Elasticity of demand

Elasticity – the concept

- The responsiveness of one variable to changes in another
- When price rises, what happens to demand?
- Demand falls
- BUT!
- How much does demand fall?

❑ **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.**

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:*

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

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 <u>extent</u> to which demand will change**

Types of Elasticity of demand

1. **Price elasticity of demand**
2. **Income elasticity of demand**
3. **Cross elasticity**

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.

Examples

1. Suppose that price of a commodity falls down from Rs.10 to Rs. 9 per unit and due to this, quantity demand of the commodity increased from 100 units to 120 units. What is the price elasticity of demand?

2. When the price of CD increased from $20 to $22, the quantity of CDs demanded decreased from 100 to 87. What is the price elasticity of demand for CDs?

Types of Price Elasticity of Demand(Extreme cases)

a. **perfectly inelastic demand** Demand in which quantity demanded does not respond at all to a change in price.

b. **inelastic demand** Demand that responds somewhat, but not a great deal, to changes in price. Inelastic demand always has a numerical value between 0 and 1.

c. **unitary elasticity** A demand relationship in which the percentage change in quantity of a product demanded is the same as the percentage change in price in absolute value (a demand elasticity with an absolute value of 1).

d. **elastic demand** A demand relationship in which the percentage change in quantity demanded is larger than the percentage change in price in absolute value (a demand elasticity with an absolute value greater than 1).

e. **perfectly elastic demand** Demand in which quantity drops to zero at the slightest increase in price.

Perfectly Inelastic and Perfectly Elastic Demand Curves
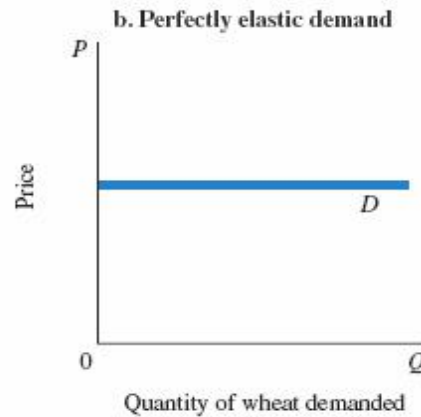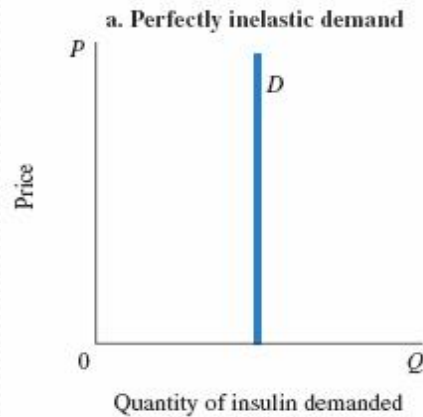
Arc and Point Elasticity of Demand

❑ *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:*
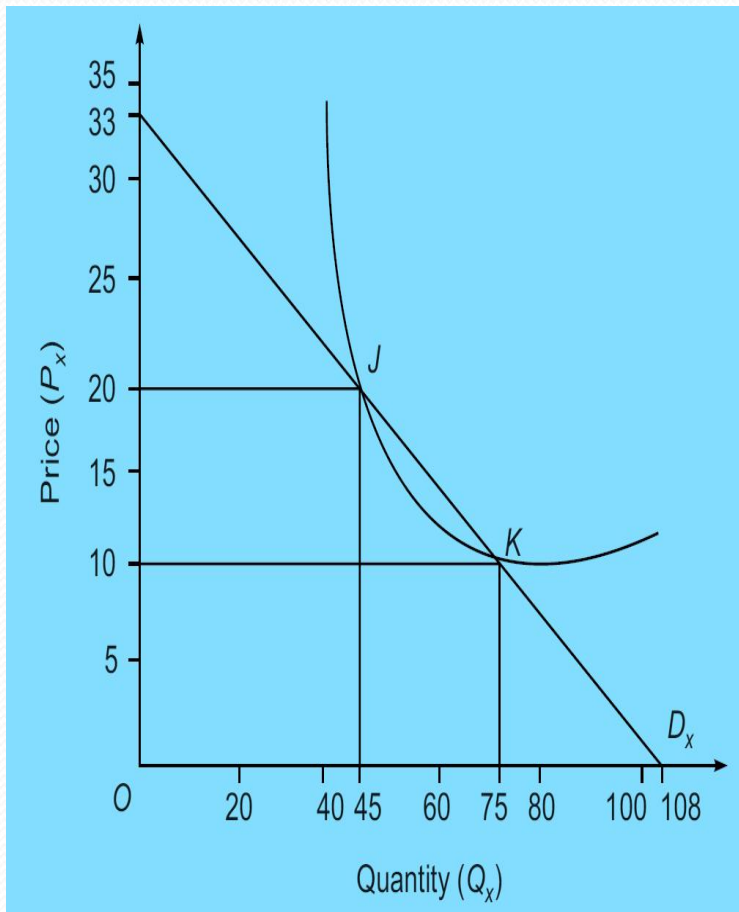

$$e_p = -\frac{-\Delta Q}{\Delta P} \cdot \frac{P}{Q} \quad \text{(with minus sign)}$$

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

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.

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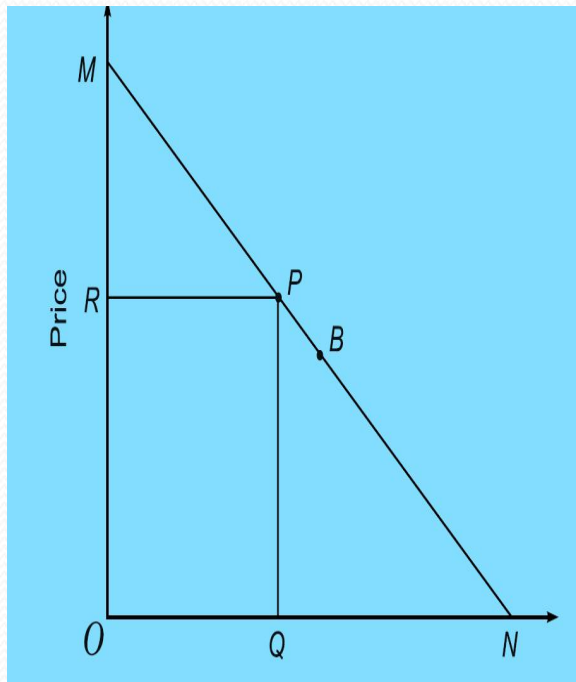
The price elasticity of demand at any point on a linear demand curve is equal to the ratio of lower segment to the upper segments of the line, i.e.,

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

Point Elasticity On A Non-linear Demand Curve
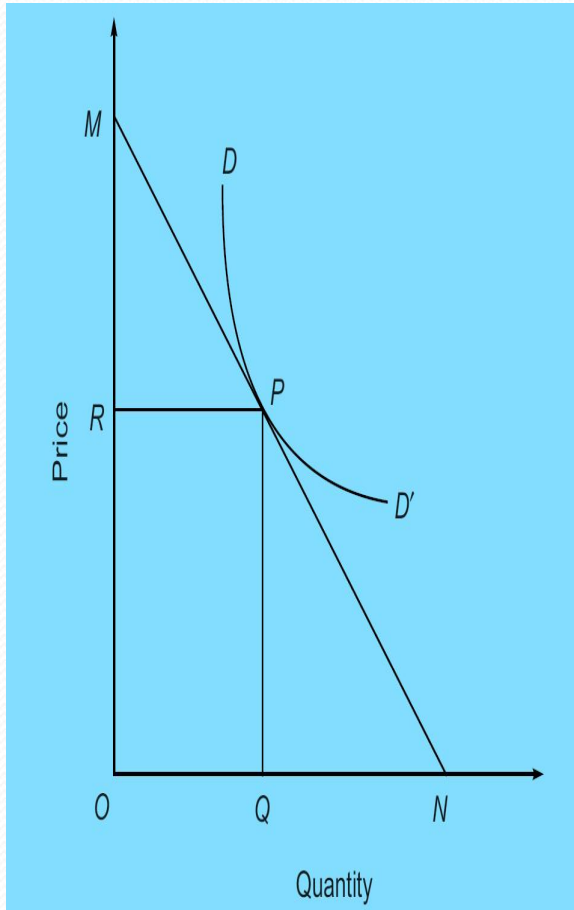
The ratio DQ/DP in respect of a non-linear demand curve is different at each point. Therefore, the method used to measure point elasticity on a linear demand curve cannot be applied straightaway to measure the elasticity on a curvilinear demand curve. A simple modification in technique is required. In 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.

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.*

FIGURE 5.4 Point Elasticity Changes along a Demand Curve
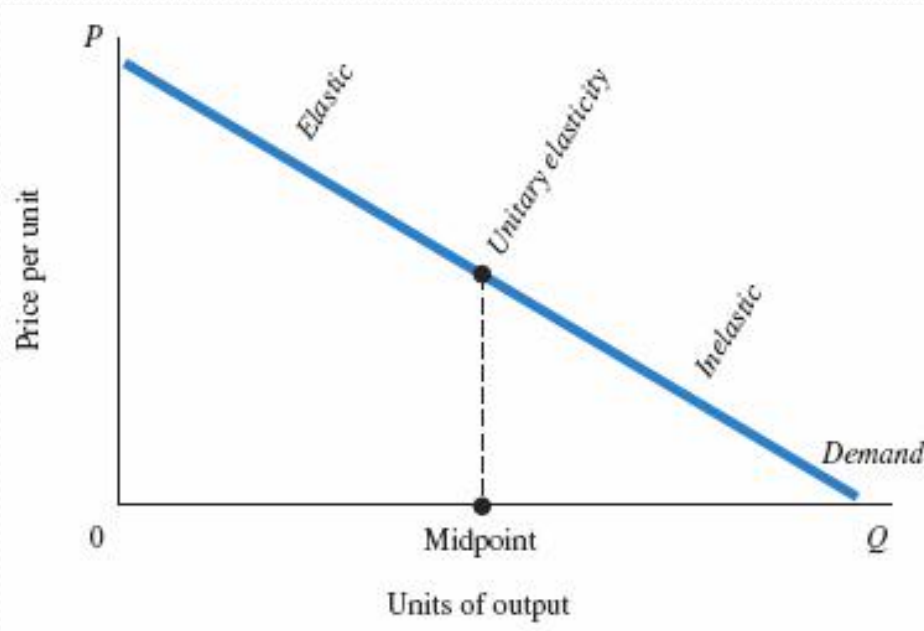
Finding Price Elasticity from a Demand Function

Linear demand function for a commodity is of the following form

$Q = a - bP$

Here b represents the slope of the demand function which is negative and shows the ratio of change in quantity to a change in price,

Now,
$$e_p = \frac{\Delta Q}{\Delta P} \cdot \frac{P}{Q}$$

Writing b for $\dfrac{\Delta Q}{\Delta P}$ we have

$$e_p = b\frac{P}{Q}$$

Example:

Suppose we are given the following demand function for milk in the city of Delhi.

$Q = 720 - 25\,P$

Q is in thousands of litres. It is required to find out the price elasticity at price of 15 rupees per litre.

$$Q = 720 - 25 \times 15$$

$$Q = 720 - 375 = 345$$

Now, substituting $P = 15$, $Q = 345$ and $b = 25$ in the elasticity expression of equation (*ii*) along we have

$$e_p = b.\frac{P}{Q} = 25 \times \frac{15}{345} = 1.08$$

Thus price elasticity at price ₹ 15 per litre is 1.08 and quantity demanded of milk is equal to 345 thousand litres

Elasticity and Total Revenue

Effect of price increase on
a product with inelastic demand: $\quad \uparrow P \times Q_D \downarrow = TR \uparrow$

Effect of price increase on
a product with elastic demand: $\uparrow P \times Q_D \downarrow = TR \downarrow$
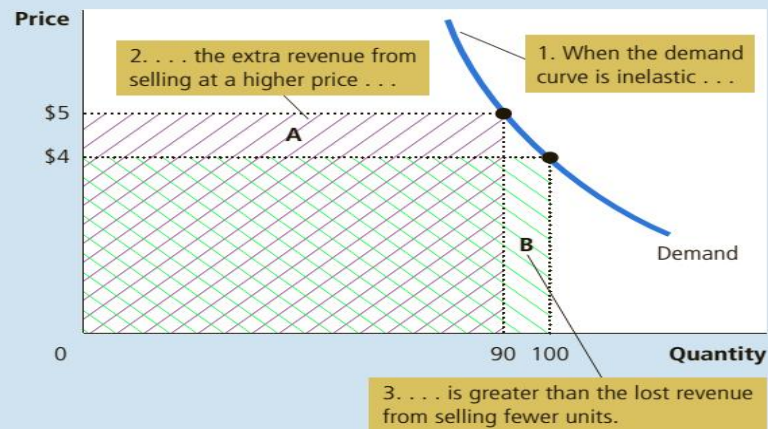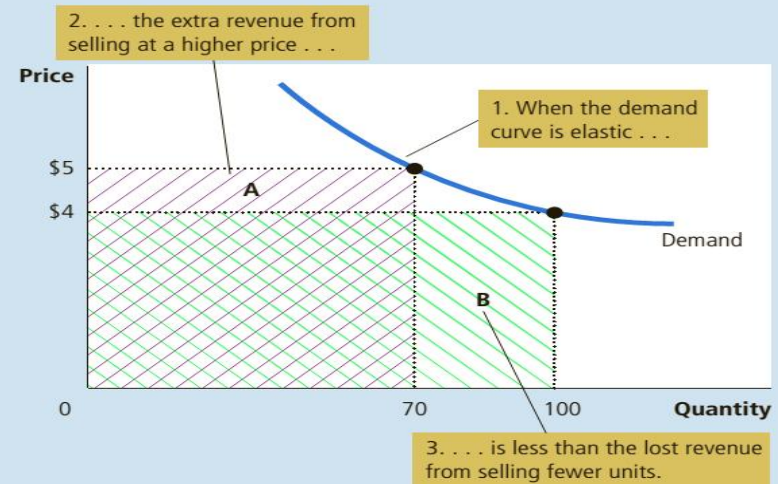
Elasticity and Total Revenue

FIGURE 3

How Total Revenue Changes When Price Changes

The impact of a price change on total revenue (the product of price and quantity) depends on the elasticity of demand. In panel (a), the demand curve is inelastic. In this case, an increase in the price leads to a decrease in quantity demanded that is proportionately smaller, so total revenue increases. Here an increase in the price from $4 to $5 causes the quantity demanded to fall from 100 to 90. Total revenue rises from $400 to $450. In panel (b), the demand curve is elastic. In this case, an increase in the price leads to a decrease in quantity demanded that is proportionately larger, so total revenue decreases. Here an increase in the price from $4 to $5 causes the quantity demanded to fall from 100 to 70. Total revenue falls from $400 to $350.

(a) The Case of Inelastic Demand

2. . . . the extra revenue from selling at a higher price . . .

1. When the demand curve is inelastic . . .

3. . . . is greater than the lost revenue from selling fewer units.

(b) The Case of Elastic Demand

2. . . . the extra revenue from selling at a higher price . . .

1. When the demand curve is elastic . . .

3. . . . is less than the lost revenue from selling fewer units.
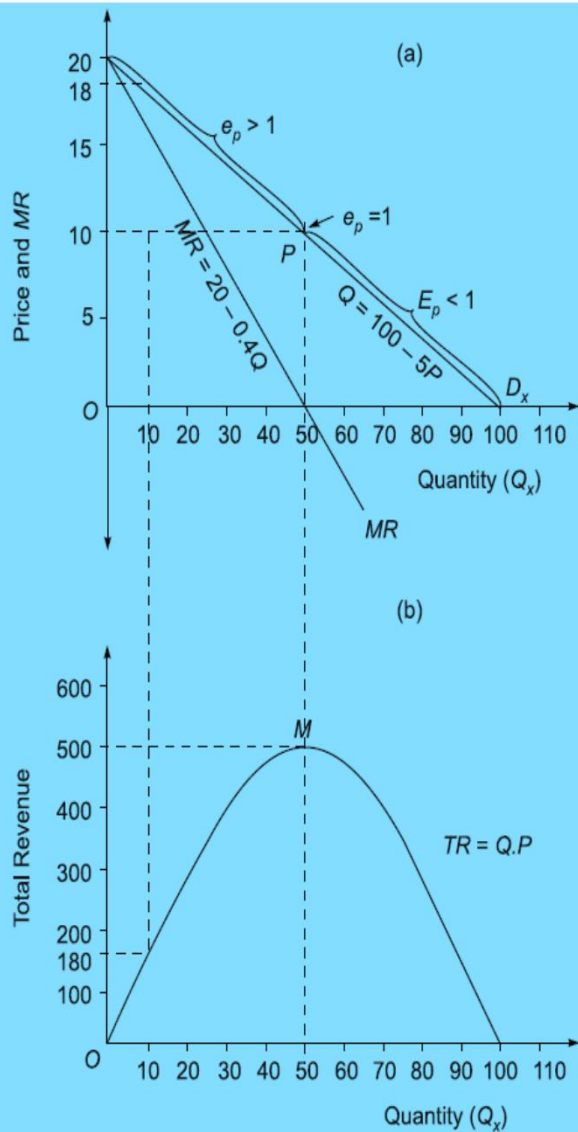
Fig. 8.5 Price Elasticity and Total Revenue

❑ **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.**

$$MR = P\left(1 - \frac{1}{e_p}\right)$$

If, A stands for average revenue

M stands for marginal rgvenue

e stands for point price elasticity on the average revenue curve,

then

$$e = \frac{A}{A - M}$$

$$eA - eM = A$$

$$eA - A = eM$$

$$A(e - 1) = eM$$

$$A = \frac{eM}{e-1}$$

Hence,

$$A = M\left(\frac{e}{e-1}\right)$$

$|e_p| > 1, MR > 0$

$|e_p| = 1, MR = 0$

$|e_p| < 1, MR < 0$

$Q_d = 1000 - 200\,P$

At price ₹ 3 per unit,

$Q_d = 1000 - 200 \times 3 = 400$

Price elasticity (e_p) at price ₹ 3 and associated quantity of ₹ 400 = $\dfrac{\Delta Q}{\Delta P} \cdot \dfrac{P}{Q}$

$$= 200 \times \dfrac{3}{400} = 1.5$$

MR at price (₹ 3) and quantity (400) = $P\left(1 + \dfrac{1}{e}\right) = 3\left(1 + \dfrac{1}{-1.5}\right)$

$$= 3\left(1 - \dfrac{1}{1.5}\right) = 1$$

Thus when price elasticity exceeds one, MR is positive

In the same demand function $(Q = 1000 - 200\,P)$ at price ₹ 2.50, price elasticity is equal to one. MR at this price is

$$= P\left(1 + \dfrac{1}{-1}\right) = 2.5\left(1 - \dfrac{1}{1}\right) = 0$$

Again at price ₹ 2, quantity demanded is 600 units and price elasticity is equal to 2/3, then MR at price ₹ 2 is

$$= P\left(1 + \dfrac{1}{-\dfrac{2}{3}}\right) = 2\left(1 - \dfrac{3}{2}\right) = -1$$

Thus at price elasticity of less than one, (e.g. $\dfrac{2}{3}$ in this case) marginal revenue is found to be negative.

Example

A firm faces the following demand function

P = 100 - 0.1Q

(i) Find the value of Price and Quantity when the price elasticity on the demand curve is 1.

(ii)Find the value of Marginal Revenue (MR) when Total Revenue (TR) is maximum.

(iii) What is the value of price elasticity when MR is positive and negative?

Determinants of Elasticity

- **Time period** – the longer the time under consideration the more elastic a good is likely to be
- **Number and closeness of substitutes** – the greater the number of substitutes, the more elastic
- **The proportion of income taken up by the product** – the smaller the proportion the more inelastic
- **Luxury or Necessity** - for example, addictive drugs

Nature of commodity:

Luxury and comforts-price elastic

Necessary-price inelastic

Availability of substitutes:

No substitutes-inelastic

Large substitute-more elastic

Habit:

demand is inelastic.

Time:

Short period-demand is less elastic.

Long period-more elastic

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.*

Elasticity

- **Goods which are complements**:
  - Cross Elasticity will have negative sign (inverse relationship between the two)
- **Goods which are substitutes**:
  - Cross Elasticity will have a positive sign (positive relationship between the two)

Problem 2. *Suppose the following demand function for coffee in terms of price of tea is given. Find out the cross elasticity of demand when price of tea rises from ₹ 50 per 250 grams pack to ₹ 55 per 250 grams pack.*

$$Q_c = 100 + 2.5P_t$$

where Q_c is the quantity demand of coffee in terms of packs of 250 grams and P_t is the price of tea per 250 grams pack.

Solution. The positive sign of the coefficient of P_t shows that rise in price of tea will cause an increase in quantity demanded of coffee. This implies that tea and coffee are substitutes.

The demand function equation implies that coefficient $\dfrac{dQ_c}{dP_t} = 2.5$.

In order to determine cross elasticity of demand between tea and coffee, we first find out quantity demanded of coffee when price of tea is ₹ 50 per 250 grams pack. Thus,

$$Q_c = 100 + 2.5 \times 50 = 225$$

Cross elasticity,
$$e_c = \frac{dQ_c}{dP_t} \times \frac{P_t}{Q_c}$$

$$= 2.5 \times \frac{50}{225} = \frac{125}{225} = 0.51.$$

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).

Income Elasticity

- **Income Elasticity of Demand:**

- A positive sign denotes a <u>normal good</u>
- A negative sign denotes an <u>inferior good</u>

Problem 3. *The following demand function for readymade trousers has been estimated*

$$Q = 2,000 + 15Y - 5.5P$$

where Y is income in thousands of rupees, Q is the quantity demanded in units and P is the price per unit.

(a) *When P = ₹ 150 and Y = 15 thousand rupees, determine the following :*

1. *Price elasticity of demand*
2. *Income elasticity of demand*

Income elasticity = $\dfrac{\Delta Q}{\Delta Y} \times \dfrac{Y}{Q}$

$\dfrac{\Delta Q}{\Delta Y} = 15$, $Q = 1400$, $Y = 15$ thousand rupees

$e_i = 15 \times \dfrac{15}{1400} = \dfrac{9}{56} = 0.16$

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.*

Example-1

When Mr. Aryan had a monthly income of ₹ 4,000, they usually ate 8 times a month at restaurants. Now Aryan earns ₹ 4,500 a month and eats 10 times a month at restaurants. Compute the income elasticity of demand for Aryan . Is a restaurant meal normal or inferior good as per your calculation?

Example-2

- The price of the Burger is ₹ 8, and the quantity demand for Dosa is 200 per day. When the price of Burger increased to ₹ 12, the quantity demand for Dosa increased to 210 per day. Calculate the cross-price elasticity of demand for Dosa. Based on your calculation, what can you conclude about the relationship between Burgers and Dosa?

- Ans:0.12

Example-3

- The annual price of cinema tickets sold in the year 2010 was $ 3.5 whereas the number of popcorns sold at cinema halls was 100,000. The ticket price increased from $ 3.5 in 2010 to $ 6 in the year 2015. There was a decrease in the sale of popcorns to 80,000 units.

- Ans: -0.42

- **Problems**
- If a consumer's demand for a commodity increases from 100 units per week to 200 units per week when his income rises from Rs 2,000 to Rs 3,000,find his income elasticity of demand?

☐ Suppose the price of sugar fall from Rs 20 TO Rs10 .due to this fall in price quantity demand increase from 15 kg to 20 kg. what is the price elasticity of demand.

☐ The price of coffee increases from rs50 per kg.to rs70 per kg,and as a result the demand for tea increases from 5 kg to 10 kg. what is the cross elasticity of demand of tea for coffee?

Question (1-Marks)

1. When price of banana is `50 per kg Sudarshan buys 10 kg and Guru buys 20 kg. If price of banana increases to `60 per kg. Sudarshan buys 5 kg and Guru buys 15 kg then (i)Sudarshan is more elastic and Guru is less elastic (ii)Guru is more elastic and Sudarshan is less elastic (iii)Both Sudarshan and Guru are more elastic (iv) None of these.

2. What type of good would you expect to have negative income elasticity of demand? (i)Luxury goods (ii)Inferior goods (iii)Both luxury and inferior goods (iv)None of these.

3. You calculate the cross price elasticity between two goods X and Y and it stands at +1.3. The goods are (i)Complementaries (ii)Perfect complementaries (iii)Substitutes (iv)None of these

4. A particular brand of washing soap has many number of substitutes available in the market. If you are to comment on the price elasticity of demand (e) of this washing soap you would say (i)e is greater than 1 (ii)e is less than 1 (iii)e is neither greater than 1 nor less than 1 (iv)None of these

5. Durgapur Steel Plant uses electricity as the main source of energy for manufacturing steel. The plant has many important uses of electricity which can't be avoided. As an engineering economist you would comment that (i)Steel plant is more elastic for electricity (ii)Steel plant is perfectly elastic for electricity (iii)Steel plant is less elastic for electricity (iv) None of these

6. What will be the value of Marginal Revenue when (i) price elasticity is one (ii) price elasticity is greater than one.

7. Are iphones elastic or inelastic?

1. Demand function for a commodity X is QX = 10,000 – 5PX (QX = Quantity demand for the commodity X, PX = Price of the commodity X). If price of the commodity is ₹ 200 per unit, then elasticity of demand is ----------.

(a)0.1   (b) 2   (c)0.13   (d) 2

2. Demand function for a commodity is given as Q = 3000 + 25Y (Q = Quantity demand for the commodity, Y = Income of the consumer per month). If a consumer's monthly income is ₹ 42,000 per month, then income elasticity of demand is ----------.

(a)0.5   (b) 0.7   (c) 0.9   (d) 0.4

3. If demand for coffee increases form 5000 units to 6000 units due to a rise in the price of tea from ₹ 300 to ₹ 350 per 250 grams pack, then cross elasticity of demand between tea and coffee will be --------.(a)4.5   (b) 1.2   (c)1.5   (d) 3.2

4. If with the increase in the price of a good from ₹ 30 to ₹ 50, quantity demand for that good decreases from 1000 units to 800 units, then price elasticity of demand will be -----------.

(a)0.8   (b) 0.3   (c)0.06   (d) 0.5

Question (5-Marks)

1. Consider the price of product x and product y and income of the public to express the demand of product x as given below.

- $$Qx = 12000 - 4200Px + 7I + 750Py$$

Where, Qx= DEMAND OF THE PRODUCT X

Px= PRICE OF THE PRODUCT X

I= INCOME OF THE PUBLIC

Py= PRICE OF THE PRODUCT Y

Assume the initial values of Px , I and Py as Rs 11, Rs 12000 and Rs 14 respectively. Find the following:

- a)Price elasticity of Product X and Income elasticity of Product X
- b)Cross elasticity of the Product X

- 2. Cross price elasticity of demand for air travels in UK between Eastern Airways and Easy Jet UK is +2.7. The income elasticity of demand for business class travel is +1.6.

- (i)How a 10% increase in price by Easy Jet UK will affect the travel in Eastern Airways.

- (ii)If income drops by 30% during the second wave of COVID-19, how air travel in UK will be troubled.

- (iii)Further it is estimated that the price elasticity of demand for business class is 0.42 in Eastern Airways which is 0.62 less than the travel in economy class in this airways. How would you explain this?

3. The demand function for novels has been estimated as

$Q = 700 - 2P + 0.02Y$

where

Q = demand

P = price per unit

Y = per capita income

(i)Find the price elasticity and income elasticity of demand when P = `25 and Y = `5000

(ii)If the novel seller wants to increase the Total Revenue, what advice you will give him on the basis of the price elasticity value.

(iii)If this novel is not an inferior good how the sales of the novel would change when income rises.

4. Cross price elasticity of demand between two medicines A and B of the same company is +0.8.

(i)How medicines A & B are related? If you expect a 12% increase in the demand for medicine A, what change in the price of medicine B would be anticipated?

(ii)Suppose there is a 20% increase in the price of medicine B and a 30% decrease in the demand for medicine A, find the cross elasticity between them. How are they related now?

(iii)Suppose cross elasticity between medicine A and B is +1.3 and there is a 15% increase in demand for medicine A. If medicine B is sold at `200 per unit, what would be the new price of medicine B now?

5. The demand equation for a demand curve is

P = 48 - 3Q

(i)Find the Price and Quantity when Total Revenue (TR) is maximum.

(ii)Find the value of Marginal Revenue (MR) when TR is maximum.

(iii)Determine the price elasticity of demand corresponding to the maximum point of TR.

6. BMW luxury and Lamborgini luxury are two good brands of luxury cars. The cross price elasticity between them is +2.8 in the USA market.

(i) How an increase in the price of BMW luxury will affect the demand for Lamborgini luxury in the market?

(ii) Suppose the current sales of Lamborgini in the market is 100000 nos. If the price of BMW luxury increases by 20 percent what will be the sales of Lamborgini luxury now?

(iii) Income elasticity for car is +1.8. If income drops by 20% how the car companies will be influenced in terms of the demand for cars?

7. The demand function faced by a company for its product is

$Q = 14000 - 3P + 3Y$

where

Q = demand

P = Price per unit

Y = Per capita income

(i) Find the price elasticity and income elasticity of demand when $P = \$100$ and $Y = \$2500$.

(ii) If the company wants to raise the sales, should the company increase or reduce the price. Give justification to your answer on the basis of the price elasticity value.

(iii) On the basis of income elasticity value state whether the demand will change more than proportionately or less than proportionately for a certain change in income. Give justification to your answer.