Elasticity of Demand

What is Elasticity?

Elasticity is responsiveness/flexibility of anything to its factors.

What is Elasticity of Demand?

Elasticity of demand is the responsiveness of demand of any product or service due to change in any of its factors. As already studied these factors include own price, income, prices of related goods, fashion, taste, etc.

Either absolute change or percentage change is considered?

In order to avoid the complications/issue of difference of units of measurement in factors of demand and product or service being studied percentage changes are used e.g. demand for milk is measured in litres while its price is measured in rupees so it is not possible to compare change in term of rupees with litres. The only possible way to avoid such complications is use of percentages i.e. percentage change in price of milk can be compared with percentage change in quantity demanded of milk.

Therefore, elasticity of demand is defined as "*Percentage change in demand of any product or service due to percentage change in any of its factors*"

Types of Elasticity of Demand

Elasticity of demand is categorized on the basis of its factors. However, as some factors are quantitative and some are qualitative so elasticity of demand is categorized on the basis of quantitative factors only. These include own price, income of consumers and prices of related goods. Hence following are the types of elasticity of demand:

1. Price Elasticity of Demand
2. Income Elasticity of Demand
3. Cross Elasticity of Demand

Price Elasticity of Demand

Price Elasticity of demand can be defined as "*percentage change in quantity demanded of any product or service due to percentage change in its price*"

Measurement of Price Elasticity of Demand

The price elasticity of demand (E_p) is measured by the percentage change in the quantity demanded of the commodity divided by the percentage change in commodity's price, holding all other factors constant. Mathematically the formula is as follows:

$$E_P = \frac{\Delta Q / Q}{\Delta P / P} = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q}$$

The derivation is shown in the attached document.

The above formula is called point elasticity formula or calculation of elasticity at a given point. The other formula i.e. arc price elasticity is as follows:

$$E_P = \frac{Q_2 - Q_1}{P_2 - P_1} \cdot \frac{P_2 + P_1}{Q_2 + Q_1}$$

There is no hard and fast rule about when to use which formula but when the change is very small i.e. less than 05% then point elasticity can be utilized. However, if changes are greater than 05% then arc price elasticity must be calculated.

Use the following values to calculate the elasticity of demand.

P	Q
20 → P_1	100 → Q_1
40 → P_2	50 → Q_2

As change is price i.e. price rose from 20 to 40 rupees is greater than 5% so elasticity of demand should be calculated with arc price elasticity.

E_P = (100-50)/(20-40) × (40+20)/(50+100)
E_P = 50/-20 × 60/150
E_P = -2.5 × 0.4
E_P = -1

P	Q
30 → P_1	70 → Q_1
20 → P_2	100 → Q_2

As change is price i.e. price decreased to 20 from 30 rupees is greater than 5% so elasticity of demand should be calculated with arc price elasticity.

E_P = (70-100)/(30-20) × (20+30)/(100+70)
E_P = -30/10 × 50/170
E_P = -3 × 0.3
E_P = -0.9

Interpretation of Price Elasticity of Demand

In the above examples elasticity of demand is negative. In one case it is -1 and in other case it is -0.9. The negative sign gives an impression that the elasticity is less than one. However, it is important to understand that the sign along with the mathematical value interprets the nature of relationship between price and quantity demanded i.e. negative sign indicates that if price rises quantity demanded decreases and vice versa. The mathematical value indicates the magnitude of the change. Hence elasticity is interpreted by ignoring the sign as follows:

E_P = -0.9 then $|E_P| = |0.9| < 1$ In this manner elasticity of demand can be interpreted that one percent change in price brings 0.9 percent or less than one percent change in quantity demanded in opposite direction.

E_P = -1 then $|E_P| = |1| = 1$ Elasticity of demand can be interpreted that one percent change in price brings one percent change in quantity demanded in opposite direction.

or if E_P = -1.2 then $|E_P| = |1.2| > 1$ Elasticity of demand can be interpreted that one percent change in price brings 1.2 percent or more than one percent change in quantity demanded in opposite direction.

Cases of Price Elasticity of Demand

Keeping in view the above examples it can be seen that quantity demanded shows various responses i.e. in some cases demand changes too much and in some cases demand does not show that much change. These responses of demand are categorized as cases of price elasticity of demand. There are the following cases of price elasticity of demand:

Infinite elastic / perfectly elastic / elasticity equal to infinity: the quantity demanded is showing infinite response & $E_P=\infty$. The example of such commodity can be the life saving drugs

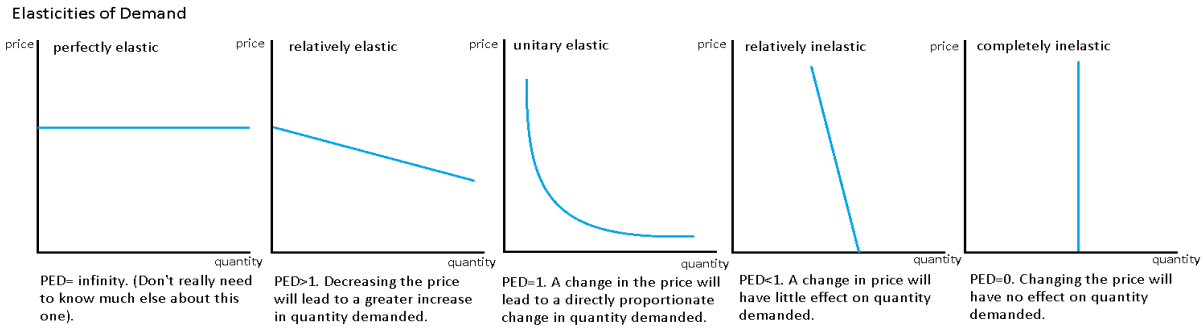
More elastic / relatively elastic / elasticity greater than one: the quantity demanded shows more response & $E_P>1$. The examples are Luxuries, goods having many close substitutes, goods for which more adjustment time is available.

Unit elastic /elasticity equal to one: the quantity demanded shows equal response & $E_P=1$

Less elastic / relatively inelastic / elasticity less than one: the quantity demanded shows less response & $E_P<1$. The examples are necessities, goods having less close substitutes, goods for which less adjustment time is available.

In elastic / elasticity equal to zero: the quantity demand shows zero response due to changes in price & $E_P=0$. The example may be life saving drugs and goods having too low prices and making a minute portion of total expenses like salt.

Cases of Price Elasticity of Demand and shape of Demand curve



The above figure shows the variation in shape of demand curve in relation to various cases of price elasticity of demand. In case of perfectly elastic or infinite elastic demand the demand curve in horizontal and in case of inelastic demand the demand curve is vertical. For more elastic demand the demand curve is flatter as compared to less elastic demand curve. In case of unit elastic demand curve the demand curve is rectangular hyperbola.

Use of Price Elasticity of Demand

1. Wage Bargaining (Less elastic demand more wage bargaining)
2. Decision regarding automation (more elastic demand: automation, labor is fired, cost is reduced, price is reduced, demand increases more leading to more production and rehiring of labor)
3. Pricing Policy (with aim to increase Revenue) less elastic - price increase - revenue increase
4. Taxation (less elastic-tax increase tax collection increase)
5. Price Discrimination (electricity-household vs commercial)

Income Elasticity of Demand

Income Elasticity of demand can be defined as "*percentage change in demand of any product or service due to percentage change consumer's income, holding other factors constant*"

Measurement of Income Elasticity of Demand

The Income elasticity of demand (E_I) is measured by the percentage change in demand of the commodity divided by the percentage change in consumer's income, holding all other factors constant. Mathematically the formula is as follows:

$$E_I = \frac{\Delta Q / Q}{\Delta I / I} = \frac{\Delta Q}{\Delta I} \cdot \frac{I}{Q}$$

The above formula is called point elasticity formula or calculation of elasticity at a given point. The other formula i.e. arc elasticity is as follows:

$$E_I = \frac{Q_2 - Q_1}{I_2 - I_1} \cdot \frac{I_2 + I_1}{Q_2 + Q_1}$$

There is no hard and fast rule about when to use which formula but when the change is very small i.e. less than 05% then point elasticity can be utilized. However, if changes are greater than 05% then arc elasticity must be calculated.

Use the following values to calculate the income elasticity of demand.

I	Q
2500 → I_1	22 → Q_1
1750 → I_2	20 → Q_2

As change in income i.e. income decreased to 1750 from 2500 rupees is greater than 5% so elasticity of demand should be calculated with arc elasticity formula.

$E_I = (20-22)/(1750-2500) \times (1750+2500)/(20+22)$
$E_I = -2/-850 \times 4250/42$
$E_I = 0.0023 \times 101.19$
$E_I = 0.23$

I	Q
1750 → I_1	18 → Q_1
2500 → I_2	40 → Q_2

As change is income i.e. income rose from 1750 to 2500 rupees is greater than 5% so elasticity of demand should be calculated with arc elasticity formula.

$E_I = (40-18)/(2500-1750) \times (2500+1750)/(40+18)$
$E_I = 22/850 \times 4250/58$
$E_I = 0.0259 \times 73.27$
$E_I = 1.89$

Interpretation of Income Elasticity of Demand

In the above examples income elasticity of demand is positive. It is important to understand that the sign along with the mathematical value interprets the nature of relationship between income and demand i.e. positive sign indicates that if income rises demand increases and vice versa. The mathematical value indicates the magnitude of the change.

In the above examples, $|E_I| = |0.23| < 1$ means that one percent decrease in income decreases demand by less than one percent i.e. demand is less elastic and $|E_I| = |1.89| > 1$ means that one percent increase in income increases demand by more than one percent i.e. demand is more elastic.

For normal goods E_I is positive and for inferior goods income elasticity is negative i.e. if income increases the demand for inferior good decreases and vice versa.

The following points should be kept in mind while interpreting income elasticity of demand:

- For normal goods $E_I > 0$
- For inferior goods $E_I < 0$
- For necessities $0 < E_I < 1$
- For luxuries $E_I > 1$

Cases of Income Elasticity of Demand

These responses of demand due to change in income are categorized as cases of income elasticity of demand. There are the following cases of income elasticity of demand:

More elastic / relatively elastic / elasticity greater than one: the demand shows more response due to change in income & $E_I>1$. The example is luxury goods

Less elastic / relatively inelastic / elasticity less than one: the demand shows less response due to change in income & $0< E_I < 1$. The example includes normal necessities.

In elastic / elasticity equal to zero: the demand shows zero response due to changes in income & $E_I=0$.

Negative elastic demand: the demand shows negative response to changes in income and $E_I<0$

Use of Income Elasticity of Demand

1. Forecasting Demand
2. Categorization of Goods (normal vs inferior)
3. Analysing Economic Conditions (prosperity more normal goods are in demand - regression more inferior goods are in demand)

Cross Price Elasticity of Demand

Cross Price Elasticity of demand can be defined as "*percentage change in demand for x commodity or service due to percentage change in price of y commodity (related good) holding other factors constant*"

Measurement of Cross Elasticity of Demand

The cross elasticity of demand (E_{XY}) is measured by the percentage change in the quantity demanded of x commodity divided by the percentage change in price of y commodity, holding all other factors constant. Mathematically the formula is as follows:

$$E_{XY} = \frac{\Delta Q_X / Q_X}{\Delta P_Y / P_Y} = \frac{\Delta Q_X}{\Delta P_Y} \cdot \frac{P_Y}{Q_X}$$

The above formula is called point elasticity formula or calculation of elasticity at a given point. The other formula i.e. arc price elasticity is as follows:

$$E_{XY} = \frac{Q_{X2} - Q_{X1}}{P_{Y2} - P_{Y1}} \cdot \frac{P_{Y2} + P_{Y1}}{Q_{X2} + Q_{X1}}$$

There is no hard and fast rule about when to use which formula but when the change is very small i.e. less than 05% then point elasticity can be utilized. However, if changes are greater than 05% then arc price elasticity must be calculated.

Use the following values to calculate the cross elasticity of demand.

P_X	P_Y	Q_X
$20 \rightarrow P_1$	$22 \rightarrow P_1$	$100 \rightarrow Q_1$
$20 \rightarrow P_2$	$20 \rightarrow P_2$	$90 \rightarrow Q_2$

As change is cross price i.e. price decreased to 20 from 22 rupees is greater than 5% so elasticity of demand should be calculated with arc price elasticity.

E_{XY} = (90-100)/(20-22) × (20+22)/(90+100)
E_{XY} = -10/-2 × 42/190
E_{XY} = 5 × 0.22
E_{XY} = 1.1

P_X	P_Y	Q_X
$20 \rightarrow P_1$	$22 \rightarrow P_1$	$100 \rightarrow Q_1$
$20 \rightarrow P_2$	$20 \rightarrow P_2$	$110 \rightarrow Q_2$

As change in cross price i.e. price decreased to 20 from 22 rupees is greater than 5% so elasticity of demand should be calculated with arc price elasticity.

E_{XY} = (110-100)/(20-22) × (20+22)/(110+100)
E_{XY} = 10/-2 × 42/210
E_{XY} = -5 × 0.2
E_{XY} = -1

Interpretation of Cross Price Elasticity of Demand

As discussed in price elasticity of demand the sign shows the nature of relationship so in the above examples the negative and positive signs indicate the types of related goods.

Cross elasticity of demand for substitutes (*goods that are alternative of each other like pepsi and coke*) is positive i.e. increase in price of substitute leads to increase in demand of the product and vice versa.

Cross elasticity of demand for complementary goods (*goods that are used jointly like car and petrol*) is negative i.e. increase in price of complement decreases the demand for the product and vice versa.

So if $E_{XY} < 0$ then goods are complementary and if $E_{XY} > 0$ then goods are substitutes. For unrelated goods cross elasticity is zero.

The magnitude of the change can be interpreted by ignoring the sign as discussed previously.

If $E_{XY} < 1$ then it is less elastic and if $E_{XY} > 1$ then it is the case of more elastic

If E_{XY} is positive and greater than one then the products are strong substitute and if E_{XY} is positive but less than one then the goods are weal substitutes

Similarly if E_{XY} is negative and greater than one (check by ignoring sign) then the products are strong complementary goods and if E_{XY} is negative but less than one (check by ignoring sign) then the products are weak complementary goods

Use of Cross Elasticity of Demand

1. Forecasting Demand
2. Competitive Pricing (effect of price change is more in case of more elastic)
3. Classification of Goods and market (complements vs substitutes) more elastic more competitive market etc)

Derivation of Formula for price elasticity of Demand

E_P = Percentage Change in Demand / Percentage Change in Price

$E_P = \%\Delta Q / \%\Delta P$

$E_P = \{(Q_2-Q_1)/Q \times 100\} / \{(P_2-P_1)/P \times 100\}$……. 100 is cancelled

$E_P = \{(Q_2-Q_1)/Q\} / \{(P_2-P_1)/P\}$

$E_P = (Q_2-Q_1)/Q \times P/(P_2-P_1)$ ……by converting division to multiplication

$E_P = (Q_2-Q_1)/(P_2-P_1) \times P/Q$

or

$E_P = \Delta Q/\Delta P \times P/Q$