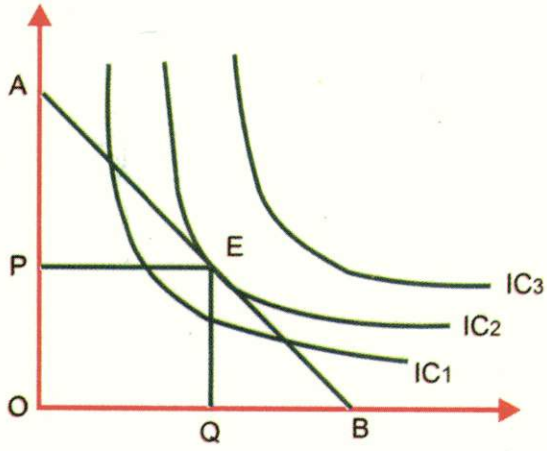
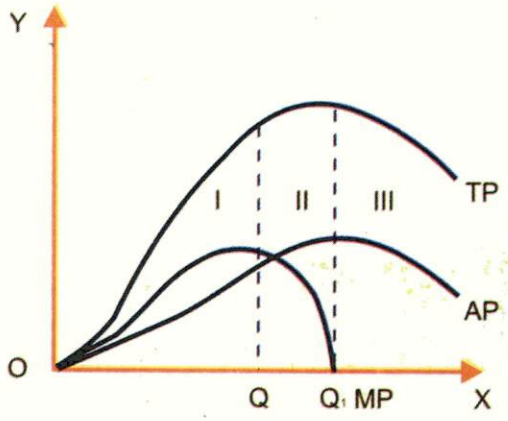
Karnataka State Open University
Manasagangothri, Mysore- 570 006

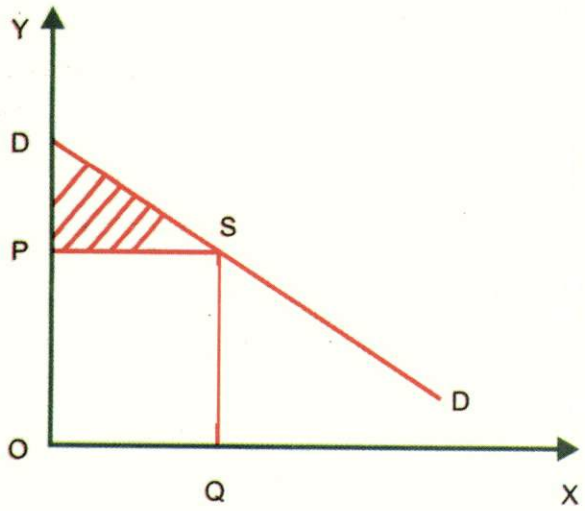
ಕರ್ನಾಟಕ ರಾಜ್ಯ ಮುಕ್ತ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ
ಮಾನಸಗಂಗೋತ್ರಿ, ಮೈಸೂರು ೫೭೦ ೦೦೬

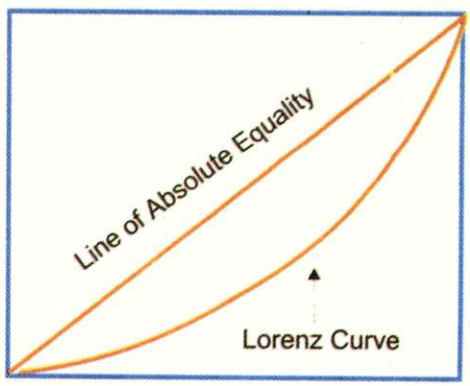
COURSE : 1

M.A. (PREVIOUS)
MICRO-ECONOMIC ANALYSIS









ಉನ್ನತ ಶಿಕ್ಷಣಕ್ಕಾಗಿ ಇರುವ ಅವಕಾಶಗಳನ್ನು ಹೆಚ್ಚಿಸುವುದಕ್ಕೆ ಮತ್ತು ಶಿಕ್ಷಣವನ್ನು ಪ್ರಜಾತಂತ್ರೀಕರಿಸುವುದಕ್ಕೆ ಮುಕ್ತ ವಿಶ್ವವಿದ್ಯಾನಿಲಯ ವ್ಯವಸ್ಥೆಯನ್ನು ಆರಂಭಿಸಲಾಗಿದೆ.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿ 1986

ಮುಕ್ತ ವಿಶ್ವವಿದ್ಯಾನಿಲಯವು ದೂರಶಿಕ್ಷಣ ಪದ್ಧತಿಯಲ್ಲಿ ಬಹುಮಾಧ್ಯಮಗಳನ್ನು ಉಪಯೋಗಿಸುತ್ತದೆ. ..... ವಿದ್ಯಾಕಾಂಕ್ಷಿಗಳನ್ನು ಜ್ಞಾನ ಸಂಪಾದನೆಗಾಗಿ ಕಲಿಕಾ ಕೇಂದ್ರಕ್ಕೆ ಕೊಂಡೊಯ್ಯುವ ಬದಲು, ಜ್ಞಾನ ಸಂಪತ್ತನ್ನು ವಿದ್ಯೆ ಕಲಿಯುವವರ ಬಳಿ ಕೊಂಡೊಯ್ಯುವ ವಾಹಕವಾಗಿದೆ.

ಡಾ. ಕುಳಂದೈಸ್ವಾಮಿ

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M.A. Economics
(Previous)
Course - I
Micro Economic Analysis

Block 3

Course Design and Editorial Committee

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Karnataka State Open University
Mysore-570 006

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Karnataka State Open University
Mysore-570 006

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Reader & Chairperson
DOS in Economics
Karnataka State Open University
Mysore-570 006

Subject-Co-Ordinator

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Reader of Economics
Karnataka State Open University,
Mysore

Course Co-ordinator & Writer
Course -1
Block-3
Unit 10 to 14

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Karnataka State Open University
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Block -III
Block Introduction

Block 3 deals with theory of production and cost. In this block there are five units. The block begins with the unit on Law of supply. In the earlier block you have studied the law of demand. In order to understand the determination of price, it is necessary to examine the law of supply together with the law of demand. In unit 10 the law of supply is dealt with. Here Cob-Web model is also discussed to understand the market which is dynamic. In unit 10 elasticity of supply is also dealt with. In unit 11 the production function is discussed. Both short term and long term production functions are discussed. The law of variable propotion and the law of Returns to scale are explained. Unit 12 examines Isoquants and their importance. Unit 13 dealswith multi product firm and empirical work on production function. In unit 14 traditional and modern theories of cost are discussed.

M.A. Economics(Pre)

Course –I

Block – 3

Unit –10

Law of supply

unit –10

Law of Supply

10.1 Objectives:

A Study of this unit enables you to

- Analyse the Law of Supply.
- Discuss Market equilibrium.
- explain the views of Cob-Web model regarding determination of prices in a market

10.2 Introduction

In unit 6 you studied about the importance of demand, in the determination of price. There are two market forces which assume significance. They are "demand": and "Supply". Demand and Supply are the two sides of a market. In this unit we are going to study the law of Supply and the elasticity of supply. We also study the theory of price formation and Cob-Web theorem. It is also necessary to study how supply affects the market's stability

10.3 Market Supply

The market supply schedule shows the amounts of the commnodity that firms or sellers are ready to sell at different prices. Supply denotes the various quantities of a commnodity offered for sales by producers during a given period of time at various prices. "Supply" is always at a price and is related to a period of time. Supply and price are directly related. Lower the price smaller is the quantity supplied, higher the price, larger is the quantity supplied. The law of supply shows the functional relationship between price and quantity offered for sale.

10.3.1 The quantity supplied is the amount of a good that firms want to sell at a given price assuming that other things are remaining constant. Other things which are assumed to remain constant are costs, government action. Costs of production affect how much firms want to sell of a good. If a firm's costs exceed its earnings from selling the product, the frm does not sell. If a technological advance allows a firm to produce a good at a lower cost, the firm can supply more. In the same way government rules, taxation affect how much firms want to sell or allowed to sell.

10.4 Supply Curve

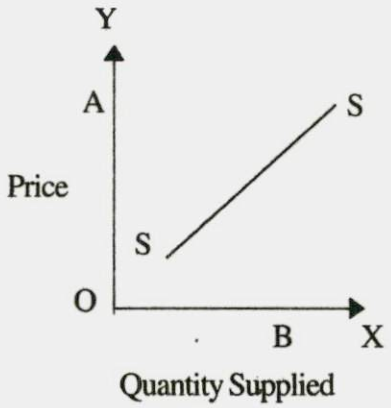
It is possible to show the relationship between price and the quantity supplied graphically. A supply curve shows the quantity supplied at each possible price. It is assumed that other factors influencing a firm's supply remain constant.

10.4.1 Let us First consider the supply schedule with the help of a table

Table

Price of per Kg(Rs)	Quantity supplied in (oootonnes)
15	500
10	300
8	200
5	100
2	50

The table shows that as price of sugar falls the quantity supplied becomes less and less. In other words as the price of sugar rises the quantity of sugar supplied increases. The relationship between supply and price can be explained with the help of a diagram.



10.4.2 In the diagram SS is the supply curve. It is upward rising. As the price of a commodity increases, firms supply more of that product. If the price of sugar is Rs.2, only 50,000 tonnes are supplied if its price rises to Rs. 15, 500, 000 tonnes are supplied.

10.4.3 Slope of supply curve

The law of demand requires that the slope of the demand curve must be downward sloping. There is no law of supply that requires the market supply curve to have a particular slope. The market supply curve can be upward sloping, vertical, horizontal or downward sloping. Many supply curvesSlope upwards such as supply curve of sugar shown in the diagram. "Along such supply curves, higher the price, the firms are willing to sell more, holding costs and governament regulations fixed"(Jeffrey M perloff Micro economics - Second edition - Addison wesley Long man (Singapore)pte ltd Indian branch Delhi p.22)

10.4.4 Supply Function

It is possible to write the supply function. Supply function is the mathematical relationship between the quantity supplied and price and other factors,

$$Q = S (P)$$

Q is the quantity supplied. P is the price of that product.

The total supply curve shows the total quantity produced by all suppliers at that possible price.

Check your progress –1

1. State the Law of supply.
2. Explain the slope of supply curve.
3. What is a supply Function ?

10.4.5 Factors affecting supply

Like demand, supply depends on many things .In general the quantity supplied is expected to depend on technological knowledge, input price and expectations. These are assumed to be constant to obtain the supply function.

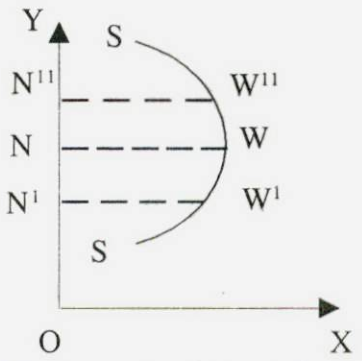
10.4.6 Movement of supply curve

There can be two movements on supply curve. There can be movements along an unchanging supply curve . This movement explains a change in the quantity supplied. There can be shift in supply curve. This explains a change in supply.

10.5 Exceptions to the Law of Supply.

The direct relationship between supply and price has certain exceptions.

1. When prices are expected to fall in future sellers sell more at present than in future. They try to clear the present stock.
2. Supply in the long run is mainly influenced by technology and not by price.
3. Changes in habits, tastes, fashion etc affect the supply of commodities
4. Sometimes as in case of labour, supply curve is backward rising.



Back ward rising supply curve

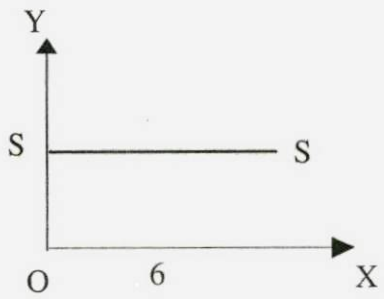
When wages rise workers may prefer leisure to work. An increased wage makes the worker to send their children to school and children are not sent to work. Supply curve then is backward rising like SS. At ON wage, OW is the supply of labour, when wages move to ON^{11} the supply of labour is reduced.

10.6 Elasticity of Supply

Elasticity of supply is the degree of responsiveness of change in supply to a change in the price on the part of the sellers.

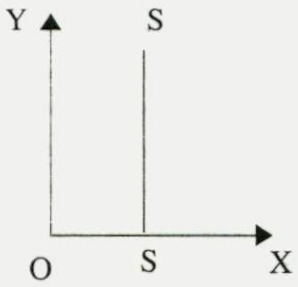
$$ES = \frac{\text{Change in amount supplied}}{\text{amount supplied}} = \frac{\text{Change in price}}{\text{price}}$$

Like elasticity of demand, elasticity of supply may be of five types

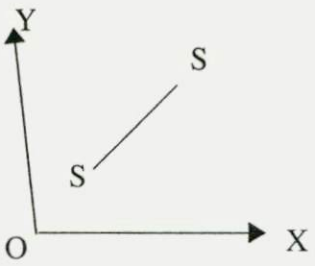


Supply is infinitely elastic and supply is a horizontal line

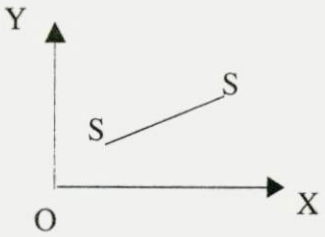
(b) Supply may be infinitey inelastic where supply curve is a vertical line



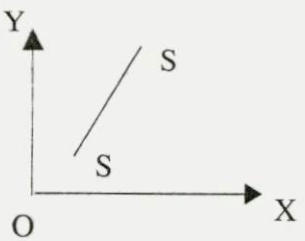
c) Elasticity of supply may be equal to one



(d) Elasticity of supply is greater than one



(e) Elasticity of supply is less than one



Check Your Progress 2

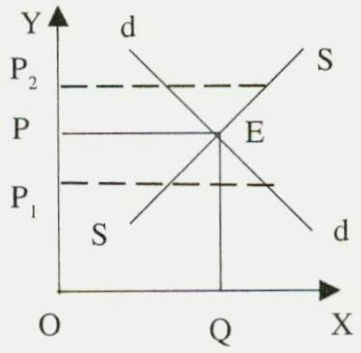
Q1. Examine the Law of supply and point out its limitations.

Q2. Explain the exceptions to the law of supply

Q3. What is elasticity of supply ? How is it measured ? What are the factors which influence elasticity of supply.?

10.7 Theory of price formation - (demand and supply equilibrium)

The supply and demand curve determine the price and quantity at which goods and services are bought and sold The demand curve shows the quantities consumers want to buy at various prices and the supply curve shows the quantities firms want to sell at various prices. A price at which consumer can buy as much as they want and sellers can sell as much as they want is called the equilibrium price. The quantity that is bought and sold at the equilibrium price is called the equilibrium quantity.



In the diagram SS in the supply curve, dd is the demand curve. dd and ss intersect at a point called E. At this point quantity demanded and supplied are equal to OQ at a price OP.

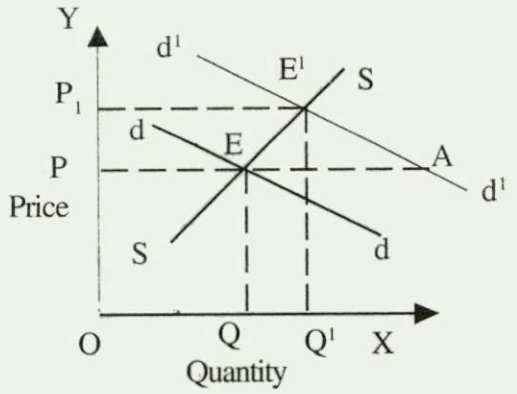
10.7.1

Let us examine a case where the market price is other than OP. Suppose the price isOP_1 then there is excess supply. The demand is smaller than the supply. An excess supply means that suppliers cannot sell off every thing they want to at the prevailing price, in this case OP_1 . Some of the suppliers try to reduce prices to sell off their unsold stocks. So price gradually reaches OP where quantity supplied is equal to quantity demanded.

Suppose price is OP^{11}. At OP^{11} there is excess demand over supply. When there is excess demand some buyers are unable to satisfy their demand and will bid up prices to induce sellers to supply them the desired amount of goods .In either case there are forces in the market which push the actual price towards the equilibrium price.

10.7.2

A particular market equilibrium is valid only for a fixed set of demand and supply curves. If these curves shift then a different equilibrium is obtained. This can be explained with the help of a diagram

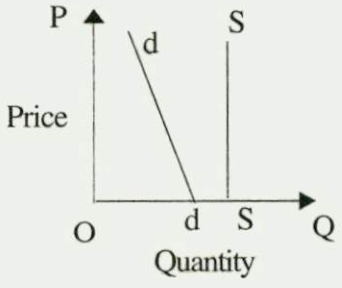


In the diagram the demand curve shifts from dd to d^1d^1. Initial equilibrium price is OP. At this price OP there is excess demand EA which tends to push up the price. But as the price increases it induces more supply from sellers and tends to reduce demand. The new equilibrium is reached at the price quantity pair of P^1Q^1

In markets where demand and supply curve are rapidly shifting, the market may not be able to settle down at any equilibrium position.

10.7.3 Stability of equilibrium

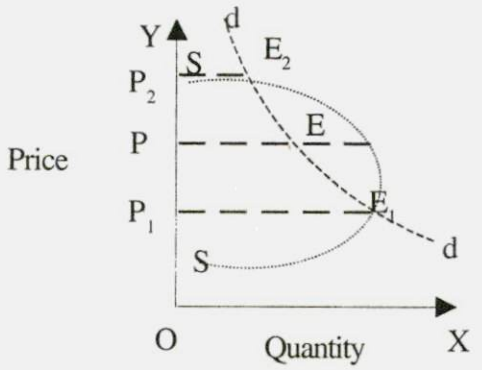
It is possible to examine whether at least one equilibrium exists always or not. Consider the following diagram



In the diagram dd is downward sloping and supply SS is upward sloping curve. There is no equilibrium. The demand and supply curve have not intersected at zero price. But they may intersect at negative price. For most commodities a negative price does not carry any meaning. Thus no equilibrium may exist in this case.

10.7.4

There is a second possibility. The supply curve may be backward bending. In that case there may be two equilibrium points. Consider the following diagram.



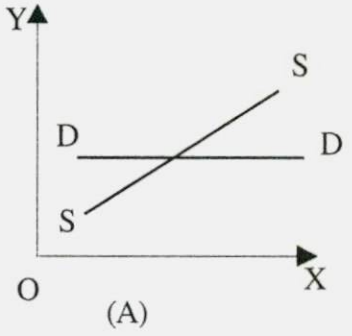
E_1 and E_2 are the two points of equilibrium Supply curve intersects demand curve. In this case equilibrium is not unique. In this case without further informatiom it is not possible to predict what price and quantity will be established in the market.

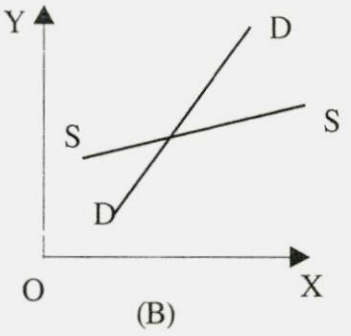
10.7.5

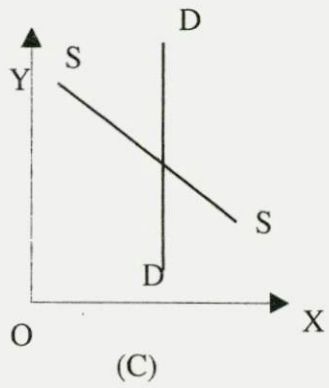
There is an impartant distinction between E_1 and E_2. Consider a price slightly above p_1. Call this P. At this price supply is more than demand and there is a pressure on the price to fall and move towards P_1. Similarly if P is less than P_1, there is excess demand over supply, and there is going to be pressure on price to move towards P_1 So E_1 can be called stable equilibrium.

If we consider a price above OP_2. At this price there is excess of demand over supply. Price tends to move away from OP_2. If the price is slightly less than OP_2 there is excess of supply over demand. This results in further fall in price. So price will be moving away firm op_2. Therefore E_2 is an unstable equilibrium. Any movement firm OP_2 is aggravated and the market is pushed farther away from equilibrium.

Let us consider another possibility. What happens if the demand curve is upward sloping and/or the supply curve is downward sloping ? There are four possibilities.







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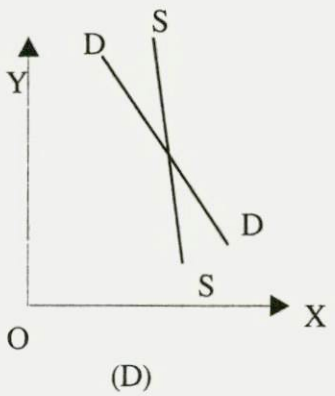


(D)

Equilibrium will be stable as long as the inverse supply curve cuts the inverse demand curve at equilibrium

10.8 Welfare properties of equilibrium

When equilibrium is established it will have a desirable property. It says that the reallocation of a commodity can be made without affecting the allocation of another. The free market equilibrium is Pareto- optimum. At equilibrium there is Pareto optimum situation. But from this it is not possible to establish about the fairness of the equilibrium. A market demand curve is an aggregate of individual demand curves . Each individual demand curve presupposes a particular distribution of incomes among the agents. The prevailing income distribution might be considered unfair by the society with most agents having very small incomes and unable to afford the price established in equilibrium .

An analysis of market equilibrium helps the government intervention in framing rent control laws, minimum wage legislation commodity taxation.

Check your Progress –3

1. How is price determined in a market ?
2. Explain equilibrium in theory of price determination.
3. Examine stability of equilibrium in a market.

10.9 Cob-web model:

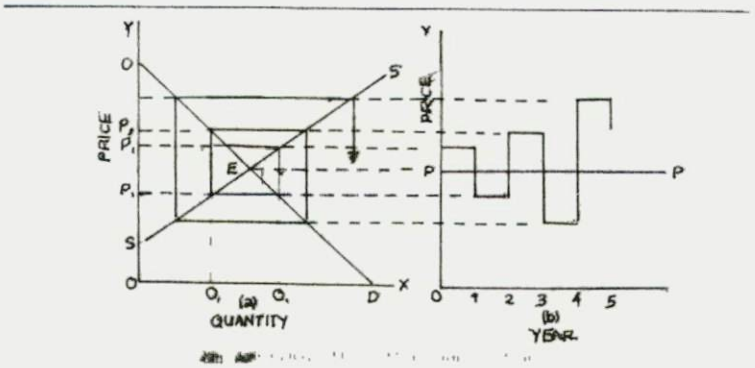
It is a dynamic model. It received particular attention by agricultural economists In some product markets the time paths of prices and output appear to exhibit regular fluctuations or cycles.

The model provides an explanation for certain types of cyclical behavior. It is used as a basis of theoretical and empirical analysis of several product markets.

The model is based on the assumption that production plans are based on current price and that there is a one period time lag in production response. In other words price (P_t) for output sold in period t is equal to the actual price in the previous period. so $p_t = p_{t-1}$

If it is assumed that production plans are made and these plans are fully realized, there is a lag between price. changes and adjustment in supply. Shortrun supply is a function of lagged price, in a very shortrun supply is assumed to be perfectly inelastic.

10.9.2 Cob-web model can be explained with the help of a diagram



It explains the cyclical behaviour. Let us assume that initial price is P_1 on the assumption that P_1 is going to prevail, producers supply Q_2 in the subsequent period. This quantity may be sold at a price which is the market clearing price determined by the intersection of demand and very short run supply at E. Producers base their production plans on P_1 for the next period.

Three equations explain Cob-web model

$$Q_{st} = f(P_{t-1})$$

$$Qd_t = F(P_t)$$

$$Qd_t = QS_t$$

Quantity supplied in period t depends on the prevailing price in t-1

Quantity demanded in t depends on the prevailing price in period t.

Cob-web model offers a better representation of those markets in which price and quantity cycles are observed. The model is considered to be elementary to provide a comprahensive analysis. Some authors are of the opinion that the model has limitations because assumptions are unrealistic Eg the model assumes that expected price depends on the last period's observed price This assumption is justified if the cyclical behaviour predicted by the model were observed in product market . Such cyclical behaviour is not found in a market. Price and quantity cycles are not continuous as assumed in the model. The model suggests that a cycle shoud have a length twice the production lag. In reality the length is several times the production lag, may be four times the time lag in production. The complex empirical observations are not explained in Cob-Web model. In order to explain the empirical observations it is suggested that shift factors have to be introduced to demand and supply functions. Supply may be partially adjusted.

10.10 Let Us Sum Up

In this unit it is made clear that supply is a determinant of price in a market. The law of supply explains the direct relationship between the level of price and quantity supplied. The shape of the supply curve, its slope, the factors affecting supply, supply functions are discussed in this unit. It is pointed out that price expectations, changes in technology, tastes and preferences, are exceptions to law of supply . The degree of change in supply arising out of a given price change is elasticity of supply. The price elasticity of supply is discussed. The unit explains the theory of price formation in a market. It examines equilibrium, stability of equilibrium and welfare properties of equilibrium. Cob web model is analysed to explain the time lag observed in a market in the process of price determination

10.11 Questions for Self Study

1. Explain the law of supply. How does supply behave in the determination of equilibrium price ?
2. Bring out the importance of Cob-Web model.
3. Explain stable and unstable equilibrium.

10.12 Books for study

1. S.K. Misra, U.K. Puri : Advanced Micro Economic Theory
2. H.L. Ahuja : Micro Economic Theory
3. Samuelson P.A : Economics
4. M.L. Seth : Micro Economic Theory

10.13 Key words

1. Equilibrium: It is the position where two opposite forces are equal Eg demand and supply
2. Stable Equilibrium: If there is any disturbance to initial equilibrium, changes occur and initial equilibrium is restored.
3. Unstable Equilibrium: If any disturbance to equilibrium results in a new equilibrium it is called unstable equilibrium
4. Elasticity of supply: It measures responsive ness of the supply of commodity to a change in its price.
5. Trade cycles: Show the fluctuations in economic activities.
6. Changes in supply: Changes in price bring about a change in quantity supplied.
7. Increase in Supply: Prices remain constant but supply curve shifts to the right.
8. Inelastic supply: A change in price of a commodity does not result in a change in quantity of supply.

Unit – 11

Production Function

Unit 11- Production function

11.1 Objectives:-

After the study of this unit you will be in a position to explain

- What is production function
- Types of production function
- The Law of Variable Proportion
- The Economies and diseconomies of scale

11.2 Introduction:

Production in economics means the creation of economic utilities. A producer in micro economic entity is one who combines with a given level of technology various "inputs" for the purpose of transforming them into "output". These outputs are sold in the market. There are two important theories in this context - (a) Theory of production and (b) Theory of cost. In this unit theory of production is going to be discussed.

Theory of Production analyses the physical relationship between inputs and outputs. The theory of cost explains the relationship between the level of output and level of costs.

11.3 Production function

Production function denotes the technological relationship between physical inputs and outputs. Stigler writes "the production function is the name given to the relationship between the rates of inputs of productive services and the rate of output of product. It is the economists summary of technological knowledge".

The concept of production function was found in the writings of the classical and neoclassical school. When the writers explained the law of variable proportion and the law of Returns to scale they were talking of production function of short term and long-term. In modern writings production function is widely used under Linear programming and Input output analysis. Dr Klein has stated that " in classifying the different relationship implied by the theory of the firm according to their degree of autonomy, of late , the production function is in a very high position".

Production function is a purely technical relation which connects factor inputs and outputs. It is a catalogue of output possibilities. It shows the

relationship between physical input and output of a firm . It is a relationship between time flows. It is a mathematical expression to the relationship between the physical units of inputs and the physical units of outputs achieved over a period of time.

The general mathematical form of the production function may be expressed as $x = f(L_1 K_1 N \ldots)$. X = output, L is the labour, K is capital and N – Land and other natural resources. The level of output depends on the quantities of labour, capital, land and other natural resources available to a firm.

Each firm has its own production function which is determined by the state of technology and managerial ability of a firm. Any change in the state of technology of the firm distorts the existing production function and a new production function is given to the firm.

Production function differs firm technology because technical efficiency and the maximization of output from every possible input combination are given importance in production function. Technology includes all physical possibilities. A single combination of input can be used in different ways to yield a number of different output levels.

A producer has to prepare production plan which specifies all inputs required and output to be achieved. Production plan gives production set to a producer. It comprises all the production possibilities in such a way to maximize production and minimize cost over time. Earlier economists described production alternatives not by a set but by a production function. Koopman points out that a production function represents the "efficient boundary of the production set".

Production function indicates the optimal organization of production. Technological knowledge does not always minimize cost. Minimisation of cost depends on the price and supply of factors of production. Quality of inputs is another factor which determines production function.

The writers of the classical school called production function as the "state of arts". According to them land was a fixed factor. Labour and capital were used in relation to land in a variable proportion. Ricardo wrote about the marginal product of capital and labour combined together. Production function was continuous in Ricardiaun model. Pareto analysed some production functions where some coefficients were fixed and others variables. Production function according to Wicksteed was of the first order.

11.4 Assumptions of production function

There are certain assumptions of production function.

(a) Production function is related to time.

(b) Technology does not change.

(c) A firm makes use of the best and the most efficient technology to maximize production function

(d) the factors of productions are divisible into viable units.

11.5. Types of production function

There are three types of production function.

1. Production function where only one input is variable and all other inputs are fixed. It is a short term production function.
2. Production function where all inputs are variable. It is a long term production function.
3. Production function where two inputs are variables.

11.6 Production function with one variable input or short term production function.

production function is determined by technical condition of production . In the short term technical conditions are rigid and various inputs used to produce a given output are in fixed proportion. Even in the short period it is possible to alter the quantity of one input while keeping the quantities of other inputs constant, in order to have more and more output. This aspect of production function where only one productive factor input is variable is known as the Law of variable proportion.

Let us assume that all inputs viz land, capital, machinery etc. of a firm are fixed. Let us also assume that labour is the only variable input. By increasing the use of labour a firm tries to increase its output. In this attempt the proportion between the fixed and variable inputs is altered .This leads to the operation of the law of diminishing returns or the law of variable proportion.

11.7 The law of variable proportion

Various economists have explained the law of variable proportion. Stigler says "an equal increments of one input are added the input of other productive services being held constant, beyond a certain point, the resulting, increments of products will decrease i.e. the marginal products will diminish"

Benham is of the opinion "As the proportion of one factor in a combination of factors is increased after a point, first the marginal and then the average product of the factor will diminish".

P.A. Samuelson has expressed "As increase in some inputs relative to other fixed inputs will in a given state of technology cause output to increase; but after a point the extra output resulting or the same additions of extra inputs will become less and less".

According to the Law of Diminishing returns when a firm attempts to increase output by adding units of a variable input to the fixed inputs the increase in the total production after a particular point becomes less and less. In other words the marginal physical output increases but after a point it increases at a diminishing rate, when a firm uses more and more of variable inputs in relation to other fixed inputs.

11.7.1 Illustration of the law

The law of variable proportion can be explained with the help of an illustration. Let us assume that a farmer has 5 hectares of land. He has a number of fixed inputs like land, building, live stocks etc. The farmer desires to increase farm output say wheat. He increases the use of labour since labour is said to be the only variable input. With the larger dose of labour on the given land, the physical productivity of labour under goes a change. This can be understood with the help of a table

Table

Output of wheat in physical units			
No. of workers	Total physical products	Average Physical products	Marginal Physical products
1.	10	10	10
2.	22	11	12
3.	27	09	05
4.	30	7.5	03
5.	32	6.4	02
6.	33	5.5	01
7.	33	4.71	0
8.	32	4	-01

In the table the production function is shown in the first two columns (Column 1 and 2) column 3 and 4 are derived from column 2. The average physical Product is derived from dividing total product from the number of workers. The marginal physical product is the addition to the total physical product by employing an extra unit of labour.

Table shows that the units of workers on the given land are used successively. When the second worker is employed the total physical products is increased from 10 to 22. The total physical products continues to increase till the seventh worker is employed. The use of seventh worker does not help to increase the total physical products. The use of 8th worker results in a decline in total out put. So total output after reaching a maximum level starts declining.

Average product is obtained by dividing total product from the number of men employed.

$$\text{i.e.} = \frac{\text{total product}}{\text{number of men employed}} = \text{Average product}$$

Average physical product of a labour starts declining with the use of 3rd labour. The marginal physical product of labour also declines with the use of 3rd labour. The marginal physical product rises or falls faster than the average physical product. Total physical product was at the maximum when 6th worker was made use of. It was 33. When 7th worker was used on the land the total product remained the same and the marginal product was zero. with the use of 8th worker the total product declines and the marginal product is negative (it is –1)

Table helps to define a relationship between inputs and outputs with a given technology . It explains that as an increasing number of units of one variable factor is applied to a fixed number of units of other factor inputs, output first increases at an increasing rate, then at a diminishing rate and eventually decreases absolutely. This can also be explained with the help of a diagram.

11.7.2

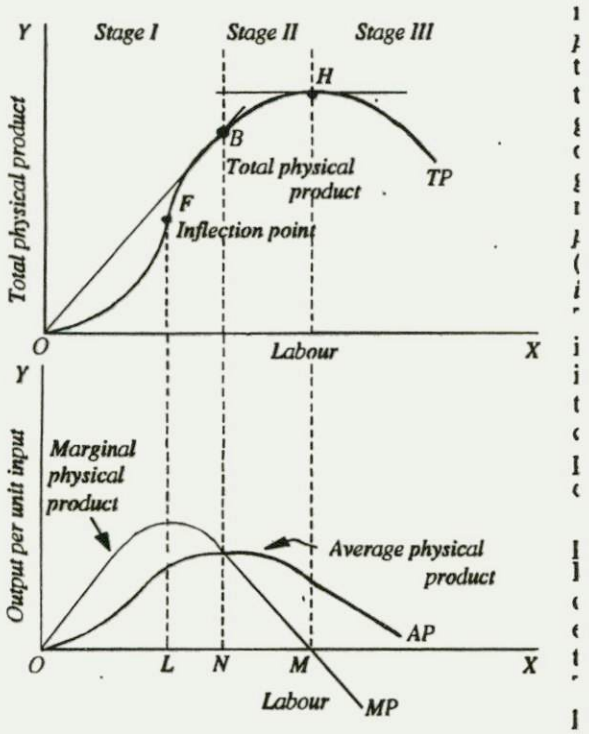


Fig. 16.5. Three Stages of Production Function with one Factor Variable.

In the diagram there are three curves AP, MP and TP. TP curve is the total product curve. It rises first at an increasing rate and later at a decreasing rate. The TP reaches its maximum at "H" After H, TP starts declining. AP and MP curves are derived from TP curve. The slope of the MP curve is the same as the slope of TP curve . MP curve touches zero corresponding to the position of "H". TP is at the maximum.

The slope of MP curve is steeper than AP curve. Because the fall in marginal physical product is faster and greater than the fall in the average physical product.

The behaviour of total, average and marginal physical product undergo changes under three different stages, consequent upon the increase in the use of variable input. Cassel has remarked that " If without change in the methods of production, successive physical units of one factor of production were added to a fixed physical quantity of another factor (or combination of other factors) the total physical output obtained would vary in magnitude through different phases"

The rising, the falling and negative phases of total, average and marginal physical product are the three different stages of the law of variable proportion. These stages have to be understood.

In the first stage the total physical product increases. It increases in the example from 10 units to 22 units. when the second worker is used on land the output on land more than doubled. Total physical product in the first stage increases progressively. TP curve rises upto B. upto B the total product increases at an increasing rate The slope of TP is increasing. MP curve is also rising From the point B TP curve goes on rising but its slope is declining. The point where the total product starts increasing at the diminishing rate is called the "point of inflexion" In the first stage the marginal as well as average physical product rise. The rise in the marginal physical product is larger than the risein the average physical product. In the first stage although marginal physical product starts falling the marginal physical product is larger than the average physical product. This causes the marginal physical product curve to rise . It should be noted that in the first stage marginal physical product rises in a part and then falls where as the average physical product rises throughout.

In the second stage the total physical product continues to increase but at a diminishing returns until it reaches the maximum point H. The second stage ends at H. In this stage both marginal and average product of the variable factors diminish but then are positive. At the end of this stage marginal product is zero. MP curve touches OX line . This stage is important because the firm decides to produce in this range. This stage is referred as the stage of the diminishing returns as both average and marginal products continuously fall.

In the third stage total product declines. TP curve slopes downwards. Marginal product becomes negative. This stage is called the stage of negative returns as MP becomes negative. Variable factors are too much in relation to the fixed factor, which causes a decline in total productivity of the firm . No firm attempts to operate on this stage as the firm faces losses. It is only the second stage which is relevant to the operation of a rational firm. In the second stage the firm will be maximising total product and will be making the maximum use of the variable factor. The first stage is irrelevant to the firm because it will not be possible to utilize the opportunities of increasing production. Average product continuously increases in the first stage which makes the firm to expand beyond the first stage. stages 1 and 3 are considered as non economic region in production function. The rational firm chooses a point in the second stage The choice of the point depends on the price of factors.

11.8 Three stages of the operation of the law

In the first stage the law of increasing returns operates because the fixed factor is abundant relative to the quantity of variable factor. When the variable factor is increasingly used the fixed factor is used to the maximum extent. The efficiency of the fixed factor is increased when variable factors are increasingly used. So the law of increasing returns operates. It is also assumed that when variable factors are increasingly used, the scope of division of labour and specialization of variable factor also increases. This is another factor responsible for the operation of the law of increasing returns.

In the second stage the law of diminishing return comes into operation after a particular point. At that particular point the amount of the variable factor used will be sufficient to utilize the fuller utilization of the fixed factor. Continuous increase in the variable factor beyond the point of full utilization of the fixed factor results in diminishing returns of the variable factor. It is the indivisibility of the variable factor which causes the operation of the law of increasing returns and diminishing returns. In the second stage when the fixed factor is used in the best or in the optimum proportion with the variable factor the average output will be at the maximum. Once this optimum proportion is disturbed the diminishing return sets in. If both the fixed and variable factors are completely divisible there is no scope for the operation of the increasing and decreasing returns. Prof. Bober expresses the view that if divisibility "is allowed to enter through the window" the operation of the increasing and decreasing returns move "out of the door" In the third stage use of variable inputs is larger than necessary and so marginal product becomes negative.

11.9 Long term production function [Returns to Scale]

The long run production function deals with all variable inputs. This is also called the laws of returns to scale. The law assumes that all inputs are increased in the same proportion. Factor inputs which cannot be changed in a short period determine the scale of a firm.

The problem of returns to scale is studied in two ways(a) All inputs are varied in the same proportion (b) Returns to scale refer to situations in which all inputs are varied in different proportion. Returns to scale is an empirical relationship between in puts and out puts where all inputs are homogeneous according to some writers. But a few writers regard returns to scale to consist of factors which are variable.

11.10 Difference between the law of returns to scale and the law of variable proportion.

The law of returns to scale is different from the law of variable proportion, since returns to scale is relevant in the long period. It assumed that all factors are variable. The law of variable proportion is relevant in the short period as it assumes that all the factors except one are fixed. It explains the behaviour of output when changes are made in the factor proportion. Under returns to scale output changes when all inputs are increased in the same proportion. Changes in scales of production are considered under returns to scale. All inputs are increased in the same proportion when there is an increase in scale. Factor proportions do not change when the scale of production changes.

There are various returns to scale – increasing, decreasing and constant returns to scale . If all inputs are increased by 10% and if output increases by (more than 10%) 15%, then the increasing returns to scale operates. If an increased inputs of 10% results in an increased output by 10% it is constant returns to scale. If an increased output by 10% results in an increase of output by 5% (less than 10%) It is a case of decreasing returns to scale.

11.11 Increasing returns to scale

Adam Smith was of the opinion that increasing returns to scale was the result of division of labour. Marshall said that an increase use of labour and capital leads to generally an improved organasation. This increases efficiency of labour and capital. So Marshall explained increasing returns in terms of efficiency.

11.12 Economies of scale

There are causes for increasing returns to scale. The causes are grouped under external economies and internal economies. Internal economies are economies of scale of large scale production. They are economies of production and economies of marketing. Economies of the production include economies arising out of skill, use of machinery, materials etc. Economy of buying and selling come under economies of marketing. It is possible to discuss internal economies in detail.

Dimensional economies

Prof. Baumol attributes increasing returns to dimensional relations. When the size of capital good is enlarged production increases. eg. a wooden

box of 3 foot –cube contains 9 times greater wood than 1 foot –cube. But the capacity of 3-foot cube wooden box is 27 times greater than that of 1 foot cube. If the diameter of a pipe is doubled the flow through it is more than doubled. Storage capacity of a ware house can be increased more than proportionately by increasing the perimeter of the ware house. By smaller increase of input, larger than proportionate increase in output can be had.

Economies flowing from indivisibility

Economists like Joan Robinson, Kaldor, Lerner, Knight attribute increasing returns to scale to the indivisibility of factors. Some factors are available in lump and in large units. Some capital equipments are available in minimum size. A machinery has its own capacity of production Eg. Power loom may produce 100 meters of cloth with a day's labour. If the power loom is used to produce 80 meters of cloth. (less than its maximum capacity) the cost of production of cloth is distributed on 80 meters of cloth. If the power loom is fully used, the cost is distributed on 100 meters of cloth. The average cost becomes less. The advantage arising out of the fuller utilisation of the plant or machinery is known as technical economies of production. These economies are associated not only with plant and machinery but also with labour, management, finance, research, advertisement etc.

Economies of Specialisation

Adamsmith discussed about economies of specialization when he discussed division of labour. Prof chamberlin emphasizes specialisation as a factor leading to increasing returns to scale. Production processes are subdivided into sub processes , leading to greater divisions of labour and increased specialisation. Productivity is increased following division of labour. With an expansion of industry a number of specialized firms appear which do a specific job. This type of specialization is called vertical disintegration by Joan Robinson eg. the growth of ancillary industries financial institutions are seen in big industrial centre

Marketing Economies:- A large firm buys raw materials cheap compared to a small firm. Selling cost per unit is small to a big firm compared to a small firm. Marketing cost per unit is low with large firms

Financial Economies:

Large firms are in a position to raise funds from a number of financial institutions and also from the public. Adequate finance helps big firms to adopt modern techniques and to use good machines which enable the firns to enjoy technical economies.

External economies:

An expanding firm enjoys certain external economies on account of growth of industry E.g. When an area develops industrially people begin to migrate to the industrial area seeking employment. Recruitment becomes easy. Many subsidiary industrial units appear around a big industrialist center. Centers to supply raw materials, intermediary products to the major industry appear on the scene. An area which is developed industrially comes to possess centres which offer services like technical training, banking etc. Development of transport facilities, promotion of trade accompany the development of industry.

An expanding industry avails itself of many internal and external economies. These economies reduce the cost of the produced unit and causes the firm to experience increasing returns to scale. Increasing returns to scale is limited to the availability and to the utilization of capital. Increasing returns to scale is determined by the scope for division of labour and specialization.

11.13 Constant returns to scale

When a firm exhausts all its advantages arising out of internal and external economies the firm experiences constant returns to scale. Some economists have doubted the operation of constant returns to scale. But empirical evidences have shown the existence of a phase of constant returns to scale. This phase is long. eg. Cobb Douglas production function . A production function showing constant returns to scale is often called "linear' and homogeneous", " Linear homogeneous Production function of first degree". An increase in input brings about a proportionate increase in output under constant returns to scale.

11.14 Diminishing returns to scale.

When a business firm continues to expand beyond the point of constant returns, a stage comes when diminishing returns to scale set in. The diseconomies of large scale production replace the economies of large scale production at this stage. Diseconomies arise out of large scale management which give room for the appointment of too many supervisors, delay in decision making, appearance of bureaucracy etc. Diseconomies are seen when a machine is used beyond its built in capacity. Inadequacies in transport facilities are felt when various types of industries start growing.

In the long run all the factor inputs are elastic and a firm can choose any stage of production operation, increasing, constant and decreasing returns to scale.

11.15 Production function with two variable inputs

Production function with two variable inputs assumes that the two variable factor inputs are substitutes. Let us assume that there are two factor inputs X and Y which are substitutes. Various Combinations of X And Y give place to different quantities of output.

Table

Output from different combinations of X and Y				
No of X	Outputs			
4	50	55	60	65
3	45	50	55	63
2	40	45	50	55
1	35	40	45	50
No. of Y	1	2	3	4

Table shows various combinations of two variable inputs to produce a given output. The number of x an input used is shown in the left hand side of the table. The number of y another input used in shown at the bottom of the table . The intersection of the columns and rows show the output produced with a given combination of x and y E.g. A Combination of 4x + 1y gives an output of 50 units . A combination of 3x + 2y gives an output of 50 units. A Combination of 1x + 4y also gives an output of 50 units. A combination of 4x + 4y gives an output of 65 units. This is the maximum output possible with the given combination of resources x and y. From the table it is possible to understand that a given output can be produced by different factors combinations of x and y Eg. 55 units of output can be had by combination of 4x +2y, 3X + 3y and 2x +4y . All the combinations are technologically and economically efficient. But a choice of a particular combination is made after considering the prices of two factors of inputs namely x and y.

11.16 Let us Sum up

Production function is a technological relationship that exists between inputs and output. There are certain assumptions of production function . It is related to a particular unit of time, particular technology and that production which ensures maximum output is chosen. factors of production are divisible.

Production function may be for short term or long term, production function may be with one variable input. This is called the law of variable proportion. This law explains the three stages of operation and this law is universally applicable . The production function may be with more than two variable inputs and which in long term production function is called returns to scale. The operation of the returns to scale can be explained with economies of scale and diseconomies.

11.17 Questions for self study

1. Explain the law of variable proportion.
2. Critically examine the law of increasing returns to scale.
3. Examine the case of universal applicability of the law of variable propotion.

11.18 Books

1. S.K. Misra and U.K.Puri : Advanced Economic Theory
2. Ahuja : Micro economic theory.

unit 12

Isoquants

Least Cost Combination

Unit 12

Isoquants - Least cost combination

12.1 Objectives :

After studying this unit it is possible to

- Explain Isoproduct Curve.
- Explain producers' equilibrium.
- examine Least cost combination of a firm.
- and to analyse the choice made by a multi product firm.

12.2 Introduction:

Production function explains the technological relationship between the rates of inputs of productive services and the rate of output of product. It is a catalogue of output possibilities. It is also assumed that the firm makes use of the best and most efficient technology to maximize production function. In this unit the tools that are necessary to identify the best and efficient combination of inputs to maximize output are studied. One such tool is Isoquants.

12.3 Isoproduct curves

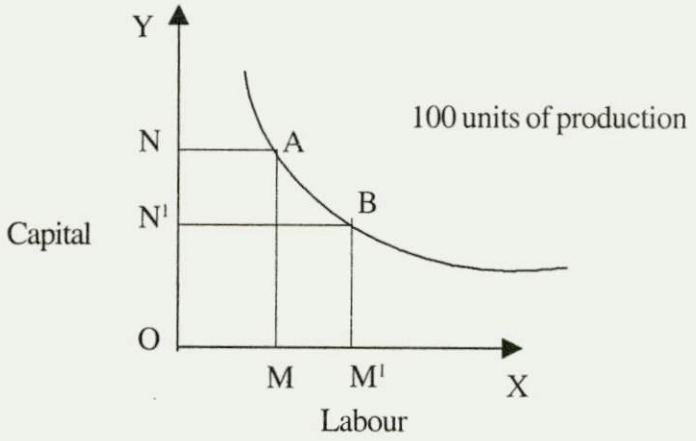
Isoproduct curves are called Isoquants. They are known as equal product curves or production indifference curves. These curves represent production function with two variable inputs. Isoproduct curve s are the firms counterpart of the consumers'. indifference curves. Isoproduct curves indicate the combinations of inputs which yield a specified level of output. Different alternatives of factor combinations are represented on isoproduct curve. These alternatives of factor combinations yield the same level of output. A firm has to make a choice of the alternative of factor combination. An isoquant includes all the technically efficient methods for a given level of output. An isoquant is the locus of all the combinations of factor of production for a given level of output.

Let us suppose a firm has two inputs capital and labour. To produce 100 units of X the firm employs the factors in the various combinations.

12.4 Isoquant Schedule

Combination	units of Labour	units of Capital	Total product of x units
I	1	20	100
II	2	15	100
III	3	11	100
IV	4	8	100

This can be put on a graph



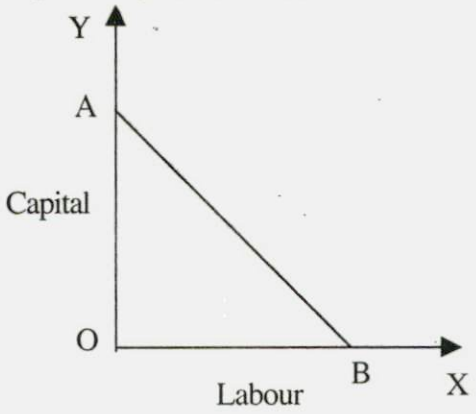
Each of the factor combination produces the same level of output 100 units of x . Factor combination I consistis of one unit of labour and 20 units of capital and produces 100 units of x. combination II consistis of 2 unit of labour and 15 units of capital and produces 100 units of x. combination IV consists of 4 unit of labour and 8 units of capital and produces 100 units of x. In the graph these points are plotted and joined to obtain an isoquant.

12.5 Shapes of Isoquants curve

Isoproduct curve assumes a number of shapes. These shapes are determined by the degree of substitutability between factors.

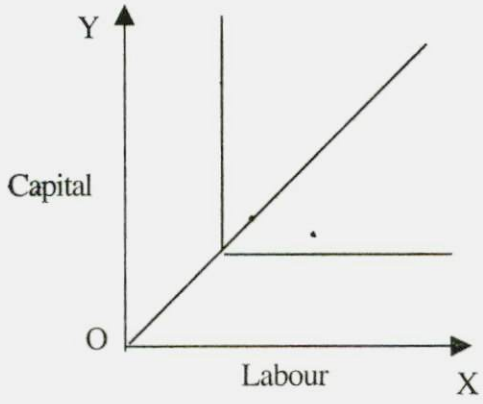
Linear Isoquant: If factors are perfect substituties, a given output is produced by using only labour(OB) or only capital (OA) or by an infinite combinations of labour and capital.

Linear Isoquant may be drawn thus

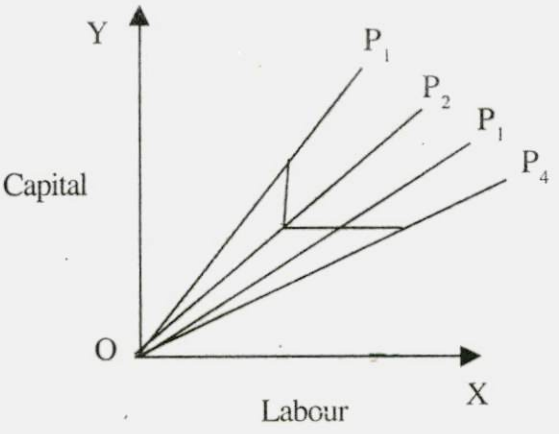


Input –output Isoquant: This isoquant is also known as Leontieff isoquant. There is no substitutability of factors in this type of isoquant. Factors are complementary, an increased use in one factor leads to an increased use in another. Isoquant takes the shape of a right angle

Leontieff Isoquant

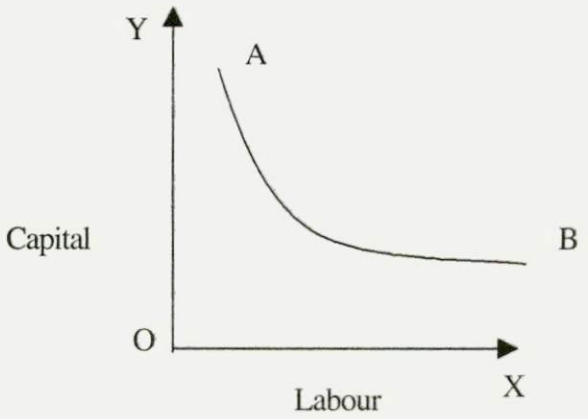


Kinked Isoquant: There is scope for substitutability but it is limited. E.g. labour can be substituted for capital to an extent and viceversa.Substitutability is possible only at Kink. These Isoquants are known as Activity Analysis Isoquants or Linear programming isoquants. Kinked isoquants are used in Linear programming.



Kinked isoquants are said to be realistic

Convex and Smooth isoquants: These isoquants are found in traditional economic theory. It assumes that the factors are good substitutes, that is one factor can be substituted for the other over a range. But after a point they cannot be substituted . So curve becomes smooth. Isoquant is convex to the origin.



Smooth convex isoquants are generally discussed when one discusses isoquants and their properties etc.

12.6 Isoproduct curve and Indifference curve

Isoproduct is similar to indifference curve. Isoproduct curve shows a number of combinations of factor inputs which yield a given quantity of product. Indifference curve shows a number of combination of goods which yield the same satisfaction to a consumer. Isoproduct map helps to decide producers' equilibrium. Indifference map helps to decide consumers' equilibrium.

There are a few differences between isoproduct curve and indifference curve.

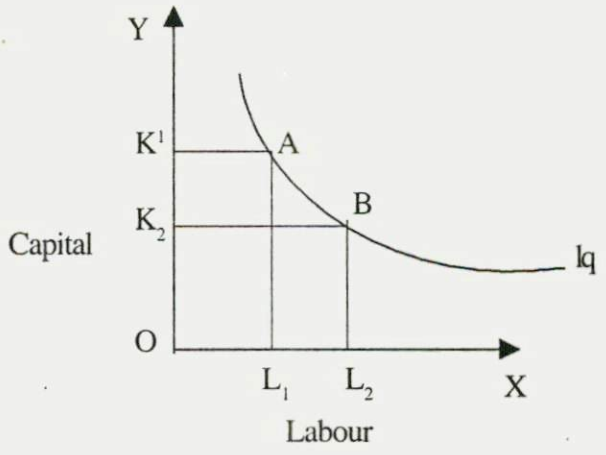
An indifference curve does not measure utility in physical units. An isoproduct curve measures output in physical units.

An indifference curve found on the right yields higher utility than the one found on the left. But the difference between the utilities of these indifference curves are not measured in physical units. When equal product curves are drawn they are quantified in physical units and their difference can easily be quantified.

Indifference curves are labelled with non-commital number like Ic_1, Ic_2, and Ic_3 but isoquants are labelled in physical units of output.

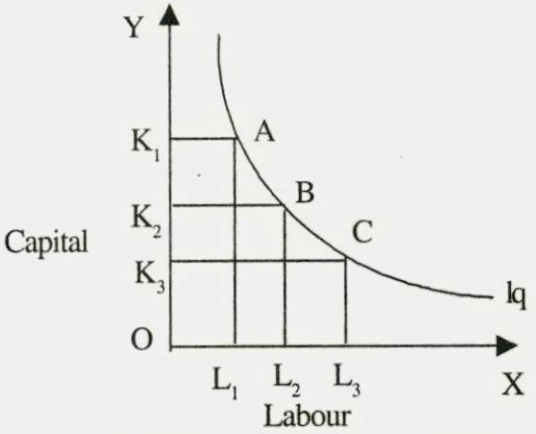
12.7 Propertities of Isoproduct Curve

1. Equal product curve slopes downwards to the right. They have negative slopes. The slopes explain different combination of factors yielding equal output. Negative sloping isoproduct curves explain rational behaviour of a firm or producer. When the producer uses more of labour (OL_2) he uses less of capital (OK_2) and when he uses more of capital (OK_1), he uses less of labour (OL_1) But output remains the same.



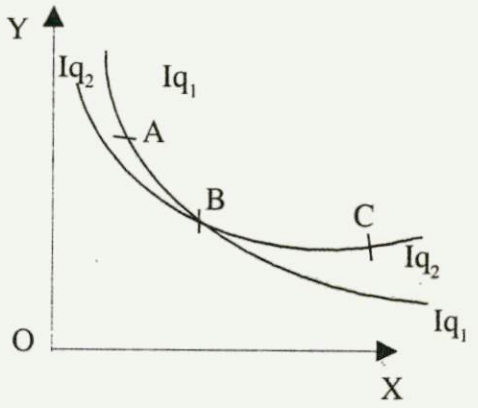
So a Negative sloping isoquant indicates all combinations of the two factors labour and capital which yield the same output. This concept cannot be explained by horizantal or vertical isoquants or by an upward rising isoquant.

2. Isoquants are convex to the origin because isoquants assume diminishing marginal rate of technical substitution between factors. Diminishing marginal rate of technical substitution determines the slope of an isoquant



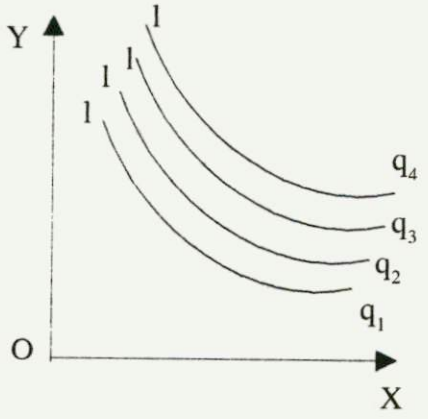
In the figure at A the factor combination of labour and capital is K_1L_1. In the beginning OK_2 capital are sacrificed to increase the use of labour by L_1L_2. To increase the use of labour L_2L_3 only K_2K_3 capital are sacrificed. So the rate of capital exchanged for labour goes on decreasing.

3. Iso product curves do not cut each other. If they cut each other there is a logical contradiction.

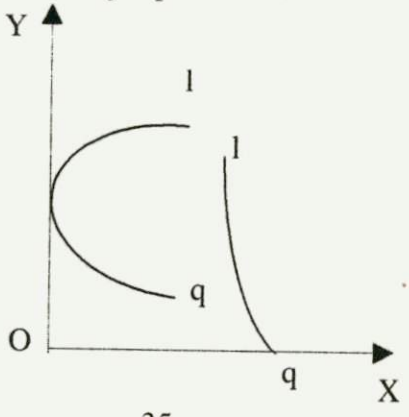


lq_1 is found on the left and lq_2 is found to the right. A is found on lq_1 and C is found on lq_2, C yields more output than any combination found on Iq_1. But in the figure Iq_1 cuts Iq_2 at B. This means that ABC should yield same output. So there is a logical inconsistency when two lq_2 cut one another.

4. Isoquants are not parallel to one another. Their slope need not exhibit equal rate of substitution between factors. The slopes of Isoquants need not be the same since the rate of technical substitution is not the same.



5. Isoquants do not touch either of the axis. If an Isoquant touches OY axis it means only capital is used.



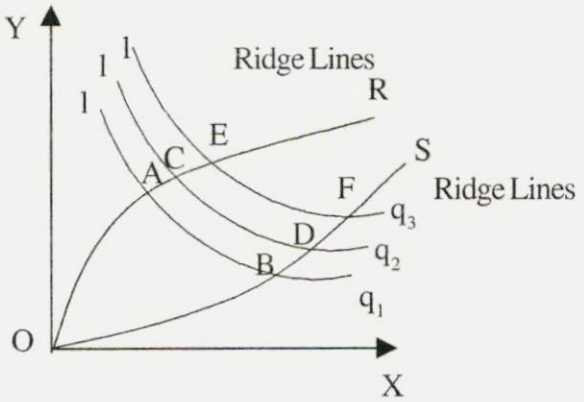
nothing is produced with ox of labour alone and with OY of capital alone.

Ckeck your progress 1

1. What is isoquant ?
2. Point out the differences between Isoquants and Indifference curves.
3. Analyse the properties of Isoquants.

12.8 Oval shaped equal product curve

Equal product curves help the firm to decide the boundary lines for economic region of production. The curves bend back upon themselves with positively sloped segments at both ends



In the diagram there are three Isoquants, lq_1, lq_2, lq_3 bend back at AB, CD, EF respectively. By joining these points we get two lines OR and OS. These lines are called ridge lines. The portion of the equal product curve which lies between the ridge lines are suited for economic production.

12.9 Diminishing Marginal Technical Substitution

The convex shape and the slope of the Isoquants are determined by the principle of diminishing marginal technical substitution. It is assumed that factors are substituted for one another. If more of one factor is used, the other factor used is less but output resulting from these factors remains the same . The rate at which one factor is substituted for the other without changing the output level is termed as the rate of marginal technical substitution.

The marginal rate of technical substitution can be understood with an example. Let us assume that there are two factors of production, labour and

capital. They can be substituted to an extent. Producer decides to produce 100 units of X. He begins to substitute labour for capital. Smaller and smaller units of capital are given up to use additional units of labour.

Table

Factor input combinations	Unit of labour	Unit of capital	Unit of output	MRTS of labour for capital
A	1L	+ 10 K	100	-
B	2L	+ 7 K	100	3
C	3L	+ 5 K	100	2
D	4L	+ 4 K	100	1

All factors of combinations of A,B,C and D Produce 100 units of X. . If the producer chooses A combination, he uses 1 unit of labour and 10 units of capital . If he desires to move to B, he has to exchange 3 units of capital to hire one unit of labour. If he desires to use 3rd unit of labour, he decides to part with only 2 unit of capital. At D he parts with only one unit of capital to employ 1 more unit of labour. In this way the marginal rate of substitution between labour and capital goes on declining. The marginal rate of labour is the loss of capital which will just be compensated for by additional units of labour. The rate goes on diminishing.

Marginal rate of technical substitution becomes irrelevant if factors are complements and if factors are used in fixed proportion.

Isoquants have some practical importance.

1. They are used to analyse optimum factor combination and equilibrium of the firm.

2. They are useful to decide least-cost combination of a firm

3. They are used to explain the operation of returns to scale and the law of variable proportion.

12.10 Least cost combination and the choice of product

A firm aims at maximizing profit. Profit maximization calls for the least cost combination of factor of production. The least combination of

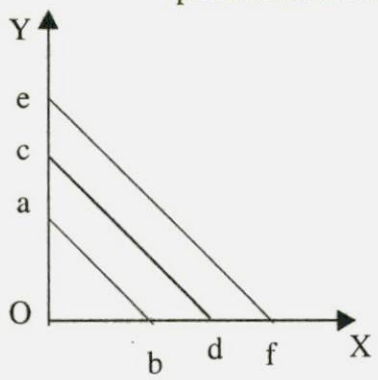
factors of production refers to a firm getting the largest volume of output from a given cost outlay on factors when they are combined in an optimum manner. This optimum level is different for different quantities of output of the same commodity. When a firm decides to maximise profit it may maximise profit with cost constraint or with minimization of cost for a given level of output.

The producing firm needs Isoquant map and Isocost line to decide the optimum factor combination. Isoquant map shows the different technical possibilities open to the firm for producing the various size of output. It shows to the firm the various possible factor combination which can be adapted for producing a given level of output.

Isocost line is "the locus of all combinations of factors the firm can purchase with a given monetary cost outlay". It indicates the different combinations of the two inputs which a firm can purchase at given price and with a given outlay.

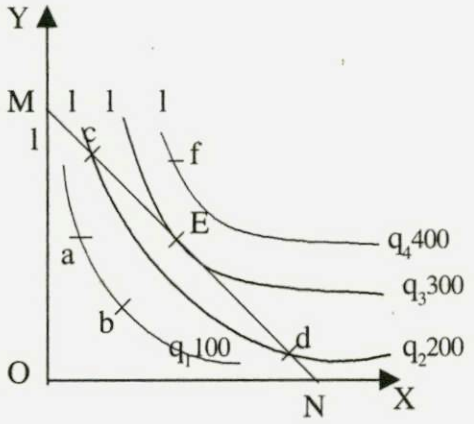
Isocost line shows (a) Price of two factor and (b) the total outlay of the firm. Isocost line is also called equal outlay curve. It is also called price line or Ray. A price line is a line of constant expenditure. It is the firm's budget constraint. It assumes Perfect competition. So it takes the form of a straight line. The price of inputs are assumed to be constant. The slope of the isocost line is equal to the ratio of the price of the factors of the production. If AB is the isocostline its slope is

$$AB = \frac{\text{Price of factor X}}{\text{price of the factor}}$$



Let us draw an isocost map. It represents the various factor combinations which can yield various levels of output. Every equal product curve shows those factor combinations each of which produce a specified level of output. A Family of isocost lines like ab, cd, ef represents the various levels of total cost or outlay given the price of two factors x and y . The entrepreneur may desire to minimize his cost of producing a given level of output or may desire to maximize his output for a given cost or outlay. when the entre

preneur makes a decision about the level of output to be produced, he will have to make a choice of factor combinations. His choice can be explained with the help of a diagram.

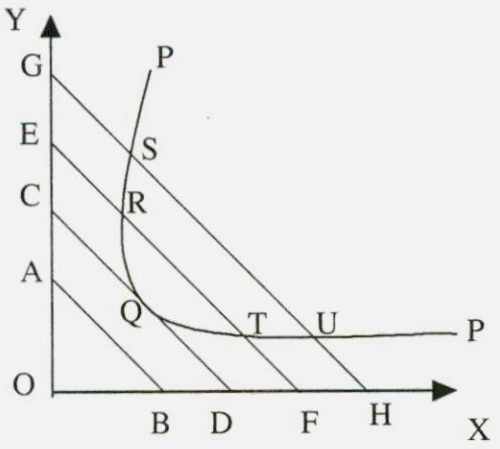


In the diagram MN is the isocost line lq_1, lq_2 lq_3 and lq_4 are isoproduct curves. lq_4 is higher than lq_3, and lq_3 is higher than lq_2, and lq_2 is higher than lq_1, The firm chooses E to maximize its output Given the cost constraint. E is tangent to Isocast line MN. E is on lq_3 which is higher than lq_1 and lq_2. Points of AB, are not chosen because they are on lower isoquants lq_1, points C and D are also not chosen because they are on lq_2 which is lower than isoquant lq_3. "F" is on lq_4 which is higher than all other isoquants, lq_1, lq_2 and lq_3 . "F" cannot be chosen because it cannot be attainable. Hence "E" is the maximum output possible and the slope of the isocost line is equal to the slope of the isoquant. At "E" the firm is said to be in equilibrium because it equates the ratio of the marginal productivities of factors to the ratio of their prices.

12.11 Minimising cost

The entrepreneur along with maximizing profit aims to minimize cost. The entrepreneur wants to produce a given output with the minimum cost outlay. In this case we have to make use of isocost curves. Curves closer to the origin shows a lower total cost outlay . It is assumed that price of factors are constant. In the diagram "Q" shows the minimization of cost, points above Q mean costs are high.

The concept of marginal rate of technical substitution and the price ratio of two factors are made use of to explain minimizing the cost. With the help of a diagram this can be examined.



The concept of marginal rate of technical substitution and the price ratio of two factors are made use of to explain minimizing cost. In the diagram AB, CD, EF, GH are the isocost lines. QRSTU are the points noted on the isocost lines. R and S are not chosen, because the marginal rate of technical substitution of x for y is greater than the price ratio of factors as indicated by the slope of the equal product curves on R and S. Q indicates the position of equilibrium. At Q the ratio of the technical substitution of X and Y is equal to the price ratio of the factors since the slopes of the isoquant and isocost line CD are equal to each other . Points T and U lie on the higher iso-cost lines and at those points the marginal rate of technical substitution of X for Y is smaller than the price ratio of the factor and the entrepreneur substitutes Y for X and moves upward on the isoproduct curve P until he reaches Q. At Q Isoproduct curve is tangent to isocost line and where the marginal rate of technical substitution is equal to the price ratio of factors. At equilibrium it can be said

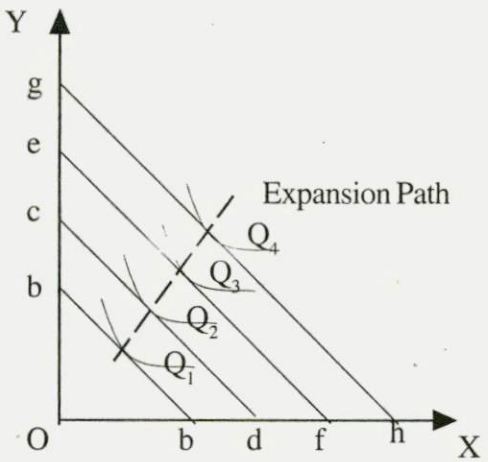
$$MRTS = \frac{PX}{PY} = \frac{MPX}{MPY}$$

In other words the position of equilibrium ensure optimum output and minimum cost. It is a position where there is no scope for substitution of one factor for the other where prices of factors equal their respective marginal productivity.

12.12 Optimal Expansion path

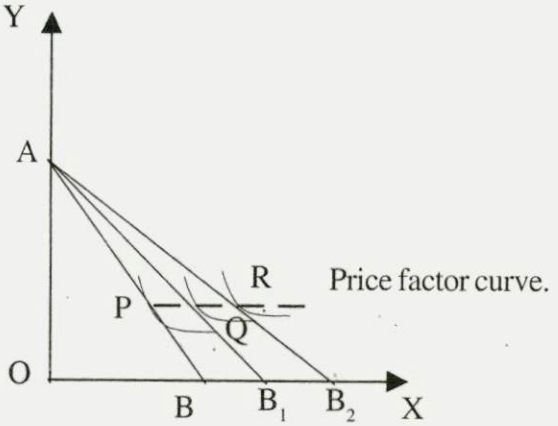
In the long run all the factors of productions are variable. There is no limitation to the expansion of out put . The motive to expand output is the maximisation of profits. Let us assume that there are two factors X and Y.

These prices are represented by the slope of AB line. As out put expands the costs are also change. These changes are indicated by ab, cd, ef, gh. lines. They are parallel because price of the factor remains the same. If the firm wants to produce output denoted by the isoquant Iq_1 the factor combination Q1. If the output desired is Iq_4 factor combinations is Q4. The firm chooses respective tangency combinations Q1,Q2,Q3 and Q4 which minimize cost for the given outputs. The line joining the minimum cost combinations such as Q1,Q2,Q3 and Q4 is called expansion path. The expansion path is also known as scale line because it shows how the entrepreneur changes the quantities of the two factors when he increases the scale of production . The slope of the scale line depends upon the factor price and production function. Expansion path is also known Isoclive



12.13 Price effect on the factor Usage:

Let us assume that there are two factors X and Y to produce "A" . Let us assume that the price of X Falls and the price of Y remains constant as shown in the diagram.



AB is the isocost line. With a fall in the price of X the new isocost line is AB^1. Factor X becomes cheap and firm begins to substitute the X for Y. The entrepreneur will now seek to produce at the point where the isocost line AB^1 is tangent to isoquant. The point in the diagram is R. It is the point of maximizing output under the new situation. A fall in the price of X makes the entrepreneur to move from Q. on AB to R on AB this action in factor combination as the result of change in price is known as factor price effect. With the change in price of a factor, the equilibrium positions also change. By connecting the various positions of the equilibrium we are going to get price factor curve.

12.14 Technical substitution effect:

With the help of the diagram we have seen that a fall in the price of X factor changes the isocost line from MN to MN_1. X is substituted for Y. There is a change in the position of equilibrium from Q to R. This change is due to the price effect. The price effect can be looked from two angles. When the price of X falls the firm tries to maximize the output by substituting X. a cheap factor for Y. With the given outlay a firm can buy more of X now than before. Let us try to understand the movement of the firm from one position of equilibrium to the other. The reason of the movement is explasion as the expantion effect and substitution effect. In the diagram isocost line is NM to start with.

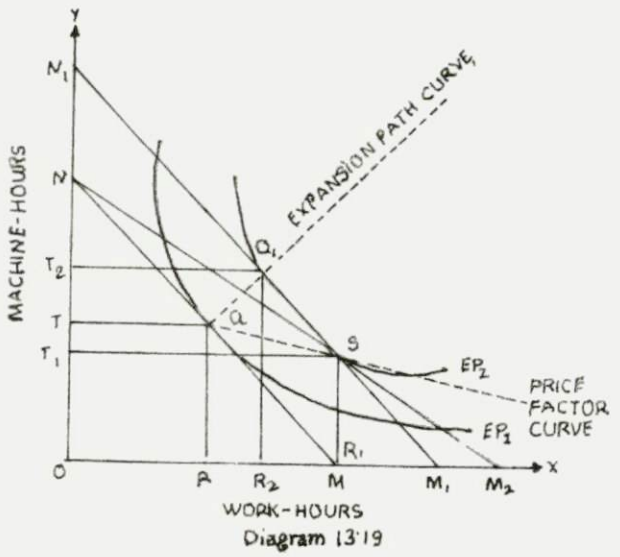


Diagram 13.19

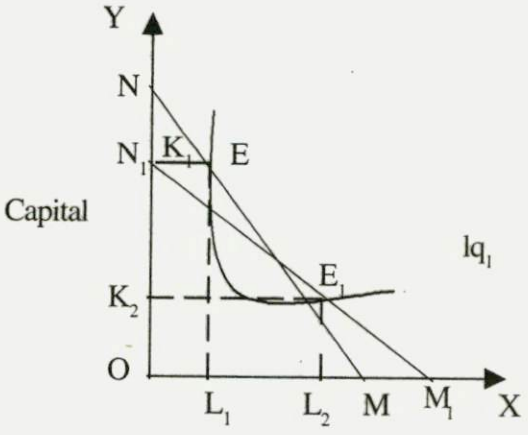
The firm's position of the equilibrium is Q then. Let us assume that the price of X falls following which isocost line moves to NM_2 as shown in the diagram. the price of Y is remaing the same. The resources at the hands of the firm are remaining the same. The new isocost line NM_2 touches the Iq_2 at S. This is the new position of equilibrium of the firm. The movement of

the firm following a decline in price level of X from the position of Q to S is the result of the fall in the price of X. This is the Technical Substitution effect.

The expansion effect following the fa11 in the price of X can be explained thus. When price of X falls the real value outlay of the firm goes up even though money value remains the same. With the fall in the price of X the purchasing power of the firm's, outlay has increased. The firm as a result can secure a large output from the same outlay on the two factors X and Y. The increased real value of the outlay is ,shown in the diagram by the isocost line N_1M_1 Which touches the lsoquant lq_2 at Q^1. The movement of the firm from Q to Q^1 is regared as the effect of the expansion path At Q^1 following the expansion effect the firm uses more of both X and' Y than at Q. The resources used at Q^1 are OK ^{1} *of* Y and OL' of X. At S following the substitution effect the firm uses larger X a cheap factor than the use of X at Q. The use of X at 'S' is OL_2 and the use of Y is OK_2 (Which is less than OK at Q). So a fall in the price of one of the two variable factors results in a decline in the quantity used of the other factor. One is substituted for the other.

12.15 Substitute and complementary factors:

When a change in the factor brings about a change in the use of other factors the two factors are substitutes. The change in the use of the substitutes is illustrated with the help of a diagram.



MN is the original cost line. Iq touches MN at E. E is the firm's equilibrium position. Assume price of X falls and price of y rises proportionately. X becomes cheap Y becomes costly. The new cost line is N_1M_1. N_1M_1 tauches Iq_1 at E_1. With the new price, OK_1 of Y and OL_1 of the X are made use of.

In case of perfect complements the factor proportion is fixed. The isoquant is L Shaped.

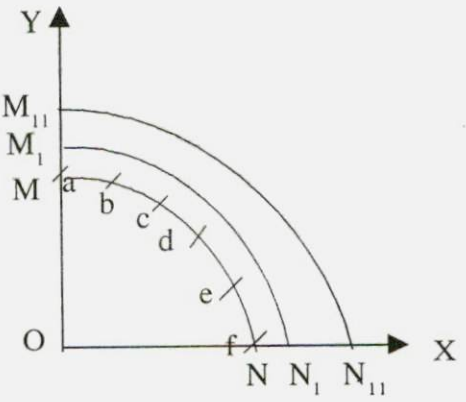
Check your progress 2

Write a note on

1. Oval shaped equal product curve.
2. Price factor curve.
3. Output expansion.

12.16 Multi product firm – choice of products:

When a firm product diverse produces, the firm produces joint products. It has to choose the proportion in which to produce its two or more products. This calls the help of production possibility curve. This is called transformation curve also.



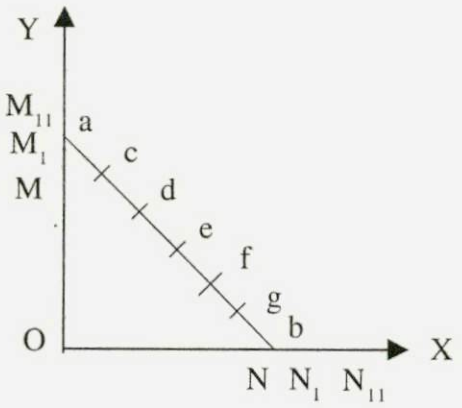
In the diagram ABCDEF are the various points of the transformation curve. If possibility A is chosen only Y can be produced and X cannot be produced. If F is chosen only X is produced and Y is not produced. A firm chooses one of the points on the transformation curve where both X and Y are produced. If more of X is produced. the output of Y is small and vicevarse.

The Production possibility curve is called product transformation curve. Because in moving from one point to another one product is transformed into another. With given resources being fully utilised the combination of two factors lies on the production possibility curve af. Production possibility curve shifts to the right when resources are found. The rate at which one product is transformed into another is called marginal rate of transformation. The marginal rate of transformation between X and Y is the amount of Y. sacrificed for the production of X. The sacrifice of Y for an additional

unit of X goes on increasing as the firm produces more of X and less of Y and vicevarse. The increasing marginal rate of transformation means the production possibility curve is concave to the origin. The slope of the curve indicates the rate of marginal transformation.

12.17 Factor Combination and Choice of output of Multi product firm.

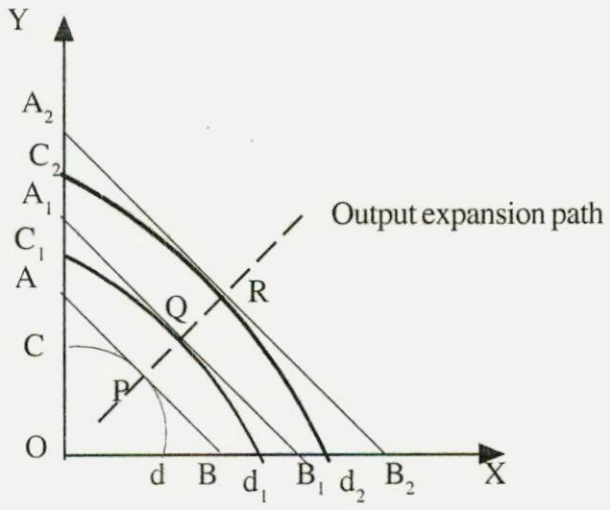
In order to understand the factor combination and choice of output by a multiproduct firm we have to make use of Isorevenue curve and Production posibality curve. An Isorevenue curve is defined as the locus of product combination that will earn the same revenue. An Isorevenue line consists of various combination of two products eg. X and Y. All the combination of X and Y found on the Isorevenue line yield same revenueto the firm. This can be shown in the diagram



In the diagram AB is the Isorevenue line. AB is made up of a number of product combinations of two products X and Y. When these product combinations are sold in the market the revenue earned is the same. If a firm producing multiproducts are given additional resources The isorevenue curves go on shifting to the right. Higher isorevenue curve means higher income. Different isorevenue lines show different levels of income. When factor prices are assumed to be constant the isorevenue lines run parallel & the slope of the isorevenue lines is equal to the ratio of the price of X and the price of y.

$$MRTS = \frac{PX}{PY} - \frac{MPY}{MPX}$$

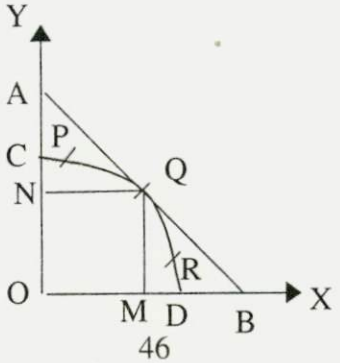
Output expansion path of a firm selling multi product can be explained with the help of a diagram.



In the diagram AB is the iso revenue line . CD is the production possibility curve given the resources. AB. CD is tangent to AB at P. when the resources of the firm are increased isorevenue curve is shifted to A^1B^1 and the production possibility curve also shift to C^1D^1. A further increase in the resources of the firm enables the firm to operate on the isorevenue curve $A_2$and B_2, the production possibility curve changes to C_2D_2. AB is tangent to CD at P. A^1B^1 is tangent to the C_1D_1 at Q. When the isorevenue curve A_2B_2. C_2D_2 is tangent at R. By joining the various tangent points P, Q, and R we get a curve called expansion output curve.

When firm chooses to sell multiproducts its aim is to maximise profits. Maximising profit of a firm depends on the ability of the firm to maximise its revenue. In diagram the isorevenue curves and production possibility curve are shown which enable the firm to choose the desired combinations of output . Let us assume that the firm chooses a combination represented by the position Q. Q is on isorevenue curve A^1B^1 which enables the firm to maximise revenue The revenue can be at maximum when the marginal rate of the transformation of X and Y on the given production possibility curve is equal to the given price ratio between the two products namely X, Y , . At Q the marginal rate of transformation of X and Y is equal to the price ratio between X and Y.

Maximisation of the revenue is explained with the help of a diagram.



In the diagram AB is the isorevenue curve. CD is the production possibility curve At Q on CD Marginal rate of the transformation of X for Y is absent . Suppose "P" is choosen . At "P" the marginal rate of transformation of X for Y is less than the given price ratio between X and Y. The revenue can be increased by moving from P to Q on CD line. At point R the marginal rate of the transformation of Y for X is more than the given price ratio between X and Y. The revenue can be increased if the firm moves from R to Q. Only at Q revenue is maximum where marginal rate of transformation of X and Y is equal to given price ratio. Q is on the highest isorevenue line under the given circumstances. Firm chooses to produce OM of product X and ON of product Y and its choice of product combination is found at Q.

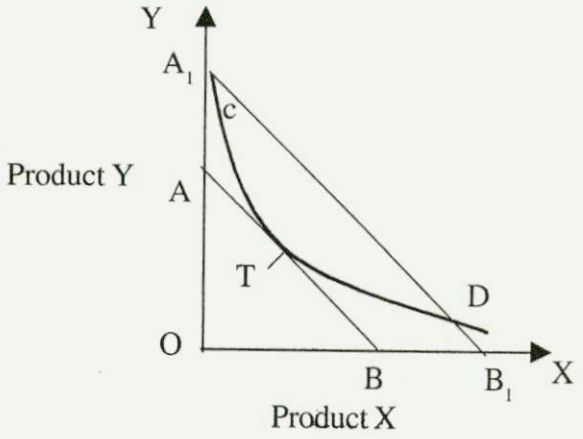
The choice of factor -output combination of a multiproduct firm can be expressed in geometric terms. The revenue is maximum where a given production possibility curve is tangent to the isorevenue line. Both P and R lie on a lower isorevenue line CD where Q lies. At tangent point Q marginal rate of transformations is equal to the price ratio since the slope of production possibility curve is equal to tangency point. At Q marginal rate of transformations of X for Y is equal to price ratio of X and Y . This can be written as MRT.

$$XY = \frac{PX}{PY}$$

The choice of combinations of out put and low cost of a multi product firm must full fil two conditions of equilibrium.

1. At the position of equilibrium $MRTXY = \frac{PX}{PY}$
2. Production possibility curve is concave from below.

Production possibility curve must be concave. otherwise the firms' revenue will be at the maximum not by producing one product but two. This can be explained with the help of a diagram.



In diagram CD is the Production possibility curve which is concave.

T is tangent to isorevenue curve AB. T does not yield maximum revenue given the production possibility curve CD. Because the movement along CD in either direction yield larger revenue than that received from the position T. Beside D is lying on A^1B^1 a higher isorevenue line than AB. The firm chooses D and likes to produce X instead of producing both X and Y. So when a production possibility curve is convex the firm cannot be a multiproduct firm but a firm producing only one product. Production possibility curve is convex only when the firm is subject to the operation of the law of increasing returns. The discussion carried out so far has enabled us to conclude that the attainment of equilibrium in case of a multi product firm is possible only when the marginal rate of transformation is equal to the given ratio between the two products and the production possibility curve is convex to the origin.

12.18 Let us Sum Up

Isoproduct curves represent production function with two variable inputs. They are firm's counterpart of consumer's indifference curve. They indicate various combinations of inputs which yield a specifed level of output. Isoproduct curve assumes a number of shapes. There are a few properties of isoquants and oval shaped isoquants help the firm to draw the boundary lines of production. Isoquants based on the assumption of diminishing rate of technical substitution helps the firm to decide about the least cost combination and the products to be chosen. Isoquants help to identify the equilibrium of a firm . They also help the firm to consider price effect-on factor usuage, technical substitution effect. A multi product firm decides about minimization of cost and the marginal rate of transformation.

12.19 Questions for self study

1. How does a firm determine the least cost combination of the factors of production ?

2. Explain output, and substitution effects of a fall in the price of one input.

3. How does a firm get an optimum combination of two outputs ? Illustrate your answer with suitable diagrams.

4. How does a multi product firm determine optimum combination of output at least combination of the factors of production ?

12.20 Books for self study

1. A. Koutsoyiannis - Modren Micro Economics.
2. G.S. Stigler – The theory of price
3. K.E. Boulding – Economic analysis Vol.1
4. Alfred marshall – Principles of Economics
5. Donald S. Watson – Price theory and its uses
6. Ferguson C.S. –Economic Theory

12.21 Key words

1. Isoquant:- It is locus of all combinations of two factors of production that yield the same level of output.

2. Linear Isoquant:- It indicates perfect substitution of the factors of production.

3. Kinked Isoquant:- It indicates limited substitutability of two factors of production

4. Marginal rate of technical substitution :- It is that quantity of one input which can be reduced on an increase in the use of another input by one unit to keep the level of production constant.

5. Multiproduct firm:- A firm producing diversified products.

Note

Unit 13: Production function and Multi-product firm

Unit 13: Production function and Multi-product firm

13.1 Objectives:

The study of this unit enables you to explain

- ⊡ Production function and Multi product firm
- ⊡ Share of factors of production as explained by Cobb-Douglas
- ⊡ Technological progress and production function

13.2 Introduction:

In this unit we are going to study production function of a multi product firm. We also study types of production function like Cobb Douglas model, Euler's theorem, translag production function in this unit.

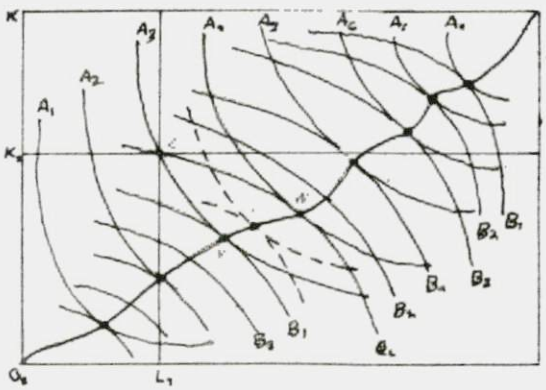
13.3 Multi product firm:

When a firm produces two or more products then a firm becomes a multi product firm. It is possible to extend the production function to a multi product firm. For simplification let us assume that a firm produces two products X and Y. Same analysis can be extended to any number of products.

X and Y are the products which are assumed to be produced by two factors L and K. So we can write the production function of X and Y.

$$X = F_1 (L, K)$$
$$Y = F_2 (L, K)$$

Each production funtion is presented by a set of isoquant with their usual properties. In order to get the production possibility curve of the firm we have to make use of Edgeworth box. Let us assume that the firm has total quantities of factors OL and OK measured along the sides of the Edgeworth box.



Edgeworth's contract curve

Any point of the Edgeworth box shows a certain combination of quantities of X and Y produced by the available factors of production. The production function for commodity X is represented by the set of isoquants denoted by A which are convex to the origin OX. The production function for commodity Y is represented by the set of isoquants denoted by B which are convex to the origin OY. If isoquants B lies down, it represents larger quantity of Y. The two sets of isoquants have a point of tangency which form the contract curve. Points lying on the contract curve are efficient. Any other point shows the use of all resources for producing a combination of output which includes less quantity of atleast one commodity.

Let us assume that the firm produces at point Z. At Z the quantity of X is A_3 and quantity of Y is B_6. The production of A_3 of X requires OxL_1 of labour and OxK_1 of capital. The remaining resources L_1L and K_1K are used in the production of commodity Y.

The firm can produce more of either X or Y or both commodities by reallocating its resources so as to move to any point between V and W on the contract curve. If the firm moves to W it will produce the same level of Y (B6) but a higher level of X(A_4). If the firm chooses to produce at V it will produce same quantity of X (A_3) but more of Y (B_7). If the firm produces at any intermediate point between V and W eg. at point C, it will attain higher levels of production of both X and Y. So points on the contract curve are efficient in that any other point off this curve implies a smaller level of output of atleast one product. The choice of the actual point off this curve implies a smaller level of output of atleast one product. The choice of the actual point on the contract curve depends on the ratio of the prices of two commodities.

13.4 Production possibility curve

It is necessary to derive the production possibility curve of the firm to determine the amount of X and Y that is likely to be produced. The production possibility curve shows the locus of points of level of X and Y which can be produced with the available resources of the firm. The production possibility curve is derived from contract curve. Each point of tangency between isoquants. i.e., any one point of the contract curve, defines a combination of X and Y levels of output which lies on the production possibility curve. For example point "V" represents the output pair A_3 from X and B_7 from Y. (This is correspond to V in the figure 2) (similarly point W of the contract curve is W^1 on production possibility curve in figure 2)

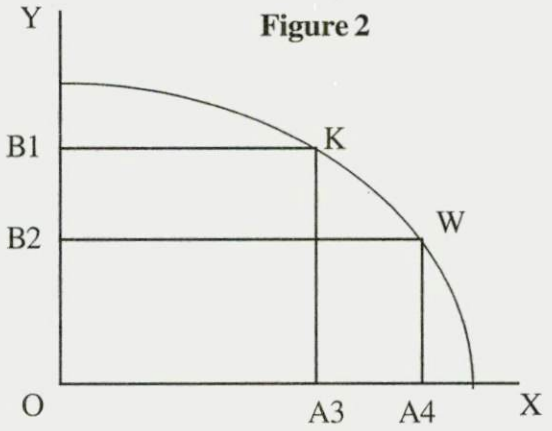
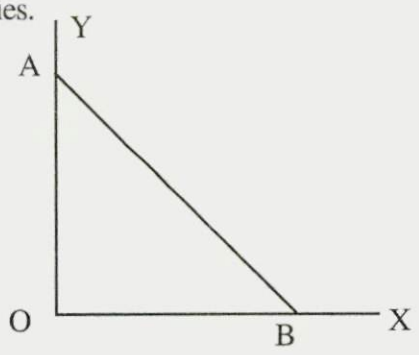


Figure 2

The optimal combination of the output pair is the one which yields the highest revenue when production function and resources are given. To find the equilibrium of a firm we have to consider isorevenue curve also.

13.5 Isorevenue curve

Isorevenue curve of the multi product firm indicates the sale yields of the firm. AB is the isorevenue curve. It is locus of points of various combinations of quantities of X and Y whose sale yields the same revenue to the firm. The slope of the isorevenue curve is equal to the ratio of the prices of same commodities.



13.6 Equilibrium of a multi-product firm

The multi product firm maximizes its profit given (a) the constraint of factors of production (b) transformation curve and (c) the prices of commodities of X and Y. and prices of the factors of production (w. r). Maximization of profit is achieved by maximizing the revenue R. The equilibrium of the firm is defined by the point of tangency of the given production possibility curve and the highest isorevenue curve. At the point of tangency the slope of the isorevenue and product transformation curves are equal.

Check your progress:

1. What is a multi product firm?
2. Explain Edgeworth contract curve.
3. Explain production possibility curve of a multi product firm.

13.7 Cobb-Douglas Production function

Cobb-Douglas production function was propounded in 1928. It is a linear homogeneous function. It was empirically tested in USA. The general form of Cobb-Douglas production function is

$$X = A\ L\ \alpha\ K\beta\ U$$

X is output, L is labour input , K = capital input, U = random disturbance term. A is a constant, α and β are positive parameters.

Marginal product of L factor is always α times its average product. Marginal product of K factor is always β times its average product. Cobb-Douglas production function indicates a proportionate change in output for a given change in capital and labour. The sum of α and β equals one. It governs the degree of homogeneity of production function. It measures the returns to scale.

Cobb-Douglas production function is a production function of constant elasticities. It assumes that the elasticity of substitution between capital and labour is constant. Income is distributed between these two variable inputs, labour and capital in this production function.

Assumptions:

There are some assumptions in this model.

a) Labour and capital are the two factors.
b) They are used with a constant degree of intensity.
c) Industry is subject to constant returns to scale.
d) Volume of working capital is given.
e) Technical progress is absent.
f) Elasticities of the production are equal to one. Relative share of capital and labour are constant.
g) The production function shifts in parallel to itself.
h) The time period is given.

Critical evaluation:

Cobb-Douglas production function has occupied a unique place in the literature of Economics. It is a simple production function which is used for homogeneity of the first order and is useful in monetary analysis. It indicates the relative share of factors of production. It is useful in the linear programming model of production in input output theory.

Cobb-Douglas production function is criticized on several grounds. K.J.Arrow, H.B.Chenery, B.S.Minhas and R.M.Solow are the main critics of Cobb-Douglas production function.

1. Cobb-Douglas production function considers only two factors of production, labour and capital. It is concerned with the manufacturing industry. It neglects the role of intermediary goods used and produced there in.
2. Land and working capital are assumed to be constant. This may not be true.
3. Constant returns to scale cannot be true in the long run. The economies and diseconomies of production are ignored.
4. It expresses output in physical units. It does not consider value added to production.
5. Assumption of perfect competition is far from reality.
6. Labour units are considered homogeneous which is not true.
7. Labour and capital are assumed to have elasticity of substitution which is equal to unity. It is not so.
8. The model disregards institutional factors while determining the relative shares of capital and labour.
9. Walter, examining Cobb-Douglas production function remarks "The cross section inter industry studies do not measure the production function and shed no light either on the marginal productivity theory or economies of scale". The cross sectional unit's results achieved under this production function are subject to the criticism of "indeterminacy of multi-collinearity.

Despite these criticisms Cobb-Douglas production function has its own place in the writings on production function.

13.8 Constant elasticity of Substitution of production function.

Constant elasticity of substitution production function is used for statistical testing. This production function assumes that the basic measure of the degree of substitution is called "Priori". Cobb-Douglas and Leontieff production functions are special cases of constant elasticity of substitution of production function.

C.E.S production function was derived from two groups of economists. K.J.Arrow, H.B.Chenery, B.S.Minhas and R.M.Solow belonged to one group and the other group consisted of Murray Brown and Decani. Studies made by Arrow and chenery assume that C.E.S. production function is below unity. The equation of this function is

$$X = Y\left\{Kc - a + \left(1 - K\right) N^{-a}\right\}_{d}^{-r} \quad d$$

X is output, C is capital, N is labour, XcN are variables, y, k, d, r are parameters, Y is a parameter of technological efficiency.

Assumption:

C.E.S production function makes certain assumptions.

1. Value of "a" determines the value of elasticity of substitution.
2. Marginal product is positive
3. MP curve should slope downwards.
4. Labour and capital are perfect substitutes. If the use of one is increased the use of another is reduced.

Limitations:

1. It is difficult to put into data.
2. Capital intensity cannot change without any limit.
3. An expansion in output is the effect of two forces, economies of scale associated with expansion in the scale of operation for a given technology and changes in technology given the scale of operation. CES production function fails to make a distinction between the two.
4. Prof. H.Uzawa has examined this function and concludes that it is difficult to generalize into n-factors of production.

5. According to CES function elasticity of substitution is variant to change in factors of production which is not proved by available statistics and data.

CES production function enjoys certain advantages over Cobb-Douglas production function.

1. CES represents a production function which explains all types of returns.
2. It covers a wide range of parameters like substitutability, efficiency etc.,

13.9 Euler's theorem.

This theorem assumes linearly homogeneous production function. According to this theorem total product is the aggregation of the marginal products of different inputs multiplied by their respective quantities. This relationship holds true for any values assigned to independent variables or different inputs. In other words under constant cost conditions total production will exhaust all factors of production available. All factors are paid their rewards. These rewards are equal to the value of their marginal products.

Euler's theorem explains the constant share of the factors of production. In Cobb-Douglas production function a and $(1-\alpha)$ show the elasticities of the two inputs namely X_1 and X_2. So α is defined as elasticity of input X. Thus

$$\alpha = \frac{\%\text{ change in output}}{\%\text{ change in labour } (X_1)} = \alpha \text{ (capital or } X_2 \text{ held constant)}$$

under perfect competitive conditions a firm employs labour (X_1) at a level where price paid to labour (PX_1) is equal to its marginal product. So $PX_1 = MPX_1$. Same is true in case of capital where $PX_2 = MPX_2$.

On a global level under a linearly homogeneous production, due to constant values of α, APX_1, MPX_1, MPX_2 and APX_2, the share of X_1 and X_2 in Q will remain unchanged. This is due to constant factor price and constant ratio of factors of production.

The theorem explains the relationship among average, total and marginal products. In case of a linearly homogeneous production function, average, marginal and total products of different inputs are related directly. Let us assume X_1 and X_2 are two different inputs. Total product is assumed to be the sum of total of marginal products of different inputs multiplied by their quantities. It is also assumed that average product of an input is equal to its marginal product.

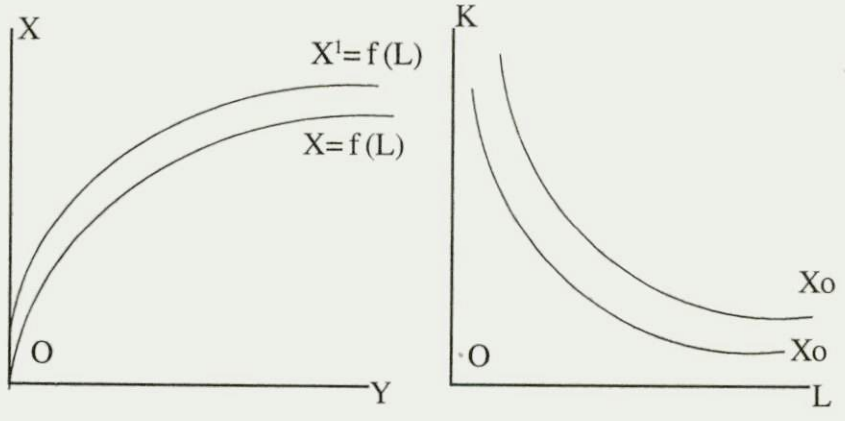
Check your progress

1. Examine important assumptions of Cobb-Douglas production function.
2. Point out the limitations of CES production function.
3. Outline Euler's theorem.

13.10 Technological progress and production function.

The use of new and more efficient methods of production results in the increase of the efficiency of all methods of production. At the same time same techniques may become inefficient and drop out from production function. These changes in technology constitute technological progress.

Graphically the effect of innovation in processes results in upward shift of the production function. Same output may be produced by less factor inputs or more output may be obtained with the same inputs.



Technical progress may also change the shape of the Isoquants. Hicks has distinguished three types of technical progress, depending on its effect on the rate of substitution of the factors of production function.

Capital deepening technical progress:

Technical progress is capital deepening if the marginal product of capital increases more than the marginal product of labour.

Labour deepening technical progress:

Technical progress is labour deepening if technical progress increases the marginal product of labour faster than the marginal product of capital.

Neutral technical progress:

Technical progress is neutral if it increases the marginal product of both factors by same percentage.

13.11 Let us Sum-Up

Production function of a multi product firm is explained with the help of Edge worth Box. It is also necessary to derive production possibility curve to know the quantity of product produced by a firm. In order to understand the equilibrium of a multi product firm it is necessary to know the Isorevenue curve and the production possibility curve. The tangency point of Isorevenue curve and production possibility curve is the equilibrium position.

Cobb-Douglas explained homogeneous production function and the share of income of capital and labour. It also explains cyclical changes. There are certain criticisms to this approach.

Constant Elasticity substitution production function is used for statistical testing. It also explains the share of labour and capital. Euler explains that at equilibrium rewards paid to factors of production are equal to the value of their marginal product. The unit explains the impact of technological progress on production function.

13.12 Questions for Self Study

1. Examine Cobb-Douglas production function.
2. Discuss constant substitution of elasticity of production function.
3. Write a note on technological progress and production function.

13.13 Books

1. Koutsoyiannis - Modern Micro Economics.
2. K.N. Prasad - Lectures on Micro Economic Theory.
3. H.R. Ahuja - Advanced Economic Theory.

13.14 Key words

1. Multi-product firm -firm producing more than one product.
2. Production possibility curve. It shows the various outputs that can be produced with the given resources.
3. Isorevenue curve - It shows the sale yields of a firm.
4. Capital deepening technical progress : It indicates that marginal product of capital is increasing more than marginal product of labour.
5. Labour deepening technology: indicates the growing increase of marginal product of labour.

NOTES

Unit 14: Traditional and Modern theories of costs

Unit 14: Traditional and Modern theories of costs

14.1 Objectives

This unit enables one to have a knowledge about

- ⊡ Various concepts of cost
- ⊡ Short run cost curves
- ⊡ Long run cost curves
- ⊡ Modern theory of cost

14.2 Introduction

Cost functions are derived function. In the previous units we have studied production function. Cost functions are derived from production function. We are aware that production function helps to explain the efficient methods of production at any one time.

In this unit we are going to study the behaviour of short run costs and longterm costs. Short run costs are the costs over a period during which some factors of production are fixed. (e.g., capital, natural resources, management etc). Long term costs are the costs over a period where all factors of production change. In the long run all factors are variable.

14.3 Concepts of cost:

Money cost: In order to understand the cost concept it is necessary to understand different types of cost. The widely accepted cost is the money cost of production. Money cost of production means aggregate money expenditure incurred by a firm on various inputs in order to produce a given volume of output. Money payments made in the form of wages, salaries, payments to purchase raw-materials, to buy power, payment of insurance and of transportation etc., are included in aggregate money cost. Money is spent on advertisement, spent on machinery, equipment etc. These are money costs and economists are interested in this cost.

Real cost: Real cost is another term used. Dr.Marshall says that exertion of all labour involves abstinence. Eg. Savings are the result of abstinence. Capital involves waiting. So Marshall says that efforts and sacrifices are the real cost of production of that particular commodity which is produced with the help of labour and capital. Real cost is important as a social cost but it is not significant in the determination of price. Prof. Henderson says that the doctrine of real cost is unreal and hypothetical.

Opportunity cost: Opportunity cost is another term used. It is also called alternative cost. The opportunity cost of any good is the next best alternative good that is sacrificed. Prof. Benham defined opportunity cost thus. "The opportunity cost of any thing is the next best alternative that could be produced instead by the same factors or by an equivalent group of factors costing the same amount of money".

Opportunity cost of anything is only the next best alternative sacrificed. All the factors used in the production of one good may not be the same as required for the production of next best alternative good. Robbins was referring to this concept while he was discussing the problem of economic choice. Eg. When resources are fully employed more of one good would be produced at the cost of producing less of the other.

Money value can be given to opportunity cost. In order to produce an output the producer has to employ a number of factors by paying them sufficient prices. The factors have alternative uses. The factors must be paid atleast that payment that they are able to obtain from their alternative uses. The total alternative earnings of the various factors employed in the production of a good will be the opportunity cost of that commodity.

Relative price of goods represent alternative costs. Resources will remain employed in the production of a particular good when they are paid atleast the money rewards that are sufficient to induce them to stay in the industry.

Implicit cost and Explicit cost:

Costs are divided into explicit cost and implicit cost. Capital invested by an entrepreneur in his business if it had been invested elsewhere would have earned him a certain amount of interest or dividend. A capitalist works in his business. If he had lent his services outside he would have earned an income. So an economist includes in his cost, the normal return on money capital invested by an entrepreneur in his business, which he would have earned if invested elsewhere. Wages or salary an entrepreneur would have earned if he had sold his services outside his business are calculated to include in cost. These costs are implicit costs. It is also called imputed costs. Contractual cash payments to land, labour, capital and organisation come under explicit cost. Implicit cost and explicit cost constitute economic cost.

Check your progress

Write a note on (with an example for each)

a) Opportunity cost.

b) Alternative cost.

c) Real cost.

d) Money cost.

14.4 The traditional theory of cost.

Traditional theory distinguishes between the short run and the long run. The short run is the period during which some factors are fixed e.g., capital equipment, entrepreneur. The long run is the period over which all factors become variable.

Total cost: In the traditional theory of the firm total cost is divided into total fixed costs and total variable costs. In other words

$$TC = T\,Fc + T\,Vc$$

Salaries to the administrative staff, depreciation of machinery, expenses for building depreciation and expenses on land maintenance etc., are fixed cost in the short run. Normal profit also comes under fixed cost.

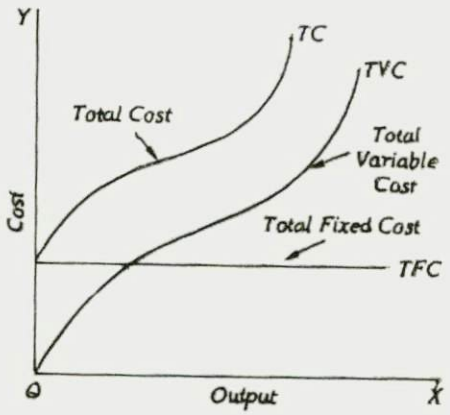
Short term variable costs include cost on raw materials, labour, the running expenses of fixed capital, such as fuel, repairs and maintenance.

Fixed cost and variable cost add up to make total cost. Fixed costs are independent of output. The fixed costs have to be incurred by a firm in the short run whether the output is small or large. Even if the business closes down for some time in the short run, the fixed costs are incurred. As long as a firm desires to be in business, fixed costs are incurred. Fixed costs are known as overhead costs. Variable costs change with changes in output. If a firm stops production for sometime variable costs are not incurred by the firm. Variable costs are called prime cost or direct costs.

14.5 Short term cost curve.

The study of cost curve in the short run calls for the study of the behaviour of total cost, average cost and marginal cost curve in the short period.

Koutsoyiannis sums up the behaviour of the various cost curve thus. The traditional theory of cost postulates that in the short run the cost curves (AVC, ATC & MC) are "U" shaped. These curves reflect the law of variable proportion. In the short run with a fixed plant there is a phase of decreasing productivity of the variable factor. There is a phase of increasing productivity also. Between these two phases of plant operation there is a single point at which the unit cost is minimum. At this point short term average total cost, the plant is fully used. This point indicates the optimal combination of fixed and variable factors.



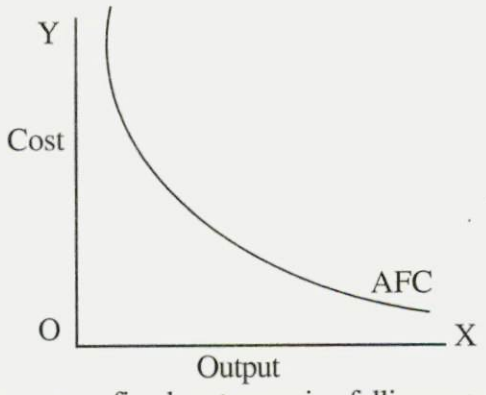
The cost of a firm is the sum of its total variable costs and fixed costs. Total cost changes only if fixed cost or variable cost changes or if both change. The total fixed cost is graphically a straight line parallel to output axis i.e. ox axis. TFC does not arise from the origin. It means that total fixed cost will be incurred even if the output is zero. Total variable cost rises from the origin. TVC in the traditional theory of cost has broadly an inverse "S" shape. It reflects the law of variable proportion. Accordingly at the initial stage of production as more of the variable factor is employed, its productivity increases and the average variable cost falls. This continues til the optimal combination of fixed and the average variable factors is reached. Beyond the point the productivity of variable factor falls. So TVC curve rises. By adding TFC and TVC we get TC curve which is having inverse "S" shape as shown in the figure. The vertical distance between the TVC curve and TC curve is constant through out. This is because the vertical distance between TVC and TC curve represent the amount of total fixed cost which remains unchanged as output is increased in the short run. It should be noted that the vertical distance between the total cost curve and total fixed cost curve represents the amount of total variable costs which increase with an increase in output.

14.6 Short run Average fixed cost curve

Average fixed cost is the total fixed costs divided by the number of the units of output produced. It can be expressed thus

$$AFC = \frac{TFC}{q}$$

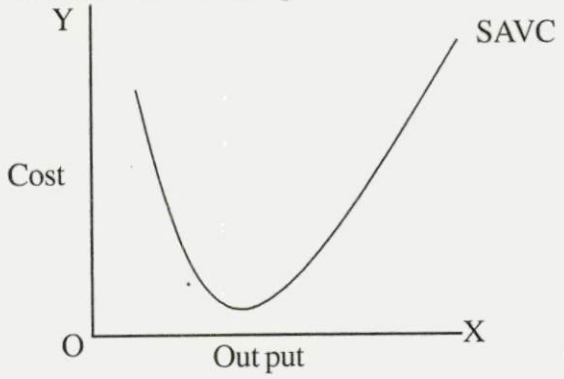
The average fixed cost curve is shown in the figure.



The average fixed cost curve is a falling curve through out its length. It looks like a rectangular hyperbola. The falling slope is the result of "spreading the overheads". In the short run AFC slopes downwards because fixed cost is distributed among larger number of output as output rises. AFC curve approaches both axis asymptotically. AFC curve gets very near but never touches either axis. Cairncross referring to short term fixed cost writes that the cost of producing a given output in the short run is what the firm could save by producing nothing. But producing nothing may still involve some fixed costs throughout. A curve with such a property is called hyperbola.

14.7 Average variable cost (short run)

The average variable cost is a "U" shaped curve. It is shown in the figure.



The curve reaches its minimum at the level at which a ray from the origin becomes tangent to total variable curve. According to Lester firms are subject to decreasing variable cost within 70 to 100 % of their capacities. The average variable cost generally falls as the output increases from zero to the normal capacity output. This happens because of the occurrence of increasing returns. But beyond the normal capacity output the average variable cost rises steeply. This is due to the operation of diminishing returns. So AVC falls first reaches a minimum and then rises.

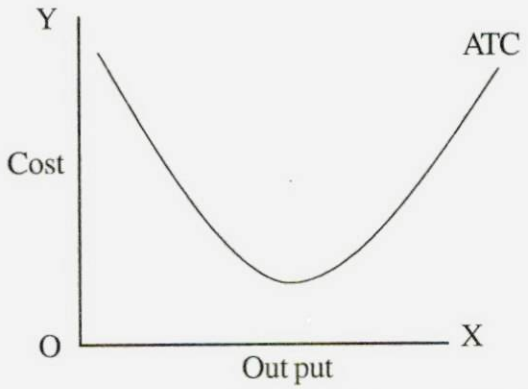
Average total cost is made up of Average variable cost and Average fixed cost. AFC becomes smaller and smaller as output expands. The vertical distance between AFC and AVC goes on reducing. When AFC curve approaches the x-axis the average variable cost curve approaches the average total cost curve.

AVC bears an important relationship with the average product per unit of the variable factor. AVC and average product vary inversely with each other. When average product rises in the beginning the AVC must be falling in the short run. When the average product of the variable factor falls the AVC must be rising. When average product is at the maximum AVC is at the minimum. AVC curve looks like the average product curve turned upside down. The minimum point of AVC curve corresponds to the maximum point of an average product curve.

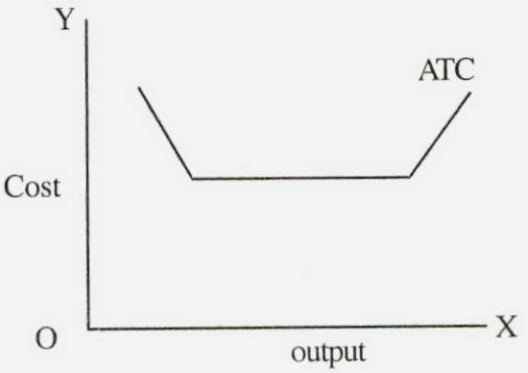
14.8 Short term average total cost.

The average total cost curve is "U" shaped. Average total cost is the total cost divided by total output. It is made up of average fixed cost and average variable cost. Average total cost is known as the unit fixed cost. It is the cost per unit of output produced.

The behaviours of average total cost depend on the behaviour of AFC and AVC. In the beginning AFC and AVC curve fall. ATC falls sharply in the beginning. When AVC curve falls ATC also falls. This is because the fall in AFC weighs more than the rise in AVC. As output increases further there is a sharp increase in AVC. This sharp rise offsets the fall in AFC. So ATC rises after a point. ATC like AVC falls first, reaches its minimum value and then rises. The ATC curve is "U" shaped.



If the production function is very flexible "U" shaped average cost is flat and shallow. A plant which is divisible and plant which works intermittently has flat bottomed "U" shape. It is in the form of a "Saucer".



14.9 Marginal cost

An addition of cost to the total cost caused by producing one more unit of output is called marginal cost. It is the addition to the total cost of producing n units instead of producing n-1 unit. n is a given number. Marginal cost can also be written thus

$$MC = \frac{\Delta TC}{\Delta q}$$

ΔTC is the incremental total cost.

Δq represents a change in output

Marginal cost is independent of fixed cost. Since fixed costs do not change there is no marginal fixed cost. In the short run when output is increased only variable costs affect marginal cost.

Marginal cost of production is closely related to the marginal product of the variable factor. Marginal cost varies inversely with the marginal factor of the variable factor. The marginal cost curve is "U" shaped as the marginal cost declines first, reaches a minimum and then rises. Haley commenting on the "U" shaped marginal cost has said that the conventional "U" shaped marginal cost curve is applicable to a case where plant is indivisible.

The shape of the marginal cost curve is determined by the law of variable proportion or the behaviour of the marginal product curve. Marginal cost is the expression of physical marginal product in marginal terms. There are three points to be noted in case of marginal cost.

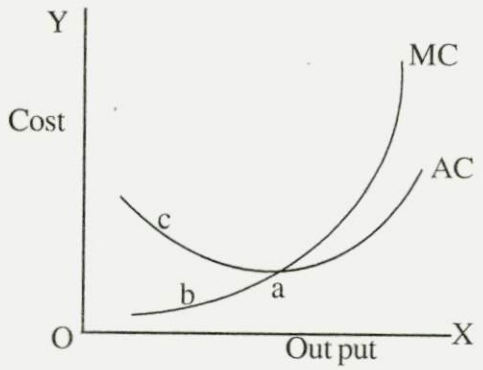
(a) Marginal cost is independent of fixed cost.
(b) The shape of the marginal cost curve is determined by the behaviour of marginal product of the variable factor.
(c) Price of variable factor remains constant when output is expanded.

Check your progress

1. What is total cost?
2. Explain Average Fixed cost.
3. Write a note on Average cost and marginal cost.

14.10 Relationship between average cost and marginal cost.

The marginal cost curve cuts the average cost curve at the lowest level.



If MC lies below AC as shown in the diagram MC pulls AC downwards. In the figure to the left of "a" MC lies below AC curve. So AC falls downwards. To the right of "a" MC curve lies above AC so that AC rises. At "a" AC has reached its minimum. MC cuts AC at its minimum point at "a".

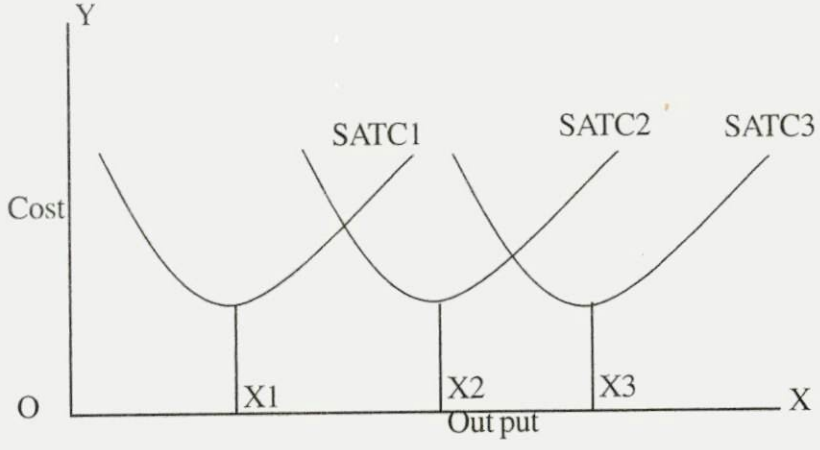
The changing average cost cannot indicate the direction in which marginal cost is moving. When AC is falling we cannot say MC is going to fall too. If AC is falling it can only be said that MC is going to be below AC. But it cannot be said whether MC is rising or falling. When AC is rising, MC must be above AC. MC be may, rising or falling. In the diagram upto b MC is falling and is below AC. Beyond b upto a MC lies below AC and AC is falling. Between "b" and "a" MC is rising. So when AC is falling it is not necessary that MC should also fall. A fall in AC can be seen if MC lies below AC.

14.11 Long run costs and traditional theory.

In the long run all factors are assumed to become variable. It is said that the long run cost curve is a planning curve. It is a guide to the entrepreneur in his decision to plan the future expansion of his output.

Long run average cost curve: In the long run a firm can vary output by changing the quantities of all factors used. None of the factors is fixed. All factors can be varied to expand output. The long run production function has no fixed costs. The size of output can be adjusted to the requirements by changing the scale of returns in the long run. The long run cost of production is the least possible cost of producing any given level of output. In the long run all inputs are variable including the size of plant.

The long run average cost curve reveals the scale of operation which generates minimum unit cost. "The long run average cost curve assumes that the scale of a firm and the rate of use of any plant factor are coordinated and simultaneously adjusted so as to produce any chosen output at the lowest possible cost", according to K.N.Prasad. With the help of a diagram we can understand long term average cost curve.

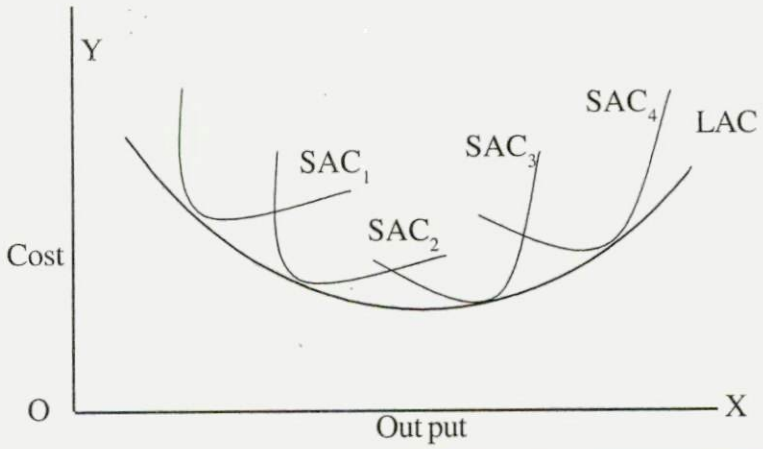


In the diagram there are three methods of production – namely $SATC_1$, $SATC_2$, $SATC_3$. These methods have different plant sizes, a small plant, a medium plant and a large plant respectively. If the firm chooses output X_1 it chooses a small plant $SATC_1$. If the choice of output is X_2 the firm chooses $SATC_2$. If the choice of output is X_3 the firm chooses $SATC_3$. Let us assume that the output is X_1 and the demand for x is increasing. The firm expands output upto OX_1 the cost is falling on $SATC_1$. Beyond X_1 the cost starts rising on $SATC_1$. If the demand reaches OX_2, the output can be increased on $SATC_1$ where costs are increasing. Then the firm decides to change the plant. It uses $SATC_2$, a medium size plant. The decision at this point depends on firms expectation about its future demand. If the firm expects a rise in demand to OX_2 the firm chooses $SATC_2$ and produces OX_2 on lower costs. Cost is OC_2.

In the long run the firm has a choice in the employment of a plant and it employs that plant which generates minimum unit cost for a given output. In the figure there are three sizes of plant. The long run AC curve has scallops in it. Long term average cost curve consists of some segments of all the short run average cost curves.

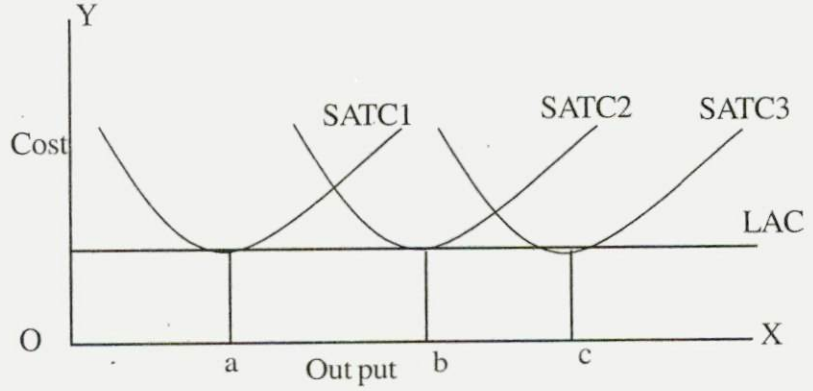
Let us assume that the size of the plant can be varied infintely. There are infinite number of plants corresponding to which there are numerous short run average cost curves. In that case long run average cost curve becomes smooth and continuous line without any scallops. The long run average cost curve is tangent to each of the short run average cost curves. The long run average cost curve is the lowest of all these tangency points of short term average cost curves and the long term curve. The long term cost curve consists of various points representing minimum costs for corresponding output. The firm chooses any of these, "U" shaped long run cost curves can be drawn as follows.

The "U" shaped LAC is also called "envelope curve". It envelops short run cost curves. The shape of the LAC reflects the laws of returns to scale. It must be noted that the point of tangency occurs to the falling plant of short run average cost curve for the point lying to the left of the minimum point of LAC. The point of tangency arises to the raising part of SACS for points lying to the right of the minimum point of LAC. The U shape of LAC is less pronounced than the U shape of SAC. The long run cost curve enables the firm to make decision about the size of plant and this choice depends on the experience of the firm or from the engineering studies undertaken by it. The envelope curve can be drawn thus.



14.12 Long run cost curve and constant costs.

If the production function is assumed to be linear and homogeneous and if the prices remain constant, the LAC remains constant at all levels of output. Linear production function assumes constant returns to scale. Under constant returns to scale an increase in inputs brings about a proportionate increases in output. Then LAC becomes a horizontal straight line as shown in the diagram.

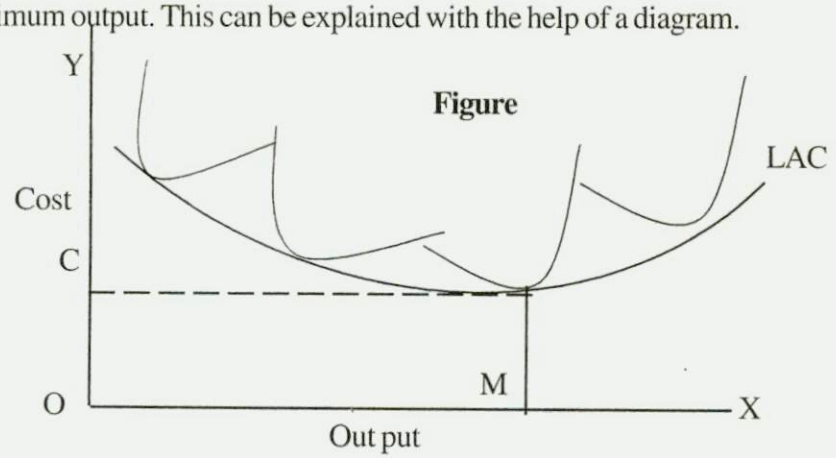


In the diagram long run cost curve is made up of three short term cost curves. All the three cost curves have the same minimum average cost of production although they represent different size of output. Under constant cost it is assumed that in the long run all the factors can be adjusted in such a way that the proportions between them always remain the optimum. Under the constant conditions different size of plants are used to produce different sizes of output although the average cost is the same. Eg Oa can be produced with a plant size of SAC_1, Ob can be produced with a plant size of SAC_2, Oc can be produced with a plant size of SAC_3. LAC under constant conditions become a horizontal line because of the absence of internal economies according to Kaldor; Mrs. Joan Robinson and Stigler. Internal economies are said to be absent because it is assumed that factors of production are perfectly divisible. But Prof. Chamberlin does not think that

perfect divisibility leads to the absence of internal economies. He rules out the possibility of constant returns to scale. He believes in division of labour and specialization which determine LAC.

14.13 Optimum output of a firm.

Short run cost curve cuts the long run cost curves at its minimum point. If the size of a plant is increased beyond the minimum cost the average cost rises. If the plant is below the minimum point of the long run cost curve then the average cost is high. The output at the low level cost is known as optimum output. This can be explained with the help of a diagram.



Figure

OM is the optimum point. An optimum firm produces optimum output. This output is produced at the minimum point of cost OC on the long run average cost curve.

Optimum size varies from industry to industry. An optimum size is small in agriculture, extractive industries, in wholesale and in retail trade. In these cases the minimum point on LAC is reached at a small output. In manufacturing industries transport and other public utilities, the minimum cost is reached at a large output.

14.14 "U" shape of LAC curve

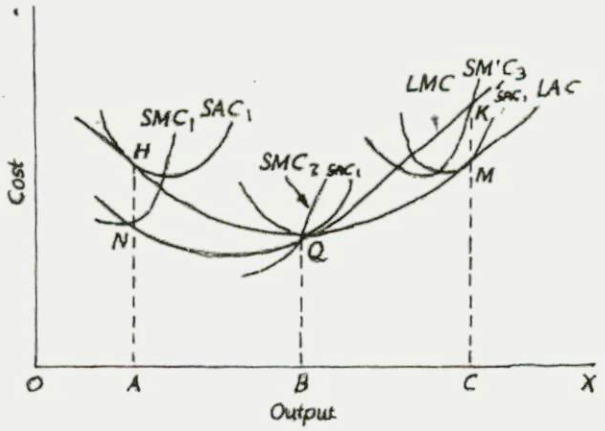
LAC is generally "U" shaped. The LAC first declines as output is increased and then beyond a certain point it rises. The shape of the long run cost curve is determined by the return to scale. If increasing returns to scale operates then the average cost falls as output is increased. If decreasing returns to scale operates then the average cost rises as output is increased. Under constant returns LAC remains the same. The three phases of returns are depicted by the "U" shaped cost curves. Increasing or decreasing returns to scale are due to the economies and diseconomies associated with expansion

of output. The decreasing shape of the cost curve is due to economies of scale and upward rising shape of the cost curve is due to diseconomies of scale.

14.15 Long run marginal cost curve

Long run marginal cost curve (LMC) is derived from long run total cost curve. LMC is derived from the slope of long run total cost curve corresponding to a given output. The derivation of LMC may be explained with the help of a diagram.

The firm is on LAC. The LMC is derived from short term marginal cost curves. But LMC does not envelop short term MC curves. The LMC is formed from points of intersection of short run MC curve with vertical lines drawn from the point of tangency of corresponding SAC_3 and LAC. The long run MC must be equal to short run MC for the given output. At this point SAC equals LAC.



In the figure three points are noted on SAC. They are a b c. a is the point where SMC = LAC. At a SAC = LAC. At point b SAC is greater than LAC. LMC is more than short run marginal cost. At b short run marginal cost is more than long run MC only at "a" LMC = SMC. If we draw a vertical line from a to x axis, the point at which the line intersects the SMC is a point of LMC. These vertical lines can be drawn from other short run cost curves and by joining the points intersection is got. LMC lies below LAC in the beginning, touches LAC at M and beyond M LMC lies above LAC.

LMC is "U" shaped. But LMC is flatter than SMC because LAC is flatter than SAC. The relationship between LAC and LMC are the same as SAC and SMC. When LMC lies below LAC, LAC is falling and when

LMC lies above LAC, LAC is rising. LMC cuts LAC at the minimum point on LAC.

Check your progress

1. Explain long term cost curve.
2. Examine long run cost courve under constant-cost condition.
3. Discuss LAC under constant cost condition.

14.16 Modern theories of cost

The "U" shaped cost curves of the traditional theory have been questioned by various writers both on theoretical a prior and on empirical grounds. In 1939 Stigler said that short run average variable cost has a flat stretch over range of output. This happens because firms build plants with some flexibility in their productive capacity.

The shape of the long run cost curve has attracted attention in economic literature. The long run cost curve is L shaped. This is because managerial diseconomies may be avoided, by improved method of modern management science. When diseconomies appear they are insignificant to economies of large plants. Empirical evidences also found "L" shaped long term cost.

LAC curve falls rapidly. After a point it becomes stagnant.

Empirical studies do not find "U" shaped LAC curve because technology has changed. A progress in technology shifts LAC downwards overtime. Learning by doing is another factor which causes LAC to slope downwards. Expansion bring efficiency and reduce cost. Prof. C.A.Smith has examined the issue of "L" shaped average cost curve. He said that in a big firm labour cost, assembly costs and distribution cost increase. So large plants are not set up in practice. He also said that empirical evidence cannot assess the cost situations. According to him it is not correct to say that costs stop to decline beyond a point when the size of plant is increased. Empirical evidences have failed to establish that costs do not rise beyond a point. So LAC is "U" shaped.

14.17 Fixed cost in modern theory

Modern theory considers both short term and long term costs. Short term cost is made up of fixed cost and variable cost. Fixed cost is made up of salaries paid to staff and other wear and tear of machinery expenses for maintenance of building, maintenance of land etc.

The planning of the plant consists in deciding the size of these fixed indirect factors. They set limits to its production. The businessman anticipates sales and decides the size of output. He produces that output efficiently. The plant will have a capacity larger than the expected average level of sales because businessman wants to create some reserve capacity.

Businessman wants to meet seasonal fluctuations in his demand, to meet this there will be reserve capacity in the plant.

Reserve capacity can help the businessman when the machinery breaks down.

It helps to meet the increased demand. All businessmen hope for growth. So there is always a reserve capacity which helps him to have some flexibility for minor alterations of his product in view of changing tastes of customers.

Technology makes it necessary to build up some reserve capacity. Some basic types of machinery have reserve capacity, which allows for flexibility in view of future growth in demand. Some machinery may be so specialized as to be available only to order which takes time. In such cases there will be reserve capacity.

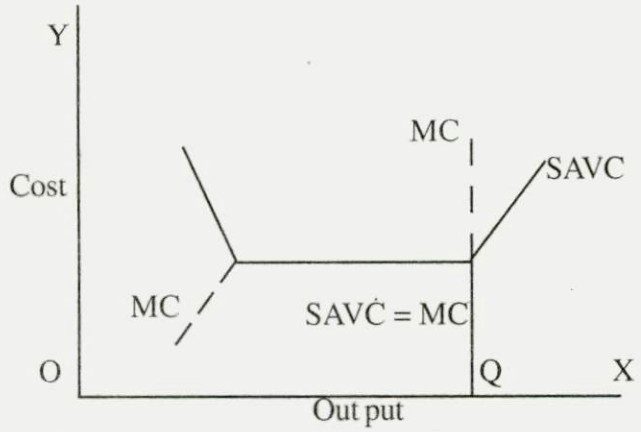
Some reserve capacity will be allowed in land and buildings in order to take up expansion in future. Even in case of organizational and administrative level there will be a reserve capacity. "In summary, the businessman will not necessarily choose the plant which will give him today the lowest cost, but rather that equipment which will allow him the greatest possible flexibility for minor alterations of his product or his technique".
[A. Koutsoyinnies "Modern micro Economics second edition P.117]

14.18 Average variable costs and modern theory

The average variable cost of modern theory includes the cost of

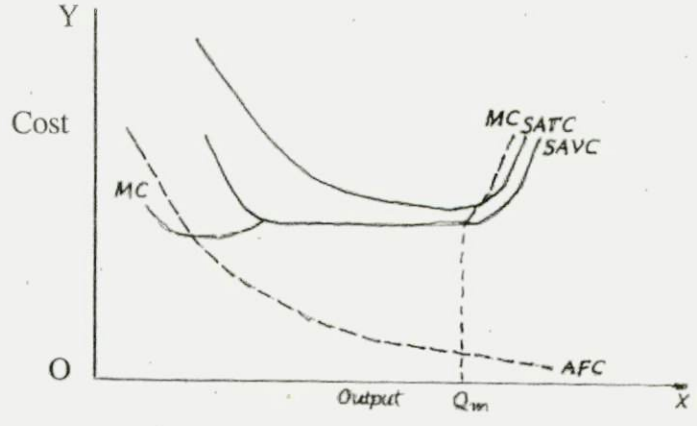
a) labour which varies with output
b) raw materials
c) running expenses of machinery

SAVC in modern theory has a saucer – type shape. It is broadly "U" shaped but it has a flat stretch over a range of output. This is shown as follows.



SAVC has a flat stretch over a range of output because of the built-in the plant, reserve capacity. Over this stretch SAVC = MC. On the left MC lies below SAVC. On the right MC lies above SAVC. The VC falls because of the better utilization of fixed factor and the consequent increase in skill and productivity of the variable factor. SAVC starts rising when labour productivity falls. It may be due to the longer hours of work, the increase in cost of labour due to overtime payment, wastes in materials and frequent breakdown of machinery. So SAVC curve has a flat stretch over a certain range of output. SAVC curve with a flat stretch is an innovation of modern micro economics. The flat stretch arises because of the built-in reserve capacity of the plant.

The average total cost in modern theory is the sum of AFC and AVC. SATC is shown thus in the modern theory.



ATC curve falls continuously upto the level of output OX_2. At OX_2 reserve capacity is exhausted. ATC starts rising, beyond this MC will intersect ATC at its minimum point at OX_2 output.

14.19 Long run cost and modern theory

Long run costs are distinguished into production cost and managerial costs. All costs are variable in the long run. They give rise to cost curve which is "L" shaped. The production cost falls continuously with increases in output. At very large scales of output managerial costs may rise. But the fall in production costs more than offsets the increase in managerial costs. So the total LAC falls with increases in scale.

14.20 Production costs

Production cost falls steeply to begin with and then gradually as the scale of production increases. The "L" shape of the production cost is explained by technical economies of large scale production. Initially these economies are substantial. After a certain level of output sometimes all of the economies are attained and the firm would have reached the minimum optimal scale, given the technology of the industry. If the new technology is introduced some economies are achieved.

a) Economies from further decentralization and improvement in skills.
b) Lower repair cost may be attained if the firm reaches a certain size.
c) The firm if it is a multi product may itself take up production of the material or equipment needed instead of buying from other firms.

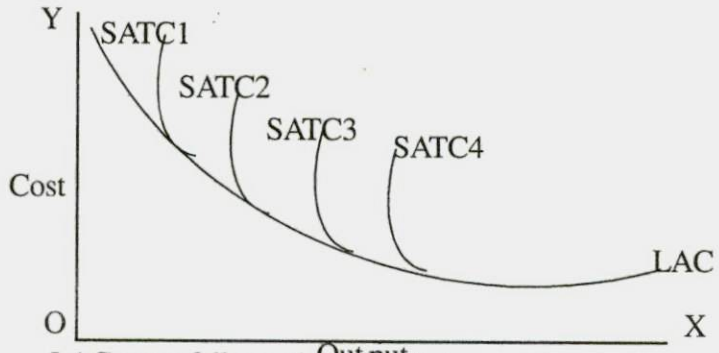
14.21 Managerial costs

For each plant size there is a corresponding organizational – administrative set up appropriate for the smooth operating of that plant. There are small scale and large scale organizational technique. The cost of different techniques of management first fall upto a certain plant size. At very large scales of output managerial costs may rise but very slowly.

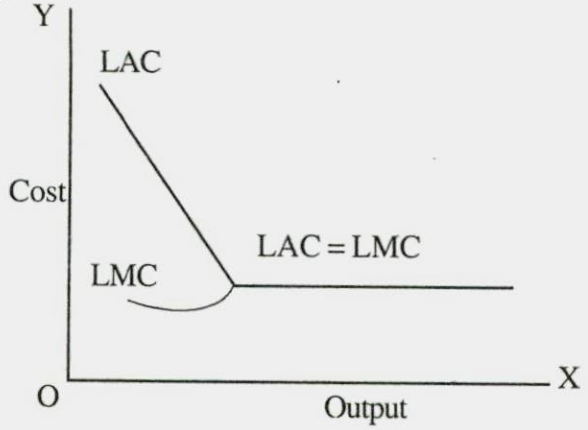
In the long run according to modern theory production costs fall smoothly at very large scales while managerial costs may rise only slowly at very large scales. It is accepted that a fall in technical costs offset the slow rise in managerial costs. So that LARC curve falls smoothly or remain constant at very large scales of output.

Modern theory of cost implies LAC as follows. For each short period there is short run total average cost (SRTC) which includes production administration and other fixed costs including normal profit. Assume there are four plant sizes. Their costs fall with output increasing (In business practice

a firm works normally if it works between 2/3 and ¾ of capacity).



LAC curve falls continuously. It does not turn up at very large scales of output. it is not the envelope of SATC curves. LAC intersects with SATC at the lowest point. If there is a minimum optimal scale of plant where the benefits of economies are reaped , beyond the point LAC remains constant. In this case LMC lies below LAC until the minimal optimal scale is reached and coincides with LAC beyond that level of output. LAC in this shape is realistic.



14.21 Derivation of costs from production function

Costs which are known as engineering costs are derived from engineering production function. Each productive method is sub-divided into sub-activities. These sub-activities correspond to production function. There may be various phases of production function. In each phase quantities of various factors are estimated. Cost for each phase is calculated. The cost is based on factor prices. The total cost of the particular method of production is the sum of the costs of its different phases.

Cost for different plant sizes are calculated. Production isoquants are subsequently estimated given the factor prices, the short-run and long-run cost functions are derived from them. They are generally production costs and not managerial costs.

Cost functions are derived from engineering costs. Engineering production functions are characterized by a limited number of method of production. Factor substitutability is not continuous but limited.

We can sum up the derivatian of cost curve from production function as follows. The production function determines the shape of a firm's cost curves. It shows the amount of inputs needed to produce a given level of output. A firm calculates its cost by multiplying the quantity of each input by its price and summing.

14.22 Derived demand for factors

Income of each factor is determined by supply and demand. Each firm's demand price for a factor is determined by supply and demand. Marshall has identified four rules in this regard. He considers constant returns to scale. He says that within an industry elasticity of demand for a factor varies directly with

1. The (absolute) elasticity of demand for the product, the factor produces.
2. The share of the factor in the cost of production.
3. The elasticity of supply of other factors.
4. The elasticity of substitution between the factor in question and other factors.

The elasticity of demand is made up of output effect and substitution effect. The output effect is the change which occurs if factor proportions are held constant. Output is changed in response to changes in its price. The substitution effect is the change which occurs if output is held constant but factor proportions are changed in response to factor price changes.

Marshall pointed out that the market demand for a factor is the sum of the demands from different industries. Each of these demands depends not only on production function but also on the demand for the industry's product and the supply of other factors of production.

14.23 Let us sum up

Cost functions are derived from production function. The behaviours of short term cost function and long term cost function are studied. Shapes of these cost curves are also studied. Some concepts of cost are studied here.

Important concept like average cost, marginal cost their inter relationships are discussed in this unit. Long term cost curve is discussed. Modern theory of cost questions U shaped cost curves. The modern theory believes in L shaped cost curve, and engineering cost is also discussed in this unit.

14.24 Questions for self study

1. Long run cost curve is an envelope of shortrun cost curves. Discuss.
2. Explain modern theory of cost.
3. Why are cost curves "L" shaped?
4. How are "cost" derived from production function?

14.25 Books

1. Ralph. T. Byrns and Gerald .W. Stone Micro economies
2. A.K. Sen - Micro-economics
3. Ahuja - Advanced economic theory.

14.26 Key words

1. Opportunity cost is the value of a resource in a fore gone employment.
2. Overhead cost is also known as fixed cost. It has to be incurved by a firm as long as it desires to be in business.
3. Average cost: It is obtained by dividing Tc by total output.
4. Marginal cost: An addition to total cost on account of an addition to total output.
5. Variable cost: Cost which is inccurred to pay wages, to buy raw materials etc

NOTES

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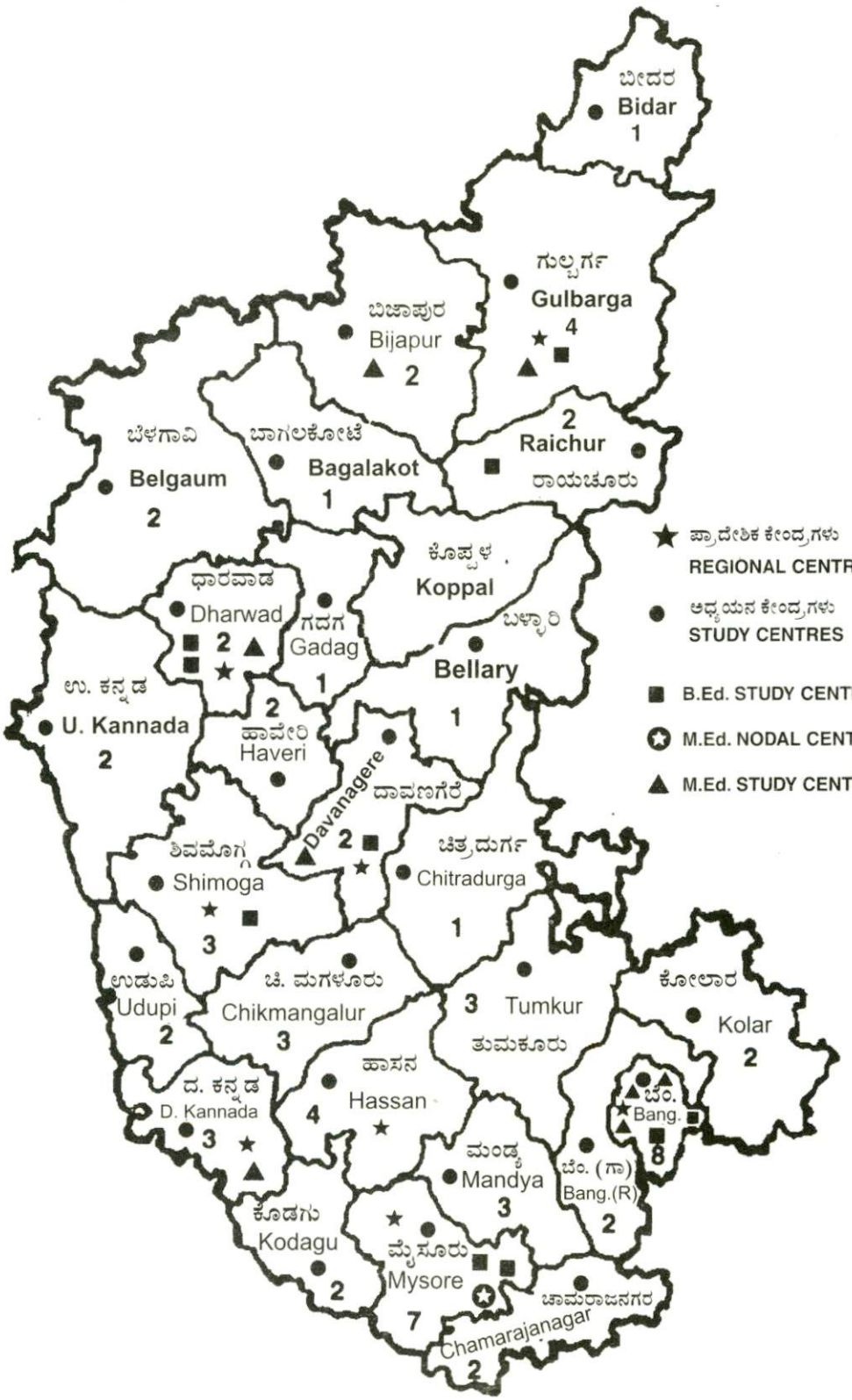

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