Demand Curves

Along D_1, cutting the price from \$3.00 to \$2.70 increases the number of gallons sold from 1,000 per day to 1,200 per day, so demand is elastic between point *A* and point *B*. Along D_2, cutting the price from \$3.00 to \$2.70 increases the number of gallons sold from 1,000 per day only to 1,050 per day, so demand is inelastic between point *A* and point *C*.



calculate the price elasticity for D_1 as the price is cut from \$3.00 to \$2.70. This reduction is a 10 percent price cut that increases the quantity demanded from 1,000 gallons to 1,200 gallons, or by 20 percent. Therefore, the price elasticity of demand between points *A* and *B* is 20/−10 = −2.0. Now let's calculate the price elasticity for D_1 as the price is *increased* from \$2.70 to \$3.00. This is an 11.1 percent price increase that decreases the quantity demanded from 1,200 gallons to 1,000 gallons, or by 16.7 percent. So, now our measure of the price elasticity of demand between points *A* and *B* is −16.7/11.1 = −1.5. It can be confusing to have different values for the price elasticity of demand between the same two points on the same demand curve. As we will see in the next section, to avoid this confusion, economists often use a particular formula when calculating elasticities.

The Midpoint Formula

We can use the *midpoint formula* to ensure that we have only one value of the price elasticity of demand between the same two points on a demand curve. The midpoint formula uses the *average* of the initial and final quantities and the initial and final prices. If Q_1 and P_1 are the initial quantity and price and Q_2 and P_2 are the final quantity and price, the midpoint formula is:

$$\text{Price elasticity of demand} = \frac{(Q_2 - Q_1)}{\left(\frac{Q_1 + Q_2}{2}\right)} \div \frac{(P_2 - P_1)}{\left(\frac{P_1 + P_2}{2}\right)}.$$

The midpoint formula may seem challenging at first, but the numerator is just the change in quantity divided by the average of the initial and final quantities, and the denominator is just the change in price divided by the average of the initial and final prices.

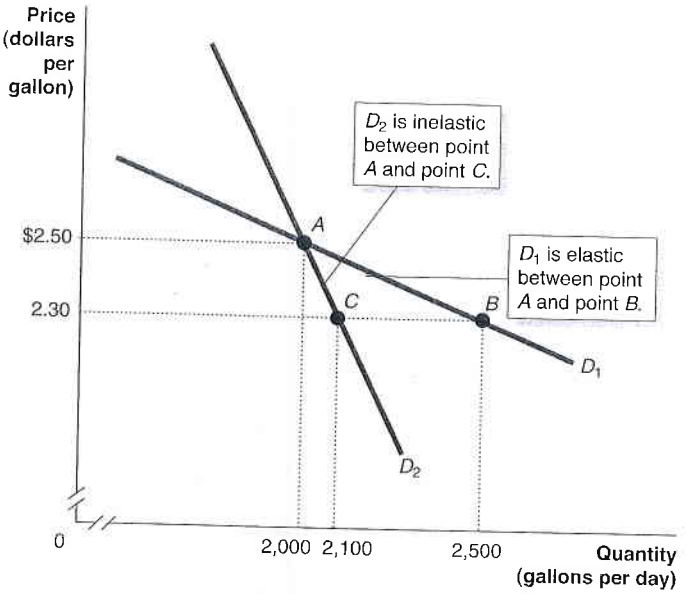
Let's apply the formula to calculating the price elasticity of D_1 in Figure 6-1. Between point *A* and point *B* on D_1, the change in quantity is 200, and the average of the two quantities is 1,100. Therefore, there is an 18.2 percent change in quantity. The change in price is −\$0.30, and the average of the two prices is \$2.85. Therefore, there is a −10.5 percent change in price. So, the price elasticity of demand is 18.2/−10.5 = −1.7. Notice these three results from calculating the price elasticity of demand using the midpoint formula: First, as we suspected from examining Figure 6-1, demand curve D_1 is elastic between points *A* and *B*. Second, our value for the price elasticity calculated using the midpoint formula is between the two values we calculated earlier. Third, the midpoint formula will give us the same value whether we are moving from the higher price to the lower price or from the lower price to the higher price.

We can also use the midpoint formula to calculate the elasticity of demand between point A and point C on D_2. In this case, there is a 4.9 percent change in quantity and a −10.5 percent change in price. So, the elasticity of demand is 4.9/−10.5 = −0.5. Once again, as we suspected, demand curve D_2 is price inelastic between points A and C.

Solved Problem 6-1

Calculating the Price Elasticity of Demand

Suppose you own a service station and you are currently selling gasoline for $2.50 per gallon. At this price you can sell 2,000 gallons per day. You are considering cutting the price to $2.30 to attract drivers who have been buying their gas at competing stations. The graph below shows two possible increases in the quantity sold as a result of your price cut. Use the information in the graph to calculate the price elasticity between these two prices on each of the demand curves. Use the midpoint formula in your calculations. State whether each demand curve is elastic or inelastic between these two prices.



SOLVING THE PROBLEM:

Step 1: **Review the chapter material.** This problem requires calculating the price elasticity of demand, so you may want to review the material in the section "The Midpoint Formula," which begins on page 170.

Step 2: **To begin using the midpoint formula, calculate the average quantity and the average price for demand curve D_1.**

$$\text{Average quantity} = \frac{2{,}000 + 2{,}500}{2} = 2{,}250$$

$$\text{Average price} = \frac{\$2.50 + \$2.30}{2} = \$2.40$$

Step 3: **Now calculate the percentage change in the quantity demanded and the percentage change in price for demand curve D_1.**

$$\text{Percentage change in quantity demanded} = \frac{2{,}500 - 2{,}000}{2{,}250} \times 100 = 22.2\%$$

$$\text{Percentage change in price} = \frac{\$2.30 - \$2.50}{\$2.40} \times 100 = -8.3\%$$

Step 4: **Divide the percentage change in the quantity demanded by the percentage change in price to arrive at the price elasticity for demand curve D_1.**

$$\text{Price elasticity of demand} = \frac{22.2\%}{-8.3\%} = -2.7$$

Because the elasticity is greater than 1 in absolute value, D_1 is price *elastic* between these two prices.

Step 5: **Calculate the price elasticity of demand curve D_2 between these two prices.**

$$\text{Percentage change in quantity demanded} = \frac{2{,}100 - 2{,}000}{2{,}050} \times 100 = 4.9\%$$

$$\text{Percentage change in price} = \frac{\$2.30 - \$2.50}{\$2.40} \times 100 = -8.3\%$$

$$\text{Price elasticity of demand} = \frac{4.9\%}{-8.3\%} = -0.6$$

Because the elasticity is less than 1 in absolute value, D_2 is price *inelastic* between these two prices.

myeconlab **YOUR TURN:** For more practice, do related problem 1.6 on page 194 at the end of this chapter.

When Demand Curves Intersect, the Flatter Curve Is More Elastic

Remember that elasticity is not the same thing as slope. While slope is calculated using changes in quantity and price, elasticity is calculated using percentage changes. But it *is* true that if two demand curves intersect, the one with the smaller slope (in absolute value)—the flatter demand curve—is more elastic, and the one with the larger slope (in absolute value)—the steeper demand curve—is less elastic. In Figure 6-1, for a given change in price, demand curve D_1 is more elastic than demand curve D_2.

Polar Cases of Perfectly Elastic and Perfectly Inelastic Demand

Perfectly inelastic demand The case where the quantity demanded is completely unresponsive to price, and the price elasticity of demand equals zero.

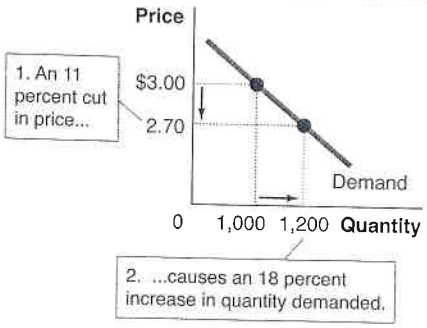
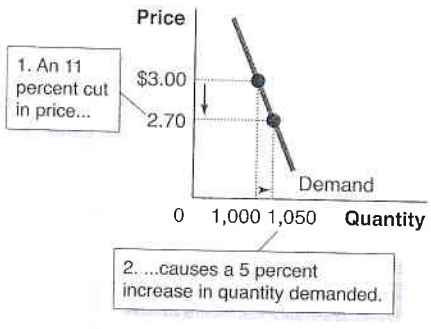
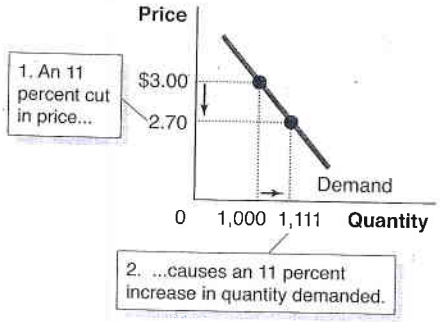
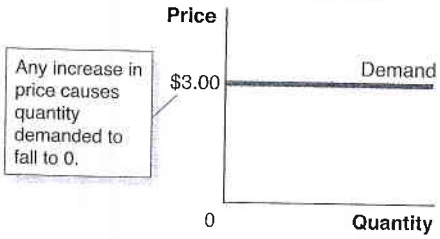
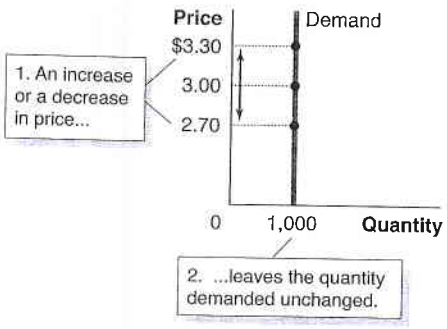
Although they do not occur frequently, you should be aware of the extreme, or polar, cases of price elasticity. If a demand curve is a vertical line, it is **perfectly inelastic**. In this case, the quantity demanded is completely unresponsive to price, and the price elasticity of demand equals zero. No matter how much price may increase or decrease, the quantity remains the same. For only a very few products will the quantity demanded be completely unresponsive to the price, making the demand curve a vertical line. The drug insulin is an example. Diabetics must take a certain amount of insulin each day. If the price of insulin declines, it will not affect the required dose and thus will not increase the quantity demanded. Similarly, a price increase will not affect the required dose or decrease the quantity demanded. (Of course, some diabetics will not be able to afford insulin at a higher price. If so, even in this case, the demand curve may not be completely vertical and, therefore, not perfectly inelastic.)

Perfectly elastic demand The case where the quantity demanded is infinitely responsive to price, and the price elasticity of demand equals infinity.

If a demand curve is a horizontal line, it is **perfectly elastic**. In this case, the quantity demanded is infinitely responsive to price, and the price elasticity of demand equals infinity. If a demand curve is perfectly elastic, an increase in price causes the quantity demanded to fall to zero. Once again, perfectly elastic demand curves are rare, and it is important not to confuse *elastic* with *perfectly elastic*. Table 6-1 summarizes the different price elasticities of demand.

TABLE 6-1

Summary of the Price Elasticities of Demand

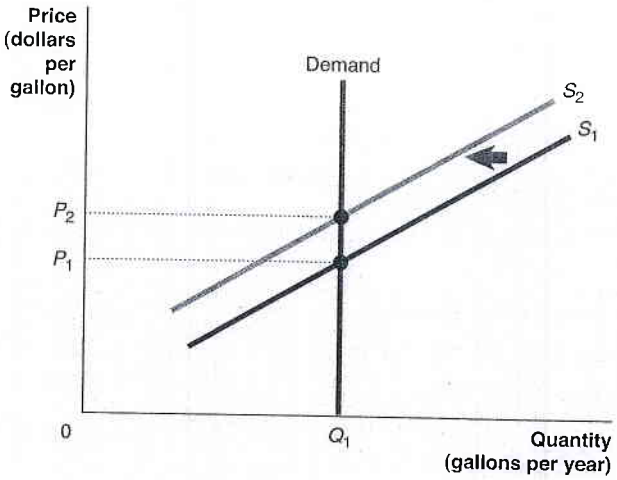
IF DEMAND IS . . .	THEN THE ABSOLUTE VALUE OF PRICE ELASTICITY IS . . .	
elastic	greater than 1	
inelastic	less than 1	
unit elastic	equal to 1	
perfectly elastic	equal to infinity	
perfectly inelastic	equal to 0	

Note: The percentage increases shown in the boxes in the graphs were calculated using the midpoint formula, given on page 170.

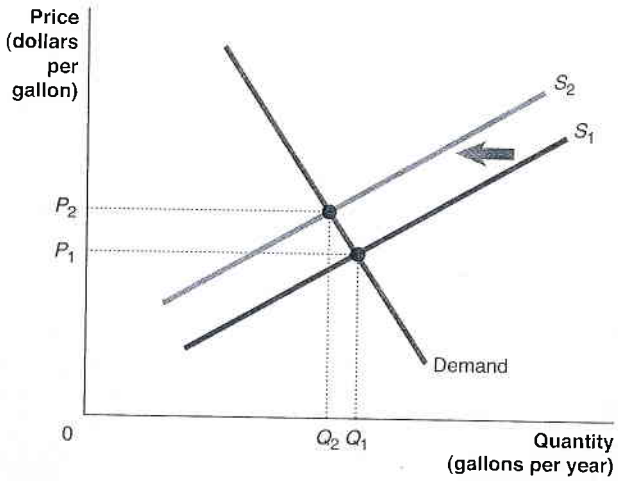
Don't Let This Happen to **YOU!**

Don't Confuse Inelastic with *Perfectly* Inelastic

You may be tempted to simplify the concept of elasticity by assuming that any demand curve described as being inelastic is *perfectly* inelastic. You should never assume this because perfectly inelastic demand curves are rare. For example, consider the following problem: "Use a demand and supply graph to show how a decrease in supply affects the equilibrium quantity of gasoline. Assume that the demand for gasoline is inelastic." The following graph would be an *incorrect* answer to this problem.



The demand for gasoline is inelastic, but it is not *perfectly* inelastic. When the price of gasoline rises, the quantity demanded falls. So, the graph that would be the correct answer to this problem would show a typical downward-sloping demand curve rather than a vertical demand curve.



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YOUR TURN: Test your understanding by doing related problem 1.11 on page 195 at the end of this chapter.

6.2 LEARNING OBJECTIVE

Understand the determinants of the price elasticity of demand.

The Determinants of the Price Elasticity of Demand

We have seen that the demand for some products may be elastic, while the demand for other products may be inelastic. In this section, we examine why price elasticities differ among products. The key determinants of the price elasticity of demand are as follows:

- Availability of close substitutes
- Passage of time
- Luxuries versus necessities
- Definition of the market
- Share of the good in the consumer's budget

Availability of Close Substitutes

The availability of substitutes is the most important determinant of price elasticity of demand because how consumers react to a change in the price of a product depends on what alternatives they have. When the price of gasoline rises, consumers have few alternatives, so the quantity demanded falls only a little. But if the price of pizza rises, consumers have many alternatives, so the quantity demanded is likely to fall quite a lot. In fact, a key constraint on a firm's pricing policies is how many close substitutes exist for its product. In general, *if a product has more substitutes available, it will have more elastic demand. If a product has fewer substitutes available, it will have less elastic demand.*

Passage of Time

It usually takes consumers some time to adjust their buying habits when prices change. If the price of chicken falls, for example, it takes a while before consumers decide to change from eating chicken for dinner once per week to eating it twice per week. If the price of gasoline increases, it also takes a while for consumers to decide to begin taking public transportation, to buy more fuel-efficient cars, or to find new jobs closer to where they live. *The more time that passes, the more elastic the demand for a product becomes.*

Luxuries versus Necessities

Goods that are luxuries usually have more elastic demand curves than goods that are necessities. For example, the demand for bread is inelastic because bread is a necessity, and the quantity that people buy is not very dependent on its price. Tickets to a concert are a luxury, so the demand for concert tickets is much more elastic than the demand for bread. *The demand curve for a luxury is more elastic than the demand curve for a necessity.*

Definition of the Market

In a narrowly defined market, consumers have more substitutes available. At the beginning of this chapter, we saw that a service station owner on Staten Island, New York, worried that if he raised the price he was charging for gasoline, many of his customers would switch to buying from a competitor. So, the demand for gasoline at his particular station is likely to be elastic. The demand for gasoline as a product, on the other hand, is inelastic because consumers have few alternatives (in the short run) to buying it. *The more narrowly we define a market, the more elastic demand will be.*

Share of a Good in a Consumer's Budget

Goods that take only a small fraction of a consumer's budget tend to have less elastic demand than goods that take a large fraction. For example, most people buy table salt infrequently and in relatively small quantities. The share of the average consumer's budget that is spent on salt is very low. As a result, even a doubling of the price of salt is likely to result in only a small decline in the quantity of salt demanded. "Big-ticket items," such as houses, cars, and furniture, take up a larger share in the average consumer's budget. Increases in the prices of these goods are likely to result in significant declines in quantity demanded. In general, *the demand for a good will be more elastic the larger the share of the good in the average consumer's budget.*

Some Estimated Price Elasticities of Demand

Table 6-2 shows some estimated short-run price elasticities of demand. It's important to remember that estimates of the price elasticity of different goods can vary, depending on the data used and the time period over which the estimates were made. The results given in the table are consistent with our discussion of the determinants of price elasticity. Goods for which there are few substitutes, such as cigarettes and gasoline, are price inelastic, as are broadly defined goods, such as bread or beer. Particular brands of products, such as Coca-Cola or Post Raisin Bran, are price elastic. (This point is discussed further in the *Making the Connection* on the price elasticity of breakfast cereal.)

The demand for books or DVDs bought from a particular retailer is typically price elastic. Note, though, that demand for books from Amazon is inelastic. This estimate would indicate that at least in the early 2000s, when the estimate was made, consumers did not consider ordering from other online sites to be good substitutes for ordering from Amazon.

An increase in the price of grapes will lead some consumers to substitute other fruits, so demand for grapes is price elastic. Similarly, an increase in the price of new automobiles will lead some consumers to buy used automobiles or to continue driving their current cars, so demand for automobiles is also price elastic. Necessities, such as natural gas and water, are also price inelastic.

TABLE 6-2
Estimated Real-World Price Elasticities of Demand

PRODUCT	ESTIMATED ELASTICITY	PRODUCT	ESTIMATED ELASTICITY
Books (Barnes&Noble)	–4.00	Water (residential use)	–0.38
Books (Amazon)	–0.60	Chicken	–0.37
DVDs (Amazon)	–3.10	Cocaine	–0.28
Post Raisin Bran	–2.50	Cigarettes	–0.25
Automobiles	–1.95	Beer	–0.23
Coca-Cola	–1.22	Residential natural gas	–0.09
Grapes	–1.18	Gasoline	–0.06
Restaurant meals	–0.67	Milk	–0.04
Bread	–0.40	Sugar	–0.04

Sources: Kelly D. Brownell and Thomas R. Frieden, "Ounces of Prevention—The Public Policy Case for Taxes on Sugared Beverages," *New England Journal of Medicine*, April 30, 2009; Sheila M. Olmstead and Robert N. Stavins, "Comparing Price and Non-Price Approaches to Urban Water Conservation," Resources for the Future, Discussion paper 08-22, June 2008; Jonathan E. Hughes, Christopher R. Knittel, and Daniel Sperling, *Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand*, Research Report UCD-ITS-RR-06-16 (University of California, Davis: Institute of Transportation Studies, 2006); Robert P. Trost, Frederick Joutz, David Shin, and Bruce McDonwell, "Using Shrinkage Estimators to Obtain Regional Short-Run and Long-Run Price Elasticities of Residential Natural Gas Demand in the U.S." George Washington University Working Paper, March 13, 2009; Lesley Chiou, "Empirical Analysis of Competition between Wal-Mart and Other Retail Channels", *Journal of Economics and Management Strategy*, forthcoming; Judith Chevalier, and Austan Goolsbee, "Price Competition Online: Amazon versus Barnes and Noble", *Quantitative Marketing and Economics*, Vol. 1, no. 2, June, 2003; Henry Saffer and Frank Chaloupka, "The Demand for Illicit Drugs," *Economic Inquiry*, Vol. 37, No. 3, July 1999; "Response to Increases in Cigarette Prices by Race/Ethnicity, Income, and Age Groups—United States, 1976–1993," *Morbidity and Mortality Weekly Report*, July 31, 1998; James Wetzel and George Hoffer, "Consumer Demand for Automobiles: A Disaggregated Market Approach," *Journal of Consumer Research*, Vol. 9, No. 2, September 1982; Jerry A. Hausman, "The Price Elasticity of Demand for Breakfast Cereal," in Timothy F. Bresnahan and Robert J. Gordon, eds., *The Economics of New Goods*, Chicago: University of Chicago Press, 1997; X. M. Gao, Eric J. Wailes, and Gail L. Cramer, "A Microeconometric Model Analysis of U.S. Consumer Demand for Alcoholic Beverages," *Applied Economics*, January 1995; and U.S. Department of Agriculture, Economic Research Service.

What happens when the price of Post Raisin Bran increases?

Making the Connection

The Price Elasticity of Demand for Breakfast Cereal

MIT economist Jerry Hausman has estimated the price elasticity of demand for breakfast cereal. He divided breakfast cereals into three categories: children's cereals, such as Trix and Froot Loops; adult cereals, such as Special K and Grape-Nuts; and family cereals, such as Corn Flakes and Raisin Bran. Some of the results of his estimates are given in the following table.

CEREAL	PRICE ELASTICITY OF DEMAND
Post Raisin Bran	–2.5
All family breakfast cereals	–1.8
All types of breakfast cereals	–0.9

Source: Jerry A. Hausman, "The Price Elasticity of Demand for Breakfast Cereal," in Timothy F. Bresnahan and Robert J. Gordon, eds., *The Economics of New Goods*, Chicago: University of Chicago Press, 1997. Used with permission of The University of Chicago Press.

Just as we would expect, the price elasticity for a particular brand of raisin bran was larger in absolute value than the elasticity for all family cereals, and the elasticity for all

family cereals was larger than the elasticity for all types of breakfast cereals. If Post increases the price of its Raisin Bran by 10 percent, sales will decline by 25 percent, as many consumers switch to another brand of raisin bran. If the prices of all family breakfast cereals rise by 10 percent, sales will decline by 18 percent, as consumers switch to child or adult cereals. In both of these cases, demand is elastic. But if the prices of all types of breakfast cereals rise by 10 percent, sales will decline by only 9 percent. Demand for all breakfast cereals is inelastic.

Source: Jerry A. Hausman, "Valuation of New Goods under Perfect and Imperfect Competition," in Timothy F. Bresnahan and Robert J. Gordon, eds., *The Economics of New Goods*, Chicago: University of Chicago Press, 1997.

YOUR TURN: Test your understanding by doing related problems 2.4 and 2.5 on page 196 at the end of this chapter. myeconlab

The Relationship between Price Elasticity of Demand and Total Revenue

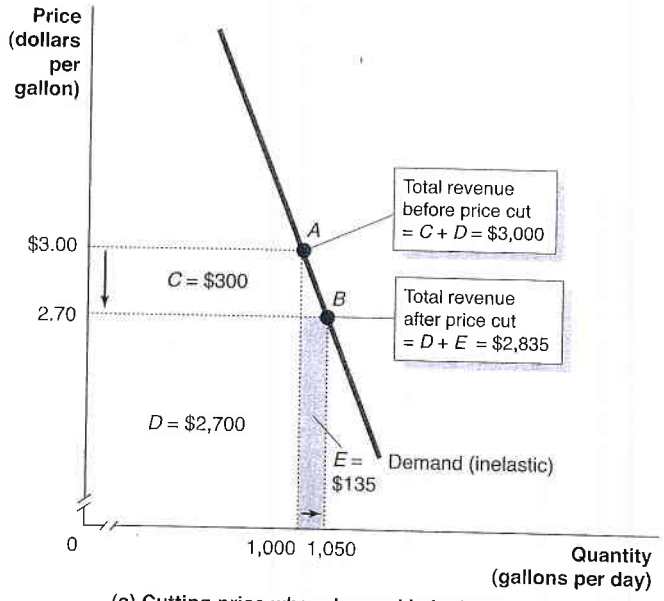
6.3 LEARNING OBJECTIVE

Understand the relationship between the price elasticity of demand and total revenue.

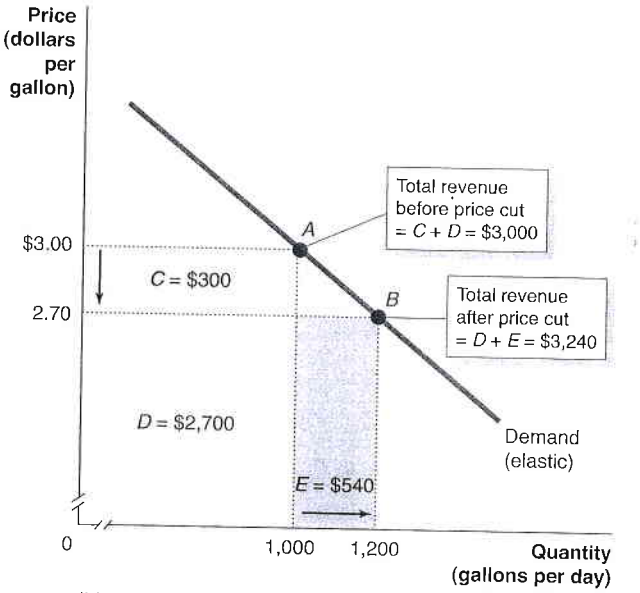
A firm is interested in price elasticity because it allows the firm to calculate how changes in price will affect its **total revenue**, which is the total amount of funds it receives from selling a good or service. Total revenue is calculated by multiplying price per unit by the number of units sold. When demand is inelastic, price and total revenue move in the same direction: An increase in price raises total revenue, and a decrease in price reduces total revenue. When demand is elastic, price and total revenue move inversely: An increase in price reduces total revenue, and a decrease in price raises total revenue.

Total revenue The total amount of funds received by a seller of a good or service, calculated by multiplying price per unit by the number of units sold.

To understand the relationship between price elasticity and total revenue, consider Figure 6-2. Panel (a) shows a demand curve for gasoline (as in Figure 6-1 on page 170). This demand curve is inelastic between point *A* and point *B*. The total revenue received



(a) Cutting price when demand is inelastic reduces total revenue.



(b) Cutting price when demand is elastic increases total revenue.

Figure 6-2 **The Relationship between Price Elasticity and Total Revenue**

When demand is inelastic, a cut in price will decrease total revenue. In panel (a), at point *A*, the price is $3.00, 1,000 gallons are sold, and total revenue received by the service station equals $3.00 × 1,000 gallons, or $3,000. At point *B*, cutting price to $2.70 increases the quantity demanded to 1,050 gallons, but the fall in price more than offsets the increase in quantity. As a result, revenue falls to $2.70 × 1,050 gallons, or $2,835. When demand is elastic, a cut in price will increase total revenue. In panel (b), at point *A*, the area of rectangles *C* and *D* is still equal to $3,000. But at point *B*, the area of rectangles *D* and *E* is equal to $2.70 × 1,200 gallons, or $3,240. In this case, the increase in the quantity demanded is large enough to offset the fall in price, so total revenue increases.

by the service station owner at point *A* equals the price of $3.00 multiplied by the 1,000 gallons sold, or $3,000. This amount equals the areas of the rectangles *C* and *D* in the figure because together the rectangles have a height of $3.00 and a base of 1,000 gallons. Because this demand curve is inelastic between point *A* and point *B* (it was demand curve D_2 in Figure 6-1), cutting the price to $2.70 (point *B*) reduces total revenue. The new total revenue is shown by the areas of rectangles *D* and *E*, and it is equal to $2.70 multiplied by 1,050 gallons, or $2,835. Total revenue falls because the increase in the quantity demanded is not large enough to make up for the decrease in price. As a result, the $135 increase in revenue gained as a result of the price cut—dark-green rectangle *E*—is less than the $300 in revenue lost—light-green rectangle *C*.

Panel (b) of Figure 6-2 shows a demand curve that is elastic between point *A* and point *B* (it was demand curve D_1 in Figure 6-1). In this case, cutting the price increases total revenue. At point *A*, the areas of rectangles *C* and *D* are still equal to $3,000, but at point *B*, the areas of rectangles *D* and *E* are equal to $2.70 multiplied by 1,200 gallons, or $3,240. Here, total revenue rises because the increase in the quantity demanded is large enough to offset the lower price. As a result, the $540 increase in revenue gained as a result of the price cut—dark-green rectangle *E*—is greater than the $300 in revenue lost—light-green rectangle *C*.

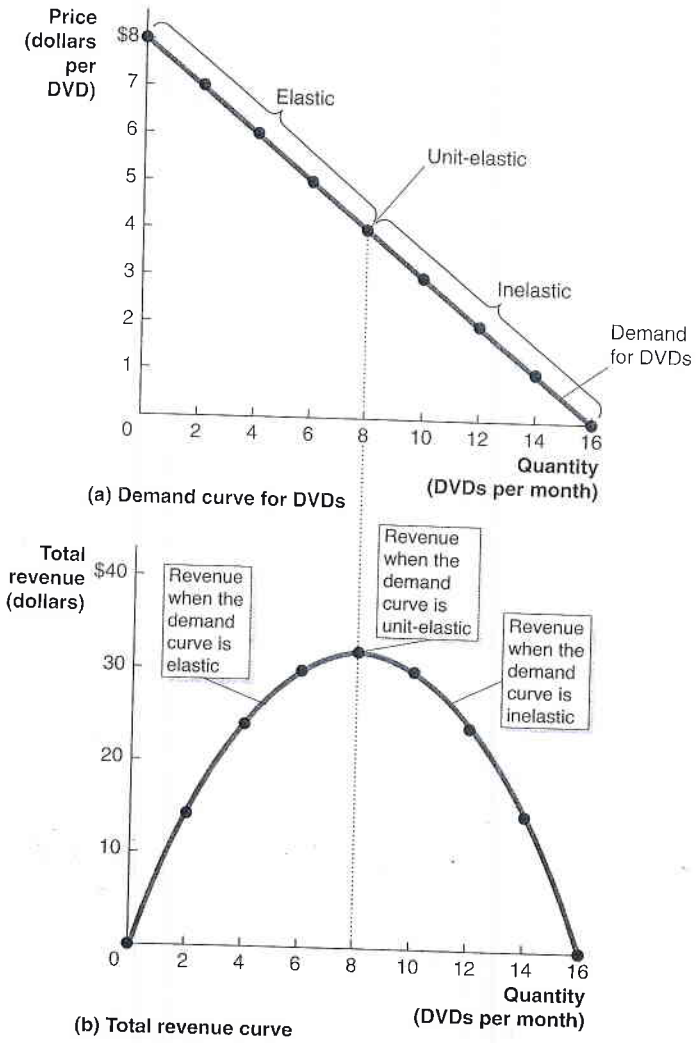
The third, less common, possibility is that demand is unit elastic. In that case, a small change in price is exactly offset by a proportional change in quantity demanded, leaving revenue unaffected. Therefore, when demand is unit elastic, neither a decrease in price nor an increase in price affects revenue. Table 6-3 summarizes the relationship between price elasticity and revenue.

Elasticity and Revenue with a Linear Demand Curve

Along most demand curves, elasticity is not constant at every point. For example, a straight-line, or linear, demand curve for rentals of DVDs is shown in panel (a) of Figure 6-3. The numbers from the table are plotted in the graphs. The demand curve shows that when the price drops by $1, consumers always respond by renting 2 more DVDs per month. When the price is high and the quantity demanded is low, demand is elastic. Demand is elastic because a $1 drop in price is a smaller percentage change when the price is high, and an increase of 2 DVD rentals is a larger percentage change when the quantity of DVD rentals is small. By similar reasoning, we can see why demand is inelastic when the price is low and the quantity demanded is high.

TABLE 6-3
The Relationship between Price Elasticity and Revenue

IF DEMAND IS . . .	THEN . . .	BECAUSE . . .
elastic	an increase in price reduces revenue	the decrease in quantity demanded is proportionally *greater* than the increase in price.
elastic	a decrease in price increases revenue	the increase in quantity demanded is proportionally *greater* than the decrease in price.
inelastic	an increase in price increases revenue	the decrease in quantity demanded is proportionally *smaller* than the increase in price.
inelastic	a decrease in price reduces revenue	the increase in quantity demanded is proportionally *smaller* than the decrease in price.
unit elastic	an increase in price does not affect revenue	the decrease in quantity demanded is proportionally *the same as* the increase in price.
unit elastic	a decrease in price does not affect revenue	the increase in quantity demanded is proportionally *the same as* the decrease in price.



Price	Quantity Demanded	Total Revenue
$8	0	$0
7	2	14
6	4	24
5	6	30
4	8	32
3	10	30
2	12	24
1	14	14
0	16	0

Figure 6-3 **Elasticity Is Not Constant Along a Linear Demand Curve**

The data from the table are plotted in the graphs. Panel (a) shows that as we move down the demand curve for DVD rentals, the price elasticity of demand declines. In other words, at higher prices, demand is elastic, and at lower prices, demand is inelastic. Panel (b) shows that as the quantity of DVDs rented increases from zero, revenue will increase until it reaches a maximum of $32 when 8 DVDs are rented. As rentals increase beyond 8 DVDs, revenue falls because demand is inelastic on this portion of the demand curve.

Panel (a) in Figure 6-3 shows that when rental price is between $8 and $4 and quantity demanded is between 0 and 8, demand is elastic. Panel (b) shows that over this same range, total revenue will increase as price falls. For example, in panel (a), as price falls from $7 to $6, quantity demanded increases from 2 to 4, and in panel (b), total revenue increases from $14 to $24. Similarly, when price is between $4 and zero and quantity demanded is between 8 and 16, demand is inelastic. Over this same range, total revenue will decrease as price falls. For example, as price falls from $3 to $2 and quantity demanded increases from 10 to 12, total revenue decreases from $30 to $24.

Estimating Price Elasticity of Demand

To estimate the price elasticity of demand, economists need to know the demand curve for a product. To calculate the price elasticity of demand for new products, firms often rely on market experiments. With market experiments, firms try different prices and observe the change in quantity demanded that results.

Apple initially misjudged the price elasticity of iPhones.

Making the Connection | Determining the Price Elasticity of Demand through Market Experiments

Firms usually have a good idea of the price elasticity of demand for products that have been on the market for at least a few years. For new products, however, firms will often experiment with different prices to determine the price elasticity. For example, Apple introduced the first-generation iPhone in June 2007, at a price of $599. But demand for the iPhone was more elastic than Apple had expected, and when sales failed to reach Apple's projections, the company cut the price to $399 just two months later. (People who had bought the phone at the higher price were so upset at the price cut that Steve Jobs, Apple's chairman, felt obliged to offer them a $100 credit for purchases of other Apple products.)

Similarly, as each new format for recorded films has been introduced—first VHS tapes, then DVDs, and, most recently, Blu-ray discs—firms have experimented with different prices in trying to determine the relevant price elasticity. The table below is from 2001, when DVDs had been recently introduced. It compares the prices that film studios suggested retailers charge for four films that were available in both DVD and VHS tape formats. The prices of DVDs were much less standardized than the prices of VHS tapes because the studios were unsure of their price elasticities.

FILM	DVD PRICE	VHS PRICE
Rugrats in Paris	$22.46	$22.99
The Mummy Returns	26.98	22.98
Miss Congeniality	16.69	22.98
The Perfect Storm	24.98	22.99

Both the film studios and retailers, such as Amazon.com and Wal-Mart, engaged in similar experimentation after the introduction of Blu-ray discs in 2006. At first, the studios were convinced that consumers would pay substantially more for Blu-ray discs than for DVDs in order to obtain the superior image quality of the discs. By the end of 2008, it had become clear that the price elasticity of demand for Blu-ray discs was significantly higher than had been expected. At that point, Blu-ray discs had captured only 8 percent of the market, with conventional DVDs accounting for the other 92 percent. By 2009, Blu-ray discs, which had been typically priced at $28 to $30 in 2008, were selling for $26 or less. Some industry analysts expected prices to fall even further. Russ Crupnick of NPD, a market research firm, argued, "Consumers were saying a year ago that the price was high and that they were much more comfortable at $22 or $23. . . . But the consumers do get that Blu-ray is a premium, but it's the extent of that premium where they are resistant." One reason that the price elasticity of demand for Blu-ray discs turned out to be higher than the film studios had expected is that many consumers considered downloads of high-definition movies to be a good substitute for buying discs.

Sources: Susanne Ault, "Blu-Ray Prices Drop at Retail," videobusiness.com, March 13, 2009; Kate Hafner and Brad Stone, "iPhone Owners Crying Foul Over Price Cut," *New York Times*, September 7, 2007; and prices from Amazon.com.

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YOUR TURN: Test your understanding by doing related problem 3.11 on page 198 at the end of this chapter.

6.4 LEARNING OBJECTIVE

Define cross-price elasticity of demand and income elasticity of demand and understand their determinants and how they are measured.

Other Demand Elasticities

Elasticity is an important concept in economics because it allows us to quantify the responsiveness of one economic variable to changes in another economic variable. In addition to price elasticity, two other demand elasticities are important: *cross-price elasticity of demand* and *income elasticity of demand.*

Cross-Price Elasticity of Demand

Suppose you work at Apple and you need to predict the effect of an increase in the price of Microsoft's Zune on the quantity of iPods demanded, holding other factors constant. You can do this by calculating the **cross-price elasticity of demand**, which is the percentage change in the quantity of iPods demanded divided by the percentage change in the price of Zunes—or, in general:

Cross-price elasticity of demand The percentage change in quantity demanded of one good divided by the percentage change in the price of another good.

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

The cross-price elasticity of demand is positive or negative, depending on whether the two products are substitutes or complements. Recall that substitutes are products that can be used for the same purpose, such as two brands of digital music players. Complements are products that are used together, such as digital music players and song downloads from online music sites. An increase in the price of a substitute will lead to an increase in quantity demanded, so the cross-price elasticity of demand will be positive. An increase in the price of a complement will lead to a decrease in the quantity demanded, so the cross-price elasticity of demand will be negative. Of course, if the two products are unrelated—such as digital music players and peanut butter—the cross-price elasticity of demand will be zero. Table 6-4 summarizes the key points concerning the cross-price elasticity of demand.

Cross-price elasticity of demand is important to firm managers because it allows them to measure whether products sold by other firms are close substitutes for their products. For example, Amazon.com and Barnesandnoble.com are the leading online booksellers. We might predict that if Amazon raises the price of a new John Grisham novel, many consumers will buy it from Barnesandnoble.com instead. But Jeff Bezos, Amazon's chief executive officer, has argued that because of Amazon's reputation for good customer service and because more customers are familiar with the site, ordering a book from Barnesandnoble.com is not a good substitute for ordering a book from Amazon. In effect, Bezos is arguing that the cross-price elasticity between Amazon's books and Barnesandnoble.com's books is low. Economists Judith Chevalier of Yale University and Austan Goolsbee of the University of Chicago used data on prices and quantities of books sold on these Web sites to estimate the cross-price elasticity. They found that the cross-price elasticity of demand between books at Amazon and books at Barnesandnoble.com was 3.5. This estimate means that if Amazon raises its prices by 10 percent, the quantity of books demanded on Barnesandnoble.com will increase by 35 percent. This result indicates that, contrary to Jeff Bezos's argument, consumers do consider books sold on the two Web sites to be close substitutes.

TABLE 6-4
Summary of Cross-Price Elasticity of Demand

IF THE PRODUCTS ARE . . .	THEN THE CROSS-PRICE ELASTICITY OF DEMAND WILL BE . . .	EXAMPLE
substitutes	positive	Two brands of digital music players
complements	negative	Digital music players and song downloads from online music stores
unrelated	zero	Digital music players and peanut butter

TABLE 6-5
Summary of Income Elasticity of Demand

IF THE INCOME ELASTICITY OF DEMAND IS . . .	THEN THE GOOD IS . . .	EXAMPLE
positive but less than 1	normal and a necessity.	Bread
positive and greater than 1	normal and a luxury.	Caviar
negative	inferior.	High-fat meat

Income Elasticity of Demand

Income elasticity of demand A measure of the responsiveness of quantity demanded to changes in income, measured by the percentage change in quantity demanded divided by the percentage change in income.

The **income elasticity of demand** measures the responsiveness of quantity demanded to changes in income. It is calculated as follows:

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

As we saw in Chapter 3, if the quantity demanded of a good increases as income increases, then the good is a *normal good*. Normal goods are often further subdivided into *luxury goods* and *necessity goods*. A good is a luxury if the quantity demanded is very responsive to changes in income, so that a 10 percent increase in income results in more than a 10 percent increase in quantity demanded. Expensive jewelry and vacation homes are examples of luxuries. A good is a necessity if the quantity demanded is not very responsive to changes in income, so that a 10 percent increase in income results in less than a 10 percent increase in quantity demanded. Food and clothing are examples of necessities. A good is *inferior* if the quantity demanded falls when income increases. Ground beef with a high fat content is an example of an inferior good. We should note that *normal good*, *inferior good*, *necessity*, and *luxury* are just labels economists use for goods with different income elasticities; the labels are not intended to be value judgments about the worth of these goods.

Because most goods are normal goods, during periods of economic expansion, when consumer income is rising, most firms can expect—holding other factors constant—that the quantity demanded of their products will increase. Sellers of luxuries can expect particularly large increases. During recessions, falling consumer income can cause firms to experience increases in demand for inferior goods. For example, the demand for bus trips increases as consumers cut back on air travel, and supermarkets find that the demand for hamburger increases relative to the demand for steak. Table 6-5 summarizes the key points about the income elasticity of demand.

Solved Problem 6-4

A Subway Fare Increase and an Economic Boom Affect the Taxi Business

Assume that two separate events affect the market for taxi rides in New York City:

1. There is a 20 percent increase in New York subway fares. As a result, the number of taxi rides increases 5 percent.
2. An economic expansion causes a 5 percent increase in the incomes of tourists visiting New York City. The number of taxi rides increases 2 percent.

Describe the cross-price and income elasticity formulas and use these formulas to determine the values of these elasticities for taxi rides.

SOLVING THE PROBLEM:

Step 1: **Review the chapter material.** This problem is about the determinants of the cross-price elasticity and income elasticity of demand, so you may want to review the section "Other Demand Elasticities," which begins on page 180.

Step 2: **State the cross-price elasticity formula and determine the value of this elasticity for taxi rides.** The cross-price elasticity formula is:

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

Because a 20 percent increase in subway fares raised the quantity demanded of taxi rides by 5 percent, the value of the cross-price elasticity is:

$$\frac{5 \text{ percent}}{20 \text{ percent}} = 0.25.$$

Subway and taxi rides are substitutes, so the elasticity is positive.

Step 2: **State the income elasticity formula and determine the value of this elasticity for taxi rides.** The income elasticity is:

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

Because a 5 percent increase in income led to a 2 percent increase in taxi rides, the value of the income elasticity is:

$$2 \text{ percent}/5 \text{ percent} = 0.4$$

The elasticity is positive but less than 1. Therefore, a taxi ride is a normal good and a necessity.

YOUR TURN: For more practice, do related problem 4.9 on page 199 at the end of this chapter.

Making the Connection | Price Elasticity, Cross-Price Elasticity, and Income Elasticity in the Market for Alcoholic Beverages

Many public policy issues are related to the consumption of alcoholic beverages. These issues include underage drinking, drunk driving, and the possible beneficial effects of red wine in lowering the risk of heart disease. X. M. Gao, an economist who works at American Express, and two colleagues have estimated statistically the following elasticities. (*Spirits* refers to all beverages that contain alcohol, other than beer and wine.)

Price elasticity of demand for beer	−0.23
Cross-price elasticity of demand between beer and wine	0.31
Cross-price elasticity of demand between beer and spirits	0.15
Income elasticity of demand for beer	−0.09
Income elasticity of demand for wine	5.03
Income elasticity of demand for spirits	1.21

The demand for beer is inelastic. A 10 percent increase in the price of beer will result in a 2.3 percent decline in the quantity of beer demanded. Not surprisingly, both wine and spirits are substitutes for beer. A 10 percent increase in the price of wine will result in a 3.1 percent *increase* in the quantity of beer demanded. A 10 percent increase

in income will result in a little less than a 1 percent *decline* in the quantity of beer demanded. So, beer is an inferior good. Both wine and spirits are categorized as luxuries because their income elasticities are greater than 1.

Source: X. M. Gao, Eric J. Wailes, and Gail L. Cramer, "A Microeconometric Model Analysis of U.S. Consumer Demand for Alcoholic Beverages," *Applied Economics*, January 1995.

myeconlab **YOUR TURN:** Test your understanding by doing related problem 4.8 on page 199 at the end of this chapter.

6.5 LEARNING OBJECTIVE

Use price elasticity and income elasticity to analyze economic issues.

Using Elasticity to Analyze the Disappearing Family Farm

The concepts of price elasticity and income elasticity can help us understand many economic issues. For example, some people are concerned that the family farm is becoming an endangered species in the United States. Although food production continues to grow rapidly, the number of farms and the number of farmers continue to dwindle. In 1950, the United States was home to more than 5 million farms, and more than 23 million people lived on farms. By 2009, only about 2 million farms remained, and fewer than 3 million people lived on them. In Chapter 4, we discussed several federal government programs designed to aid farmers. Many of these programs have been aimed at helping small, family-operated farms, but rapid growth in farm production, combined with low price and income elasticities for most food products, has made family farming difficult in the United States.

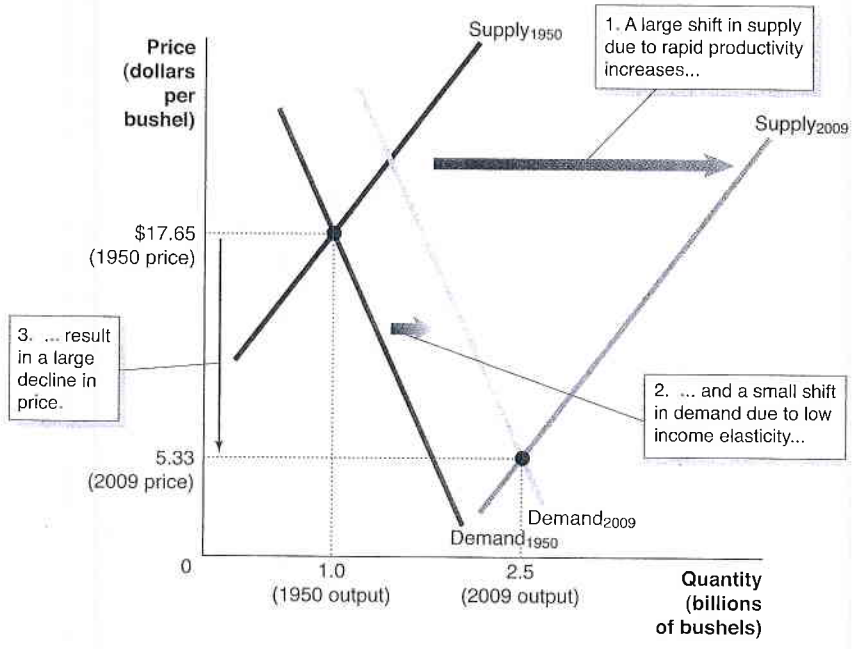
Productivity measures the ability of firms to produce goods and services with a given amount of economic inputs, such as workers, machines, and land. Productivity has grown very rapidly in U.S. agriculture. In 1950, the average U.S. wheat farmer harvested about 17 bushels from each acre of wheat planted. By 2009, because of the development of superior strains of wheat and improvements in farming techniques, the average American wheat farmer harvested 45 bushels per acre. So, even though the total number of acres devoted to growing wheat declined from about 62 million to about 50 million, total wheat production rose from about 1.0 billion bushels to about 2.5 billion.

Unfortunately for U.S. farmers, this increase in wheat production resulted in a substantial decline in wheat prices. Two key factors explain this decline in wheat prices: (1) Th

Figure 6-4

Elasticity and the Disappearing Family Farm

In 1950, U.S. farmers produced 1.0 billion bushels of wheat at a price of $17.65 per bushel. Over the next 60 years, rapid increases in farm productivity caused a large shift to the right in the supply curve for wheat. The income elasticity of demand for wheat is low, so the demand for wheat increased relatively little over this period. Because the demand for wheat is also inelastic, the large shift in the supply curve and the small shift in the demand curve resulted in a sharp decline in the price of wheat, from $17.65 per bushel in 1950 to $5.33 per bushel in 2009.



demand for wheat is inelastic and (2) the income elasticity of demand for wheat is low. Even though the U.S. population has increased greatly since 1950 and the income of the average American is much higher than it was in 1950, the demand for wheat has increased only moderately. For all of the additional wheat to be sold, the price has had to decline. Because the demand for wheat is inelastic, the price decline has been substantial. Figure 6-4 illustrates these points.

A large shift in supply, a small shift in demand, and an inelastic demand curve combined to drive down the price of wheat from $17.65 per bushel in 1950 to $5.33 per bushel in 2009. (The 1950 price is measured in terms of prices in 2009, to adjust for the general increase in prices since 1950.) With low prices, only the most efficiently run farms have been able to remain profitable. Smaller, family-run farms have found it difficult to survive, and many of these farms have disappeared. The markets for most other food products are similar to the market for wheat. They are characterized by rapid output growth and low income and price elasticities. The result is the paradox of American farming: ever more abundant and cheaper food, supplied by fewer and fewer farms. American consumers have benefited, but most family farmers have not.

The Price Elasticity of Supply and its Measurement

6.6 LEARNING OBJECTIVE

Define price elasticity of supply and understand its main determinants and how it is measured.

We can use the concept of elasticity to measure the responsiveness of firms to a change in price, just as we used it to measure the responsiveness of consumers. We know from the law of supply that when the price of a product increases, the quantity supplied increases. To measure how much the quantity supplied increases when price increases, we use the *price elasticity of supply*.

Measuring the Price Elasticity of Supply

Just as with the price elasticity of demand, we calculate the **price elasticity of supply** using percentage changes:

Price elasticity of supply The responsiveness of the quantity supplied to a change in price, measured by dividing the percentage change in the quantity supplied of a product by the percentage change in the product's price.

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

Notice that because supply curves are upward sloping, the price elasticity of supply will be a positive number. We categorize the price elasticity of supply the same way we categorized the price elasticity of demand: If the price elasticity of supply is less than 1, then supply is *inelastic*. For example, the price elasticity of supply of gasoline from U.S. oil refineries is about 0.20, and so it is inelastic; a 10 percent increase in the price of gasoline will result in only a 2 percent increase in the quantity supplied. If the price elasticity of supply is greater than 1, then supply is *elastic*. If the price elasticity of supply is equal to 1, then supply is *unit elastic*. As with other elasticity calculations, when we calculate the price elasticity of supply, we hold the values of other factors constant.

Determinants of the Price Elasticity of Supply

Whether supply is elastic or inelastic depends on the ability and willingness of firms to alter the quantity they produce as price increases. Often, firms have difficulty increasing the quantity of the product they supply during any short period of time. For example, a pizza parlor cannot produce more pizzas on any one night than is possible using the ingredients on hand. Within a day or two it can buy more ingredients, and within a few months it can hire more cooks and install additional ovens. As a result, the supply curve for pizza and most other products will be inelastic if we measure it over a short period of time, but the supply curve will be increasingly elastic the longer the period of time over which we measure it. Products that require resources that are themselves in fixed supply are an exception to this rule. For example, a French winery may rely on a particular

variety of grape. If all the land on which that grape can be grown is already planted in vineyards, then the supply of that wine will be inelastic even over a long period.

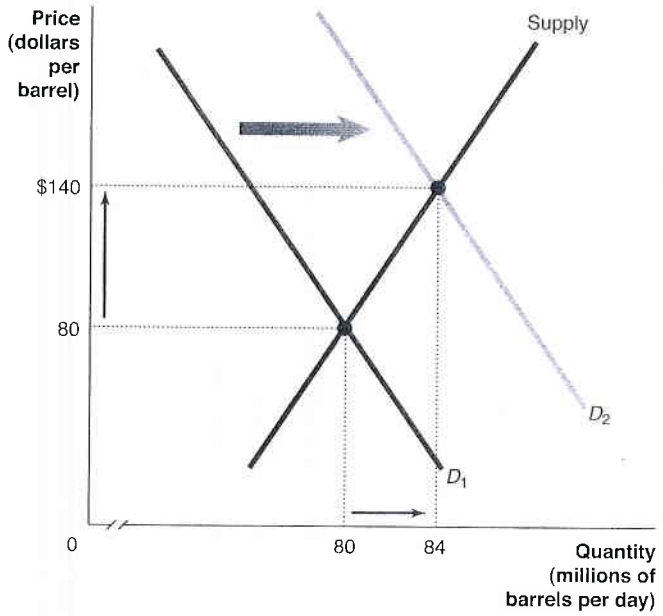
Making the Connection

Why Are Oil Prices So Unstable?

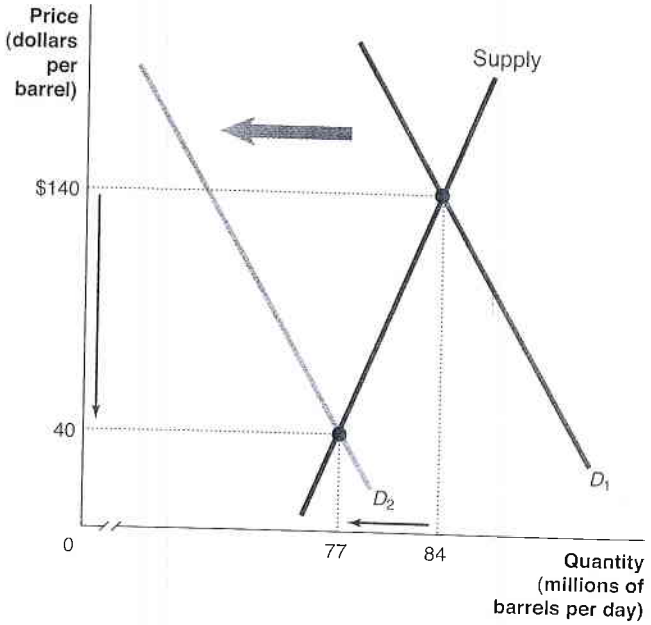
Bringing oil to market is a long process. Oil companies hire geologists to locate fields for exploratory oil well drilling. If significant amounts of oil are present, the company begins full-scale development of the field. The process from exploration to pumping significant amounts of oil can take years. This long process is why the price elasticity of supply for oil is very low.

During the period from 2003 to mid-2008, the worldwide demand for oil increased rapidly as India, China, and some other developing countries increased both their manufacturing production and their use of automobiles. As the graph shows, when supply is inelastic, an increase in demand can cause a large increase in price. The shift in the demand curve from D_1 to D_2 causes the equilibrium quantity of oil to increase only by 5 percent, from 80 million barrels per day to 84 million, but the equilibrium price rises by 75 percent, from $80 per barrel to $140 per barrel.

The world oil market is heavily influenced by the Organization of Petroleum Exporting Countries (OPEC). OPEC has 11 members, including Saudi Arabia, Kuwait, Iran, Venezuela, and Nigeria. Together these countries own 75 percent of the world's proven oil reserves. Periodically, OPEC has attempted to force up the price of oil by reducing the quantity of oil its members supply. As we will discuss further in Chapter 13, since the 1970s, the attempts by OPEC to reduce the quantity of oil on world markets have been successful only sporadically. As a result, the supply curve for oil shifts fairly frequently. Combined with the low price elasticities of oil supply and demand, these shifts in supply have caused the price of oil to fluctuate significantly over the past 30 years, from as low as $10 per barrel to more than $140 per barrel.



Beginning in mid-2008, the financial crisis that had begun in the United States had spread to other countries, resulting in a severe recession. As production and incomes fell during the recession, the worldwide demand for oil declined sharply. Over the space of a few months, the equilibrium price of oil fell from $140 per barrel to $40 per barrel. As the graph below shows, once again, the extent of the price change reflected not only the size of the decline in demand but also oil's low price elasticity of supply.



YOUR TURN Test your understanding by doing related problem 6.3 on page 201 at the end of this chapter. myeconlab

Solved Problem 6-6

The Supply of Medallions and the Supply of Taxis

The number of taxi licenses in New York City has been limited since 1937, when there were fewer than 14,000 outstanding licenses. These licenses are also called *medallions*. Because some cab owners allowed their licenses to expire, the number of licenses fell to the current number of 11,787. The New York City Council created the Taxi and Limousine Commission in 1971 to regulate taxi and livery service. Despite the great demand for taxi service, with more than 220 million passengers per year, no new taxis are allowed to operate without one of the existing medallions. License holders are allowed to sell their medallions. In 2004, the average price paid for a medallion was over $275,000.

a. Use the price elasticity of supply formula to calculate the elasticity of supply for taxi medallions in New York City.

b. Assume that the Taxi and Limousine Commission doubles the number of available medallions. Describe the likely impact on the quantity supplied and the elasticity of supply of taxis.

SOLVING THE PROBLEM:

Step 1: **Review the chapter material.** This problem is about the determinants of the elasticity of supply, so you may want to review the section "The Price Elasticity of Supply and Its Measurement," which begins on page 185.

Step 2: **State the price elasticity of supply formula and determine the value of this elasticity for taxi medallions.** The price elasticity of supply formula is:

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

Because the quantity supplied of medallions is fixed, the percentage change in quantity supplied is zero, the value of the elasticity of supply is zero, and the

supply curve is vertical at the existing quantity of 11,787 medallions, no matter how much the price of medallions changes.

Step 3: **Determine the impact of a doubling of medallions.** The high price of existing medallions suggests that current, and possibly new, taxi companies would bid for the new medallions. But the number of taxis in service would not rise immediately because companies would have to acquire new vehicles and hire and train new drivers. As the market period lengthens (from one day to one month, to one year, and so on), the quantity supplied of taxis in service and the elasticity of supply of taxis would increase; the supply curve would become increasingly flatter.

Sources: Bruce Schaller, *The New York City Taxicab Fact Book*, 3rd ed., 2006, www.schallerconsult.com/taxi/taxifb.pdf. New York City Taxi & Limousine Commission Medallion Sale Information, www.nyc.gov/html/tlc/medallion/html/home/home.shtml.

YOUR TURN: For more practice, do related problem 6.6 on page 201 at the end of this chapter.

Polar Cases of Perfectly Elastic and Perfectly Inelastic Supply

Although it occurs infrequently, it is possible for supply to fall into one of the polar cases of price elasticity. If a supply curve is a vertical line, it is *perfectly inelastic*. In this case, the quantity supplied is completely unresponsive to price, and the price elasticity of supply equals zero. Regardless of how much price may increase or decrease, the quantity remains the same. Over a brief period of time, the supply of some goods and services may be perfectly inelastic. For example, a parking lot may have only a fixed number of parking spaces. If demand increases, the price to park in the lot may rise, but no more spaces will become available. Of course, if demand increases permanently, over a longer period of time the owner of the lot may buy more land to add additional spaces.

If a supply curve is a horizontal line, it is *perfectly elastic*. In this case, the quantity supplied is infinitely responsive to price, and the price elasticity of supply equals infinity. If a supply curve is perfectly elastic, a very small increase in price causes a very large increase in quantity supplied. Just as with demand curves, it is important not to confuse a supply curve being elastic with its being perfectly elastic and not to confuse a supply curve being inelastic with its being perfectly inelastic. Table 6-6 summarizes the different price elasticities of supply.

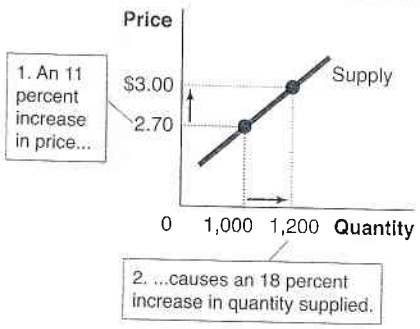
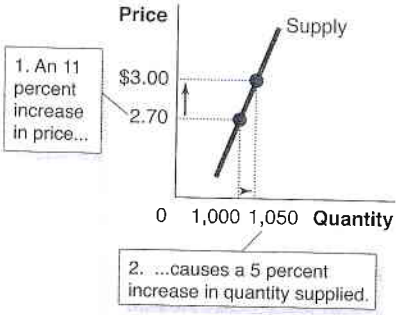
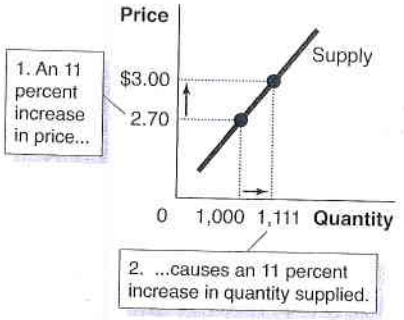
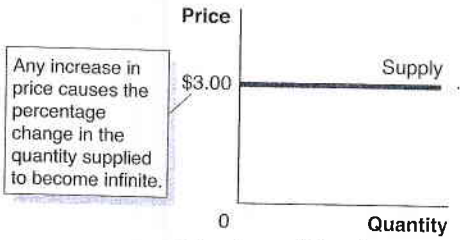
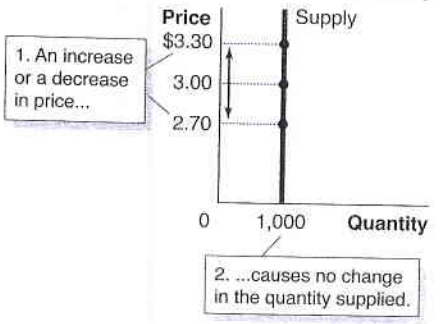
Using Price Elasticity of Supply to Predict Changes in Price

Figure 6-5 illustrates the important point that, when demand increases, the amount that price increases depends on the price elasticity of supply. The figure shows the demand and supply for parking spaces at a beach resort. In panel (a), on a typical summer weekend, equilibrium occurs at point *A*, where $\text{Demand}_{\text{Typical}}$ intersects a supply curve that is inelastic. The increase in demand for parking spaces on the Fourth of July shifts the demand curve to the right, moving the equilibrium to point *B*. Because the supply curve is inelastic, the increase in demand results in a large increase in price—from $2.00 per hour to $4.00—but only a small increase in the quantity of spaces supplied—from 1,200 to 1,400.

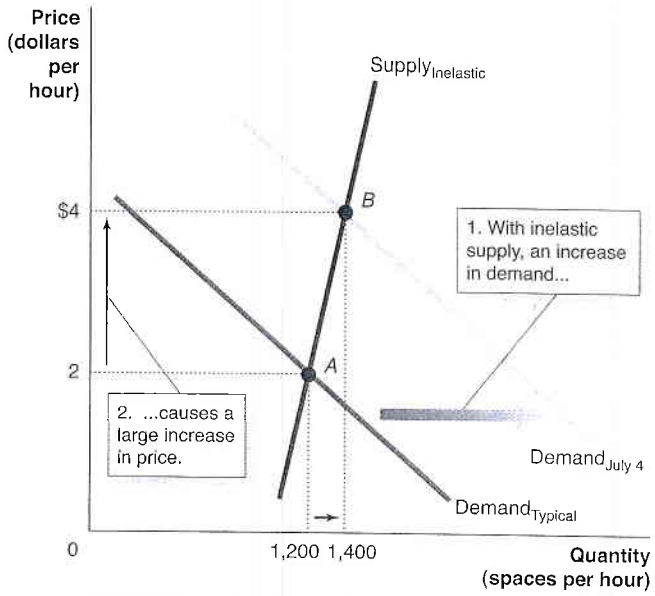
In panel (b), supply is elastic, perhaps because the resort has vacant land that can be used for parking during periods of high demand. As a result, the shift in equilibrium from point *A* to point *B* results in a smaller increase in price and a larger increase in the quantity supplied. An increase in price from $2.00 per hour to $2.50 is sufficient to increase the quantity of parking spaces supplied from 1,200 to 2,100. Knowing the price

TABLE 6-6

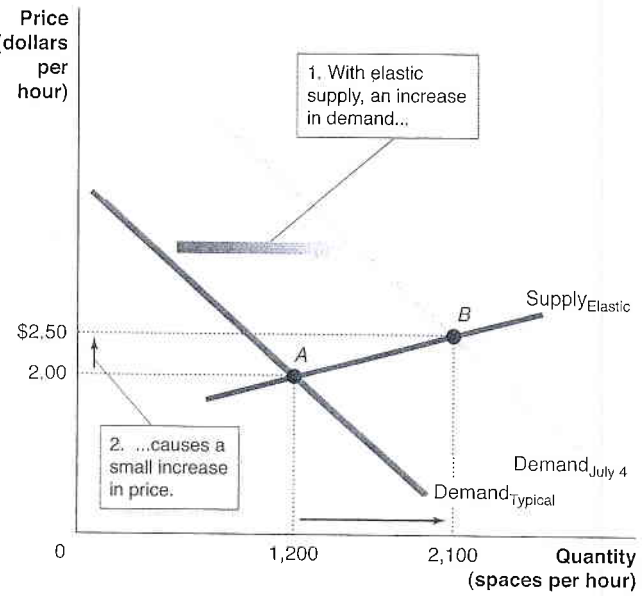
Summary of the Price Elasticities of Supply

IF SUPPLY IS . . .	THEN THE VALUE OF PRICE ELASTICITY IS . . .	
elastic	greater than 1	
inelastic	less than 1	
unit elastic	equal to 1	
perfectly elastic	equal to infinity	
perfectly inelastic	equal to 0	

Note: The percentage increases shown in the boxes in the graphs were calculated using the midpoint formula, given on page 170.)



(a) Price increases more when supply is inelastic.



(b) Price increases less when supply is elastic.

Figure 6-5 **Changes in Price Depend on the Price Elasticity of Supply**

In panel (a), $\text{Demand}_{\text{Typical}}$ represents the typical demand for parking spaces on a summer weekend at a beach resort. $\text{Demand}_{\text{July 4}}$ represents demand on the Fourth of July. Because supply is inelastic, the shift in equilibrium from point *A* to point *B* results in a large increase in price—from $2.00 per hour to $4.00—but only a small increase in the quantity of spaces supplied—from 1,200 to 1,400. In panel (b), supply is elastic. As a result, the shift in equilibrium from point *A* to point *B* results in a smaller increase in price and a larger increase in the quantity supplied. An increase in price from $2.00 per hour to $2.50 is sufficient to increase the quantity of parking supplied from 1,200 to 2,100.

elasticity of supply makes it possible to predict more accurately how much price will change following an increase or a decrease in demand.

▶ Continued from page 167

Economics in YOUR LIFE!

At the beginning of the chapter, we asked you to think about three questions: What factors would make you more or less sensitive to price when purchasing gasoline? Have you responded differently to price changes during different periods of your life? and Why do consumers seem to respond more to changes in gas prices at a particular service station but seem less sensitive when gas prices rise or fall at all service stations? A number of factors are likely to affect your sensitivity to changes in gas prices, including how high your income is (and, therefore, how large a share of your budget is taken up by gasoline purchases), whether you live in an area with good public transportation (which can be a substitute for having to use your own car), and whether you live within walking distance of your school or job. Each of these factors may change over the course of your life, making you more or less sensitive to changes in gas prices. Finally, consumers respond to changes in the price of gas at a particular service station because gas at other service stations is a good substitute. But there are presently few good substitutes for gasoline as a product.

Conclusion

In this chapter, we have explored the important concept of elasticity. Table 6-7 summarizes the various elasticities we discussed. Computing elasticities is important in economics because it allows us to measure how one variable changes in response to changes in another variable. For example, by calculating the price elasticity of demand for its product, a firm can make a quantitative estimate of the effect of a price change on the revenue

TABLE 6-7
Summary of Elasticities

PRICE ELASTICITY OF DEMAND

$$\text{Formula: } \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

$$\text{Midpoint Formula: } \frac{(Q_2 - Q_1)}{\left(\frac{Q_2 + Q_1}{2}\right)} \div \frac{(P_2 - P_1)}{\left(\frac{P_1 + P_2}{2}\right)}$$

	ABSOLUTE VALUE OF PRICE ELASTICITY	EFFECT ON TOTAL REVENUE OF AN INCREASE IN PRICE
Elastic	Greater than 1	Total revenue falls
Inelastic	Less than 1	Total revenue rises
Unit elastic	Equal to 1	Total revenue unchanged

CROSS-PRICE ELASTICITY OF DEMAND

$$\text{Formula: } \frac{\text{Percentage change in quantity demanded of one good}}{\text{Percentage change in price of another good}}$$

TYPES OF PRODUCTS	VALUE OF CROSS-PRICE ELASTICITY
Substitutes	Positive
Complements	Negative
Unrelated	Zero

INCOME ELASTICITY OF DEMAND

$$\text{Formula: } \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in income}}$$

TYPES OF PRODUCTS	VALUE OF INCOME ELASTICITY
Normal and a necessity	Positive but less than 1
Normal and a luxury	Positive and greater than 1
Inferior	Negative

PRICE ELASTICITY OF SUPPLY

$$\text{Formula: } \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}$$

	VALUE OF PRICE ELASTICITY
Elastic	Greater than 1
Inelastic	Less than 1
Unit elastic	Equal to 1

it receives. Similarly, by calculating the price elasticity of demand for cigarettes, the government can better estimate the effect of an increase in cigarette taxes on smoking.

Before going further in analyzing how firms decide on the prices to charge and the quantities to produce, we need to look at how firms are organized. We do this in the next chapter. Read *An Inside Look* on pages 192–193 for a discussion of the effect of higher gas prices on the demand for public transportation.

>> Consumers Change Their Behavior in Response to the Gas Prices

NEW YORK TIMES

Politics Failed, but Fuel Prices Cut Congestion

Soaring gas prices and higher tolls seem to be doing for traffic in New York what Mayor Michael R. Bloomberg's ambitious congestion pricing was supposed to do: reducing the number of cars clogging the city's streets and pushing more people to use mass transit.

a In May, with gasoline at more than $4 a gallon, traffic at the Metropolitan Transportation Authority's bridges and tunnels dropped 4.7 percent compared with the same month the previous year. Preliminary data for June shows a similar decrease in traffic, and officials say the change is largely because of higher prices at the pump. The Port Authority of New York and New Jersey has recorded a similar decline in travel across its bridges and tunnels since early March, when it raised tolls. The greatest decline was in April, when traffic fell by 4.2 percent.

. . .

b At the same time, subway, bus and commuter rail ridership has increased. Weekday subway ridership was up 6.5 percent in April, compared with the same month a year ago. April ridership increased 5.5 percent on the Long Island Rail Road, 4.3 percent on the Metro-North Railroad and almost 9 percent on PATH trains between Manhattan and New Jersey. Use of the subways and rail lines also increased in May, compared with the previous year, but in most cases by smaller amounts. New Jersey Transit ridership, including bus, commuter rail and light rail, was up about 4.6 percent in April and May combined.

"We're at the point where people really are changing habits," said Sam Schwartz, a transportation consultant. He said that if gas prices stayed high, the result could be . . . to reduce traffic in much of Manhattan by 6.3 percent. "If we start eclipsing $5 a gallon, which we might over the summer, I think we might get very close," Mr. Schwartz said.

. . .

"It shows that pricing matters and that people respond to it," said Jeffrey M. Zupan, a senior fellow for transportation at the Regional Plan Association. It is hard to say exactly what the impact of lighter bridge and tunnel traffic has been on the streets of Manhattan—or other boroughs—since the city does not take traffic measurements that show changes from month to month. But there are other indications.

The Metropolitan Parking Association, which represents garage and parking lot owners, said that its members had seen about a 10 percent decrease in daily customers. And gas station managers interviewed in Brooklyn, Queens and New Jersey said that the number of drivers buying gas had also declined. . . . Commuter trains have also become more crowded, riders say.

. . .

At the Secaucus Junction train station of New Jersey Transit, Brian Simmons, 30, said that it had become much harder to get a seat on the train in recent months. "It's like the New York City subway," he said.

. . .

c . . . The current reduction in traffic at bridges and tunnels could actually take money away from transit, because a large portion of the tolls collected at the transportation authority's crossings helps to finance the subways, buses and commuter railroads. In May, toll revenues were more than $4 million below budget projections, and Gary J. Dellaverson, the authority's chief financial officer, said that June toll revenues appeared to be down even further.

. . .

While some drivers have given up and switched to trains or buses, those who are sticking with their cars say they are driving less. Singh Bridgemohan, 50, was putting some gas, at $4.35 a gallon, in his red 1996 Jeep Grand Cherokee on a recent morning at an Exxon station in Bay Terrace, Queens. Mr. Bridgemohan, who runs a small construction company, said he used to drive his wife, a nanny, from their home in Jamaica to her work in Bayside every day. Now he does it rarely, to save on gas, while she makes a much longer commute by bus.

. . .

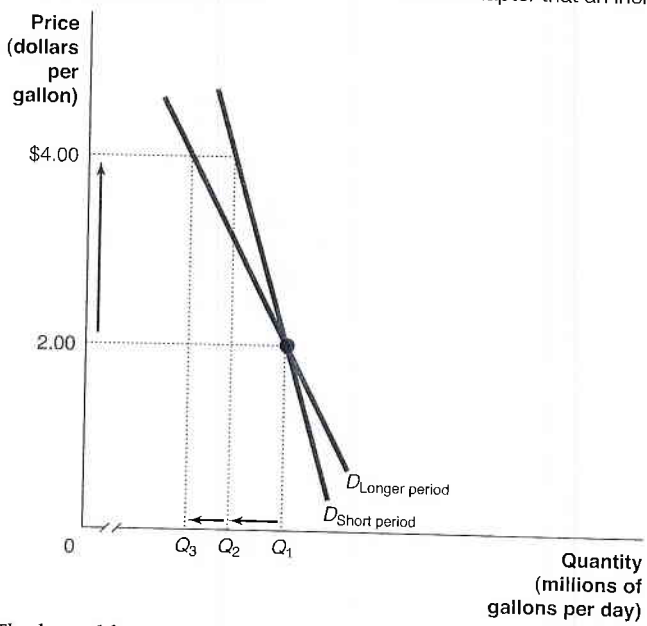
Source: William Neuman, "Politics Failed, but Fuel Prices Cut Congestion," *New York Times*, July 3, 2008.

Key Points in the Article

The article discusses the effects that high gas prices have on the choice of consumers in the New York City area to drive or take public transportation. As gas prices rose during early 2008, more consumers decided to take public transportation rather than drive into the city. The number of motorists crossing bridges into the city declined, as did the number of cars parked in city lots. At the same time, ridership of buses, subways, and commuter rail lines increased. The decline in travel across bridges was also due to an increase in bridge tolls. Revenue from commuters traveling across the bridges decreased following the increase in tolls.

Analyzing the News

a This chapter discusses the price elasticity of demand, which measures the responsiveness of quantity demanded to a change in price. This article shows an example of elasticity in action. During 2008, when gas prices rose above $4.00 per gallon, the quantity of gasoline demanded declined as consumers cut back on driving. For people who live near a bus, subway, or commuter line, public transportation provides a substitute to driving their own cars. So, the cross-price elasticity of demand between gasoline and public transportation is positive: An increase in the price of gasoline will result in an increase in the quantity of bus or subway rides demanded.



The demand for gasoline becomes more elastic over time.

b The chapter discusses the fact that the price elasticity of demand for a product will be larger (in absolute value) the longer the period of time involved. It takes time for buyers to adjust their routines as a result of a change in price. As gasoline prices increased through 2007 and early 2008—finally reaching $4.00 or more per gallon—consumers began to explore alternatives to driving their cars. The result was more people using public transportation. The figure below illustrates the effect of price elasticity increasing over time. Suppose that initially the price of gasoline is $2.00 per gallon, and Q_1 gallons of gasoline are being purchased. If the price of gasoline increases to $4.00 per gallon, then at first consumers will move up the demand curve, $D_{\text{Short period}}$, and the quantity of gasoline demanded will decline only to Q_2. But if high gasoline prices persist, consumers will make adjustments, such as driving less and taking public transportation more. The demand for gasoline will become the more elastic curve, $D_{\text{Longer period}}$. (Remember that if two demand curves pass through the same point, the flatter curve is more elastic.) As demand becomes more elastic over the longer period of time, the quantity of gasoline demanded will decline further, to Q_3.

c The article also notes that in the spring of 2008, tolls on the bridges leading into New York City were raised. Following the increase in tolls, both the number of cars crossing the bridges and the total revenue collected from the tolls declined. We learned in the chapter that an increase in the price of a product will increase the revenue from the product if demand is price inelastic and decrease the revenue if demand is price elastic. So, can we conclude that the demand by motorists to use the bridges into New York City must be price elastic because revenues fell when the tolls were increased? Possibly, but in this case we have a complicating factor. We could draw a conclusion about price elasticity only if all other factors that might affect the demand by motorists to use the bridges had remained constant. In fact, though, during this time another factor affecting the demand for bridge crossings had changed because gasoline prices had been rising. The fact that the quantity of bridge crossings declined by more than enough to offset the increase in tolls might indicate that the demand for bridge crossings is price elastic, but it also might indicate that during this period the demand for bridge crossings shifted to the left as gasoline prices increased.

Thinking Critically

1. Joe Ferris owns Joe's Gas-and-Go service station. Joe reads a newspaper article in which an economist describes the demand for gasoline as price inelastic. Remembering his principles of economics course from college, Joe comes to the following conclusion: "Because the demand for gasoline is inelastic, if I increase the price I charge, I will lose a few customers, but the price increase will more than compensate for the fact that I will be selling a smaller quantity of gasoline. Therefore, the revenue I earn from gasoline sales will increase." Briefly explain whether you agree with Joe's reasoning.
2. Suppose that initially the only sellers of gasoline in a town are conventional service stations. Then Wal-Mart and Sam's Club decide to begin selling gasoline. They install service islands near their stores and sell gasoline for lower prices than the conventional service stations. What effect do these new gasoline sellers have on the demand curves faced by the conventional service stations?

Key Terms

Cross-price elasticity of demand, p. 181
Elastic demand, p. 169
Elasticity, p. 168
Income elasticity of demand, p. 182
Inelastic demand, p. 169
Perfectly elastic demand, p. 172
Perfectly inelastic demand, p. 172
Price elasticity of demand, p. 168
Price elasticity of supply, p. 185
Total revenue, p. 177
Unit-elastic demand, p. 169

6.1 The Price Elasticity of Demand and Its Measurement, pages 168-174

LEARNING OBJECTIVE: Define price elasticity of demand and understand how to measure it.

Summary

Elasticity measures how much one economic variable responds to changes in another economic variable. The **price elasticity of demand** measures how responsive quantity demanded is to changes in price. The price elasticity of demand is equal to the percentage change in quantity demanded divided by the percentage change in price. If the quantity demanded changes more than proportionally when price changes, the price elasticity of demand is greater than 1 in absolute value, and demand is **elastic**. If the quantity demanded changes less than proportionally when price changes, the price elasticity of demand is less than 1 in absolute value, and demand is **inelastic**. If the quantity demanded changes proportionally when price changes, the price elasticity of demand is equal to 1 in absolute value, and demand is **unit elastic**. **Perfectly inelastic demand** curves are vertical lines, and **perfectly elastic demand** curves are horizontal lines. Relatively few products have perfectly elastic or perfectly inelastic demand curves.

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Review Questions

1.1 Write the formula for the price elasticity of demand. Why isn't elasticity just measured by the slope of the demand curve?

1.2 If a 10 percent increase in the price of Cap'n Crunch cereal causes a 25 percent reduction in the number of boxes of cereal demanded, what is the price elasticity of demand for Cap'n Crunch cereal? Is demand for Cap'n Crunch elastic or inelastic?

1.3 What is the midpoint method for calculating price elasticity of demand? How else can you calculate the price elasticity of demand? What is the advantage of the midpoint method?

1.4 Draw a graph of a perfectly inelastic demand curve. Think of a product that would have a perfectly inelastic demand curve. Explain why demand for this product would be perfectly inelastic.

Problems and Applications

1.5 Suppose the following table gives data on the price of rye and the number of bushels of rye sold in 2009 and 2010.

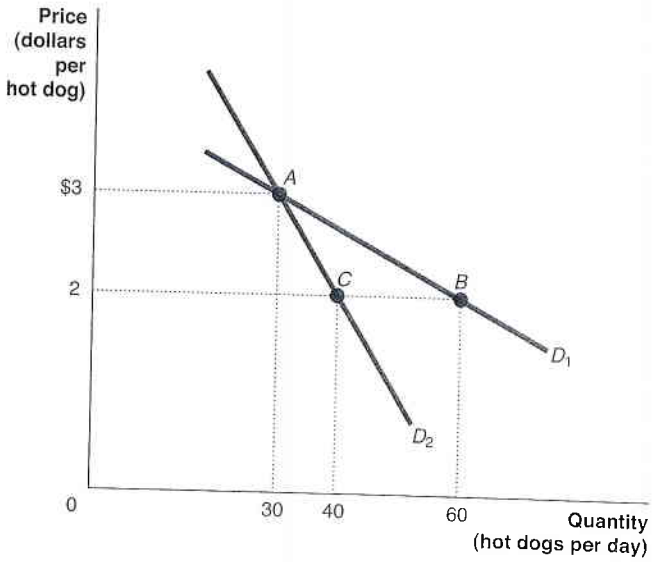
YEAR	PRICE (DOLLARS PER BUSHEL)	QUANTITY (BUSHELS)
2009	$3.00	8 million
2010	2.00	12 million

a. Calculate the change in the quantity of rye demanded divided by the change in the price of rye. Measure the quantity of rye in bushels.

b. Calculate the change in the quantity of rye demanded divided by the change in the price of rye, but this time measure the quantity of rye in millions of bushels. Compare your answer to the one you computed in a.

c. Assuming that the demand curve for rye did not shift between 2009 and 2010, use the information in the table to calculate the price elasticity of demand for rye. Use the midpoint formula in your calculation. Compare the value for the price elasticity of demand to the values you calculated in a and b.

1.6 (Related to *Solved Problem 6-1* on page 171) You own a hot dog stand that you set up outside the student union every day at lunch time. Currently, you are selling hot dogs for a price of $3, and you sell 30 hot dogs a day. You are considering cutting the price to $2. The following graph shows two possible increases in the quantity sold as a result of your price cut. Use the information in the graph to calculate the price elasticity between these two prices on each of the demand curves. Use the midpoint formula to calculate the price elasticities.



1.7 In fall 2006, Pace University in New York raised its annual tuition from $24,751 to $29,454. Freshman enrollment declined from 1,469 in the fall of 2005 to 1,131 in the fall of 2006. Assuming that the demand curve for places in the freshman class at Pace did not shift between 2005 and 2006, use this information to calculate the price elasticity of demand. Use the midpoint formula in your calculation. Is the demand for places in Pace's freshman class elastic or inelastic? Did the total amount of tuition Pace received from its freshman class rise or fall in 2006 compared with 2005?

Source: Karen W. Arenson, "At Universities, Plum Post at Top Is Now Shaky," *New York Times*, January 9, 2007.

1.8 Consider the following excerpt from a newspaper story on increases in college tuition:

> Facing stiff competition, Hendrix College, a small liberal arts institution in Conway, Ark., decided two years ago to bolster its academic offerings, promising students at least three hands-on experiences outside the classroom, including research, internships and service projects. It also raised tuition and fees 29 percent, to $21,636. . . . As a result, 409 students enrolled in the freshman class this year, a 37 percent increase. "What worked was the buzz," said J. Timothy Cloyd, the Hendrix president. "Students saw that they were going to get an experience that had value, and the price positioning conveyed to them the value of the experience."

Does this excerpt provide enough information to calculate the price elasticity of demand for places in Hendrix College's freshman class? Briefly explain.

Source: Jonathan D. Glater and Alan Finder, "In New Twist on Tuition Game, Popularity Rises with the Price," *New York Times*, December 12, 2006.

1.9 In the fall of 2008, analyst Charlie Wolf of the investment banking firm Needham & Company argued that if Apple cut the price of its 8GB iPhone from $199 to $99, its sales would double or triple. Calculate the price elasticity of demand for iPhones if the price cut would lead to a *doubling* of iPhone sales. Use the midpoint formula in your calculation. Now calculate the price elasticity of demand for iPhones if the price would lead to a *tripling* of iPhone sales.

Source: Jesus Diaz, "iPhone Could Hit $99, Analyst Says," Gizmodo.com, October 27, 2008.

1.10 In 1916, the Ford Motor Company sold 500,000 Model T Fords at a price of $440 each. Henry Ford believed that he could increase sales of the Model T by 1,000 cars for every dollar he cut the price. Use this information to calculate the price elasticity of demand for Model T Fords. Use the midpoint formula in your calculation.

1.11 **(Related to the *Don't Let This Happen to You!* on page 174)** The publisher of a magazine gives his staff the following information:

Current price	$2.00 per issue
Current sales	150,000 copies per month
Current total costs	$450,000 per month

He tells the staff, "Our costs are currently $150,000 more than our revenues each month. I propose to eliminate this problem by raising the price of the magazine to $3.00 per issue. This will result in our revenue being exactly equal to our cost." Do you agree with the publisher's analysis? Explain. (*Hint:* Remember that a firm's revenue is equal to the price of the product multiplied by the quantity sold.)

» End Learning Objective 6.1

6.2 The Determinants of the Price Elasticity of Demand, pages 174-177

LEARNING OBJECTIVE: Understand the determinants of the price elasticity of demand.

Summary

The main determinants of the price elasticity of demand for a product are the availability of close substitutes, the passage of time, whether the good is a necessity or a luxury, how narrowly the market for the good is defined, and the share of the good in the consumer's budget.

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Review Questions

2.1 Is the demand for most agricultural products elastic or inelastic? Why?

2.2 What are the key determinants of the price elasticity of demand for a product? Which determinant is the most important?

Problems and Applications

2.3 Briefly explain whether the demand for each of the following products is likely to be elastic or inelastic.
a. Milk
b. Frozen cheese pizza
c. Cola
d. Prescription medicine

2.4 **(Related to the *Making the Connection* on page 176)** One study found that the price elasticity of demand for soda is −0.78, while the price elasticity of demand for Coca-Cola is −1.22. Coca-Cola is a type of soda, so why isn't its price elasticity the same as the price elasticity for soda as a product?

Source: Kelly D. Brownell and Thomas R. Frieden, "Ounces of Prevention—The Public Policy Case for Taxes on Sugared Beverages," *New England Journal of Medicine*, April 30, 2009, pp. 1805–1808.

2.5 **(Related to the *Making the Connection* on page 176)** A study of the price elasticities of products sold in supermarkets contained the following data:

PRODUCT	PRICE ELASTICITY OF DEMAND
Soft drinks	−3.18
Canned soup	−1.62
Cheese	−0.72
Toothpaste	−0.45

a. For which products is the demand inelastic? Discuss reasons why the demand for each product is either elastic or inelastic.
b. Use the information in the table to predict the change in the quantity demanded for each product following a 10 percent price increase.

Source: Stephen J. Hoch, Byung-do Kim, Alan L. Montgomery, and Peter E. Rossi, "Determinants of Store-Level Price Elasticity," *Journal of Marketing Research*, Vol. 32, February 1995, pp. 17–29.

2.6 According to an article in the *Wall Street Journal*, in 1999 when the average price of a gallon of gasoline was $1.19, the average household spent 4.0 percent of its income on gasoline. In 2008, when the average price of gasoline had risen to $4.06 per gallon, the average household spent 11.5 percent of its income on gasoline. During which year was the price elasticity of gasoline likely to have been higher? Briefly explain.

Source: "Income vs. Gas Prices, an Update," *Wall Street Journal*, August 4, 2008.

>> End Learning Objective 6.2

6.3 The Relationship between Price Elasticity of Demand and Total Revenue, pages 177-180

LEARNING OBJECTIVE: Understand the relationship between the price elasticity of demand and total revenue.

Summary

Total revenue is the total amount of funds received by a seller of a good or service. When demand is inelastic, a decrease in price reduces total revenue, and an increase in price increases total revenue. When demand is elastic, a decrease in price increases total revenue, and an increase in price decreases total revenue. When demand is unit elastic, an increase or a decrease in price leaves total revenue unchanged.

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Review Questions

3.1 If the demand for orange juice is inelastic, will an increase in the price of orange juice increase or decrease the revenue received by orange juice sellers?

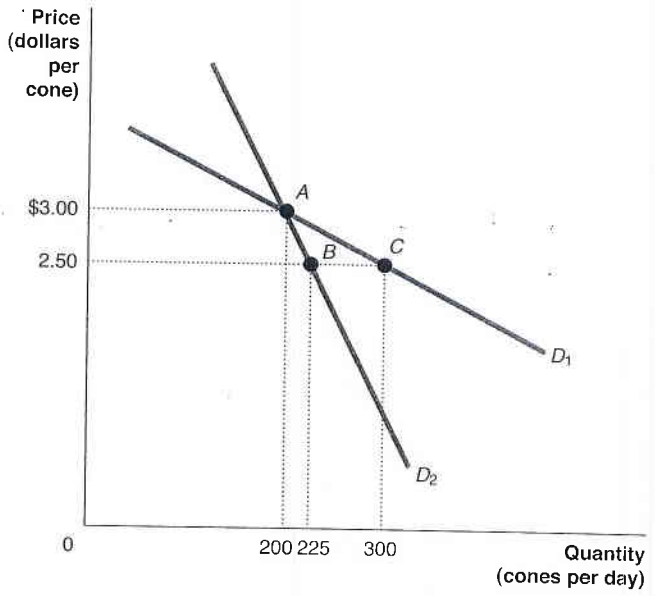
3.2 The price of organic apples falls, and apple growers find that their revenue increases. Is the demand for organic apples elastic or inelastic?

Problems and Applications

3.3 Economists' estimates of price elasticities can differ somewhat, depending on the time period and on the markets in which the price and quantity data used in the estimates were gathered. An article in the *New York Times* contained the following statement from the Centers for Disease Control and Prevention: "A 10 percent increase in the price of cigarettes reduces consumption by 3 percent to 5 percent." Given this information, compute the range of price elasticity of demand for cigarettes. Explain whether the demand for cigarettes is elastic, inelastic, or unit elastic. If cigarette manufacturers raise prices, will their revenue increase or decrease? Briefly explain.

Source: Shaila Dewan, "States Look at Tobacco to Balance the Budget," *New York Times*, March 20, 2009.

3.4 Use the following graph for Yolanda's Frozen Yogurt Stand to answer the questions that follow.



a. Use the midpoint formula to calculate the price elasticity of demand for D_1 between point A and point C and the price elasticity of demand for D_2 between point A and point B. Which demand curve is more elastic, D_1 or D_2? Briefly explain.

b. Suppose Yolanda is initially selling 200 cones per day at a price of $3.00 per cone. If she cuts her price to $2.50 per cone and her demand curve is D_1, what will be the change in her revenue? What will be the change in her revenue if her demand curve is D_2?

3.5 A sportswriter makes the following observation: "The Yankees slashed some ticket prices. . . . Only the Yankees know exactly how much money this will cost them, but it makes sense that they're working to fill the empty seats around home plate." Is this sportswriter correct that the Yankees will lose money if they cut ticket prices? Briefly explain.

Source: Buster Olney, "Steroids Talk Kept Alive By More Than Just Media," Espn.com, April 29, 2009.

3.6 Consider the following description of a pricing decision by an academic book publisher:

> A publisher may have issued a monograph several years ago, when both costs and book prices were lower, and priced it at $14.95. The book is still selling reasonably well and would continue to do so at $19.95. Why not, then, raise the price? The only danger is miscalculation: By raising the price you may reduce sales to the point where you make less money overall, even while making more per copy.

Assume that the situation described in the last sentence happens. What does this tell us about the price elasticity of demand for that book? Briefly explain.

Source: Beth Luey, *Handbook for Academic Authors*, 4th ed., Cambridge, UK: Cambridge University Press, 2002, p. 250.

3.7 In November 2008, parking rates were increased substantially for the "Big Blue Deck" at Detroit's Metro Airport. According to an article in a local newspaper, "In December, . . . after parking rates jumped from $10 to $16 a day . . . fewer cars used the Big Blue Deck compared to the previous year. . . . Still, the move at the North Terminal structure brought in about $61,000 more than the previous December. . . ." Use the information in the following table to calculate the price elasticity of demand for parking spaces at the Big Blue Deck using the midpoint formula. Assume that nothing happened between December 2007 and December 2008 to shift the demand curve for parking places. Be sure to state whether demand is elastic or inelastic.

MONTH	RATE	REVENUE
December 2007	$10	$1,387,000
December 2008	16	1,448,000

Sources: Mary Francis Masson, "Metro Airport Parking Rate Hikes Worry Employees," *Detroit Free Press*, February 14, 2009; and Tanveer Ali, "Parking Dips; Revenue Soars," *Detroit News*, February 13, 2009.

3.8 An article about the newspaper industry that appeared in the *Wall Street Journal* noted the following: "Declining circulation hasn't stopped Knight Ridder papers from raising subscription prices. Such increases, while boosting revenue per copy, almost always trigger a readership decline."

a. What is a newspaper's "circulation"?

b. To what is "revenue per copy" equal?

c. Why would a newspaper's management increase its subscription price if the result was a decline in the quantity of newspapers sold?

Source: Patricia Callahan and Kevin Helliker, "Subscriptions Fall, but Knight Ridder Lifts Advertising Rates," *Wall Street Journal*, June 18, 2001.

3.9 Stephen Rubin, who is an executive vice-president at Random House, once made the following argument about book prices: "I am just convinced that there is no difference between $22 and $23. Let's face it. If you want a book in translation from a Czech writer, you are going to buy the book—price is not a factor if it is a book that you really want." Doubleday, which is part of Random House, is selling John Grisham's novel *The Associate* at a price of $27.95.

a. Assume that the demand for this book is perfectly inelastic. Draw a demand curve showing the effect on the quantity demanded of raising the price from $27.95 to $39.95. Assume that sales are 500,000 at a price of $27.95. What is the change in revenue as a result of the price change?

b. Now assume that the price elasticity of demand is −2. Draw a demand curve showing the effect of raising the price from $27.95 to $39.95. Be sure to show the quantity demanded at each price. Now what is the change in revenue as a result of the price change?

c. In the quote from Stephen Rubin at the beginning of this question, does it matter that he was referring to "a book in translation from a Czech writer" rather than a book by a popular author such as John Grisham?

Source: Virginia Postrel, "Often, Basic Concepts in Economics Are Taken for Granted," *New York Times*, January 3, 2002.

3.10 The Delaware River Joint Toll Bridge Commission increased the toll on the bridges on Route 22 and Interstate 78 from New Jersey to Pennsylvania from $0.50 to $1.00. Use the information in the table to answer the questions. (Assume that besides the toll change, nothing occurred during the months that would affect consumer demand.)

		NUMBER OF VEHICLES CROSSING THE BRIDGE	
MONTH	TOLL	ROUTE 22 BRIDGE	INTERSTATE 78 BRIDGE
November	$0.50	519,337	728,022
December	1.00	433,691	656,257

a. Calculate the price elasticity of demand for each bridge, using the midpoint formula.

b. How much total revenue did the commission collect from these bridges in November? How much did it collect in December? Relate your answer to your answer in part a.

Source: Garrett Therolf, "Frugal Drivers Flood Free Bridge," (*Allentown, Pennsylvania*) *Morning Call*, January 20, 2003.

3.11 (Related to the *Making the Connection* on page 180) Suppose you check out the prices of two products on Amazon.com: conventional DVD players and Blu-ray players. For which type of players would you expect manufacturers to be offering similar players at about the same prices and for which type of players would you expect prices to be more spread out? Briefly explain.

>> End Learning Objective 6.3

6.4 Other Demand Elasticities, pages 180–182

LEARNING OBJECTIVE: Define cross-price elasticity of demand and income elasticity of demand and understand their determinants and how they are measured.

Summary

In addition to the elasticities already discussed, other important demand elasticities are the **cross-price elasticity of demand**, which is equal to the percentage change in quantity demanded of one good divided by the percentage change in the price of another good, and the **income elasticity of demand**, which is equal to the percentage change in the quantity demanded divided by the percentage change in income.

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Review Questions

4.1 Define the cross-price elasticity of demand. What does it mean if the cross-price elasticity of demand is negative? What does it mean if the cross-price elasticity of demand is positive?

4.2 Define the income elasticity of demand. Use income elasticity to distinguish a normal good from an inferior good. Is it possible to tell from the income elasticity of demand whether a product is a luxury good or a necessity good?

Problems and Applications

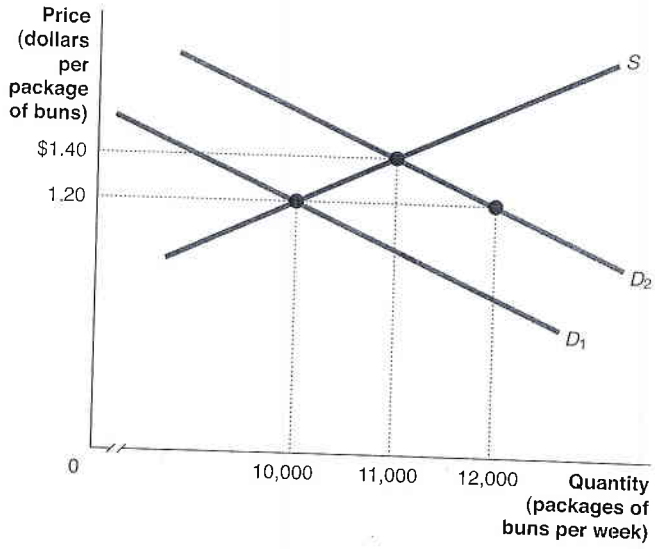
4.3 In the spring of 2002, lettuce prices doubled, from about $1.50 per head to about $3.00. The reaction of one consumer was quoted in a newspaper article: "I will not buy [lettuce] when it's $3 a head," she said, adding that other green vegetables can fill in for lettuce. "If bread were $5 a loaf we'd still have to buy it. But lettuce is not that important in our family."

a. For this consumer's household, which product has the higher price elasticity of demand: bread or lettuce? Briefly explain.

b. Is the cross-price elasticity of demand between lettuce and other green vegetables positive or negative for this consumer? Briefly explain.

Source: Justin Bachman, "Sorry, Romaine Only," Associated Press, March 29, 2002.

4.4 In the following graph, the demand for hot dog buns has shifted outward because the price of hot dogs has fallen from $2.20 to $1.80 per package. Calculate the cross-price elasticity of demand between hot dogs and hot dog buns.



4.5 Are the cross-price elasticities of demand between the following pairs of products likely to be positive or negative? Briefly explain.

a. Pepsi and Coca-Cola
b. French fries and ketchup
c. Steak and chicken
d. Blu-ray players and Blu-ray discs

4.6 **(Related to the *Chapter Opener* on page 167)** During the spring of 2008, gasoline prices increased sharply in the United States. According to a newspaper article, rising gas prices had the following impact in the car market:

> Sales of Toyota's subcompact Yaris increased 46 percent, and Honda's tiny Fit had a record month. Ford's compact Focus model jumped 32 percent in April from a year earlier. All those models are rated at more than 30 miles per gallon for highway driving. . . .
>
> Sales of traditional S.U.V.'s are down more than 25 percent this year. In April, for example, sales of G.M.'s Chevrolet Tahoe fell 35 percent. Full-size pickup sales have fallen more than 15 percent this year, with Ford's industry-leading F-Series pickup dropping 27 percent in April alone.

a. Is the cross-price elasticity of demand between gasoline and high-mileage subcompact cars positive or negative? Is the cross-price elasticity of demand between gasoline and low-mileage SUVs and full-size pickups positive or negative? Briefly explain.

b. How can we best think of the relationships among gasoline, subcompact cars, and SUVs? Briefly discuss which can be thought of as substitutes and which can be thought of as complements.

Source: Bill Vlasic, "As Gas Costs Soar, Buyers Are Flocking to Small Cars," *New York Times*, May 2, 2008.

4.7 Rank the following four goods from lowest income elasticity of demand to highest income elasticity of demand. Briefly explain your ranking.

a. Bread
b. Pepsi
c. Mercedes-Benz automobiles
d. Personal computers

4.8 **(Related to the *Making the Connection* on page 183)** Is the cross-price elasticity of demand between wine and spirits likely to be positive or negative? Can you think of reasons why the income elasticity of demand for wine is so much higher than the income elasticity of demand for spirits?

4.9 **(Related to *Solved Problem 6-4* on page 182)** Suppose two separate events occur that affect the demand for train tickets:

1. There is a 15 percent increase in the price of taxi fares. As a result, sales of train tickets increase by 30 percent.
2. An economic expansion causes a 3 percent increase in income. Sales of train tickets increase by 5 percent.

Give the cross-price and income elasticities formulas and use these formulas to determine the value of these elasticities for train tickets.

>> End Learning Objective 6.4

6.5 Using Elasticity to Analyze the Disappearing Family Farm, pages 184-185

LEARNING OBJECTIVE: Use price elasticity and income elasticity to analyze economic issues.

Summary

Price elasticity and income elasticity can be used to analyze many economic issues. One example is the disappearance of the family farm in the United States. Because the income elasticity of demand for food is low, the demand for food has not increased proportionally as incomes in the United States have grown. As farmers have become more productive, they have increased the supply of most foods. Because the price elasticity of demand for food is low, increasing supply has resulted in continually falling food prices.

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Review Questions

5.1 The demand for agricultural products is inelastic, and the income elasticity of demand for agricultural products is low. How do these facts help explain the disappearing family farm?

Problems and Applications

5.2 Corruption has been a significant problem in Iraq. Opening and running a business in Iraq usually requires paying multiple bribes to government officials. We can think of there being a demand and supply for bribes, with the curves having the usual shapes: The demand for bribes will be downward sloping because the smaller the bribe, the more business owners will be willing to pay it. The supply of bribes will be upward sloping because the larger the bribe, the more government officials will be willing to run the risk of breaking the law by accepting the bribe. Suppose that the Iraqi government introduces a new policy to reduce corruption that raises the cost to officials of accepting bribes—perhaps by increasing the jail term for accepting a bribe. As a result, the supply curve for bribes will shift to the left. If we measure the burden on the economy from corruption by the total value of the bribes paid, what must be true of the demand for bribes if the government policy is to be effective? Illustrate your answer with a demand and supply graph. Be sure to show on your graph the areas representing the burden of corruption before and after the government policy is enacted.

Source: Frank Gunter, "Corruption in Iraq: Poor Data, Questionable Policies," Working Paper, March 2009.

5.3 The head of the United Kumquat Growers Association makes the following statement:

> The federal government is considering implementing a price floor in the market for kumquats. The government will not be able to buy any surplus kumquats produced at the price floor or to pay us any other subsidy. Because the demand for kumquats is elastic, I believe this program will make us worse off, and I say we should oppose it.

Explain whether you agree or disagree with this reasoning.

5.4 Review the concept of economic efficiency from Chapter 4 before answering the following question: Will there be a greater loss of economic efficiency from a price ceiling when demand is elastic or inelastic? Illustrate your answer with a demand and supply graph.

>> End Learning Objective 6.5

6.6 The Price Elasticity of Supply and Its Measurement, pages 185-190

LEARNING OBJECTIVE: Define price elasticity of supply and understand its main determinants and how it is measured.

Summary

The **price elasticity of supply** is equal to the percentage change in quantity supplied divided by the percentage change in price. The supply curves for most goods are inelastic over a short period of time, but they become increasingly elastic over longer periods of time. Perfectly inelastic supply curves are vertical lines, and perfectly elastic supply curves are horizontal lines. Relatively few products have perfectly elastic or perfectly inelastic supply curves.

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Review Questions

6.1 Write the formula for the price elasticity of supply. If an increase of 10 percent in the price of frozen pizzas results in a 9 percent increase in the quantity of frozen pizzas supplied, what is the price elasticity of supply for frozen pizzas? Is the supply of pizzas elastic or inelastic?

6.2 What is the main determinant of the price elasticity of supply?

Problems and Applications

6.3 **(Related to the *Making the Connection* on page 186)** Refer again to the first graph in the *Making the Connection* on page 186. Suppose that demand had stayed at the level indicated in the graph, with the equilibrium price of oil remaining at $140 per barrel. Over long periods of time, high oil prices lead to greater increases in the quantity of oil supplied. In other words, the price elasticity of supply for oil increases. This happens because higher prices provide an economic incentive to recover oil from more costly sources, such as under the oceans, from tar sands, or at greater depths in the earth. If the supply of oil becomes more elastic, explain how the increase in demand shown in the figure will result in a lower equilibrium price than $140 per barrel and a higher equilibrium quantity than 84 million barrels per day. Illustrate your answer with a demand and supply graph.

6.4 Use the midpoint formula for calculating elasticity to calculate the price elasticity of supply between point *A* and point *B* for each panel of Figure 6-5 on page 190.

6.5 Briefly explain whether you agree with the following statement: "The longer the period of time following an increase in the demand for apples, the greater the increase in the equilibrium quantity of apples and the smaller the increase in the equilibrium price."

6.6 **(Related to *Solved Problem 6-6* on page 187)** In New York City, the government sets the fares that taxi drivers can charge. The number of taxi licenses in New York City has been limited since 1937, when there were fewer than 14,000 outstanding licenses. These licenses are also called *medallions*. Because some cab owners allowed their licenses to expire, the number of licenses fell to the current number of 11,787. The New York City Council created the Taxi and Limousine Commission in 1971 to regulate taxi service. Despite the great demand for taxi service, with more than 220 million passengers per year, no new taxis are allowed to operate without one of the existing medallions. License holders are allowed to sell their medallions. In 2004, the average price paid for a medallion was over $275,000. Suppose that the New York City Taxi and Limousine Commission decides that if the price of medallions rises to $350,000 from its current level, the commission will increase the number of medallions to 13,000. What is the elasticity of supply in this case? If the elasticity of supply remains constant, how high will the price need to rise in order for the commission to issue another 1,000 medallions, bringing the total back to the 1937 level of 14,000?

6.7 On most days, the price of a rose is $1, and 8,000 roses are purchased. On Valentine's Day, the price of a rose jumps to $2, and 30,000 roses are purchased.

a. Draw a demand and supply diagram that shows why the price jumps.

b. Based on this information, what do we know about the price elasticity of demand for roses? What do we know about the price elasticity of supply for roses? Calculate values for the price elasticity of demand and the price elasticity of supply or explain why you can't calculate these values.

>> End Learning Objective 6.6