

1.2 Elasticities

Price elasticity of demand and its determinants

- Explain the concept of price elasticity of demand, understanding that it involves responsiveness of quantity demanded to a change in price, along a given demand curve.
- Calculate PED using the PED equation.
- State that the PED value is treated as if it were positive although its mathematical value is usually negative.
- Explain, using diagrams and PED values, the concepts of price elastic demand, price inelastic demand, unit elastic demand, perfectly elastic demand and perfectly inelastic demand.
- Explain the determinants of PED, including the number and closeness of substitutes, the degree of necessity, time and the proportion of income spent on the good.
- Calculate PED between two designated points on a demand curve using the PED equation.
- Explain why PED varies along a straight line demand curve and is not represented by the slope of the demand curve

Introduction to elasticities

Elasticity is an economic concept that refers to the responsiveness among consumers or producers to a change in a variable that affects either the market demand or the market supply. There are four types of elasticity that we will study in this unit:

- **Price Elasticity of Demand (PED):** Measures the responsiveness of consumers of a particular good to a change in the good's price.
- **Price elasticity of Supply (PES):** Measures the responsiveness of producers of a particular good to a change in the price of that good.
- **Cross-price elasticity of Demand (XED):** Measures the responsiveness of consumers of one good to a change in the price of a related good (either a substitute or a complement).
- **Income Elasticity of Demand (YED):** Measures the responsiveness of consumers of a particular good to a change in their income.

Price elasticity of demand – definition and formula

Price Elasticity of Demand (PED) is a measurement of how much the quantity demanded for a good will change as a result of a particular change in the good's price. PED can range from a value of 0 to infinity, and is calculated using the following formula:

PED = The percentage change in the quantity of a good demanded ÷ The percentage change in the price of the good, or

$$PED = \frac{\% \Delta Q_d}{\% \Delta P}$$

If, for example, we know that an increase in the price of bananas from \$4 to \$6 caused the quantity demanded to fall from 1,000 bananas to 800 bananas, we can calculate the PED for bananas.

$$\% \Delta Q_d = (800 - 1000) \div 1000 = -0.2 \times 100 = -20\%$$

$$\% \Delta P = (6 - 4) \div 4 = 0.5 \times 100 = 50\%$$

$$PED = (-20) \div 50 = -0.4$$

Notice that our PED has a negative value.

- This reflects the law of demand
- Whichever direction the price of good moves in, the quantity will always move in the opposite direction
- Since PED will always be negative, we can refer to it in its absolute value. So, the PED for bananas is 0.4.

Interpretation of the PED coefficient:	
If PED is less than 1:	Demand is inelastic . This means that the percentage change in the quantity is less than the percentage change in the price.
If PED is greater than 1	Demand is elastic . The percentage change in the quantity is greater than the percentage change in the price.
If PED=0:	Demand is perfectly inelastic . There was no change in quantity resulting from the price change.
If PED=1:	Demand is unit elastic . The percentage change in the quantity was identical to the percentage change in the price.
If PED = infinity:	Demand is perfectly elastic . The smallest increase in price causes the quantity demanded to fall to ZERO.

Interpretation of PED

Demand for bananas was 0.4. Based on our interpretations of PED from the table above, we know that demand for bananas is inelastic.

- For every 1% increase in the price of bananas between \$4 and \$6, the quantity demanded fell by 0.4%.
- Since price increased by a total of 50%, the quantity fell by a total of just 20%.
- Consumers are relatively unresponsive to the price of bananas.

The determinants of PED

Whether demand for a good at a particular price is elastic or inelastic depends on several characteristics of the good itself. Just how much will consumers respond to a price change for the good? The following table presents some of the primary **determinants of PED**.

S	Substitutes	The number of substitutes available. The more substitutes, more elastic demand, as consumers can replace a good whose price has gone up with one of its now relatively cheaper substitutes.
P	Proportion of income	The proportion of income the purchase of a good represents. If a good represent a higher proportion of a consumer's income, his demand tends to be more elastic.
L	Luxury or necessity?	Luxury or necessity? If a good is a necessity, changes in price tend not to affect quantity demand, i.e. demand is inelastic. If it's a luxury that a consumer can go without, consumers tend to be more responsive.
A	Addictive?	If a product is addictive or habit forming, demand tends to be inelastic.
T	Time	The amount of time a consumer has to respond to the price change. If prices remain high over a longer period of time, consumers can find substitutes or learn to live without, so demand is more elastic over time.

Applications of price elasticity of demand

- Examine the role of PED for firms in making decisions regarding price changes and their effect on total revenue.
- Explain why the PED for many primary commodities is relatively low and the PED for manufactured products is relatively high.
- Examine the significance of PED for government in relation to indirect taxes.

The PED formula is useful for more than just telling us how much consumers respond to price changes. It can be very useful to businesses and government decision-making.

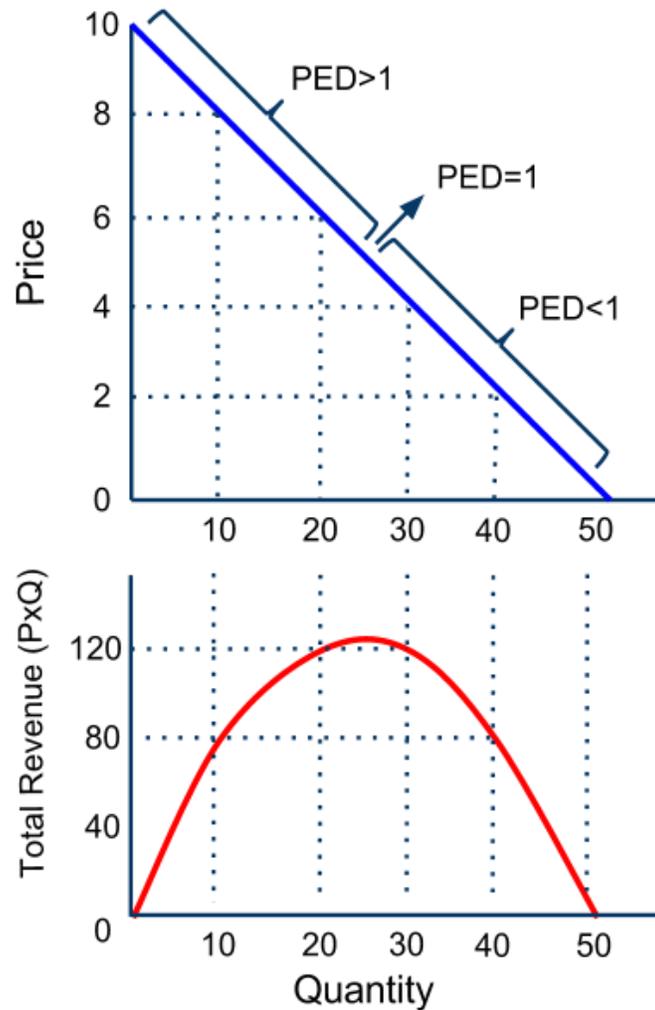
Applications of PED for	
Businesses	<p>Businesses benefit from knowing how responsive their consumers are to price changes at any given time.</p> <ul style="list-style-type: none"> • If a seller knows demand is HIGHLY elastic, he may wish to lower the price and capture many new customers. • If a seller knows demand is highly inelastic, he may wish to raise his price as he will not lose many sellers but will enjoy higher revenues.
Government	<p>The government needs to know how consumers will respond to taxes imposed on particular goods. For example, if the government wishes to raise revenues from taxing goods, it should know that:</p> <ul style="list-style-type: none"> • A tax on restaurant meals (relatively elastic) will not raise much revenue because people will just stop going to restaurants. • A tax on cigarettes (relatively inelastic) will raise lots of revenue because most people will continue smoking and thus have to pay the tax.

The total revenue test of PED

A quick way to determine whether demand is elastic or inelastic between two prices is to determine whether the sellers revenues (or consumers expenditures) rise or fall as a result of a price change. Total revenue (or expenditures) is calculated as the price times the quantity

$(P \times Q)$.

The graphs below show a good's demand and the total revenues of its sellers at each of the prices from \$10 to \$0.



We can calculate total revenue at each of the prices:

- At \$10: $TR = 10 \times 0 = 0$
- At \$8: $TR = 8 \times 10 = 80$
- At \$6: $TR = 6 \times 20 = 120$
- At \$4: $TR = 4 \times 30 = 120$
- At \$2: $TR = 2 \times 40 = 80$
- At \$0: $TR = 0 \times 50 = 0$

By looking at how a change in price causes total revenues to change, we can determine whether demand is inelastic or elastic between two prices.

- If a decrease in price causes TR to rise, demand is elastic.
- If a decrease in price causes TR to fall, demand is inelastic
- If an increase in price causes TR to rise, demand is inelastic

- If an increase in price causes TR to fall, demand is elastic

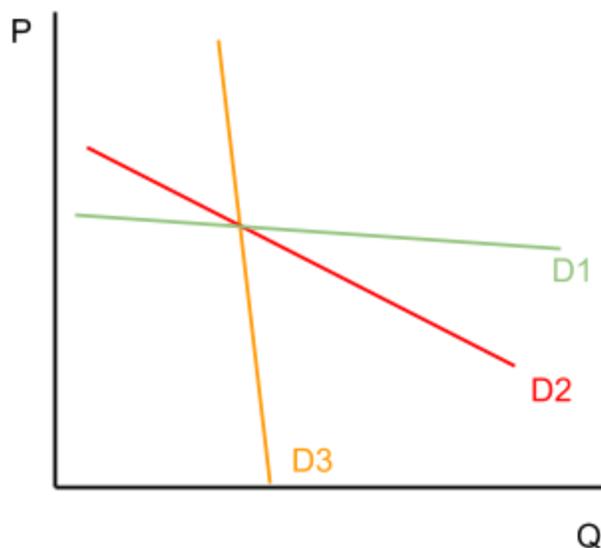
Based on the test above, we can see that demand is elastic as price falls from \$10 to \$5, unit elastic at \$5, and inelastic below \$5. Consumers are relatively responsive to price changes when price is high and quantity is low; but they are less responsive to price changes when price is low and quantity is high.

The **total revenue test** is helpful for businesses considering changing their prices. For instance, if a fast food restaurant wants to raise its prices, but knows that demand for its food is elastic, then the restaurant could be sure that a higher price will cause its revenues to decrease. On the other hand if they know demand is elastic, then a price cut would cause their revenues to increase.

PED and the slope of the demand curve

PED and slope are different concepts.

- Slope of a line measures the rise over the run, or in the demand curve the change in price over the change in quantity.
- PED measures the percentage change in quantity over the percentage change in price.
- However, by comparing the relative slopes of demand curves plotted on the same axis, we can determine the relative elasticity of different goods.



Between any two price, consumers of the good represented by D1 will be more responsive than consumers of the goods represented by D2 and D3. The steeper the demand curve on a particular axis, the more elastic demand for that good is between any two prices.

Perfectly elastic and perfectly inelastic demand

In some rare cases, any increase in price, no matter how small, will result in the quantity of a good demanded falling to zero. In such a case demand is perfectly elastic.

On the other hand, if the quantity demanded of a good does not change no matter how much price increases, demand is perfectly inelastic.

- If the value of the elasticity coefficient = ∞ , demand is perfectly elastic and the demand curve is horizontal.
- If the value of the elasticity coefficient = 0, demand is perfectly inelastic and the demand curve is vertical.



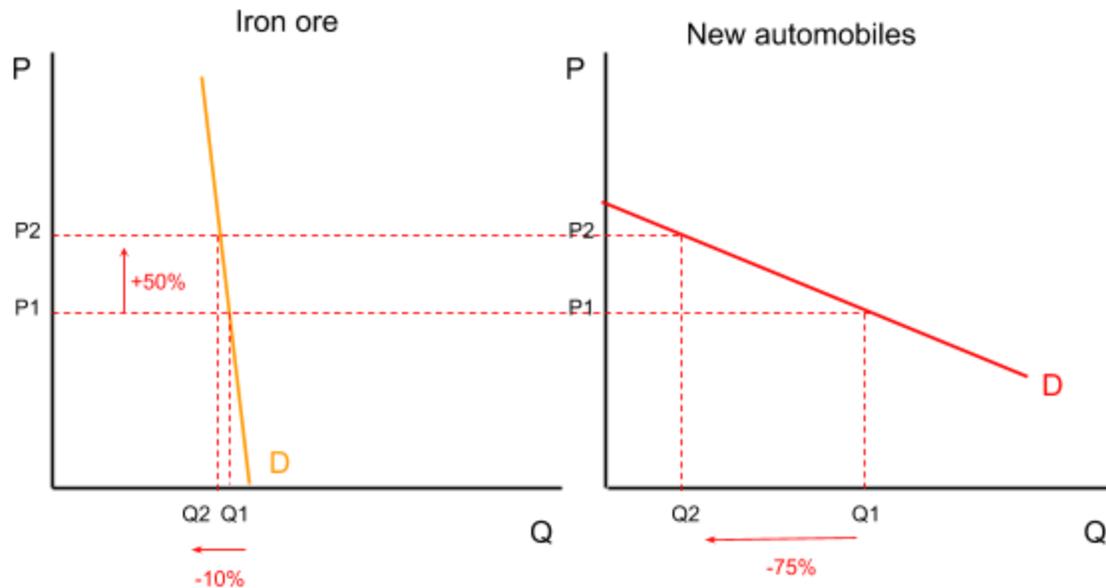
D1 in the graph above is perfectly elastic. Any change in price will cause quantity to change infinitely in the opposite direction. D2 is perfectly inelastic. Any change in price will have no impact on the quantity demanded.

PED and primary vs. manufactured goods

Whether a good is a primary commodity or a manufactured good is likely to impact whether its demand is relatively elastic or inelastic.

- Primary commodities, such as energy and mineral resources, agricultural commodities, and other raw materials used in the production of goods tend to have relatively inelastic demand. They have few substitutes and their prices often make up a small proportion of the value of the finished goods they are used to produce.
- Manufactured goods tend to have relatively more substitutes than the primary goods that go into their production, and therefore demand for manufactured goods tends to be relatively elastic.

The graphs below show the demand for iron ore, a primary commodity, and new cars, a manufactured good for which iron ore is included in the production.



Notice:

- The demand for iron ore is relatively inelastic: $PED = \frac{-10\%}{50\%} = -0.2$
- The demand for new cars is relatively elastic: $PED = \frac{-75\%}{50\%} = -1.5$

New cars have a nearly perfect substitute: used cars. Therefore, when new car prices increase by 50%, buyers in large numbers switch to used cars.

Iron ore, on the other hand, has no substitutes when it comes to its primary use as an industrial input. Therefore, a 50% increase in iron prices only causes a 10% fall in quantity demanded.

Demand for primary commodities is relatively inelastic compared to their manufactured counterparts.

PED and a government's taxation of goods and services

Governments interested in raising revenues to finance government spending often decide to tax consumption of particular goods and services. Taxing goods for which demand is relatively inelastic will generate more revenue than taxing goods that have a relatively elastic demand.

- A tax on an inelastic good will have relatively little impact on the quantity of the good consumed. Therefore, tax revenues will be relatively large.
- A tax on an elastic good will lead to a proportionally large fall in the quantity of the good consumed. Therefore, rather than raising significant amounts of revenue, taxing elastic goods will just wipe out demand for that good and reduce the amount of both consumer and producer surplus.

A graphical analysis of the importance of PED in regards to consumption taxes will be explored in a later unit.

Cross price elasticity of demand and its determinants

- Explain the concept of cross price elasticity of demand, understanding that it involves responsiveness of demand for one good (and hence a shifting demand curve) to a change in the price of another good.
- Calculate XED using the XED equation.
- Show that substitute goods have a positive value of XED and complementary goods have a negative value of XED.
- Explain that the (absolute) value of XED depends on the closeness of the relationship between two goods.
- Examine the implications of XED for businesses if prices of substitutes or complements change.

Cross price elasticity of demand (XED) measures the responsiveness of consumers of one good to a change in the price of a related good.

For example, consider apples and pears, two fruits that are close substitutes for one another.

- How will demand for pears be affected by an increase in the price of apples?
- XED tells us the percentage by which quantity of pears demanded will change following a particular percentage change in the price of apples.

XED = $\frac{\text{The percentage change in the quantity of one good}}{\text{The percentage change in the price of a related good, or}}$

$$\text{XED} = \frac{\% \Delta Q_d \text{ of good A}}{\% \Delta P \text{ of good B}}$$

Assume the following:

- The price of apples rises from \$2 to \$2.50
- The quantity of pears demanded rises from 30 to 50

$$\begin{aligned} \text{XED of apples and pears} &= \frac{(50-30) \div 30}{(2.5-2) \div 2} \\ &= 0.67 \div 0.25 = \mathbf{2.7} \end{aligned}$$

Demand for pears is cross price elastic with apples (i.e. XED > 1)

Just like PED, the absolute value of XED can be:

- 0-1: Inelastic – Consumers of Good A are relatively unresponsive to a change in the price of Good B (the % change in Q_A will be smaller than the % change in P_B)
- 1: Unit Elastic – Consumers of Good A will respond proportionally to a change in the price of Good B (the % change in Q_A will be the same as the % change in P_B)
- >1: Elastic – Consumers of Good A will be relatively responsive to a change in the price of Good B (the % change in Q_A will be greater than the % change in P_B)

XED can be either negative or positive

The XED for complementary goods will always be negative, because when the price of one

complement goes up, the demand for the other will fall.

- Example: When the price of hot dogs rises, the demand for hot dog buns will decrease. XED coefficient will be negative

The XED for substitutes will always be positive, because when the price of one substitute goes up, the demand for the other will rise.

- Example: When the price of beef rises, the demand for pork will rise. XED coefficient will be positive, reflecting the direct relationship

Income elasticity of demand and its determinants

- Explain the concept of income elasticity of demand, understanding that it involves responsiveness of demand (and hence a shifting demand curve) to a change in income.
- Calculate YED using the YED equation.
- Show that normal goods have a positive value of YED and inferior goods have a negative value of YED.
- Distinguish, with reference to YED, between necessity (income inelastic) goods and luxury (income elastic) goods.
- Examine the implications for producers and for the economy of a relatively low YED for primary products, a relatively higher YED for manufactured products and an even higher YED for services.

Income elasticity of demand (YED) measures the responsiveness of consumers of a good to a change in the level of their income.

For example, imagine a country is going into recession, so the income of the average household is falling. Demand for new cars is falling, but demand for bicycles is rising. YED is a measure of how responsive consumers' demand for bicycles and cars is to changes in their incomes.

YED = Percentage change in the quantity of a good ÷ Percentage change in consumer's income, or

$$YED = \frac{\% \Delta Q_d}{\% \Delta Y}$$

Assume the following:

- Incomes in America have fallen by 4%
- Bike sales have risen by 8%
- Car sales have fallen by 3%

$$YED \text{ for bikes} = 8 \div -4 = -2$$

Demand for bikes is income elastic

$$YED \text{ for cars} = -3 \div -4 = 0.75$$

Demand for cars is income inelastic

As with PED and XED, the absolute value of YED can be:

- 0-1: Inelastic – Demand for the good is relatively unresponsive to changes in consumer income (quantity will change by a smaller percentage than the change in income)
- 1: Unit Elastic – Demand for the good is proportionally responsive to income changes (quantity will change by the same percentage as the change in income)
- >1: Elastic – Demand for the good is relatively responsive to changes in income (quantity will change by a larger percentage than consumers' income)

YED can be either positive or negative

A **normal good** is one with a positive YED coefficient. There is a direct relationship between income and demand.

- Example: As incomes fell, car sales fell as well. If incomes were to rise, car sales would begin to rise. Cars are a normal good, so the YED coefficient is positive.

An **inferior good** is one with a negative YED coefficient. This is a good that people will buy more of as income falls, and less of as income rises.

- Example: Bicycle transportation is an inferior good, because Americans demanded MORE bicycles as their incomes fell. If income were to rise, bicycle sales would begin to fall. Since income and quantity move in opposite directions, the YED coefficient for an inferior good is always negative.

Price elasticity of supply and its determinants

- Explain the concept of price elasticity of supply, understanding that it involves responsiveness of quantity supplied to a change in price along a given supply curve.
- Calculate PES using the PES equation.
- Explain, using diagrams and PES values, the concepts of elastic supply, inelastic supply, unit elastic supply, perfectly elastic supply and perfectly inelastic supply.
- Explain the determinants of PES, including time, mobility of factors of production, unused capacity and ability to store stocks.
- Explain why the PES for primary commodities is relatively low and the PES for manufactured products is relatively high.

Price elasticity of supply measures the responsiveness of producers to price changes. Since there is always a direct relationship between price and quantity supplied, the PES coefficient will always be positive. PES can be calculated using the formula:

$$\text{PES} = \text{Percentage change in the quantity supplied} \div \text{Percentage change in the price}$$

or...

$$\text{PES} = \frac{\% \Delta Q_s}{\% \Delta P}$$

PES will always be positive, since there is a direct relationship between the price of a good and the quantity firms wish to supply.

Consider the following:

- The price of tablet computers rises from \$400 to \$500
- In the week that follows, the quantity rises from 1 million to 1.1 million
- In the three months that follow, the quantity rise from 1 million to 2 million

PES in the short-run (1 week after price change)

$$= ((1.1-1) \div 1) \div ((500-400) \div 400)$$

$$= 0.1 \div 0.25 = \mathbf{0.4}$$

PES in the long run (3 months after price change)

$$= ((2-1) \div 1) \div ((500-400) \div 400)$$

$$= 1 \div 0.25 = \mathbf{4}$$

Notice that supply for the same good (tablet computers) is more elastic in the long run than in the short run. This is explained below.

The determinants of PES

The primary **determinant of PES** is the amount of time producers have to respond to a price change.

- In the tablet computer market producers were relatively unresponsive to the rise in price in the one week following the price increase (PES equaled only 0.4)
- After three months, producers had the time to increase their production to meet the higher demand, thus they were much more responsive (PES equaled 4)

Three time periods in determining PES

- The Market Period: Immediately after a change in price. Supply is highly inelastic, because firms cannot immediately produce more of a good.
- The short-run: Firms can use their fixed capital more or less intensively, so supply is more slightly more elastic.
- The long run: Firms have time to vary the amount of capital they use, so supply is highly elastic. In the long run an increase in price will result in a much greater increase in Qs than in the market period or the short-run.

Other determinants of PES

In addition to the amount of time following a price change, the following help determine PES:

- The mobility of resources: If resources (labor and capital) can be quickly put into or

- taken out of the production, supply tends to be more elastic. Generally, this applies to low-skilled manufactured goods, the supply of which is more elastic than high-tech, capital-intensive manufactured goods.
- The ability to store stocks: If large inventories can be kept, producers can respond to price rises by drawing on those inventories to meet rising demand and to price declines by adding to inventories in response to falling demand. Goods that can be stored tend to have more elastic supply than perishable, non-storable goods.

Applications of PES

Similar to PED, knowledge of PES can help businesses and the government better plan for the anticipated price changes to particular goods.

- Business firms: If a producer expects the price of his product to change in the future, he will want to adjust his output accordingly. Being able to adjust output in a timely manner to price changes is key to maximizing a firm's profits.
- Government: A government must consider the PES for a good if it is considering intervening in the market for that good in any way. For example, if a government is considering imposing price controls (maximum or minimum prices) on an agricultural commodity, the PES should be considered so any changes in output resulting from the government controlled price could be anticipated.

Just like PED, the value of PES can be:

- 0-1: Inelastic – Producers are relatively unresponsive to a price change
- 1: Unit Elastic – Producers will respond proportionally to a change in the price
- >1: Elastic – Producers of Good A will be relatively responsive to a price change