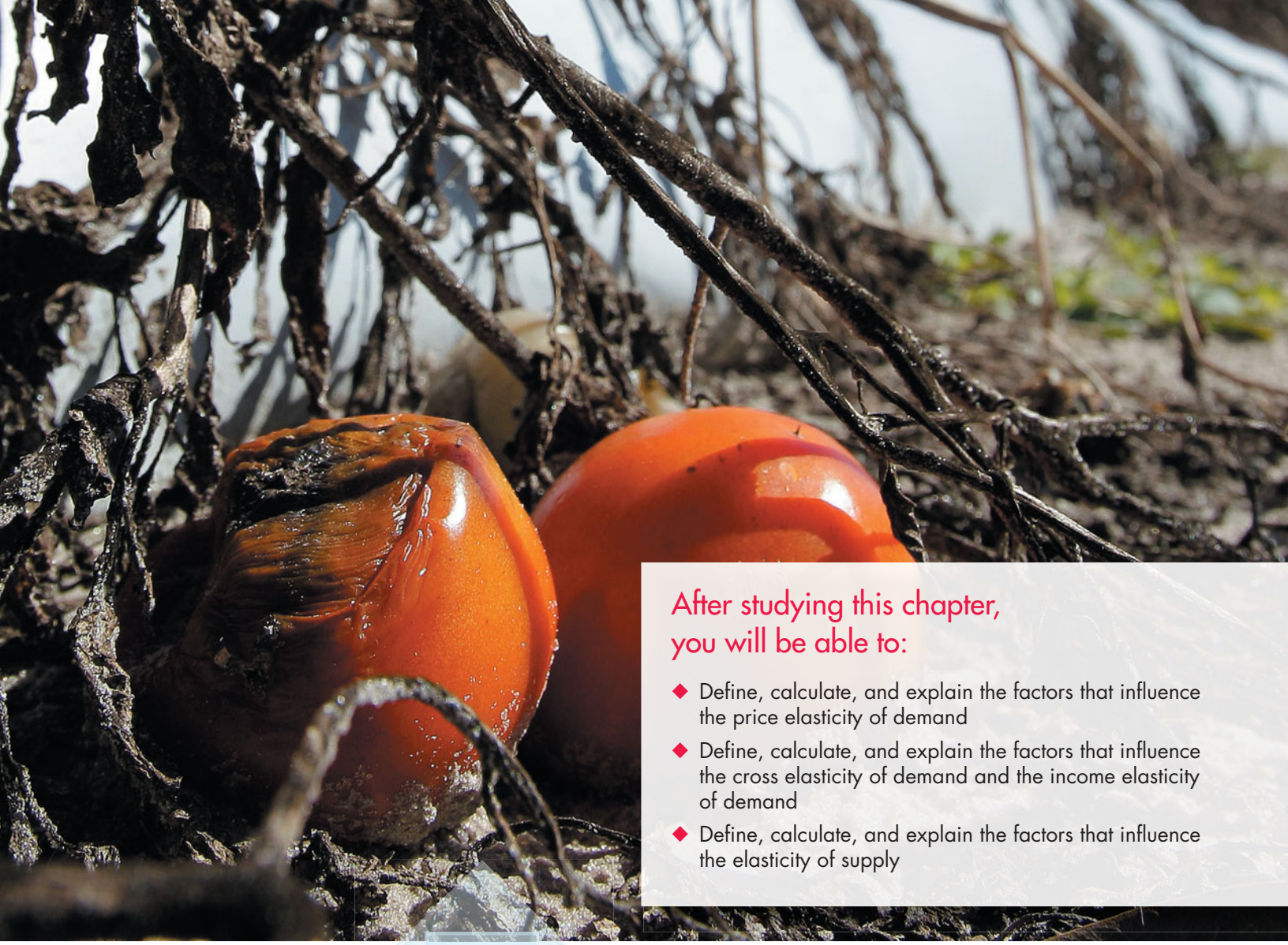


After studying this chapter, you will be able to:

- Define, calculate, and explain the factors that influence the price elasticity of demand
- Define, calculate, and explain the factors that influence the cross elasticity of demand and the income elasticity of demand
- Define, calculate, and explain the factors that influence the elasticity of supply

4 ELASTICITY

What do you do when the price of gasoline soars to $3 a gallon? If you're like most people, you complain a lot but keep on filling your tank and spending more on gas. Would you react the same way to a rise in the price of tomatoes? In the winter of 2010, a prolonged Florida frost wiped out most of the state's tomato crop, driving the price of tomatoes to almost five times its normal level. If faced with this price rise, do you keep buying the same quantity of tomatoes, or do you find less costly substitutes?

How can we compare the effects of price changes on buying plans for different goods such as gasoline and tomatoes?

This chapter introduces you to elasticity: a tool that addresses the quantitative questions like the ones you've just considered and enables us to compare the sensitivity of the quantity demanded to a change in price regardless of the units in which the good is measured.

At the end of the chapter, in Reading Between the Lines, we'll use the concepts of the elasticity of demand and the elasticity of supply to explain what was happening in the market for fresh winter tomatoes from Florida during the severe winter of 2010. But we'll begin by explaining elasticity in another familiar setting: the market for pizza.

Price Elasticity of Demand

You know that when supply increases, the equilibrium price falls and the equilibrium quantity increases. But does the price fall by a large amount and the quantity increase by a little? Or does the price barely fall and the quantity increase by a large amount?

The answer depends on the responsiveness of the quantity demanded to a change in price. You can see why by studying Fig. 4.1, which shows two possible scenarios in a local pizza market. Figure 4.1(a) shows one scenario, and Fig. 4.1(b) shows the other.

In both cases, supply is initially S_0. In part (a), the demand for pizza is shown by the demand curve D_A. In part (b), the demand for pizza is shown by the demand curve D_B. Initially, in both cases, the price is \$20 a pizza and the equilibrium quantity is 10 pizzas an hour.

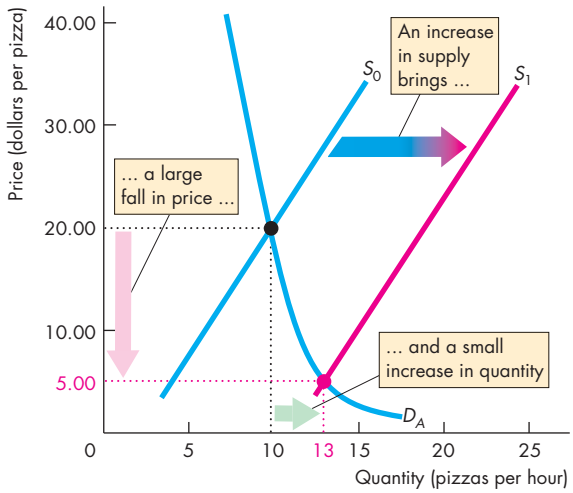
Now a large pizza franchise opens up, and the supply of pizza increases. The supply curve shifts rightward to S_1. In case (a), the price falls by an enormous \$15 to \$5 a pizza, and the quantity increases by only 3 to 13 pizzas an hour. In contrast, in case (b), the price falls by only \$5 to \$15 a pizza and the quantity increases by 7 to 17 pizzas an hour.

The different outcomes arise from differing degrees of responsiveness of the quantity demanded to a change in price. But what do we mean by responsiveness? One possible answer is slope. The slope of demand curve D_A is steeper than the slope of demand curve D_B.

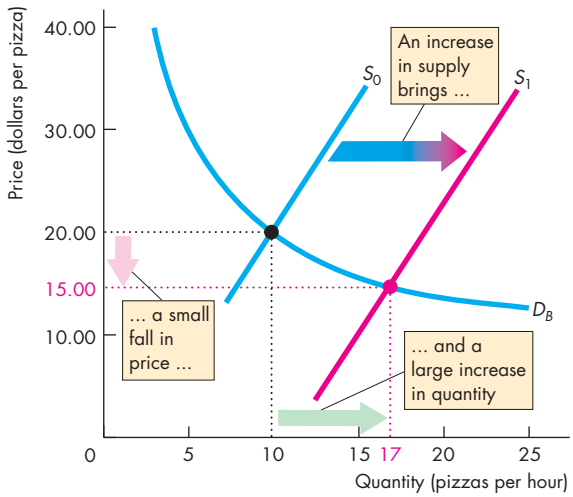
In this example, we can compare the slopes of the two demand curves, but we can't always make such a comparison. The reason is that the slope of a demand curve depends on the units in which we measure the price and quantity. And we often must compare the demand for different goods and services that are measured in unrelated units. For example, a pizza producer might want to compare the demand for pizza with the demand for soft drinks. Which quantity demanded is more responsive to a price change? This question can't be answered by comparing the slopes of two demand curves. The units of measurement of pizza and soft drinks are unrelated. The question can be answered with a measure of responsiveness that is independent of units of measurement. Elasticity is such a measure.

The **price elasticity of demand** is a units-free measure of the responsiveness of the quantity demanded of a good to a change in its price when all other influences on buying plans remain the same.

FIGURE 4.1 How a Change in Supply Changes Price and Quantity



(a) Large price change and small quantity change



(b) Small price change and large quantity change

Initially, the price is \$20 a pizza and the quantity sold is 10 pizzas an hour. Then supply increases from S_0 to S_1. In part (a), the price falls by \$15 to \$5 a pizza, and the quantity increases by 3 to 13 pizzas an hour. In part (b), the price falls by only \$5 to \$15 a pizza, and the quantity increases by 7 to 17 pizzas an hour. The price change is smaller and the quantity change is larger in case (b) than in case (a). The quantity demanded is more responsive to the change in the price in case (b) than in case (a).

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Calculating Price Elasticity of Demand

We calculate the *price elasticity of demand* by using the formula:

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

To calculate the price elasticity of demand for pizza, we need to know the quantity demanded of pizza at two different prices, when all other influences on buying plans remain the same.

Figure 4.2 zooms in on the demand curve for pizza and shows how the quantity demanded responds to a small change in price. Initially, the price is $20.50 a pizza and 9 pizzas an hour are demanded—the original point. The price then falls to $19.50 a pizza, and the quantity demanded increases to 11 pizzas an hour—the new point. When the price falls by $1 a pizza, the quantity demanded increases by 2 pizzas an hour.

To calculate the price elasticity of demand, we express the change in price as a percentage of the *average price* and the change in the quantity demanded as a percentage of the *average quantity*. By using the average price and average quantity, we calculate the elasticity at a point on the demand curve midway between the original point and the new point.

The original price is $20.50 and the new price is $19.50, so the price change is $1 and the average price is $20 a pizza. Call the percentage change in the price $\%\Delta P$, then

$$\%\Delta P = \Delta P/P_{ave} \times 100 = (\$1/\$20) \times 100 = 5\%.$$

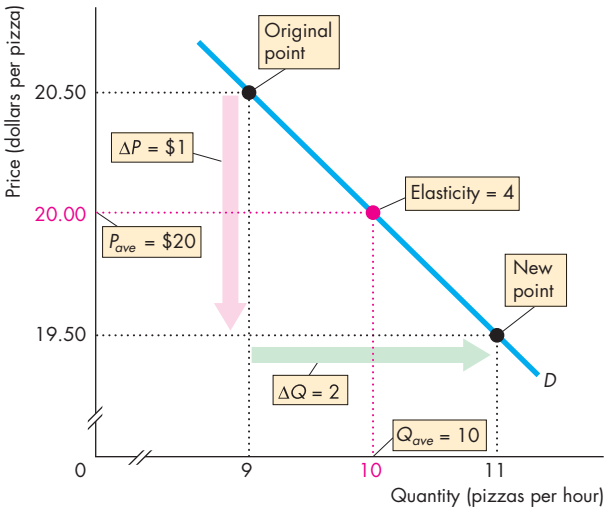
The original quantity demanded is 9 pizzas and the new quantity demanded is 11 pizzas, so the quantity change is 2 pizzas and the average quantity demanded is 10 pizzas. Call the percentage change in the quantity demanded $\%\Delta Q$, then

$$\%\Delta Q = \Delta Q/Q_{ave} \times 100 = (2/10) \times 100 = 20\%.$$

The price elasticity of demand equals the percentage change in the quantity demanded (20 percent) divided by the percentage change in price (5 percent) and is 4. That is,

$$\text{Price elasticity of demand} = \frac{\%\Delta Q}{\%\Delta P} = \frac{20\%}{5\%} = 4.$$

FIGURE 4.2 Calculating the Elasticity of Demand



The elasticity of demand is calculated by using the formula:*

$$\text{Price elasticity of demand} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}} = \frac{\%\Delta Q}{\%\Delta P} = \frac{\Delta Q/Q_{ave}}{\Delta P/P_{ave}} = \frac{2/10}{1/20} = 4.$$

This calculation measures the elasticity at an average price of $20 a pizza and an average quantity of 10 pizzas an hour.

* In the formula, the Greek letter delta (Δ) stands for "change in" and %Δ stands for "percentage change in."

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Average Price and Quantity Notice that we use the *average* price and *average* quantity. We do this because it gives the most precise measurement of elasticity—at the midpoint between the original price and the new price. If the price falls from $20.50 to $19.50, the $1 price change is 4.9 percent of $20.50. The 2 pizza change in quantity is 22.2 percent of 9 pizzas, the original quantity. So if we use these numbers, the price elasticity of demand is 22.2 divided by 4.9, which equals 4.5. If the price

rises from $19.50 to $20.50, the $1 price change is 5.1 percent of $19.50. The 2 pizza change in quantity is 18.2 percent of 11 pizzas, the original quantity. So if we use these numbers, the price elasticity of demand is 18.2 divided by 5.1, which equals 3.6.

By using percentages of the *average* price and *average* quantity, we get the same value for the elasticity regardless of whether the price falls from $20.50 to $19.50 or rises from $19.50 to $20.50.

Percentages and Proportions Elasticity is the ratio of two percentage changes, so when we divide one percentage change by another, the 100s cancel. A percentage change is a *proportionate* change multiplied by 100. The proportionate change in price is $\Delta P/P_{ave}$, and the proportionate change in quantity demanded is $\Delta Q/Q_{ave}$. So if we divide $\Delta Q/Q_{ave}$ by $\Delta P/P_{ave}$ we get the same answer as we get by using percentage changes.

A Units-Free Measure Now that you've calculated a price elasticity of demand, you can see why it is a *units-free measure*. Elasticity is a units-free measure because the percentage change in each variable is independent of the units in which the variable is measured. The ratio of the two percentages is a number without units.

Minus Sign and Elasticity When the price of a good *rises*, the quantity demanded *decreases*. Because a *positive* change in price brings a *negative* change in the quantity demanded, the price elasticity of demand is a negative number. But it is the magnitude, or *absolute value*, of the price elasticity of demand that tells us how responsive the quantity demanded is. So to compare price elasticities of demand, we use the *magnitude* of the elasticity and ignore the minus sign.

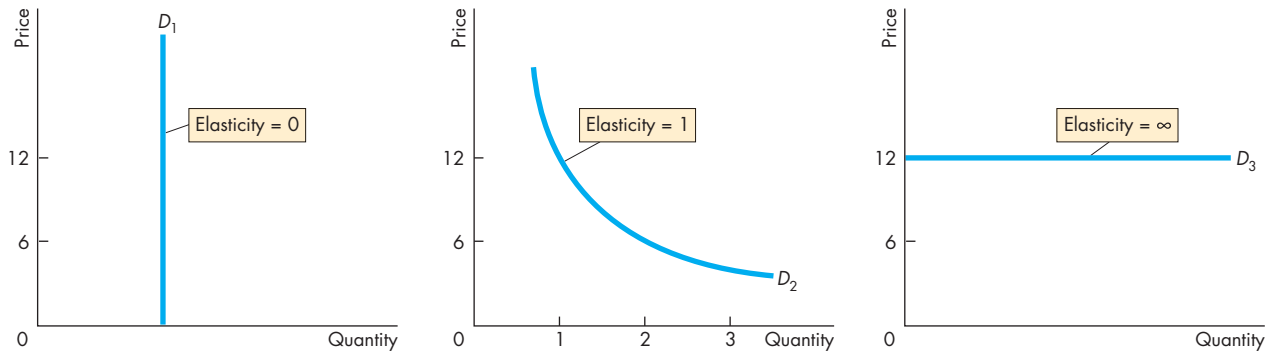
Inelastic and Elastic Demand

Figure 4.3 shows three demand curves that cover the entire range of possible elasticities of demand. In Fig. 4.3(a), the quantity demanded is constant regardless of the price. If the quantity demanded remains constant when the price changes, then the price elasticity of demand is zero and the good is said to have a **perfectly inelastic demand**. One good that has a very low price elasticity of demand (perhaps zero over some price range) is insulin. Insulin is of such importance to some diabetics that if the price rises or falls, they do not change the quantity they buy.

If the percentage change in the quantity demanded equals the percentage change in the price, then the price elasticity equals 1 and the good is said to have a **unit elastic demand**. The demand in Fig. 4.3(b) is an example of a unit elastic demand.

Between the cases shown in Fig. 4.3(a) and Fig. 4.3(b) is the general case in which the percentage change in the quantity demanded is less than the percentage change in the price. In this case, the price elasticity of demand is between zero and 1 and the good is said to have an **inelastic demand**. Food and shelter are examples of goods with inelastic demand.

FIGURE 4.3 Inelastic and Elastic Demand



(a) Perfectly inelastic demand **(b) Unit elastic demand** **(c) Perfectly elastic demand**

Each demand illustrated here has a constant elasticity. The demand curve in part (a) illustrates the demand for a good that has a zero elasticity of demand. The demand curve in part (b) illustrates the demand for a good with a unit elasticity of demand. And the demand curve in part (c) illustrates the demand for a good with an infinite elasticity of demand.

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If the quantity demanded changes by an infinitely large percentage in response to a tiny price change, then the price elasticity of demand is infinity and the good is said to have a **perfectly elastic demand**. Figure 4.3(c) shows a perfectly elastic demand. An example of a good that has a very high elasticity of demand (almost infinite) is a soft drink from two campus machines located side by side. If the two machines offer the same soft drinks for the same price, some people buy from one machine and some from the other. But if one machine's price is higher than the other's, by even a small amount, no one buys from the machine with the higher price. Drinks from the two machines are perfect substitutes. The demand for a good that has a perfect substitute is perfectly elastic.

Between the cases in Fig. 4.3(b) and Fig. 4.3(c) is the general case in which the percentage change in the quantity demanded exceeds the percentage change in price. In this case, the price elasticity of demand is greater than 1 and the good is said to have an **elastic demand**. Automobiles and furniture are examples of goods that have elastic demand.

Elasticity Along a Linear Demand Curve

Elasticity and slope are not the same. A linear demand curve has a constant slope but a varying elasticity. Let's see why.

The demand curve in Fig. 4.4 is linear. A $5 fall in the price brings an increase of 10 pizzas an hour no matter what the initial price and quantity.

Let's now calculate some elasticities along this demand curve.

At the midpoint of the demand curve, the price is $12.50 and the quantity is 25 pizzas per hour. When the price falls from $15 to $10 a pizza the quantity demanded increases from 20 to 30 pizzas an hour and the average price and average quantity are at the midpoint of the demand curve. So

$$\text{Price elasticity of demand} = \frac{10/25}{5/12.25}$$

$$= 1.$$

That is, at the midpoint of a linear demand curve, the price elasticity of demand is one.

At prices *above* the midpoint, demand is elastic. For example, when the price falls from $25 to $15 a pizza, the quantity demanded increases from zero to 20 pizzas an hour. The average price is $20 a pizza, and the average quantity is 10 pizzas. So

$$\text{Price elasticity of demand} = \frac{\Delta Q/Q_{ave}}{\Delta P/P_{ave}}$$

$$= \frac{20/10}{10/20}$$

$$= 4.$$

That is, the price elasticity of demand at an average price of $20 a pizza is 4.

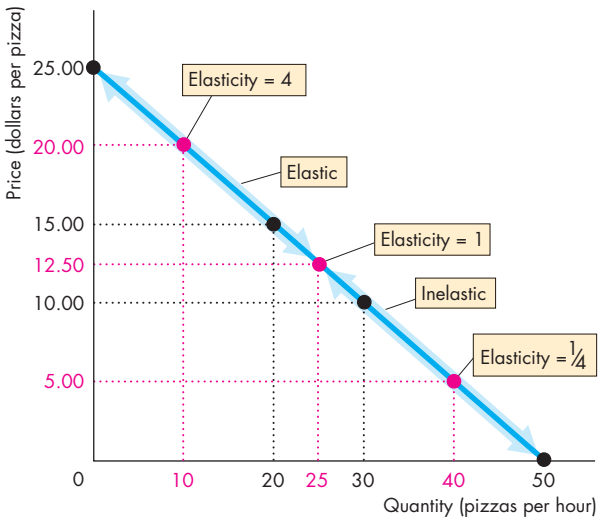
At prices *below* the midpoint, demand is inelastic. For example, when the price falls from $10 a pizza to zero, the quantity demanded increases from 30 to 50 pizzas an hour. The average price is now $5 and the average quantity is 40 pizzas an hour. So

$$\text{Price elasticity of demand} = \frac{20/40}{10/5}$$

$$= 1/4.$$

That is, the price elasticity of demand at an average price of $5 a pizza is 1/4.

FIGURE 4.4 Elasticity Along a Linear Demand Curve



On a linear demand curve, demand is unit elastic at the midpoint (elasticity is 1), elastic above the midpoint, and inelastic below the midpoint.

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Total Revenue and Elasticity

The **total revenue** from the sale of a good equals the price of the good multiplied by the quantity sold. When a price changes, total revenue also changes. But a cut in the price does not always decrease total revenue. The change in total revenue depends on the elasticity of demand in the following way:

- If demand is elastic, a 1 percent price cut increases the quantity sold by more than 1 percent and total revenue increases.
- If demand is inelastic, a 1 percent price cut increases the quantity sold by less than 1 percent and total revenue decreases.
- If demand is unit elastic, a 1 percent price cut increases the quantity sold by 1 percent and total revenue does not change.

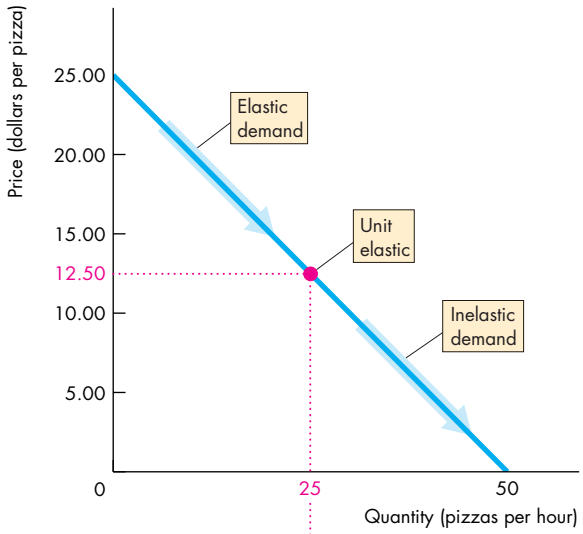
In Fig. 4.5(a), over the price range from $25 to $12.50, demand is elastic. Over the price range from $12.50 to zero, demand is inelastic. At a price of $12.50, demand is unit elastic.

Figure 4.5(b) shows total revenue. At a price of $25, the quantity sold is zero, so total revenue is zero. At a price of zero, the quantity demanded is 50 pizzas an hour and total revenue is again zero. A price cut in the elastic range brings an increase in total revenue—the percentage increase in the quantity demanded is greater than the percentage decrease in price. A price cut in the inelastic range brings a decrease in total revenue—the percentage increase in the quantity demanded is less than the percentage decrease in price. At unit elasticity, total revenue is at a maximum.

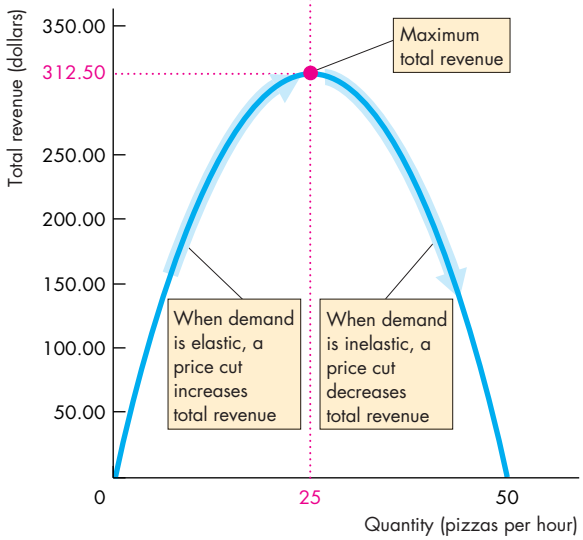
Figure 4.5 shows how we can use this relationship between elasticity and total revenue to estimate elasticity using the total revenue test. The **total revenue test** is a method of estimating the price elasticity of demand by observing the change in total revenue that results from a change in the price, when all other influences on the quantity sold remain the same.

- If a price cut increases total revenue, demand is elastic.
- If a price cut decreases total revenue, demand is inelastic.
- If a price cut leaves total revenue unchanged, demand is unit elastic.

FIGURE 4.5 Elasticity and Total Revenue



(a) Demand



(b) Total revenue

When demand is elastic, in the price range from $25 to $12.50, a decrease in price (part a) brings an increase in total revenue (part b). When demand is inelastic, in the price range from $12.50 to zero, a decrease in price (part a) brings a decrease in total revenue (part b). When demand is unit elastic, at a price of $12.50 (part a), total revenue is at a maximum (part b).

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Your Expenditure and Your Elasticity

When a price changes, the change in your expenditure on the good depends on *your* elasticity of demand.

- If your demand is elastic, a 1 percent price cut increases the quantity you buy by more than 1 percent and your expenditure on the item increases.
- If your demand is inelastic, a 1 percent price cut increases the quantity you buy by less than 1 percent and your expenditure on the item decreases.
- If your demand is unit elastic, a 1 percent price cut increases the quantity you buy by 1 percent and your expenditure on the item does not change.

So if you spend more on an item when its price falls, your demand for that item is elastic; if you spend the same amount, your demand is unit elastic; and if you spend less, your demand is inelastic.

The Factors That Influence the Elasticity of Demand

The elasticity of demand for a good depends on

- The closeness of substitutes
- The proportion of income spent on the good
- The time elapsed since the price change

Closeness of Substitutes The closer the substitutes for a good or service, the more elastic is the demand for it. Oil from which we make gasoline has no close substitutes (imagine a steam-driven, coal-fueled car). So the demand for oil is inelastic. Plastics are close substitutes for metals, so the demand for metals is elastic.

The degree of substitutability depends on how narrowly (or broadly) we define a good. For example, a personal computer has no close substitutes, but a Dell PC is a close substitute for a Hewlett-Packard PC. So the elasticity of demand for personal computers is lower than the elasticity of demand for a Dell or a Hewlett-Packard.

In everyday language we call goods such as food and shelter *necessities* and goods such as exotic vacations *luxuries*. A necessity has poor substitutes and is crucial for our well-being. So a necessity generally has an inelastic demand. A luxury usually has many substitutes, one of which is not buying it. So a luxury generally has an elastic demand.

Proportion of Income Spent on the Good Other things remaining the same, the greater the proportion of income spent on a good, the more elastic (or less inelastic) is the demand for it.

Economics in Action

Elastic and Inelastic Demand

The real-world price elasticities of demand in the table range from 1.52 for metals, the item with the most elastic demand in the table, to 0.05 for oil, the item with the most inelastic demand in the table. The demand for food is also inelastic.

Oil and food, which have poor substitutes and inelastic demand, might be classified as necessities. Furniture and motor vehicles, which have good substitutes and elastic demand, might be classified as luxuries.

Price Elasticities of Demand

Good or Service	Elasticity
Elastic Demand	
Metals	1.52
Electrical engineering products	1.39
Mechanical engineering products	1.30
Furniture	1.26
Motor vehicles	1.14
Instrument engineering products	1.10
Professional services	1.09
Transportation services	1.03
Inelastic Demand	
Gas, electricity, and water	0.92
Chemicals	0.89
Drinks	0.78
Clothing	0.64
Tobacco	0.61
Banking and insurance services	0.56
Housing services	0.55
Agricultural and fish products	0.42
Books, magazines, and newspapers	0.34
Food	0.12
Oil	0.05

Sources of data: Ahsan Mansur and John Whalley, "Numerical Specification of Applied General Equilibrium Models: Estimation, Calibration, and Data," in *Applied General Equilibrium Analysis*, eds. Herbert E. Scarf and John B. Shoven (New York: Cambridge University Press, 1984), 109, and Henri Theil, Ching-Fan Chung, and James L. Seale, Jr., *Advances in Econometrics, Supplement I, 1989, International Evidence on Consumption Patterns* (Greenwich, Conn.: JAI Press Inc., 1989), and Geoffrey Heal, Columbia University, Web site.

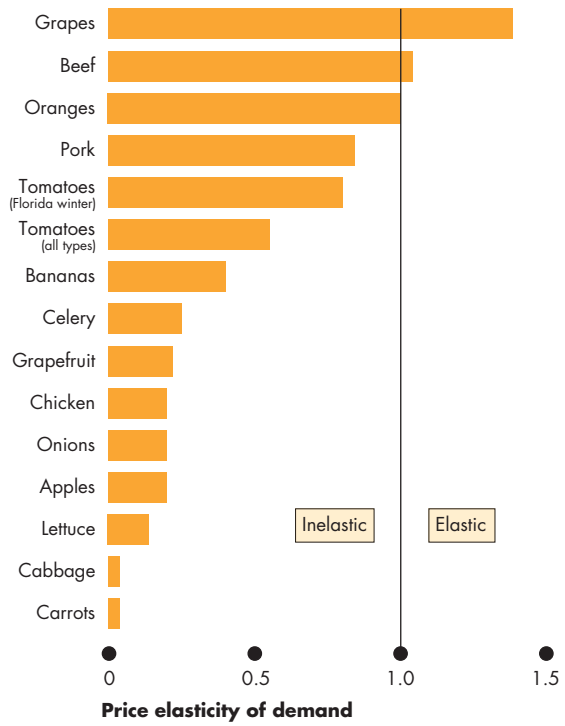
Economics in Action

Price Elasticities of Demand for Food

The price elasticity of demand for food in the United States is estimated to be 0.12. This elasticity is an average over all types of food. The demand for most food items is inelastic, but there is a wide range of elasticities as the figure below shows for a range of fruits, vegetables, and meats.

The demand for grapes and beef is elastic. The demand for oranges is unit elastic. These food items have many good substitutes. Florida winter tomatoes have closer substitutes than tomatoes in general, so the demand for the Florida winter variety is more elastic (less inelastic) than the demand for tomatoes.

Carrots and cabbage, on which we spend a very small proportion of income, have an almost zero elastic demand.



Price Elasticities of Demand for Food

Sources of data: Kuo S. Huang, *U.S. demand for food: A complete system of price and income effects* U.S. Dept. of Agriculture, Economic Research Service, Washington, DC, 1985 and J. Scott Shonkwiler and Robert D. Emerson, "Imports and the Supply of Winter Tomatoes: An Application of Rational Expectations", *American Journal of Agricultural Economics*, Vol. 64, No. 4 (Nov., 1982), pp. 634-641 and Kuo S. Huang, "A Further Look at Flexibilities and Elasticities", *American Journal of Agricultural Economics*, Vol. 76, No. 2 (May, 1994), pp. 313–317.

Think about your own elasticity of demand for chewing gum and housing. If the price of gum doubles, you consume almost as much as before. Your demand for gum is inelastic. If apartment rents double, you look for more students to share accommodation with you. Your demand for housing is not as inelastic as your demand for gum. Why the difference? Housing takes a large proportion of your budget, and gum takes only a tiny proportion. You don't like either price increase, but you hardly notice the higher price of gum, while the higher rent puts your budget under severe strain.

Time Elapsed Since Price Change The longer the time that has elapsed since a price change, the more elastic is demand. When the price of oil increased by 400 percent during the 1970s, people barely changed the quantity of oil and gasoline they bought. But gradually, as more efficient auto and airplane engines were developed, the quantity bought decreased. The demand for oil became more elastic as more time elapsed following the huge price hike.

REVIEW QUIZ

1. Why do we need a units-free measure of the responsiveness of the quantity demanded of a good or service to a change in its price?
2. Define the price elasticity of demand and show how it is calculated.
3. What is the total revenue test? Explain how it works.
4. What are the main influences on the elasticity of demand that make the demand for some goods elastic and the demand for other goods inelastic?
5. Why is the demand for a luxury generally more elastic (or less inelastic) than the demand for a necessity?

You can work these questions in Study Plan 4.1 and get instant feedback. myeconlab

You've now completed your study of the *price* elasticity of demand. Two other elasticity concepts tell us about the effects of other influences on demand. Let's look at these other elasticities of demand.

More Elasticities of Demand

Back at the pizzeria, you are trying to work out how a price rise by the burger shop next door will affect the demand for your pizza. You know that pizzas and burgers are substitutes. You also know that when the price of a substitute for pizza rises, the demand for pizza increases. But by how much?

You also know that pizza and soft drinks are complements. And you know that if the price of a complement of pizza rises, the demand for pizza decreases. So you wonder, by how much will a rise in the price of a soft drink decrease the demand for your pizza?

To answer these questions, you need to calculate the cross elasticity of demand. Let's examine this elasticity measure.

Cross Elasticity of Demand

We measure the influence of a change in the price of a substitute or complement by using the concept of the cross elasticity of demand. The **cross elasticity of demand** is a measure of the responsiveness of the demand for a good to a change in the price of a substitute or complement, other things remaining the same. We calculate the *cross elasticity of demand* by using the formula:

$$\text{Cross elasticity of demand} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price of a substitute or complement}}.$$

The cross elasticity of demand can be positive or negative. It is *positive* for a *substitute* and *negative* for a *complement*.

Substitutes Suppose that the price of pizza is constant and people buy 9 pizzas an hour. Then the price of a burger rises from $1.50 to $2.50. No other influence on buying plans changes and the quantity of pizzas bought increases to 11 an hour.

The change in the quantity demanded is +2 pizzas—the new quantity, 11 pizzas, minus the original quantity, 9 pizzas. The average quantity is 10 pizzas. So the quantity of pizzas demanded increases by 20 percent. That is,

$$\Delta Q/Q_{ave} \times 100 = (+2/10) \times 100 = +20\%.$$

The change in the price of a burger, a substitute for pizza, is +$1—the new price, $2.50, minus the original price, $1.50. The average price is $2 a burger. So the price of a burger rises by 50 percent. That is,

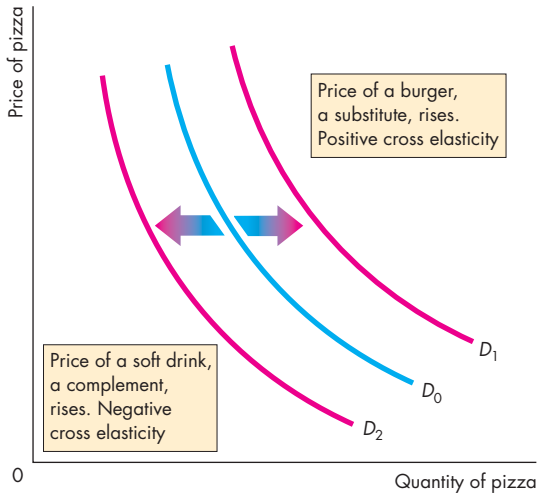
$$\Delta P/P_{ave} \times 100 = (+\$1/\$2) \times 100 = +50\%.$$

So the cross elasticity of demand for pizza with respect to the price of a burger is

$$\frac{+20\%}{+50\%} = 0.4.$$

Figure 4.6 illustrates the cross elasticity of demand. Pizza and burgers are substitutes. Because they are substitutes, when the price of a burger rises, the demand for pizza increases. The demand curve for pizza shifts rightward from D_0 to D_1. Because a *rise* in the price of a burger brings an *increase* in the demand for pizza, the cross elasticity of demand for pizza with respect to the price of a burger is *positive*. Both the price and the quantity change in the same direction.

FIGURE 4.6 Cross Elasticity of Demand



A burger is a *substitute* for pizza. When the price of a burger rises, the demand for pizza increases and the demand curve for pizza shifts rightward from D_0 to D_1. The cross elasticity of demand is *positive*.

A soft drink is a *complement* of pizza. When the price of a soft drink rises, the demand for pizza decreases and the demand curve for pizza shifts leftward from D_0 to D_2. The cross elasticity of demand is *negative*.

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Complements Now suppose that the price of pizza is constant and 11 pizzas an hour are bought. Then the price of a soft drink rises from $1.50 to $2.50. No other influence on buying plans changes and the quantity of pizzas bought falls to 9 an hour.

The change in the quantity demanded is the opposite of what we've just calculated: The quantity of pizzas demanded decreases by 20 percent (–20%).

The change in the price of a soft drink, a complement of pizza, is the same as the percentage change in the price of a burger that we've just calculated. The price rises by 50 percent (+50%). So the cross elasticity of demand for pizza with respect to the price of a soft drink is

$$\frac{-20\%}{+50\%} = -0.4.$$

Because pizza and soft drinks are complements, when the price of a soft drink rises, the demand for pizza decreases. The demand curve for pizza shifts leftward from D_0 to D_2. Because a *rise* in the price of a soft drink brings a *decrease* in the demand for pizza, the cross elasticity of demand for pizza with respect to the price of a soft drink is *negative*. The price and quantity change in *opposite* directions.

The magnitude of the cross elasticity of demand determines how far the demand curve shifts. The larger the cross elasticity (absolute value), the greater is the change in demand and the larger is the shift in the demand curve.

If two items are close substitutes, such as two brands of spring water, the cross elasticity is large. If two items are close complements, such as movies and popcorn, the cross elasticity is large.

If two items are somewhat unrelated to each other, such as newspapers and orange juice, the cross elasticity is small—perhaps even zero.

Income Elasticity of Demand

Suppose the economy is expanding and people are enjoying rising incomes. This prosperity brings an increase in the demand for most types of goods and services. But by how much will the demand for pizza increase? The answer depends on the **income elasticity of demand**, which is a measure of the responsiveness of the demand for a good or service to a change in income, other things remaining the same.

The income elasticity of demand is calculated by using the formula:

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

Income elasticities of demand can be positive or negative and they fall into three interesting ranges:

- Greater than 1 (*normal* good, income elastic)
- Positive and less than 1 (*normal* good, income inelastic)
- Negative (*inferior* good)

Income Elastic Demand Suppose that the price of pizza is constant and 9 pizzas an hour are bought. Then incomes rise from $975 to $1,025 a week. No other influence on buying plans changes and the quantity of pizzas sold increases to 11 an hour.

The change in the quantity demanded is +2 pizzas. The average quantity is 10 pizzas, so the quantity demanded increases by 20 percent. The change in income is +$50 and the average income is $1,000, so incomes increase by 5 percent. The income elasticity of demand for pizza is

$$\frac{20\%}{5\%} = 4.$$

The demand for pizza is income elastic. The percentage increase in the quantity of pizza demanded exceeds the percentage increase in income. *When the demand for a good is income elastic, the percentage of income spent on that good increases as income increases.*

Income Inelastic Demand If the income elasticity of demand is positive but less than 1, demand is income inelastic. The percentage increase in the quantity demanded is positive but less than the percentage increase in income. *When the demand for a good is income inelastic, the percentage of income spent on that good decreases as income increases.*

Inferior Goods If the income elasticity of demand is negative, the good is an *inferior* good. The quantity demanded of an inferior good and the amount spent on it *decrease* when income increases. Goods in this category include small motorcycles, potatoes, and rice. Low-income consumers buy most of these goods.

Economics in Action

Necessities and Luxuries

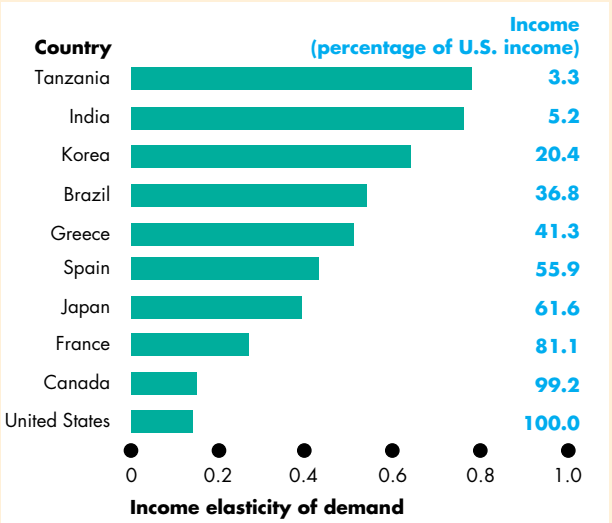
The table shows estimates of some real-world income elasticities of demand. The demand for a necessity such as food or clothing is income inelastic, while the demand for a luxury such as transportation, which includes airline and foreign travel, is income elastic.

But what is a necessity and what is a luxury depends on the level of income. For people with a low income, food and clothing can be luxuries. So the level of income has a big effect on income elasticities of demand. The figure shows this effect on the income elasticity of demand for food in 10 countries. In countries with low incomes, such as Tanzania and India, the income elasticity of demand for food is high. In countries with high incomes, such as the United States, the income elasticity of demand for food is low. That is, as income increases, the income elasticity of demand for food decreases. Low-income consumers spend a larger percentage of any increase in income on food than do high-income consumers.

Some Real-World Income Elasticities of Demand

Income Elastic Demand	
Airline travel	5.82
Movies	3.41
Foreign travel	3.08
Electricity	1.94
Restaurant meals	1.61
Local buses and trains	1.38
Haircuts	1.36
Automobiles	1.07
Income Inelastic Demand	
Tobacco	0.86
Alcoholic drinks	0.62
Furniture	0.53
Clothing	0.51
Newspapers and magazines	0.38
Telephone	0.32
Food	0.14

Sources of data: H.S. Houthakker and Lester D. Taylor, *Consumer Demand in the United States* (Cambridge, Mass.: Harvard University Press, 1970), and Henri Theil, Ching-Fan Chung, and James L. Seale, Jr., *Advances in Econometrics, Supplement 1, 1989, International Evidence on Consumption Patterns* (Greenwich, Conn.: JAI Press, Inc., 1989).



Income Elasticities in 10 Countries

REVIEW QUIZ

1. What does the cross elasticity of demand measure?
2. What does the sign (positive versus negative) of the cross elasticity of demand tell us about the relationship between two goods?
3. What does the income elasticity of demand measure?
4. What does the sign (positive versus negative) of the income elasticity of demand tell us about a good?
5. Why does the level of income influence the magnitude of the income elasticity of demand?

You can work these questions in Study Plan 4.2 and get instant feedback. myeconlab

You've now completed your study of the *cross elasticity* of demand and the *income elasticity* of demand. Let's look at the other side of the market and examine the elasticity of supply.

Elasticity of Supply

You know that when demand increases, the equilibrium price rises and the equilibrium quantity increases. But does the price rise by a large amount and the quantity increase by a little? Or does the price barely rise and the quantity increase by a large amount?

The answer depends on the responsiveness of the quantity supplied to a change in price. You can see why by studying Fig. 4.7, which shows two possible scenarios in a local pizza market. Figure 4.7(a) shows one scenario, and Fig. 4.7(b) shows the other.

In both cases, demand is initially D_0. In part (a), supply is shown by the supply curve S_A. In part (b), supply is shown by the supply curve S_B. Initially, in both cases, the price is $20 a pizza and the equilibrium quantity is 10 pizzas an hour.

Now increases in incomes and population increase the demand for pizza. The demand curve shifts rightward to D_1. In case (a), the price rises by $10 to $30 a pizza, and the quantity increases by only 3 to 13 pizzas an hour. In contrast, in case (b), the price rises by only $1 to $21 a pizza, and the quantity increases by 10 to 20 pizzas an hour.

The different outcomes arise from differing degrees of responsiveness of the quantity supplied to a change in price. We measure the degree of responsiveness by using the concept of the elasticity of supply.

Calculating the Elasticity of Supply

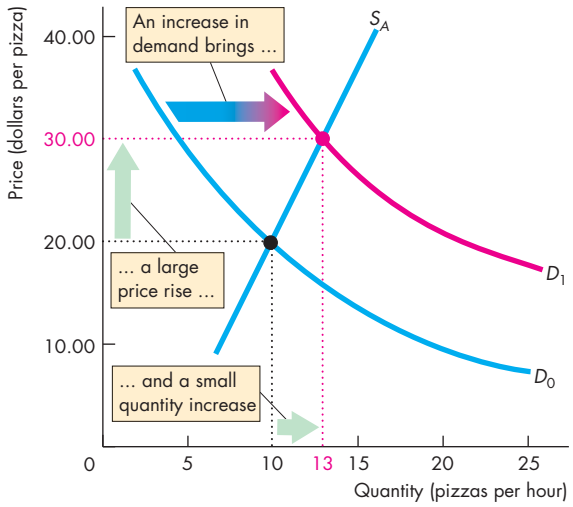
The **elasticity of supply** measures the responsiveness of the quantity supplied to a change in the price of a good when all other influences on selling plans remain the same. It is calculated by using the formula:

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

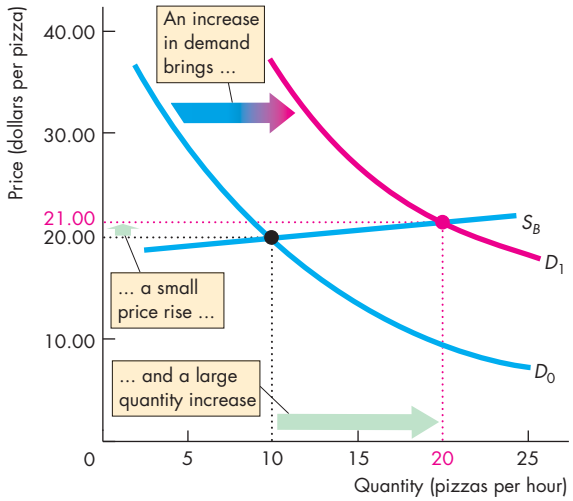
We use the same method that you learned when you studied the elasticity of demand. (Refer back to p. 85 to check this method.) Let's calculate the elasticity of supply along the supply curves in Fig. 4.7.

In Fig. 4.7(a), when the price rises from $20 to $30, the price rise is $10 and the average price is $25, so the price rises by 40 percent of the average price. The quantity increases from 10 to 13 pizzas an hour,

FIGURE 4.7 How a Change in Demand Changes Price and Quantity



(a) Large price change and small quantity change



(b) Small price change and large quantity change

Initially, the price is $20 a pizza, and the quantity sold is 10 pizzas an hour. Then the demand for pizza increases. The demand curve shifts rightward to D_1. In part (a), the price rises by $10 to $30 a pizza, and the quantity increases by 3 to 13 pizzas an hour. In part (b), the price rises by only $1 to $21 a pizza, and the quantity increases by 10 to 20 pizzas an hour. The price change is smaller and the quantity change is larger in case (b) than in case (a). The quantity supplied is more responsive to a change in the price in case (b) than in case (a).

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so the increase is 3 pizzas, the average quantity is 11.5 pizzas an hour, and the quantity increases by 26 percent. The elasticity of supply is equal to 26 percent divided by 40 percent, which equals 0.65.

In Fig. 4.7(b), when the price rises from $20 to $21, the price rise is $1 and the average price is $20.50, so the price rises by 4.9 percent of the average price. The quantity increases from 10 to 20 pizzas an hour, so the increase is 10 pizzas, the average quantity is 15 pizzas, and the quantity increases by 67 percent. The elasticity of supply is equal to 67 percent divided by 4.9 percent, which equals 13.67.

Figure 4.8 shows the range of elasticities of supply. If the quantity supplied is fixed regardless of the price, the supply curve is vertical and the elasticity of supply is zero. Supply is perfectly inelastic. This case is shown in Fig. 4.8(a). A special intermediate case occurs when the percentage change in price equals the percentage change in quantity. Supply is then unit elastic. This case is shown in Fig. 4.8(b). No matter how steep the supply curve is, if it is linear and passes through the origin, supply is unit elastic. If there is a price at which sellers are willing to offer any quantity for sale, the supply curve is horizontal and the elasticity of supply is infinite. Supply is perfectly elastic. This case is shown in Fig. 4.8(c).

The Factors That Influence the Elasticity of Supply

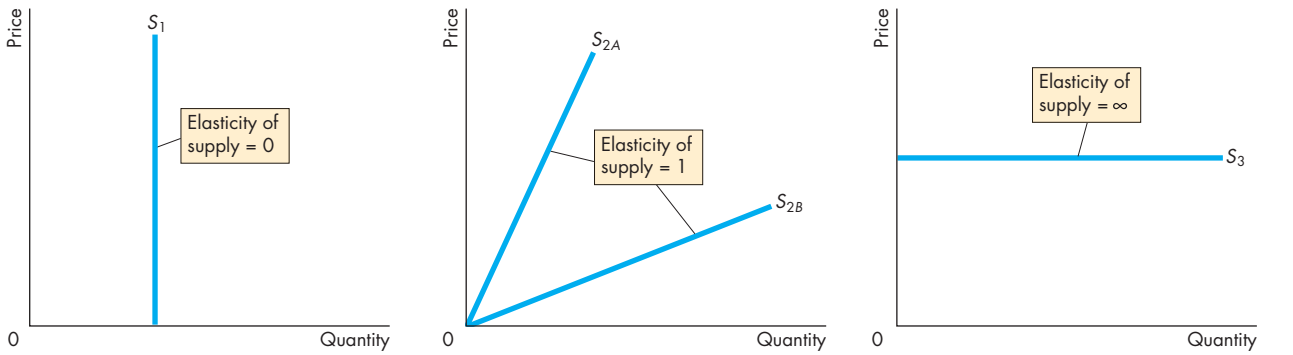
The elasticity of supply of a good depends on

- Resource substitution possibilities
- Time frame for the supply decision

Resource Substitution Possibilities Some goods and services can be produced only by using unique or rare productive resources. These items have a low, perhaps even a zero, elasticity of supply. Other goods and services can be produced by using commonly available resources that could be allocated to a wide variety of alternative tasks. Such items have a high elasticity of supply.

A Van Gogh painting is an example of a good with a vertical supply curve and a zero elasticity of supply. At the other extreme, wheat can be grown on land that is almost equally good for growing corn, so it is just as easy to grow wheat as corn. The opportunity cost of wheat in terms of forgone corn is almost constant. As a result, the supply curve of wheat is almost horizontal and its elasticity of supply is very large. Similarly, when a good is produced in many different countries (for example, sugar and beef), the supply of the good is highly elastic.

FIGURE 4.8 Inelastic and Elastic Supply



(a) Perfectly inelastic supply **(b) Unit elastic supply** **(c) Perfectly elastic supply**

Each supply illustrated here has a constant elasticity. The supply curve in part (a) illustrates the supply of a good that has a zero elasticity of supply. The supply curve in part (b) illustrates the supply of a good with a unit elasticity of supply. All linear supply curves that pass through the origin illustrate supplies that are unit elastic. The supply curve in part (c) illustrates the supply of a good with an infinite elasticity of supply.

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The supply of most goods and services lies between these two extremes. The quantity produced can be increased but only by incurring a higher cost. If a higher price is offered, the quantity supplied increases. Such goods and services have an elasticity of supply between zero and infinity.

Time Frame for the Supply Decision To study the influence of the amount of time elapsed since a price change, we distinguish three time frames of supply:

- Momentary supply
- Short-run supply
- Long-run supply

Momentary Supply When the price of a good changes, the immediate response of the quantity supplied is determined by the *momentary supply* of that good.

Some goods, such as fruits and vegetables, have a perfectly inelastic momentary supply—a vertical supply curve. The quantities supplied depend on crop-planting decisions made earlier. In the case of oranges, for example, planting decisions have to be made many years in advance of the crop being available. Momentary supply is perfectly inelastic because, on a given day, no matter what the price of oranges, producers cannot change their output. They have picked, packed, and shipped their crop to market, and the quantity available for that day is fixed.

In contrast, some goods have a perfectly elastic momentary supply. Long-distance phone calls are an example. When many people simultaneously make a call, there is a big surge in the demand for telephone cables, computer switching, and satellite time. The quantity supplied increases, but the price remains constant. Long-distance carriers monitor fluctuations in demand and reroute calls to ensure that the quantity supplied equals the quantity demanded without changing the price.

Short-Run Supply The response of the quantity supplied to a price change when only *some* of the possible adjustments to production can be made is determined by *short-run supply*. Most goods have an inelastic short-run supply. To increase output in the short run, firms must work their labor force overtime and perhaps hire additional workers. To decrease their output in the short run, firms either lay off workers or reduce their hours of work. With the passage of time, firms can make more adjustments, perhaps training additional workers or buying additional tools and other equipment.

For the orange grower, if the price of oranges falls, some pickers can be laid off and oranges left on the trees to rot. Or if the price of oranges rises, the grower can use more fertilizer and improved irrigation to increase the yields of their existing trees.

But an orange grower can't change the number of trees producing oranges in the short run.

Long-Run Supply The response of the quantity supplied to a price change after *all* the technologically possible ways of adjusting supply have been exploited is determined by *long-run supply*. For most goods and services, long-run supply is elastic and perhaps perfectly elastic.

For the orange grower, the long run is the time it takes new tree plantings to grow to full maturity—about 15 years. In some cases, the long-run adjustment occurs only after a completely new production plant has been built and workers have been trained to operate it—typically a process that might take several years.

REVIEW QUIZ

1. Why do we need a units-free measure of the responsiveness of the quantity supplied of a good or service to a change in its price?
2. Define the elasticity of supply and show how it is calculated.
3. What are the main influences on the elasticity of supply that make the supply of some goods elastic and the supply of other goods inelastic?
4. Provide examples of goods or services whose elasticities of supply are (a) zero, (b) greater than zero but less than infinity, and (c) infinity.
5. How does the time frame over which a supply decision is made influence the elasticity of supply? Explain your answer.

You can work these questions in Study Plan 4.3 and get instant feedback.

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You have now learned about the elasticities of demand and supply. Table 4.1 summarizes all the elasticities that you've met in this chapter. In the next chapter, we study the efficiency of competitive markets. But first study *Reading Between the Lines* on pp. 98–99, which puts the elasticity of demand to work and looks at the market for winter tomatoes.

TABLE 4.1 A Compact Glossary of Elasticities

Price Elasticities of Demand

A relationship is described as	When its magnitude is	Which means that
Perfectly elastic	Infinity	The smallest possible increase in price causes an infinitely large decrease in the quantity demanded*
Elastic	Less than infinity	The percentage decrease in the quantity demanded exceeds the percentage increase in price
Unit elastic	1	The percentage decrease in the quantity demanded equals the percentage increase in price
Inelastic	Less than 1 but greater than zero	The percentage decrease in the quantity demanded is less than the percentage increase in price
Perfectly inelastic	Zero	The quantity demanded is the same at all prices

Cross Elasticities of Demand

A relationship is described as	When its value is	Which means that
Close substitutes	Large	The smallest possible increase in the price of one good causes an infinitely large increase in the quantity demanded of the other good
Substitutes	Positive	If the price of one good increases, the quantity demanded of the other good also increases
Unrelated goods	Zero	If the price of one good increases, the quantity demanded of the other good remains the same
Complements	Negative	If the price of one good increases, the quantity demanded of the other good decreases

Income Elasticities of Demand

A relationship is described as	When its value is	Which means that
Income elastic (normal good)	Greater than 1	The percentage increase in the quantity demanded is greater than the percentage increase in income
Income inelastic (normal good)	Less than 1 but greater than zero	The percentage increase in the quantity demanded is greater than zero but less than the percentage increase in income
Negative (inferior good)	Less than zero	When income increases, quantity demanded decreases

Elasticities of Supply

A relationship is described as	When its magnitude is	Which means that
Perfectly elastic	Infinity	The smallest possible increase in price causes an infinitely large increase in the quantity supplied
Elastic	Less than infinity but greater than 1	The percentage increase in the quantity supplied exceeds the percentage increase in the price
Unit elastic	1	The percentage increase in the quantity supplied equals the percentage increase in the price
Inelastic	Greater than zero but less than 1	The percentage increase in the quantity supplied is less than the percentage increase in the price
Perfectly inelastic	Zero	The quantity supplied is the same at all prices

*In each description, the directions of change may be reversed. For example, in this case, the smallest possible *decrease* in price causes an infinitely large *increase* in the quantity demanded.

The Elasticities of Demand and Supply for Tomatoes

Frigid Florida Winter Is Bad News for Tomato Lovers

USA Today
March 5, 2010

ST. PETERSBURG, Fla. - A frigid Florida winter is taking its toll on your sandwich. The Sunshine State is the main U.S. source for fresh winter tomatoes, and its growers lost some 70 percent of their crop during January's prolonged cold snap. …

The average wholesale price for a 25-pound box of tomatoes is now $30, up from $6.50 a year ago. Florida's growers would normally ship about 25 million pounds of tomatoes a week; right now, they're shipping less than a quarter of that, according to Reggie Brown of the Florida Tomato Grower's Exchange, a tomato farmer cooperative in Maitland. …

And because high demand has driven up domestic prices, many wholesalers are buying from Mexico instead.

"We're obviously losing market share to Mexico, and there's always a price to pay to get the customer to get back into the Florida market," Brown said.

Florida is the only place where tomatoes are grown on a large scale in the United States during winter. California doesn't grow them until later in the year, and much of that state's crop is used for processed foods, such as ketchup, sauce, and juice. Other states grow tomatoes in greenhouses year-round, but Florida's winter tomato crop is by far the largest. …

Some Wendy's restaurants posted signs saying tomatoes would only be provided upon request because of limited availability. …

ESSENCE OF THE STORY

- Florida is the main U.S. source for fresh winter tomatoes.
- California tomatoes come to market later in the year and are mainly used for ketchup, sauce, and juice.
- Other states grow tomatoes in greenhouses year-round.
- In January 2010, a prolonged cold snap wiped out 70 percent of the Florida crop.
- The average wholesale price for a 25-pound box of tomatoes rose from $6.50 in January 2009 to $30 in January 2010.
- The quantity of tomatoes shipped decreased from a normal 25 million pounds per week to less than a quarter of that quantity.
- "High demand has driven up prices" and wholesalers are buying from Mexico.
- Some restaurants provided tomatoes only on request.

ECONOMIC ANALYSIS

- Using the information provided in this news article supplemented with an independent estimate of the price elasticity of demand, we can find the demand and supply curves in the market for winter tomatoes shown in Fig. 1.
- According to J. Scott Shonkwiler and Robert D. Emerson, two agricultural economists at the University of Florida, the price elasticity of demand for winter tomatoes is 0.8.
- A 1 percent rise in the price of these tomatoes brings a 0.8 percent decrease in the quantity demanded, other things remaining the same.
- According to the news article, in a normal period, the price of Florida winter tomatoes is $6.50 a box (25 pounds) and growers normally ship 25 million pounds a week.
- With the information just stated, we can determine the demand for winter tomatoes. It is the curve *D* in Figs. 1 and 2. This demand curve passes through the point that shows that 25 million pounds are demanded at a price of $6.50 a box. The elasticity of demand for winter tomatoes is 0.8.
- Figure 2 shows the calculation that confirms the price elasticity of demand is 0.8. When the price rises from $6.50 to $30 a box, as it did in January 2010, the quantity demanded decreases from 25 million to 8 million pounds. Use the numbers and the midpoint formula to confirm that the elasticity of demand is 0.8.
- Figures 1 and 3 show the supply of winter tomatoes. The news article says that Florida growers (the main producers of winter tomatoes) shipped less than a quarter of their normal 25 million pounds a week. So assume that they shipped 6 million pounds a week.
- Other growers (using greenhouses or in Mexico) make up the difference between what the Florida growers supply and the quantity demanded.
- The supply curve in normal times, S_0, must pass through the equilibrium point 25 million pounds and $6.50 a box.
- The supply curve in January 2010, S_1, must pass through the equilibrium point at that time of 8 million pounds and $30 a box. It also passes through the point 6 million pounds and $6.50 a box because that is the quantity that Florida growers would ship even if the price remained at $6.50 a box.
- We can calculate the elasticity of supply by using the numbers in Fig. 3 and the midpoint formula. The elasticity of supply is 0.22, which means that supply is inelastic.

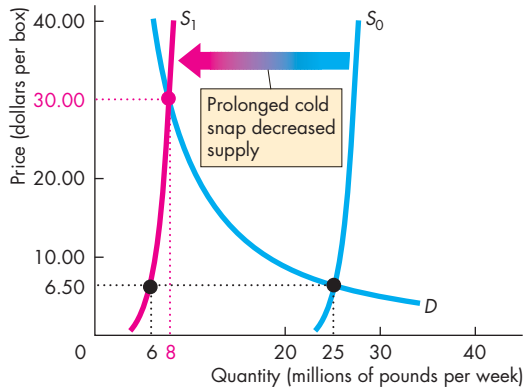


Figure 1 The market for winter tomatoes

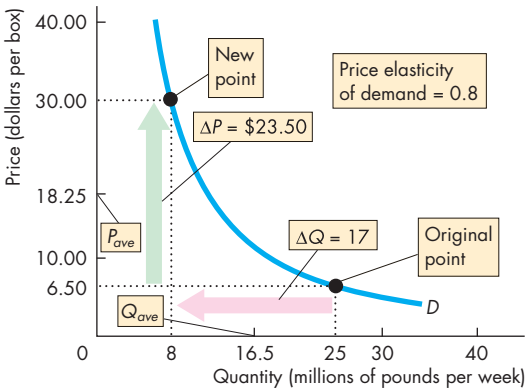


Figure 2 Price elasticity of demand for winter tomatoes

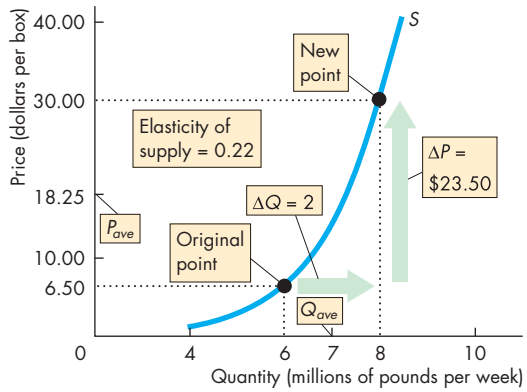


Figure 3 Price elasticity of supply of winter tomatoes

SUMMARY

Key Points

Price Elasticity of Demand (pp. 84–90)

- Elasticity is a measure of the responsiveness of the quantity demanded of a good to a change in its price, other things remaining the same.
- Price elasticity of demand equals the percentage change in the quantity demanded divided by the percentage change in the price.
- The larger the magnitude of the price elasticity of demand, the greater is the responsiveness of the quantity demanded to a given price change.
- If demand is elastic, a cut in price leads to an increase in total revenue. If demand is unit elastic, a cut in price leaves total revenue unchanged. And if demand is inelastic, a cut in price leads to a decrease in total revenue.
- Price elasticity of demand depends on how easily one good serves as a substitute for another, the proportion of income spent on the good, and the length of time elapsed since the price change.

Working Problems 1 to 8 will give you a better understanding of the price elasticity of demand.

More Elasticities of Demand (pp. 91–93)

- Cross elasticity of demand measures the responsiveness of the demand for one good to a change in the price of a substitute or a complement, other things remaining the same.
- The cross elasticity of demand with respect to the price of a substitute is positive. The cross elasticity of demand with respect to the price of a complement is negative.
- Income elasticity of demand measures the responsiveness of demand to a change in income, other things remaining the same. For a normal good, the income elasticity of demand is positive. For an inferior good, the income elasticity of demand is negative.
- When the income elasticity of demand is greater than 1 (income elastic), the percentage of income spent on the good increases as income increases.
- When the income elasticity of demand is less than 1 (income inelastic and inferior), the percentage of income spent on the good decreases as income increases.

Working Problems 9 to16 will give you a better understanding of cross and income elasticities of demand.

Elasticity of Supply (pp. 94–96)

- Elasticity of supply measures the responsiveness of the quantity supplied of a good to a change in its price, other things remaining the same.
- The elasticity of supply is usually positive and ranges between zero (vertical supply curve) and infinity (horizontal supply curve).
- Supply decisions have three time frames: momentary, short run, and long run.
- Momentary supply refers to the response of the quantity supplied to a price change at the instant that the price changes.
- Short-run supply refers to the response of the quantity supplied to a price change after some of the technologically feasible adjustments in production have been made.
- Long-run supply refers to the response of the quantity supplied to a price change when all the technologically feasible adjustments in production have been made.

Working Problems 17 and 18 will give you a better understanding of the elasticity of supply.

Key Terms

Cross elasticity of demand, 91
Elastic demand, 87
Elasticity of supply, 94
Income elasticity of demand, 92
Inelastic demand, 86
Perfectly elastic demand, 87
Perfectly inelastic demand, 86
Price elasticity of demand, 84
Total revenue, 88
Total revenue test, 88
Unit elastic demand, 86

STUDY PLAN PROBLEMS AND APPLICATIONS

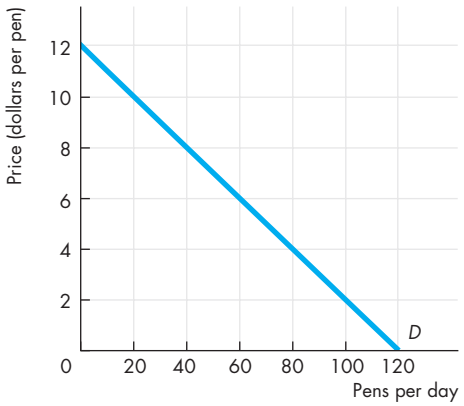
myeconlab You can work Problems 1 to 18 in MyEconLab Chapter 4 Study Plan and get instant feedback.

Price Elasticity of Demand (Study Plan 4.1)

1. Rain spoils the strawberry crop, the price rises from $4 to $6 a box, and the quantity demanded decreases from 1,000 to 600 boxes a week.
   a. Calculate the price elasticity of demand over this price range.
   b. Describe the demand for strawberries.
2. If the quantity of dental services demanded increases by 10 percent when the price of dental services falls by 10 percent, is the demand for dental services inelastic, elastic, or unit elastic?
3. The demand schedule for hotel rooms is

Price (dollars per night)	Quantity demanded (millions of rooms per night)
200	100
250	80
400	50
500	40
800	25

   a. What happens to total revenue when the price falls from $400 to $250 a night and from $250 to $200 a night?
   b. Is the demand for hotel rooms elastic, inelastic, or unit elastic?
4. The figure shows the demand for pens.



   Calculate the elasticity of demand when the price rises from $4 to $6 a pen. Over what price range is the demand for pens elastic?
5. In 2003, when music downloading first took off, Universal Music slashed the average price of a CD from $21 to $15. The company expected the price cut to boost the quantity of CDs sold by 30 percent, other things remaining the same.
   a. What was Universal Music's estimate of the price elasticity of demand for CDs?
   b. If you were making the pricing decision at Universal Music, what would be your pricing decision? Explain your decision.
6. The demand for illegal drugs is inelastic. Much of the expenditure on illegal drugs comes from crime. Assuming these statements to be correct,
   a. How will a successful campaign that decreases the supply of drugs influence the price of illegal drugs and the amount spent on them?
   b. What will happen to the amount of crime?
   c. What is the most effective way of decreasing the quantity of illegal drugs bought and decreasing the amount of drug-related crime?
7. **The Grip of Gas**

   U.S. drivers are ranked as the least sensitive to changes in the price of gasoline. For example, if the price rose from $3 to $4 per gallon and stayed there for a year U.S. purchases of gasoline would fall only about 5 percent.

   Source: *Slate*, September 27, 2005

   a. Calculate the price elasticity of demand for gasoline. Is the demand for gasoline elastic, unit elastic, or inelastic?
   b. Explain how the price rise from $3 to $4 a gallon changes the total revenue from gasoline sales.
8. **Spam Sales Rise as Food Costs Soar**

   Sales of Spam are rising as consumers realize that Spam and other lower-cost foods can be substituted for costlier cuts of meat as a way of controlling their already stretched food budgets.

   Source: *AOL Money & Finance*, May 28, 2008

   a. Is Spam a normal good or inferior good? Explain.
   b. Would the income elasticity of demand for Spam be negative or positive? Explain.

More Elasticities of Demand (Study Plan 4.2)

9. If a 12 percent rise in the price of orange juice decreases the quantity of orange juice demanded by 22 percent and increases the quantity of apple juice demanded by 14 percent, calculate the
   a. Price elasticity of demand for orange juice.
   b. Cross elasticity of demand for apple juice with respect to the price of orange juice.

10. When Judy's income increased from $130 to $170 a week, she increased her demand for concert tickets by 15 percent and decreased her demand for bus rides by 10 percent. Calculate Judy's income elasticity of demand for (a) concert tickets and (b) bus rides.
11. If a 5 percent rise in the price of sushi increases the quantity of soy sauce demanded by 2 percent and decreases the quantity of sushi demanded by 1 percent, calculate the
    a. Price elasticity of demand for sushi.
    b. Cross elasticity of demand for soy sauce with respect to the price of sushi.
12. **Swelling Textbook Costs Have College Students Saying "Pass"**

    Textbook prices have doubled and risen faster than average prices for the past two decades. Sixty percent of students do not buy textbooks. Some students hunt for used copies and sell them back at the end of the semester; some buy online, which is often cheaper than the campus store; some use the library copy and wait till it's free; some share the book with a classmate.

    Source: *Washington Post*, January 23, 2006

    Explain what this news clip implies about
    a. The price elasticity of demand for college textbooks.
    b. The income elasticity of demand for college textbooks.
    c. The cross elasticity of demand for college textbooks from the campus bookstore with respect to the online price of a textbook.

Use the following information to work Problems 13 to 15.

As Gas Costs Soar, Buyers Flock to Small Cars

Faced with high gas prices, Americans are substituting smaller cars for SUVs. In April 2008, Toyota Yaris sales increased 46 percent and Ford Focus sales increased 32 percent from a year earlier. Sales of SUVs decreased by more than 25 percent in 2008 and Chevrolet Tahoe sales fell 35 percent. Full-size pickup sales decreased more than 15 percent in 2008 and Ford F-Series pickup sales decreased by 27 percent in April 2008. The effect of a downsized vehicle fleet on fuel consumption is unknown. In California, gasoline consumption decreased by 4 percent in January 2008 from a year earlier. The price of gasoline in January 2008 increased by about 30 percent from a year earlier.

Source: *The New York Times*, May 2, 2009

13. Calculate the price elasticity of demand for gasoline in California.
14. Calculate the cross elasticity of demand for
    a. Toyota Yaris with respect to the price of gasoline.
    b. Ford Focus with respect to the price of gasoline.
15. Calculate the cross elasticity of demand for
    a. Chevrolet Tahoe with respect to the price of gasoline.
    b. A full-size pickup with respect to the price of gasoline.
16. **Home Depot Earnings Hammered**

    As gas and food prices increased and home prices slumped, people had less extra income to spend on home improvements. And the improvements that they made were on small inexpensive types of repairs and not major big-ticket items.

    Source: CNN, May 20, 2008

    a. What does this news clip imply about the income elasticity of demand for big-ticket home-improvement items?
    b. Would the income elasticity of demand be greater or less than 1? Explain.

Elasticity of Supply (Study Plan 4.3)

17. The table sets out the supply schedule of jeans.

Price (dollars per pair)	Quantity supplied (millions of pairs per year)
120	24
125	28
130	32
135	36

    Calculate the elasticity of supply when
    a. The price rises from $125 to $135 a pair.
    b. The average price is $125 a pair.
18. **Study Ranks Honolulu Third Highest for "Unaffordable Housing"**

    A study ranks Honolulu number 3 in the world for the most unaffordable housing market in urban locations, behind Los Angeles and San Diego and is deemed "severely unaffordable." With significant constraints on the supply of land for residential development, housing inflation has resulted.

    Source: *Hawaii Reporter*, September 11, 2007

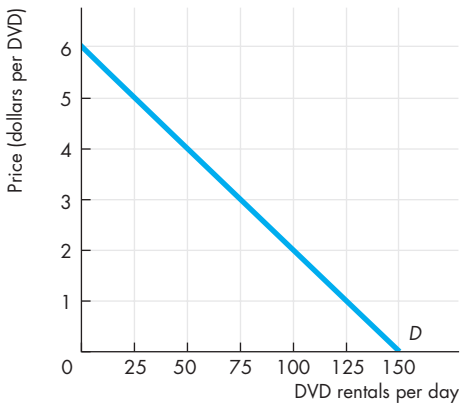
    a. Would the supply of housing in Honolulu be elastic or inelastic?
    b. Explain how the elasticity of supply plays an important role in influencing how rapidly housing prices in Honolulu rise.

ADDITIONAL PROBLEMS AND APPLICATIONS

myeconlab You can work these problems in MyEconLab if assigned by your instructor.

Price Elasticity of Demand

19. With higher fuel costs, airlines raised their average fare from 75¢ to $1.25 per passenger mile and the number of passenger miles decreased from 2.5 million a day to 1.5 million a day.
    a. What is the price elasticity of demand for air travel over this price range?
    b. Describe the demand for air travel.
20. The figure shows the demand for DVD rentals.



    a. Calculate the elasticity of demand when the price of a DVD rental rises from $3 to $5.
    b. At what price is the elasticity of demand for DVD rentals equal to 1?

Use the following table to work Problems 21 to 23.

The demand schedule for computer chips is

Price (dollars per chip)	Quantity demanded (millions of chips per year)
200	50
250	45
300	40
350	35
400	30

21. a. What happens to total revenue if the price falls from $400 to $350 a chip and from $350 to $300 a chip?
    b. At what price is total revenue at a maximum?
22. At an average price of $350, is the demand for chips elastic, inelastic, or unit elastic? Use the total revenue test to answer this question.
23. At $250 a chip, is the demand for chips elastic or inelastic? Use the total revenue test to answer this question.
24. Your price elasticity of demand for bananas is 4. If the price of bananas rises by 5 percent, what is
    a. The percentage change in the quantity of bananas you buy?
    b. The change in your expenditure on bananas?
25. **As Gasoline Prices Soar, Americans Slowly Adapt**

    As gas prices rose in March 2008, Americans drove 11 billion fewer miles than in March 2007. Realizing that prices are not going down, Americans are adapting to higher energy costs. Americans spend 3.7 percent of their disposable income on transportation fuels. How much we spend on gasoline depends on the choices we make: what car we drive, where we live, how much time we spend driving, and where we choose to go. For many people, higher energy costs mean fewer restaurant meals, deferred weekend outings with the kids, less air travel, and more time closer to home.

    Source: *International Herald Tribune*, May 23, 2008

    a. List and explain the elasticities of demand that are implicitly referred to in the news clip.
    b. Why, according to the news clip, is the demand for gasoline inelastic?

More Elasticities of Demand

Use this information to work Problems 26 and 27.

Economy Forces Many to Shorten Summer Vacation Plans

This year Americans are taking fewer exotic holidays by air and instead are visiting local scenic places by car. The global financial crisis has encouraged many Americans to cut their holiday budgets.

Source: *USA Today*, May 22, 2009

26. Given the prices of the two holidays, is the income elasticity of demand for exotic holidays positive or negative? Are exotic holidays a normal good or an inferior good? Are local holidays a normal good or an inferior good?
27. Are exotic holidays and local holidays substitutes? Explain your answer.
28. When Alex's income was $3,000, he bought 4 bagels and 12 donuts a month. Now his income is $5,000 and he buys 8 bagels and 6 donuts a month.

Calculate Alex's income elasticity of demand for
a. Bagels.
b. Donuts.

29. **Wal-Mart's Recession-Time Pet Project**
During the recession, Wal-Mart moved its pet food and supplies to in front of its other fast-growing business, baby products. Retail experts point out that kids and pets tend to be fairly recession-resistant businesses—even in a recession, dogs will be fed and kids will get their toys.
Source: CNN, May 13, 2008
a. What does this news clip imply about the income elasticity of demand for pet food and baby products?
b. Would the income elasticity of demand be greater or less than 1? Explain.

30. If a 5 percent fall in the price of chocolate sauce increases the quantity of chocolate sauce demanded by 10 percent and increases the quantity of ice cream demanded by 15 percent, calculate the
a. Price elasticity of demand for chocolate sauce.
b. Cross elasticity of demand for ice cream with respect to the price of chocolate sauce.

31. **Netflix to Offer Online Movie Viewing**
Online movie rental service Netflix has introduced a new feature to allow customers to watch movies and television series on their personal computers. Netflix competes with video rental retailer Blockbuster, which added an online rental service to the in-store rental service.
Source: CNN, January 16, 2007
a. How will online movie viewing influence the price elasticity of demand for in-store movie rentals?
b. Would the cross elasticity of demand for online movies and in-store movie rentals be negative or positive? Explain.
c. Would the cross elasticity of demand for online movies with respect to high-speed Internet service be negative or positive? Explain.

32. **To Love, Honor, and Save Money**
In a survey of caterers and event planners, nearly half of them said that they were seeing declines in wedding spending in response to the economic slowdown; 12% even reported wedding cancellations because of financial concerns.
Source: *Time*, June 2, 2008
a. Based upon this news clip, are wedding events a normal good or inferior good? Explain.
b. Are wedding events more a necessity or a luxury? Would the income elasticity of demand be greater than 1, less than 1, or equal to 1? Explain.

Elasticity of Supply

33. The supply schedule of long-distance phone calls is

Price (cents per minute)	Quantity supplied (millions of minutes per day)
10	200
20	400
30	600
40	800

Calculate the elasticity of supply when
a. The price falls from 40¢ to 30¢ a minute.
b. The average price is 20¢ a minute.

34. **Weak Coal Prices Hit China's Third-Largest Coal Miner**
The chairman of Yanzhou Coal Mining reported that the recession had decreased the demand for coal, with its sales falling by 11.9 percent to 7.92 million tons from 8.99 million tons a year earlier, despite a 10.6 percent cut in the price.
Source: Dow Jones, April 27, 2009
Calculate the price elasticity of supply of coal. Is the supply of coal elastic or inelastic?

Economics in the News

35. After you have studied *Reading Between the Lines* on pp. 98–99 answer the following questions.
a. Which demand is more price elastic and why: tomatoes in general or Florida winter tomatoes?
b. When cold weather destroyed the Florida crop and more tomatoes came from Mexico and greenhouses, what happened to the supply of tomatoes and the quantity of tomatoes supplied?
c. The news article says the "High demand has driven up prices and wholesalers are buying from Mexico." What does this statement mean? Did demand increase? Did it decrease? Is the news article correct?
d. Reggie Brown says "We're obviously losing market share to Mexico, and there's always a price to pay to get the customer to get back into the Florida market." What does he mean and what does that imply about the elasticity of demand for Florida tomatoes when the price rises and when the price falls?