Elasticity

You have previously learnt how the equilibrium price and quantity respond to changes in demand and supply. Elasticity measures the relative size of these changes in price and quantity.

Elasticity: a measure of the sensitivity of one variable to changes in another variable.

Elasticity = \( \frac{\% \text{ change in dependent variable}}{\% \text{ change in independent variable}} \)

In this unit, you will be introduced to four types of elasticity...
- Price elasticity of demand
- Income elasticity of demand
- Cross elasticity of demand
- Price elasticity of supply

**Price Elasticity of Demand (Ped)**

In the case of a demand curve, the dependent variable is the quantity demanded and the independent variable is the price of the product.

Price elasticity of demand: measures the percentage change in demand for a product following a change in its price.

\[
\text{Ped} = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price}}
\]

OR

\[
\text{PED} = \frac{\% \Delta Q}{\% \Delta P}
\]

Percentage change in quantity = \( \frac{\Delta Q}{Q} \times 100 \)

Percentage change in price = \( \frac{\Delta P}{P} \times 100 \)

An easy way to remember the formula... You have to Q up to P down!!!

**Some important things to remember when working with PED**
- Elasticity is calculated using percentage changes - these are relative changes and not absolute changes. This is done because prices are calculated in monetary units (Rands, cents, Dollars, Pounds etc) and quantity is measured using physical units (kgs, bags, boxes etc.) Using percentages negates the fact that prices and quantities are measured in different units.

- The answer is in the form of an elasticity co-efficient which is simply a number and has no units.

- Since changes in price and quantity nearly always move in opposite directions, we usually do not bother to put in the minus sign. As economists, we are more concerned with the co-efficient of elasticity of demand.
There are 5 possible different values for price elasticity of demand...

1. If the % change in quantity is greater than the % change in price, then the ratio will be GREATER THAN 1, and we say that the product is ELASTIC.
   - (i.e. if the price changes a little, then the quantity changes relatively more.)
   - E.g. a 20% rise in price from R10 to R12 leads to a larger fall in sales from 150 units to 100 (50%).

2. If the % change in quantity is less than the % change in price, then the ratio will be LESS THAN 1, and we say that the product is INELASTIC.
   - (i.e. quantity does not change much with changes in price.)
   - E.g. a 50% rise in price from R10 to R15 leads to a smaller fall in sales (demand) form 100 units to 80 (20%).

3. If the % change in quantity is equal to the % change in price, then the ratio will be EXACTLY 1 and we say that the product has UNITARY ELASTICITY.
   - E.g. price increases by 50%, demand decreases by 50%

4. If PED is equal to 0, a change in price has no effect on the quantity demanded and we say that the good is PERFECTLY INELASTIC.
   - i.e. demand does not change at all when the price changes
   - the demand curve will be vertical

5. If PED is infinite, a price rise will cause demand to fall to zero and we say that the product is PERFECTLY ELASTIC.
   - The demand curve will be horizontal

Therefore the greater the PED, the greater the quantity will change with smaller changes in price.

**Unitary elasticity**     = 1  
**Inelastic**            = from 0 - < 1  
**Perfectly inelastic**  = 0  
**Elastic**              = >1  
**Perfectly elastic**    = ∞
What Determines Price Elasticity of Demand?

1. The number of close substitutes for a good/uniqueness of the product

   This is possibly the most important factor in determining price elasticity of demand. The more close substitutes in the market, the more elastic the demand for a product because consumers can more easily switch their demand if the price of one product changes relative to others in the market.

   Some examples of good/services with close substitutes are...
   - Butter
   - Margarine
   - Taxi services
   - Bus & train services
   - Hamburgers
   - Hot dogs
   - Airlines

2. The degree of complementarity of a good/service

   Highly complementary goods tend to have a low PED. In essence, it is often the lack of substitutes rather than the degree of complementarity that causes the demand to be inelastic. However, this is not always the case. Whereas a fall in the price of a good without close substitutes will tend to increase the quantity demanded, the quantity demanded of goods with a high degree of complementarity will not necessarily increase if their prices fall. Take salt for example. People will not start buying more salt just because the price of salt has decreased relative to other goods (e.g. pepper.)

   Examples of goods with a high degree of complementarity include...
   - iPhones
   - iTunes
   - Games consoles
   - Games
   - Golf clubs
   - Golf balls
   - Cars
   - Car parts

3. The cost of switching between different products

   There may be significant transaction costs involved in switching between different goods and services. If this is the case, demand tends to be relatively inelastic.

   For example, mobile phone service providers may include penalty clauses in contracts or insist on 24 month contracts being taken out.

4. Whether the good is a necessity or not

   Goods and services deemed by consumers to be necessities tend to have an inelastic demand whereas luxuries will tend to have a more elastic demand because consumers can make do without luxuries when their budgets are stretched.

   Remember that there is no standard definition for what a necessity is. This is because different people consider different items to be necessities. Most Grade 11 pupils would consider their cell phone as an absolute necessity, on par with water and food, whereas other people might consider a cell phone as a luxury item.

5. The time period allowed following a price change

   Demand tends to be more price elastic, the longer that we allow consumers to respond to a price change. As the petrol price increases, the demand for petrol in the short term remains very inelastic, however in the long term people might start to switch to smaller, more fuel-efficient cars. Therefore in the long run, a change in the petrol price may cause demand to become more elastic.

   The same theory applies when consumers are forced to make purchases on the spur of the moment. Due to a lack of information and usually out of necessity, spur of the moment purchases tend to be very inelastic, whereas when we have a long time to gather information and consider all of the alternatives (substitutes) our purchases tend to be a lot more elastic.
6. The % of a consumer’s income allocated to spending on the good
   Goods and services that take up a high proportion of a household’s income will tend to have a more elastic demand than products where large price changes makes little or no difference to someone’s ability to purchase the product.

   E.g. a box of matches vs. a new car

7. Habit forming goods
   When this occurs, the consumer becomes much less sensitive to the price of the good in question.

   Cigarettes, alcohol and other drugs can come into this category. Drug dealers, whether they know it or not, use elasticity of demand to get people to buy drugs. They start off by selling drugs at a low price, and once their ‘clients’ are addicted they increase the price and demand is hardly affected at all. This is turn can have a negative impact on crime.

8. Peak and off-peak demand
   Demand tends to be price inelastic at peak times – a feature that suppliers can take advantage of when setting higher prices. Demand is more elastic at off-peak times, leading to lower prices for consumers.

   E.g. cheaper deals available at hotels during the week and away from the high-season. Also train fares and mobile phone charges are cheaper off peak.

9. Advertising and brand loyalty
   The PED for a particular brand of washing powder is usually greater than washing powder itself. The reason for this is that different brands have substitutes, whereas washing powder itself does not. Producers however try their best to convince us that their brand does NOT have any suitable substitutes by advertising their non-price benefits like packaging, quality and convenience. They spend a lot of money on expensive marketing campaigns in the hope that they will increase brand loyalty which is, in effect, an attempt to decrease the PED for their particular product.
Price elasticity of demand and total revenue for a producer

The relationship between price elasticity of demand and a firm’s total revenue is a very important one. PED can be used to determine by how much the total expenditure by consumers (total revenue) changes, when the price of the product changes.

The diagrams below show demand curves with different price elasticity and the effect of a change in the market price.

When demand is inelastic – a rise in price leads to a rise in total revenue
- for example a 20% rise in price might cause demand to contract by only 5%
- \( \text{Ped} = 0.25 \)

When demand is elastic – a fall in price leads to a rise in total revenue
- for example a 10% fall in price might cause demand to expand by 25%
- \( \text{Ped} = 2.5 \)

The table below gives a simple example of the relationships between market prices; quantity demanded and total revenue for a supplier.

As price falls, the total revenue initially increases, in our example the maximum revenue occurs at a price of R12 per unit when 520 units are sold giving total revenue of R6240.

<table>
<thead>
<tr>
<th>Price (R per unit)</th>
<th>Quantity (Units)</th>
<th>Total Revenue (R's)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>200</td>
<td>4000</td>
</tr>
<tr>
<td>18</td>
<td>280</td>
<td>5040</td>
</tr>
<tr>
<td>16</td>
<td>360</td>
<td>5760</td>
</tr>
<tr>
<td>14</td>
<td>440</td>
<td>6160</td>
</tr>
<tr>
<td>12</td>
<td>520</td>
<td>6240</td>
</tr>
<tr>
<td>10</td>
<td>600</td>
<td>6000</td>
</tr>
<tr>
<td>8</td>
<td>680</td>
<td>5440</td>
</tr>
<tr>
<td>6</td>
<td>760</td>
<td>4560</td>
</tr>
</tbody>
</table>
Consider the price elasticity of demand of a price change from R20 per unit to R18 per unit.

- The % change in demand is 40% following a 10% change in price - giving an elasticity of demand of 4 (i.e. highly elastic).
- In this situation when demand is price elastic, a fall in price leads to higher total consumer spending/producer revenue.

Consider a price change further down the estimated demand curve (from R10 per unit to R8 per unit).

- The % change in demand = 13.3% following a 20% fall in price – giving a co-efficient of elasticity of 0.67 (i.e. inelastic).
- A fall in price when demand is price inelastic leads to a reduction in total revenue.

Using the table above, we can deduce 3 important facts about price elasticity of demand...

1. When PED is greater than 1 total revenue increases as the quantity sold increases
2. Total revenue reaches a maximum when PED is equal to 1
3. When PED is less than 1 total revenue decreases as the quantity sold increases
Changing elasticities along a demand curve

PED is elastic when...

\[ \frac{(5 - 10)}{5} \times 100 = \frac{(4 - 3)}{4} \times 100 \]

= 100

25

= 4 (Elastic)

PED is unit elastic when...

\[ \frac{(10.00 - 12.50)}{12.50} \times 100 = \frac{(3.00 - 2.50)}{2.50} \times 100 \]

= 20

20

= 1 (Unit elastic)

PED is inelastic when...

\[ \frac{(15 - 20)}{20} \times 100 = \frac{(2.00 - 1.00)}{1} \times 100 \]

= 25

100

= 0.25 (Inelastic)
Usefulness of price elasticity for producers

How can businesses make use of price elasticity of demand? Firms can use price elasticity of demand (PED) estimates to predict...

- The effect of a change in price on total revenue & expenditure
- The likely price volatility in a market following unexpected changes in supply – important for commodity producers
- The effect of a change in indirect tax on price and quantity demanded and also whether the business is able to pass on some or all of the tax onto the consumer
- Information on the price elasticity of demand can be utilised as part of a policy of price discrimination. This is where a monopoly supplier decides to charge different prices for the same product to different segments of the market e.g. peak and off peak rail travel

Usefulness of price elasticity for the government (indirect taxation)

Many products are subject to indirect taxation imposed by the government. Good examples include the excise duty on cigarettes, alcohol and fuels.

Here we consider the effects of indirect taxes on a producers costs and the importance of price elasticity of demand in determining the effects of a tax on market price and quantity.

A tax increases the costs of a business causing an inward shift in the supply curve.

With an indirect tax, the supplier may be able to pass on some or all of this tax onto the consumer through a higher price. This is known as shifting the burden of the tax and the ability of businesses to do this depends on the price elasticity of demand and supply.
Consider the two diagrams on the previous page...

In the left hand diagram, the demand curve is drawn as price *elastic*.
- The **producer** must **absorb** the majority of the tax itself (i.e. accept a lower profit margin on each unit sold).
- When demand is *elastic*, the effect of a tax is still to raise the price – but we see a **greater fall in equilibrium quantity**.
  - Output has fallen from **Q1 to Q2** due to a **contraction** in demand.

In the right hand diagram above, demand is assumed to be price *inelastic*
- The producer is therefore able to **pass on** most of the tax to the **consumer** through a higher price without losing too much in the way of sales.
- The price rises from **P1 to P2** – but a large rise in price leads only to a small contraction in demand from **Q1 to Q2**.

So, the government are clever as they place high indirect taxes on goods that have an inelastic demand. In this way as the prices increase, people continue to buy the goods and the government continue to collect a lot of tax revenue in this way. This is why items like petrol, cigarettes and alcohol are so heavily taxed.

There would be little use in taxing items with an elastic demand, as if the prices went up, people would stop buying these items and the government would not gain much tax revenue.
Income elasticity of demand (Yed)

Income elasticity of demand (Yed): measures the relationship between a percentage change in quantity demanded for a good or service and a change in real income.

The results are important since the values of income elasticity tell us something about the nature of a product and how it is perceived by consumers. It also affects the extent to which changes in economic growth affect the level and pattern of demand for different goods and services.

\[
\text{Income elasticity of demand} = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in income}}
\]

OR

\[
\text{YED} = \frac{\% \Delta Q}{\% \Delta Y}
\]

IMPORTANT: Unlike with PED, whether or not YED is + or – is important and is therefore taken into account.

Normal Goods

Normal goods: goods that have a positive income elasticity of demand so as consumers’ income rises, more is demanded at each price level.

1. Normal necessities (essential goods) have an income elasticity of demand of between 0 and +1
   - For example, if income increases by 10% and the demand for fruit increases by 4% then the income elasticity is +0.4.
   - Demand is rising less than proportionately to income as these are items that people tend to buy irrespective of their income.

2. Luxuries have an income elasticity of demand > +1.
   I.e. the demand rises more than proportionate to a change in income
   - For example an 8% increase in income might lead to a 16% rise in the demand for restaurant meals. The income elasticity of demand in this example is +2.0.
   - Demand is highly sensitive to increases or decreases in income.

Inferior Goods

Inferior goods: goods that have a negative income elasticity of demand. Demand falls as income rises.

Typically inferior goods or services tend to be products where there are superior goods available if the consumer has the money to be able to buy it.

- Examples include low-priced own label foods in supermarkets and the demand for council-owned properties.

Income elasticity of demand is usually strongly positive for...

- Wines and spirits
- Consumer durables - audio visual equipment, new kitchens and bathrooms etc...
- Sports and leisure facilities (including gym membership and sports clubs)

In contrast, income elasticity of demand is lower (but still positive) for

- Staple products such as bread, vegetables and frozen foods
- Mass transport (bus and rail)
- Beer and take-away pizza
Long-term changes

There is a general downward trend in the income elasticity of demand for many products, particularly foodstuffs. One reason for this is that as a society becomes richer, there are changes in consumer perceptions about different goods and services together with changes in consumer tastes and preferences. What might have been considered a luxury good several years ago might now be regarded as a necessity (with a lower income elasticity of demand).

Consider the market for foreign travel. A few decades ago, long-distance foreign travel was regarded as a luxury out of the reach of the majority of households. Now as real price levels have come down and incomes have grown, so millions of consumers are able to fly overseas on short and longer breaks. For many an annual holiday overseas has become a necessity and not a discretionary item of spending!

Estimates for income elasticity of demand

The table below shows the estimated price elasticity of demand and income elasticity of demand for a selection of foods.

<table>
<thead>
<tr>
<th>Product</th>
<th>Share of budget (% of household income)</th>
<th>Price elasticity of demand (Ped)</th>
<th>Income elasticity of demand (Yed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Foods</td>
<td>15.1</td>
<td>n/a</td>
<td>0.2</td>
</tr>
<tr>
<td>Meat</td>
<td>1.15</td>
<td>0.69</td>
<td>0.2</td>
</tr>
<tr>
<td>Fruit juices</td>
<td>0.19</td>
<td>0.55</td>
<td>0.45</td>
</tr>
<tr>
<td>Tea</td>
<td>0.19</td>
<td>0.37</td>
<td>-0.02</td>
</tr>
<tr>
<td>Instant coffee</td>
<td>0.17</td>
<td>0.45</td>
<td>0.16</td>
</tr>
<tr>
<td>Margarine</td>
<td>0.03</td>
<td>n/a</td>
<td>-0.37</td>
</tr>
</tbody>
</table>

The income elasticity of demand for most types of food is pretty low – occasionally negative (e.g. for margarine) and likewise the price elasticity of demand for most foodstuffs is also inelastic. In other words, the demand for these products among consumers is not sensitive to changes in the product’s price or changes in consumer income.

How do businesses make use of estimates of income elasticity of demand?

Knowledge of income elasticity of demand for different products helps firms predict the effect of a business cycle on sales. All countries experience a business/economic cycle where actual GDP moves up and down in a regular pattern causing booms and slowdowns or perhaps a recession. The business cycle means incomes rise and fall.

Luxury products with a high income elasticity experience greater sales volatility over the business cycle than necessities where demand from consumers is less sensitive to changes in the economic cycle.
Cross Price Elasticity of Demand (Xed)

Cross price elasticity (Xed): measures the percentage change of demand for good X following a change in the price of good Y (a related good).

The formula for calculating Xed is...

\[
X_{ed} = \frac{\% \text{ change in DEMAND for product } X}{\% \text{ change in PRICE for product } Y}
\]

Once again, it is important that we take the + or – value into account.

With cross price elasticity we make an important distinction between substitute products and complementary goods and services.

Substitutes

Substitutes goods: goods in competitive demand and act as replacements for another product.

For example, a rise in the price of BP petrol (other factors held constant) should cause a substitution effect away from BP towards competing brands as consumers will tend over time to switch to the cheaper brand or service provider. When it is easy to switch, consumer demand will be sensitive to price changes.

With substitute goods such as brands of cereal or washing powder, an increase in the price of one good will lead to an increase in demand for the rival product.

**THE CROSS PRICE ELASTICITY FOR TWO SUBSTITUTES WILL BE POSITIVE (+).**

Complements

Complementary goods: two goods that are typically used at the same time, e.g. cars and petrol, fish and chips. A change in demand for one has a direct effect on the other.

With goods that are in complementary demand, such as the demand for DVD players and DVD’s, when there is a fall in the price of DVD players we expect to see more DVD players bought, leading to an expansion in market demand for DVD’s.

**THE CROSS PRICE ELASTICITY FOR TWO COMPLEMENTS IS NEGATIVE.**

E.g. an increase in the price of games consoles will lead to an in decrease in the demand for games.

The stronger the relationship between two products, the higher is the co-efficient of cross-price elasticity of demand.

For example with two close substitutes, the cross-price elasticity will be strongly positive. E.g. Coke and Pepsi

Likewise when there is a strong complementary relationship between two products, the cross-price elasticity will be highly negative. E.g. fish and chips

Unrelated products have a zero cross elasticity. E.g. fruit and computers.
Examples of Substitutes, Necessities and Complementary goods

<table>
<thead>
<tr>
<th>Normal Luxury</th>
<th>Normal Necessity</th>
<th>Inferior Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>International air travel</td>
<td>Fresh vegetables</td>
<td>Frozen vegetables</td>
</tr>
<tr>
<td>Fine wines</td>
<td>Instant coffee</td>
<td>Cigarettes</td>
</tr>
<tr>
<td>Luxury chocolates</td>
<td>Natural cheese</td>
<td>Processed cheese</td>
</tr>
<tr>
<td>Private education</td>
<td>Fruit juice</td>
<td>Margarine</td>
</tr>
<tr>
<td>Private health care</td>
<td>Spending on utilities</td>
<td>Tinned meat</td>
</tr>
<tr>
<td>Antique furniture</td>
<td>Shampoo / toothpaste / detergents</td>
<td>Value “own-brand” bread</td>
</tr>
<tr>
<td>Designer clothes</td>
<td>Rail travel</td>
<td>Bus travel</td>
</tr>
</tbody>
</table>

![Graph showing XED Value and Relationship types]

- XED Value: Negative, Zero, Positive
- Relationship: Close Complements, Remote Complements, Unrelated Products, Remote Substitutes, Close Substitutes
Price elasticity of supply (Pes)

Price elasticity of supply: measures the relationship between a percentage change in quantity supplied and a change in price.

The formula for price elasticity of supply is...

\[
\text{Pes} = \frac{\% \text{ change in quantity supplied}}{\% \text{ change in price}}
\]

If supply is elastic, producers can increase output without a rise in cost or a time delay if prices rise.

If supply is inelastic, firms find it hard to change production in a given time period even if prices for their goods/services rise.

In almost all cases a positive answer is obtained indicating that the two variables of price and quantity supplied have a positive correlation and hence move in the same direction.

There are 5 possible different values for price elasticity of supply...

1. When \( \text{Pes} > 1 \)
   • supply is price elastic
   • i.e. the \% \text{ change in supply} > \% \text{ change in the price of a good}
   • e.g. a 10% fall in price of cashmere jumpers causes a 20% decrease in the quantity supplied, therefore Pes = 2

2. When \( \text{Pes} < 1 \)
   • supply is price inelastic
   • i.e. the \% \text{ change in supply} < \% \text{ change in the price of a good}
   • e.g. a 10% rise in the price of Coke causes a 5% increase in the quantity supplied.

3. When \( \text{Pes} = 1 \)
   • supply has unit elasticity
   • i.e. the \% \text{ change in supply} = \% \text{ change in price}
   • e.g. a 10% fall in the price of cars may cause a 6% decrease in the quantity of cars supplied

4. When \( \text{Pes} = 0 \)
   • supply is perfectly inelastic
   • i.e. a change in price has no effect on the quantity supplied
   • the supply curve will be vertical

5. When \( \text{Pes} = \text{infinity} \)
   • supply is perfectly elastic
   • i.e. a change in quantity supplied has no effect on the price
   • the supply curve will be horizontal
Supply curves with different price elasticity of supply

If Pes is inelastic: it will be difficult for suppliers to react swiftly to changes in price
If Pes is elastic – supply can react quickly to changes in price

Perfectly inelastic supply: Pes = zero (supply cannot respond to a change in demand / price) – often associated with the momentary period with agricultural products
Factors that Affect Price Elasticity of Supply

1. Spare production capacity

If there is plenty of spare capacity, a business should be able to increase its output in response to increased prices without a rise in costs and therefore supply will be elastic in response to a change in demand.

The supply of goods and services is often most elastic in a recession, when there is plenty of spare labour and capital resources available to step up output as the economy recovers.

2. Stocks of finished products and components

If stocks of raw materials and finished products are at a high level then a firm is able to respond to a change in demand quickly by supplying these stocks onto the market - supply will be elastic.

Conversely when stocks are low, dwindling supplies force prices higher and unless stocks can be replenished, supply will be inelastic in response to a change in demand.

3. The ease and cost of factor substitution

If both capital and labour resources are occupationally mobile then the elasticity of supply for a product is higher than if capital and labour cannot easily and quickly be switched.

4. Time period involved in the production process

Supply is more price elastic the longer the time period that a firm is allowed to adjust its production levels.

In some agricultural markets for example, the momentary supply is fixed and is determined mainly by planting decisions made months before, and also climatic conditions, which affect the overall production yield.