

**TRANSPORTATION ECONOMICS & EVALUATION (CTEP-303
E1)**

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COURSE CONTENTS

Principles of Economics: Supply and demand models, consumer's surplus and social surplus criteria, framework for social accounting: accounting rate of interest, social opportunity cost, rate of interest, social time preference rate of interest, accounting prices of goods and services, measuring input costs, applications of social accounting framework.

Transport Costs and Benefits: Fixed and variable cost, cost of improvement, maintenance cost, cost estimating methods, accounting for inflation, external costs, pavement cost analysis. Direct benefits-reduced vehicle operation costs, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost.

Economic Analysis: Generation and screening of project alternatives, different methods of economic analysis: annual cost and benefit ratio methods, discounted cash flow methods, shadow pricing techniques, determination of IRR and NPV, examples of economic analysis, application economic theory in traffic assignment problem.

References:

S.No.	Name of the author/books//publishers
1	Winfrey R, Highway Economic Analysis, International Textbook Company.
2	Kenneth J. Button, Transport Economics, Elgar
3	David A. Hensher, Ann M. Brewer, Transport : An Economics and Management Perspective, Oxford University Press
4	Emile Quinet, Roger Vickerman, Principles Of Transport Economics, Edward Elgar Pub
5	Road User Cost Study, Central Road Research Institute
6	Ian G. Heggie, Transportation Engineering Economics, McGraw Hill.
7	IRC:SP:30-1993, Manual on Economic Evaluation of Highway Projects in India
8	Dr. Vinay Maitri, Dr. P. K. Sarkar Theory and Applications of Economics in Highway and Transport Planning

LECTURE 1

1 Introduction to Economics

1.1 INTRODUCTION

It is the tendency of the humans to optimize their resources to extract the maximum benefit or utilization of it. Economics is an art, which helps or guides a person in achieving his goal. Economics can also be referred to as a social science as it deals with human behavior which influences one to make choices for the use of scarce resources to achieve the maximum satisfaction of wants. It also refers to efficient consumption, production and distribution of scarce resources for providing the maximum welfare.

Different researchers define economics under following aspects.

Wealth-based definition: Adam Smith in 1776 defines economics as “a science of wealth” in his book. According to him, wealth is a source to satisfy one’s desires or wants; however this concept doesn’t consider human welfare.

Welfare-based definition: Alfred Marshall defines economy in his book as “a political economy or economics is a study of mankind in the ordinary business of life; it concerns with how one earns his income and how one spends it”.

Scarcity-based definition: In 1932, Lionel Robbins, in his book defines “economics as a science which studies human behavior as a relationship between ends (human wants and desires) and scarce (limited resources) which have alternative uses”.

Growth-based definition: Nobel laureate Paul A. Samuelson said “Economics is the study of how man and society choose, with or without the use of money, to employ scarce productive resources, which could have alternative uses, to produce various commodities over time and distribute them for consumption now and in future among various people and groups of society”.

Therefore, the study of economics is concerned with the economic activities of people related to earnings, spending and wealth generation. If an activity is not money related, then it is called non-economic activity. Thus, economic activities are those activities which are related with the following.

- **Production:** It is related with the value of goods or services. Car manufacturing, garment production etc. are production activities. Similarly transportation of the passengers and products is also a production activity. Goods or services which are useful, transferable or have a potential to generate money are called economic products. Collection of all these

economic products, which are tangible useful and capable of generating money, is called *wealth*. *Service* refers to a work performed for someone to generate money.

- **Consumption:** Utilization of goods or services is referred to as consumption. Using water for household purposes is an example of consumption.
- **Investment or capital formation:** When money or labor is used for further production purposes, then it is referred to as investment. It is also related to spending for acquiring capital goods. For example, when land is purchased for making a hotel on it, then the money paid to acquire land is called investment.
- **Exchange:** Buying or selling of products or services is called exchange. The money is transferred from one hand to another in exchange for produces or services.

1.2 Basic principles

Time value of money:

The time value of money is important when one is interested either in investing or borrowing the money. If a person invests his money today in bank savings, by next year he will definitely accumulate more money than his investment. This accumulation of money over a specified time period is called as time value of money. Similarly if a person borrows some money today, by tomorrow he has to pay more money than the original loan. This is also explained by time value of money. The time value of money is generally expressed by interest amount. The original investment or the borrowed amount (i.e. loan) is known as the principal. The amount of interest indicates the increase between principal amount invested or borrowed and the final amount received or owed. In case of an investment made in the past, the total amount of interest accumulated till now is given by; Amount of interest = Total amount to be received – original investment (i.e. principal amount) Similarly in case of a loan taken in past, the total amount of interest is given by; Amount of interest = Present amount owed – original loan (i.e. principal amount) In both the cases there is a net increase over the amount of money that was originally invested or borrowed. When the interest amount is expressed as the percentage of the original amount per unit time, the resulting parameter is known as the rate of interest and is generally designated as „i“.

The time period over which the interest rate is expressed is known as the interest period. The interest rate is generally expressed per unit year. However in some cases the interest rate may also be expressed per unit month.

Simple interest: The interest is said to simple, when the interest is charged only on the principal amount for the interest period. No interest is charged on the interest amount accrued during the preceding interest periods. In case of simple interest, the total amount of interest accumulated for a given interest period is simply a product of the principal amount,

the rate of interest and the number of interest periods. It is given by the following expression.

$$I_T = P \times n \times i$$

Where I_T = total amount of interest

P = Principal amount

n = number of interest periods

i = rate of interest Simple interest reflects the effect of time value of money only on the principal amount.

Compound interest: The interest is said to be compound, when the interest for any interest period is charged on principal amount plus the interest amount accrued in all the previous interest periods. Compound interest takes into account the effect of time value of money on both principal as well as on the accrued interest also.

Example: 1

A person has taken a loan of amount of Rs.10, 000 from a bank for a period of 5 years. Estimate the amount of money, the person will repay to the bank at the end of 5 years for the following cases; a) Considering simple interest rate of 8% per year b) Considering compound interest rate of 8% per year.

Solution: a) Considering the simple interest @ 8% per year;

The interest for each is year is calculated only on the principal amount i.e. Rs.10, 000. Thus the interest accumulated at the end of each year is constant i.e. Rs.800. The year-by-year details about the interest accrued and amount owed at the end of each year are shown in the table below.

Table 1 Payment using simple interest

End of Year (EOY)	Amount of interest (Rs.)	Total amount owed (Rs.)
1	800	10,800
2	800	11,600
3	800	12,400
4	800	13,200
5	800	14,000

b) Considering the compound interest @ 8% per year; The amount of interest and the total amount owed at the end of each year, considering compound interest are presented in Table 1.1.

End of Year (EOY)	Amount of interest (Rs.)	Total amount owed (Rs.)
1	800.00	10,800
2	864.00	11,664.00
3	933.12	12,597.12
4	1007.77	13,604.89
5	1088.39	14,693.28

The year-by-year values of amount of interest and the total amount owed (as shown in Table 1.2) are calculated as follows;

Amount of interest accumulated at the end of year 1

$$=Rs.10,000 \times 0.08 = Rs.800$$

Total amount owed at the end of year 1 = Rs.10,000 + Rs.800 = Rs.10,800

Amount of interest accumulated at the end of year 2

$$=Rs.10,800 \times 0.08 =Rs.864$$

Total amount owed at the end of year 2 = Rs. 10,800 + Rs. 864 = Rs. 11664

Similarly the interest amount and the total amount owed at the end of year 3, year 4 and year 5 can be calculated in the same manner.

From these calculations it is clear that, in case of compound interest the interest for each year is calculated on the principal amount plus the interest amount accumulated till that period.

Time Horizon

The investment for highway construction, maintenance, and its benefits are spread over a time span, and is called as the time horizon of economic assessment. This is generally selected as twenty to thirty years for a highway project, depending on policy or type of road. Time horizon, basically, is the economic analysis period.

Inflation

Construction of major highway project takes a number of years, and meanwhile the cost of material, labour, equipment etc. undergoes price escalation due to inflation. At the same time, due to inflation, the Vehicle Operating Cost (VOC) increases, thereby reducing

the benefit. Thus in the benefit-cost considerations, the effect of inflation also needs to be considered (IRC: SP-30 1993) in all the cost and benefit components.

Salvage value

Salvage value (S) is the worth of the structure at the end of the analysis period. This value is carried over to the next analysis period. There could be different basis of calculating the salvage value. If, after the expiry of the first analysis period, it is assumed that the pavement materials would be recycled, then the cost of existing pavement materials (to be used for recycling) are considered in computation of salvage value.

Alternatively, if the pavement life is extended further by putting overlay, in the next analysis period, the salvage value, S , could be calculated in the following way (MS-1 1999):

$$S = (1 - Y/X) O_{nm}$$

Where, Y is the number of years between the last overlay (which is done in the year nm) and the analysis period for which was the cost incurred and X is the number of years it is expected to actually serve. This is based on the assumption that the service life of the last resurfacing overshoots beyond the analysis period, and accordingly a proportionate salvage value is assigned.

Present worth

Present worth is the total cost of the project, when investments in various years (during the analysis period) are brought back to the equivalent worth of present year. The present worth factor can be expressed in the form of the following equation.

$$P = [(1+i)^n - 1 / i (1+i)^n] A$$

Sinking fund factor

It is concerned with the annuity payment that must be made at each period of interval at a given rate of compound interest in order to ensure a specific sum of money is made available at a given future period. Mathematical expression for sinking fund factor is as under:

$$SSF = i / (1+i)^n - 1$$

Capital recovery factor

It is similar to the situation when somebody receives equal amount of money for n number of years on a capital amount deposited by him. Mathematically it can be written as

$$CR = i (1+i)^n / \{(1+i)^n - 1\}$$

LECTURE 2

2.0 TRANSPORTATION DEMAND

2.1 INTRODUCTION

The demand for goods and services, in general depends mainly on consumer's income and the price of the particular good or service relative to other prices. For example the demand for the travel depends on the income of the traveller. The choice of the travel mode depends upon several factors, such as the purpose of the trip, the distance travelled and the income of the traveller.

The demand function for a particular product represents the willingness of the consumers to purchase the product at alternate prices. A demand function shows, for example, number of passengers willing to use a commuter train at different price levels between a pair of origins and destinations, for a specific trip, during a given period.

2.2 FACTORS AFFECTING TRANSPORT DEMAND

According to Law of demand, demand is inversely proportional to price or cost. This law is not only applicable to commodities but also to transport demand. In the case of transportation system, the problem is more complex. Firstly, the nature and type of system for goods movement is altogether different. Secondly, the types of modes available for both types of demands provide complex situations for a user to make an appropriate choice. The factors, that affect demand, are different for goods and for passengers.

2.2.1 DEMAND FOR GOODS TRANSPORT

Demand for goods is a derived demand. So when the demand for commodities increases, then the demand for the commodities also increases. The cumulative of all types of goods transport is termed as demand for goods transport. It basically depends on the following factors:

Type of goods: Different types of goods require different modes of transport. The requirement and process for transporting coal, cement, glass furniture etc. will be entirely different. Some goods can be sent in open trucks while others require packaging and need to be fully covered to protect them from rain. Perishables like fruits, vegetables and milk need to be transported over long distances in refrigerated trucks.

Quantity of goods: This decides the capacity of the vehicle that needs to be selected. Normally LCV costs less than HCV but if the cost is calculated on the basis of units of goods, then HCV may be cheaper than LCV.

Location of source and destination: length of the haul determines the type of the vehicle to be used for transporting the goods. If the goods are to be transported from the warehouse to loading yard, then non-motorized or smaller capacity vehicles are used, however if the goods are to be transported from one city to other city then HCV'S are generally used, trains are used for transporting goods from one state to other state, big ships are used to haul large quantities of goods from one country to another.

Speed: speed of the delivery depends upon the urgency with which the goods need to be delivered. For example medicines need to be transported urgently to epidemic hit areas; this requires a system that can transport goods at higher speeds to their destination.

Certainty of timing/delivery timing: if a system fails to deliver the goods at the appropriate time then it may cause great loss to the users.

Reliability: this factor assures that the goods will be delivered at the destination even if there are interruptions.

Regularity: a businessman wants a company which provides services on that route; it is another factor which affects the decision.

Safety: one of the major problems associated with goods transportation is damage caused to the goods. Generally damage occurs when roads are in bad shape or delivers are inexperienced. Similarly theft of goods may occur at warehouses, so a company with good safety record is generally preferred.

Value added services: if the service providers are more flexible in rates for bulk transportation, then it gains more business.

Gwilliam and Mackie presented results of survey conducted by Traders Road Transport Association, UK, the reasons for preference of road haulage is given in table below.

Reasons	% for road haulage	% for rail
Speed of delivery and certainty of timing	68	75
Warehouse facilities	32	42
Cost	44	56
Avoidance of breakage and damage	33	44
Avoidance of pilferage	21	25
Reduction in packaging costs	24	31
Prompt return of empties	30	32
Special vehicle used	29	31
Services provided by the driver	39	32

2.2.2 DEMAND FOR PASSENGER TRANSPORT

In finding out the demand for passenger transport, price plays an important role. In comparison to goods, the factors influencing passenger transport are totally different. Here it is not a question of total passenger demand but also the cumulative demand of all passenger modes. The factors influencing demand are as follows:

Cost/fare: this factor influences the travel behavior, which bears an impact on travel demand. If the travel cost is high, then one performs only essential trips. Normally, traveller considers cost of line haul travel, but one has to consider the total or generalized cost of the journey, which includes the following:

- Cost incurred in reaching the bus stop or terminal
- Waiting time for the bus
- Fare paid for line haul
- Comfort
- Cost of interchange
- Cost incurred in reaching the destination.

Income: it has been observed that as the income of the household increases, the rate of trip generation also increases. It has also been seen that as income increases the mode of travel also changes.

Journey time: journey time is sensitive to mode choice. If one wants to save time then, then one has to choose that mode which takes less time. The chosen mode will cost him more but save his time, so it depends on the individual how he values his time and if he is ready to pay more to save time.

Journey distance: the length of the journey also decides the mode of travel to be chosen. If one has to travel from one city another or from one country to another then one has to choose air, rail or water transport.

Quality of service: usually one chooses the service which offers higher quality of service.

Level of service: the frequency of particular service, connectivity between different places, load per vehicle and availability of services at all times decide the level of service of a particular service provider which may attract higher number of users.

Number of interchanges: usually people prefer those modes which have lesser number of interchanges.

Time of service: this is also a major point in selection of the mode. Woman may prefer to use public transport instead of taxis at odd hours.

Frequency of travel: frequency of travel depends upon factors like vehicle ownership, income, accessibility to public transport system etc.

Location of origin: the availability of a particular mode at a particular place also decides the mode of choice.

LECTURE 3

3.0 ELASTICITY OF DEMAND:

In any business, one of the requirements of the management is to study the degree of impact of various factors on demand. It means that if a particular independent factor of demand function changes, then how much change will occur in the demand. Governments, business firms, supermarkets, consumers, and law courts need a way to measure how responsive demand is to price changes—for example, will a 10 percent cut in the price of commodity X increase quantity of X demanded a little or a lot? Economists measure the responsiveness of quantity demanded to price changes via a concept called *elasticity*.

So elasticity is the ratio of rate (%) of change in demand in response to rate (%) of change in a factor influencing the demand.

As the demand is mostly affected by price or fair, income, service level, the following study of elasticity will be of interest.

- Price or fare-based elasticity of demand
- Income-based elasticity of demand
- Service-based elasticity of demand

3.1 Price or fare-based elasticity of demand (E_p)

It is the ratio of % change in quantity demanded to % change in price and is represented as follows:

$E_p = \% \text{ change in quantity demanded} / \% \text{ change in price}$

$E_p = ((\partial Q/Q))/ (\partial P/P)$

$E_p = (\% \partial Q)/ (\% \partial P)$

Where Q is the quantity demanded

P is the price

∂Q is the change in quantity demanded

∂P is the change in price

3.1.1 Types of Price Elasticity of Demand

Price elasticity of demand is of following types:

Perfectly Elastic Demand: in this case, price doesn't have an effect on demand. So, whatever be the price the demand still increases. It is a case where price has no meaning. It is represented by

$$E_p = \infty \text{ (elasticity of price)}$$

The perfectly elastic demand curve is horizontal *i.e.* Parallel to x – axis

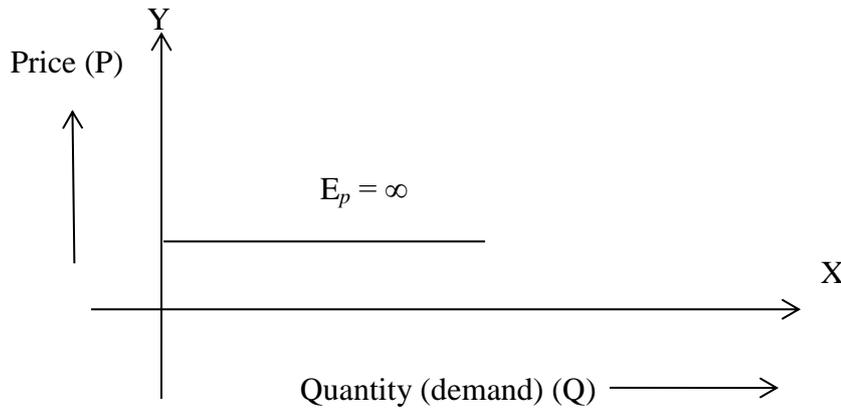


Fig.3.1. Perfectly elastic curve

Example: even if the railway fare remains constant the number of passengers will still increase.

Perfectly inelastic demand: In this case, whatever changes occur in price the demand remains constant. It is represented as

$$E_p = 0$$

And, the shape of the perfectly inelastic curve is vertical, *i.e.* parallel to y – axis

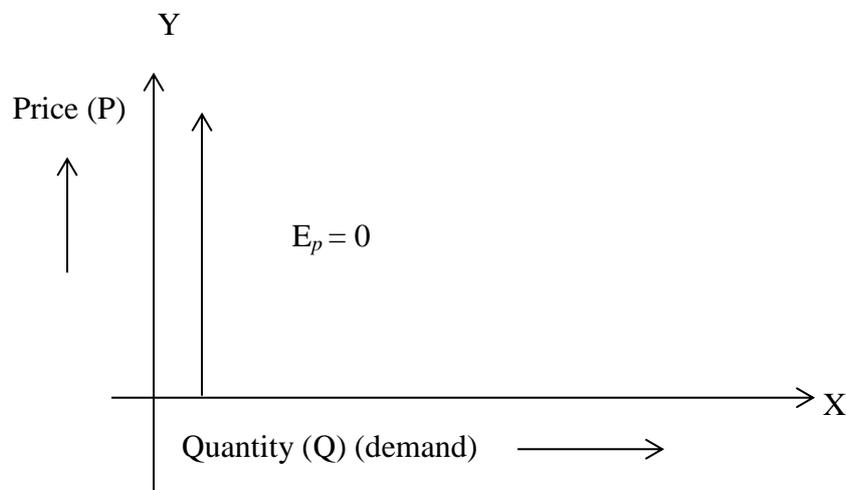


Fig.3.2. Perfectly inelastic demand curve

Unity Elasticity of Demand: In this case the proportionate change in price proportionate change in the quantity demanded is the same. It is represented as

$$E_p = 1$$

And the shape of the curve is given below:

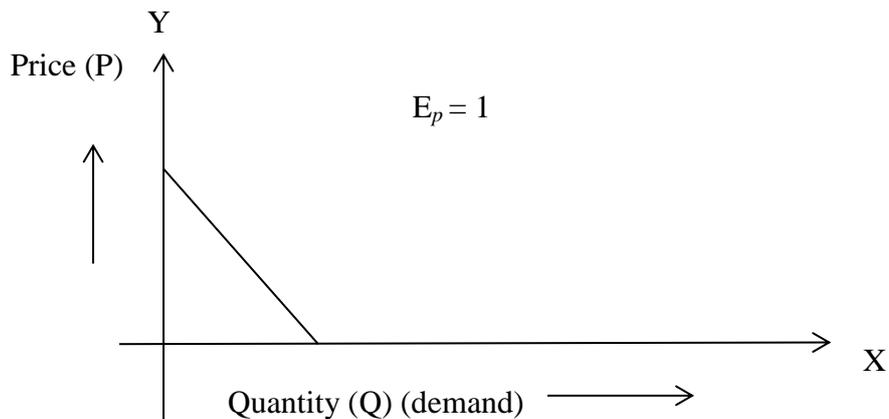


Fig.3.3. Unity elasticity of demand curve

Elastic demand: in this case, the rate of change in price is less than the rate of change in demand. It is represented as

$$E_p > 1$$

And the curve is more flat as given below

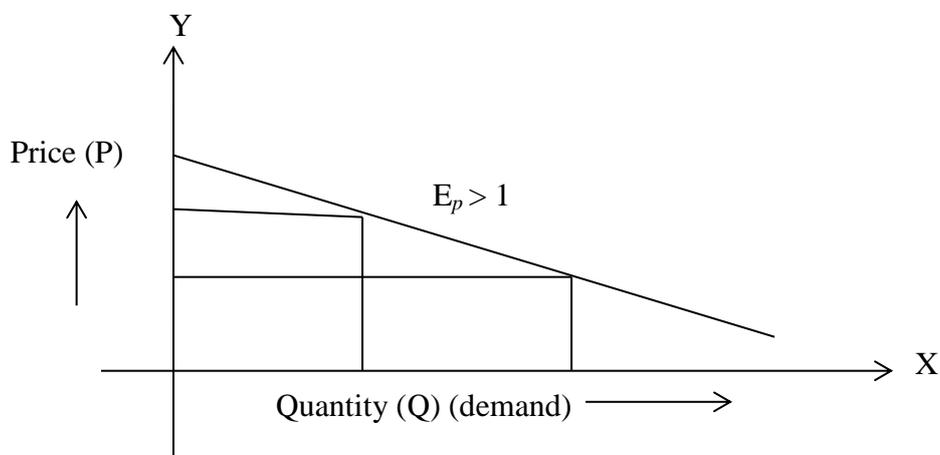


Fig.3.4. Elastic demand curve

Inelastic demand: in this case, the rate of change in price is greater than the rate of change in demand. It is represented as

$$E_p < 1$$

And the curve is steeper as given below

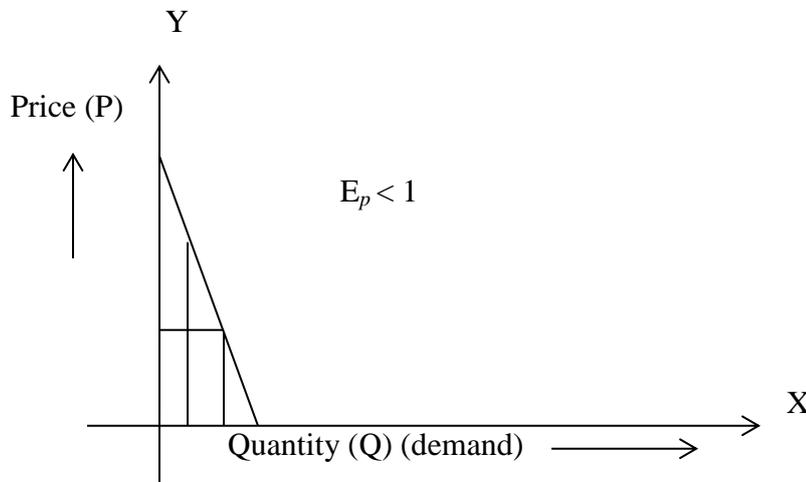


Fig.3.5. Inelastic demand curve

3.1.2 Methods for Measuring Price/Fare Elasticity of Demand

The law of demand holds good when the demand increases or decreases and correspondingly the price also increases or decreases, provided other factors remain constant. Here the price is taken as independent variable and demand as a dependent variable. There are a number of methods to measure price elasticity of demand, which are listed below.

- Proportionate or percentage method
- Total expenditure or outlay method
- Slope or graphical method
- Mathematical method
- Using past experience

3.1.2.1 Proportionate or percentage method:

In this method eccentricity is the ratio of percentage change in quantity demanded to percentage change in price or fare and it is represented as

$$E_p = \frac{\% \text{ change in quantity demanded}}{\% \text{ change in price fair}}$$

$$E_p = \frac{\frac{\partial Q}{Q}}{\frac{\partial F}{F}}$$

$$E_p = \frac{\% \partial Q}{\% \partial F}$$

$$E_p = \frac{\frac{Q_2 - Q_1}{Q_1}}{\frac{F_2 - F_1}{F_1}}$$

Where, Q is the quantity (passengers or goods) demanded

F is the fair or price

∂Q is the change in quantity demanded

∂F is the change in price or fare

Q_2 is the new demand

Q_1 is the old demand

F_2 is the new fair

F_1 is the old fair

3.1.2.2 Total expenditure or outlay method:

This method is based on the change that occurs in total revenue when the price or fare changes. The general rule for elasticity is given in table below:

	$E_p < 1$	$E_p = 1$	$E_p > 1$
Price rise	Total revenue rises	Total revenue unchanged	Total revenue falls
Price fall	Total revenue falls	Total revenue unchanged	Total revenue rises

NOTE:

Slope or graphical method, Mathematical method and Using past experience method to be studied as a part of assignment.

3.2 KRAFT DEMAND MODEL

Occasionally we come across a demand function where the elasticity of demand for the travel with respect to its price is essentially constant. The demand function for such a situation corresponds to the equation

$$Q = \alpha(P)^\beta$$

Where α and β are constant parameters of the demand function. To prove that this function has a constant elasticity, we differentiate this function with respect to price:

$$\frac{dQ}{dP} = \alpha\beta(P)^{\beta-1}$$

And then substitute the result into standard elasticity equation

$$\begin{aligned} e_p &= \frac{dQ}{dP} \frac{P}{Q} \\ &= \alpha\beta(P)^{\beta-1} \frac{P}{Q} \\ &= \alpha\beta(P)^{\beta-1} P Q^{-1} \\ &= \beta \end{aligned}$$

Thus, β , the exponent of price is the price elasticity.

3.3 INCOME ELASTICITY

It is another important technique by which the direct impact on demand can be measured. It may be positive or negative depending upon the nature of the mode. For example, demand for bus service might experience negative elasticity as people switch mode when their income rises. As the income of the people increases, the demand for buses may decrease.

Income elasticity is defined as the ratio of proportionate change of quantities demanded to the given proportionate change in the income. It is denoted by E_y .

$$\begin{aligned} E_y &= \frac{\text{proportionate change in quantities demanded}}{\text{(proportionate change in income)}} \\ &= \frac{\frac{Q_2 - Q_1}{Q_2 + Q_1}}{\frac{Y_2 - Y_1}{Y_2 + Y_1}} \end{aligned}$$

Where Q_1 and Q_2 , stand for quantities demanded for income Y_1 and income Y_2 respectively.

3.3.1 Types of Income Elasticity

The income elasticity is of following types:

3.3.1.1 Zero Income Elasticity:

In zero income elasticity the income has no effect on the quantity demanded. So, whatever change in income occurs, it has no impact on quantity demanded. E.g. the consumption of drinking water will remain same whatsoever the income.

3.3.1.2 Negative Income Elasticity:

In this case the rise in the income may reduce the quantity demanded. E.g. the usage of bus transport may decrease if the income of the person increases as he may switch to any other mode of transport. Such type of goods may be referred to as inferior goods or services.

Positive Income Elasticity:

Here as the income increases there is also an increase in the quantity of the goods demanded. E.g. if the income of a person increases he/she may switch from rail transport to air transport, thus air travel shows positive elasticity in this case. Normally, the impact occurs in case of expensive goods.

Positive elasticity is of three types:

- **Unit elasticity:** this is seen when change in income produces corresponding proportionate change in quantities demanded.
- **More than unity:** in this case the increase in income produces more than proportionate change in quantities demanded. Luxury items fall in this category.
- **Less than unity:** here increase in income produces less than proportionate change in quantities demanded.

3.4 Service Level Elasticity:

In this case, service is an independent variable instead of fair or price. Bell, Blackledge and Brown have shown from their studies that service level changes appear to have more impact on passenger response to demand in comparison to fare change.

3.5 CROSS ELASTICITY

The effect of change in the price of a good on the demand for the same good is referred to as direct elasticity. However, the measure of responsiveness of the demand for a good to the price of another good is referred to as cross elasticity.

When consumers buy more of good A when good B's price goes up, we say that good A is a substitute for good B. For example when the price of crude oil goes up, travelers tend to use more transit. On the other hand, when consumers buy less of good A when good B's price goes up, we say that good A is a complement to good B. In general, complementary goods are ones that are used together. For example, when the price of parking in downtown areas goes up, the demand for driving a car to downtown goes down.

Goods are substitutes when their cross elasticities are positive, and goods are compliments when their cross elasticities of demand are negative.

$$\text{Cross elasticity or } E_{BA} = \frac{\% \text{ change in demand for one good}}{\% \text{ change in price of substitute or complement good}}$$

In the case of transport,

$$\text{Cross elasticity or } E_{BA} = \frac{\% \text{ or proportional change in demand for one mode of transport}}{\% \text{ or proportional change in fare of other mode of transport}}$$

LECTURE 4

4.1 INTRODUCTION

Concept of supply: In the field of public transportation system, it is very difficult to find out the fleet size or mixed fleet required for a city. It means that it is not easy for any company to decide how many buses should be supplied to meet the demand in the most optimum way. It means that the supply is dependent on demand.

Stock and supply: the stock of a commodity is the total volume of that commodity which is available at a given time with the seller in the market. Supply refers to that part of the stock, which the seller is prepared to sell at a certain price or a given price during a period of time.

Let us assume that a transit company owns 100 buses. In the market the hiring charges are Rs 3000 per day. At this price the company is ready to supply 10 buses out of the total fleet of 100 buses. If the hiring charges are increased to Rs 4000 per day then the company is ready to supply 50 buses for hiring. This is called supply.

Supply and quantity supplied: quantity supplied refers to the specific amount of goods provided for sale against a specific price at a point of time. Supply is the whole volume of goods provided for sale corresponding to different possible prices at a point of time.

4.2 Factors Affecting Supply or determinants of Supply Function

The following are some of the factors that affect the supply of a commodity:

Price of the commodity: considering other factors or market conditions remain the same, the quantity of a commodity offered for sale is affected by its price. The relationship between price and sale is termed as Law of supply.

Price of related commodities: in a market, if competitive goods are available at a competitive price, then it affects the relative profitability of a commodity. This has an influence on its supply.

Prices of factor of production (inputs): if the price of input varies, then naturally the price of output will also vary. This fluctuation in price has an effect on supply or sale.

Use of technology: new technology or improved technology helps in reducing the production cost, which helps in increasing the supply and profit margin.

Objectives of the producers: Normally, companies operate with a view to maximize their profits, but sometimes companies wish to globalize their products even though it may not maximize their profits. A number of times, it is also related with the status and the prestige of the company because it wants the presence of its product and the company name everywhere. Naturally supply will be affected if such strategies are adopted by the companies.

Presence of other companies: If in the market there are a number of companies producing the same type of goods, then the overall supply in the market will increase.

Government policy: Taxation and subsidy policy of the government also affects the market supply of a commodity. Increase in taxation tends to reduce the supply, while subsidy tends to increase the supply.

Other reasons: Any unforeseen reason can also affect the supply. For example, war, natural calamities, etc. can result in increase or decrease in supply of different types of commodities.

4.3 Supply Function

The supply function gives the relationship between supply of goods and the factors affecting it. It is defined as

$$S_y = (P_y, P_x, F, T, O, G \dots)$$

Where,

S_y = supply of commodity 'y'

P_y = price of commodity 'y'

P_x = price of related commodities

F = prices of all factors of production

T = use of technology

O = objectives of producer

G = government policy

Supply schedule: it is a tabular presentation of volume of goods which a company is prepared to sell at different prices at a given time period. It is of two types:

- The supply schedule of an individual company
- Market supply schedule

The supply schedule of an individual company: It is a tabular presentation of volume of goods which an individual company is prepared to sell at different prices at a given time period.

Market supply schedule: It is the total quantities available in the market from different companies for sale at different prices at a given time period.

4.4 LAW OF SUPPLY:

If other factors like market conditions remain the same, then the law of supply states that the quantity for sale is directly related with the price of that commodity. It is represented as

$$S_y \propto P_y$$

Where

S_y = supply of commodity 'y'

P_y = price of commodity 'y'

Other factors mean

- 1) The price of the competitive goods remains constant.
- 2) The production process should also remain the same.
- 3) The company should not change its objectives.
- 4) The prices of inputs remain constant.
- 5) The government policy should remain unchanged.
- 6) No unforeseen event occurs.

There are some exceptions to the Law of supply, such as

- 1) The perishable nature of items.
- 2) Status symbol.
- 3) Clearance stock or discontinuation of that model of equipment.

4.5 Elasticity of supply

This can be defined as percentage change in quantity supplied divided by the change in price of that commodity.

$$E_s = \frac{\partial q}{\partial p} \times \frac{p}{q}$$

Where

E_s is the elasticity of supply

∂q is the change in quantity supplied

∂p is change in price

q is quantity supplied

p is price

E_s is also called price elasticity of supply

Elasticity for non-linear supply curve:

In case the supply curve is non-linear, then draw a tangent at the point on the curve at which one wants to find out the elasticity.

Arc elasticity of supply: as in the case of demand, the arc elasticity is defined as the arc elasticity of supply.

$$\text{Arc elasticity of supply} = \left\{ \frac{(Q_1 - Q_2)}{(Q_1 + Q_2)} \right\} / \left\{ \frac{(P_1 - P_2)}{(P_1 + P_2)} \right\}$$

Where

Q_1 = quantity supplied before change in price

Q_2 = quantity supplied after change in price

P_1 = initial price

P_2 = changed price

Perfectly elastic supply: It is a situation when supply rises to a great extent with very little or no change in price. It means $E_s = \infty$.

Unit elastic supply: it is a situation when percentage change in supply is equal to percentage change in price. It means $E_s = 1$.

Less than unit elastic supply: It is a situation when percentage change in supply is less than percentage change in price. i.e. $E_s < 1$.

More than unit elastic supply: In this situation percentage change in supply is more than percentage change in price. i.e. $E_s > 1$.

Perfectly inelastic supply: It is a situation when supply remains same whatsoever be the increase in price. i.e. $E_s = 0$.

4.6 FACTORS AFFECTING ELASTICITY OF SUPPLY

There are a number of factors which affect the elasticity of supply.

- **Nature of commodity:** Non-durable goods are difficult to store and due to that their elasticity is less.
- **Nature of inputs:** if the types of inputs are common to the production of other types of goods, then supply will be more elastic.
- **Cost of production:** the cost of production also plays an important role in the elasticity of supply. If the cost is low, then it is more elastic.
- **Technology of production:** if the technology of production is simple and can be modified easily, then supply is more elastic.
- **Time factor:** in a short period, unusually the supply is inelastic, but over a long period it becomes elastic.
- **Risk bearing factor:** if a company is ready to increase the supply in spite of a business risk, then the elasticity is affected.
- **Natural calamities:** wars , floods ,etc., can influence the elasticity of supply.

Note: For any queries / clarifications, contact

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