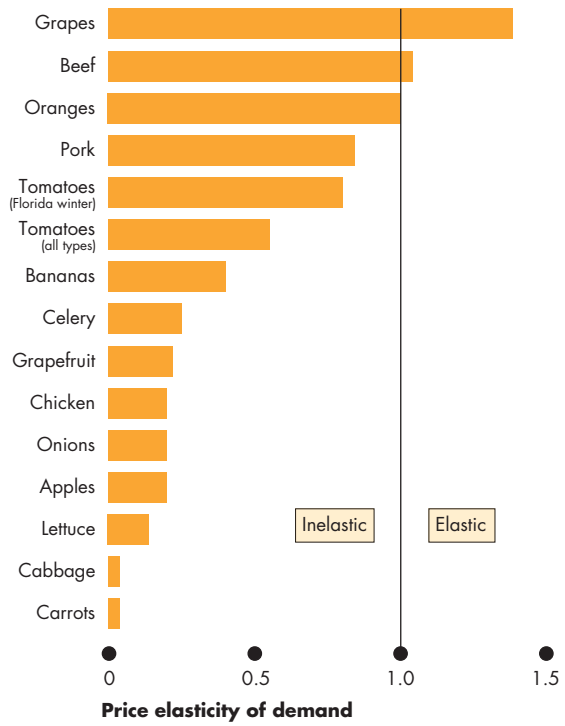
Economics in Action

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,

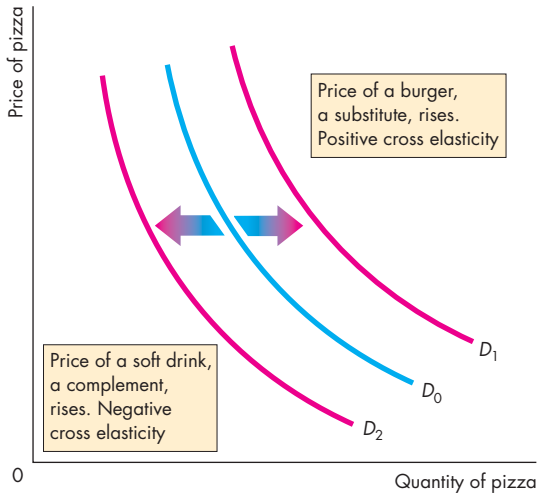
$$\Delta P/P_{ave} \times 100 = (+\$1/\$2) \times 100 = +50\%.$$

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

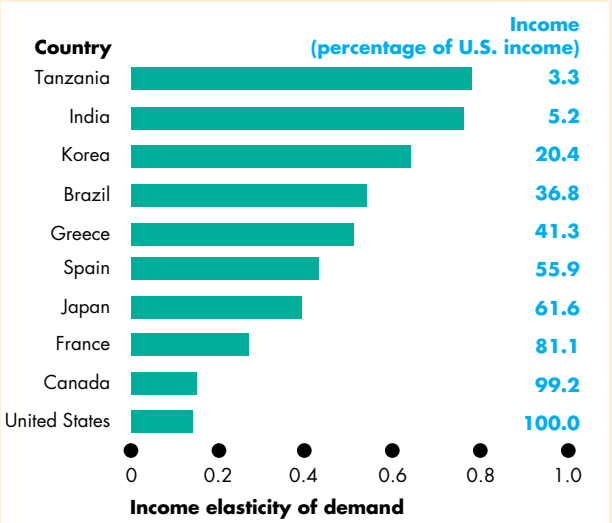
The table shows estimates of some real-world income elasticities of demand. The demand for a necessity such as food or clothing is income inelastic, while the demand for a luxury such as transportation, which includes airline and foreign travel, is income elastic.

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

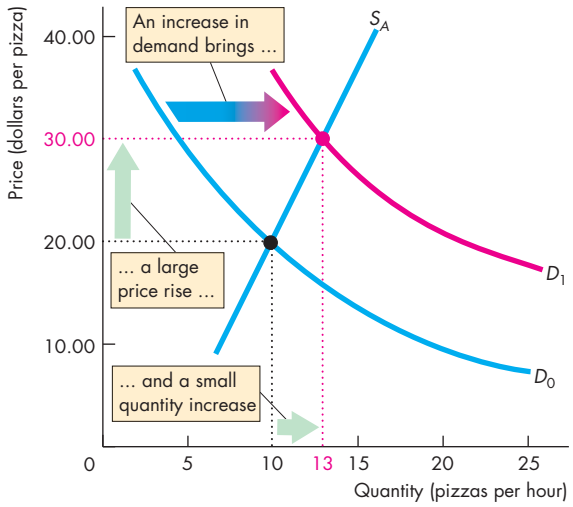
The **elasticity of supply** measures the responsiveness of the quantity supplied to a change in the price of a good when all other influences on selling plans remain the same. It is calculated by using the formula:

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

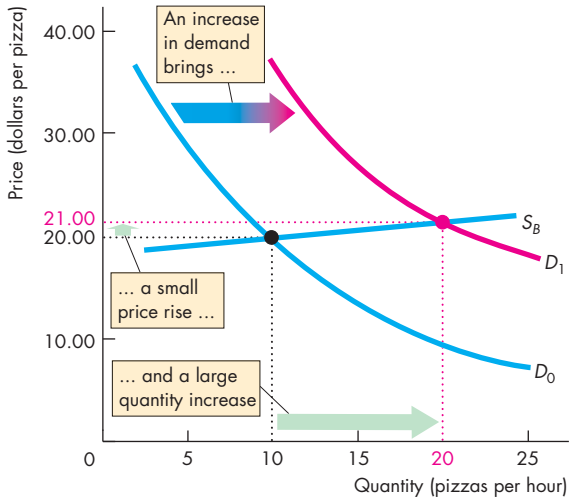
We use the same method that you learned when you studied the elasticity of demand. (Refer back to p. 85 to check this method.) Let's calculate the elasticity of supply along the supply curves in Fig. 4.7.

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

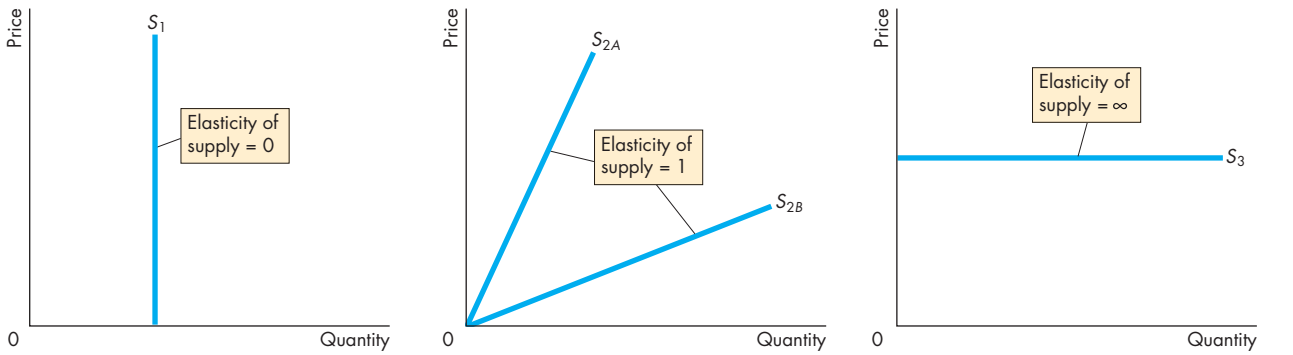
The elasticity of supply of a good depends on

- 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.