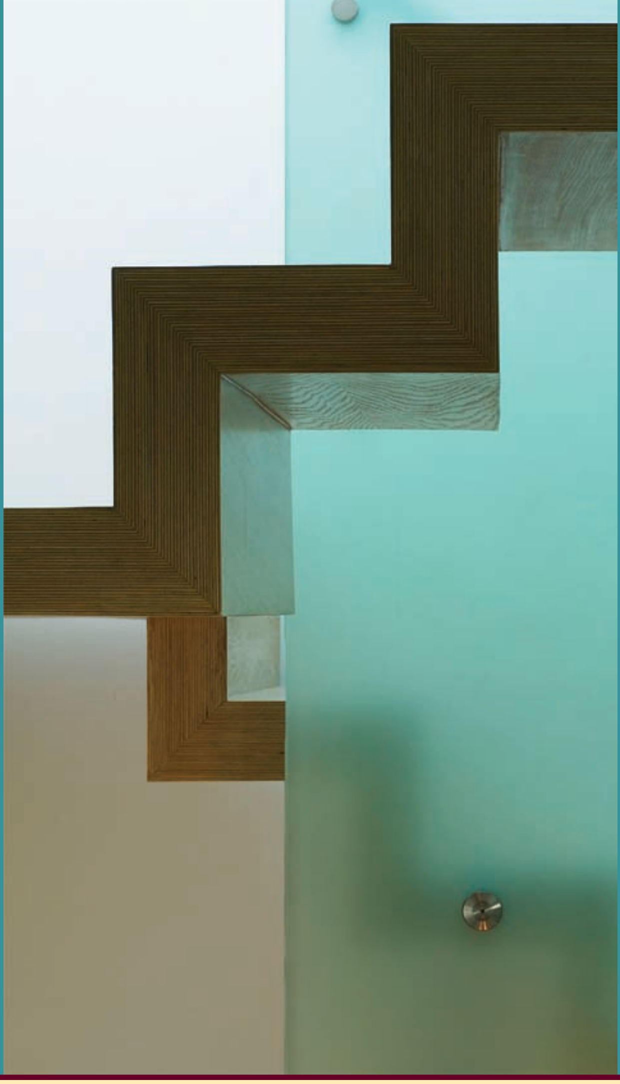
PART TWO

Microeconomics of Product Markets



IN THIS CHAPTER YOU WILL LEARN:

1 About price elasticity of demand and how it can be applied.

2 The usefulness of the total revenue test for price elasticity of demand.

3 About price elasticity of supply and how it can be applied.

4 About cross elasticity of demand and income elasticity of demand.

5 About consumer surplus, producer surplus, and efficiency losses.

6

Elasticity, Consumer Surplus, and Producer Surplus

Today's market economies rely mainly on the activities of consumers, businesses, and resource suppliers to allocate resources efficiently. Those activities and their outcomes are the subject of microeconomics, to which we now turn.

In this chapter we extend Chapter 3's discussion of demand and supply by explaining significant ideas that help us answer such questions as: Why do buyers of some products (for example, ocean cruises) respond to price increases by substantially reducing their purchases while buyers of other products (say, gasoline) respond by only slightly cutting back their purchases? Why do higher market prices for some products (for example, chicken) cause producers to greatly increase their output while price rises for other products (say, gold) cause only limited increases in output? Why does the demand for some products (for example, books) rise a great deal when household income increases while the demand for other products (say, milk) rises just a little? How is it that most consumers obtain products at prices below the prices they actually would have been willing to pay? How is it that most producers obtain higher prices for their products than the prices they actually would have been willing to accept?

The ideas of *elasticity*, *consumer surplus*, and *producer surplus* help answer these questions. Let's begin by looking at elasticity.

Price Elasticity of Demand

The law of demand tells us that, other things equal, consumers will buy more of a product when its price declines and less when its price increases. But how much more or less will they buy? The amount varies from product to product and over different price ranges for the same product. It also may vary over time. And such variations matter. For example, a firm contemplating a price hike will want to know how consumers will respond. If they remain highly loyal and continue to buy, the firm's revenue will rise. But if consumers defect en masse to other sellers or other products, the firm's revenue will tumble.

The responsiveness (or sensitivity) of consumers to a price change is measured by a product's **price elasticity of demand.** For some products—for example, restaurant meals—consumers are highly responsive to price changes. Modest price changes cause very large changes in the quantity purchased. Economists say that the demand for such products is *relatively elastic* or simply *elastic*.

ORIGIN OF THE IDEA

O 6.1

Price elasticity of demand

For other products—for example, toothpaste—consumers pay much less attention to price changes. Substantial price changes cause only small changes in the amount purchased. The demand for such products is *relatively inelastic* or simply *inelastic*.

ThePr ice-Elasticity Coefficient and Formula

Economists measure the degree to which demand is price elastic or inelastic with the coefficient E_d, defined as

$$E_d = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in price of product X}}$$

The percentage changes in the equation are calculated by dividing the *change* in quantity demanded by the original quantity demanded and by dividing the *change* in price by the original price. So we can restate the formula as

$$E_d = \frac{\text{change in quantity demanded of X}}{\text{original quantity demanded of X}} \div \frac{\text{change in price of X}}{\text{original price of X}}$$

Using Averages

Unfortunately, an annoying problem arises in computing the price-elasticity coefficient. A price change from, say, \$4 to \$5 along a demand curve is a 25 percent (= \$1/\$4) increase, but the opposite price change from \$5 to \$4 along the same curve is a 20 percent (= \$1/\$5) decrease. Which percentage change in price should we use in the denominator to compute the price-elasticity coefficient? And when quantity changes, for example, from 10 to 20, it is a 100 percent (= 10/10) increase. But when quantity falls from 20 to 10 along the identical demand curve, it is a 50 percent (= 10/20) decrease. Should we use 100 percent or 50 percent in the numerator of the elasticity formula? Elasticity should be the same whether price rises or falls!

The simplest solution to the problem is to use the **midpoint formula** for calculating elasticity. This formula simply averages the two prices and the two quantities as the reference points for computing the percentages. That is,

$$E_d = \frac{\text{change in quantity}}{\text{sum of quantities/2}} \div \frac{\text{change in price}}{\text{sum of prices/2}}$$

For the same \$5−\$4 price range, the price reference is \$4.50 [= (\$5 + \$4)/2], and for the same 10–20 quantity range, the quantity reference is 15 units [= (10 + 20)/2]. The percentage change in price is now \$1/\$4.50, or about 22 percent, and the percentage change in quantity is $\frac{10}{15}$, or about 67 percent. So E_d is about 3. This solution eliminates the "up versus down" problem. All the price-elasticity coefficients that follow are calculated using this midpoint formula.

WORKED PROBLEMS

W 6.1

Elasticity of demand

Using Percentages Why use percentages rather than absolute amounts in measuring consumer responsiveness? There are two reasons.

First, if we use absolute changes, the choice of units will arbitrarily affect our impression of buyer responsiveness. To illustrate: If the price of a bag of popcorn at the local softball game is reduced from $3 to $2 and consumers increase their purchases from 60 to 100 bags, it will seem that consumers are quite sensitive to price changes and therefore that demand is elastic. After all, a price change of 1 unit has caused a change in the amount demanded of 40 units. But by changing the monetary unit from dollars to pennies (why not?), we find that a price change of 100 units (pennies) causes a quantity change of 40 units. This may falsely lead us to believe that demand is inelastic. We avoid this problem by using percentage changes. This particular price decline is the same whether we measure it in dollars or pennies.

Second, by using percentages, we can correctly compare consumer responsiveness to changes in the prices of different products. It makes little sense to compare the effects on quantity demanded of (1) a $1 increase in the price of a $10,000 used car with (2) a $1 increase in the price of a $1 soft drink. Here the price of the used car has increased by .01 percent while the price of the soft drink is up by 100 percent. We can more sensibly compare the consumer responsiveness to price increases by using some common percentage increase in price for both.

Elimination of Minus Sign We know from the downsloping demand curve that price and quantity demanded are inversely related. Thus, the price-elasticity coefficient of demand E_d will always be a negative number. As an example, if price declines, then quantity demanded will increase. This means that the numerator in our formula will be positive and the denominator negative, yielding a negative E_d. For an increase in price, the numerator will be negative but the denominator positive, again yielding a negative E_d.

Economists usually ignore the minus sign and simply present the absolute value of the elasticity coefficient to avoid an ambiguity that might otherwise arise. It can be confusing to say that an E_d of -4 is greater than one of -2. This possible confusion is avoided when we say an E_d of 4 reveals greater elasticity than one of 2. So, in what follows, we ignore the minus sign in the coefficient of price elasticity of demand and show only the absolute value. Incidentally, the ambiguity does not arise with supply because price and quantity supplied are positively related. All elasticity of supply coefficients therefore are positive numbers.

Interpretationsof E_d

We can interpret the coefficient of price elasticity of demand as follows.

Elastic Demand Demand is **elastic** if a specific percentage change in price results in a larger percentage change in quantity demanded. Then E_d will be greater than 1. Example: Suppose that a 2 percent decline in the price of cut flowers results in a 4 percent increase in quantity demanded. Then demand for cut flowers is elastic and

$$E_d = \frac{.04}{.02} = 2$$

Inelastic Demand If a specific percentage change in price produces a smaller percentage change in quantity demanded, demand is **inelastic.** Then E_d will be less than 1. Example: Suppose that a 2 percent decline in the price of coffee leads to only a 1 percent increase in quantity demanded. Then demand is inelastic and

$$E_d = \frac{.01}{.02} = .5$$

Unit Elasticity The case separating elastic and inelastic demands occurs where a percentage change in price and the resulting percentage change in quantity demanded are the same. Example: Suppose that a 2 percent drop in the price of chocolate causes a 2 percent increase in quantity demanded. This special case is termed **unit elasticity** because E_d is exactly 1, or unity. In this example,

$$E_d = \frac{.02}{.02} = 1$$

Extreme Cases When we say demand is "inelastic," we do not mean that consumers are completely unresponsive to a price change. In that extreme situation, where a price change results in no change whatsoever in the quantity demanded, economists say that demand is **perfectly inelastic.** The price-elasticity coefficient is zero because there is no response to a change in price. Approximate examples include an acute diabetic's demand for insulin or an addict's demand for heroin. A line parallel to the vertical axis, such as D_1 in Figure 6.1a, shows perfectly inelastic demand graphically.

Conversely, when we say demand is "elastic," we do not mean that consumers are completely responsive to a price change. In that extreme situation, where a small price reduction causes buyers to increase their purchases from zero to all they can obtain, the elasticity coefficient is infinite (= ∞) and economists say demand is **perfectly elastic.** A line parallel to the horizontal axis, such as D_2 in

FIGURE 6.1 Perfectly inelastic and elastic demands. Demand curve D_1 in (a) represents perfectly inelastic demand ($E_d = 0$). A price increase will result in no change in quantity demanded. Demand curve D_2 in (b) represents perfectly elastic demand. A price increase will cause quantity demanded to decline from an infinite amount to zero ($E_d = \infty$).

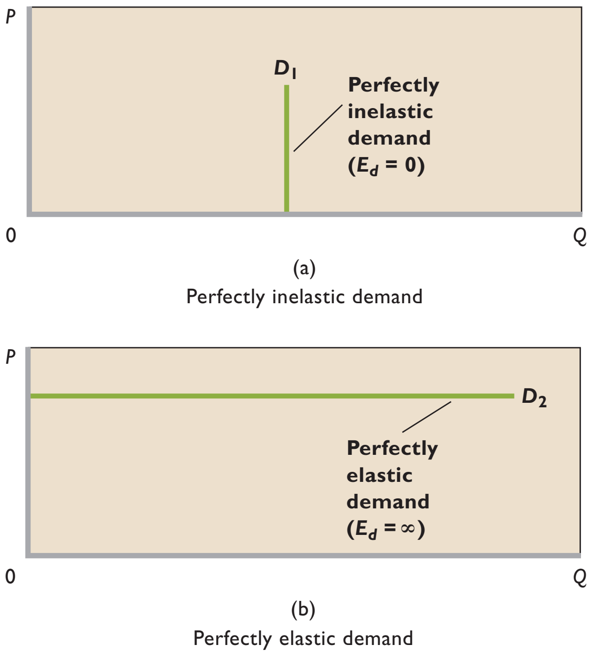


Figure 6.1b, shows perfectly elastic demand. You will see in Chapter 9 that such a demand applies to a firm—say, a mining firm that is selling its output in a purely competitive market.

The Total-Revenue Test

The importance of elasticity for firms relates to the effect of price changes on total revenue and thus on profits (= total revenue minus total costs).

Total revenue (TR) is the total amount the seller receives from the sale of a product in a particular time period; it is calculated by multiplying the product price (P) by the quantity sold (Q). In equation form:

$$TR = P \times Q$$

Graphically, total revenue is represented by the $P \times Q$ rectangle lying below a point on a demand curve. At point *a* in Figure 6.2a, for example, price is \$2 and quantity demanded is 10 units. So total revenue is \$20 (= \$2 × 10), shown by the rectangle composed of the gold and orange areas under the demand curve. We know from basic geometry that the area of a rectangle is found by multiplying one side by the other. Here, one side is "price" (\$2) and the other is "quantity demanded" (10 units).

CONSIDER THIS . . .

A Bit of a Stretch

The following analogy might help you remember the distinction between "elastic" and "inelastic." Imagine two objects—one an Ace elastic bandage used to wrap injured joints and the other a relatively firm rubber tie-down (rubber strap) used for securing items for transport. The Ace bandage stretches a great deal when pulled with a particular force; the rubber tie-down stretches some, but not a lot.

Similar differences occur for the quantity demanded of various products when their prices change. For some products, a price change causes a substantial "stretch" of quantity demanded. When this stretch in percentage terms exceeds the percentage change in price, demand is elastic. For other products, quantity demanded stretches very little in response to the price change. When this stretch in percentage terms is less than the percentage change in price, demand is inelastic.

In summary:

- Elastic demand displays considerable "quantity stretch" (as with the Ace bandage).
- Inelastic demand displays relatively little "quantity stretch" (as with the rubber tie-down).

And through extension:

- Perfectly elastic demand has infinite quantity stretch.
- Perfectly inelastic demand has zero quantity stretch.

Total revenue and the price elasticity of demand are related. In fact, the easiest way to infer whether demand is elastic or inelastic is to employ the **total-revenue test.** Here is the test: Note what happens to total revenue when price changes. If total revenue changes in the opposite direction from price, demand is elastic. If total revenue changes in the same direction as price, demand is inelastic. If total revenue does not change when price changes, demand is unit-elastic.

Elastic Demand If demand is elastic, a decrease in price will increase total revenue. Even though a lesser price is received per unit, enough additional units are sold to more than make up for the lower price. For an example,

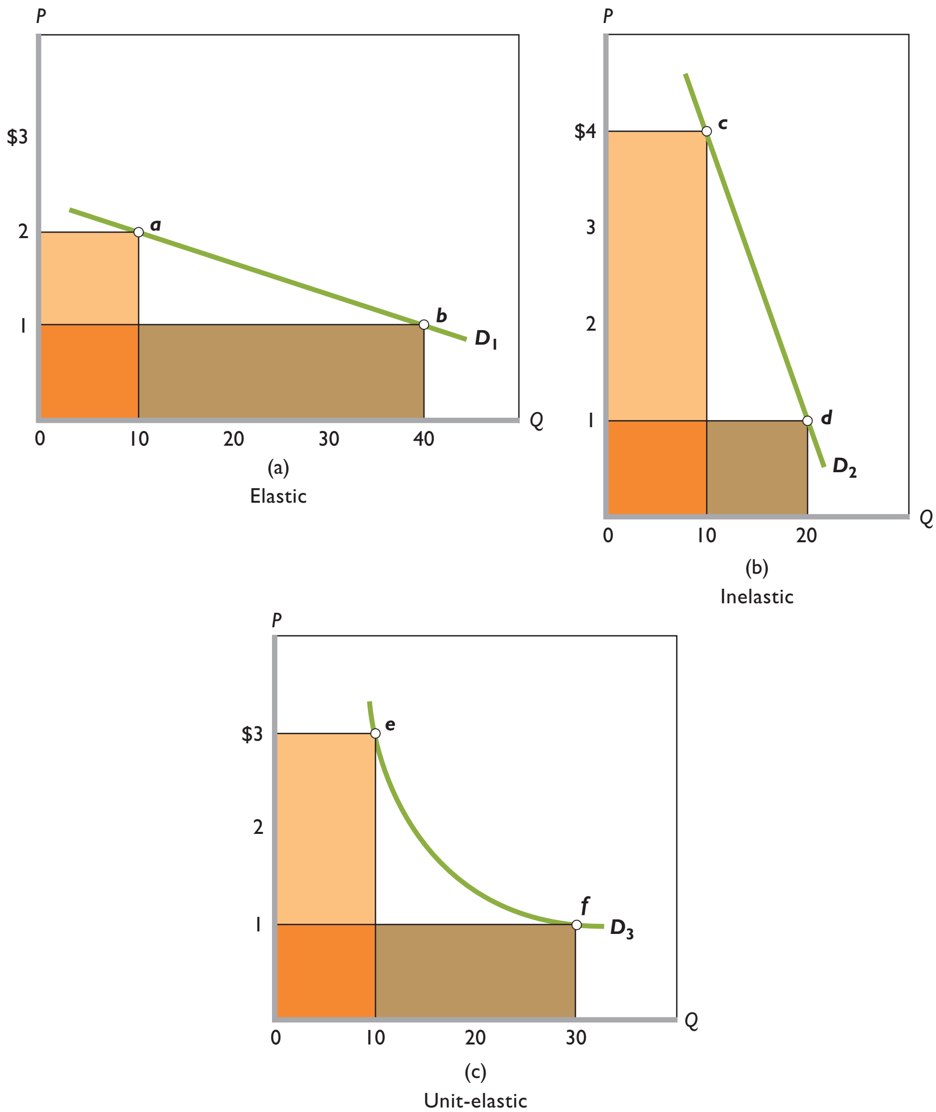


FIGURE 6.2 The total-revenue test for price elasticity. (a) Price declines from \$2 to \$1, and total revenue increases from \$20 to \$40. So demand is elastic. The gain in revenue (brown area) exceeds the loss of revenue (gold area). (b) Price declines from \$4 to \$1, and total revenue falls from \$40 to \$20. So, demand is inelastic. The gain in revenue (brown area) is less than the loss of revenue (gold area). (c) Price declines from \$3 to \$1, and total revenue does not change. Demand is unit-elastic. The gain in revenue (brown area) equals the loss of revenue (gold area).

look at demand curve D_1 in Figure 6.2a. We have already established that at point *a*, total revenue is \$20 (= \$2 × 10), shown as the gold plus orange area. If the price declines from \$2 to \$1 (point *b*), the quantity demanded becomes 40 units and total revenue is \$40 (= \$1 × 40). As a result of the price decline, total revenue has increased from \$20 to \$40. Total revenue has increased in this case because the \$1 decline in price applies to 10 units, with a consequent revenue loss of \$10 (the gold area). But 30 more units are sold at \$1 each, resulting in a revenue gain of \$30 (the brown area). Visually, the gain of the brown area clearly exceeds the loss of the gold area. As indicated, the overall result is a net increase in total revenue of \$20 (= \$30 − \$10).

The analysis is reversible: If demand is elastic, a price increase will reduce total revenue. The revenue gained on the higher-priced units will be more than offset by the revenue lost from the lower quantity sold. Bottom line: Other things equal, when price and total revenue move in opposite directions, demand is elastic. E_d is greater than 1, meaning the percentage change in quantity demanded is greater than the percentage change in price.

Inelastic Demand If demand is inelastic, a price decrease will reduce total revenue. The increase in sales will not fully offset the decline in revenue per unit, and total revenue will decline. To see this, look at demand curve D_2 in Figure 6.2b. At point *c* on the curve, price is \$4 and quantity demanded is 10. Thus total revenue is $40, shown by the combined gold and orange rectangle. If the price drops to $1 (point *d*), total revenue declines to $20, which obviously is less than $40. Total revenue has declined because the loss of revenue (the gold area) from the lower unit price is larger than the gain in revenue (the brown area) from the accompanying increase in sales. Price has fallen, and total revenue has also declined.

Our analysis is again reversible: If demand is inelastic, a price increase will increase total revenue. So, other things equal, when price and total revenue move in the same direction, demand is inelastic. E_d is less than 1, meaning the percentage change in quantity demanded is less than the percentage change in price.

WORKED PROBLEMS
W 6.2
Total-revenue test

Unit Elasticity

In the special case of unit elasticity, an increase or a decrease in price leaves total revenue unchanged. The loss in revenue from a lower unit price is exactly offset by the gain in revenue from the accompanying increase in sales. Conversely, the gain in revenue from a higher unit price is exactly offset by the revenue loss associated with the accompanying decline in the amount demanded.

In Figure 6.2c (demand curve D_3) we find that at the price of $3, 10 units will be sold, yielding total revenue of $30. At the lower $1 price, a total of 30 units will be sold, again resulting in $30 of total revenue. The $2 price reduction causes the loss of revenue shown by the gold area, but this is exactly offset by the revenue gain shown by the brown area. Total revenue does not change. In fact, that would be true for all price changes along this particular curve.

Other things equal, when price changes and total revenue remains constant, demand is unit-elastic (or unitary). E_d is 1, meaning the percentage change in quantity equals the percentage change in price.

Price Elasticity along a Linear Demand Curve

Now a major confession! Although the demand curves depicted in Figure 6.2 nicely illustrate the total-revenue test for elasticity, two of the graphs involve specific movements along linear (straight-line) demand curves. That presents no problem for explaining the total-revenue test. However, you need to know that elasticity typically varies over the different price ranges of the same demand curve. (The exception is the curve in Figure 6.2c. Elasticity is 1 along the entire curve.)

Table 6.1 and Figure 6.3 demonstrate that elasticity typically varies over the different price ranges of the same demand schedule or curve. Plotting the hypothetical data for movie tickets shown in columns 1 and 2 of Table 6.1 yields demand curve *D* in Figure 6.3. Observe that the demand curve is linear. But we see from column 3 of the table that the price elasticity coefficient for this demand curve declines as we move from higher to lower prices. For all downsloping straight-line and most other demand curves, demand is more price-elastic toward the upper left (here, the $5–$8 price range of *D*) than toward the lower right (here, the $4–$1 price range of *D*).

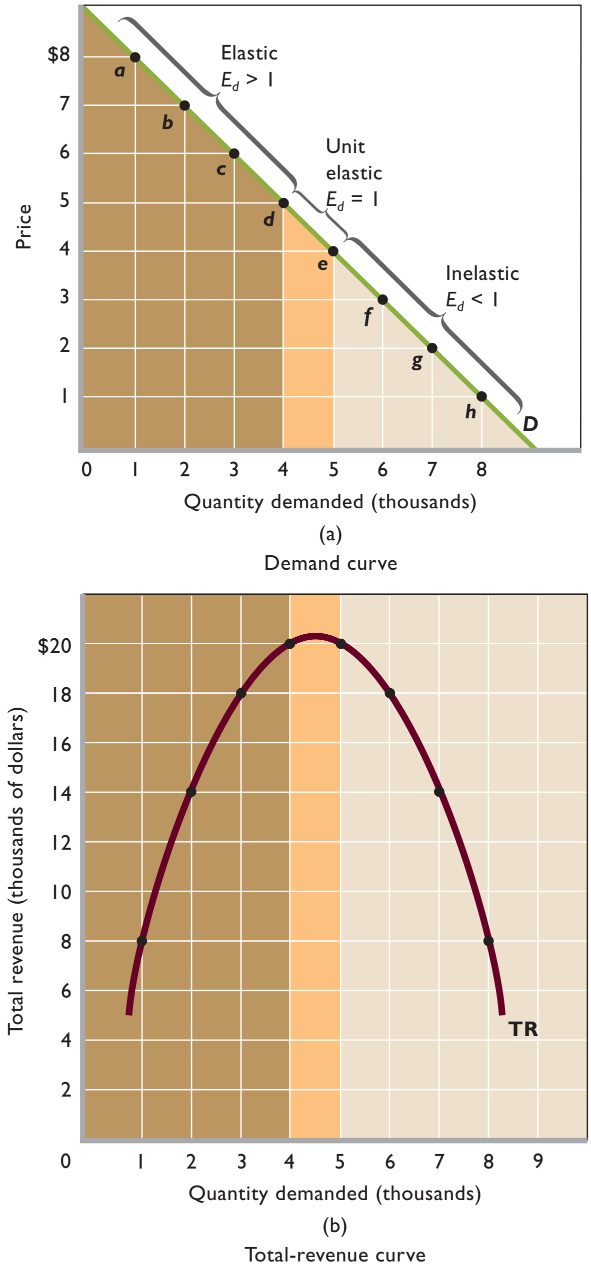
This is the consequence of the arithmetic properties of the elasticity measure. Specifically, in the upper-left segment of the demand curve, the percentage change in quantity is large because the original reference quantity is small. Similarly, the percentage change in price is

INTERACTIVE GRAPHS
G 6.1
Elasticity and revenue

TABLE 6.1 Price Elasticity of Demand for Movie Tickets as Measured by the Elasticity Coefficient and the Total-Revenue Test

(1) Total Quantity of Tickets Demanded per Week, Thousands	(2) Price per Ticket	(3) Elasticity Coefficient (E_d)	(4) Total Revenue, (1) × (2)	(5) Total-Revenue Test
1	$8		$ 8000	
		5.00		Elastic
2	7		14,000	
		2.60		Elastic
3	6		18,000	
		1.57		Elastic
4	5		20,000	
		1.00		Unit elastic
5	4		20,000	
		0.64		Inelastic
6	3		18,000	
		0.38		Inelastic
7	2		14,000	
		0.20		Inelastic
8	1		8000	

FIGURE 6.3 The relation between price elasticity of demand for movie tickets and total revenue. Demand curve *D* in (a) is based on Table 6.1 and is marked to show that the hypothetical weekly demand for movie tickets is elastic at higher price ranges and inelastic at lower price ranges. The total-revenue curve TR in (b) is derived from demand curve *D*. When price falls and TR increases, demand is elastic; when price falls and TR is unchanged, demand is unit-elastic; and when price falls and TR declines, demand is inelastic.



small in that segment because the original reference price is large. The relatively large percentage change in quantity divided by the relatively small change in price yields a large E_d—an elastic demand.

The reverse holds true for the lower-right segment of the demand curve. Here the percentage change in quantity is small because the original reference quantity is large; similarly, the percentage change in price is large because the original reference price is small. The relatively small percentage change in quantity divided by the relatively large percentage change in price results in a small E_d—an inelastic demand.

The demand curve in Figure 6.3a also illustrates that the slope of a demand curve—its flatness or steepness—is not a sound basis for judging elasticity. The catch is that the slope of the curve is computed from *absolute* changes in price and quantity, while elasticity involves *relative* or *percentage* changes in price and quantity. The demand curve in Figure 6.3a is linear, which by definition means that the slope is constant throughout. But we have demonstrated that such a curve is elastic in its high-price ($8–$5) range and inelastic in its low-price ($4–$1) range. **(Key Question 2)**

Price Elasticity and the Total-Revenue Curve

In Figure 6.3b we graphed the total revenue per week to the theater owner that corresponds to each price-quantity combination indicated along demand curve *D* in Figure 6.3a. The price–quantity-demanded combination represented by point *a* on the demand curve yields total revenue of $8000 (= $8×1000 tickets). In Figure 6.3b, we graphed this $8000 amount vertically at 1 unit (1000 tickets) demanded. Similarly, the price–quantity-demanded combination represented by point *b* in the upper panel yields total revenue of $14,000 (= $7×2000 tickets). This amount is graphed vertically at 2 units (2000 tickets) demanded in the lower panel. The ultimate result of such graphing is total-revenue curve TR, which first slopes upward, then reaches a maximum, and finally turns downward.

Comparison of curves *D* and TR sharply focuses the relationship between elasticity and total revenue. Lowering the ticket price in the elastic range of demand—for example, from $8 to $5—increases total revenue. Conversely, increasing the ticket price in that range reduces total revenue. In both cases, price and total revenue change in opposite directions, confirming that demand is elastic.

The $5−$4 price range of demand curve *D* reflects unit elasticity. When price either decreases from $5 to $4 or increases from $4 to $5, total revenue remains $20,000. In both cases, price has changed and total revenue has remained constant, confirming that demand is unit-elastic when we consider these particular price changes.

TABLE 6.2 Price Elasticity of Demand: A Summary

Absolute Value of Elasticity Coefficient	Demand Is:	Description	Impact on Total Revenue of a: Price Increase	Price Decrease
Greater than 1 ($E_d > 1$)	Elastic or relatively elastic	Quantity demanded changes by a larger percentage than does price	Total revenue decreases	Total revenue increases
Equal to 1 ($E_d = 1$)	Unit or unitary elastic	Quantity demanded changes by the same percentage as does price	Total revenue is unchanged	Total revenue is unchanged
Less than 1 ($E_d < 1$)	Inelastic or relatively inelastic	Quantity demanded changes by a smaller percentage than does price	Total revenue increases	Total revenue decreases

In the inelastic range of demand curve *D*, lowering the price—for example, from $4 to $1—decreases total revenue, as shown in Figure 6.3b. Raising the price boosts total revenue. In both cases, price and total revenue move in the same direction, confirming that demand is inelastic.

Table 6.2 summarizes the characteristics of price elasticity of demand. You should review it carefully. **(Key Questions 3 and 4)**

Determinants of Price Elasticity of Demand

We cannot say just what will determine the price elasticity of demand in each individual situation. However, the following generalizations are often helpful.

Substitutability Generally, the larger the number of substitute goods that are available, the greater the price elasticity of demand. Various brands of candy bars are generally substitutable for one another, making the demand for one brand of candy bar, say Snickers, highly elastic. Toward the other extreme, the demand for tooth repair (or tooth pulling) is quite inelastic because there simply are no close substitutes when those procedures are required.

The elasticity of demand for a product depends on how narrowly the product is defined. Demand for Reebok sneakers is more elastic than is the overall demand for shoes. Many other brands are readily substitutable for Reebok sneakers, but there are few, if any, good substitutes for shoes.

Proportion of Income Other things equal, the higher the price of a good relative to consumers' incomes, the greater the price elasticity of demand. A 10 percent increase in the price of low-priced pencils or chewing gum amounts to a few more pennies relative to one's income, and quantity demanded will probably decline only slightly. Thus, price elasticity for such low-priced items tends to be low. But a 10 percent increase in the price of relatively high-priced automobiles or housing means additional expenditures of perhaps $3000 or $20,000, respectively. These price increases are significant fractions of the annual incomes and budgets of most families, and quantities demanded will likely diminish significantly. Price elasticity for such items tends to be high.

Luxuries versus Necessities In general, the more that a good is considered to be a "luxury" rather than a "necessity," the greater is the price elasticity of demand. Electricity is generally regarded as a necessity; it is difficult to get along without it. A price increase will not significantly reduce the amount of lighting and power used in a household. (Note the very low price-elasticity coefficient of this good in Table 6.3.) An extreme case: A person does not decline an operation for acute appendicitis because the physician's fee has just gone up.

On the other hand, vacation travel and jewelry are luxuries, which, by definition, can easily be forgone. If the prices of vacation travel and jewelry rise, a consumer need not buy them and will suffer no great hardship without them.

What about the demand for a common product like salt? It is highly inelastic on three counts: Few good substitutes are available; salt is a negligible item in the family budget; and it is a "necessity" rather than a luxury.

Time Generally, product demand is more elastic the longer the time period under consideration. Consumers often need time to adjust to changes in prices. For example, when the price of a product rises, time is needed to find and experiment with other products to see if they are acceptable. Consumers may not immediately reduce their purchases very much when the price of beef rises by 10 percent, but in time they may shift to chicken, pork, or fish.

Another consideration is product durability. Studies show that "short-run" demand for gasoline is more inelastic ($E_d = .2$) than is "long-run" demand ($E_d = .7$). In the short run, people are "stuck" with their present cars and trucks, but with rising gasoline prices they eventually replace them with smaller, more fuel-efficient vehicles. They also switch to mass transit where it is available.

TABLE 6.3 Selected Price Elasticities of Demand

Product or Service	Coefficient of Price Elasticity of Demand (E_d)	Product or Service	Coefficient of Price Elasticity of Demand (E_d)
Newspapers	.10	Milk	.63
Electricity (household)	.13	Household appliances	.63
Bread	.15	Liquor	.70
Major League Baseball tickets	.23	Movies	.87
Telephone service	.26	Beer	.90
Cigarettes	.25	Shoes	.91
Sugar	.30	Motor vehicles	1.14
Medical care	.31	Beef	1.27
Eggs	.32	China, glassware, tableware	1.54
Legal services	.37	Residential land	1.60
Automobile repair	.40	Restaurant meals	2.27
Clothing	.49	Lamb and mutton	2.65
Gasoline	.60	Fresh peas	2.83

Source: Compiled from numerous studies and sources reporting price elasticity of demand.

Table 6.3 shows estimated price-elasticity coefficients for a number of products. Each reflects some combination of the elasticity determinants just discussed. **(Key Question 5)**

ApplicationsofPr ice Elasticity of Demand

The concept of price elasticity of demand has great practical significance, as the following examples suggest.

Large Crop Yields

The demand for most farm products is highly inelastic; E_d is perhaps .20 or .25. As a result, increases in the output of farm products arising from a good growing season or from increased productivity tend to depress both the prices of farm products and the total revenues (incomes) of farmers. For farmers as a group, the inelastic demand for their products means that large crop yields may be undesirable. For policymakers it means that achieving the goal of higher total farm income requires that farm output be restricted.

Excise Taxes

The government pays attention to elasticity of demand when it selects goods and services on which to levy excise taxes. If a $1 tax is levied on a product and 10,000 units are sold, tax revenue will be $10,000 (= $1 × 10,000 units sold). If the government raises the tax to $1.50 but the higher price that results reduces sales to 4000 because of elastic demand, tax revenue will decline to $6000 (= $1.50 × 4000 units sold). Because a higher tax on a product with elastic demand will bring in less tax revenue, legislatures tend to seek out products that have inelastic demand—such as liquor, gasoline, and cigarettes—when levying excises. In fact, the Federal government, in its effort to reduce the budget deficit, increased taxes on those very categories of goods in 1991.

Decriminalization of Illegal Drugs

In recent years proposals to legalize drugs have been widely debated. Proponents contend that drugs should be treated like alcohol; they should be made legal for adults and regulated for purity and potency. The current war on drugs, it is argued, has been unsuccessful, and the associated costs—including enlarged police forces, the construction of more prisons, an overburdened court system, and untold human costs—have increased markedly. Legalization would allegedly reduce drug trafficking significantly by taking the profit out of it. Crack cocaine and heroin, for example, are cheap to produce and could be sold at low prices in legal markets. Because the demand of addicts is highly inelastic, the amounts consumed at the lower prices would increase only modestly. Addicts' total expenditures for cocaine and heroin would decline, and so would the street crime that finances those expenditures.

Opponents of legalization say that the overall demand for cocaine and heroin is far more elastic than proponents think. In addition to the inelastic demand of addicts, there is another market segment whose demand is relatively elastic. This segment consists of the occasional users or "dabblers," who use hard drugs when their prices are low but who abstain or substitute, say, alcohol when their prices are high. Thus, the lower prices associated with the legalization of hard drugs would increase consumption by dabblers. Also, removal of the legal prohibitions against using drugs might make drug use more socially acceptable, increasing the demand for cocaine and heroin.

Many economists predict that the legalization of cocaine and heroin would reduce street prices by up to 60 percent, depending on if and how much they were taxed. According to an important study, price declines of that size would increase the number of occasional users of heroin by 54 percent and the number of occasional users of cocaine by 33 percent. The total quantity of heroin demanded would rise by an estimated 100 percent, and the quantity of cocaine demanded would rise by 50 percent.[1] Moreover, many existing and first-time dabblers might in time become addicts. The overall result, say the opponents of legalization, would be higher social costs, possibly including an increase in street crime.

QUICK REVIEW 6.1

- The price elasticity of demand coefficient E_d is the ratio of the percentage change in quantity demanded to the percentage change in price. The *averages* of the two prices and two quantities are used as the base references in calculating the percentage changes.
- When E_d is greater than 1, demand is elastic; when E_d is less than 1, demand is inelastic; when E_d is equal to 1, demand is of unit elasticity.
- When price changes, total revenue will change in the opposite direction if demand is price-elastic, in the same direction if demand is price-inelastic, and not at all if demand is unit-elastic.
- Demand is typically elastic in the high-price (low-quantity) range of the demand curve and inelastic in the low-price (high-quantity) range of the curve.
- Price elasticity of demand is greater (a) the larger the number of substitutes available; (b) the higher the price of a product relative to one's budget; (c) the greater the extent to which the product is a luxury; and (d) the longer the time period involved.

PriceE lasticityofS upply

ORIGIN OF THE IDEA

O 6.2

Price elasticity of supply

The concept of price elasticity also applies to supply. If the quantity supplied by producers is relatively responsive to price changes, supply is elastic. If it is relatively insensitive to price changes, supply is inelastic.

We measure the degree of price elasticity or inelasticity of supply with the coefficient E_s, defined almost like E_d except that we substitute "percentage change in quantity supplied" for "percentage change in quantity demanded":

$$E_s = \frac{\text{percentage change in quantity supplied of product X}}{\text{percentage change in price of product X}}$$

For reasons explained earlier, the averages, or midpoints, of the before and after quantities supplied and the before and after prices are used as reference points for the percentage changes. Suppose an increase in the price of a good from $4 to $6 increases the quantity supplied from 10 units to 14 units. The percentage change in price would be $\frac{2}{5}$, or 40 percent, and the percentage change in quantity would be $\frac{4}{12}$, or 33 percent:

$$E_s = \frac{.33}{.40} = .83$$

In this case, supply is inelastic, since the price-elasticity coefficient is less than 1. If E_s is greater than 1, supply is elastic. If it is equal to 1, supply is unit-elastic. Also, E_s is never negative, since price and quantity supplied are directly related. Thus, there are no minus signs to drop, as was necessary with elasticity of demand.

The degree of **price elasticity of supply** depends on how easily—and therefore quickly—producers can shift resources between alternative uses. The easier and more rapidly producers can shift resources between alternative uses, the greater the price elasticity of supply. Take the case of Christmas trees. A firm's response to, say, an increase in the price of trees depends on its ability to shift resources from the production of other products (whose prices we assume remain constant) to the production of trees. And shifting resources takes time: The longer the time, the greater the resource "shiftability." So we can expect a greater response, and therefore greater elasticity of supply, the longer a firm has to adjust to a price change.

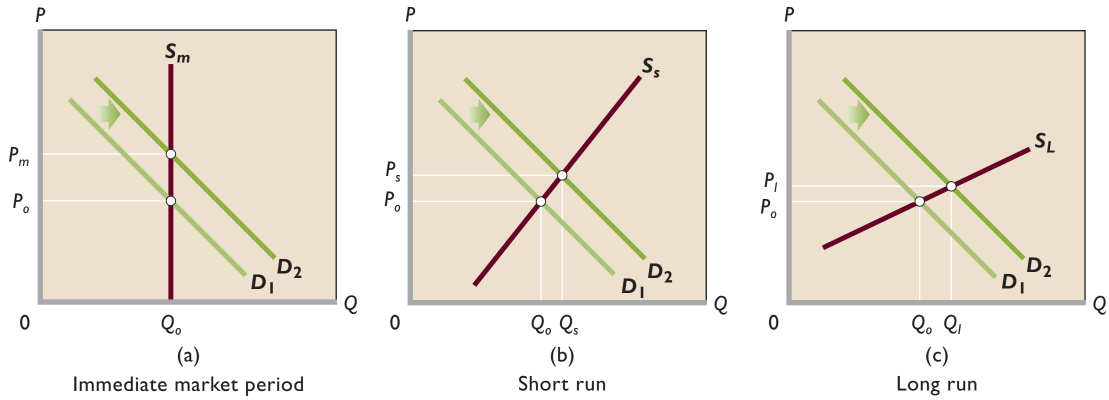
In analyzing the impact of time on elasticity, economists distinguish among the immediate market period, the short run, and the long run.

Price Elasticity of Supply: The Market Period

The **market period** is the period that occurs when the time immediately after a change in market price is too short for producers to respond with a change in quantity

[1]Henry Saffer and Frank Chaloupka, "The Demand for Illegal Drugs," *Economic Inquiry*, July 1999, pp. 401–411.

FIGURE 6.4 Time and the elasticity of supply. The greater the amount of time producers have to adjust to a change in demand, here from D_1 to D_2, the greater will be their output response. In the immediate market period (a) there is insufficient time to change output, and so supply is perfectly inelastic. In the short run (b) plant capacity is fixed, but changing the intensity of its use can alter output; supply is therefore more elastic. In the long run (c) all desired adjustments, including changes in plant capacity, can be made, and supply becomes still more elastic.



supplied. Suppose the owner of a small farm brings to market one truckload of tomatoes that is the entire season's output. The supply curve for the tomatoes is perfectly inelastic (vertical); the farmer will sell the truckload whether the price is high or low. Why? Because the farmer can offer only one truckload of tomatoes even if the price of tomatoes is much higher than anticipated. He or she might like to offer more tomatoes, but tomatoes cannot be produced overnight. Another full growing season is needed to respond to a higher-than-expected price by producing more than one truckload. Similarly, because the product is perishable, the farmer cannot withhold it from the market. If the price is lower than anticipated, he or she will still sell the entire truckload.

The farmer's costs of production, incidentally, will not enter into this decision to sell. Though the price of tomatoes may fall far short of production costs, the farmer will nevertheless sell out to avoid a total loss through spoilage. During the market period, our farmer's supply of tomatoes is fixed: Only one truckload is offered no matter how high or low the price.

Figure 6.4a shows the farmer's vertical supply curve during the market period. Supply is perfectly inelastic because the farmer does not have time to respond to a change in demand, say, from D_1 to D_2. The resulting price increase from P_0 to P_m simply determines which buyers get the fixed quantity supplied; it elicits no increase in output.

However, not all supply curves need be perfectly inelastic immediately after a price change. If the product is not perishable and the price rises, producers may choose to increase quantity supplied by drawing down their inventories of unsold, stored goods. This will cause the market supply curve to attain some positive slope. For our tomato farmer, the market period may be a full growing season; for producers of goods that can be inexpensively stored, there may be no market period at all.

Price Elasticity of Supply: The Short Run

The **short run** in microeconomics is a period of time too short to change plant capacity but long enough to use the fixed-sized plant more or less intensively. In the short run, our farmer's plant (land and farm machinery) is fixed. But he does have time in the short run to cultivate tomatoes more intensively by applying more labor and more fertilizer and pesticides to the crop. The result is a somewhat greater output in response to a presumed increase in demand; this greater output is reflected in a more elastic supply of tomatoes, as shown by S_s in Figure 6.4b. Note now that the increase in demand from D_1 to D_2 is met by an increase in quantity (from Q_0 to Q_s), so there is a smaller price adjustment (from P_0 to P_s) than would be the case in the market period. The equilibrium price is therefore lower in the short run than in the market period.

Price Elasticity of Supply: The Long Run

The **long run** in microeconomics is a time period long enough for firms to adjust their plant sizes and for new firms to enter (or existing firms to leave) the industry. In the "tomato industry," for example, our farmer has time to acquire additional land and buy more machinery and equipment. Furthermore, other farmers may, over time, be attracted to tomato farming by the increased demand and higher price. Such adjustments create a larger supply response, as represented by the more elastic supply curve S_L in Figure 6.4c. The outcome is a smaller price rise (P_0 to P_l) and a larger output increase (Q_0 to Q_l) in response to the increase in demand from D_1 to D_2.

There is no total-revenue test for elasticity of supply. Supply shows a positive or direct relationship between price and amount supplied; the supply curve is upsloping. Regardless of the degree of elasticity or inelasticity, price and total revenue always move together. **(Key Question 8)**

Applications of Price Elasticity of Supply

The idea of price elasticity of supply has widespread applicability, as suggested by the following examples.

Antiques and Reproductions

The *Antiques Road Show* is a popular PBS television program in which people bring antiques to a central location for appraisal by experts. Some people are pleased to learn that their old piece of furniture or funky folk art is worth a large amount, say, $30,000 or more.

The high price of an antique results from strong demand and limited, highly inelastic supply. Because a genuine antique can no longer be reproduced, its quantity supplied either does not rise or rises only slightly as its price goes up. The higher price might prompt the discovery of a few more of the remaining originals and thus add to the quantity available for sale, but this quantity response is usually quite small. So the supply of antiques and other collectibles tends to be inelastic. For one-of-a-kind antiques, the supply is perfectly inelastic.

Factors such as increased population, higher income, and greater enthusiasm for collecting antiques have increased the demand for antiques over time. Because the supply of antiques is limited and inelastic, those increases in demand have greatly boosted the prices of antiques.

Contrast the inelastic supply of original antiques with the elastic supply of modern “made-to-look-old” reproductions. Such faux antiques are quite popular and widely available at furniture stores and knickknack shops. When the demand for reproductions increases, the firms making them simply boost production. Because the supply of reproductions is highly elastic, increased demand raises their prices only slightly.

Volatile Gold Prices

The price of gold is quite volatile, sometimes shooting upward one period and plummeting downward the next. The main sources of these fluctuations are shifts in demand and highly inelastic supply. Gold production is a costly and time-consuming process of exploration, mining, and refining. Moreover, the physical availability of gold is highly limited. For both reasons, increases in gold prices do not elicit substantial increases in quantity supplied. Conversely, gold mining is costly to shut down and existing gold bars are expensive to store. Price decreases therefore do not produce large drops in the quantity of gold supplied. In short, the supply of gold is inelastic.

The demand for gold is partly derived from the demand for its uses, such as for jewelry, dental fillings, and coins. But people also demand gold as a speculative financial investment. They increase their demand for gold when they fear general inflation or domestic or international turmoil that might undermine the value of currency and more traditional investments. They reduce their demand when events settle down. Because of the inelastic supply of gold, even relatively small changes in demand produce relatively large changes in price. (Web-based question 1 at the end of the chapter provides an Internet source for finding current and past prices of gold.)

Cross Elasticity and Income Elasticity of Demand

Price elasticities measure the responsiveness of the quantity of a product demanded or supplied when its price changes. The consumption of a good also is affected by a change in the price of a related product or by a change in income.

Cross Elasticity of Demand

The **cross elasticity of demand** measures how sensitive consumer purchases of one product (say, X) are to a change in the price of some other product (say, Y). We calculate the coefficient of cross elasticity of demand E_{xy} just as we do the coefficient of simple price elasticity, except that we relate the percentage change in the consumption of X to the percentage change in the price of Y:

$$E_{xy} = \frac{\text{percentage change in quantity demanded of product X}}{\text{percentage change in price of product Y}}$$

This cross-elasticity (or cross-price-elasticity) concept allows us to quantify and more fully understand substitute and complementary goods, introduced in Chapter 3. *Unlike price elasticity, we allow the* *coefficient of cross elasticity of demand to be either positive or negative.*

Substitute Goods If cross elasticity of demand is positive, meaning that sales of X move in the same direction as a change in the price of Y, then X and Y are substitute goods. An example is Evian water (X) and Dasani (Y). An increase in the price of Evian causes consumers to buy more Dasani, resulting in a positive cross elasticity. The larger the positive cross-elasticity coefficient, the greater is the substitutability between the two products.

Complementary Goods When cross elasticity is negative, we know that X and Y "go together"; an increase in the price of one decreases the demand for the other. So the two are complementary goods. For example, a decrease in the price of digital cameras will increase the number of memory sticks purchased. The larger the negative cross-elasticity coefficient, the greater is the complementarity between the two goods.

Independent Goods A zero or near-zero cross elasticity suggests that the two products being considered are unrelated or independent goods. An example is walnuts and plums: We would not expect a change in the price of walnuts to have any effect on purchases of plums, and vice versa.

Application The degree of substitutability of products, measured by the cross-elasticity coefficient, is important to businesses and government. For example, suppose that Coca-Cola is considering whether or not to lower the price of its Sprite brand. Not only will it want to know something about the price elasticity of demand for Sprite (will the price cut increase or decrease total revenue?), but it will also be interested in knowing if the increased sales of Sprite will come at the expense of its Coke brand. How sensitive are the sales of one of its products (Coke) to a change in the price of another of its products (Sprite)? By how much will the increased sales of Sprite "cannibalize" the sales of Coke? A low cross elasticity would indicate that Coke and Sprite are weak substitutes for each other and that a lower price for Sprite would have little effect on Coke sales.

Government also implicitly uses the idea of cross elasticity of demand in assessing whether a proposed merger between two large firms will substantially reduce competition and therefore violate the antitrust laws. For example, the cross elasticity between Coke and Pepsi is high, making them strong substitutes for each other. Consequently, the government would likely block a merger between them because the merger would lessen competition. In contrast, the cross elasticity between cola and gasoline is low or zero. A merger between Coke and Shell would have a minimal effect on competition. So government would let that merger happen. **(Key Question 9)**

Income Elasticity of Demand

Income elasticity of demand measures the degree to which consumers respond to a change in their incomes by buying more or less of a particular good. The coefficient of income elasticity of demand E_i is determined with the formula

$$E_i = \frac{\text{percentage change in quantity demanded}}{\text{percentage change in income}}$$

Normal Goods For most goods, the income-elasticity coefficient E_i is positive, meaning that more of them are demanded as incomes rise. Such goods are called normal or superior goods, which we first described in Chapter 3. But the value of E_i varies greatly among normal goods. For example, income elasticity of demand for automobiles is about +3, while income elasticity for most farm products is only about +.20.

Inferior Goods A negative income-elasticity coefficient designates an inferior good. Retread tires, cabbage, long-distance bus tickets, used clothing, and muscatel wine are likely candidates. Consumers decrease their purchases of inferior goods as incomes rise.

Insights Coefficients of income elasticity of demand provide insights into the economy. For example, when recessions (business downturns) occur and incomes fall, income elasticity of demand helps predict which products will decline in demand more rapidly than others.

Products with relatively high income elasticity coefficients, such as automobiles ($E_i = +3$), housing ($E_i = +1.5$), and restaurant meals ($E_i = +1.4$), are generally hit hardest by recessions. Those with low or negative income elasticity coefficients are much less affected. For example, food products prepared at home ($E_i = +.20$) respond relatively little to income fluctuations. When incomes drop, purchases of food (and toothpaste and toilet paper) drop little compared to purchases of movie tickets, luxury vacations, and plasma screen TVs. Products we view as essential tend to have lower income elasticity coefficients than products we view as luxuries. When our incomes fall, we cannot easily eliminate or postpone the purchase of essential products. **(Key Question 10)**

TABLE 6.4 Cross and Income Elasticities of Demand

Value of Coefficient	Description	Type of Good(s)
Cross elasticity:		
Positive ($E_{wz} > 0$)	Quantity demanded of W changes in same direction as change in price of Z	Substitutes
Negative ($E_{xy} < 0$)	Quantity demanded of X changes in opposite direction from change in price of Y	Complements
Income elasticity:		
Positive ($E_i > 0$)	Quantity demanded of the product changes in same direction as change in income	Normal or superior
Negative ($E_i < 0$)	Quantity demanded of the product changes in opposite direction from change in income	Inferior

In Table 6.4 we provide a convenient synopsis of the cross-elasticity and income-elasticity concepts.

QUICK REVIEW 6.2

- Price elasticity of supply measures the sensitivity of suppliers to changes in the price of a product. The price-elasticity-of-supply coefficient E_s is the ratio of the percentage change in quantity supplied to the percentage change in price. The elasticity of supply varies directly with the amount of time producers have to respond to the price change.
- The cross-elasticity-of-demand coefficient E_{xy} is computed as the percentage change in the quantity demanded of product X divided by the percentage change in the price of product Y. If the cross-elasticity coefficient is positive, the two products are substitutes; if negative, they are complements.
- The income-elasticity coefficient E_i is computed as the percentage change in quantity demanded divided by the percentage change in income. A positive coefficient indicates a normal or superior good. The coefficient is negative for an inferior good.

Consumer and Producer Surplus

Our final goal for this chapter is to examine the following reality: Consumers and producers obtain "benefit surpluses" through market transactions. These surpluses vary in size among the various buyers and sellers.

ConsumerS urplus

The benefit surplus received by a consumer or consumers in a market is called **consumer surplus**. It is defined as the difference between the maximum price a consumer is (or consumers are) willing to pay for a product and the actual price. In nearly all markets, consumers individually and collectively gain greater total utility in dollar terms (total satisfaction) from their purchases than the amount of their expenditures (= product price × quantity). This utility surplus arises because all consumers pay the equilibrium price even though many would be willing to pay more than that price to obtain the product.

Consider Figure 6.5, where the demand curve shows the buyers' maximum willingness to pay for each unit of the product and we assume that the equilibrium price, P_1, of oranges is $8 per bag. The portion of the demand curve *D* lying above the $8 equilibrium price shows that many consumers of oranges would be willing to pay more than $8 per bag rather than go without oranges.

See Table 6.5, for example, where column 2 reveals that Bob is willing to pay a maximum of $13 for a bag of oranges; Barb, $12; Bill, $11; Bart, $10; and Brent, $9. Betty,

FIGURE 6.5 Consumers surplus. Consumer surplus—shown as the green triangle—is the differences between the maximum prices consumers are willing to pay for a product and the lower equilibrium price, here assumed to be $8. For quantity Q_1, consumers are willing to pay the sum of the amounts represented by the green triangle and the tan rectangle. Because they need to pay only the amount shown as the tan rectangle, the green triangle shows consumer surplus.

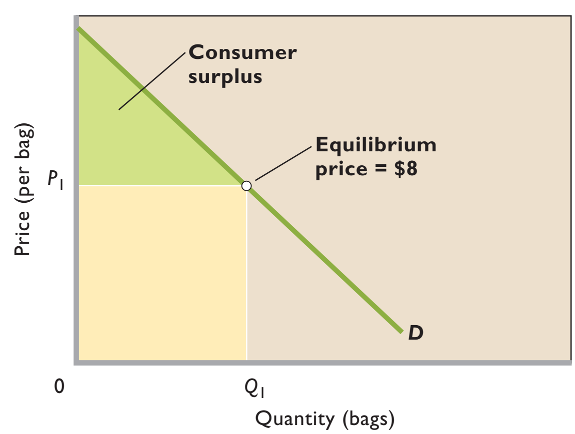


TABLE 6.5 ConsumerS urplus

(1) Person	(2) Maximum Price Willing to Pay	(3) Actual Price (Equilibrium Price)	(4) Consumer Surplus
Bob	$13	$8	$5 (= $13 − $8)
Barb	12	8	4 (= $12 − $8)
Bill	11	8	3 (= $11 − $8)
Bart	10	8	2 (= $10 − $8)
Brent	9	8	1 (= $9 − $8)
Betty	8	8	0 (= $8 − $8)

in contrast, is willing to pay only the $8 equilibrium price. Because all six buyers listed obtain the oranges for the $8 equilibrium price (column 3), five of them obtain a consumer surplus. Column 4 shows that Bob receives a consumer surplus of $5 (= $13 − $8); Barb, $4 (= $12 − $8); Bill, $3 (= $11 − $8); Bart, $2 (= $10 − $8); and Brent, $1 (= $9 − $8). Only Betty receives no consumer surplus because her maximum willingness to pay $8 matches the $8 equilibrium price.

Obviously, most markets have more than six people. Suppose there are many other consumers besides Bob, Barb, Bill, Bart, Brent, and Betty in the market represented by Figure 6.5. It is reasonable to assume that many of these additional people are willing to pay more than $8 for a bag of oranges. By adding together the individual consumer surpluses obtained by our named and unnamed buyers, we obtain the collective consumer surplus in this specific market. To obtain the Q_1 bags of oranges represented, consumers collectively are willing to pay the total amount shown by the sum of the green triangle and tan rectangle under the demand curve and to the left of Q_1. But consumers need pay only the amount represented by the tan rectangle (= $P_1 \times Q_1$). So the green triangle is the consumer surplus in this market. It is the sum of the vertical distances between the demand curve and the $8 equilibrium price at each quantity up to Q_1. Alternatively, it is the sum of the gaps between maximum willingness to pay and actual price, such as those we calculated in Table 6.5.

Consumer surplus and price are inversely (negatively) related. Given the demand curve, higher prices reduce consumer surplus; lower prices increase it. To test this generalization, draw in an equilibrium price above $8 in Figure 6.5 and observe the reduced size of the triangle representing consumer surplus. When price goes up, the gap narrows between the maximum willingness to pay and the actual price. Next, draw in an equilibrium price below $8 and see that consumer surplus increases. When price declines, the gap widens between maximum willingness to pay and actual price.

ORIGIN OF THE IDEA
O 6.3
Consumer surplus

ProducerS urplus

Like consumers, producers also receive a benefit surplus in markets. This **producer surplus** is the difference between the actual price a producer receives (or producers receive) and the minimum acceptable price. The supply curve shows the seller's minimum acceptable price at each unit of the product. Sellers collectively receive a producer surplus in most markets because most sellers would be willing to accept a lower-than-equilibrium price if that were required to sell the product. Those lower acceptable prices for each of the units up to Q_1 are shown by the portion of the supply curve in Figure 6.6 lying to the left of and below the assumed $8 equilibrium price.

Suppose that Carlos, Courtney, Chuck, Cindy, Craig, and Chad are six of the many sellers of oranges in the market. Due to differences in production costs, suppose that Carlos' minimum acceptable payment for a bag of oranges is $3, as shown in column 2 of Table 6.6, whereas Courtney's minimum acceptable payment is $4, Chuck's is $5, Cindy's is $6, Craig's is $7, and Chad's is $8. But each seller receives as payment the equilibrium price of $8. As shown in column 4, Carlos thus obtains a producer surplus of $5 (= $8 − $3); Courtney, $4 (= $8 − $4); Chuck, $3 (= $8 − $5); Cindy, $2 (= $8 − $6); Craig, $1 (= $8 − $7); and Chad, zero (= $8 − $8).

FIGURE 6.6 Producer surplus. Producer surplus—shown as the orange triangle—is the differences between the actual price producers receive for a product (here $8) and the lower minimum payments they are willing to accept. For quantity Q_1, producers receive the sum of the amounts represented by the orange triangle plus the tan area. Because they need receive only the amount shown by the tan area to produce Q_1, the orange triangle represents producer surplus.

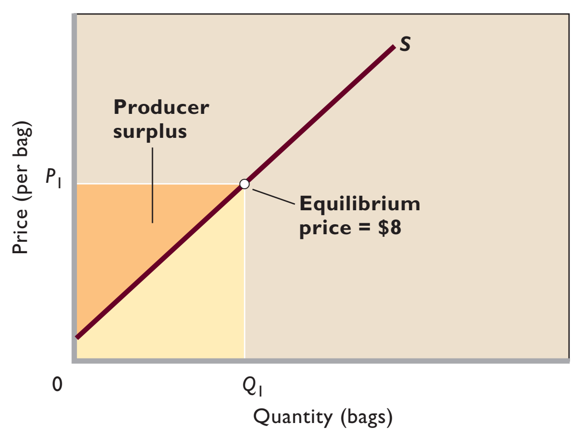


TABLE 6.6 Producer Surplus

(1) Person	(2) Minimum Acceptable Price	(3) Actual Price (Equilibrium Price)	(4) Producer Surplus
Carlos	$3	$8	$5 (= $8 − $3)
Courtney	4	8	4 (= $8 − $4)
Chuck	5	8	3 (= $8 − $5)
Cindy	6	8	2 (= $8 − $6)
Craig	7	8	1 (= $8 − $7)
Chad	8	8	0 (= $8 − $8)

By summing the producer surpluses of these sellers along with those of other sellers, we obtain the producer surplus for the entire market for oranges. In Figure 6.6, producers collect revenues of $P_1 \times Q_1$, which is the sum of the orange triangle and the tan area. As shown by the supply curve, however, revenues of only those illustrated by the tan area would be required to entice producers to offer Q_1 bags of oranges for sale. The sellers therefore receive a producer surplus shown by the orange triangle. That surplus is the sum of the vertical distances between the supply curve and the $8 equilibrium price at each of the quantities to the left of Q_1.

There is a direct (positive) relationship between equilibrium price and the amount of producer surplus. Given the supply curve, lower prices reduce producer surplus; higher prices increase it. If you pencil in a lower equilibrium price than $8, you will see that the producer surplus triangle gets smaller. The gaps between the minimum acceptable payments and the actual prices narrow when the price falls. If you pencil in an equilibrium price above $8, the size of the producer surplus triangle increases. The gaps between minimum acceptable payments and actual prices widen when the price increases.

WORKED PROBLEMS

W 6.3

Consumer and producer surplus

Efficiency Revisited

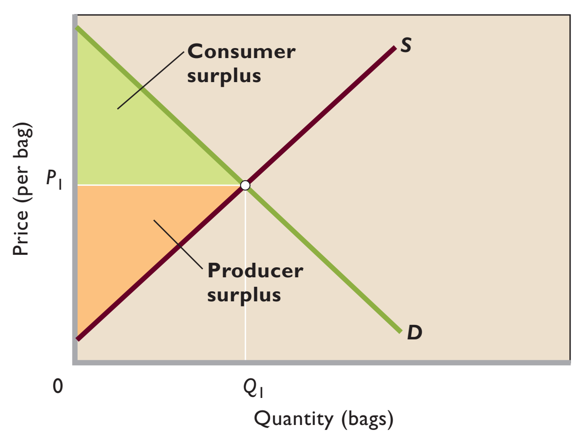
In Figure 6.7 we bring together the demand and supply curves of Figures 6.5 and 6.6 to show the equilibrium price and quantity and the previously described regions of consumer and producer surplus. All markets that have downward-sloping demand curves and upward-sloping supply curves yield consumer and producer surplus.

The equilibrium quantity in Figure 6.7 reflects economic efficiency, which consists of productive efficiency and allocative efficiency. *Productive efficiency* is achieved because competition forces producers to use the best techniques and combinations of resources in growing and selling oranges. Production costs of each level of output are minimized. *Allocative efficiency* is achieved because the correct quantity of output—Q_1—is produced relative to other goods and services. Points on the demand curve in Figure 6.7 measure the marginal benefit (MB) of oranges at each level of output. Points on the supply curve measure the marginal cost (MC) of oranges at each output level. The demand and supply curves intersect at the equilibrium output Q_1, indicating that MB = MC. (For the significance of the MB = MC equality for efficiency, review the discussion relating to Figure 1.3).

Our analysis of consumer and producer surplus provides another way of thinking about efficiency. Each point on a demand curve identifies not only the marginal benefit of the corresponding unit of output but also the *maximum willingness to pay* for it. Willingness to pay derives from the benefit that a product provides. Similarly, each point on the supply curve identifies not only the marginal cost of a good but also the *minimum acceptable price* for the good. To stay profitable, sellers must receive minimum prices that "cover" their marginal costs.

In Figure 6.7 the maximum willingness to pay for each bag of oranges up to Q_1 exceeds the corresponding minimum acceptable price. So each of these bags adds a positive amount (= maximum willingness to pay *minus* minimum acceptable price) to the *total* of consumer and producer surplus. Only at the equilibrium price Q_1, where maximum willingness to pay for the last unit equals minimum

FIGURE 6.7 Efficiency: maximum combined consumer and producer surplus. At quantity Q_1 the combined amount of consumer surplus, shown as the green triangle, and producer surplus, shown as the orange triangle, is maximized. Efficiency occurs because, at Q_1, maximum willingness to pay, indicated by the points on the demand curve, equals minimum acceptable price, shown by the points on the supply curve.



acceptable price for that unit, does society exhaust all the opportunities to add to combined consumer and producer surplus. So allocative efficiency occurs where the triangle representing "consumer surplus + producer surplus" is at its maximum size.

Other things equal, competitive markets produce equilibrium prices and quantities that maximize the sum of consumer and producer surplus. Allocative efficiency occurs at quantity levels where three conditions exist:

- MB = MC (Figure 1.3).
- Maximum willingness to pay = minimum acceptable price.
- Combined consumer and producer surplus is at a maximum.

Allocative efficiency and maximum benefit surpluses are the reasons that economists are so enamored of markets and why they usually think that markets are the best option for allocating resources in cases where they are possible.

Efficiency Losses (or Deadweight Losses)

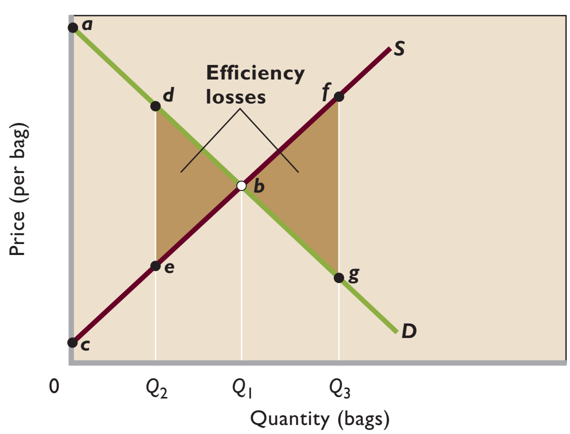
Figure 6.8 demonstrates **efficiency losses**—reductions of combined consumer and producer surplus—associated with underproduction or overproduction of a product. Suppose that output is Q_2 rather than the efficient level Q_1. The sum of consumer and producer surplus, previously *abc*, falls to *adec*. So the combined consumer and producer surplus declines by the amount of the brown triangle to the left of Q_1. That triangle represents an efficiency loss to buyers and sellers. And since buyers and sellers are members of society, it represents an efficiency loss (or a so-called **deadweight loss**) to society.

For output levels from Q_2 to Q_1, the maximum willingness to pay by consumers (as reflected by points on the demand curve) exceeds the minimum acceptable price of sellers (as reflected by points on the supply curve). By failing to produce a product for which a consumer is willing to pay, say, \$10, and for which a producer is willing to accept \$6, society suffers a \$4 loss of net benefits. The triangle *dbe* in Figure 6.8 shows the total loss of such net benefits due to the underproduction at Q_2.

In contrast, suppose that the number of oranges produced is Q_3 rather than the efficient level of Q_1. In Figure 6.8 the combined consumer and producer surplus therefore declines by *bfg*—the brown triangle to the right of Q_1. This triangle subtracts from the total consumer and producer surplus of *abc* that would occur if the quantity had been Q_1.

For all units beyond Q_1, the consumer's maximum willingness to pay is less than the producer's minimum acceptable price. Producing an item for which the maximum willingness to pay is, say, \$7 and the minimum acceptable price is \$10 subtracts \$3 from society's net benefits. Such production is uneconomical and creates an efficiency loss (or deadweight loss) for society. The brown triangle *bfg* to the right of Q_1 in Figure 6.8 shows the total efficiency loss from overproduction at Q_3. We are again reminded that there can be too much as well as too little of a good thing. Under most conditions, however, a competitive market ensures that the "right amount" of a particular good gets produced. **(Key Question 15)**

FIGURE 6.8 Efficiency losses (or deadweight losses). Quantity levels less than or greater than the efficient quantity, Q_1, create efficiency losses. The triangle *dbe* shows the efficiency loss associated with underproduction Q_2, whereas the triangle *bfg* illustrates the efficiency loss associated with overproduction Q_3.



QUICK REVIEW 6.3

- Consumer surplus is the difference between the maximum price that a consumer is willing to pay for a product and the lower price actually paid.
- Producer surplus is the difference between the minimum price that a producer is willing to accept for a product and the higher price actually received.
- At the equilibrium price and quantity in competitive markets, marginal benefit equals marginal cost, maximum willingness to pay equals minimum acceptable price, and the total of consumer surplus and producer surplus is maximized. These individual conditions define allocative efficiency.
- Quantities less than or greater than the allocatively efficient level of output create efficiency losses, often called deadweight losses.

LAST Word

Elasticity and Pricing Power: Why Different Consumers Pay Different Prices

Firms and Nonprofit Institutions Often Recognize and Exploit Differences in Price Elasticity of Demand.

All buyers in a highly competitive market pay the same market price for the product, regardless of their individual price elasticities of demand. If the price rises, Jones may have an elastic demand and greatly reduce her purchases. Green may have a unit-elastic demand and reduce his purchases less than Jones. Lopez may have an inelastic demand and hardly curtail his purchases at all. But all three consumers will pay the single higher price regardless of their respective demand elasticities.

In later chapters we will find that not all sellers must passively accept a "one-for-all" price. Some firms have "market power" or "pricing power" that allows them to set their product prices in their best interests. For some goods and services, firms may find it advantageous to determine differences in price elasticity of demand and then charge different prices to different buyers.

It is extremely difficult to tailor prices for each customer on the basis of price elasticity of demand, but it is relatively easy to observe differences in group elasticities. Consider airline tickets. Business travelers generally have inelastic demand for air travel. Because their time is highly valuable, they do not see slower modes of transportation as realistic substitutes. Also, their employers pay for their tickets as part of their business expenses. In contrast, leisure travelers tend to have elastic demand. They have the option to drive rather than fly or to simply not travel at all. They also pay for their tickets out of their own pockets and thus are more sensitive to price.

Airlines recognize this group difference in price elasticity of demand and charge business travelers more than leisure travelers. To accomplish that, they have to dissuade business travelers from buying the less expensive round-trip tickets aimed at leisure travelers, so they try to place restrictions on the lower-priced tickets. For instance, they have at times made such tickets nonrefundable, required at least a 2-week advance purchase, and required Saturday-night stays. These restrictions chase off most business travelers who engage in last-minute travel and want to be home for the weekend. As a result, a business traveler often pays hundreds of dollars more for a ticket than a leisure traveler on the same plane.

Discounts for children are another example of pricing based on group differences in price elasticity of demand. For many products, children have more elastic demands than adults because children have low budgets, often financed by their parents. Sellers recognize the elasticity difference and price accordingly. The barber spends as much time cutting a child's hair as an adult's but charges the child much less. A child takes up a full seat at the baseball game but pays a lower price than an adult. A child snowboarder occupies the same space on a chairlift as an adult snowboarder but qualifies for a discounted lift ticket.

Finally, consider pricing by colleges and universities. Price elasticity of demand for higher education is greater for prospective students from low-income families than similar students from high-income families. This makes sense because tuition is a much larger proportion of household income for a low-income student or family than for his or her high-income counterpart. Desiring a diverse student body, colleges charge different *net* prices (= tuition *minus* financial aid) to the two groups on the basis of price elasticity of demand. High-income students pay full tuition, unless they receive merit-based scholarships. Low-income students receive considerable financial aid in addition to merit-based scholarships and, in effect, pay a lower *net* price.

It is common for colleges to announce a large tuition increase and immediately cushion the news by emphasizing that they also are increasing financial aid. In effect, the college is increasing the tuition for students who have inelastic demand by the full amount and raising the *net* tuition of those with elastic demand by some lesser amount or not at all. Through this strategy, colleges boost revenue to cover rising costs while maintaining affordability for a wide range of students.

There are a number of other examples of dual or multiple pricing. All relate directly to price elasticity of demand. We will revisit this topic again in Chapter 10 when we analyze *price discrimination*—charging different prices to different customers for the same product.

Summary

1. Price elasticity of demand measures consumer response to price changes. If consumers are relatively sensitive to price changes, demand is elastic. If they are relatively unresponsive to price changes, demand is inelastic.
2. The price-elasticity coefficient E_d measures the degree of elasticity or inelasticity of demand. The coefficient is found by the formula

$$E_d = \frac{\text{percentage change in quantity demanded of X}}{\text{percentage change in price of X}}$$

   Economists use the averages of prices and quantities under consideration as reference points in determining percentage changes in price and quantity. If E_d is greater than 1, demand is elastic. If E_d is less than 1, demand is inelastic. Unit elasticity is the special case in which E_d equals 1.
3. Perfectly inelastic demand is graphed as a line parallel to the vertical axis; perfectly elastic demand is shown by a line above and parallel to the horizontal axis.
4. Elasticity varies at different price ranges on a demand curve, tending to be elastic in the upper-left segment and inelastic in the lower-right segment. Elasticity cannot be judged by the steepness or flatness of a demand curve.
5. If total revenue changes in the opposite direction from prices, demand is elastic. If price and total revenue change in the same direction, demand is inelastic. Where demand is of unit elasticity, a change in price leaves total revenue unchanged.
6. The number of available substitutes, the size of an item's price relative to one's budget, whether the product is a luxury or a necessity, and length of time to adjust are all determinants of elasticity of demand.
7. The elasticity concept also applies to supply. The coefficient of price elasticity of supply is found by the formula

$$E_s = \frac{\text{percentage change in quantity supplied of X}}{\text{percentage change in price of X}}$$

   The averages of the prices and quantities under consideration are used as reference points for computing percentage changes. Elasticity of supply depends on the ease of shifting resources between alternative uses, which varies directly with the time producers have to adjust to a price change.
8. Cross elasticity of demand indicates how sensitive the purchase of one product is to changes in the price of another product. The coefficient of cross elasticity of demand is found by the formula

$$E_{xy} = \frac{\text{percentage change in quantity demanded of X}}{\text{percentage change in price of Y}}$$

   Positive cross elasticity of demand identifies substitute goods; negative cross elasticity identifies complementary goods.
9. Income elasticity of demand indicates the responsiveness of consumer purchases to a change in income. The coefficient of income elasticity of demand is found by the formula

$$E_i = \frac{\text{percentage change in quantity demanded of X}}{\text{percentage change in income}}$$

   The coefficient is positive for normal goods and negative for inferior goods.
10. Consumer surplus is the difference between the maximum price that a consumer is willing to pay for a product and the lower price actually paid; producer surplus is the difference between the minimum price that a producer is willing to accept for a product and the higher price actually received. Collectively, consumer surplus is represented by the triangle under the demand curve and above the actual price, whereas producer surplus is shown by the triangle above the supply curve and below the actual price.
11. Graphically, the combined amount of producer and consumer surplus is represented by the triangle to the left of the intersection of the supply and demand curves that is below the demand curve and above the supply curve. At the equilibrium price and quantity in competitive markets, marginal benefit equals marginal cost, maximum willingness to pay equals minimum acceptable price, and the combined amount of consumer surplus and producer surplus is maximized.
12. Output levels that are either less than or greater than the equilibrium output create efficiency losses, also called deadweight losses. These losses are reductions in the combined amount of consumer surplus and producer surplus. Underproduction creates efficiency losses because output is not being produced for which maximum willingness to pay exceeds minimum acceptable price. Overproduction creates efficiency losses because output is being produced for which minimum acceptable price exceeds maximum willingness to pay.

Terms and Concepts

price elasticity of demand
midpoint formula
elastic demand
inelastic demand
unit elasticity
perfectly inelastic demand
perfectly elastic demand
total revenue (TR)
total-revenue test

price elasticity of supply
market period
short run
long run
cross elasticity of demand
income elasticity of demand
consumer surplus
producer surplus
efficiency losses (or deadweight losses)

Study Questions

connect ECONOMICS

1. Explain why the choice between 1, 2, 3, 4, 5, 6, 7, and 8 "units," or 1000, 2000, 3000, 4000, 5000, 6000, 7000, and 8000 movie tickets, makes no difference in determining elasticity in Table 6.1. **LO1**
2. **KEY QUESTION** Graph the accompanying demand data, and then use the midpoint formula for E_d to determine price elasticity of demand for each of the four possible $1 price changes. What can you conclude about the relationship between the slope of a curve and its elasticity? Explain in a nontechnical way why demand is elastic in the northwest segment of the demand curve and inelastic in the southeast segment. **LO1**

Product Price	Quantity Demanded
$5	1
4	2
3	3
2	4
1	5

3. **KEY QUESTION** Calculate total-revenue data from the demand schedule in question 2. Graph total revenue below your demand curve. Generalize about the relationship between price elasticity and total revenue. **LO2**
4. **KEY QUESTION** How would the following changes in price affect total revenue? That is, would total revenue increase, decline, or remain unchanged? **LO2**
   a. Price falls and demand is inelastic.
   b. Price rises and demand is elastic.
   c. Price rises and supply is elastic.
   d. Price rises and supply is inelastic.
   e. Price rises and demand is inelastic.
   f. Price falls and demand is elastic.
   g. Price falls and demand is of unit elasticity.
5. **KEY QUESTION** What are the major determinants of price elasticity of demand? Use those determinants and your own reasoning in judging whether demand for each of the following products is probably elastic or inelastic: (*a*) bottled water; (*b*) toothpaste; (*c*) Crest toothpaste; (*d*) ketchup; (*e*) diamond bracelets; (*f*) Microsoft Windows operating system. **LO1**
6. What effect would a rule stating that university students must live in university dormitories have on the price elasticity of demand for dormitory space? What impact might this in turn have on room rates? **LO1**
7. In November 1998 Vincent van Gogh's self-portrait sold at auction for $71.5 million. Portray this sale in a demand and supply diagram and comment on the elasticity of supply. Comedian George Carlin once mused, "If a painting can be forged well enough to fool some experts, why is the original so valuable?" Provide an answer. **LO3**
8. **KEY QUESTION** What is the formula for measuring the price elasticity of supply? Suppose the price of apples goes up from $20 to $22 a box. In direct response, Goldsboro Farms supplies 1200 boxes of apples instead of 1000 boxes. Compute the coefficient of price elasticity (midpoints approach) for Goldsboro's supply. Is its supply elastic, or is it inelastic? **LO3**
9. **KEY QUESTION** Suppose the cross elasticity of demand for products A and B is +3.6 and for products C and D is −5.4. What can you conclude about how products A and B are related? Products C and D? **LO4**
10. **KEY QUESTION** The income elasticities of demand for movies, dental services, and clothing have been estimated to be +3.4, +1, and +.5, respectively. Interpret these coefficients. What does it mean if an income elasticity coefficient is negative? **LO4**
11. Research has found that an increase in the price of beer would reduce the amount of marijuana consumed. Is cross elasticity of demand between the two products positive or negative? Are these products substitutes or complements? What might be the logic behind this relationship? **LO4**
12. Refer to Table 6.5. If the six people listed in the table are the only consumers in the market and the equilibrium price is $11 (not the $8 shown), how much consumer surplus will the market generate? **LO5**
13. Refer to Table 6.6. If the six people listed in the table are the only producers in the market and the equilibrium price is $6 (not the $8 shown), how much producer surplus will the market generate? **LO5**
14. Draw a supply and demand graph and identify the areas of consumer surplus and producer surplus. Given the demand curve, what impact will an increase in supply have on the amount of consumer surplus shown in your diagram? Explain why. **LO5**
15. **KEY QUESTION** Use the ideas of consumer surplus and producer surplus to explain why economists say competitive markets are efficient. Why are below- or above-equilibrium levels of output inefficient, according to these two sets of ideas? **LO5**

16. **LAST WORD** What is the purpose of charging different groups of customers different prices? Supplement the three broad examples in the Last Word with two additional examples of your own. Hint: Think of price discounts based on group characteristic or time of purchase.

Web-Based Questions

1. **THE PRICE OF GOLD—TODAY, YESTERDAY, AND THROUGHOUT THE YEAR** Visit **www.goldprices.com** and use the chart to find the very latest price of gold. Compare that price to the price at the beginning of the day. Next, select "1 year" at the bottom of the chart. What was the highest price during the last 12 months? The lowest price? Assume the price fluctuations observed resulted exclusively from changes in demand. Would the observed price changes have been greater or less if the gold supply had been elastic rather than inelastic? Explain.
2. **PRICE, CROSS, AND INCOME ELASTICITIES—HOW DO THEY RELATE TO ALCOHOL AND CIGARETTES?** Go to the National Bureau of Economic Research (NBER) Web site, **www.nber.org,** and select New Working Papers. In the Google search space, type "alcohol." Use the titles and summaries of the papers to answer the following questions relating to elasticity: (*a*) Do the mentally ill have perfectly inelastic demands for cigarettes and alcohol? (*b*) Does alcohol consumption increase in bad times? (*c*) What is the effect of cigarette taxes (and smuggling) on the consumption of alcohol? What does that imply about the cross elasticity of demand between the two? (*d*) Is binge drinking among college students sensitive to the price of alcohol?

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