

# Elasticity

- 1.** Do you think the price elasticity of demand for Ford sport-utility vehicles (SUVs) will increase, decrease, or remain the same when each of the following events occurs? Explain your answer.
- Other car manufacturers, such as General Motors, decide to make and sell SUVs.
  - SUVs produced in foreign countries are banned from the American market.
  - Due to ad campaigns, Americans believe that SUVs are much safer than ordinary passenger cars.
  - The time period over which you measure the elasticity lengthens. During that longer time, new models such as four-wheel-drive cargo vans appear.

## Solution

- 1.**
- The price elasticity of demand for Ford SUVs will increase because more substitutes are available.
  - The price elasticity of demand for Ford SUVs will decrease because fewer substitutes are available.
  - The price elasticity of demand for Ford SUVs will decrease because other cars are viewed as less of a substitute.
  - The price elasticity of demand for Ford SUVs will increase over time because more substitutes (such as four-wheel-drive cargo vans) become available.
- 2.** In the United States, 2013 was a bad year for growing wheat. And as wheat supply decreased, the price of wheat rose dramatically, leading to a lower quantity demanded (a movement along the demand curve). The accompanying table describes what happened to prices and the quantity of wheat demanded.

	2012	2013
Quantity demanded (bushels)	2.2 billion	2.0 billion
Average price (per bushel)	\$3.42	\$4.26

- Using the midpoint method, calculate the price elasticity of demand for winter wheat.
- What is the total revenue for U.S. wheat farmers in 2012 and 2013?
- Did the bad harvest increase or decrease the total revenue of U.S. wheat farmers? How could you have predicted this from your answer to part a?

## Solution

- 2.**
- Using the midpoint method, the percent change in the quantity of U.S. winter wheat demanded is

$$\frac{2.0 \text{ billion} - 2.2 \text{ billion}}{2.1 \text{ billion}} \times 100 = \frac{-0.2 \text{ billion}}{2.1 \text{ billion}} \times 100 = -9.5\%$$

and the percent change in the price of U.S. winter wheat is

$$\frac{\$4.26 - \$3.42}{\$3.84} \times 100 = \frac{\$0.84}{\$3.84} \times 100 = 21.9\%$$

Dropping the minus sign, the price elasticity of demand is therefore

$$\frac{9.5\%}{21.9\%} = 0.43$$

so that demand is inelastic.

- b.** The total revenue in 2012 is the price per bushel in 2012 times the quantity of bushels demanded in 2012. That is, total revenue in 2012 is  $\$3.42 \times 2.2$  billion = \$7.524 billion. Similarly, total revenue in 2013 is  $\$4.26 \times 2.0$  billion = \$8.52 billion.
- c.** The rise in price from 2012 to 2013 increased U.S. wheat farmers' total revenue. This could have been predicted by knowing that demand is inelastic: in part a we calculated a price elasticity of demand of 0.43. The price effect of this price rise (which tends to increase total revenue) outweighed the quantity effect (which tends to decrease total revenue).

- 3.** The accompanying table gives part of the supply schedule for personal computers in the United States.

Price of computer	Quantity of computers supplied
\$1,100	12,000
900	8,000

- a.** Calculate the price elasticity of supply when the price increases from \$900 to \$1,100 using the midpoint method.
- b.** Suppose firms produce 1,000 more computers at any given price due to improved technology. As price increases from \$900 to \$1,100, is the price elasticity of supply now greater than, less than, or the same as it was in part a?
- c.** Suppose a longer time period under consideration means that the quantity supplied at any given price is 20% higher than the figures given in the table. As price increases from \$900 to \$1,100, is the price elasticity of supply now greater than, less than, or the same as it was in part a?

- 3. a.** Using the midpoint method, the percent change in the quantity supplied is

$$\frac{12,000 - 8,000}{(8,000 + 12,000)/2} \times 100 = \frac{4,000}{10,000} \times 100 = 40\%$$

and the percent change in the price is

$$\frac{\$1,100 - \$900}{(\$900 + \$1,100)/2} \times 100 = \frac{\$200}{\$1,000} \times 100 = 20\%$$

The price elasticity of supply is therefore

$$\frac{40\%}{20\%} = 2$$

- b.** The elasticity estimate would be lower. A price change from \$900 to \$1,100 is a 20% price change, just as calculated in part a. Previously, when the quantity supplied changed from 8,000 to 12,000, that was a 40% change in the quantity supplied. Now that the quantity supplied at each price is higher by 1,000, the same price change would imply a change in the quantity supplied from 9,000 to 13,000, which is a 36% change using the midpoint method. The new price elasticity of supply is  $36\%/20\% = 1.8$ , which is lower than in part a.

- c. The elasticity estimate would be unchanged. The price increase from \$900 to \$1,100 is a 20% increase, just as calculated in part a. But now that all quantities are 20% higher, the quantity supplied increases from 9,600 to 14,400. Using the midpoint method, this is an increase of

$$\frac{14,400 - 9,600}{(9,600 + 14,400)/2} \times 100 = \frac{4,800}{12,000} \times 100 = 40\%$$

so that the price elasticity of supply is

$$\frac{40\%}{20\%} = 2$$

Therefore the price elasticity of supply is the same as in part a.

4. The accompanying table lists the cross-price elasticities of demand for several goods, where the percent quantity change is measured for the first good of the pair, and the percent price change is measured for the second good.

Good	Cross-price elasticities of demand
Air-conditioning units and kilowatts of electricity	-0.34
Coke and Pepsi	+0.63
High-fuel-consuming sport-utility vehicles (SUVs) and gasoline	-0.28
McDonald's burgers and Burger King burgers	+0.82
Butter and margarine	+1.54

- Explain the sign of each of the cross-price elasticities. What does it imply about the relationship between the two goods in question?
- Compare the absolute values of the cross-price elasticities and explain their magnitudes. For example, why is the cross-price elasticity of McDonald's burgers and Burger King burgers less than the cross-price elasticity of butter and margarine?
- Use the information in the table to calculate how a 5% increase in the price of Pepsi affects the quantity of Coke demanded.
- Use the information in the table to calculate how a 10% decrease in the price of gasoline affects the quantity of SUVs demanded.

## Solution

4. a. A negative cross-price elasticity of demand implies that the two goods are complements. So air-conditioning units and kilowatts of electricity are complements, as are sport-utility vehicles and gasoline. A positive cross-price elasticity of demand implies that the two goods are substitutes. So Coke and Pepsi are substitutes, as are McDonald's and Burger King burgers as well as butter and margarine.
- b. The larger (and positive) the cross-price elasticity of demand is, the more closely the two goods are substitutes. Since the cross-price elasticity of butter and margarine is larger than the cross-price elasticity of McDonald's burgers and Burger King burgers, butter and margarine are closer substitutes than are McDonald's and Burger King burgers. Similarly, the greater (and negative) the cross-price elasticity of demand is, the more strongly the two goods are complements.
- c. A cross-price elasticity of 0.63 implies that a 1% increase in the price of Pepsi would increase the quantity of Coke demanded by 0.63%. So a 5% increase in the price of Pepsi would increase the quantity of Coke demanded by five times as much, that is, by  $5 \times 0.63\% = 3.15\%$ .

d. A cross-price elasticity of  $-0.28$  implies that a 1% fall in the price of gasoline would increase the quantity of SUVs demanded by 0.28%. So a 10% fall in the price of gasoline would increase the quantity of SUVs demanded by 10 times as much, that is, by  $10 \times 0.28\% = 2.8\%$ .

5. What can you conclude about the price elasticity of demand in each of the following statements?

- a. "The pizza delivery business in this town is very competitive. I'd lose half my customers if I raised the price by as little as 10%."
- b. "I owned both of the two Jerry Garcia autographed lithographs in existence. I sold one on eBay for a high price. But when I sold the second one, the price dropped by 80%."
- c. "My economics professor has chosen to use the Krugman/Wells textbook for this class. I have no choice but to buy this book."
- d. "I always spend a total of exactly \$10 per week on coffee."

5. a. This statement says that a 10% increase in price reduces the quantity demanded by 50%. That is, the price elasticity of demand is

$$\frac{50\%}{10\%} = 5$$

So demand is elastic.

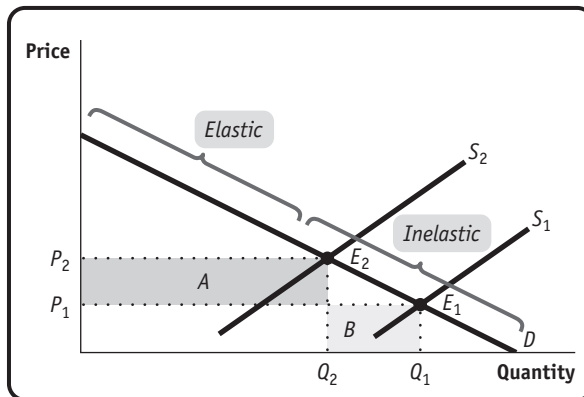
- b. The fact that it was necessary for price to drop by 80% in order to sell one more unit (an increase in quantity of 67%, using the midpoint method) indicates that the demand for Jerry Garcia autographed lithographs is inelastic.
- c. There is no substitute available, so demand is inelastic. (Although, over time, as more used Krugman/Wells textbooks become available, the price elasticity of demand will increase.)
- d. Demand is unit-elastic: no matter what the price of coffee is, the total revenue to the producer (which is my total expenditure on coffee) remains the same.

6. Take a linear demand curve like that shown in Figure 6-5, where the range of prices for which demand is elastic and inelastic is labeled. In each of the following scenarios, the supply curve shifts. Show along which portion of the demand curve (that is, the elastic or the inelastic portion) the supply curve must have shifted in order to generate the event described. In each case, show on the diagram the quantity effect and the price effect.

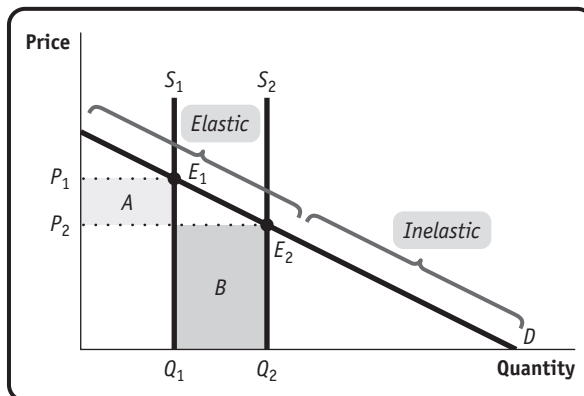
- a. Recent attempts by the Colombian army to stop the flow of illegal drugs into the United States have actually benefited drug dealers.
- b. New construction increased the number of seats in the football stadium and resulted in greater total revenue from box-office ticket sales.
- c. A fall in input prices has led to higher output of Porsches. But total revenue for the Porsche Company has declined as a result.

## Solution

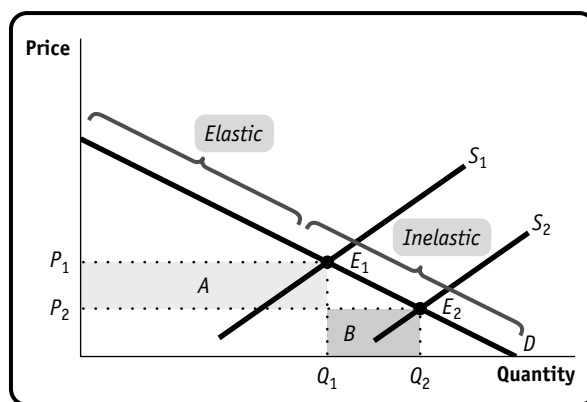
6. a. Attempts to stop the flow of drugs into the United States shift the supply curve leftward, raising the price of drugs and reducing the quantity demanded. If this benefits drug dealers, their total revenue must have increased. That is, we must be on the inelastic portion of the demand curve, where a rise in price results in an increase in revenue (the price effect outweighs the quantity effect). In the accompanying diagram, as supply shifts from  $S_1$  to  $S_2$ , revenue decreases by area  $B$  but increases by area  $A$ .



- b. An increase in the number of seats shifts the supply curve rightward, reducing the price of stadium seats and increasing the quantity demanded. If this increases total revenue, we must be on the elastic portion of the demand curve, where a fall in price results in an increase in total revenue from box-office sales (the quantity effect outweighs the price effect). In the accompanying diagram, as supply shifts from  $S_1$  to  $S_2$ , total revenue decreases by area  $A$  but increases by area  $B$ . (The supply curve is a vertical line because the supply of seats is perfectly inelastic: whatever the price, the supply of seats is just how many seats there are in the stadium.)



- c. Increasing production shifts the supply curve rightward, lowering the price of Porsches and increasing the quantity demanded. If this reduces total revenue, we must be on the inelastic portion of the demand curve, where a fall in price results in a fall in total revenue (the price effect outweighs the quantity effect). In the accompanying diagram, as supply shifts from  $S_1$  to  $S_2$ , total revenue decreases by area A but increases only by area B.



7. The accompanying table shows the price and yearly quantity sold of souvenir T-shirts in the town of Crystal Lake according to the average income of the tourists visiting.

Price of T-shirt	Quantity of T-shirts demanded when average tourist income is \$20,000	Quantity of T-shirts demanded when average tourist income is \$30,000
\$4	3,000	5,000
5	2,400	4,200
6	1,600	3,000
7	800	1,800

- a. Using the midpoint method, calculate the price elasticity of demand when the price of a T-shirt rises from \$5 to \$6 and the average tourist income is \$20,000. Also calculate it when the average tourist income is \$30,000.
- b. Using the midpoint method, calculate the income elasticity of demand when the price of a T-shirt is \$4 and the average tourist income increases from \$20,000 to \$30,000. Also calculate it when the price is \$7.

7. a. Suppose the average tourist income is \$20,000. Using the midpoint method, the percent change in the quantity demanded is

$$\frac{1,600 - 2,400}{(2,400 + 1,600)/2} \times 100 = \frac{-800}{2,000} \times 100 = -40\%$$

and the percent change in the price is

$$\frac{\$6 - \$5}{(\$5 + \$6)/2} \times 100 = \frac{\$1}{\$5.50} \times 100 = 18.2\%$$

Dropping the minus sign, the price elasticity of demand is therefore

$$\frac{40\%}{18.2\%} = 2.2$$

Now suppose the average tourist income is \$30,000. The percent change in the quantity demanded is

$$\frac{3,000 - 4,200}{(4,200 + 3,000)/2} \times 100 = \frac{-1,200}{3,600} \times 100 = -33.3\%$$

and the percent change in the price is, as before,

$$\frac{\$6 - \$5}{(\$5 + \$6)/2} \times 100 = \frac{\$1}{\$5.50} \times 100 = 18.2\%$$

Dropping the minus sign, the price elasticity of demand is therefore

$$\frac{33.3\%}{18.2\%} = 1.8$$

- b. Suppose the price of a T-shirt is \$4. Using the midpoint method, the percent change in the quantity demanded is

$$\frac{5,000 - 3,000}{(3,000 + 5,000)/2} \times 100 = \frac{2,000}{4,000} \times 100 = 50\%$$

and the percent change in income is

$$\frac{\$30,000 - \$20,000}{(\$20,000 + \$30,000)/2} \times 100 = \frac{\$10,000}{\$25,000} \times 100 = 40\%$$

The income elasticity of demand is therefore

$$\frac{50\%}{40\%} = 1.25$$

Now suppose the price is \$7. The percent change in the quantity demanded is

$$\frac{1,800 - 800}{(800 + 1,800)/2} \times 100 = \frac{1,000}{1,300} \times 100 = 76.9\%$$

and the percent change in income is, as before,

$$\frac{\$30,000 - \$20,000}{(\$20,000 + \$30,000)/2} \times 100 = \frac{\$10,000}{\$25,000} \times 100 = 40\%$$

The income elasticity of demand is therefore

$$\frac{76.9\%}{40\%} = 1.9$$

8. A recent study determined the following elasticities for Volkswagen Beetles:

$$\begin{aligned} \text{Price elasticity of demand} &= 2 \\ \text{Income elasticity of demand} &= 1.5 \end{aligned}$$

The supply of Beetles is elastic. Based on this information, are the following statements true or false? Explain your reasoning.

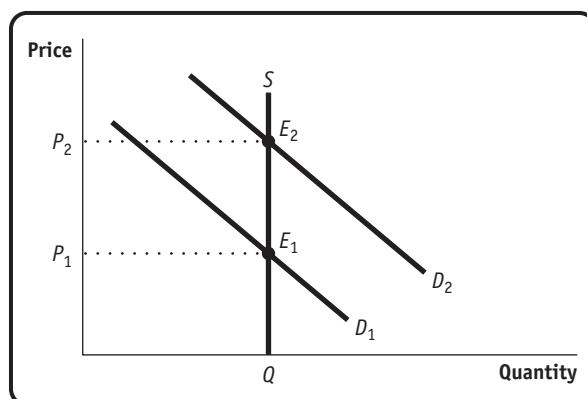
- a. A 10% increase in the price of a Beetle will reduce the quantity demanded by 20%.  
 b. An increase in consumer income will increase the price and quantity of Beetles sold.

## Solution

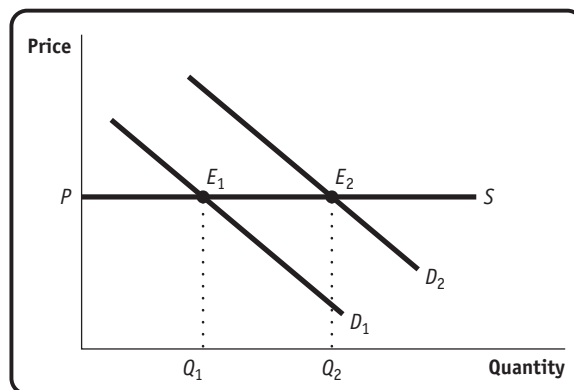
8. a. True. The price elasticity of demand for Beetles is 2. That is, a 1% increase in the price would reduce the quantity demanded by 2%. Therefore, a 10% increase in the price would reduce the quantity demanded by 20%.  
 b. The first part of the statement is true. The income elasticity of demand for Beetles is positive (they are a normal good). That is, an increase in income will increase the demand for Beetles. The demand curve shifts rightward, and the price and quantity of Beetles supplied both increase.

9. In each of the following cases, do you think the price elasticity of supply is (i) perfectly elastic; (ii) perfectly inelastic; (iii) elastic, but not perfectly elastic; or (iv) inelastic, but not perfectly inelastic? Explain using a diagram.
- An increase in demand this summer for luxury cruises leads to a huge jump in the sales price of a cabin on the *Queen Mary 2*.
  - The price of a kilowatt of electricity is the same during periods of high electricity demand as during periods of low electricity demand.
  - Fewer people want to fly during February than during any other month. The airlines cancel about 10% of their flights as ticket prices fall about 20% during this month.
  - Owners of vacation homes in Maine rent them out during the summer. Due to the soft economy this year, a 30% decline in the price of a vacation rental leads more than half of homeowners to occupy their vacation homes themselves during the summer.

9. a. Supply is perfectly inelastic: the quantity of cabins on the *Queen Mary 2* is fixed. As demand increases (a rightward shift in the demand curve), the price of a cabin on the *Queen Mary 2* increases, without an increase in the quantity supplied. See the accompanying diagram.



- b. Supply is perfectly elastic. As demand changes (for instance, as demand increases in times of high electricity demand), price does not change but the quantity supplied does change. See the accompanying diagram.

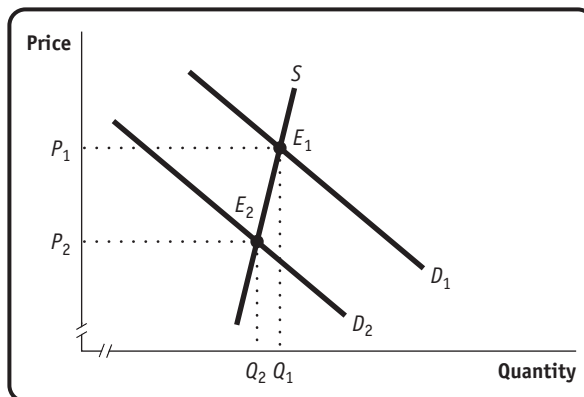


- c. Supply is inelastic. As price falls by 20%, the quantity supplied falls by 10%. This implies a price elasticity of supply of

$$\frac{10\%}{20\%} = 0.5$$



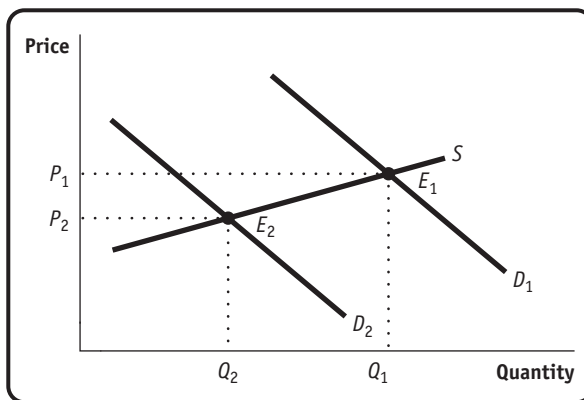
which is inelastic. See the accompanying diagram.



- d. Supply is elastic. As price falls by 30%, the quantity supplied falls by more than 50%. This implies a price elasticity of supply greater than

$$\frac{50\%}{30\%}$$

that is, a price elasticity of supply greater than 1.7. See the accompanying diagram.



10. Use an elasticity concept to explain each of the following observations.
- During economic booms, the number of new personal care businesses, such as gyms and tanning salons, is proportionately greater than the number of other new businesses, such as grocery stores.
  - Cement is the primary building material in Mexico. After new technology makes cement cheaper to produce, the supply curve for the Mexican cement industry becomes relatively flatter.
  - Some goods that were once considered luxuries, like a telephone, are now considered virtual necessities. As a result, the demand curve for telephone services has become steeper over time.
  - Consumers in a less developed country like Guatemala spend proportionately more of their income on equipment for producing things at home, like sewing machines, than consumers in a more developed country like Canada.

10. a. During times of economic boom, incomes rise. Whether, and by how much, demand responds to changes in income is determined by the income elasticity of demand. Since the demand for personal care services increases as income increases, personal care services are a normal good. If the demand for personal care

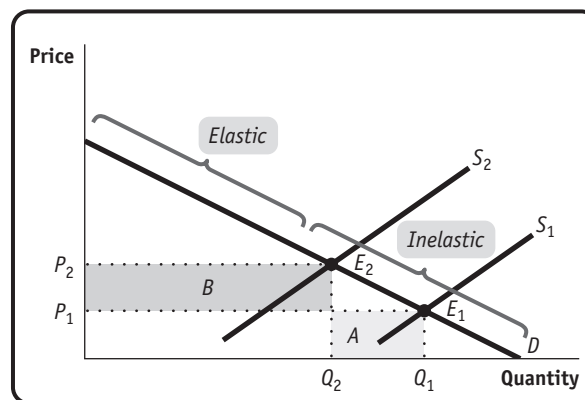
services is more responsive to changes in income than the demand for other products, the income elasticity of demand for personal care services is greater than the income elasticity of demand for other products. As a result of the proportionately greater increase in demand, you would see the quantity of personal care services supplied increase by proportionately more.

- b. New technology has made cement easier to produce. This implies that as the price of cement rises, many more firms are now willing to supply cement than before; that is, supply has become more elastic, leading to a relatively flatter supply curve.
- c. As telephones have become less and less of a luxury, the price elasticity of demand for telephones has fallen: telephones have become so much a necessity of daily life that it is now more difficult for consumers to substitute away from telephones. As demand for telephones has become less elastic (less responsive to changes in the price), the demand curve for telephones has become steeper.
- d. Incomes in Canada are higher than those in Guatemala. The statement therefore implies that as income rises, the demand for sewing machines increases by proportionately less than the change in income, making the income elasticity of demand inelastic. Maybe the demand for sewing machines even decreases as income rises, implying that sewing machines are an inferior good, with a negative income elasticity of demand.

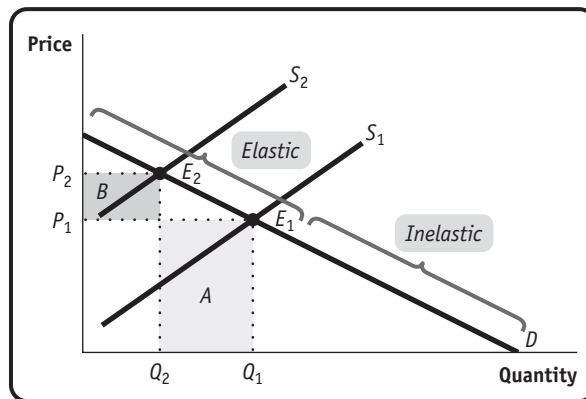
**11.** Taiwan is a major world supplier of semiconductor chips. A recent earthquake severely damaged the production facilities of Taiwanese chip-producing companies, sharply reducing the amount of chips they could produce.

- a. Assume that the total revenue of a typical non-Taiwanese chip manufacturer rises due to these events. In terms of an elasticity, what must be true for this to happen? Illustrate the change in total revenue with a diagram, indicating the price effect and the quantity effect of the Taiwan earthquake on this company's total revenue.
- b. Now assume that the total revenue of a typical non-Taiwanese chip manufacturer falls due to these events. In terms of an elasticity, what must be true for this to happen? Illustrate the change in total revenue with a diagram, indicating the price effect and the quantity effect of the Taiwan earthquake on this company's total revenue.

**11. a.** The earthquake shifts the supply curve to the left, leading to a price increase. If the increase in price results in an increase in total revenue, then the price effect (which tends to increase total revenue) must outweigh the quantity effect (which tends to reduce total revenue). That is, demand must have been inelastic. In the accompanying diagram, as supply shifted leftward from  $S_1$  to  $S_2$ , the fall in total revenue due to the quantity effect (area A) is outweighed by the gain in total revenue due to the price effect (area B).



- b. If the increase in price results in a fall in total revenue, then the quantity effect (which tends to reduce total revenue) must outweigh the price effect (which tends to increase total revenue). That is, demand must have been elastic. In the accompanying diagram, as supply shifted leftward from  $S_1$  to  $S_2$ , total revenue falls by the amount of the quantity effect (area A) but rises by the amount of the price effect (area B). The quantity effect (area A) is larger than the price effect (area B), so total revenue declines.

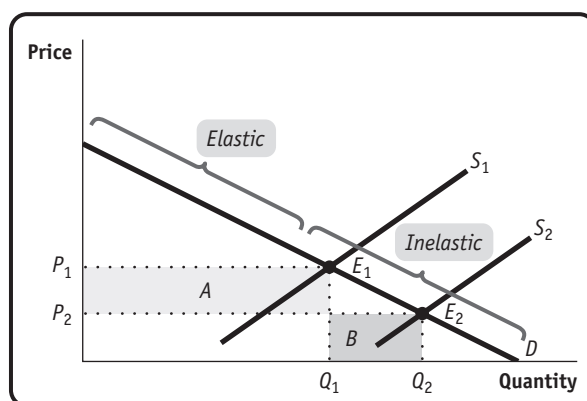


12. There is a debate about whether sterile hypodermic needles should be passed out free of charge in cities with high drug use. Proponents argue that doing so will reduce the incidence of diseases, such as HIV/AIDS, that are often spread by needle sharing among drug users. Opponents believe that doing so will encourage more drug use by reducing the risks of this behavior. As an economist asked to assess the policy, you must know the following: (i) how responsive the spread of diseases like HIV/AIDS is to the price of sterile needles and (ii) how responsive drug use is to the price of sterile needles. Assuming that you know these two things, use the concepts of price elasticity of demand for sterile needles and the cross-price elasticity between drugs and sterile needles to answer the following questions.
- In what circumstances do you believe this is a beneficial policy?
  - In what circumstances do you believe this is a bad policy?

- 12. a.** Handing out free needles lowers the price of needles to zero. First consider the demand for needles. The higher the price elasticity of demand for sterile needles, the greater the increase in the quantity of sterile needles demanded in response to a decrease in the price. And the greater the increase in the quantity of sterile needles demanded, the lower the spread of diseases like HIV/AIDS. Now consider the demand for drugs. Drugs and sterile needles are complements: as the price of sterile needles falls, the demand for drugs increases. This implies that the cross-price elasticity of demand between drugs and sterile needles is negative. The less negative (the closer to zero) the cross-price elasticity of demand between drugs and sterile needles, the less responsive is the demand for drugs to the price of sterile needles. So the policy would be beneficial if the price elasticity of demand for sterile needles is high (elastic) and the cross-price elasticity of demand between drugs and sterile needles is negative and low (close to zero, that is, weakly complementary).
- b.** Similar reasoning as in part a implies that the policy would be a bad idea if the price elasticity of demand for sterile needles is low (inelastic) and the cross-price elasticity of demand between drugs and sterile needles is high and negative (strongly complementary).

- 13.** Worldwide, the average coffee grower has increased the amount of acreage under cultivation over the past few years. The result has been that the average coffee plantation produces significantly more coffee than it did 10 to 20 years ago. Unfortunately for the growers, however, this has also been a period in which their total revenues have plunged. In terms of an elasticity, what must be true for these events to have occurred? Illustrate these events with a diagram, indicating the quantity effect and the price effect that gave rise to these events.

- 13.** An increase in the amount of acreage that is cultivated results in a rightward shift in the supply of coffee. This reduces the price of coffee and increases the quantity demanded. If total revenue from coffee sales have decreased, this means that the price effect (which tends to lower total revenue) must have outweighed the quantity effect (which tends to increase total revenue). This implies that demand must be inelastic. As shown in the accompanying diagram, the price effect results in a loss of total revenue equal to the size of area A. The quantity effect (the quantity demanded increases as a result of the price fall) results in an increase in total revenue equal to the size of area B. Area A exceeds area B, so total revenue falls.



- 14.** A recent report by the U.S. Centers for Disease Control and Prevention (CDC), published in the CDC's *Morbidity and Mortality Weekly Report*, studied the effect of an increase in the price of beer on the incidence of new cases of sexually transmitted disease in young adults. In particular, the researchers analyzed the responsiveness of gonorrhea cases to a tax-induced increase in the price of beer. The report concluded that "the . . . analysis suggested that a beer tax increase of \$0.20 per six-pack could reduce overall gonorrhea rates by 8.9%." Assume that a six-pack costs \$5.90 before the price increase. Use the midpoint method to determine the percent increase in the price of a six-pack, and then calculate the cross-price elasticity of demand between beer and incidence of gonorrhea. According to your estimate of this cross-price elasticity of demand, are beer and gonorrhea complements or substitutes?

- 14.** The percent increase in the price of beer is

$$\frac{\$0.20}{(\$5.90 + \$6.10)/2} \times 100 = \frac{\$0.20}{\$6.00} \times 100 = 3.3\%$$

Since the incidence of gonorrhea fell by 8.9%, the cross-price elasticity of demand is

$$\frac{-8.9\%}{3.3\%} = -2.7$$

Since the cross-price elasticity of demand is negative, beer and gonorrhea are complements.

15. The U.S. government is considering reducing the amount of carbon dioxide that firms are allowed to produce by issuing a limited number of tradable allowances for carbon dioxide (CO<sub>2</sub>) emissions. In an April 25, 2007, report, the U.S. Congressional Budget Office (CBO) argues that “most of the cost of meeting a cap on CO<sub>2</sub> emissions would be borne by consumers, who would face persistently higher prices for products such as electricity and gasoline . . . poorer households would bear a larger burden relative to their income than wealthier households would.” What assumption about one of the elasticities you learned about in this chapter has to be true for poorer households to be disproportionately affected?

**15.** For poorer households to be disproportionately affected by an increase in energy prices, it is necessary that those households spend a larger share of their income on energy products than wealthier households. In other words, as income rises, the quantity of energy products demanded has to increase less than proportionately. So the CBO must think that the income elasticity of demand for energy products, although positive, is less than 1: energy products are income-inelastic. In fact, this is just what the CBO report says: “lower-income households tend to spend a larger fraction of their income than wealthier households do and . . . energy products account for a bigger share of their spending.”

16. According to data from the U.S. Department of Energy, sales of the fuel-efficient Toyota Prius hybrid fell from 158,574 vehicles sold in 2008 to 139,682 in 2009. Over the same period, according to data from the U.S. Energy Information Administration, the average price of regular gasoline fell from \$3.27 to \$2.35 per gallon. Using the midpoint method, calculate the cross-price elasticity of demand between Toyota Prii (the official plural of “Prius” is “Prii”) and regular gasoline. According to your estimate of the cross-price elasticity, are the two goods complements or substitutes? Does your answer make sense?

- 16.** A fall in price of regular gasoline from \$3.27 to \$2.35 per gallon, using the midpoint method, is a percent change of

$$\frac{\$2.35 - \$3.27}{\$2.81} \times 100 = \frac{-\$0.92}{\$2.81} \times 100 = -32.7\%$$

And a fall in the quantity of Prii demanded from 158,574 to 139,682 vehicles, using the midpoint method, is a percent change of

$$\frac{139,682 - 158,574}{149,128} \times 100 = \frac{-18,892}{149,128} \times 100 = -12.7\%$$

So the cross-price elasticity of demand is

$$\frac{-12.7\%}{-32.7\%} = 0.4$$

Since the cross-price elasticity of demand between Toyota Prii and regular gasoline is positive, this estimate indicates that the two are substitutes. This answer might seem perplexing because cars and gasoline are generally complements: you need gasoline to run a (gasoline-powered) car like a Toyota Prius. The generally complementary relationship between gas and cars implies that the cross-price elasticity between them would be negative. But a Toyota Prius adds another dimension to the comparison: it is a fuel-efficient car, not a gas-guzzler. And fuel-efficient cars and gas-guzzlers are substitutes. So as gasoline prices rise, the demand for gas-guzzling cars falls and the demand for fuel-efficient cars (such as the Toyota Prius), which are substitutes, rises. So the substitute nature of gas-guzzlers and Toyota Prii implies a positive cross-price elasticity between gas and Toyota Prii. Which effect is stronger? Clearly the substitution effect is stronger because the data show a positive cross-price elasticity.

**WORK IT OUT**

Interactive, step-by-step help solving this problem is available to your students via



- 17.** Nile.com, the online bookseller, wants to increase its total revenue. One strategy is to offer a 10% discount on every book it sells. Nile.com knows that its customers can be divided into two distinct groups according to their likely responses to the discount. The accompanying table shows how the two groups respond to the discount.

	Group A (sales per week)	Group B (sales per week)
Volume of sales before the 10% discount	1.55 million	1.50 million
Volume of sales after the 10% discount	1.65 million	1.70 million

- Using the midpoint method, calculate the price elasticities of demand for group A and group B.
- Explain how the discount will affect total revenue from each group.
- Suppose Nile.com knows which group each customer belongs to when he or she logs on and can choose whether or not to offer the 10% discount. If Nile.com wants to increase its total revenue, should discounts be offered to group A or to group B, to neither group, or to both groups?

- 17. a.** Using the midpoint method, the percent change in the quantity demanded by group A is

$$\frac{1.65 \text{ million} - 1.55 \text{ million}}{(1.55 \text{ million} + 1.65 \text{ million})/2} \times 100 = \frac{0.1 \text{ million}}{1.6 \text{ million}} \times 100 = 6.25\%$$

and since the change in price is 10%, the price elasticity of demand for group A is

$$\frac{6.25\%}{10\%} = 0.625$$

Using the midpoint method, the percent change in the quantity demanded by group B is

$$\frac{1.7 \text{ million} - 1.5 \text{ million}}{(1.5 \text{ million} + 1.7 \text{ million})/2} \times 100 = \frac{0.2 \text{ million}}{1.6 \text{ million}} \times 100 = 12.5\%$$

and since the change in price is 10%, the price elasticity of demand for group B is

$$\frac{12.5\%}{10\%} = 1.25$$

- For group A, since the price elasticity of demand is 0.625 (demand is inelastic), total revenue will decrease as a result of the discount. For group B, since the price elasticity of demand is 1.25 (demand is elastic), total revenue will increase as a result of the discount.
- If Nile.com wants to increase total revenue, it should definitely not offer the discount to group A and it should definitely offer the discount to group B.