Chapter-8

Elasticity of Demand and Its Application

Law of Demand states that if price of commodity increases quantity demanded will falls and if price of commodity falls quantity will increases.

Law of demand indicates only direction of change in quantity demanded in response to change in price but ***ELASTICITY OF DEMAND*** states with how much or to what extent the quantity demanded will change in response to change in any determinants.

- The law of demand states only the direction of change in demand due to change in price. The law of demand does not reveal the extent of change in demand due to change in price.

- The law or the theory of demand so stated does not provided sufficient guidance for price management. Therefore, pricing decisions may produce a result contrary to the objective.

- Obviously the law of demand did work but the objective was defeated.

- The reason is that the firm had reduced the price randomly without knowing the degree of relationship between the change in price and the consequent change in demand.

ELASTICITY - The Concept

- If price rises by 10% - what happens to demand?
- We know demand will fall.
- By more than 10% ?
- By less than 10% ?
- Elasticity measures the extent to which demand will change.

Meaning & Definition of Elasticity of Demand

Elasticity of Demand measures the extent to which quantity demanded of a commodity increases or decreases in response to increase or decrease in any of its quantitative determinants.

So, we have several types of elasticity of demand according to the source of the change in the demand. For example, if the price is the source of the change, we have the "price elasticity of demand".

"The elasticity (or responsiveness) of demand in a market is great or small according as the amount demanded increases much or little for a given fall in price, and diminishes much or little for a given rise in price". – ***Dr. Marshall.***

Elasticity of Demand

According to the source of the change, the following types of elasticity of demand can be mentioned:

- Price Elasticity of Demand
- Cross Elasticity of Demand (the elasticity in relation to the change of the price of other good and services)
- Income Elasticity of Demand
- Advertisement Elasticity of Demand (the elasticity in relation to the advertisement expenditure)

According to the degree of the change in the demand, the elasticity can be classified in:

- Perfectly Elastic
- Relatively Elastic
- Unitary Elasticity
- Relatively Inelastic
- Perfect Inelastic

- ***The general theory of demand does not provide a reasonable answer to these questions.***

- ***The answer to these question lies in the degree of response of demand to the change in its determinants.***

- ***In economics, the degree of responsiveness of demand to change in its determinants is called the elasticity of demand.*** **The following kinds of elasticities of demand have been discussed in this Chapter.:**

  (i) Price elasticity of demand,

  (ii) Cross elasticity of demand,

  (iii) Income elasticity of demand,

  (iv) Advertisement elasticity of demand, and

  (v) Elasticity of price expectations.

MEASUREMENT OF ELASTICITY CONCEPT

- **The measure of the degree of responsiveness of demand to change in its determinants gives the *extent of relationship between the demand for a product and any of its determinants.***

- ***In technical terms, the measure of elasticity of demand is called elasticity coefficient. The elasticity of coefficient (Ed) is measured by the following formula:***

$$E_d = \frac{\text{Percentage Change in Quantity Demanded of Product } X}{\text{Percentage Change in Demand Determinant Factor } Y}$$

Price Elasticity of Demand

Price Elasticity of demand is a measurement of percentage change in demand due to percentage change in own price of the commodity.

The price elasticity of Demand may be defined as the ratio of the relative change in demand and price variables.

$$e = \frac{\text{Percentage/Proportional Change in Quantity Demanded}}{\text{Percentage/Proportional Change in Price}}$$

Price Elasticity of Demand

$$\text{Price Elasticity } (E_p) = \frac{\%\text{ Change in quantity demanded}}{\%\text{ Change in prices}}$$

$$\text{Or, } E_p = \frac{\dfrac{\text{Change in quantity}}{\text{Original quantity}} \times 100}{\dfrac{\text{Change in price}}{\text{Original price}} \times 100}$$

$$\text{Or, } E_p = \frac{\text{Change in Quantity}}{\text{Original Quantitiy}} \times \frac{\text{Original Price}}{\text{Change in Price}}$$

Or in symbolic terms, $E_p = \frac{\Delta Q}{Q} \times \frac{P}{\Delta P} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$

Where, E_p = Price elasticity,

Q = Quantity,

P = Price,

ΔQ = Change in quantity demanded,

ΔP = Change in price.

Definition of Price Elasticity of Demand

- ***Price elasticity of demand is generally defined as the responsiveness of demand for a commodity to the changes in its price, all other factors remaining constant.***

- ***More precisely, elasticity of demand is the percentage change in demand due to one per cent change in the price of the commodity. A formal definition of price elasticity of demand (ep) is given as***

$$e_p = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}}$$

A general formula1 for measuring coefficient of price elasticity of demand, as given in Equation:

$$e_p = \frac{\Delta Q}{Q} \div \frac{\Delta P}{P} = \frac{\Delta Q}{Q} \times \frac{P}{\Delta P}$$

$$= \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$$

where *Q = original quantity demanded, P = original price, ΔQ = change in quantity demanded, and ΔP = change in price.*

Degree of Price Elasticity of Demand

Five cases of elasticity of demand are studied depending upon their degree:

- Perfectly Elastic
- Perfectly Inelastic
- Unitary Elastic
- Relatively Elastic
- Relatively Inelastic

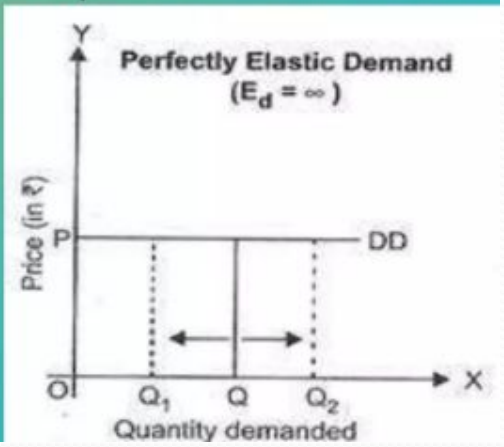
Perfectly Elastic Demand

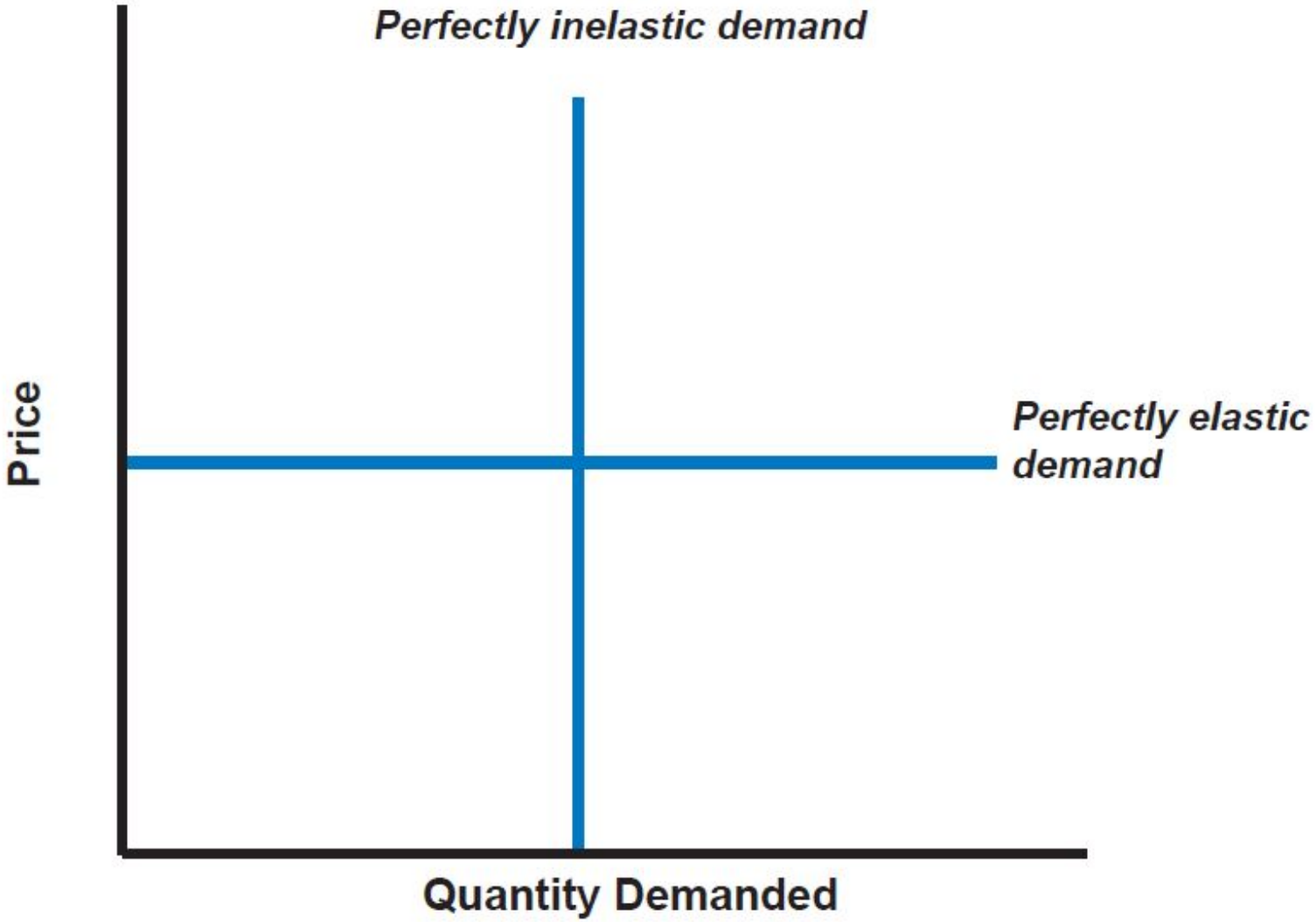
When a small change in price of a product causes a major change in its demand, it is said to be perfectly elastic demand. In perfectly elastic demand, a small rise in price results in fall in demand to zero, while a small fall in price causes increase in demand to infinity.

A perfectly elastic demand refers to the situation when demand is infinite at the prevailing price.

In perfectly elastic demand, a small rise in price results in fall in demand to zero, while a small fall in price causes increase in demand to infinity.

The degree of elasticity of demand helps in defining the shape and slope of a demand curve. Therefore, the elasticity of demand can be determined by the slope of the demand curve. **Flatter the slope of the demand curve, higher the elasticity of demand.**




Perfectly inelastic demand
Price
Perfectly elastic demand
Quantity Demanded

Perfectly Inelastic Demand

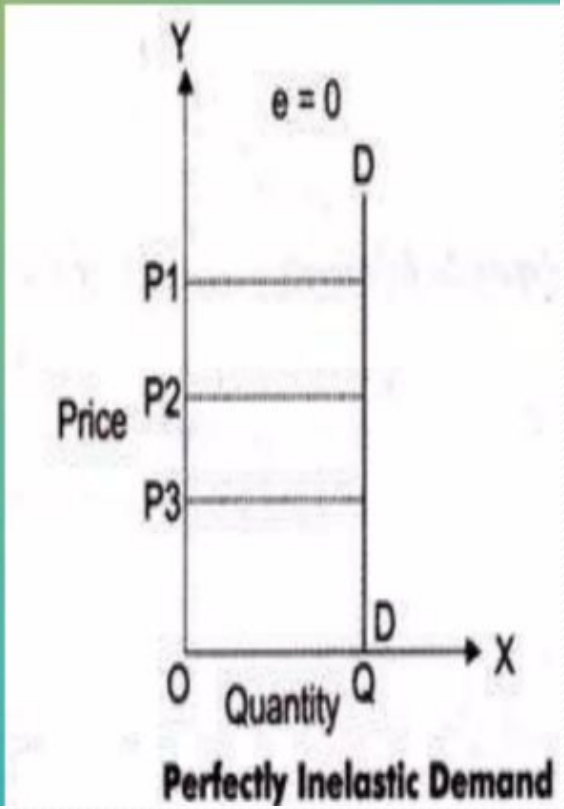
A Perfectly inelastic demand is one in which a change in price causes no change in quantity demanded.

It is a situation where even substantial changes in price leave the demand unaffected.

It can be interpreted from Figure that the movement in price from OP1 to OP2 and OP2 to OP3 does not show any change in the demand of a product (OQ).

The demand remains constant for any value of price.

Perfectly inelastic demand is a theoretical concept and cannot be applied in a practical situation. However, in case of essential goods, such as salt, the demand does not change with change in price. Therefore, the demand for essential goods is perfectly inelastic.



Perfectly Inelastic Demand

Unitary Elastic Demand

- When the proportionate change in demand produces the same change in the price of the product, the demand is referred as unitary elastic demand. The numerical value for unitary elastic demand is equal to one (e_p=1).

- **The demand curve for unitary elastic demand is represented as a rectangular hyperbola.**

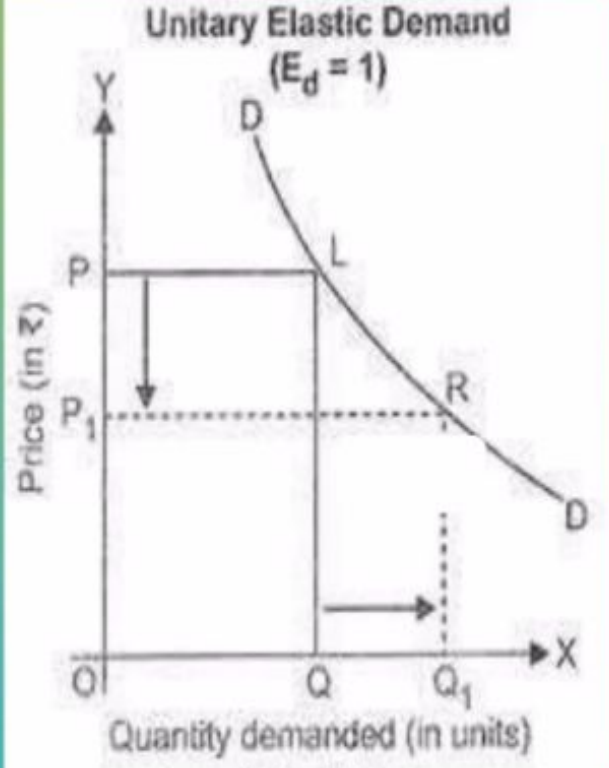


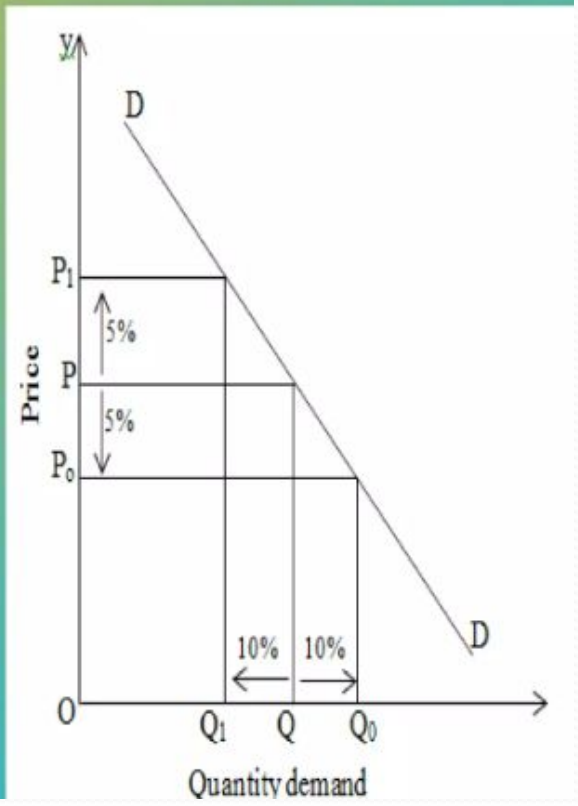
Fig. 4.8

Relatively Elastic Demand

Relatively elastic demand refers to the demand when the proportionate change produced in demand is greater than the proportionate change in price of a product.

Mathematically, relatively elastic demand is known as more than unit elastic demand ($e_p>1$). For example, if the price of a product increases by 20% and the demand of the product decreases by 25%, then the demand would be relatively elastic.

In this the demand is more responsive to the change in price



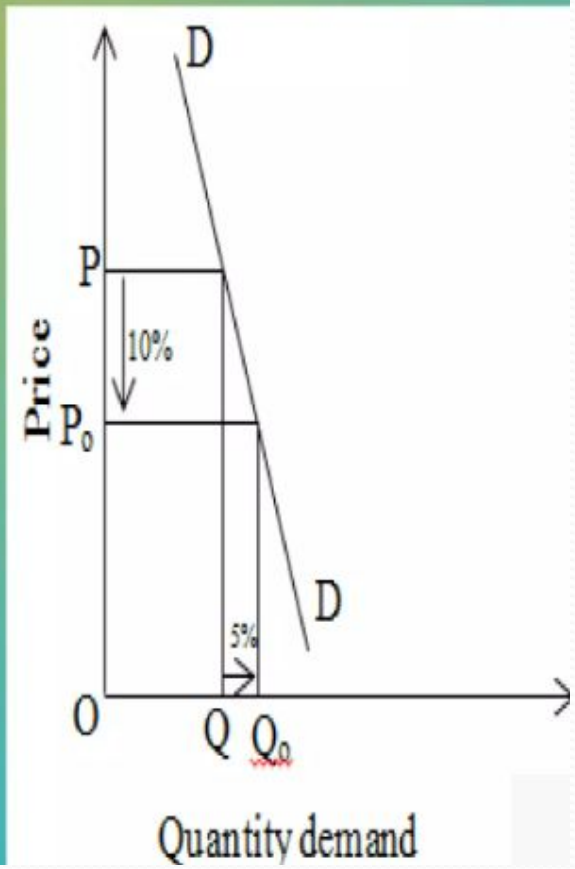
Relatively Inelastic Demand

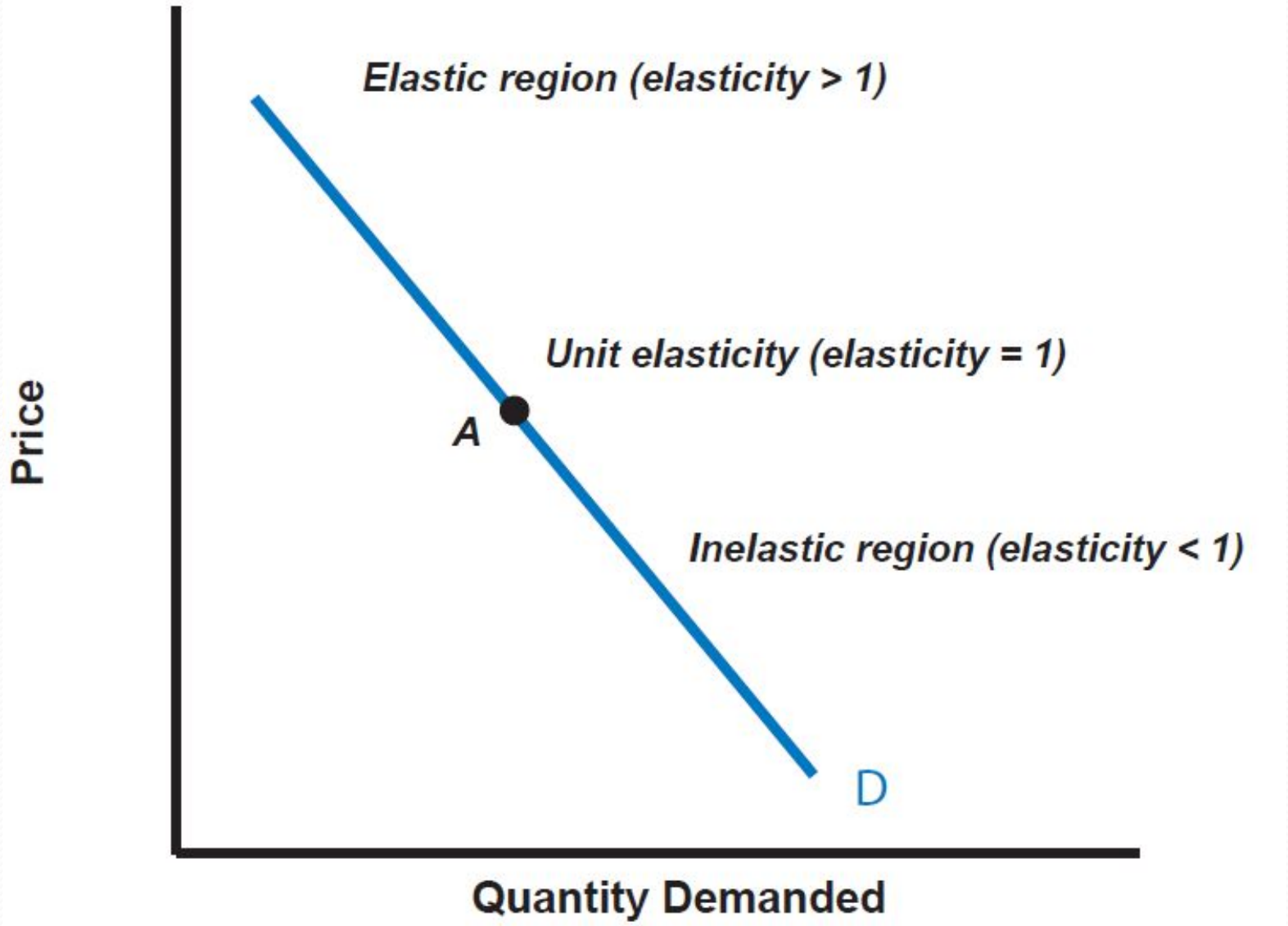
Relatively inelastic demand is one when the percentage change produced in demand is less than the percentage change in the price of a product.

For example, if the price of a product increases by 30% and the demand for the product decreases only by 10%, then the demand would be called relatively inelastic.

The numerical value of relatively elastic demand ranges between zero to one (e_p<1).

Marshall has termed relatively inelastic demand as elasticity being less than unity.




Elastic region (elasticity > 1)
Unit elasticity (elasticity = 1)
A
Inelastic region (elasticity < 1)
D
Price
Quantity Demanded

If a 10% increase in the price of luxury cars leads to a 20% decrease in demand, PED = -20%/10% = -2. This indicates elastic demand.

If a 20% increase in the price of insulin leads to a 5% decrease in demand, PED = -5%/20% = -0.25. This indicates inelastic demand.

If a 15% increase in the price of jeans leads to a 15% decrease in demand, PED = -15%/15% = -1. This indicates unit elastic demand.

Elastic demand: Reducing prices can increase total revenue.
Inelastic demand: Increasing prices can increase total revenue.
Unit elastic demand: Changes in price do not affect total revenue.

Elasticity value (e)	Elasticity description	Effect of a price increase on revenues	Effect of a price decrease on revenues
$e = 0$	Perfectly inelastic	Increase	Decrease
$0 < e < 1$	Inelastic	Increase	Decrease
$e = 1$	Unit elastic	No change	No change
$1 < e < \infty$	Elastic	Decrease	Increase
∞	Perfectly elastic	Revenues fall to zero	Decrease

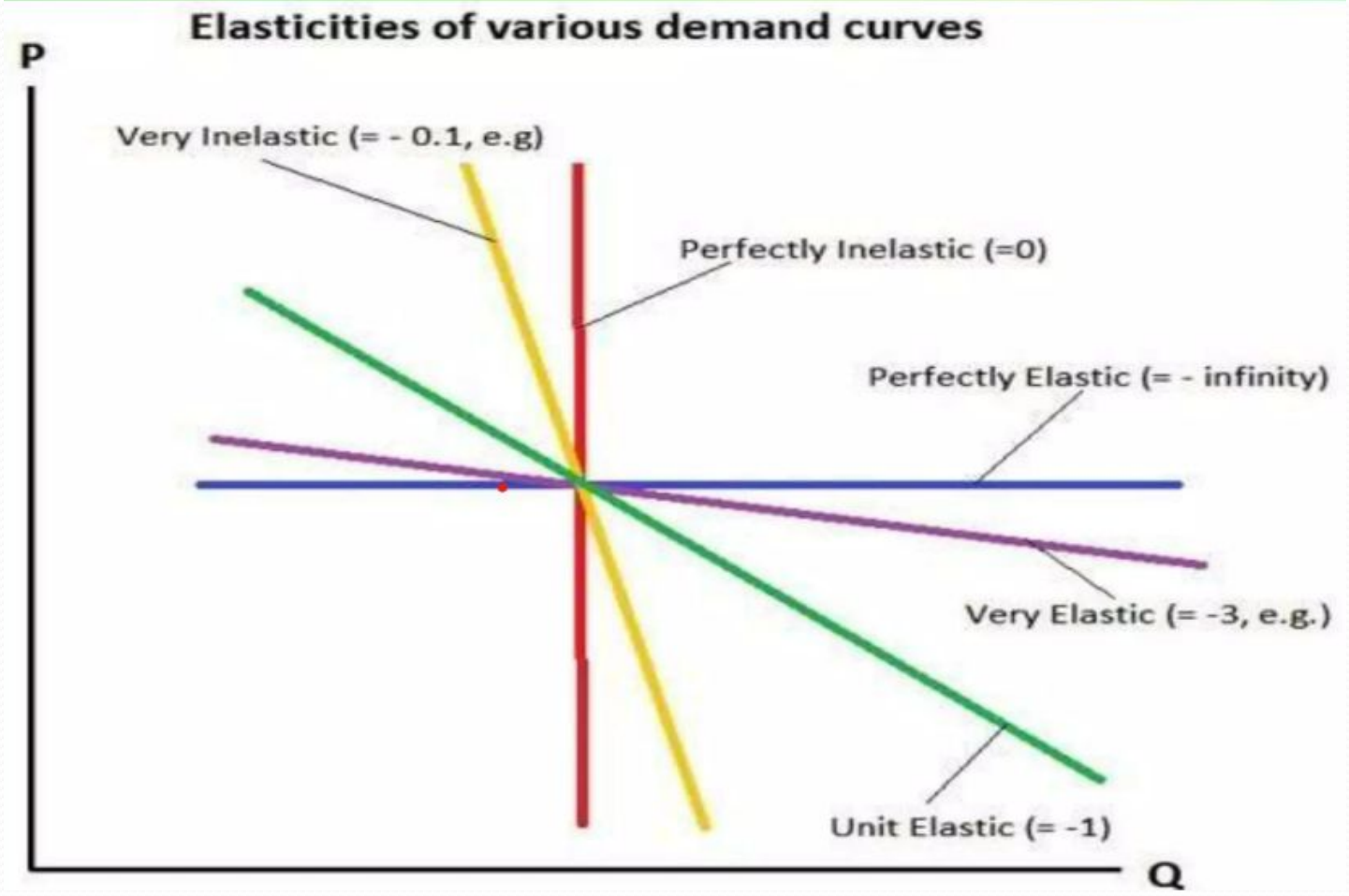
	Price elasticity of demand	
Good or service	*Low range*	*High range*
Cigarettes	0.4 (developed countries)	0.8 (developing countries)
Gasoline	0.1 (short term)	0.3 (long term)
Residential water	0.1 (lower estimates)	0.7 (higher estimates)
Air travel	0.3 (first-class travelers)	1.4 (pleasure travelers)
Soft drinks	0.8 (soft drinks in general)	4.4 (specific drink brands)
Eggs	0.1 (United States)	0.6 (South Africa)
Rice	0.3 (United States)	0.8 (China)

The different types of price elasticity of demand are summarized in Table

Table-4: Price Elasticity of Demand

Numerical Value	Type of Price Elasticity	Description
$e_p = \infty$	Perfectly elastic demand	There is a greater change in demand in response to percentage or smaller change in the price. For example, the demand for a product decreases or completely stops, with a little change in its price and vice versa.
$e_p = 0$	Perfectly inelastic demand	Consumers do not respond to the demand for a product with increase or decreases in its price. This implies that the demand remains the same with change in the price.
$e_p > 1$	Relatively elastic demand	The percentage change in the quantity demanded of a product is greater than percentage change in its price. In such a case, consumers generally switch to new brands when the price of a particular brand increases. However, some consumers are loyal to the same brand.
$e_p < 1$	Relatively inelastic demand	The change in the demand of a product is less than that of change in its price.
$e_p = 1$	Unitary elastic demand	The change in the demand and change in the price of a product is same.

Flatter the slope of the demand curve, higher the elasticity of demand.




Measurement of Price Elasticity of Demand
Measurement of Price Elasticity of Demand
Total Expenditure Method
Proportionate Method
Point Elasticity of Demand
Arc Elasticity of Demand

Percentage or Proportionate Method

This method is also associated with the name of Dr. Marshall.

According to this method "Price elasticity of demand is the ratio of the proportionate change in quantity demanded to proportionate change in price.

It is also known as the Percentage Method, Flux Method, Ratio Method, and Arithmetic Method. Its formula is as under:

Formula

E_P = **Percentage Change in Quantity Demanded**
Percentage Change in the Price of the good

$$\text{Or, } E_p = \frac{\frac{\text{Change in quantity}}{\text{Original quantity}} \times 100}{\frac{\text{Change in price}}{\text{Original price}} \times 100}$$

$$\text{Or, } E_p = \frac{\text{Change in Quantity}}{\text{Original Quantitiy}} \times \frac{\text{Original Price}}{\text{Change in Price}}$$

Or in symbolic terms, $E_p = \frac{\Delta Q}{Q} \times \frac{P}{\Delta P} = \frac{\Delta Q}{\Delta P} \times \frac{P}{Q}$

Where, E_p = Price elasticity,

Q = Quantity,

P = Price,

ΔQ = Change in quantity demanded,

ΔP = Change in price.

Calculate the Price Elasticity of demand if the price fell by 10% causing the demand to rise from 800 to 850 units.

Percentage change in quantity demanded = $\frac{\Delta Q}{Q} \times 100$

$= \frac{(850-800)}{800} \times 100 = 6.25\%$

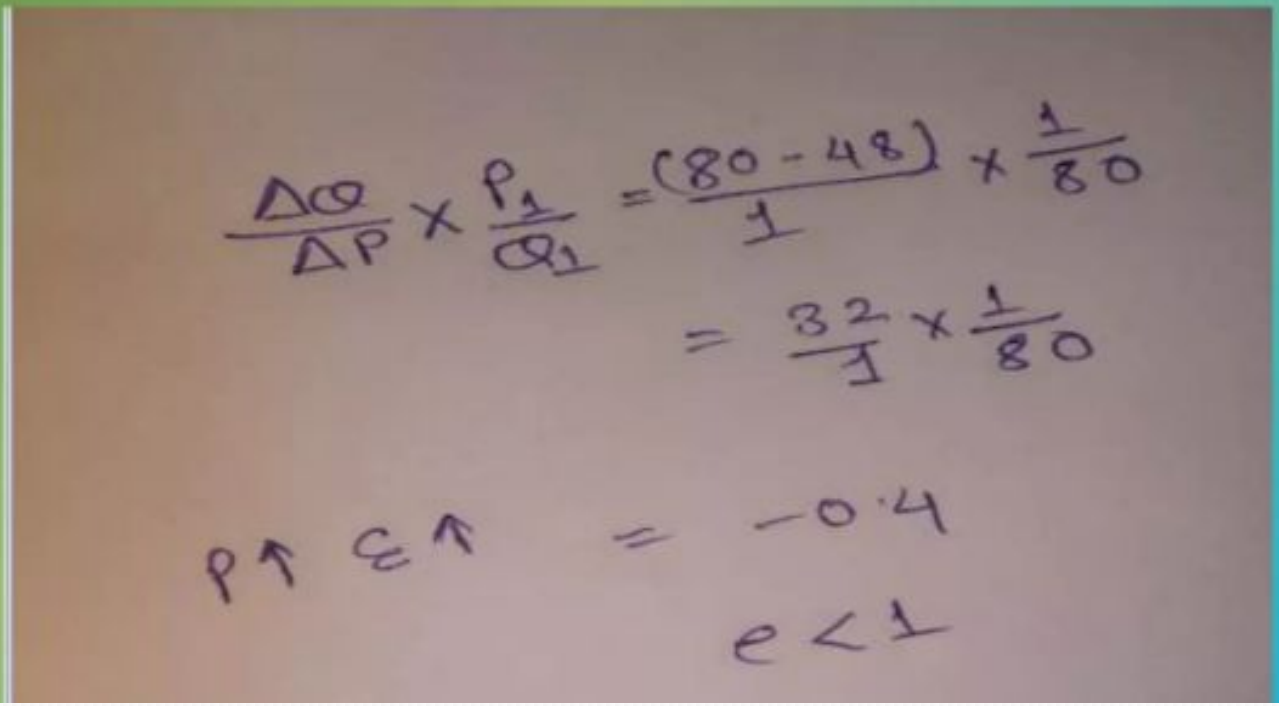
✓ Ed = $\frac{\text{percentage change in demand for the good}}{\text{percentage change in the price of the good}}$

$= \frac{6.25}{10} \times 100 = 0.63$ (less than unity)

When Price of Commodity is Rs. 1, then Consumer spends Rs. 80 & If the price of commodity is Rs. 20 then consumer spends Rs. 96.

Calculate the Elasticity of demand with Percentage Method.

Price	Expenditure	Quantity
1	80	80
2	96	48



Income Elasticity of Demand

Income elasticity of demand is the degree of responsiveness of quantity demanded of a commodity due to change in consumer's income, other things remaining constant.

In other words, it measures by how much the quantity demanded changes with respect to the change in income.

The income elasticity of demand is defined as the percentage change in quantity demanded due to certain percent change in consumer's income.

Mathematically, it is expressed as:

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

Symbolically, it is expressed as:

$$E_Y = \frac{\Delta q}{\Delta y} \times \frac{y}{q}$$

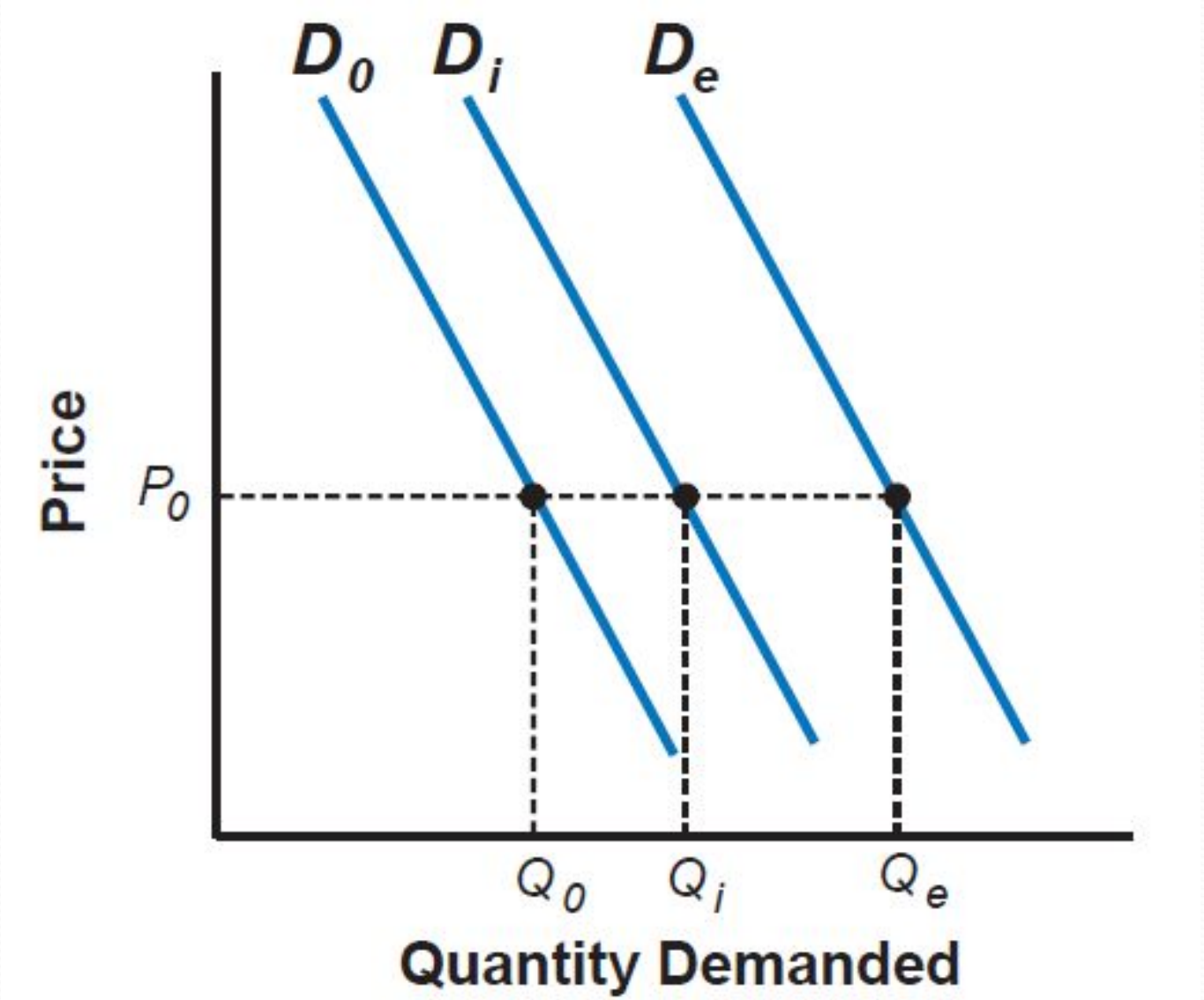
Where,

- **EY = Elasticity of demand**
- **q = Original quantity demanded**
- **Δq = Change in quantity demanded**

y = Original consumer's income

- **Δy= Change in consumer's income**

Figure 5.7: Income Elasticity of Demand



1. **Income elasticity more than 1,it is luxury goods or a superior goods.**

   E>1

2. **Income elasticity less than 1,** a **necessity good** or a **necessary good** is a type of **normal good**

   E<1 - Essential goods

3. **Income elasticity is 0 , that an increase in income does not change the quantity demanded of the good.**

   E=0

4. **Income elasticity is negative is associated with inferior goods .**

   E<0

5. **Income elasticity is more than 0 [Postive Income Elasticity]**

   E>0 Normal goods

6. **Income elasticity is equal to 1**

   E=1 Semi Luxury

Example to Explain Income Elasticity of Demand

Suppose that the initial income of a person is Rs.2000 and quantity demanded for the commodity by him is 20 units. When his income increases to Rs.3000, quantity demanded by him also increases to 40 units. Find out the income elasticity of demand.

Solution:

Here, q = ~~100~~ **20 Units** units

Δq = (40-20) units = 20 units

y = Rs.2000

Δy = Rs. (3000-2000) = Rs.1000

$$\therefore E_y = \frac{\Delta q}{\Delta y} \times \frac{y}{q}$$

$$= \frac{20}{20} \times \frac{2000}{1000}$$

$$= 2\%$$

Hence, an increase of Rs.1000 in income i.e. 1% in income leads to a rise of 2% in quantity demanded.

The measure of responsiveness of the demand for a good towards the change in the price of a related good is called cross price elasticity of demand. It is always measured in percentage terms.

With the consumption behavior being related, the change in the price of a related good leads to a change in the demand of another good.

Related goods are of two kinds, i.e. substitutes and complementary goods.

Cross Elasticity of Demand

- **A change in price of one article causes a change in demand of another article.**

$$E_c = \frac{Proportionate\ change\ in\ purchase\ of\ commodity}{Proportionate\ change\ in\ price\ of\ commodity}$$

Cross Elasticity of Demand

In case the two goods are substitutes for each other like tea and coffee, **the cross price elasticity will be positive,** i.e. if the price of coffee increases, the demand for tea increases.

On the other hand**, in case the goods are complementary** in nature like pen and ink, then **the cross elasticity will be negative**, i.e. demand for ink will decrease if prices of pen increase or vice-versa.

It can be expressed as:

$$Ce = \frac{\text{Proportionate change in the quantity demanded of Y}}{\text{Proportionate change in the price of X}}$$

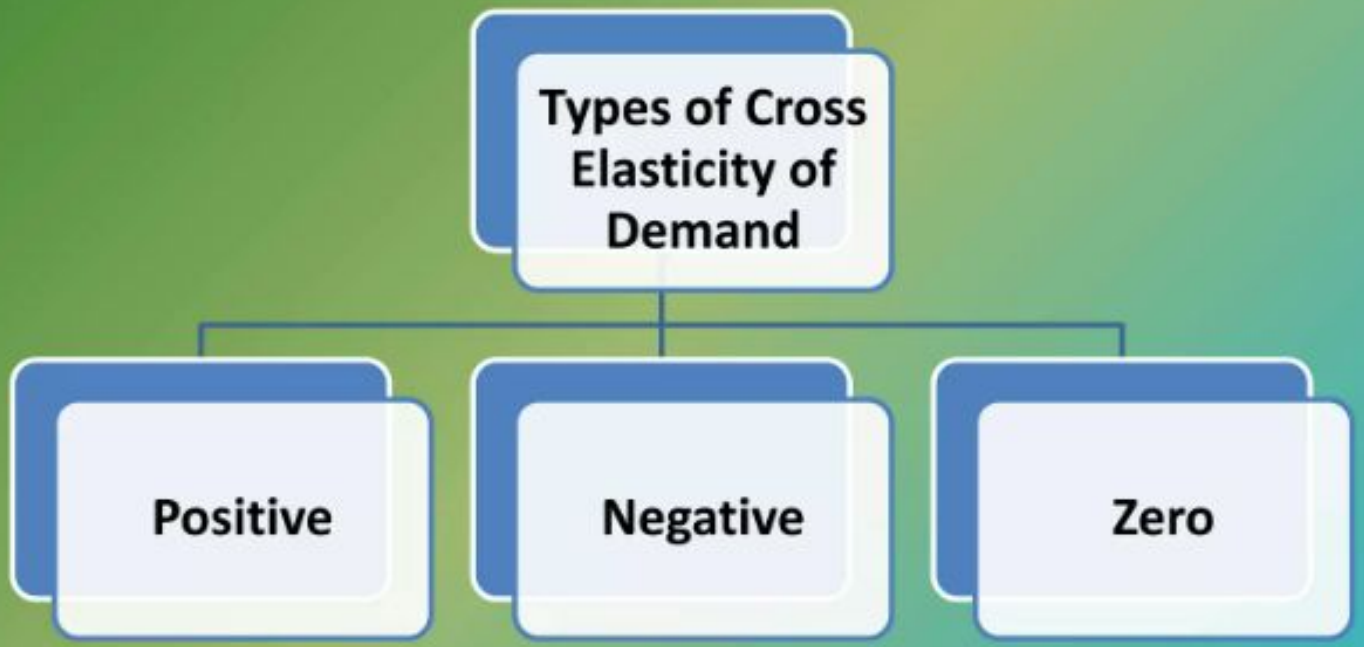
Substitute Goods:

In case the two goods are substitutes for each other like tea and coffee, the **cross price elasticity will be positive**, i.e. if the price of coffee increases, the demand for tea increases.

Complementary Goods:

On the other hand, in case the goods are complementary in nature like pen and ink, then the **cross elasticity will be negative**, i.e. demand for ink will decrease if prices of pen increase or vice-versa.

Types of Cross Elasticity of Demand

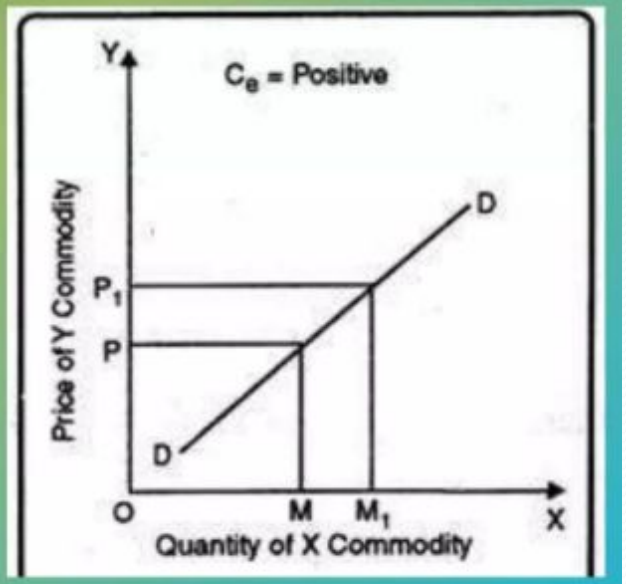


Positive Cross Elasticity of Demand

When goods are substitute of each other then cross elasticity of demand is positive.

In other words, when an increase in the price of Y leads to an increase in the demand of X.

For instance, with the increase in price of tea, demand of coffee will increase.

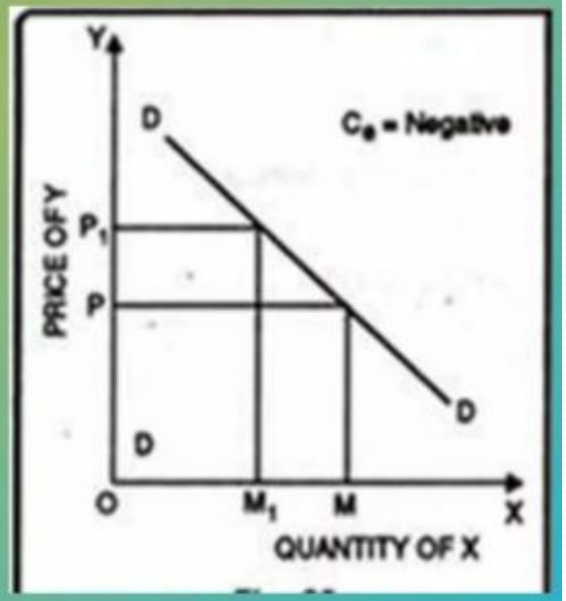


In figure quantity has been measured on OX-axis and price on OY-axis. At price OP of Y-commodity, demand of X-commodity is OM. Now as price of Y commodity increases to OP_1 demand of X-commodity increases to OM_1 Thus, cross elasticity of demand is positive.

Negative Cross Elasticity of Demand

In case of complementary goods, cross elasticity of demand is negative.

A proportionate increase in price of one commodity leads to a proportionate fall in the demand of another commodity because both are demanded jointly.

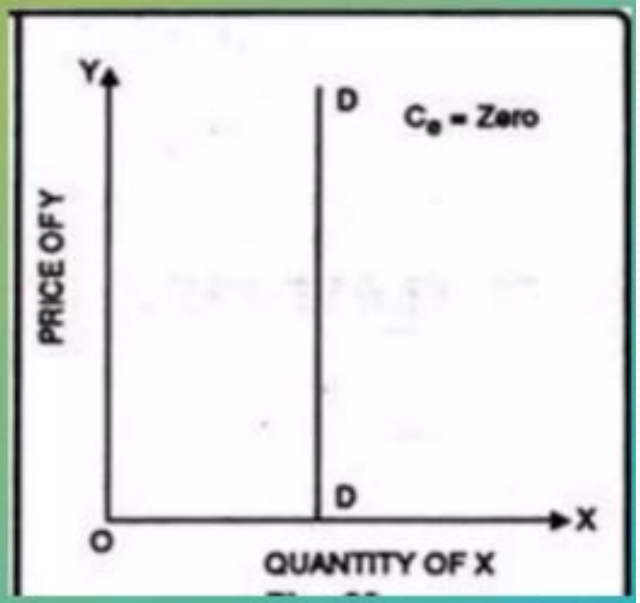


In figure quantity has been measured on OX-axis while price has been measured on OY-axis. When the price of commodity increases from OP to OP_1 quantity demanded falls from OM to OM_1. Thus, cross elasticity of demand is negative.

Zero Cross Elasticity of Demand

Cross elasticity of demand is zero when two goods are not related to each other.

For instance, increase in price of car does not effect the demand of cloth. Thus, cross elasticity of demand is zero.



1. **When cross elasticity is more than 0 (Substitute goods)**

   Ec>0

2. **When cross elasticity is less than 0 (Complimentary goods)**

   Ec<0

3. **When cross elasticity is equal to 0 (Unrelated goods)**

   Ec=0

Q1: Demand function for a book is Q=500-5P

(a) find the demand schedule and demand curve

(b) (b) number of book sold when P= Rs. 25

(c) (c) price for selling 2500 book copies

(d) (d) price for zero sales

(e) (e) point elasticity of demand at price Rs 20

(f) (f) arc elsticity for a fall of price from 25 to 20 and a rise in price from 20 to 25

We are given a linear demand function: Q = 500 - 5P. This means that the quantity demanded (Q) is dependent on the price (P).

(a) Demand Schedule and Demand Curve
Demand Schedule: We can create a demand schedule by assigning different values to P and calculating the corresponding values of Q.

Price (P)	Quantity Demanded (Q)
0	500
20	400
40	300
60	200
80	100
100	0

Demand Curve: The demand curve is a graphical representation of the demand schedule. It is a downward sloping straight line.

(b) Number of Books Sold When P = Rs. 25
Substitute P = 25 into the demand function: Q = 500 - 5(25) = 500 - 125 = 375 books

(c) Price for Selling 2500 Books
Substitute Q = 2500 into the demand function: 2500 = 500 - 5P 5P = 500 - 2500 P = -400 This result is not possible as price cannot be negative. Therefore, it is not possible to sell 2500 books based on the given demand function.

(d) Price for Zero Sales
Substitute Q = 0 into the demand function: 0 = 500 - 5P 5P = 500 P = 100

(e) Point Elasticity of Demand at Price Rs 20

Elasticity of demand (Ed) = (% change in quantity demanded) / (% change in price)

For small changes in price, the elasticity can be approximated as: Ed = (dQ/Q) / (dP/P) = (P/Q) * (dQ/dP)

First, find the quantity demanded when P = 20: Q = 500 - 5(20) = 400

Then, find dQ/dP: dQ/dP = -5

Now, calculate elasticity: Ed = (20/400) * (-5) = -0.25

The absolute value of point elasticity of demand at price Rs 20 is 0.25.

(f) Arc Elasticity for a Fall of Price from 25 to 20 and a Rise in Price from 20 to 25

Arc Elasticity: Arc elasticity is used for larger changes in price and quantity.

Fall of price from 25 to 20:

- Q1 = 500 - 5(25) = 375
- Q2 = 500 - 5(20) = 400
- P1 = 25
- P2 = 20

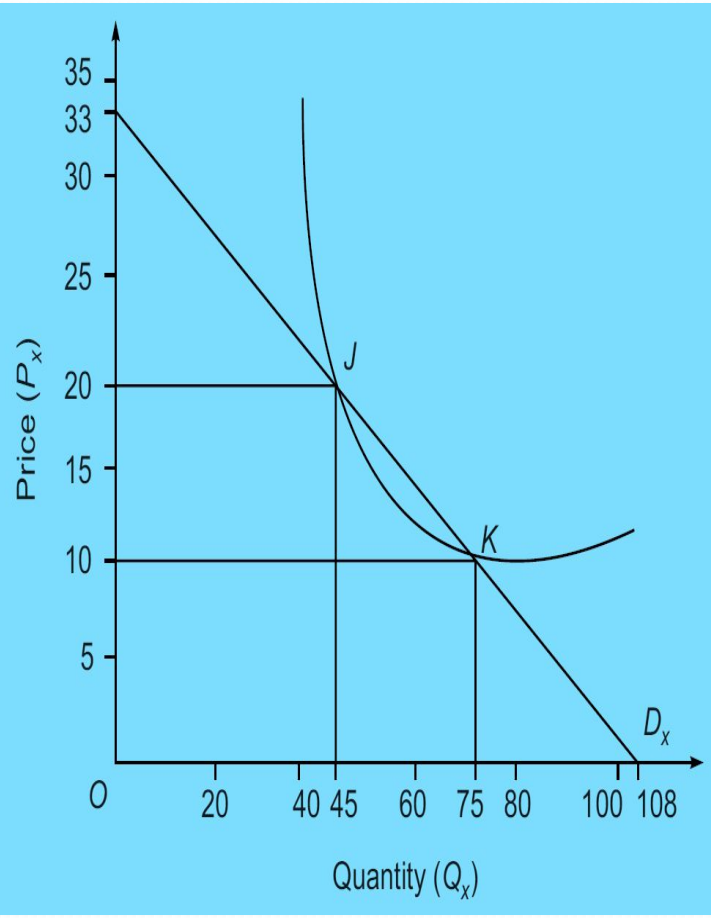
Rise in price from 20 to 25: The arc elasticity will be the same as for the fall in price, but with the opposite sign, so it would be -0.26.

Arc Elasticity = [(Q2 - Q1) / ((Q1 + Q2)/2)] / [(P2 - P1) / ((P1 + P2)/2)] = [(400 - 375) / ((375 + 400)/2)] / [(20 - 25) / ((25 + 20)/2)] ≈ 0.26

Arc and Point Elasticity of Demand

- ***Arc Elasticity:*** ***The concept of arc elasticity of demand refers to the elasticity of demand for a significant change in price and consequent change in demand.***
- **When there is a big change in price, demand changes greatly and then the demand-price point shifts from one point to another on the demand curve showing an arc on the curvilinear demand curve. Thus, the measure of elasticity of demand between any two finite points on a demand curve is known as *arc elasticity.***
- ***For example, measurement of elasticity between points J and K (Figure) is the measure of arc elasticity. The movement from point J to K on the demand curve (Dx) shows a big (50%) fall in the price from `20 to `10 so that ΔP = 20 – 10 = 10. The big fall in price causes a large increase in demand from 45 units to 75 units so that ΔQ = 45 – 75 = – 30.***

- ***The arc elasticity between points J and K (moving from J to K) can be calculated by substituting these values into the elasticity formula as follows:***



$$e_p = -\frac{-\Delta Q}{\Delta P}\cdot\frac{P}{Q} \text{ (with minus sign)}$$

$$= -\frac{-30}{10}\cdot\frac{20}{45} = 1.33$$

The elasticity measured in Equation, means that a one per cent decrease in price of commodity *X results in a 1.33 percent increase in demand for it*.

Arc Elasticity (Ea) = [(Q2 - Q1) / ((Q1 + Q2)/2)] / [(P2 - P1) / ((P1 + P2)/2)]

Suppose the demand function for a product is Q = 100 - 2P. We want to find the arc elasticity between P = 20 and P = 25.

- Find the quantities demanded at P1 = 20 and P2 = 25:
  - Q1 = 100 - 2(20) = 60
  - Q2 = 100 - 2(25) = 50
- Calculate arc elasticity: Ea = [(50 - 60) / ((60 + 50)/2)] / [(25 - 20) / ((25 + 20)/2)] = (-10/55) / (5/22.5) = -0.82

Direction of Change in Price and Problem in Using Arc Elasticity

- ***It is important to note that the arc elasticity co-efficients differ between the same two finite points on a demand curve if direction of change in price is reversed.***

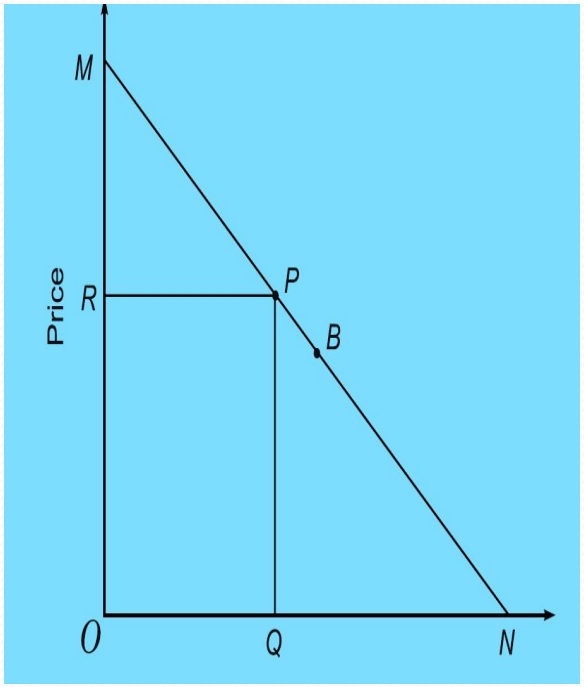
- ***It means that the elasticity depends also on the direction of change in price. Therefore, while measuring price elasticity, the direction of price change should be carefully noted.***

- ***Otherwise, it will lead to a wrong decision regarding the change in price.***

- ***For instance, if price elasticity between points J and K is taken to be the same whether price increases or decreases, it leads to the conclusion that total sales revenue will remain the same whether price increases or decreases. But, this is a wrong conclusion.***

Point Elasticity: Point elasticity on a linear demand curve

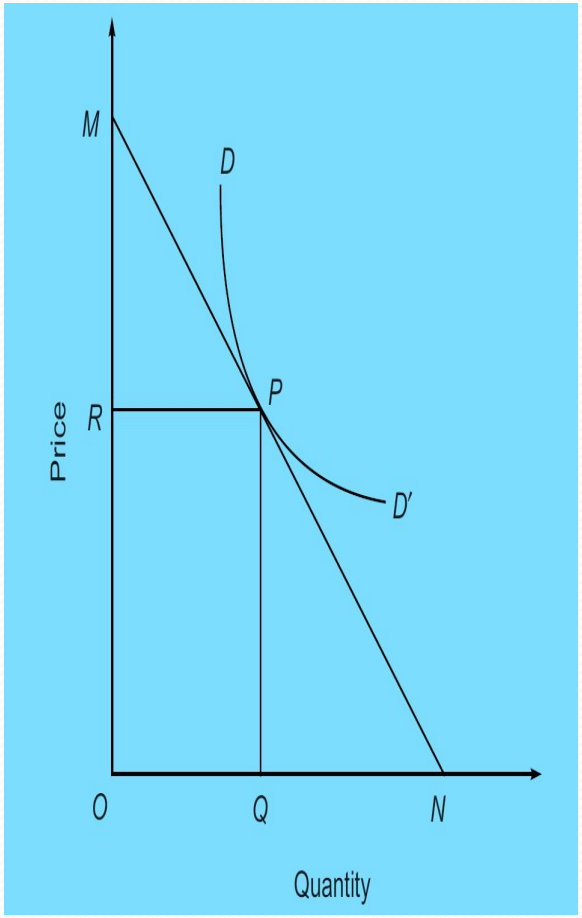
Point elasticity is also a way to resolve the problem in measuring the elasticity. The concept of point elasticity is used for measuring price elasticity where change in price is infinitesimally small.



The price elasticity of demand at any point on a linear demand curve is equal to the ratio of lower segment to the upper segments of the line, i.e.,

$$e_p = \frac{\text{Lower segment of Demand Curve}}{\text{Upper segment of Demand Curve}}$$

Point Elasticity On A Non-linear Demand Curve



The ratio DQ/DP in respect of a non-linear demand curve is different at each point. Therefore, the method used to measure point elasticity on a linear demand curve cannot be applied straightaway to measure the elasticity on a curvilinear demand curve. A simple modification in technique is required. In order to measure point elasticity on a non-linear demand curve, the chosen point is first brought on a linear demand curve. This is done by drawing a tangent through the chosen point.

Point Elasticity (Ed) = (P/Q) * (dQ/dP)

Suppose the demand function for a product is Q = 100 - 2P. We want to find the point elasticity at P = 20.

- First, find the quantity demanded at P = 20: Q = 100 - 2(20) = 60.
- Next, find the derivative of Q with respect to P: dQ/dP = -2.
- Calculate point elasticity: Ed = (20/60) * (-2) = -2/3.

Price Elasticity and Total Revenue

- *A firm aiming at enhancing its total revenue would like to know whether increasing or decreasing the price would achieve its goal.*

- *The price elasticity coefficient of demand for its product at different levels of its price provides the answer to this question.*

- *The simple answer is that if ep > 1, then decreasing price will increase total revenue and if eq < 1, then increasing price will increase total revenue.*

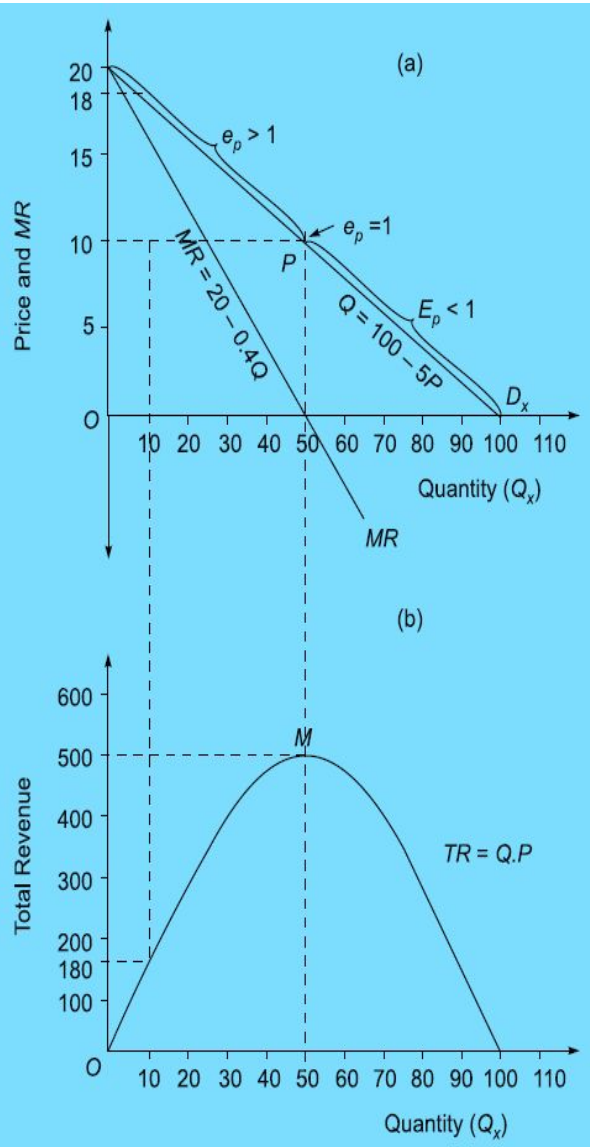


Fig. 8.5 *Price Elasticity and Total Revenue*

- ***To prove this point, the total revenue (TR) and the marginal revenue (MR) functions and measures of price-elasticity are required. Since TR = Q · P, we need to know P and Q. This information can be obtained through the demand function.***

- ***Over the range of demand curve with e > 1, quantity demanded increases by more than the proportionate decrease in price and hence the total revenue increase when price falls. The total revenue increases till price decreases till e = 1.***

- If demand for a product is *unit elastic (ep = 1), quantity demanded increases (or decreases) in the proportion of decrease (or increase) in the price. It implies that a small change in price leaves total revenue unchanged. Therefore, total revenue remains constant.*

- If demand for a commodity has *ep < 1, change in quantity demanded is greater than the proportionate change in price. Therefore, total revenue decreases when price falls and vice versa.*

- The case of *infinitely elastic demand represented by a horizontal straight line is rare. Such a demand line implies that a consumer has the opportunity to buy any quantity of a commodity and the seller can sell any quantity of a commodity, at a given price. It is the case of a commodity being bought and sold in a perfectly competitive market. A seller, therefore, cannot charge a higher or a lower price.*

Determinants of Price Elasticity of Demand

Price-elasticity of demand, at a given price, varies from product to product depending on the following factors:

1. **Availability of Substitutes: One of the most important determinants of elasticity of demand for a commodity is the availability of its close substitutes. The higher the degree of closeness of the substitutes, the greater the elasticity of demand for the commodity. *Therefore, the price-elasticity of demand for each brand is much greater than that for the generic commodity. On the other hand, sugar and salt do not have close substitutes and hence their price-elasticity is lower.***

2. ***Nature of Commodity: The nature of a commodity also affects the price-elasticity of its demand. Commodities can be grouped as luxuries, comforts, and necessities.***

Demand for luxury goods is more elastic than the demand for necessities and comforts On the other hand, consumption of necessary goods, cannot be postponed and hence their demand is inelastic.

3. Weightage in the Total Consumption: If proportion of income spent on a commodity is large, its demand is found to be more elastic. On the contrary, if the proportion of income spent on a commodity is small, its demand is less price-elastic.

4. Time Factor in Adjustment of Consumption Pattern : Price-elasticity of demand depends also on the time consumers need to adjust their consumption pattern to a new price: the longer the time available, the lower the price-elasticity. The reason is that over a period of time, consumers are able to adjust their expenditure pattern to price changes.

5. Range of Commodity Use : ***The range of uses of a commodity also influences the price-elasticity of its demand. The wider the range of the uses of a product, the higher the elasticity of demand for the decrease in price. As the price of a multi-use commodity decreases, people extend their consumption to its other uses. Therefore, the demand for such a commodity generally increases more than the proportionate decrease in its price.***

6.Proportion of Market Supplied : ***The elasticity of market demand also depends on the proportion of the market supplied at the ruling price. If less than half of the market is supplied at the ruling price, price-elasticity of demand will be higher than 1 and if more than half of the market is supplied, e < 1.***

Application of Price Elasticity

The application of price elasticity of demand with respect to

(a) manoeuvring price to maximize sales revenue, and

(b) (b) determination of optimal price for profit maximization.

1. Manoeuvring of Price: ***Price manoeuvring means changing price of the product to achieve business objective. The concept of elasticity of demand plays a crucial role in business-decisions regarding manoeuvring of prices for the benefit of the firm. Firms may decide to change the price even without any change in the cost of production.***

2. Determination of Optimum Price. ***Another and a rather more important application of price elasticity is that it can be used, at least theoretically, to determine the optimum price with the objective of profit maximization by a firm facing downward sloping demand curve.***

CROSS-ELASTICITY OF DEMAND

- ***The cross-elasticity of demand refers to the responsiveness of demand for a commodity to the changes in the price of its substitutes and complementary goods. The formula for measuring cross-elasticity of demand is the same as that of the price elasticity with a difference. For example, cross-elasticity of demand for tea (et, c) can be measured by the formula given below:***

$$e_{t,\ c} = \frac{\text{Percentage change in demand for tea } (Q_t)}{\text{Percentage change in price of coffee } (P_c)}$$

- ***It is important to note that when two goods are substitutes for one another, their demand has positive cross-elasticity because increase in the price of one good increases the demand for its substitute. And, the demand for complementary goods has negative cross-elasticity, because increase in the price of a complementary good decreases the demand for the main good.***

Uses of Cross-Elasticity

The concept of cross-elasticity has both theoretical and practical uses:

- ***Theoretically**, an important use of cross-elasticity is to define substitute goods. If cross-elasticity between any two goods is positive, the two goods may be considered as substitutes of one another.*

- ***Practically**, the concept of cross-elasticity is of vital importance in pricing decisions, i.e., in changing prices of products having substitutes and complementary goods. If cross-elasticity in response to the price of substitutes is greater than one, it would be inadvisable to increase the price; rather, reducing the price may prove beneficial.*

INCOME-ELASTICITY OF DEMAND

The relationship between the quantity demanded of most consumer goods and consumer's income is of positive nature. The demand for most goods and services increases with increase in consumer's income and vice versa. The responsiveness of demand to the changes in consumer's income is known as income-elasticity of demand.

Income-elasticity of demand for a product, say X, (i.e., ey) may be measured as

$$e_y = \frac{\%\text{ change in demand for product } X}{\%\text{ change in consumer's income } Y} = \frac{\Delta X_q}{X_q} \Big/ \frac{\Delta Y}{Y}$$

$$e_y = \frac{Y}{X_q} \cdot \frac{\Delta X_q}{\Delta Y}$$

(where *Xq = quantity of X demanded; Y = disposable income; ΔXq = change in quantity of X demanded; and ΔY = change in income).*

Nature of Commodity and Income-Elasticity

- ***For all normal goods, income-elasticity is positive though the degree of elasticity varies in accordance with the nature of commodities. Consumer goods of the three categories, viz., necessities, comforts and luxuries, have different elasticities.***
- ***Income-elasticity of demand for different categories of goods may, however, vary from household to household and from time to time, depending on the choice and preference of the consumers, levels of consumption and income, and their susceptibility to 'demonstration effect'.***
- ***The other factor which may cause deviation from the general pattern of income-elasticities is the frequency of increase in income. If frequency of rise in income is high, income-elasticities conforms to the general pattern.***

Uses of Income-Elasticity in Business Decisions

- ***While price and cross elasticities of demand are of greater significance in price management aimed at maximizing the total revenue in the short run, income-elasticity of a product is of a greater significance in production planning and management in the long run, particularly during the period of a business cycle.***

- ***The concept of income-elasticity can be used in estimating future demand provided that the rate of increase in income and income-elasticity of demand for the products are known.***

- ***The knowledge of income elasticity can thus be useful in forecasting demand, when a change in personal incomes is expected, other things remaining the same. It also helps in avoiding over-production or under-production.***

ADVERTISEMENT OR PROMOTIONAL ELASTICITY OF SALES

The expenditure on advertisement and on other sales-promotion activities does help in promoting sales, but not at the same degree at all levels of the total sales and total ad-expenditure. The concept of advertisement elasticity is useful in determining the optimum level of advertisement expenditure. The concept of advertisement elasticity assumes a greater significance in deciding on advertisement expenditure, particularly when there is competitive advertising by the rival firms. Advertisement elasticity (eA) of sales is measured as

$$e_A = \frac{\%\ \text{change in sales}}{\%\ \text{change in Ad-expenditure}}$$

The formula for measuring eA is given as

$$e_A = \frac{\Delta S / S}{\Delta A / A} = \frac{\Delta S}{\Delta A} \cdot \frac{A}{S}$$

where S = sales; ΔS = increase in sales; A = initial advertisement cost, and ΔA = additional expenditure on advertisement.

Interpretation of Advertisement Elasticity: ***The advertisement elasticity of sales promotion varies between eA = o and eA = ∞ depending on the nature of the product, the level of market supplied, the trend in consumers' income, the compatitive strength of the competitors, etc.***

Determinants of Advertisement Elasticity

Some important factors that determine the level of ad-elasticity are the following ones:

(i) The level of total sales:

- ***In the initial stages of sale of a product, particularly of one which is newly introduced in the market, advertisement elasticity is greater than unity.***

- ***Beyond a point of market supplied, however, sales increase, but ad-elasticity decreases.***

(*ii*) ***Advertisement by rival firms:*** ***In a highly competitive market, the effectiveness of advertisement by a firm is also determined by the relative effectiveness of advertisement by the rival firms. Simultaneous advertisement by the rival firms reduces the rate of increase in sales of firm and also the ad-elasticity.***

(*iii*) ***Cumulative effect of past advertisement:*** ***In case ad-expenditure in the initial stages is not adequate enough to be effective, elasticity may be very low. But over time, additional advertisement expenditure may have a cumulative effect on the promotion of sales and advertising elasticity may increase considerably.***

(*iv*) ***Other factors:*** ***Advertisement elasticity depends on the factors affecting the demand for a product, e.g., change in products' price, consumers' income and growth of substitutes and their prices.***

ELASTICITY OF PRICE EXPECTATIONS

Sometimes, mainly during the period of price fluctuations, consumer's price expectations play a more important role than any other factor in determining the demand for a commodity. The concept of price-expectation-elasticity was devised and popularized by J.R. Hicks in 1939. The price-expectation-elasticity refers to the expected change in future price as a result of change in current prices of a product. The elasticity of price-expectation is defined and measured by the general formula given below.

$$e_x = \frac{\Delta P_f / P_f}{\Delta P_c / P_c} = \frac{\Delta P_f}{\Delta P_c} \cdot \frac{P_c}{P_f}$$

Here, ***Pc = price in the recent past; ΔPc = the current change in present price; Pf = expected future price; and ΔPf = expected change in future price.***

Suppose the demand function for a product is given by:

$$Q = 50 - 3P$$

This function tells us that for every unit increase in price, the quantity demanded decreases by 3 units.

1. **Calculate the derivative $\frac{\partial Q}{\partial P}$:**

   The derivative of Q with respect to P is:

   $$\frac{\partial Q}{\partial P} = -3$$

   This tells us the slope of the demand curv[illegible] -3.

2. **Choose a specific point (P, Q):**

   Let's calculate the point elasticity at $P = 10$.

   First, find the quantity demanded at $P = 10$:
   $Q = 50 - 3(10) = 50 - 30 = 20$

3. **Apply the Point Elasticity Formula:**

   Now, use the point elasticity formula:
   $\text{PED} = -3 \times \frac{10}{20}$

   Simplify:
   $\text{PED} = -3 \times 0.5 = -1.5$

The point elasticity of demand at $P = 10$ is -1.5. This means that at this price, the demand is elastic. Specifically, a 1% increase in price would lead to a 1.5% decrease in quantity demanded.

4. Suppose there are only three consumers — *A*, *B*, and *C* — and their individual demand schedules are given as follows:

Price (₹)	*A's demand*	*B's demand*	*C's demand*
5	80	40	20
10	40	20	10
15	20	10	5
20	10	5	0
25	0	0	0

Find (*i*) market demand schedule,
(*ii*) market demand curve,
(*iii*) elasticity when price falls from ₹15 to ₹10, and
(*iv*) elasticity when price rises from ₹10 to ₹15.

(i) Market Demand Schedule

The market demand schedule is found by summing the individual demands of consumers A, B, an at each price level.

Price (₹)	A's Demand	B's Demand	C's Demand	Market Demand (Qm)
5	80	40	20	$80 + 40 + 20 = 140$
10	40	20	10	$40 + 20 + 10 = 70$
15	20	10	5	$20 + 10 + 5 = 35$
20	10	5	0	$10 + 5 + 0 = 15$
25	0	0	0	$0 + 0 + 0 = 0$

(ii) Market Demand Curve

To plot the market demand curve, you can graph the market demand (Qm) against the price (₹). The points on the graph will be:

iii) Elasticity When Price Falls from ₹15 to ₹10

Price elasticity of demand (PED) is calculated using the midpoint formula:

$$PED = \frac{(\mathrm{Q2} - \mathrm{Q1})}{(\mathrm{Q2} + \mathrm{Q1})/2} \div \frac{(\mathrm{P2} - \mathrm{P1})}{(\mathrm{P2} + \mathrm{P1})/2}$$

Where:

- $P1 = 15, P2 = 10$
- $Q1 = 35, Q2 = 70$

$$PED = \frac{(70 - 35)}{(70 + 35)/2} \div \frac{(10 - 15)}{(10 + 15)/2} = \frac{35}{52.5} \div \frac{-5}{12.5} = 0.6667 \div -0.4 = -1.67$$

So, the elasticity is -1.67. This indicates that the demand is elastic when the price falls from ₹15 to ₹10.

(iv) **Elasticity When Price Rises from ₹10 to ₹15**

Using the same formula:

Where:

- $P1 = 10, P2 = 15$
- $Q1 = 70, Q2 = 35$

$$PED = \frac{(35 - 70)}{(35 + 70)/2} \div \frac{(15 - 10)}{(15 + 10)/2} = \frac{-35}{52.5} \div \frac{5}{12.5} = -0.6667 \div 0.4 = -1.67$$

So, the elasticity is again -1.67, indicating that the demand is equally elastic when the price rises from ₹10 to ₹15.

Total Revenue (TR)

- **Definition:** The total income a firm receives from selling a given quantity of output.
- **Formula:** TR = Price (P) * Quantity (Q)

Example: If a company sells 10 units of a product at $5 each, the total revenue is $50 (10 units * $5/unit).

Average Revenue (AR)

- **Definition:** The revenue earned per unit of output sold.
- **Formula:** AR = Total Revenue (TR) / Quantity (Q)
- **Note:** In perfect competition, AR is equal to the price of the product.

Example: Continuing the previous example, the average revenue is $5 ($50 total revenue / 10 units).

Marginal Revenue (MR)

- **Definition:** The additional revenue generated from selling one more unit of output.
- **Formula:** MR = Change in Total Revenue / Change in Quantity

Example: If total revenue increases from $50 to $58 when one more unit is sold, the marginal revenue is $8 ($8 increase in total revenue / 1 unit increase in quantity).

Relationship Between TR, AR, and MR

- **TR** is the total income from all units sold.
- **AR** is the average income per unit sold.
- **MR** is the additional income from selling one more unit.

Quantity (Q)	Price (P)	Total Revenue (TR)	Marginal Revenue (MR)	Average Revenue (AR)
1	10	10	10	10
2	9	18	8	9
3	8	24	6	8
4	7	28	4	7

If demand function is Q= 12-P
(a) find the demand and marginal revenue schedule
(b) plot the AR and MR schedule
(c) find the marginal revenue when p= 10
(d) estimte the elasticity coefficient of the demand curve, when the total revenue is maximum

Marginal Revenue (MR)
Marginal revenue is the change in total revenue due to a one-unit change in quantity. For a linear demand curve, the MR curve has the same intercept as the demand curve but twice the slope.

Given the demand function Q = 12 - P,
P = 12 - Q.
Total Revenue (TR) = P * Q = (12 - Q) * Q = 12Q - Q^2
Marginal Revenue (MR) = d(TR)/dQ = 12 - 2Q

Price (P)	Quantity Demanded (Q)	Total Revenue (TR)	Marginal Revenue (MR)
0	12	0	12
2	10	20	10
4	8	32	8
6	6	36	6
8	4	32	4
10	2	20	2
12	0	0	0

(c) Find the marginal revenue when P = 10

When P = 10, Q = 12 – P = 12 – 10 = 2
MR = 12 – 2Q = 12 – 2(2) = 8

Therefore, the marginal revenue when P = 10 is 8.

(d) Estimate the elasticity coefficient when total revenue is maximum

Total revenue is maximum when MR = 0

12 - 2Q = 0

Q = 6

When Q = 6, P = 12 - Q = 12 - 6 = 6

Elasticity (E) = (% change in Q / % change in P)

E = (dQ/Q) / (dP/P) = (dQ/dP) * (P/Q)

Since Q = 12 - P, dQ/dP = -1

E = -1 * (6/6) = -1

Thank You