

in—they faced a 60% price hike to retain the same service in 2011.

In early 2011, Netflix consumers paid about \$10 a month for a package consisting of streaming video and DVD rentals. In July 2011, the company announced a packaging change. Customers wishing to retain both streaming video and DVD rental would be charged \$15.98 per month, a price increase of about 60%. In 2014, Netflix also raised its streaming video subscription price from \$7.99 to \$8.99 per month for new U.S. customers. The company also changed its policy of 4K streaming content from \$9.00 to \$12.00 per month that year.

How would customers of the 18-year-old firm react? Would they abandon Netflix? Would the ease of access to other venues make a difference in how consumers responded to the Netflix price change? At the time, Netflix had few competitors; in the intervening years, the field has grown to ten major competitors and nearly 200 smaller ones. Is that likely to have a greater impact than the price changes? We will explore the answers to those questions in this chapter, which focuses on the change in quantity with respect to a change in price, a concept economists call elasticity.

Anyone who has studied economics knows the law of demand: a higher price will lead to a lower quantity demanded. What you may not know is how much lower the quantity demanded will be. Similarly, the law of supply states that a higher price will lead to a higher quantity supplied. The question is: How much higher? This chapter will explain how to answer these questions and why they are critically important in the real world.

To find answers to these questions, we need to understand the concept of elasticity. **Elasticity** is an economics concept that measures responsiveness of one variable to changes in another variable. Suppose you drop two items from a second-floor balcony. The first item is a tennis ball. The second item is a brick. Which will bounce higher? Obviously, the tennis ball. We would say that the tennis ball has greater elasticity.

Consider an economic example. Cigarette taxes are an example of a “sin tax,” a tax on something that is bad for you, like alcohol. Governments tax cigarettes at the state and national levels. As of 2021, state taxes ranged from a low of 17 cents per pack in Missouri to \$4.35 per pack in Connecticut and New York. The average state cigarette tax is \$1.76 per pack. The 2021 federal tax rate on cigarettes was \$1.01 per pack. In 2015, the Obama Administration proposed raising the federal tax nearly a dollar to \$1.95 per pack. The key question is: How much would cigarette purchases decline?

Taxes on cigarettes serve two purposes: to raise tax revenue for government and to discourage cigarette consumption. However, if a higher cigarette tax discourages consumption considerably, meaning a greatly reduced quantity of cigarette sales, then the cigarette tax on each pack will not raise much revenue for the government. Alternatively, a higher cigarette tax that does not discourage consumption by much will actually raise more tax revenue for the government. Thus, when a government agency tries to calculate the effects of altering its cigarette tax, it must analyze how much the tax affects the quantity of cigarettes consumed. This issue reaches beyond governments and taxes. Every firm faces a similar issue. When a firm considers raising the sales price, it must consider how much a price increase will reduce the quantity demanded of what it sells. Conversely, when a firm puts its products on sale, it must expect (or hope) that the lower price will lead to a significantly higher quantity demanded.

5.1 Price Elasticity of Demand and Price Elasticity of Supply

LEARNING OBJECTIVES

By the end of this section, you will be able to:

- Calculate the price elasticity of demand
- Calculate the price elasticity of supply

Both the demand and supply curve show the relationship between price and the number of units demanded or supplied. **Price elasticity** is the ratio between the percentage change in the quantity demanded (Qd) or supplied (Qs) and the corresponding percent change in price. The **price elasticity of demand** is the percentage

change in the quantity *demanded* of a good or service divided by the percentage change in the price. The **price elasticity of supply** is the percentage change in quantity *supplied* divided by the percentage change in price.

We can usefully divide elasticities into three broad categories: elastic, inelastic, and unitary. Because price and quantity demanded move in opposite directions, price elasticity of demand is always a negative number. Therefore, price elasticity of demand is usually reported as its absolute value, without a negative sign. The summary in [Table 5.1](#) is assuming absolute values for price elasticity of demand. An **elastic demand** or **elastic supply** is one in which the elasticity is greater than one, indicating a high responsiveness to changes in price. Elasticities that are less than one indicate low responsiveness to price changes and correspond to **inelastic demand** or **inelastic supply**. **Unitary elasticities** indicate proportional responsiveness of either demand or supply, as [Table 5.1](#) summarizes.

If . . .	Then . . .	And It Is Called . . .
% change in quantity > % change in price	$\frac{\% \text{ change in quantity}}{\% \text{ change in price}} > 1$	Elastic
% change in quantity = % change in price	$\frac{\% \text{ change in quantity}}{\% \text{ change in price}} = 1$	Unitary
% change in quantity < % change in price	$\frac{\% \text{ change in quantity}}{\% \text{ change in price}} < 1$	Inelastic

TABLE 5.1 Elastic, Inelastic, and Unitary: Three Cases of Elasticity

LINK IT UP

Before we delve into the details of elasticity, enjoy this [article \(http://openstax.org/l/Super_Bowl\)](http://openstax.org/l/Super_Bowl) on elasticity and ticket prices at the Super Bowl.

To calculate elasticity along a demand or supply curve economists use the average percent change in both quantity and price. This is called the Midpoint Method for Elasticity, and is represented in the following equations:

$$\% \text{ change in quantity} = \frac{Q_2 - Q_1}{(Q_2 + Q_1)/2} \times 100$$

$$\% \text{ change in price} = \frac{P_2 - P_1}{(P_2 + P_1)/2} \times 100$$

The advantage of the Midpoint Method is that one obtains the same elasticity between two price points whether there is a price increase or decrease. This is because the formula uses the same base (average quantity and average price) for both cases.

Calculating Price Elasticity of Demand

Let's calculate the elasticity between points A and B and between points G and H as [Figure 5.2](#) shows.

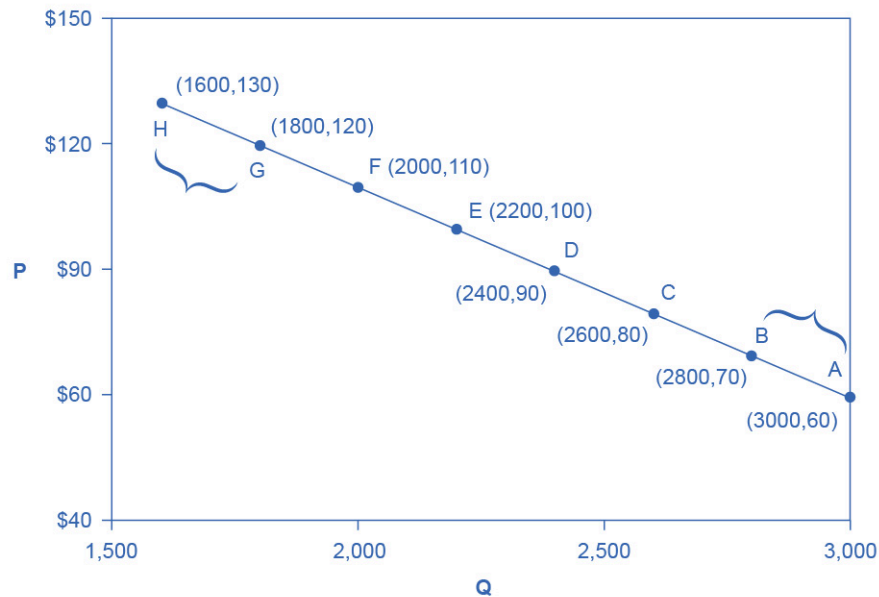


FIGURE 5.2 Calculating the Price Elasticity of Demand We calculate the price elasticity of demand as the percentage change in quantity divided by the percentage change in price.

First, apply the formula to calculate the elasticity as price decreases from \$70 at point B to \$60 at point A:

$$\begin{aligned}
 \% \text{ change in quantity} &= \frac{3,000 - 2,800}{(3,000 + 2,800)/2} \times 100 \\
 &= \frac{200}{2,900} \times 100 \\
 &= 6.9 \\
 \% \text{ change in price} &= \frac{60 - 70}{(60 + 70)/2} \times 100 \\
 &= \frac{-10}{65} \times 100 \\
 &= -15.4 \\
 \text{Price Elasticity of Demand} &= \frac{6.9\%}{-15.4\%} \\
 &= 0.45
 \end{aligned}$$

Therefore, the elasticity of demand between these two points is $\frac{6.9\%}{-15.4\%}$ which is 0.45, an amount smaller than one, showing that the demand is inelastic in this interval. Price elasticities of demand are *always* negative since price and quantity demanded always move in opposite directions (on the demand curve). By convention, we always talk about elasticities as positive numbers. Mathematically, we take the absolute value of the result. We will ignore this detail from now on, while remembering to interpret elasticities as positive numbers.

This means that, along the demand curve between point B and A, if the price changes by 1%, the quantity demanded will change by 0.45%. A change in the price will result in a smaller percentage change in the quantity demanded. For example, a 10% *increase* in the price will result in only a 4.5% *decrease* in quantity demanded. A 10% *decrease* in the price will result in only a 4.5% *increase* in the quantity demanded. Price elasticities of demand are negative numbers indicating that the demand curve is downward sloping, but we read them as absolute values. The following Work It Out feature will walk you through calculating the price elasticity of demand.

WORK IT OUT

Finding the Price Elasticity of Demand

Calculate the price elasticity of demand using the data in [Figure 5.2](#) for an increase in price from G to H. Has the elasticity increased or decreased?

Step 1. We know that:

$$\text{Price Elasticity of Demand} = \frac{\% \text{ change in quantity}}{\% \text{ change in price}}$$

Step 2. From the Midpoint Formula we know that:

$$\% \text{ change in quantity} = \frac{Q_2 - Q_1}{(Q_2 + Q_1)/2} \times 100$$

$$\% \text{ change in price} = \frac{P_2 - P_1}{(P_2 + P_1)/2} \times 100$$

Step 3. So we can use the values provided in the figure in each equation:

$$\begin{aligned} \% \text{ change in quantity} &= \frac{1,600 - 1,800}{(1,600 + 1,800)/2} \times 100 \\ &= \frac{-200}{1,700} \times 100 \\ &= -11.76 \end{aligned}$$

$$\begin{aligned} \% \text{ change in price} &= \frac{130 - 120}{(130 + 120)/2} \times 100 \\ &= \frac{10}{125} \times 100 \\ &= 8.0 \end{aligned}$$

Step 4. Then, we can use those values to determine the price elasticity of demand:

$$\begin{aligned} \text{Price Elasticity of Demand} &= \frac{\% \text{ change in quantity}}{\% \text{ change in price}} \\ &= \frac{-11.76}{8} \\ &= -1.47 \end{aligned}$$

Therefore, the elasticity of demand from G to H is 1.47. The magnitude of the elasticity has increased (in absolute value) as we moved up along the demand curve from points A to B. Recall that the elasticity between these two points was 0.45. Demand was inelastic between points A and B and elastic between points G and H. This shows us that price elasticity of demand changes at different points along a straight-line demand curve.

Calculating the Price Elasticity of Supply

Assume that an apartment rents for \$650 per month and at that price the landlord rents 10,000 units as [Figure 5.3](#) shows. When the price increases to \$700 per month, the landlord supplies 13,000 units into the market. By what percentage does apartment supply increase? What is the price sensitivity?

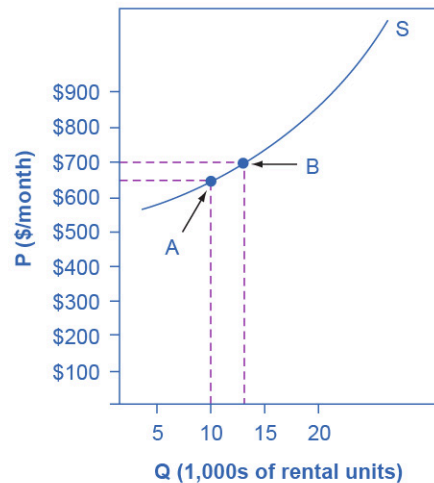


FIGURE 5.3 Price Elasticity of Supply We calculate the price elasticity of supply as the percentage change in quantity divided by the percentage change in price.

Using the Midpoint Method,

$$\begin{aligned}
 \% \text{ change in quantity} &= \frac{13,000 - 10,000}{(13,000 + 10,000)/2} \times 100 \\
 &= \frac{3,000}{11,500} \times 100 \\
 &= 26.1 \\
 \% \text{ change in price} &= \frac{\$700 - \$650}{(\$700 + \$650)/2} \times 100 \\
 &= \frac{\$50}{675} \times 100 \\
 &= 7.4 \\
 \text{Price Elasticity of Supply} &= \frac{26.1\%}{7.4\%} \\
 &= 3.53
 \end{aligned}$$

Again, as with the elasticity of demand, the elasticity of supply is not followed by any units. Elasticity is a ratio of one percentage change to another percentage change—nothing more—and we read it as an absolute value. In this case, a 1% rise in price causes an increase in quantity supplied of 3.5%. The greater than one elasticity of supply means that the percentage change in quantity supplied will be greater than a one percent price change. If you're starting to wonder if the concept of slope fits into this calculation, read the following Clear It Up box.



CLEAR IT UP

Is the elasticity the slope?

It is a common mistake to confuse the slope of either the supply or demand curve with its elasticity. The slope is the rate of change in units along the curve, or the rise/run (change in y over the change in x). For example, in [Figure 5.2](#), at each point shown on the demand curve, price drops by \$10 and the number of units demanded increases by 200 compared to the point to its left. The slope is $-10/200$ along the entire demand curve and does not change. The price elasticity, however, changes along the curve. Elasticity between points A and B was 0.45 and increased to 1.47 between points G and H. Elasticity is the *percentage* change, which is a different calculation from the slope and has a different meaning.

When we are at the upper end of a demand curve, where price is high and the quantity demanded is low, a small change in the quantity demanded, even in, say, one unit, is pretty big in percentage terms. A change in price of, say, a dollar, is going to be much less important in percentage terms than it would have been at the bottom of the

demand curve. Likewise, at the bottom of the demand curve, that one unit change when the quantity demanded is high will be small as a percentage.

Thus, at one end of the demand curve, where we have a large percentage change in quantity demanded over a small percentage change in price, the elasticity value would be high, or demand would be relatively elastic. Even with the same change in the price and the same change in the quantity demanded, at the other end of the demand curve the quantity is much higher, and the price is much lower, so the percentage change in quantity demanded is smaller and the percentage change in price is much higher. That means at the bottom of the curve we'd have a small numerator over a large denominator, so the elasticity measure would be much lower, or inelastic.

As we move along the demand curve, the values for quantity and price go up or down, depending on which way we are moving, so the percentages for, say, a \$1 difference in price or a one unit difference in quantity, will change as well, which means the ratios of those percentages and hence the elasticity will change.

5.2 Polar Cases of Elasticity and Constant Elasticity

LEARNING OBJECTIVES

By the end of this section, you will be able to:

- Differentiate between infinite and zero elasticity
- Analyze graphs in order to classify elasticity as constant unitary, infinite, or zero

There are two extreme cases of elasticity: when elasticity equals zero and when it is infinite. A third case of interest is that of constant unitary elasticity. We will describe each case. **Infinite elasticity** or **perfect elasticity** refers to the extreme case where either the quantity demanded (Q_d) or supplied (Q_s) changes by an infinite amount in response to any change in price at all. In both cases, the supply and the demand curve are horizontal as [Figure 5.4](#) shows. While perfectly elastic supply curves are for the most part unrealistic, goods with readily available inputs and whose production can easily expand will feature highly elastic supply curves. Examples include pizza, bread, books, and pencils. Similarly, perfectly elastic demand is an extreme example. However, luxury goods, items that take a large share of individuals' income, and goods with many substitutes are likely to have highly elastic demand curves. Examples of such goods are Caribbean cruises and sports vehicles.

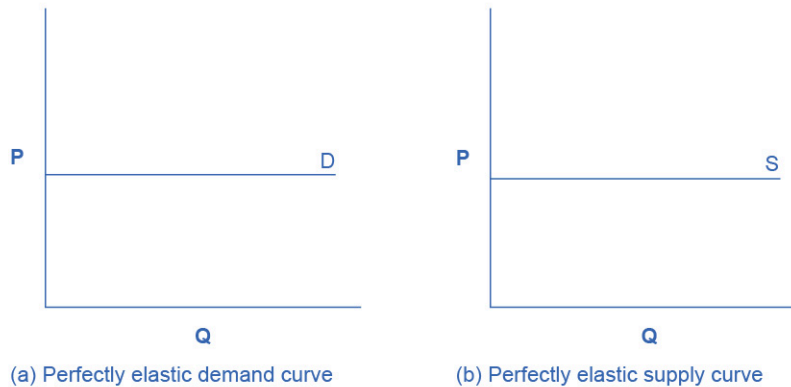


FIGURE 5.4 Infinite Elasticity The horizontal lines show that an infinite quantity will be demanded or supplied at a specific price. This illustrates the cases of a perfectly (or infinitely) elastic demand curve and supply curve. The quantity supplied or demanded is extremely responsive to price changes, moving from zero for prices close to P to infinite when prices reach P .

Zero elasticity or **perfect inelasticity**, as [Figure 5.5](#) depicts, refers to the extreme case in which a percentage change in price, no matter how large, results in zero change in quantity. While a perfectly inelastic supply is an extreme example, goods with limited supply of inputs are likely to feature highly inelastic supply curves. Examples include diamond rings or housing in prime locations such as apartments facing Central Park in New