UNIT-III

THEORY OF PRODUCTION FUNCTION

PRODUCTION ANALYSIS

The term "production" means rising of crops or making of physical goods in factories. For example, if you make ice cream, you will say that you have produced ice- cream (goods). But from the point of view of Economics, you have not produced any new thing in the form of ice-cream; rather, you have changed the form of milk, sugar, cream, etc, and thus, have created the utility. Marshall is right to say, "Man does not produce physical (material) goods; but when it is said that he produces material goods, in fact, he only creates the utility. Even the scientists also agree that "Matter can neither be created nor destroyed." Thus, in Economics, the word "production" is used to imply creation or increasing the utility of a good so that its value is increased. Production theory is the study of production, or the economic process of producing outputs from the inputs. Production uses resources to create a good or service that are suitable for use of exchange in a market economy. This can include manufacturing, storing, shipping and packaging. There are three aspects of production

1. The quantity of the good or service produced.
2. The form of the good or service created.
3. The temporal and spatial distribution of the good or service produced.

Sno.	Definitions	Scientist
1	*"Production may be defined as the creation of utilities".*	***Anatol Murad***
2	*"Production is the process that creates utility in goods.*	***A.H. Smith***
3	*"Production is the creation of value in a commodity."*	***Thomas***
4	*"Production is the creation of economic utility "*	***Ely***
5	*"Production means an increase in the value of a commodity."*	***Nicholson***
6	*"Production is any activity which adds to the value of a nation's supply of goods and services."*	***M.J.UImer***
7	*"Production may be defined as the process by which inputs may be transformed into output"*	***Robert Awh***

In economics, a production function relates physical output of a production process to physical inputs or factors of production.

The production function expresses a functional relationship between physical inputs and physical outputs of a firm at any particular time period. The output is thus a function of inputs. Mathematically production function that related the maximum amount of output that can be obtained from a given number of inputs and can be written as

$$Q = f(A, B, C, D)$$

Where "Q" stands for the quantity of output and A, B, C, D are various input factors such as land, labour, capital and organization. Here output is the function of inputs. Hence output becomes the dependent variable and inputs are the independent variables. The above function does not state by how much the output of "Q" changes as a consequence of change of variable inputs. In order to express the quantitative relationship between inputs and output, Production function has been expressed in a precise mathematical equation i.e. Y= a+b(x)

Which shows that there is a constant relationship between applications of input (the only factor input 'X' in this case) and the amount of output (y) produced. Production analysis plays a pivotal role in managerial economics. It is concerned with the supply side of the market. It deals with physical terms of the product produced in a business firm. Production analysis relates physical output to physical inputs (factors of production). Production theory includes the analysis of production function with one variable input; production function with all variable inputs; and production function with two variable inputs. The production function with one variable input is otherwise known as *the law of variable proportions.* The production function with all variable inputs is otherwise known as *the laws of returns to scale.* The production function with two variable inputs is otherwise known as *production function through isoquants.* The main aspects dealt with under production analysis are: production functions, returns to scale, isoquants, economies and diseconomies of scale.

FACTOR OF PRODUCTION

The fundamental tasks of a firm are the production. Economists describe this task with the production function, an abstract way of discussing how the firm gets output from its inputs. It describes, in mathematical terms, the technology available to the firm. For the production of wheat, you require land, workers, tractor, tube well, seeds, pesticides, favorable climatic conditions and fertilizer, etc. All these are called the means of production or inputs. With the help of these, we get the output or production. Firms use the production function to determine how much output they should produce given the price of a good, and what combination of inputs they should produce given the price of a good, and what combination of inputs.

Sno.	Definition	Scientist
1	*"The sources of services which enter into the process of production are called factors of production. The factors are broadly classified as land, labour, capital, organisation and enterprise*	M J Ulmer
2	*"In a sense, only nature and man are the two sources of production-"* Benham has rightly remarked, *"Factors of production are neither two nor four but millions."*	Dr Marshall
3	*"The production function is the Technical relationship telling the maximum amount of output capable of being produced by each and every set of specified inputs. It is defined for a given set of technical knowledge."*	Mr *Samuelson*
4	*"The production function is the name given to the relationship between the rates of input of productive services and the rate of output of product. It is the economist's summary of technical knowledge.*	Mr Stigler

Production is the transformation of inputs into outputs. Inputs are the factors of production -- land, labor, and capital -- plus raw materials and business services. The transformation of inputs into outputs is determined by the technology in use. Limited quantities of inputs will yield only limited quantities of outputs. The relationship between the quantities of inputs and the maximum quantities of outputs produced is called the "production function."

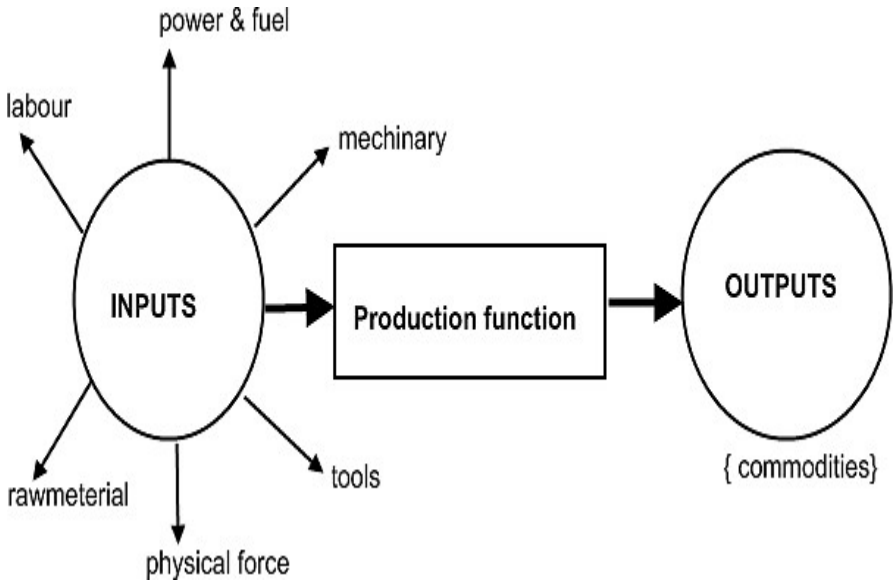
But according to moden economists and for the sake of simplicity, there are four factors of production namely: (i) land (ii) labour (iii) capital (iv) organization and enterprise. Modem economists call all these factors as Input or resources, as under;

1. **Land:** Land is that factor of production which is freely available from nature. In it, not only on the surface of soil is included, but also all other free gifts of the nature below the surface and above the surface are included; for example, forests, minerals, fertility of soil, water, etc. According to Marshall, "Land means *the material and the forces which nature gives freely for man's aid, in land and water, in air, light and heat."* Land is also called a natural resource. Using land for industrial purposes allows nations to improve the production process for turning natural resources into consumer goods.

2. **Labour:** Labour is a human factor of production and represents human capital available to transform raw or national resources into consumer goods. In it all those mental and physical activities of man are included which are performed in order to earn money. The services of a carpenter, black-smith, weaver, teacher, lawyer and doctor, etc., are called labour.

3. **Capital:** Capital can represent the monetary resources companies use to purchase natural resources and other capital goods. Monetary resources flow through a economy as individual and companies use when the production of goods or services. Capital also represents the major physical assets individuals and companies use when production of goods or services. These assets include buildings, production facilities, equipment , vehicles and other similar items. Individuals may create their own capital production resources, purchase them from another individual or business or lease them for a specific amount of time from individuals or other businesses.

4. **Entrepreneurship:** Is considered a factor of production because economic resources can exist in economy and not be transformed into consumer goods. Entrepreneurs usually have an idea for creating a valuable good or service and assume the risk involved with transforming economics resources into consumer products. Also considered a factor of production since someone must complete the managerial functions of gathering, allocating and distributing economic resources or consumer products to individuals and other businesses in the economy.



In a general mathematical form, a production function can be expressed as:

$$production\ function \quad Q = f(LB, L, K, M, T, t)$$

- *Q=output/quantity*
- *LB = Land & Buildings.*
- *L = Labour.*
- *K = capital.*
- *M = raw material.*
- *t= time.*

IMPORTANCE OF PRODUCTION FUNCTION:

Micro Economics has both theoretical and practical importance. From the theoretical point of view, it explains the function of a free intense economics it tells as how consumer and producer take the decision for millions of goods and services to consume and produce. It tells us how goods and services distributed among them. It explains the determination of the relative prices of various goods and services. For Practical importance micro economics helps in the formulation of economics policies calculated to promote efficiency in production and welfare of the masses. In professor Lerner's words Micro Economics theory facilities the understanding of what would be a hopelessly complicated confusion of billions of facts by constructing simplified model of behaviors.

LAWS OF RETURNS

Production analysis in economics theory considers two types of input-output relationships.
1. When quantities of certain inputs, are fixed and others are variable and

2. When all inputs are variable.
These two types of relationships have been explained in the form of laws.
i) Law of variable proportions

ii) Law of returns to scale

When there is increase in the production, we normally increase the labor rather than the machinery. The more labor employed in the production process; there will be raise in the production. But continues increase in the labor may lead to decrease in the production after certain point. Here comes the question. How many employees should be employed to get maximum production? Law of variable proportion answers the question of the employment of labor for optimum production.

Law of variable proportions: One Factor Fixed and others Variable

The law of variable proportions which is a new name given to old classical concept of "Law of diminishing returns has played a vital role in the modern economics theory. In economics, the production function with one variable input is illustrated with the well-known Law of Variable Proportions. The law of variable proportion is one of the fundamental laws of economics. It has also been called as the *Law of Diminishing Marginal Returns.*

Assume that a firms production function consists of fixed quantities of all inputs (land, equipment, etc.) except labour which is a variable input when the firm expands output by employing more and more labour it alters the proportion between fixed and the variable inputs.

One Factor Fixed and others Variable

Law of variable Proportion shows the inputs-output relationship or production function with one factor variable while other factors of production are kept constant. Suppose a farmer has 20 acres of land to cultivate. The land has some fixed investment, capital on it: a tube well, farm house and farm machinery. They farmer can, however, vary the number of men to be employed on its cultivation. Labour is thus the variable factor. The change in the number of men will change the output.

Law of Eventually Diminishing Returns, i.e., Marginal Returns only Eventually Declining:

The point worth noting is that the law does not state that each and every increase in the amount of the variable factor employed in the production process will yield diminishing marginal returns. It is possible that initial increases in the amount of variable factor employed in the production process may yield increasing marginal returns. However, in increasing the amount of the variable factor employed, a point will be reached where the marginal increases in total output will begin declining or marginal return will begin declining.

Assumptions

1. *Constant technology.* If technology changes. Marginal and average product may rise instead of diminishing.
2. *Short Run.* The law operates in the short run because it is here that some factors are fixed and others are variable. In the long run, all factors are variable.
3. *Homogeneous Input.* The variable input as applied unit by unit is homogeneous or identical in amount and quality.
4. It is possible to use various amounts of a variable factor on the fixed factors of product.

The law can be stated as follows:

"When total output or production of a commodity is increased by adding units of a variable input while the quantities of other inputs are held constant, the increase in total production becomes after some point, smaller and smaller".

S.no	Definition	Economist
1	"If equal increments of one input are added, the inputs of other production services being held constant, beyond a certain point the resulting increments of product will decrease i.e. the marginal product will diminish"	**G. Stigler**
2	"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 that factor will diminish"	**F. Benham**

The law of variable proportions refers to the behaviour of output as the quantity of one Factor is increased Keeping the quantity of other factors fixed and further it states that the marginal product and average product will eventually do cline. This law states three types of productivity an input factor – Total, average and marginal physical productivity.

Assumptions of the Law: The law is based upon the following assumptions:

i) The state of technology remains constant. If there is any improvement in technology, the average and marginal out put will not decrease but increase.

ii) Only one factor of input is made variable and other factors are kept constant. This law does not apply to those cases where the factors must be used in rigidly fixed proportions.

iii) All units of the variable factors are homogenous.

S.No	**Definition**	**Economist**
1	The law of variable proportions states that if the input of one resource is increased by equal increments per unit of time while the inputs of other resources are held constant, total output will increase, but beyond some point the resulting output increases will become smaller and smaller.	Leftwitch
2	The law states that an increase in some inputs relative to other fixed input will, in a given state of technology, cause total output to increase; but after a point the extra output resulting from the same addition of extra inputs is likely to become less and less."	Samuelson

This law of variable proportion shows the input and output relationship with **one variable factor**. e.g. labor

Number of labour	Total output or total returns (acres)
0	0
1	2
2	6
3	9
4	10
5	10
6	9

Solution:

From the above given data, we should find out the average production and the marginal production.

$$\boldsymbol{average\ product} = \frac{total\ output}{number\ of\ labour}$$

$$\boldsymbol{marginal\ product} = difference\ between\ total\ product\ by\ increase\ in\ labour.$$

Number of labour {a}	Total output or total returns (acres) {b}	Average output or average returns in (acres) {b/a =}	Marginal output or marginal returns [additional output]
0	0	0	0
1	2	2	2
2	6	3	4
3	9	3	3
4	10	2.5	1
5	10	2	0
6	9	1.5	-1

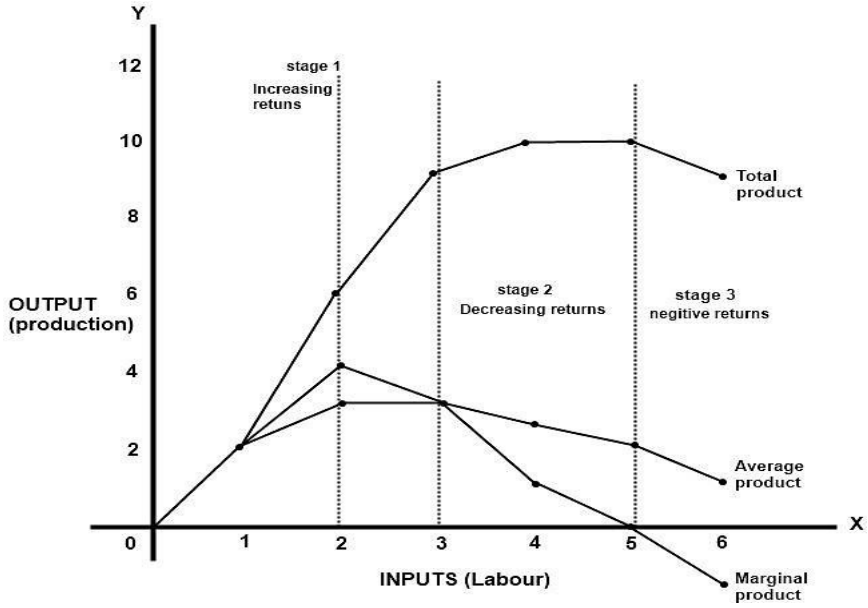
Points to remember:

1. Point out the maximum value in the marginal production Colum.
2. Point out the maximum value relating to the marginal production value in the average production Colum.
3. At this intersection point indicates best number of employees employed to have the maximum production.

3 stages of the production with Graph analysis:

(Stage 1): The maximum value of the marginal product is at 4 and maximum value of the average product relating to the marginal product Colum is 3. This is intersection point where the maximum 6 units of production can be done by employing 2 labors. Up to this point it is called as increasing returns stage.

(Stage 2): when we employee more than 2 labors ie. 3 labors total production is raising but the marginal production is falling down from 4 to 3 and average product is nearly same. So this stage is stated as



decreasing returns to the production.

(Stage 3): at 6 labors employed the marginal production is -1 units and the curve is cutting the X axis and moving down to the negative position. Hence this stage is stated as the negative returns in the production.

Three Stages of Production

The total, marginal and average product curves in demonstrate the law of variable proportions. The figure also shows three stages of production associated with Law of Variable Proportions.

Total product curve is divided into three segments popularly known as three stages of production as under:

Stage I

(1) Stage I is the segment from the origin to point, X2.

(2) At this point (, X2), the marginal product of X equals its average product.

(3) X2 is, of course, also the point at which the average product is maximized.

(4) In this stage, the production function is characterized first by increasing marginal returns to the variable factor from the origin to point X1 and then by diminishing marginal returns, from X1 and X2.

(5) In stage I, it is not correct to understand that only increasing marginal returns take place. For upto a point, increasing returns and thereafter diminishing returns take place. Stage I should not, therefore, be identified with increasing marginal returns only.

Stage II

The second stage lies in the range from X2 to X3. In other words, Stage II begins where the average product of the variable factor is maximized and continues to the point at which total product is maximized and marginal product is Zero. This stage is characterised by diminishing returns to the variable input over its entire range. That is, although total product is increasing in this range, it does so at

a continuously decreasing rate.

Stage III

Finally, we have Stage III, the area beyond X3 where the total product curve starts decreasing. In this range, the marginal product of the variable factor is negative.

Stage II is Rational

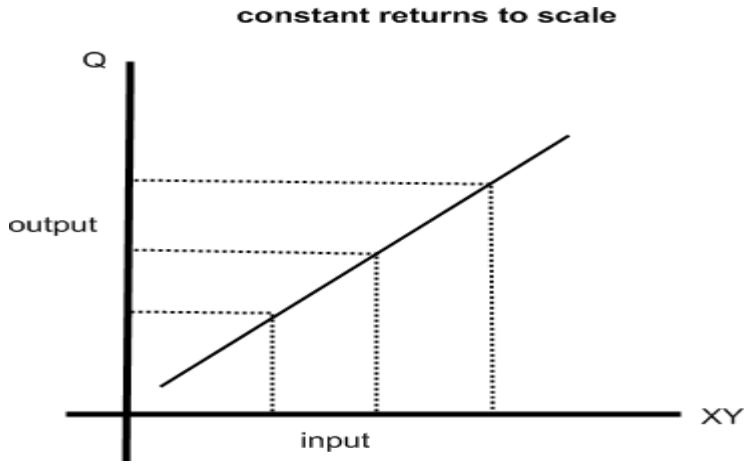
Only stage II is rational which means relevant range for a rational firm to operate. For no firm will choose to operate either in Stage I or Stage III; in Stage I, it is profitable for the firm to keep on increasing the use for labour and in Stage III<MP in negative and hence it is inadvisable to use additional labour. The firm, therefore, has a strong incentive to expand through Stage I into Stage II.

Stages I and III are Irrational

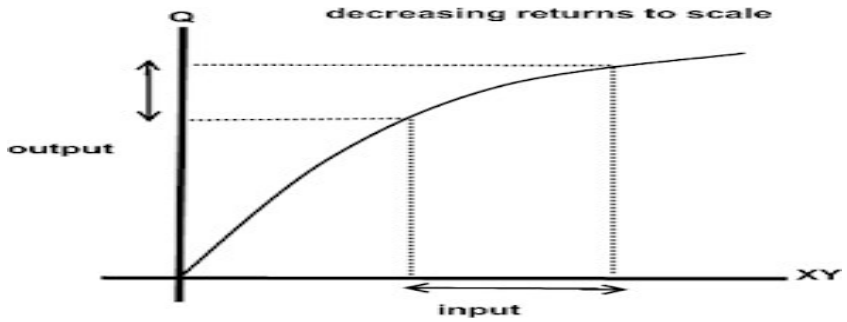
Stages I and III are described as irrational in that management if it is to maximize profits will never knowingly apply the variable to the fixed factors in any combination which will yield a total product falling in either of these two stages.

Constant Returns to Scale

Law of Constant Returns to Scale When the scope for division of labor gets restricted, the rate of increase in output remains constant, the law of constant returns to scale is said to operate. This law states that the increase/decrease in volume of output is same to that of rate of increase/decrease in inputs.



Law of Decreasing Returns to Scale Where the proportionate increase in the inputs does not lead to equivalent increase in output, the output increases at a decreasing rate, the law of decreas- ing returns to scale is said to operate. This results in higher average cost per unit. output (production) increases than the proportionality with input increases, we have decreasing returns to scale



All factors of production (land, labor and capital) have been doubled. There is 100 percent increase in the factors of production whereas output has increased from 10 units to 15 units, which is less than double. There is an increase in output by 50%. It means increase in all inputs leads to a less than proportional increase in the output of the firm. Here diminishing returns to scale are operating. Diminishing returns to scale is achieved in those activities involving natural resources such as growing agricultural products. These laws can be illustrated with an example of agricultural land. Take one acre of land. If you till the land well with adequate bags of fertilizers and sow good quality seeds, the volume of output increases. The following table illustrates further:

Capital (in units)	***labour (in units)***	***Percentage of Increase in both both inputs***	***Output (in units)***	***Percentage of Increase in output***	**Laws *applicable***
1	3	-----	--------	------	
2	6	100	120	140	Law of increasing returns to scale
4	12	100	240	100	Law of constant returns to scale
8	24	100	360		Law of decreasing returns to scale

From the above table, it is clear that with 1 unit of capital and 3 units of labour, the firm produces 50 units of output. When the inputs are doubled two units of capital and six units of labour, the output has gone up to 120 units. (From 50 units to 120 units). Thus, when inputs are increased by 100 percent, the output has increased by 140 percent. That is, output has increased by more than double. This is governed by ***Law of Increasing Returns to Scale.***

When the inputs are further doubled that is to 4 units of capital and 12 units of labour, the output has gone up to 240 units, (from 120 units to 240 units). Thus, when inputs arc increased by 100 per cent, the output has increased by 100 per cent. That is, output also has doubled. This is governed by ***Law of Constant Returns to Scale.***

When the inputs are further doubled, that is, to 8 units of capital and 24 units of labour, the output has gone up to 360 units, (from 240 units to 360 units). Thus, when input are increased by 100 per cent, the has increased only by 50 per cent. This is governed by ***Law of Decreasing Returns to Scale.***

PRODUCTION OPTIMIZATION

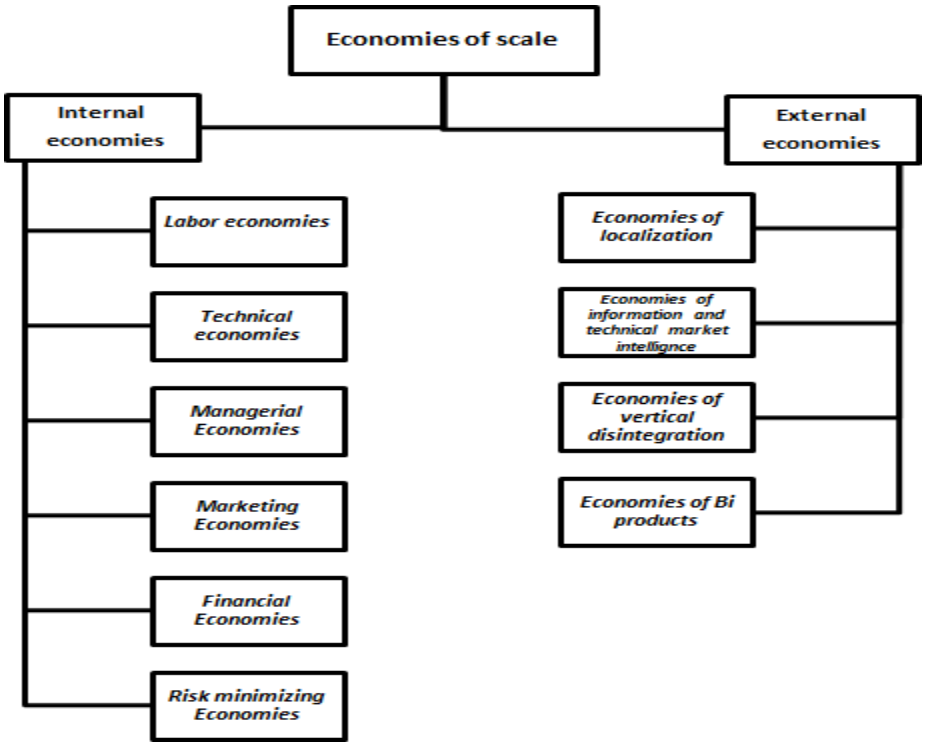
Production Optimization refers to the various activities of measuring, analyzing, modelling, prioritizing and implementing actions to enhance productivity of a field: reservoir/well/surface . Production Optimization is a fundamental practice to ensure recovery of developed reserves while maximizing returns. Production Optimization it is the practice of making changes or adjustments to a product to make it more desirable. It is possible to optimize a product by making minor adjustments. Typically the goal is to make the product more desirable and to increase marketing metrics such as purchase Intent, believability, frequency of purchase, etc .The product optimization is beneficial for companies in various ways like cost of manufacturing will drop, more desirable, more profitable, make more no. of products, compete with competitors.

LEAST COST COMBINATION OF INPUTS,ISOQUANTS

Economies of scale arise when the **cost per unit falls as output increases**. Economies of scale are the main advantage of increasing the scale of production and becoming 'big'.When we produce in large quantities generally the production cost reduces. It is the general principle everybody knows. Reduction in the cost of production, when output (production) is increased is

called as **economies of scale**. Large scale of production is economical than small scale of production. Increase in returns to scale (reduction of cost by producing more goods) are caused by real economies, which are classified under

Economies of scale is classified as



ISOQUANTS:

Production function using 2 variable inputs is explained with the help of the **Isoquants.** In economics, an **isoquant** (derived from quantity and the Greek word **iso** [equal) and Latin word quants meaning 'quantity'. The isoquant therefore called as the "Equal Product Curve" or can be named as the "indifference curve". As isoquant curve can be defined as the locus of points representing various combinations of two inputs capital and labor yielding the same output. In economics, an **isoquant** is a contour line drawn through the set of points at which the same quantity of output is produced while changing the quantities of two or more inputs.

Sno.	Definition	Scientist
1	*"An isoquant is a curve showing all possible combinations of inputs physically capable of producing a given level of output"*	**Ferguson**
2	*"An isoquant curve may be defined as a curve showing the possible combinations of two variable factors that can be used to produce the same total product"*	**Peterson**

The term Isoquant or Iso-product is composed of 'iso' implying equal and 'quant' implying quantity or product or output. Thus it means equal quantity or equal output. Different factors are needed to produce goods. These factors may be substituted for one another. For example 100 watches may be produced with 90 units of capital and 10 units of labour. The same number of watches (100 units) may also be produced with such combinations as 60 units of capital and 20 units of labour or with 40 units of capital and 30 units of labour. If different combinations of two factors yielding equal amount of total output are diagrammatically presented in the form of a curve, then such a curve is called on Isoquant or Iso-product curve. Thus isoquant curve is that curve which shows the different possible combinations of two factor inputs yielding the same amount of output. Isoquant curves are also known as Equal product or Iso- product or Production Indifference Curves. Isoquant curve is called production indifference curve since it is an extension of indifference curve analysis from the theory of consumption to the theory of production. An isoquant shows that if the firm has ability to substitute between the two different inputs (labour and machines) in order to produce the same level of output

Main Properties of Isoquants

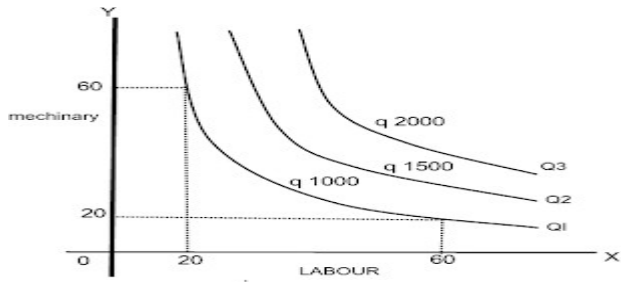
1. An isoquant is downward sloping to the right, i.e., negatively inclined. This implied that for the same level of output, the quantity of one variable will have to be reduced in order to increase the quantity of other variable.
2. A higher isoquant represents larger output. That is, with the same quantity of

one input and larger quantity of the other input. Larger output will be produced.

No two isoquants interest or touch each other. If two isoquants intersect or touch each other, this would mean that there will be a common point on the two curves; and this would imply that the same amount of two inputs can produce two different levels of output (i.e., 400 and 500 units) which is absurd.

3. Isoquant is convex to the origin. This means that its slope declines from left to right along the curve. In other words, when we go on increasing the quantity of one input say labour by reducing the quantity of other input say capital, we see that less units of capital are sacrificed for the additional units of labour.

Returns to Scale



By the isoquant curve we came to know that if we want to produce certain quantity of good (q=1000) ie 1000 goods, we can employee more labour and we can use less machinery. In the same way for the same output that is (q=1000) we can use more number of machinery and we can employee less number of labour in the firm for production of same quantity. Here according to the budget and the financial position of the firm the producer can switch between the alternative production systems.

Eg: for producing 1000 goods we can use 60 machines and 20 labours. OR we can use 20 machines and 60 labours for same production.

Linear isoquants: This liner isoquant is drawn if there is a perfect substitutability in the inputs of production. For example Power plant equipped to burn either oil or gas, various amounts of electric power can be produced by burning gas only or oil only. Gas and oil are perfect substitutes here. Hence isoquants are straight lines.

COST CONCEPTS – EXPLICIT AND IMPLICIT COST

- **Implicit cost or imputed cost:** (cost that is implied but not reflected in the financial reports of the firm). Cost which belong to owners or to the owners himself. Cost which does not include cash payments to the outsiders, it will remain in the form but showed as cost to the firm Eg: Rent on own building, interest on own capital.

- **Explicit or paid out cost:** Cost which are actually paid by firm to the outsiders. Expense that is contractual in nature and definite in amount, such as rent, salaries, wages

- **Book Cost:** Cost which does not require any cash payments to the outsiders, but is treated as cost to the firm. Eg: Depreciation on assets.

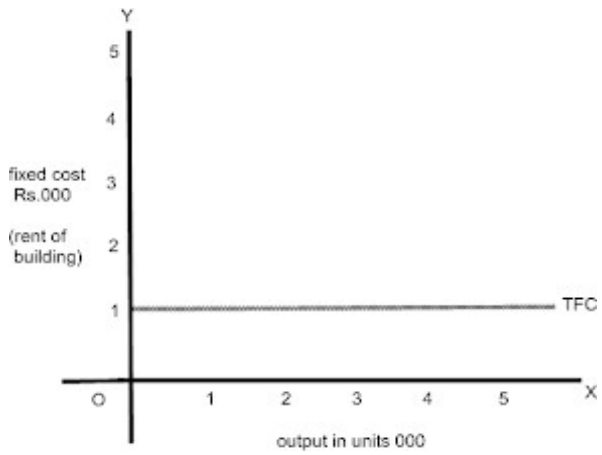
Explicit costs are those expenses that involve cash payments. These are the actual or business costs that appear in the books of accounts. These costs include payment of wages and salaries, payment for raw-materials, interest on borrowed capital funds, rent on hired land, Taxes paid etc.

FIXED AND VARIABLE COST

Fixed cost:The much we produce the goods, fixed cost will not change, it will be constant (not change). If we close the production also fixed cost must be faced by the firm.eg: (Rent, salaries, Interest on capital) these are to paid by the firm, if there is production are not.

Cost schedule table

No. of Units produced	Total fixed cost (eg: salaries)
0	1000
1000	1000
2000	1000
3000	1000
4000	1000
5000	1000



Average fixed cost

Fixed cost spends towards single unit of output or production is called Average fixed cost.

$$AFC = \frac{TFC}{TQ} = \frac{1000}{1000} = 1/- Rs. average\ fixed\ cost\ per\ unit$$

Total fixed cost (Rent) TFC =

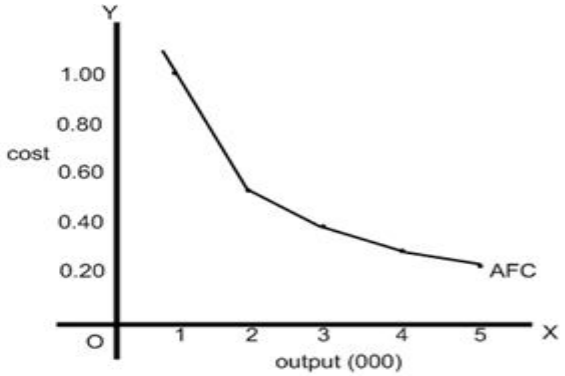
1000/- No. of units produced TQ=

1000

The more he produces, per unit cost will be decreased {per unit cost of fixed cost is average fixed cost}

Cost schedule table:

No. of Units produced	Total fixed cost	Average fixed cost
0	1000	-
1000	1000	1.00
2000	1000	0.50
3000	1000	0.33
4000	1000	0.25
5000	1000	0.20



Average variable Cost

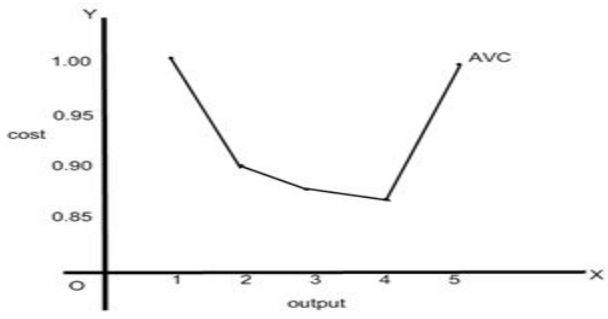
Variable cost spent on single unit on goods is called Average variable Cost**.** By dividing the total variable cost with number of units of production we get Average Variable Cost.

$$Average\ Variable\ Cost = \frac{TVC}{TQ}$$

Per unit variable cost on production is called Average Variable Cost.

Cost Schedule Table

No. of Units produced	Total Variable cost (TVC)	Average Variable Coast (AVC)
0	0	0
1000	1000	1.00
2000	1800	0.90
3000	2600	0.87
4000	3500	0.88
5000	5000	1.00



It is common when production is raised; variable cost (raw material & electricity) per unit will come down. Then after certain limit again the cost per unit will raise. The reason behind this situation is as follows. More the raw material is purchased to raise the production, the cost will be charged low by the supplier. But in the case of the power more the production the cost of the power will be raise by slab rate. When these two variable cost power and raw material combines together, cost will be coming down to certain limit, the cost raises gradually.

OPPORTUNITY AND SUNK COST

Opportunity cost or economic cost is the amount of subjective value foregone in choosing one activity over the next best alternative. It is an indirect cost or an imputed cost. Opportunity costs are incurred when budgetary resources are allocated to one department instead of the other. A firm cannot retain a hired input if it is paid a lower price for it than another firm. Actual costs mean the actual expenditure incurred for producing a good or service. In this example the cost of factors hired, Rs.16,000 crores is known as the actual cost or outlay cost or absolute cost.

- **Actual cost (outlay cost or acquisition cost or absolute cost):** cost which is incurred by the firm while producing the goods. eg: cost of raw material, labor, power

- **sunk cost:** Sunk costs are unrecoverable past expenditures. These should not normally be taken into account when determining whether to continue a project or abandon it, because they cannot be recovered either way. It is a common instinct to count them, however. Sunk costs are expenditures made in the past or that may be made in future as part of contractual agreement. The costs for inventory and future rental payments on a warehouse and contractual commitment to labour unions that must be paid as a long term lease are sunk costs. They are not affected by decision making therefore, they are regarded as irrelevant for short run analysis, *for eg: when TATA MOTORS had set up the nano plant in west best Bengal .it was welcome by protests by the farmers of the nearby area since it may pose a threat to their farmland so at last they had to shift the nano plant to Gujarat after bearing a huge loss.*

COST FUNCTION

Costs which a firm incurs in the production of good or service depends on two things:

1. Firm□s production function
2. Market□s input□s supply functions

As seen in the previous chapter, production function specifies the technical relationship between combinations of inputs and the level of output. Given this relationship and input prices (if they are fixed for the firm), one can easily determine the costs associated with different levels of output. The costs would thus vary as output level varies, nature of production function varies, or factor prices change. The nature of a production function is tantamount to factor productivities (efficiencies).

Putting all this together, we have the following cost function: C = f (Q, E1, P1)

f 1, f3 > 0 > f2
Where
C = Total (production)
cost Q = Total output
E1= Efficiencies of
inputs P1 = Prices of
inputs

The total cost is obviously an increasing function of output, for "there is no free lunch". Increasing production, ceteris paribus, requires increasing units of inputs and all inputs carry price tags. Improvements in factor productivities, other things remaining the same, have a depressing effect on input requirements per unit of output, and since inputs have price tags, it leads to a decrease in total cost. It must be noted that factor productivities depends on the level of technology (use of computer, modern plants and equipment's, etc), the quality of the work force and management, which are influenced by education, training and health conditions, and sincerity and integrity of the labour and management, which are reflected in absenteeism, strikes, lock outs and fooling around during working hours. Thus, through factor efficiencies, many factors exercise influence on the cost of production.

Methods of Estimating Cost Functions

Several methods exist for the measurement of the actual cost output relation for a particular firm or a group of firms, but the four broad approaches accounting, engineering and statistical are the most important and commonly used.

1. Accounting Method: This method is used by the cost accountants. Essentially, in this method, the data is classified into various cost categories (i.e., fixed, variable and semi variable) and then observations of cost are taken at the extreme and various intermediate output levels. Then by plotting the output levels and the corresponding costs on a graph and joining them by a line, the cost functions are estimated. The cost functions, thus found, may be linear or non-linear. It must be noted that in finding cost functions from basic data in this way, no attention is generally paid to build up a hypothesis or to find out the changes in conditions which influences cost.

2. Engineering Method: In the engineering approach, the cost functions are estimated with the help of physical relationship such as weight of supplied and materials used in a process, rated capacity of a equipment, etc. Emphasis is placed primarily on the physical relationship of production and these are then converted into money terms (i.e., rupees) to arrive at estimated costs. This method may be useful if good historical data is difficult to obtain. But his method requires a sound understanding of engineering and a detailed sampling of the different processes under controlled conditions, which may not always be possible.

3. Statistical or Econometric Method: This method uses statistical techniques on economic data to find the nature of cost output relationship. The economic data may relate to past records of the firm (called, the time series data) or to the different firms in the same business to a point if time (called, the cross-section data). If we use the time series data, we generally get a short run cost function, while if we take recourse to the cross section data we derive a long run cost function.

4. Survivor Method: This technique is developed on empirical evidence. In this method, it is assumed that relatively more efficient firms those with lower average costs will survive through

time. Hence, by examining the size make up of an industry over time, one can determine the nature of its costs and output relations.

This method suffers from the following limitations

a) This technique assumes that survival is directly related to minimization of long run average costs, which implicitly assumes that firms are operating in a very competitive market.

b) It does not indicate the relative inefficiency of greater than or less than optimally sized operations.

c) Because of the long-run nature of the analysis, the survivor technique is particularly vulnerable to the distortions that may result from changing technologies. It must be understood that the four approaches discussed above are not competitive, but are rather complementary to each other. They supplement each other. The choice of a method therefore depends upon the purpose of study, time and expense considerations.

Problems in the estimation of Cost Functions

We confront certain problems while attempting to derive empirical cost function from economic data. Some of these problems are briefly discussed below. Basically, cost function is a relationship between cost and output. Had the shape of cost curve depended only on the rate of output, determining a cost function would have been fairly simple. But we know that cost in factors, besides the rate of output. So, the impact of these other factors has to be eliminated while estimating cost functions. This elimination process involves the following considerations.

1. Time Period

We must choose an appropriate time period for the analysis of cost. The choice of such a time period involves the following important considerations:

(A) **Normality:** The time period of study should be normal i.e., a period during which the changes in technology, plant size efficiency, and other dynamic events are non-existent or at the minimum.

(B) **Variety:** The length of period should be such that it includes sufficiently wide variations in output, so that enough observations are available for getting a reliable cost function.

(C) **Recent period:** Since the results of the cost function are to be used as a guide for future planning, the period chosen should be recent enough to include data which will be relevant for the future.

(D) **Units of Observation:** The cause and effect relationship between cost and output would be more useful if the data pertains to a shorter length of time. For example, by taking weekly or monthly data, we average a smaller number of changes in cost and output than by taking yearly data.

2. Technical Homogeneity

To eliminate or minimise the impact of technical differences on cost, the plants chosen for the study of cost output relationship should be characterized by homogeneous input and output structures. Homogeneity of inputs will ensure that the variations in costs due to different machines and equipment used in productions at different output levels are eliminated. Homogeneity in output reduces the problem of additively of heterogeneous product measurement.

3. Cost Adjustments

The choice of a proper data for cost measurement is obviously necessary. Generally, the cost data is not available in the form which can be readily used. It needs certain adjustments and precautions, which are the following:

(A) **Selection of Cost Data:** In order to find cost output relationship, one must select only those elements of cost that vary with output. Overhead costs and allocated expenses that do not bear any relation to changes in output must be excluded. Further, it is always better to use data on total cost rather than unit cost, because (1) the unit or average cost will not be very revealing and there may be basic problems in interpretation of the results: and (2) average and marginal cost functions can be derived from the total cost function, no additional purpose is therefore served in using unit cost data.

(B) **Cost Deflation:** Since prices changes over time, any money value cost would therefore relate partly to output changes and partly to price changes. In order to estimate the cost output relationship, the impact of price change on cost needs to be eliminated by deflating the cost data by price indices. Wages and equipment price indices are readily available and frequently used to deflate the money cost.

(C) **Cost Deflation:** Since prices changes over time, any money value cost would therefore relate partly to output changes and partly to price changes. In order to estimate the cost output relationship, the impact of price change on cost needs to be eliminated by deflating the cost data by price indices. Wages and equipment price indices are readily available and frequently used to deflate the money cost.

3. Choice of the Functional Form

Finally, there is a problem of choosing the type of equation of curve that would fill the data best. The usefulness of any cost function for practical application depends, to a large extension, on appropriateness of the functional form chosen. There are three functional forms of cost function which are popular viz., linear, quadratic and cubic. The choice of a particular function depends upon the correspondence of the economic properties of the data to the mathematical properties of the functions. Let us discuss the economic and mathematical properties of the alternative hypothesis of total cost functions.

COST CURVES

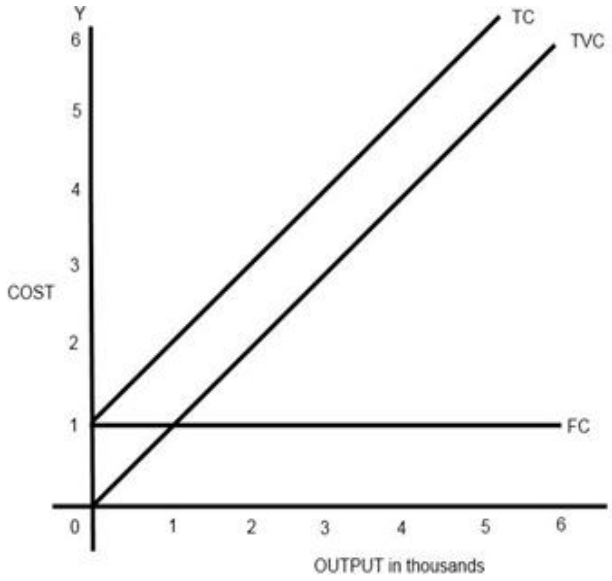
COST AND OUTPUT DECISION

Total Cost

Total cost includes {Total Cost = total fixed cost + Total Variable cost}

Cost Schedule Table

No. of Units produced	Total fixed cost	Total Variable Cost	TFC + TVC =total cost
0	1000	0	1000
1000	1000	1000	2000
2000	1000	1800	2800
3000	1000	2600	3600
4000	1000	3500	4500
5000	1000	5000	6000

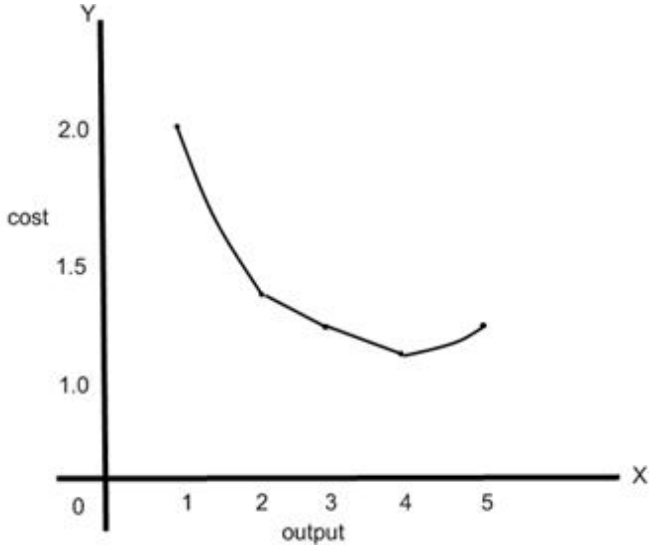


Average total cost (ATC)

{Per Unit total cost of production is called Average total cost}

Cost Schedule Table

No. of Units produced	Total cost	Average Total Cost
0	1000	--
1000	2000	2.00
2000	2800	1.40
3000	3600	1.20
4000	4500	1.13
5000	6000	1.20

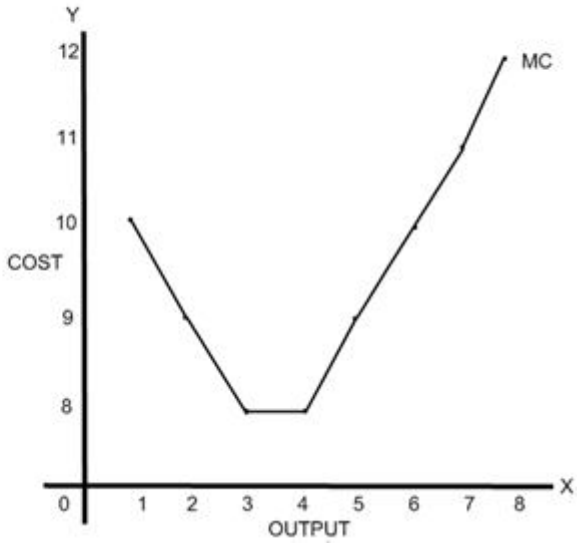


Marginal Cost (MC)

Marginal Cost is the additional cost incurred by producing one more unit extra.

Cost Schedule Table

No. of Units produced (a)	Total cost (b)	Average Total Cost b/a = ATC	Marginal Cost
1	10	10	10
2	19	9.50	9
3	27	9	8
4	35	8.75	8
5	44	8.80	9
6	54	9.0	10
7	65	9.30	11
8	77	9.60	12



COST ESTIMATION

Economy of Scale

First, as the firm increases its scale of operations, it becomes possible to use more specialized and technically more efficient form of all factors, especially capital equipment and machinery. For producing higher levels of output, technically more efficient machinery is generally available which when employed to produce a larger output yields a lower cost per unit of output.

1. Division of Labour

Secondly, when the scale of operations is increased and the amount of labour and other factors becomes larger, introduction of a greater degree of division of labour or specialization becomes possible and as a result the long-run cost per unit declines. Thus, whereas in the short run, decreases in cost (the downward sloping segment of the short run average cost curve) occur due to the fact that the ratio of the variable input comes nearer to the optimum proportion, Generally, a worker who has to perform one task in the production process of a commodity can to it more efficiently than the one who has to perform several tasks in it. Time of the workers is also saved.

2. Indivisibility and Economies of Scale

Economies of scale as arise from the imperfect divisibility of factors. In other words, they think that the economies of scale occur and therefore the long-run average cost falls because of the indivisibility of factors. They argue that most of the factors are “lumpy”. That is, they are available in large indivisible units, which can therefore yield lower cost of production when they are used to produce a large output. If a small output is produced with these costly indivisible units of the factors, the average cost of production will naturally be high.

3. Financial Economies

There are financial reasons for reduction in unit cost of production as the size of the firm increases. Due to bulk purchases large firms generally get large quantity discounts in buying raw materials and intermediate products than the small sized firms. Similarly, large firms can borrow funds from the commercial banks at relatively lower interest rate than smaller firms. Further, large firms can sell bonds and stocks in the capital market at more favorable terms. This reduces the cost of raising funds required for business purposes. Finally, large firms are able to take advantage of economies that result from spreading out of advertisement and other promotional costs.

4. Economies of Scope

Economies of scope refer to the reduction in costs that occur when a firm produces two or more commodities together rather than single one. Many examples of economies of scope can be given. For example, a passenger airline can profitably extend its operations by using the same air plane for providing cargo services which lowers its cost of operation. In such an airplane seats have to be removed and packets and bags containing goods can be placed to carry to their places of destination.

Cost Function

Costs which a firm incurs in the production of good or service depends on two things:

1. Firm's production function
2. Market's input's supply functions

Methods of Estimating Cost Functions

Several methods exist for the measurement of the actual cost output relation for a particular firm or a group of firms, but the four broad approaches accounting, engineering and statistical are the most important and commonly used.

1. Accounting Method: This method is used by the cost accountants. Essentially, in this method, the data is classified into various cost categories (i.e., fixed, variable and semi variable) and then observations of cost are taken at the extreme and various intermediate output levels. Then by plotting the output levels and the corresponding costs on a graph and joining them by a line, the cost functions are estimated. The cost functions, thus found, may be linear or non-linear. It must be noted that in finding cost functions from basic data in this way, no attention is generally paid to build up a hypothesis or to find out the changes in conditions which influences cost.

2. Engineering Method: In the engineering approach, the cost functions are estimated with the help of physical relationship such as weight of supplied and materials used in a process, rated capacity of a equipment, etc. Emphasis is placed primarily on the physical relationship of production and these are then converted into money terms (i.e., rupees) to arrive at estimated costs. This method may be useful if good historical data is difficult to obtain. But his method requires a sound understanding of engineering and a detailed sampling of the different processes under controlled conditions, which may not always be possible.

3. Statistical or Econometric Method: This method uses statistical techniques on economic data to find the nature of cost output relationship. The economic data may relate to past records of the firm (called, the time series data) or to the different firms in the same business to a point if time (called, the cross-section data). If we use the time series data, we generally get a short run cost function, while if we take recourse to the cross section data we derive a long run cost function.

BREAKEVEN ANALYSIS

The study of cost-volume-profit relationship is often referred as BEA. The term BEA is interpreted in two senses. In its narrow sense, it is concerned with finding out BEP; BEP is the point at which total revenue is equal to total cost. It is the point of no profit, no loss. In its broad determine the probable profit at any level of production.

Assumptions:

1. All costs are classified into two – fixed and variable.
2. Fixed costs remain constant at all levels of output.
3. Variable costs vary proportionally with the volume of output.
4. Selling price per unit remains constant in spite of competition or change in the volume of production.
5. There will be no change in operating efficiency.
6. There will be no change in the general price level.
7. Volume of production is the only factor affecting the cost.
8. Volume of sales and volume of production are equal. Hence there is no unsold stock.
9. There is only one product or in the case of multiple products. Sales mix remains constant.

Merits:

1. Information provided by the Break Even Chart can be understood more easily than those contained in the profit and Loss Account and the cost statement.
2. Break Even Chart discloses the relationship between cost, volume and profit. It reveals how changes in profit. So, it helps management in decision-making.
3. It is very useful for forecasting costs and profits long term planning and growth
4. The chart discloses profits at various levels of production.
5. It serves as a useful tool for cost control.
6. It can also be used to study the comparative plant efficiencies of the industry.
7. Analytical Break-even chart present the different elements, in the costs – direct material, direct labour, fixed and variable overheads.

Demerits:

Break-even chart presents only cost volume profits. It ignores other considerations such as capital amount, marketing aspects and effect of government policy etc., which are necessary in decision making.

2. It is assumed that sales, total cost and fixed cost can be represented as straight lines. In actual practice, this may not be so.
3. It assumes that profit is a function of output. This is not always true. The firm may increase the profit without increasing its output.
4. A major drawback of BEC is its inability to handle production and sale of multiple products.
5. It is difficult to handle selling costs such as advertisement and sale promotion in BEC.
6. It ignores economics of scale in production.
7. Fixed costs do not remain constant in the long run.

8. Semi-variable costs are completely ignored.
9. It assumes production is equal to sale. It is not always true because generally there may be opening stock.
10. When production increases variable cost per unit may not remain constant but may reduce on account of bulk buying etc.
11. The assumption of static nature of business and economic activities is a well-known defect of BEC.

1. Fixed cost
2. Variable cost
3. Contribution
4. Margin of safety
5. Angle of incidence
6. Profit volume ratio
7. Break-Even-Point

1. *Fixed cost:* Expenses that do not vary with the volume of production are known as fixed expenses. Eg. Manager's salary, rent and taxes, insurance etc. It should be noted that fixed changes are fixed only within a certain range of plant capacity. The concept of fixed overhead is most useful in formulating a price fixing policy. Fixed cost per unit is not fixed.

2. *Variable Cost:* Expenses that vary almost in direct proportion to the volume of production of sales are called variable expenses. Eg. Electric power and fuel, packing materials consumable stores. It should be noted that variable cost per unit is fixed.

3. *Contribution:* Contribution is the difference between sales and variable costs and it contributed towards fixed costs and profit. It helps in sales and pricing policies and measuring the profitability of different proposals. Contribution is a sure test to decide whether a product is worthwhile to be continued among different products.
Contribution = Sales – Variable cost
Contribution = Fixed Cost + Profit.

4. *Margin of safety:* Margin of safety is the excess of sales over the break even sales. It can be expressed in absolute sales amount or in percentage. It indicates the extent to which the sales can be reduced without resulting in loss. A large margin of safety indicates the soundness of the business. The formula for the margin of safety is:
Present sales – Break even sales **or** ratio V. P.Profit
Margin of safety can be improved by taking the following steps.

1. Increasing production
2. Increasing selling price
3. Reducing the fixed or the variable costs or both
4. Substituting unprofitable product with profitable one.

5. ***Angle of incidence:*** This is the angle between sales line and total cost line at the Break-even point. It indicates the profit earning capacity of the concern. Large angle of incidence indicates a high rate of profit; a small angle indicates a low rate of earnings. To improve this angle, contribution should be increased either by raising the selling price and/or by reducing variable cost. It also indicates as to what extent the output and sales price can be changed to attain a desired amount of profit.