UNIT III

Theory of Production and Cost Analysis

Contents

Introduction:

Production Function:

Samuelson define the production function as "the technical relationship which reveals the maximum amount of output capable of being produced by each and every set of inputs"

Michael defined production function as "that function which defines the maximum amount of output that can be produced with a given set of inputs".

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 can be written as

$$Q = F(L1,L2,C,O,T)$$

Where Q is the quantity of production, F explains the functions, that is, the type of relation between inputs and outputs , L1,L2,C,.O,T refer to land, labout, capital, organization and technology respectively. These inputs have been taken in conventional terms. In reality, material also can be included in a set of inputs.

A manufacturer has to make a choice of the production function by considering his technical knowledge, the process of various factors of production and his efficiency level to manage. He should not only select the factors of production but also should work out the different permutations and combinations which will mean lower cost of inputs for a given level of production.

In case of an agricultural product, increasing the other factors of production can increase the production, but beyond a point, increase output can be had only with increased use of

agricultural land, investment in land forms a significant portion of the total cost of production for output, whereas, in the case of the software industry, other factor such as technology , capital management and others become significant. With change in industry and the requirements the production function also needs to be modified to suit to the situation.

Production Function with One Variable Input

The laws of returns states that when at least one factor of production is fixed or factor input is fixed and when all other factors are varied, the total output in the initial stages will increase at an increasing rate, and after reaching certain level or output the total output will increase at declining rate. If variable factor inputs are added further to the fixed factor input, the total output may decline. This law is of universal nature and it proved to be true in agriculture and industry also. The law of returns is also called the law of variable proportions or the law of diminishing returns.

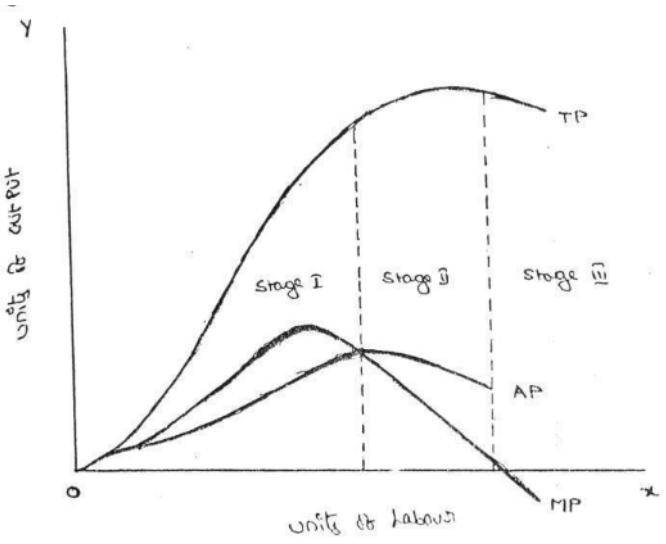
Definition According to **G. Stigler**

"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".

According to **F. Benham**

"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".

Units of labour	Total production(tp)	Marginal product (mp)	Average product (ap)	Stages
0	0	0	0	
1	10	10	10	Stages 1
2	22	12	11	
3	33	11	11	
4	40	7	10	Stages 2
5	45	5	9	
6	48	3	8	
7	48	0	6.85	Stages 3
8	45	-3	5.62	



From the above graph the law of variable proportions operates in three stages. In the first stage, total product increases at an increasing rate. The marginal product in this stage increases at an increasing rate resulting in a greater increase in total product. The average product also increases. This stage continues up to the point where average product is equal to marginal product. The law of increasing returns is in operation at this stage. The law of diminishing returns starts operating from the second stage awards. At the second stage total product increases only at a diminishing rate. The average product also declines. The second stage comes to an end where total product becomes maximum and marginal product becomes zero. The marginal product becomes negative in the third stage. So the total product also declines. The average product continues to decline.

Production Function with Two Variable Inputs And Laws Returns

Production process that requires two inputs, capital© and labour (L) to produce a given output (Q). There could be more than two inputs in a real life situation, but for a simple analysis, we restrict the number of inputs to two only. In other words, the production function based on two inputs can be expressed as

$$Q = f(C,L)$$

Where c= capital , L = labour,

Normally, both capital and labour are required to produce a product. To some extent, these two inputs can be substituted for each other. Hence the producer may choose any combination of labour and capital that gives him the required number of units of output, for any one combination of labour and capital out of several such combinations. The alternative combinations of labour and capital yielding a given level of output are such that if the use of one factor input is increased , that of another will decrease and vice versa. How ever, the units of an input foregone to get one unit of the other input changes, depends upon the degree of substitutability between the two input factors, based on the techniques or technology used, the degree of substitutability may vary.

ISO - QUANTS

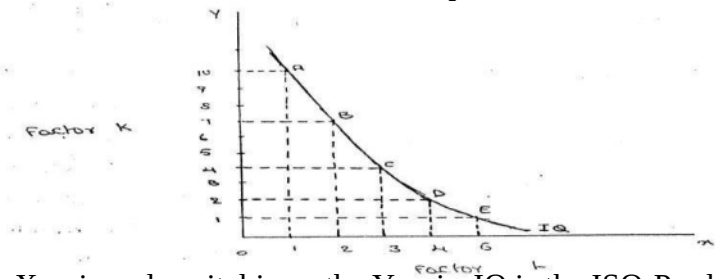
The term Isoquants is derived from the words ‘iso’ and ‘quant’ – ‘Iso’ means equal and ‘quent’ implies quantity. Isoquant therefore, means equal quantity. Isoquant are also called isopridcut curves, an isoquant curve show various combinations of two input factors such as capital and labour, which yield the same level of output.

As an isoquant curve represents all such combinations which yield equal quantity of output, any or every combination is a good combination for the manufacturer. Since he prefers all these combinations equally , an isoquant curve is also called product indifferent curve.

An isoquant may be explained with the help of an arithmetical example

Combinations	Labour (units)	Capital (Units)	Output (quintals)
A	1	10	50
B	2	7	50
C	3	4	50
D	4	4	50
E	5	1	50

Combination ‘A’ represent 1 unit of labour and 10 units of capital and produces ‘50’ quintals of a product all other combinations in the table are assumed to yield the same given output of a product say ‘50’ quintals by employing any one of the alternative combinations o f the two factors labour and capital. If we plot all these combinations on a paper and join them, we will get continues and smooth curve called Iso-product curve as shown below.



Labour is on the X-axis and capital is on the Y-axis. IQ is the ISO-Product curve

which shows all the alternative combinations A, B, C, D, E which can produce 50 quintals of a product

Features of isoquant

- Downward sloping: isoquant are downward sloping curves because , if one input increase, the other one reduces. There is no question of increase in both the inputs to yield a given output. A degree of substitution is assumed between the factors of production. In other words, an isoquant cannot be increasing, as increase in both the inputs does not yield same level of output. If it is constant, it means that the output remains constant through the use of one of the factor is increasing, which is not true, isoquant slope from left to right.

- Convex to origin: isoquant are convex to the origin. It is because the input factors are not perfect substitutes. One input factor can be substituted by other input factor in a diminishing marginal rate. If the input factors were perfect substitutes , the isoqunt would be a falling straight line. When the inputs are used infixed proportion, and substitution of one input for the other cannot trake place, the isoquant will be L shaped
- Do not intersect each other: two isoquant do not intersect with each other. It is because, each of these denote a particular level of output. If the manufacturer wants to operate at a higher level of output, he has to switch over to another isoquant with a higher level of output and vice versa.
- Do not touch axis: the isoquant touches neither X-axis nor Y- axis, as both inputs are required to produce a given product.

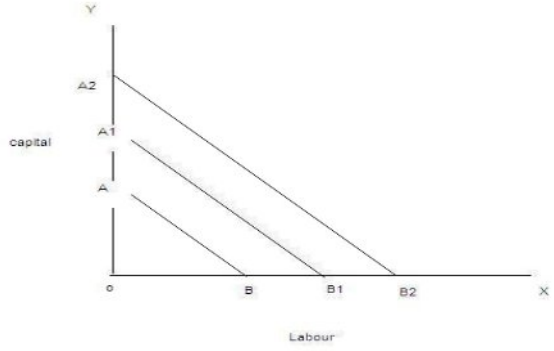
ISO COST

Iso cost refers to that cost curve that represents the combination of inputs that will cost the producer the same amount of money. In other words, each isocost denotes a particular level of total cost for a given level of production. If the level of production changes, the total cost changes and thus the isocost curve moves upwards, and vice versa.

Isocost curve is the locus traced out by various combinations of L and K, each of which costs the producer the same amount of money (C) Differentiating equation with respect to L, we have $dK/dL = -w/r$ This gives the slope of the producer's budget line (isocost curve). Iso cost line shows various combinations of labour and capital that the firm can buy for a given factor prices. The slope of iso cost line = PL/Pk. In this equation , PL is the price of labour and Pk is the price of capital. The slope of iso cost line indicates the ratio of the factor prices. A set of isocost lines can be drawn for different levels of factor prices, or different sums of money. The iso cost line will shift to the right when money spent on factors increases or firm could buy more as the factor prices are given.

With the change in the factor prices the slope of iso cost lien will change. If the price of labour falls the firm could buy more of labour and the line will shift away from the origin. The

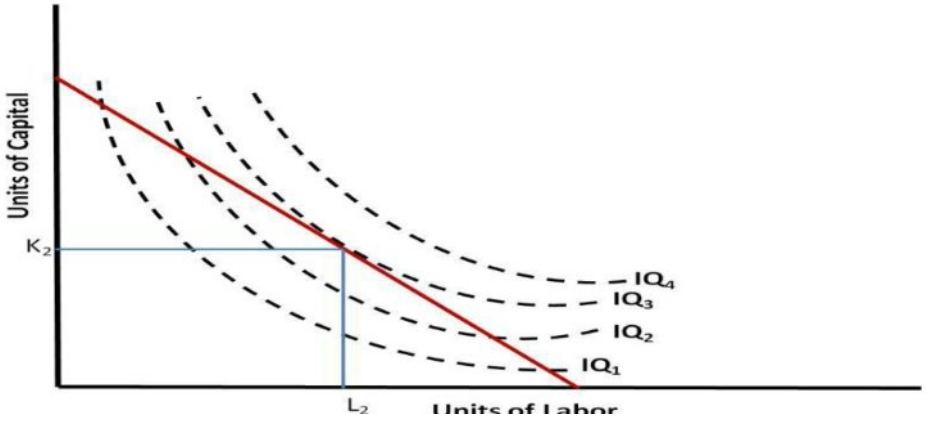
slope depends on the prices of factors of production and the amount of money which the firm spends on the factors. When the amount of money spent by the firm changes, the isocost line may shift but its slope remains the same. A change in factor price makes changes in the slope of isocost lines as shown in the figure.



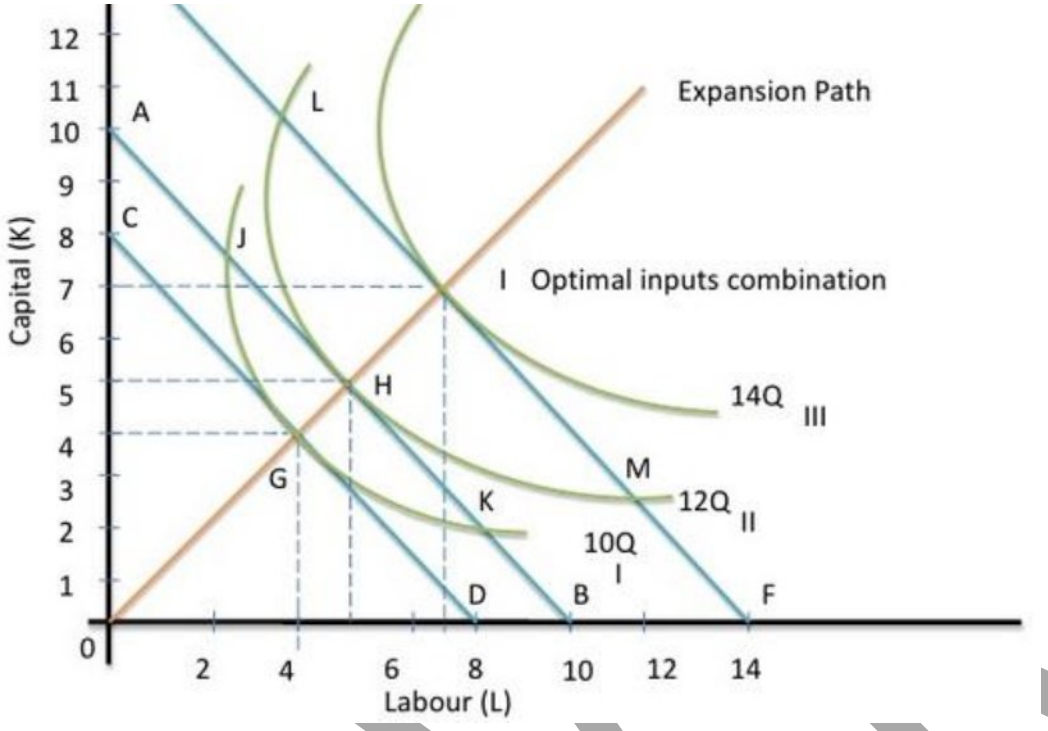
Least Cost Combination of Inputs

The manufacturer has to produce at lower costs to attain higher profits. The isocost and isoquants can be used to determine the input usage that minimizes the cost of production. Where the slope of isoquant is equal to that of isocost, there lies the lowest point of cost of production. This can be observed by superimposing the isocosts on isoproduct curves. It is evident that the producer can, with a total outlay.

The firm can achieve maximum profits by choosing that combination of factors which will cost it the least. The choice is based on the prices of factors of production at a particular time. The firm can maximize its profits either by maximizing the level of output for a given cost or by minimizing the cost of producing a given output. In both cases the factors will have to be employed in optimal combination at which the cost of production will be minimum. The least cost factor combination can be determined by imposing the isoquant map on isocost line. The point of tangency between the isocost and an isoquant is an important but not a necessary condition for producer's equilibrium. The essential condition is that the slope of the isocost line must equal the slope of the isoquant. Thus at a point of equilibrium marginal physical productivities of the two factors must be equal the ratio of their prices. The marginal physical product per rupee of one factor must be equal to tht of the other factor. And isoquant must be convex to the origin. The marginal rate of technical substitution of labour for capital must be diminishing at the point of equilibrium.



Expansion Path



In economics, an expansion path (also called a scale line) is a curve in a graph with quantities of two inputs, typically capital and labor, plotted on the axes. The path connects optimal input combinations as the scale of production expands. A producer seeking to produce the most units of a product in the cheapest possible way attempts to increase production along the expansion path.

Economists Alfred Stonier and Douglas Hague defined expansion path as "that line which reflects the least cost method of producing different levels of output, when factor prices remain constant." The points on an expansion path occur where the firm's isocost curves, each showing fixed total input cost, and its isoquants, each showing a particular level of output, are tangent. As a producer's allowable total cost increases, the firm moves from one of these tangency points to the next; the line joining the tangency points is called the expansion path.

A Cobb–Douglas production function is an example of a production function that has an expansion path which is a straight line through the origin.

Marginal Rate of Technical Substitution

The marginal rate of technical substitution (MRTS) refers to the rate at which one input factor is substituted with the other to attain a given level of output. In other words, the lesser units of one input must be compensated by increasing amounts of another input to produce the same level of output.

Isoquants are typically convex to the origin reflecting the fact that the two factors are substitutable for each other at varying rates. This rate of substitutability is called the “marginal

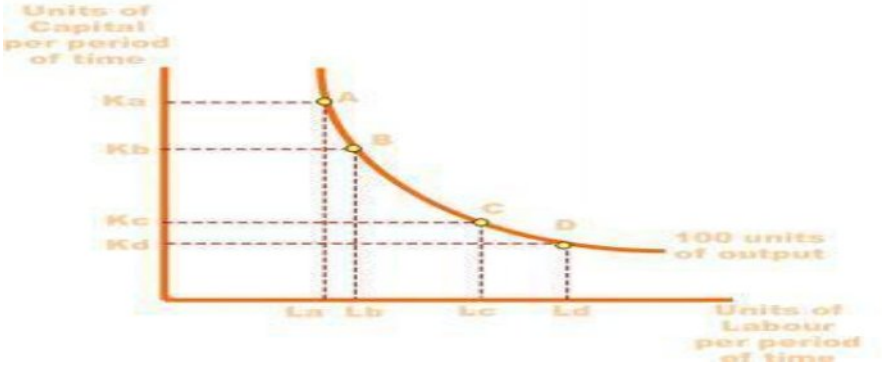
rate of technical substitution" (MRTS) or occasionally the " marginal rate of substitution in production". It measures the reduction in one input per unit increase in the other input that is just sufficient to maintain a constant level of production. For example, the marginal rate of substitution of labour for capital gives the amount of capital that can be replaced by one unit of labour while keeping output unchanged.

To move from point A to point B in the diagram, the amount of capital is reduced from Ka to Kb while the amount of labour is increased only from La to Lb. To move from point C to point D, the amount of capital is reduced from Kc to Kd while the amount of labour is increased from Lc to Ld. The marginal rate of technical substitution of labour for capital is equivalent to the absolute slope of the isoquant at that point (change in capital divided by change in labour). It is equal to 0 where the isoquant becomes horizontal, and equal to infinity where it becomes vertical.

The opposite is true when going in the other direction (from D to C to B to A). In this case we are looking at the marginal rate of technical substitution capital for labour (which is the reciprocal of the marginal rate of technical substitution labour for capital).

It can also be shown that the marginal rate of substitution labour for capital, is equal to the marginal physical product of labour divided by the marginal physical product of capital.

In the unusual case of two inputs that are perfect substitutes for each other in production, the isoquant would be linear (linear in the sense of a function $y = a - bx$). If, on the other hand, there is only one production process available, factor proportions would be fixed, and these zero-substitutability isoquants would be shown as horizontal or vertical lines.



MRTS = (Change in one input. Ex: Capital) / (Change in another input. Ex: Labour)

LAW OF RETURNS TO SCALE

There are three laws of returns governing production function. They are

1. Law of increasing returns to scale

This law states that the volume of output keeps on increasing with every increase in the inputs, where a given increase in inputs leads to a more than proportionate increase in the output, the law of increasing returns to scale is said to operate. We can introduce division of labour and other technological means to increase production. Hence, the total product increases at an increasing rate.

2. Law of constant returns to scale

   When the scope for division of labour gets restricted, the rate of increase in the total output remains constant, the law of constant returns to scale is said to operate, this law states that the rate of increase/decrease in volume of output is same to that of rate of increase/decrease in inputs.

3. 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 decreasing returns to scale is said to operate. This results in higher average cost per unit.

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)	Labor(in units)	% of increase in both inputs	Output(in units)	% of increase in output	Law applicable
1	3	---	---	---	---
2	6	100	120	140	Law of increase returns to scale
4	12	100	240	100	Law of constant returns to scale
8	24	100	360	50	Law of decrease returns to scale

INTERNAL AND EXTERNAL ECONOMIES OF SCALE

INTERNAL ECONOMIES refer to the economies introduction costs which accrue to the firm alone when it expands its output. The internal economies occur as a result of increase in the scale of production.

- **Managerial Economics**: as the firm expands, the firm needs qualified managerial personnel to handle each of its functions marketing, finance, production, human resources and others in a professional way. Functional specialization ensures minimum wastage and lowers the cost of production in the long –run.
- **Commercial Economics**: the transaction of buying and selling raw material and other operating supplies such as spares and so on will be rapid and the volume of each transaction also grows as the firm grows, there could be cheaper savings in the procurement, transportation and storage cost, this will lead to lower costs and increased profits.
- **Financial Economics**: The large firm is able to secure the necessary finances either for block capital purposes or for working capital needs more easily and cheaply. It can barrow from the public, banks and other financial institutions at relatively cheaper rates. It is in this way that a large firm reaps financial economies.
- **Technical Economies**: Technical economies arise to a firm from the use of better machines and superior techniques of production. As a result, production increases and per unit cost of production falls. A large firm, which employs costly and superior plant and equipment, enjoys a technical superiority over a small firm. Another technical economy lies in the mechanical advantage of using large machines. The cost of operating large machines is less than that of operating mall machine. More over a larger firm is able to reduce it's per unit cost of production by linking the various processes of production. Technical economies may also be associated when the large firm is able to utilize all its waste materials for the development of by-products industry. Scope for specialization is also available in a large firm. This increases the productive capacity of the firm and reduces the unit cost of production.

- **Marketing Economies:** The large firm reaps marketing or commercial economies in buying its requirements and in selling its final products. The large firm generally has a separate marketing department. It can buy and sell on behalf of the firm, when the market trends are more favorable. In the matter of buying they could enjoy advantages like preferential treatment, transport concessions, cheap credit, prompt delivery and fine relation with dealers. Similarly it sells its products more effectively for a higher margin of profit.

- **Risk Bearing Economies**: The large firm produces many commodities and serves wider areas. It is, therefore, able to absorb any shock for its existence. For example, during business depression, the prices fall for every firm. There is also a possibility for market fluctuations in a particular product of the firm. Under such circumstances the risk-bearing economies or survival economies help the bigger firm to survive business crisis.

- **Economics Of Larger Dimension**: large – scale production is required to take advantage of bigger size plant and equipment. For example, the cost of a 1.00.000 units capacity plant will not be double that of 50.000 units capacity plant. Likewise the cost of a 10.000 ton oil tanker will not be double that of a 5000 ton oil tanker. Engineers go by what is

called two by three rule wherein when the volume is increase by 100%, the material required will increase only by two – thirds. Technical economies are available only from large size, improved methods of production processes and when the products are standardized.

- **Economics Of Research And Development**: large organizations such as Dr.Reddy's labs, Hindustan Lever spend heavily on research and development and bring out several innovative products. Only such firms with a strong research and development base can cope with competition globally.

EXTERNAL ECONOMICS:

External economics refer to all the firms in the industry, because of growth of the industry as a whole or because of growth of ancillary industries, external economics benefit al the firms in the industry as the industry expands. This will lead to lowering the cost of production and thereby increasing the profitability. The external economics can be grouped under three types:

A**). Economies of Concentration**: When an industry is concentrated in a particular area, all the member firms reap some common economies like skilled labour, improved means of transport and communications, banking and financial services, supply of power and benefits from subsidiaries. All these facilities tend to lower the unit cost of production of all the firms in the industry.

B) **Economics Of Research And Development**: all the firms can pool resources to finance research and development activities and thus share the benefits of research. There could be a common facility to shares journals, newspapers and other valuable reference material of common interest.

C) **Economics Of Welfare**: there could be common facilities such as canteen, industrial housing, community halls, schools and colleges, employment burearu, hospitals and so on, which can be used in common by the employees in the whole industry.

Cobb-Douglas production function:

Production function of the linear homogenous type is invested by Junt wicksell and first tested by C. W. Cobb and P. H. Dougles in 1928. This famous statistical production function is known as Cobb-Douglas production function. Originally the function is applied on the empirical study of the American manufacturing industry. Cabb – Douglas production function takes the following mathematical form.

$$Y= (AK^{X} L^{1-x})$$

Where Y=output

K=Capital

L=Labour

Assumptions:

It has the following assumptions

1. The function assumes that output is the function of two factors viz. capital and labour.
2. It is a linear homogenous production function of the first degree
3. The function assumes that the logarithm of the total output of the economy is a linear function of the logarithms of the labour force and capital stock.
4. There are constant returns to scale
5. All inputs are homogenous
6. There is perfect competition
7. There is no change in technology

Cost Analysis

Profit is the ultimate aim of any business and the long-run prosperity of a firm depends upon its ability to earn sustained profits. Profits are the difference between selling price and cost of production. In general the selling price is not within the control of a firm but many costs are under its control. The firm should therefore aim at controlling and minimizing cost. Since every business decision involves cost consideration, it is necessary to understand the meaning of various concepts for clear business thinking and application of right kind of costs.

Cost Concepts

A managerial economist must have a clear understanding of the different cost concepts for clear business thinking and proper application. The several alternative bases of classifying cost and the relevance of each for different kinds of problems are to be studied. The various relevant concepts of cost are:

1. Opportunity costs and outlay costs:

Out lay cost also known as actual costs obsolete costs are those expends which are actually incurred by the firm these are the payments made for labour, material, plant, building, machinery traveling, transporting etc., These are all those expense item appearing in the books of account, hence based on accounting cost concept.

On the other hand opportunity cost implies the earnings foregone on the next best alternative, has the present option is undertaken. This cost is often measured by assessing the alternative, which has to be scarified if the particular line is followed.

The opportunity cost concept is made use for long-run decisions. This concept is very important in capital expenditure budgeting. This concept is very important in capital expenditure budgeting. The concept is also useful for taking short-run decisions opportunity cost is the cost

concept to use when the supply of inputs is strictly limited and when there is an alternative. If there is no alternative, Opportunity cost is zero. The opportunity cost of any action is therefore measured by the value of the most favorable alternative course, which had to be foregoing if that action is taken.

2. Explicit and implicit costs:

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.

Implicit costs are the costs of the factor units that are owned by the employer himself. These costs are not actually incurred but would have been incurred in the absence of employment of self – owned factors. The two normal implicit costs are depreciation, interest on capital etc. A decision maker must consider implicit costs too to find out appropriate profitability of alternatives.

3. Historical and Replacement costs:

Historical cost is the original cost of an asset. Historical cost valuation shows the cost of an asset as the original price paid for the asset acquired in the past. Historical valuation is the basis for financial accounts.

A replacement cost is the price that would have to be paid currently to replace the same asset. During periods of substantial change in the price level, historical valuation gives a poor projection of the future cost intended for managerial decision. A replacement cost is a relevant cost concept when financial statements have to be adjusted for inflation.

4. Short – run and long – run costs:

Short-run is a period during which the physical capacity of the firm remains fixed. Any increase in output during this period is possible only by using the existing physical capacity more extensively. So short run cost is that which varies with output when the plant and capital equipment in constant.

Long run costs are those, which vary with output when all inputs are variable including plant and capital equipment. Long-run cost analysis helps to take investment decisions.

5. Out-of pocket and books costs and Imputed Cost

Out-of pocket costs also known as explicit costs are those costs that involve current cash payment. Book costs also called implicit costs do not require current cash payments. Depreciation, unpaid interest, salary of the owner is examples of back costs.

But the book costs are taken into account in determining the level dividend payable during a period. Both book costs and out-of-pocket costs are considered for all decisions. Book cost is the cost of self-owned factors of production.

Imputed Cost: An imputed cost is a cost that is incurred by virtue of using an asset instead of investing it or undertaking an alternative course of action. An imputed cost is an invisible cost that is not incurred directly, as opposed to an explicit cost, which is incurred directly.

6. Fixed and variable costs:

Fixed cost is that cost which remains constant for a certain level to output. It is not affected by the changes in the volume of production. But fixed cost per unit decrease, when the production is increased. Fixed cost includes salaries, Rent, Administrative expenses depreciations etc.

Variable is that which varies directly with the variation is output. An increase in total output results in an increase in total variable costs and decrease in total output results in a proportionate decline in the total variables costs. The variable cost per unit will be constant. Ex: Raw materials, labour, direct expenses, etc.

7. Post and Future costs:

Post costs also called historical costs are the actual cost incurred and recorded in the book of account these costs are useful only for valuation and not for decision making.

Future costs are costs that are expected to be incurred in the futures. They are not actual costs. They are the costs forecasted or estimated with rational methods. Future cost estimate is useful for decision making because decision are meant for future.

8. Traceable and common costs:

Traceable costs otherwise called direct cost, is one, which can be identified with a products process or product. Raw material, labour involved in production is examples of traceable cost.

Common costs are the ones that common are attributed to a particular process or product. They are incurred collectively for different processes or different types of products. It cannot be directly identified with any particular process or type of product.

9. Avoidable and unavoidable costs:

Avoidable costs are the costs, which can be reduced if the business activities of a concern are curtailed. For example, if some workers can be retrenched with a drop in a product – line, or volume or production the wages of the retrenched workers are escapable costs.

The unavoidable costs are otherwise called sunk costs. There will not be any reduction in this cost even if reduction in business activity is made. For example cost of the ideal machine capacity is unavoidable cost.

10. Controllable and uncontrollable costs:

Controllable costs are ones, which can be regulated by the executive who is in change of it. The concept of controllability of cost varies with levels of management. Direct expenses like material, labour etc. are controllable costs.

Some costs are not directly identifiable with a process of product. They are appointed to various processes or products in some proportion. This cost varies with the variation in the basis of allocation and is independent of the actions of the executive of that department. These apportioned costs are called uncontrollable costs.

11. Incremental and sunk costs:

Incremental cost also known as different cost is the additional cost due to a change in the level or nature of business activity. The change may be caused by adding a new product, adding new machinery, replacing a machine by a better one etc.

Sunk costs are those which are not altered by any change – They are the costs incurred in the past. This cost is the result of past decision, and cannot be changed by future decisions. Investments in fixed assets are examples of sunk costs.

12. Total, average and marginal costs:

Total cost is the total cash payment made for the input needed for production. It may be explicit or implicit. It is the sum total of the fixed and variable costs. Average cost is the cost per unit of output. If is obtained by dividing the total cost (TC) by the total quantity produced (Q)

$$\text{Average cost} = \frac{TC}{Q}$$

Marginal cost is the additional cost incurred to produce and additional unit of output or it is the cost of the marginal unit produced.

13. Accounting and Economics costs:

Accounting costs are the costs recorded for the purpose of preparing the balance sheet and profit and ton statements to meet the legal, financial and tax purpose of the company. The accounting concept is a historical concept and records what has happened in the post.

Economics concept considers future costs and future revenues, which help future planning, and choice, while the accountant describes what has happened, the economics aims at projecting what will happen.

COST-OUTPUT RELATIONSHIP

BVK

A proper understanding of the nature and behavior of costs is a must for regulation and control of cost of production. The cost of production depends on money forces and an understanding of the functional relationship of cost to various forces will help us to take various decisions. Output is an important factor, which influences the cost.

The cost-output relationship plays an important role in determining the optimum level of production. Knowledge of the cost-output relation helps the manager in cost control, profit prediction, pricing, promotion etc. The relation between cost and its determinants is technically described as the cost function.

$$C= f (S, O, P, T \ldots.)$$

Where;

C= Cost (Unit or total cost)

S= Size of plant/scale of production

O= Output level

P= Prices of inputs

T= Technology

Considering the period the cost function can be classified as (a) short-run cost function and (b) long-run cost function. In economics theory, the short-run is defined as that period during which the physical capacity of the firm is fixed and the output can be increased only by using the existing capacity allows to bring changes in output by physical capacity of the firm.

(a) Cost-Output Relation in the short-run:

The cost concepts made use of in the cost behavior are total cost, Average cost, and marginal cost.

Total cost is the actual money spent to produce a particular quantity of output. Total cost is the summation of fixed and variable costs.

$$TC=TFC+TVC$$

Up to a certain level of production total fixed cost i.e., the cost of plant, building, equipment etc, remains fixed. But the total variable cost i.e., the cost of labour, raw materials etc., Vary with the variation in output. Average cost is the total cost per unit. It can be found out as follows.

$$AC= \frac{Q}{Q}$$

The total of average fixed cost (TFC/Q) keep coming down as the production is increased and average variable cost (TVC/Q) will remain constant at any level of output.

Marginal cost is the addition to the total cost due to the production of an additional unit of product. It can be arrived at by dividing the change in total cost by the change in total output.

In the short-run there will not be any change in total fixed cost. Hence change in total cost implies change in total variable cost only.

Cost – output relations

Units of Output Q	Total fixed cost TFC	Total variable cost TVC	Total cost (TFC + TVC) TC	Average variable cost (TVC / Q) AVC	Average fixed cost (TFC / Q) AFC	Average cost (TC/Q) AC	Marginal cost MC
0	-	-	60	-	-	-	-
1	60	20	80	20	60	80	20
2	60	36	96	18	30	48	16
3	60	48	108	16	20	36	12
4	60	64	124	16	15	31	16
5	60	90	150	18	12	30	26
6	60	132	192	22	10	32	42

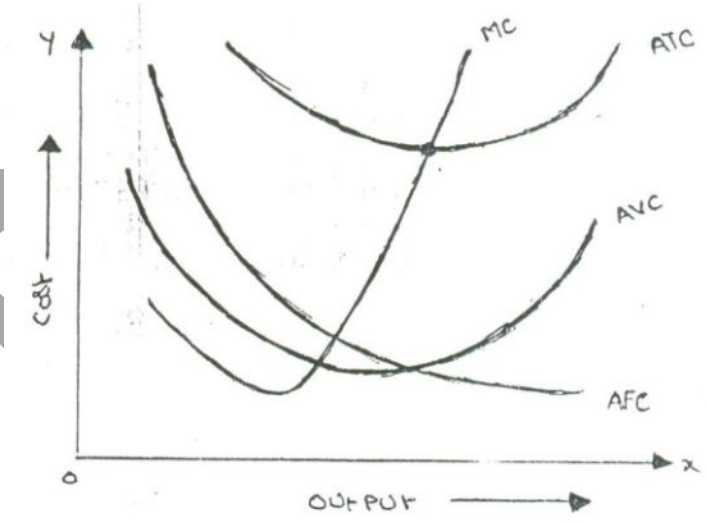
The above table represents the cost-output relation. The table is prepared on the basis of the law of diminishing marginal returns. The fixed cost Rs. 60 May include rent of factory building, interest on capital, salaries of permanently employed staff, insurance etc. The table shows that fixed cost is same at all levels of output but the average fixed cost, i.e., the fixed cost per unit, falls continuously as the output increases. The expenditure on the variable factors (TVC) is at different rate. If more and more units are produced with a given physical capacity the AVC will fall initially, as per the table declining up to 3rd unit, and being constant up to 4th unit and then

rising. It implies that variable factors produce more efficiently near a firm's optimum capacity than at any other levels of output.

And later rises. But the rise in AC is felt only after the start rising. In the table 'AVC' starts rising from the 5th unit onwards whereas the 'AC' starts rising from the 6th unit only so long as 'AVC' declines 'AC' also will decline. 'AFC' continues to fall with an increase in Output. When the rise in 'AVC' is more than the decline in 'AFC', the total cost again begin to rise. Thus there will be a stage where the 'AVC', the total cost again begin to rise thus there will be a stage where the 'AVC' may have started rising, yet the 'AC' is still declining because the rise in 'AVC' is less than the droop in 'AFC'.

Thus the table shows an increasing returns or diminishing cost in the first stage and diminishing returns or diminishing cost in the second stage and followed by diminishing returns or increasing cost in the third stage.

The short-run cost-output relationship can be shown graphically as follows.



In the above graph the "AFC' curve continues to fall as output rises an account of its spread over more and more units Output. But AVC curve (i.e. variable cost per unit) first falls and than rises due to the operation of the law of variable proportions. The behavior of "ATC' curve depends upon the behavior of 'AVC' curve and 'AFC' curve. In the initial stage of production both 'AVC' and 'AFC' decline and hence 'ATC' also decline. But after a certain point 'AVC' starts rising. If the rise in variable cost is less than the decline in fixed cost, ATC will still continue to decline otherwise AC begins to rise. Thus the lower end of 'ATC' curve thus turns up and gives it a U-shape. That is why 'ATC' curve are U-shaped. The lowest point in 'ATC' curve indicates the least-cost combination of inputs. Where the total average cost is the minimum and where the

“MC’ curve intersects ‘AC’ curve, It is not be the maximum output level rather it is the point where per unit cost of production will be at its lowest.

The relationship between ‘AVC’, ‘AFC’ and ‘ATC’ can be summarized up as follows:

1. If both AFC and ‘AVC’ fall, ‘ATC’ will also fall.
2. When ‘AFC’ falls and ‘AVC’ rises
    a. ‘ATC’ will fall where the drop in ‘AFC’ is more than the raise in ‘AVC’.
    b. ‘ATC’ remains constant is the drop in ‘AFC’ = rise in ‘AVC’
    c. ‘ATC’ will rise where the drop in ‘AFC’ is less than the rise in ‘AVC’

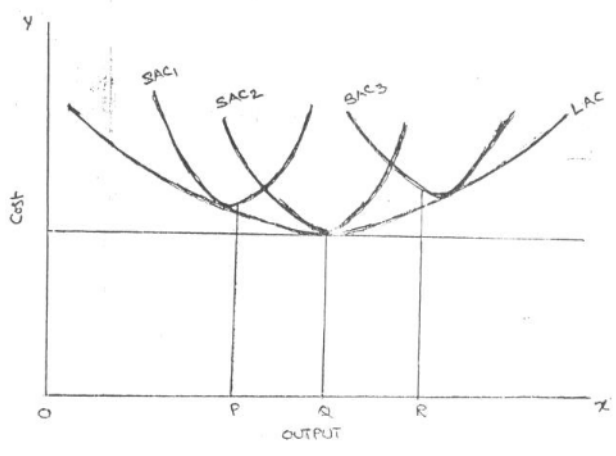
b. Cost-output Relationship in the long-run:

Long run is a period, during which all inputs are variable including the one, which are fixes in the short-run. In the long run a firm can change its output according to its demand. Over a long period, the size of the plant can be changed, unwanted buildings can be sold staff can be increased or reduced. The long run enables the firms to expand and scale of their operation by bringing or purchasing larger quantities of all the inputs. Thus in the long run all factors become variable.

The long-run cost-output relations therefore imply the relationship between the total cost and the total output. In the long-run cost-output relationship is influenced by the law of returns to scale.

In the long run a firm has a number of alternatives in regards to the scale of operations. For each scale of production or plant size, the firm has an appropriate short-run average cost curves. The short-run average cost (SAC) curve applies to only one plant whereas the long-run average cost (LAC) curve takes in to consideration many plants.

The long-run cost-output relationship is shown graphically with the help of “LCA’ curve.



To draw on ‘LAC’ curve we have to start with a number of ‘SAC’ curves. In the above figure it is assumed that technologically there are only three sizes of plants – small, medium and large, ‘SAC’, for the small size, ‘SAC2’ for the medium size plant and ‘SAC3’ for the large size plant.

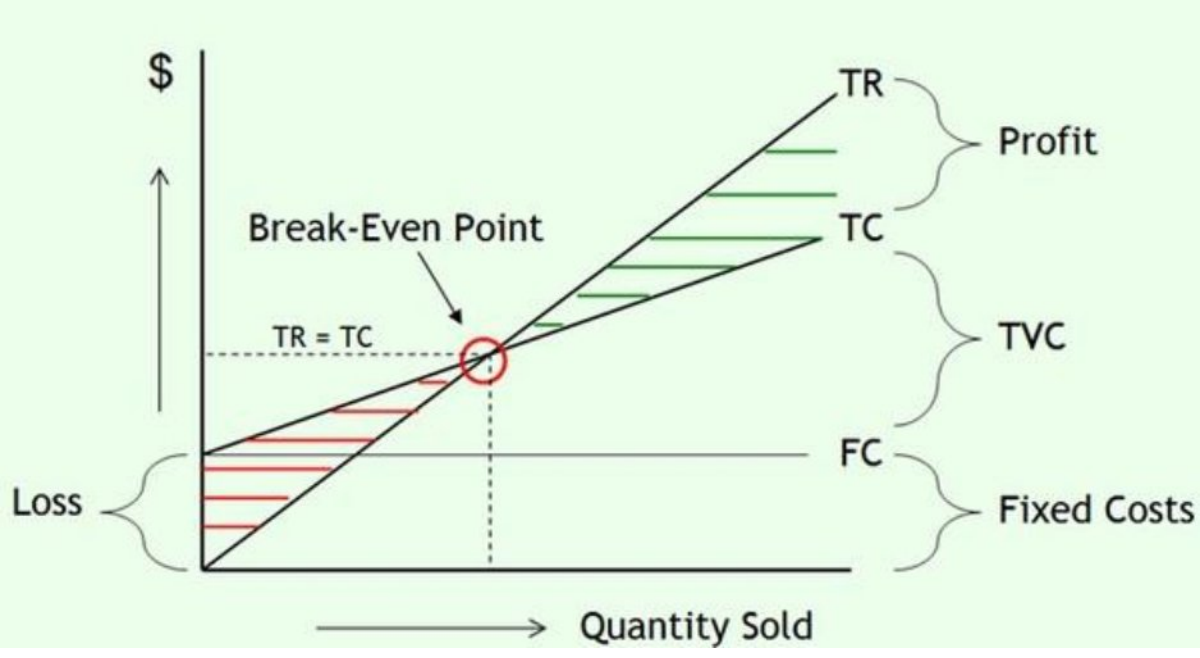
If the firm wants to produce ‘OP’ units of output, it will choose the smallest plant. For an output beyond ‘OQ’ the firm wills optimum for medium size plant. It does not mean that the OQ production is not possible with small plant. Rather it implies that cost of production will be more with small plant compared to the medium plant.

For an output ‘OR’ the firm will choose the largest plant as the cost of production will be more with medium plant. Thus the firm has a series of ‘SAC’ curves. The ‘LCA’ curve drawn will be tangential to the entire family of ‘SAC’ curves i.e. the ‘LAC’ curve touches each ‘SAC’ curve at one point, and thus it is known as envelope curve. It is also known as planning curve as it serves as guide to the entrepreneur in his planning to expand the production in future. With the help of ‘LAC’ the firm determines the size of plant which yields the lowest average cost of producing a given volume of output it anticipates.

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.

Pic:



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.

Terms used in Break-even analysis:

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.

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 $\frac{\text{Profit}}{\text{P.V. ratio}}$

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.

6. Profit Volume Ratio is usually called P. V. ratio. It is one of the most useful ratios for studying the profitability of business. The ratio of contribution to sales is the P/V ratio. It may be expressed in percentage. Therefore, every organization tries to improve the P. V. ratio of each product by reducing the variable cost per unit or by increasing the selling price per unit. The concept of P. V. ratio helps in determining break even-point, a desired amount of profit etc.
7. Break – Even- Point: If we divide the term into three words, then it does not require further explanation.

   Break-divide

   Even-equal

   Point-place or position

   Break Even Point refers to the point where total cost is equal to total revenue. It is a point of no profit, no loss. This is also a minimum point of no profit, no loss. This is also a minimum point of production where total costs are recovered. If sales go up beyond the Break Even Point, organization makes a profit. If they come down, a loss is incurred.

Break even analysis: Significance

- It's a valuable tool to ascertain profit on a particular level of sales volume or a given capacity of production
- Valuable tool to calculate sales required to earn a particular desired level of profit
- Valuable tool to compare the product lines, sales area, methods of sale for individual company
- Valuable tool to compare the efficiency of the different firms
- Valuable tool to decide whether to add a particular product to the existing product line or drop one from it
- Valuable tool to decide "make or buy" a given component or spare part
- Valuable tool to decide what promotion mix will yield optimum sales
- Valuable tool to assess the impact of changes in fixed , variable cost or selling price on BEP and profits during a given period.

Break even analysis: Limitation(s)

- BEP is based on fixed cost\, variable cost, total revenue, a change in one variable is going to affect the BEP
- All costs cannot be classified into fixed and variable cost. There is semi-variable cost also

- In case of multi product firm, a single chart cannot be of any use. Series of charts have to be made use of.
- It is based on fixed cost concept and hence holds good only in the short run
- Total cost and total revenue are not always straight as shown in the figure.
- Where the business conditions are volatile, BEP cannot give stable results

Formulae related to Break even analysis:

- Selling price=fixed cost+ variable cost+ profit
- Contribution=Selling price-variable cost= fixed cost + profit
- BEP Units = (Fixed Costs) / (Contribution margin per unit)
- BEP Value = (Fixed Costs / (Contribution margin ratio)

  Where contribution margin ratio is contribution margin per unit / selling price per unit

- Profit-Volume (P / V) ratio = (Contribution / Sales) * 100
- Margin of safety = Number of units sold – BEP in Units

BVK