

5.13: Income Elasticity, Cross-Price Elasticity and Other Types of Elasticities

Learning Objectives

- Calculate the income elasticity of demand
- Explain and calculate cross-price elasticity of demand
- Describe elasticity in labor and financial capital markets



Figure 1. S'more ingredients: negative or positive cross-price elasticities of demand?

The basic idea of elasticity—how a percentage change in one variable causes a percentage change in another variable—does not just apply to the responsiveness of supply and demand to changes in the price of a product. Recall that quantity demanded (Q_d) depends on income, tastes and preferences, population, expectations about future prices, and the prices of related goods. Similarly, quantity supplied (Q_s) depends on the cost of production, changes in weather (and natural conditions), new technologies, and government policies. Elasticity can, in principle, be measured for any determinant of supply and demand, not just the price.

Income Elasticity of Demand

The **income elasticity of demand** is the percentage change in quantity demanded divided by the percentage change in income, as follows:

$$\text{income elasticity of demand} = \frac{\text{percent change in quantity demanded}}{\text{percent change in income}}$$

For most products, most of the time, the income elasticity of demand is positive: that is, a rise in income will cause an increase in the quantity demanded. This pattern is common enough that these goods are referred to as **normal goods**. However, for a few goods, an increase in income means that one might purchase less of the good; for example, those with a higher income might buy fewer hamburgers, because they are buying more steak instead, or those with a higher income might buy less cheap wine and more imported beer. When the income elasticity of demand is negative, the good is called an **inferior good**. The concepts of normal and inferior goods were introduced in the Supply and Demand module. A higher level of income for a normal good causes a demand curve to shift to the right for a normal good, which means that the income elasticity of demand is positive. How far the demand shifts depends on the income elasticity of demand. A higher income elasticity means a larger shift. However, for an inferior good—that is, when the income elasticity of demand is negative—a higher level of income would cause the demand curve for that good to shift to the left. Again, how much it shifts depends on how large the (negative) income elasticity is.

Watch It

Watch this video for an applied example of calculating the income elasticity of demand.

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Cross-Price Elasticity of Demand

A change in the price of one good can shift the quantity demanded for another good. If the two goods are complements, like bread and peanut butter, then a drop in the price of one good will lead to an increase in the quantity demanded of the other good. However, if the two goods are substitutes, like plane tickets and train tickets, then a drop in the price of one good will cause people to substitute toward that good, and to reduce consumption of the other good. Cheaper plane tickets lead to fewer train tickets, and vice versa. The **cross-price elasticity of demand** puts some meat on the bones of these ideas. The term “cross-price” refers to the idea that the price of one good is affecting the quantity demanded of a different good. Specifically, the cross-price elasticity of demand is the percentage change in the quantity of good A that is demanded as a result of a percentage change in the price of good B, as follows:

$$\text{cross-price elasticity of demand} = \frac{\text{percent change in } Q_{\text{of good } A}}{\text{percent change in price of good } B}$$

Substitute goods have positive cross-price elasticities of demand: if good A is a substitute for good B, like coffee and tea, then a higher price for B will mean a greater quantity of A consumed. Complement goods have negative cross-price elasticities: if good A is a complement for good B, like coffee and sugar, then a higher price for B will mean a lower quantity of A consumed.

Exercise: Calculating Cross-Price Elasticity of Demand

Let’s practice calculating cross-price elasticity of demand by looking at two goods: widgets and sprockets. The initial price and quantity of widgets demanded is ($P_1 = 12$, $Q_1 = 8$). The subsequent price and quantity is ($P_2 = 9$, $Q_2 = 10$). This is all the information needed to compute the price elasticity of demand.

The price elasticity of demand is defined as follows:

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

From the midpoint formula, we know that:

$$\text{percent change in quantity} = \frac{Q_2 - Q_1}{(Q_2 + Q_1) \div 2} \times 100 = \frac{10 - 8}{(10 + 8) \div 2} \times 100 = \frac{2}{9} \times 100 = 22.2$$

And:

$$\text{percent change in price} = \frac{P_2 - P_1}{(P_2 + P_1) \div 2} \times 100 = \frac{9 - 12}{(9 + 12) \div 2} \times 100 = \frac{-3}{10.5} \times 100 = -28.6$$

Therefore:

$$\text{Price Elasticity of Demand} = \frac{22.2 \text{ percent}}{-28.6 \text{ percent}} = -0.77$$

Since the elasticity is less than 1 (in absolute value), we can say that the price elasticity of demand for widgets is in the inelastic range.

The cross-price elasticity of demand is computed similarly:

$$\text{Cross-Price Elasticity of Demand} = \frac{\text{percent change in quantity of sprockets demanded}}{\text{percent change in price of widgets}}$$

The initial quantity of sprockets demanded is 9 and the subsequent quantity demanded is 10 ($Q_1 = 9$, $Q_2 = 10$).

Using the midpoint formula, we can calculate the percent change in the quantity of sprockets demanded:

$$\text{percent change in quantity} = \frac{Q_2 - Q_1}{(Q_2 + Q_1) \div 2} \times 100 = \frac{10 - 9}{(10 + 9) \div 2} \times 100 = \frac{1}{9.5} \times 100 = 10.5$$

The percent change in the quantity of sprockets demanded is 10.5%.

The percent change in the price of widgets is the same as above, or -28.6%.

Therefore:

$$\text{Cross-Price Elasticity of Demand} = \frac{10.5 \text{ percent}}{-28.6 \text{ percent}} = -0.37$$

Because the cross-price elasticity is negative, we can conclude that widgets and sprockets are complementary goods. Intuitively, when the price of widgets goes down, consumers purchase more widgets. Because they’re purchasing more widgets, they purchase more sprockets.

Watch It

Watch this video to see an example of solving for the cross-price elasticity of demand.

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Elasticity in Labor and Financial Capital Markets

The concept of elasticity applies to any market, not just markets for goods and services. In the labor market, for example, the **wage elasticity of labor supply**—that is, the percentage change in hours worked divided by the percentage change in wages—will determine the shape of the labor supply curve. The formula is as follows:

$$\text{elasticity of labor supply} = \frac{\text{percent change in quantity of labor supplied}}{\text{percent change in wage}}$$

The wage elasticity of labor supply for teenage workers is generally thought to be fairly elastic: that is, a certain percentage change in wages will lead to a larger percentage change in the quantity of hours worked. Conversely, the wage elasticity of labor supply for adult workers in their thirties and forties is thought to be fairly inelastic. When wages move up or down by a certain percentage amount, the quantity of hours that adults in their prime earning years are willing to supply changes but by a lesser percentage amount. In markets for financial capital, the **interest elasticity of savings**—that is, the percentage change in the quantity of savings divided by the percentage change in interest rates—will describe the shape of the supply curve for financial capital, as follows:

$$\text{interest elasticity of savings} = \frac{\text{percent change in quantity of financial savings}}{\text{percent change in interest rate}}$$

Sometimes laws are proposed that seek to increase the quantity of savings by offering tax breaks so that the return on savings is higher. Such a policy will increase the quantity if the supply curve for financial capital is elastic, because then a given percentage increase in the return to savings will cause a higher percentage increase in the quantity of savings. However, if the supply curve for financial capital is highly inelastic, then a percentage increase in the return to savings will cause only a small increase in the quantity of savings. The evidence on the supply curve of financial capital is controversial but, at least in the short run, the elasticity of savings with respect to the interest rate appears fairly inelastic.

Expanding the Concept of Elasticity

The elasticity concept does not even need to relate to a typical supply or demand curve at all. For example, imagine that you are studying whether the Internal Revenue Service should spend more money on auditing tax returns. The question can be framed in terms of the elasticity of tax collections with respect to spending on tax enforcement; that is, what is the percentage change in tax collections derived from a percentage change in spending on tax enforcement? With all of the elasticity concepts that have just been described, some of which are listed in Table 1, the possibility of confusion arises. When you hear the phrases “elasticity of demand” or “elasticity of supply,” they refer to the elasticity with respect to price. Sometimes, either to be extremely clear or because a wide variety of elasticities is being discussed, the elasticity of demand or the demand elasticity will be called the price elasticity of demand or the “elasticity of demand with respect to price.” Similarly, elasticity of supply or the supply elasticity is sometimes called, to avoid any possibility of confusion, the price elasticity of supply or “the elasticity of supply with respect to price.” But in whatever context elasticity is invoked, the idea always refers to percentage change in one variable, almost always a price or money variable, and how it causes a percentage change in another variable, typically a quantity variable of some kind.

Table 1. Formulas for Calculating Elasticity

Elasticity Type	Formula
Income elasticity of demand	=%change in Qd / % change in income
Cross-price elasticity of demand	=% change in Qd of good A / % change in price of good B
Wage elasticity of labor supply	=% change in quantity of labor supplied / % change in wage

Wage elasticity of labor demand	=% change in quantity of labor demanded / % change in wage
Interest rate elasticity of savings	=% change in quantity of savings / % change in interest rate
Interest rate elasticity of borrowing	=% change in quantity of borrowing / % change in interest rate

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Glossary

[glossary-term]cross-price elasticity of demand: [glossary-definition]the percentage change in the quantity of good A that is demanded as a result of a percentage change in good B[/glossary-definition]
[glossary-term]interest elasticity of savings: [glossary-definition]the percentage change in the quantity of savings divided by the percentage change in interest rates[/glossary-definition]
[glossary-term]wage elasticity of labor supply: [glossary-definition]the percentage change in hours worked divided by the percentage change in wages[/glossary-definition]

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