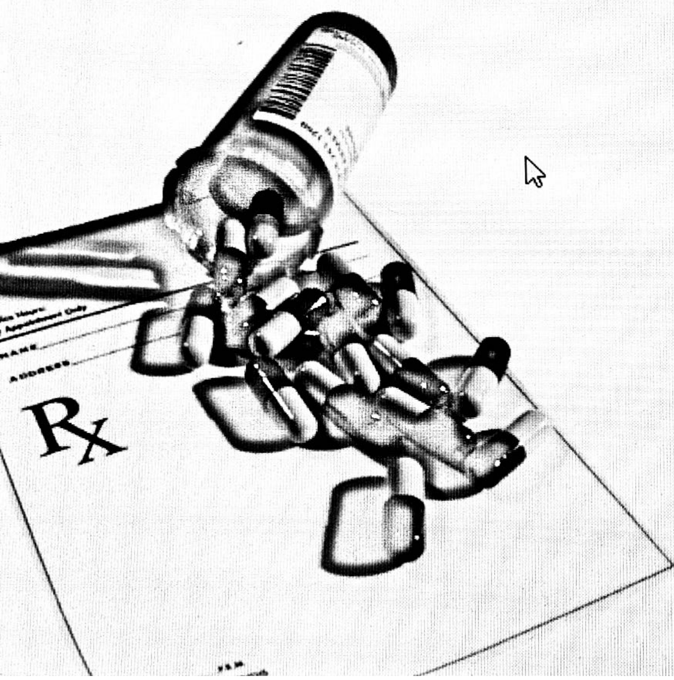
Describing Supply and Demand: Elasticities



"The master economist must understand symbols and speak in words. He must contemplate the particular in terms of the general, and touch abstract and concrete in the same flight of thought."

—J. M. Keynes

In 2014, firms increased the price of the antibiotic tetracycline from $0.03 to $2.36 a tablet. That's a 67-fold increase! They did it because they felt that the quantity demanded of tetracycline was not highly responsive to price, which meant that the increase in price would not significantly decrease the quantity demanded or, in economic terminology, that the demand for the antibiotic was highly price inelastic.

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After reading this chapter, you should be able to:

LO6-1 Use *elasticity* to describe the responsiveness of quantities to changes in price and distinguish five elasticity terms.

LO6-2 Explain the importance of substitution in determining elasticity of supply and demand.

LO6-3 Relate price elasticity of demand to total revenue.

LO6-4 Define and calculate income elasticity and cross-price elasticity of demand.

LO6-5 Explain how the concept of *elasticity* makes supply and demand analysis more useful.

highly price inelastic.

As you can see, information about elasticity is extremely important to firms in making their pricing decisions, and to economists in their study of the economy. That's one reason why grocery stores like shoppers to use their preferred-customer cards. These cards provide the stores with data about shopper behavior such as how sensitive shoppers are to price changes. Whenever a firm is thinking of changing its prices, it has a strong interest in elasticity.

Price Elasticity

The most commonly used elasticity concept is price elasticity of demand and supply. **Price elasticity of demand** is *the percentage change in quantity demanded divided by the percentage change in price:*

$$E_D = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

Price elasticity of supply is *the percentage change in quantity supplied divided by the percentage change in price:*

$$E_S = \frac{\text{Percentage change in quantity supplied}}{\text{Percentage change in price}}$$

Let's consider some numerical examples. Say the price of a good rises by 10 percent and, in response, quantity demanded falls by 20 percent. The price elasticity of demand is 2 (−20 percent/10 percent). Notice that I said 2, not −2. Because quantity demanded is inversely related to price, the calculation for the price elasticity of demand comes out negative. Despite this fact, economists talk about price elasticity of demand as a positive number. (Those of you who remember some math can think of elasticity as an *absolute value* of a number, rather than a simple number.) Using this convention makes it easier to remember that a *larger* number for price elasticity of demand means quantity demanded is *more responsive* to price.

Price elasticity is the percentage change in quantity divided by the percentage change in price.

Q-1 If when price rises by 4 percent, quantity supplied rises by 8 percent, what is the price elasticity of supply?

To make sure you have the idea down, let's consider two more examples. Say that when price falls by 5 percent, quantity supplied falls by 2 percent. In this case, the price elasticity of supply is 0.4 (2 percent/5 percent). And, finally, say the price goes up by 10 percent and in response the quantity demanded falls by 15 percent. Price elasticity of demand is 1.5 (15 percent/10 percent).

What Information Price Elasticity Provides

Price elasticity of demand and supply tells us exactly how quantity responds to a change in price. A price elasticity of demand of 0.3 tells us that a 10 percent rise in price will lead to a 3 percent decline in quantity demanded. If the elasticity of demand were a larger number, say 5, the same 10 percent rise in price will lead to a 50 percent decline in quantity demanded. As elasticity increases, quantity responds more to price changes.

Classifying Demand and Supply as Elastic or Inelastic

It is helpful to classify elasticities by relative responsiveness. Economists usually describe supply and demand by the terms *elastic* and *inelastic*. Formally, demand or supply is **elastic** if *the percentage change in quantity is greater than the percentage change in price* ($E > 1$). Conversely, demand or supply is **inelastic** if *the percentage change in quantity is less than the percentage change in price* ($E < 1$). In the last two examples, an elasticity of demand of 0.3 means demand is inelastic ($E_D < 1$), and an elasticity of demand of 5 means demand is elastic ($E_D > 1$).

Elastic: $E > 1$
Inelastic: $E < 1$

The commonsense interpretation of these terms is the following: An *inelastic* supply means that the quantity supplied doesn't change much with a change in price. For example, say the price of land rises. The amount of land supplied won't change much, so the supply of land is inelastic. An *elastic* supply means that quantity supplied changes by a larger percentage than the percentage change in price. For example, say the price of pencils doubles. What do you think will happen to the quantity of pencils supplied? I suspect it will more than double, which means that the supply of pencils is elastic.

The same terminology holds with demand. Consider a good such as Hulu, which has a close substitute, Netflix. If Hulu's price rises, the quantity demanded will fall a lot as people shift to the substitute (Netflix). So the demand for Hulu would be highly elastic. Alternatively, consider table salt, which has no close substitute, at least at current prices. Demand for table salt is highly inelastic. That is, a rise in the price of table salt does not result in a large decline in quantity demanded.

Q-2 If price elasticity of demand is greater than 1, what would we call demand: elastic or inelastic?

Elasticity Is Independent of Units

Before continuing, notice that elasticity measures the percentage, not the unit, change in variables. Using percentages allows us to measure responsiveness independent of units, making comparisons among different goods easier. Say a

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$1 increase in the price of a $1,000 computer decreases the quantity demanded by 1, from 10 to 9. Say also that a $1 increase in the price of a pen, from $1 to $2, decreases quantity demanded by 1—from 10,000 to 9,999. Using unit changes, the $1 price increase reduced the quantities demanded for both pens and computers by 1. But such a comparison of unit changes is not very helpful. To see that, ask yourself if you were planning on raising your price, which good you'd rather be selling.

The computer price increased by 1/1,000 of its original price, a relatively small percentage increase, and quantity demanded declined by 1/10 of original sales, a large percentage decline. The percentage decline in quantity demanded exceeded the percentage rise in price, so your total revenue (Price × Quantity) would decrease. The percentage increase in price of pens was relatively large—100 percent—and the percentage decline in quantity demanded was relatively small—1/100 of 1 percent. So if you raise the price of pens, total revenue increases. Clearly, if you're raising your price in these examples, you'd rather be selling pens than computers.

By using percentages, this is made clear: With computers, a 0.1 percent increase in price decreases quantity demanded by 10 percent, so the elasticity is 100. With pens, a 100 percent increase in price decreases quantity demanded by 0.01 percent—an elasticity of 0.0001.

Calculating Elasticities

To see that you've got the analysis down, calculate price elasticity of demand or supply in the following three real-world examples:

Case 1: When the City of London raised the daily toll motorists pay to drive in central London by 46 percent, the number of motorists driving in central London fell by 3 percent.

Case 2: In the 1980s, when gasoline prices rose by 10 percent in Washington, D.C., the quantity of gasoline demanded there fell by 40 percent.

Case 3: When the minimum wage in Vermont rose by 11 percent, the quantity of labor supplied for relevant jobs increased by about 1.7 percent.

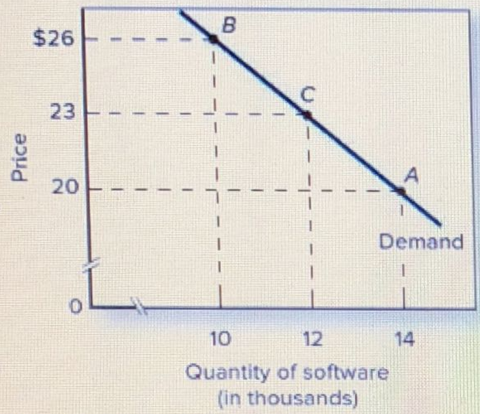
In the first case, price elasticity of demand is 0.07. The quantity of motorists in London did not change much when the toll was increased. Elasticity was less than 1, so demand was inelastic. In the second case, price elasticity of demand is 4. The quantity of gas demanded in Washington, D.C., responded by a lot to a relatively small change in gas prices. Elasticity was greater than 1, so demand was elastic. The price elasticity of supply in the third case is 0.16. The quantity of labor supplied did not respond much to the change in wage. Elasticity was less than 1, so supply was inelastic.

Let's now calculate some elasticities graphically. Let's begin by determining the price elasticity of demand between points *A* and *B* in Figure 6-1(a).

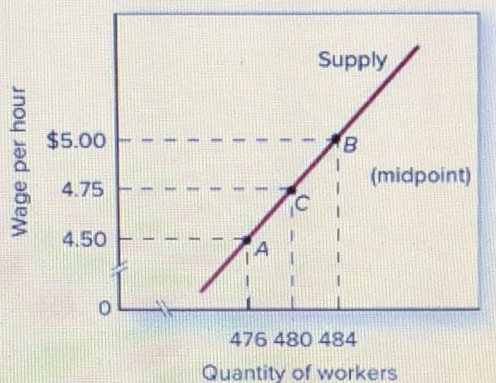
The demand curve in the figure is a hypothetical demand for WolfPack Simulation Software. You can see that as the price of the software rises from $20 to $26, the quantity demanded falls from 14,000 to 10,000 units a year. To determine the price elasticity of demand, we need to determine the percentage change in quantity and the percentage

FIGURE 6-1 (A AND B) Graphs of Elasticities

In (**a**) we are calculating the elasticity of the demand curve between *A* and *B*. We essentially calculate the midpoint and use that midpoint to calculate percentage changes. This gives us a percentage change in price of 26 percent and a percentage change in quantity of 33 percent, for an elasticity of 1.27. In (**b**) the percentage change in price is 10.53 percent and the percentage change in quantity is 1.87 percent, giving an elasticity of 0.18.



(a) Elasticity of Demand



(b) Elasticity of Supply

[(20 – 26)/20] × 100 = 30 percent. If, however, you calculate that same change in price, $6, as a fall in price from $26 to $20, the percentage decrease in price is [(26 – 20)/26] × 100 = 23 percent. The easiest way to solve this problem is to use the average of the two end values to calculate percentage change. In our example, instead of using 20 or 26 as a starting point, you use (20 + 26)/2, or 23. So the percentage change in price is

Economists use the average end values to get around the problem.

$$\frac{P_2 - P_1}{\frac{1}{2}(P_1 + P_2)} = \frac{(26 - 20)}{23} \times 100 = 26 \text{ percent}$$

Similarly, the percentage change in quantity is

$$\frac{Q_2 - Q_1}{\frac{1}{2}(Q_1 + Q_2)} = \frac{(10 - 14)}{12} \times 100 = -33 \text{ percent}$$

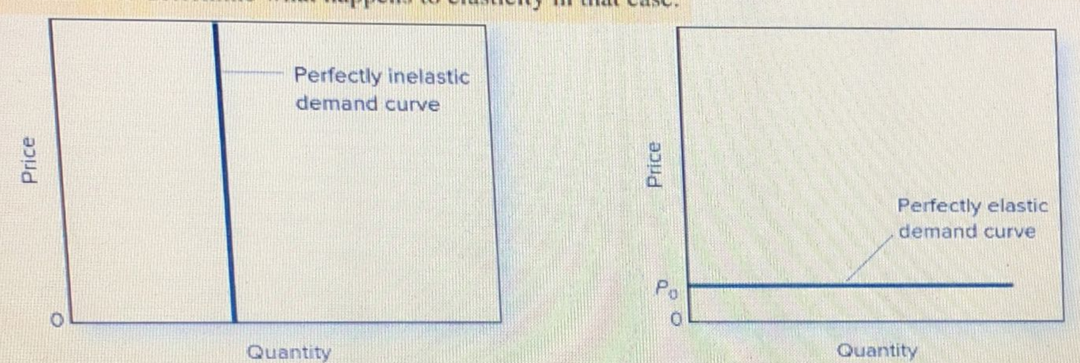
Having done this, we can calculate elasticity as usual by dividing the percentage change in quantity by the percentage change in price:[1]

$$\text{Elasticity} = \frac{\text{Percentage change in quantity}}{\text{Percentage change in price}} = \frac{-33}{26} = 1.27$$

The elasticity of demand between points *A* and *B* is approximately 1.3. This means that a 10 percent increase in price will cause a 13 percent fall in quantity demanded. Thus, demand between *A* and *B* is elastic.

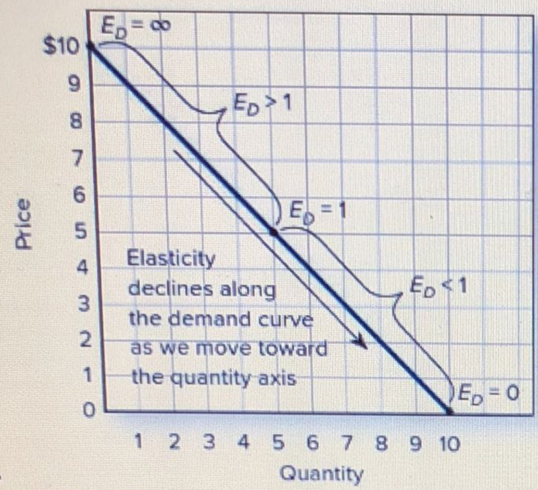
FIGURE 6-2 (A–D) Elasticities and Supply and Demand Curves

In (**a**) and (**b**), two special elasticity cases are shown. A perfectly inelastic curve is vertical; a perfectly elastic curve is horizontal. In (**c**) and (**d**), I show how elasticity generally varies along both supply and demand curves. Along demand curves, it always goes from infinity at the vertical-axis intercept to zero at the horizontal-axis intercept. How elasticity of supply varies depends on which axis the supply curve intersects. If it intersects the vertical axis, elasticity starts at infinity and declines, and eventually approaches 1. If it intersects the horizontal axis, it starts at zero and increases, and eventually approaches 1. The one exception is when the supply curve intersects the origin. A good exercise is to determine what happens to elasticity in that case.

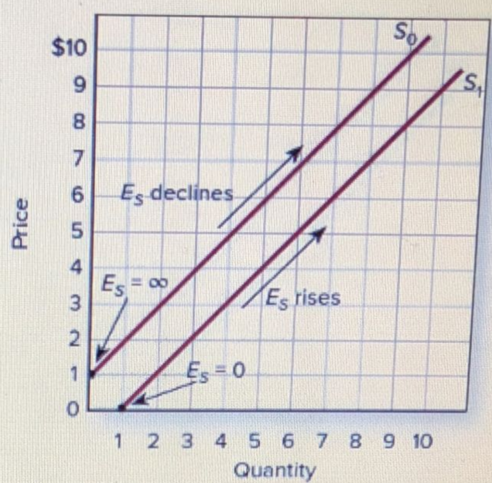


(a) Perfectly Inelastic Demand Curve

(b) Perfectly Elastic Demand Curve



(c) **Elasticity along a Demand Curve**



(d) **Elasticity along a Supply Curve**

change in price ($E = 1$). In Figure 6-2(c) demand is unit elastic at a price of \$5. To confirm this, calculate elasticity of demand between \$4 and \$6. The percentage change in price is $(2/5) \times 100 = 40$ percent, and the percentage change in quantity is $(2/5) \times 100 =$ 40 percent. The point at which demand is unit elastic divides the demand curve into two sections—an elastic portion ($E_D > 1$) above the point at which demand is unit elastic and an inelastic portion ($E_D < 1$) below the point at which demand is unit elastic.

The change in elasticity along a supply curve is less dramatic. At the point on a