Elasticity of Demand

- **Price elasticity** measures the responsiveness of the quantity demanded or supplied of a good to a change in its price. It is computed as the percentage change in quantity demanded—or supplied—divided by the percentage change in price.
- Elasticity can be described as **elastic**—or very responsive—**unit elastic**, or **inelastic**—not very responsive.
- *Elastic* demand or supply curves indicate that the quantity demanded or supplied responds to price changes in a greater than proportional manner.
- An *inelastic* demand or supply curve is one where a given percentage change in price will cause a smaller percentage change in quantity demanded or supplied.
- *Unitary elasticity* means that a given percentage change in price leads to an equal percentage change in quantity demanded or supplied.

What is price elasticity?

Both demand and supply curves 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, or supplied 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.

Elasticities can be usefully divided into five broad categories: perfectly elastic, elastic, perfectly inelastic, inelastic, and unitary. An *elastic demand* or *elastic supply* is one in which the elasticity is greater than one, indicating a high responsiveness to changes in price. An *inelastic demand* or *inelastic supply* is one in which elasticity is less than one, indicating low responsiveness to price changes. *Unitary elasticities* indicate proportional responsiveness of either demand or supply.

Perfectly elastic and *perfectly inelastic* refer to the two extremes of elasticity. Perfectly elastic means the response to price is complete and infinite: a change in price results in the quantity falling to zero. Perfectly inelastic means that there is no change in quantity at all when price changes.

$$\frac{\%\text{ change in quantity}}{\%\text{ change in price}} = \infty \quad \text{Perfectly elasti}$$

$$\frac{\%\text{ change in quantity}}{\%\text{ change in price}} > 1 \quad \text{Elastic}$$

$$\frac{\%\text{ change in quantity}}{\%\text{ change in price}} = 1 \quad \text{Unitary}$$

$$\frac{\%\text{ change in quantity}}{\%\text{ change in price}} < 1 \quad \text{Inelastic}$$

$$\frac{\%\text{ change in quantity}}{\%\text{ change in price}} = 0 \quad \text{Perfectly inelastic}$$

the midpoint method to calculate elasticity

To calculate elasticity, instead of using simple percentage changes in quantity and price, economists sometimes use the average percent change in both quantity and price. This is called the **Midpoint Method for Elasticity**:

$$\text{Midpoint method for elasticity} = \frac{\frac{Q_2 - Q_1}{\left(\frac{Q_2 + Q_1}{2}\right)}}{\frac{P_2 - P_1}{\left(\frac{P_2 + P_1}{2}\right)}}$$

The advantage of the midpoint method is that we get the same elasticity between two price points whether there is a price increase or decrease. This is because the formula uses the same base for both cases. The midpoint method is referred to as the **arc elasticity** in some textbooks.

Using the point elasticity of demand to calculate elasticity

A drawback of the midpoint method is that as the two points get farther apart, the elasticity value loses its meaning. For this reason, some economists prefer to use the **point elasticity** method. In this method, you need to know what values represent the initial values and what values represent the new values.

$$\text{Point elasticity} = \frac{\dfrac{\text{new } Q - \text{initial } Q}{\text{initial } Q}}{\dfrac{\text{initial } P - \text{new } P}{\text{initial } P}}$$

Arc Elasticity

Arc elasticity is the elasticity of one variable with respect to another between two given points. It is used when there is no general function to define the relationship between the two variables.

Arc elasticity is also defined as the elasticity between two points on a curve. The concept is used in both mathematics and economics.

The Formula for the Arc Price Elasticity of Demand Is

$$PE_d = \frac{\%\text{ Change in Qty}}{\%\text{ Change in Price}}$$

How to Calculate the Arc Price Elasticity of Demand

If the price of a product decreases from $10 to $8, leading to an increase in quantity demanded from 40 to 60 units, then the price elasticity of demand can be calculated as:

- **% change in quantity demanded** = $(Qd_2 - Qd_1) / Qd_1 = (60 - 40) / 40 = 0.5$
- **% change in price** = $(P_2 - P_1) / P_1 = (8 - 10) / 10 = -0.2$
- Thus, $\mathbf{PE_d} = 0.5 / -0.2 = 2.5$

What Does Arc Elasticity Tell You?

In economics, there are two possible ways of calculating elasticity of demand—price (or point) elasticity of demand and arc elasticity of demand. The arc price elasticity of demand measures the responsiveness of quantity demanded to a price. It takes the elasticity of demand at a particular point on the demand curve, or between two points on the curve.

- In the concept of arc elasticity, elasticity is measured over the arc of the demand curve on a graph.
- Arc elasticity calculations give the elasticity using the midpoint between two points.
- The arc elasticity is more useful for larger price changes and gives the same elasticity outcome whether price falls or rises.

Arc Elasticity of Demand

One of the problems with the price elasticity of demand formula is that it gives different values depending on whether price rises or falls. If you were to use different start and end points in our example above—that is, if you assume the price increased from $8 to $10—and the quantity demanded decreased from 60 to 40, the Pe_d will be:

- **% change in quantity demanded** = (40 – 60) / 60 = -0.33
- **% change in price** = (10 – 8) / 8 = 0.25
- **PE_d** = -0.33 / 0.25 = 1.32, which is much different from 2.5

To eliminate this problem, the arc elasticity can be used. Arc elasticity measures elasticity at the midpoint between two selected points on the demand curve by using a midpoint between the two points. The arc elasticity of demand can be calculated as:

- **Arc E_d** = $[(Qd_2 - Qd_1) / \text{midpoint } Qd] \div [(P_2 - P_1) / \text{midpoint } P]$

Cross Elasticity of Demand

The cross elasticity of demand is an economic concept that measures the responsiveness in the quantity demanded of one good when the price for another good changes. Also called cross-price elasticity of demand, this measurement is calculated by taking the percentage change in the quantity demanded of one good and dividing it by the percentage change in the price of the other good.

- The cross elasticity of demand is an economic concept that measures the responsiveness in the quantity demanded of one good when the price for another good changes.
- The cross elasticity of demand for substitute goods is always positive because the demand for one good increases when the price for the substitute good increases.
- Alternatively, the cross elasticity of demand for complementary goods is negative.

In economics, the elasticity of demand refers to how sensitive the demand for a good is to changes in other economic variables, such as price or consumer income.

Substitute Goods

The cross elasticity of demand for substitute goods is always positive because the demand for one good increases when the price for the substitute good increases. For example, if the price of coffee increases, the quantity demanded for tea (a substitute beverage) increases as consumers switch to a less expensive yet substitutable alternative. This is reflected in the cross elasticity of demand formula, as both the numerator (percentage change in the demand of tea) and denominator (the price of coffee) show positive increases.

Items with a coefficient of 0 are unrelated items and are goods independent of each other. Items may be weak substitutes, in which the two products have a positive but low cross elasticity of demand. This is often the case for different product substitutes, such as tea versus coffee. Items that are strong substitutes have a higher cross-elasticity of demand. Consider different brands of tea; a price increase in one company's green tea has a higher impact on another company's green tea demand.

Complementary Goods

Alternatively, the cross elasticity of demand for complementary goods is negative. As the price for one item increases, an item closely associated with that item and necessary for its consumption decreases because the demand for the main good has also dropped.

For example, if the price of coffee increases, the quantity demanded for coffee stir sticks drops as consumers are drinking less coffee and need to purchase fewer sticks. In the formula, the numerator (quantity demanded of stir sticks) is negative and the denominator (the price of coffee) is positive. This results in a negative cross elasticity.

Toothpaste is an example of a substitute good; if the price of one brand of toothpaste increases, the demand for a competitor's brand of toothpaste increases in turn.

Usefulness of Cross Elasticity of Demand

Companies utilize cross-elasticity of demand to establish prices to sell their goods. Products with no substitutes have the ability to be sold at higher prices because there is no cross-elasticity of demand to consider. However, incremental price changes to goods with substitutes are analyzed to determine the appropriate level of demand desired and the associated price of the good.

Additionally, complementary goods are strategically priced based on cross-elasticity of demand. For example, printers may be sold at a loss with the understanding that the demand for future complementary goods, such as printer ink, should increase.