Managerial Economics
RAS-501

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Unit-III

Cost Analysis- Introduction, Types of Costs, Cost-Output Relationship: Cost Function, Cost-Output Relationships in the Short Run, and Cost-Output Relationships in the Long Run; Short run and long run, Break- Even Analysis; Production functions: laws of variable proportions, law of returns; Economies of scale: Internal and external

UNIT-03

Concept of Costs

The concept of cost is of great significance in the micro economic theory. It is the cost of production which determines the production decision of an entrepreneur whose main aim is to maximize profit. Lower the cost of production, greater is the profit margin.

Cost of Production

The expenses incurred on all inputs of production–both factor inputs and non-factor inputs are known as the cost of production. Land, labour, capital and organization are the factors of production called factor inputs. Raw materials, fuel, equipments, tools etc are non factor inputs. Thus, cost is a function of various factors. Symbolically, cost function can be expressed as under,

$$C = f(Q, T, Pf)$$

Where C is the total cost of production, Q is output; T is technology, and Pf is the prices of factors of production. Some important concepts of costs of production are explained as under.

Real Cost and Nominal Cost

Real costs refer to those payments, which are made to factors of production for the toil and efforts in rendering their services. Real cost is estimated in terms of the pain and sacrifices of labour. It is also the cost of waiting. Nominal cost is the money cost (expenses) of production incurred on various inputs of production.

Explicit and Implicit Costs

Explicit costs are the paid out costs. These are the payments made for productive resources purchased or hired by the firm. These include wages paid to the labourers, rent paid for the premises, payments made for the raw materials, payments into depreciation accounts, premium paid towards insurance against fire, theft, etc.

According to Leftwitch, "*Explicit costs are those cash payments which firms make to outsiders for their services and goods*." These costs appear in the accounting records of the firm.

Implicit costs of production, on the other hand, are the costs of self-owned and self-employed resources. These costs are normally ignored while calculating the expenses of a producer. These include the rewards for the entrepreneur's self-owned land, labour and capital. These costs do not appear in the accounting records of the firm. The sum of explicit costs and implicit costs constitutes the total cost of production of a commodity.

Opportunity/Alternative/ Transfer Cost

The concept of opportunity cost is the most important concept in economic theory. In the simplest terms, opportunity cost of a decision may be defined as the cost of next best alternative sacrificed in order to take this decision. In short, the opportunity cost of using resources to produce a good is the value of the best alternative or opportunity forgone. Opportunity costs include both explicit and implicit costs.

For example, if with a sum of Rs. 2000, a producer can produce a bicycle or a radio set and decides to produce a radio set. In this case, opportunity cost of a radio set is equal to the cost of a bicycle that he has sacrificed.

Private, External and Social Costs

A cost that is not borne by the firm, but is incurred by others in society is called an external cost. The true cost to the society must include all costs regardless of who bears them. Private costs refer to the costs to a firm in producing a commodity. It is, in fact, the money costs of the firm.

For example, the purchase price of a car reflects the private cost experienced by the manufacturer. The air pollution created in the production of the car however, is an external cost. Because the manufacturer does not pay for these costs, and does not include them in the price of the car, they are said to be external to the market pricing mechanism. The air pollution from driving the car is also an externality. The driver does not pay for the environmental damage caused by using the car.

Social cost is the total of all the costs associated with an economic activity. It includes both costs borne by the economic agent and also all costs borne by society at large. It includes the costs reflected in the organization's production function (called private costs) and the costs external to the firm's private costs (called external costs). Thus, it is the cost of producing a commodity to the society as a whole. Hence, the social cost is the sum of private and external cost.

That is,

$$\text{Social Cost} = \text{Private Cost} + \text{External Cost}$$

Or

$$\text{External cost} = \text{social cost} - \text{private cost}$$

Economic Costs

Economic costs are the payments which must be received by resource owners in order to ensure that they will continue to supply them in the process of production. Economic cost includes normal profit.

Short Run Costs and Long Run Costs

Short run is a period of time within which the firm can change its output by changing only the amount of variable factors, such as labour and raw materials etc. In short period, fixed factors such as land, machinery etc, cannot be changed. Costs of production incurred in the short run i.e., on variable factors are called short run costs. The long run costs are the costs over a period in which all factors are changeable. Thus, costs of production on all factors (in the long run all factors become variable) are long run costs.

Fixed/Supplementary and Variable/Prime Costs

The expenses incurred on fixed factors are called fixed costs, whereas those incurred on the variable factors may be called variable costs. The fixed costs include the costs of:
(*a*) The salaries and other expenses of administrative staff;
(*b*) The salaries of staff involved directly in the production, but on a fixed term basis;
(*c*) The wear and tear of machinery (standard depreciation allowances);
(*d*) The expenses for maintenance of buildings;
(*e*) The expenses for the maintenance of the land on which the plant is installed and operates and
(*f*) Normal profit, which is a lump sum including a percentage return on fixed capital and allowance for risk.

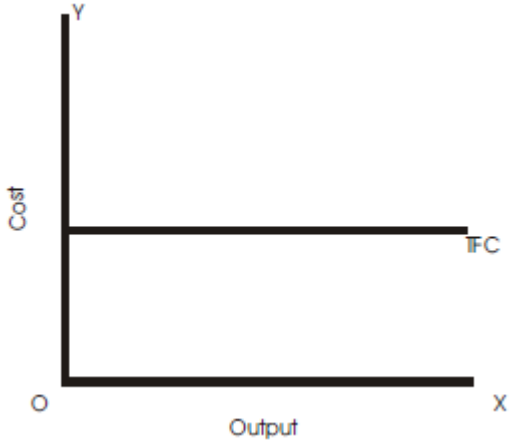
The variable costs include the cost of:
(*a*) Direct labour, which varies with output.
(*b*) Raw materials; and
(*c*) Running expenses of machinery.
The sum of fixed and variable costs constitutes the total cost of production. Symbolically,

$$TC = TFC + TVC$$

Total Fixed Cost (TFC)

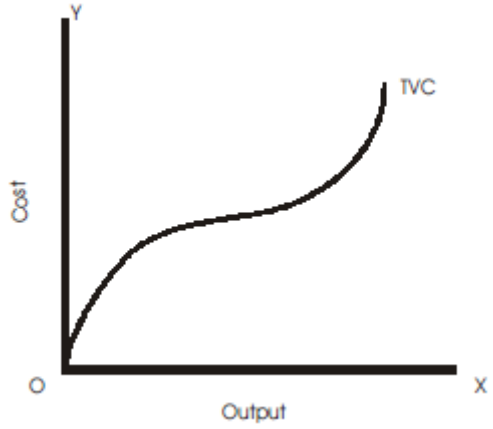
Total fixed cost is the sum of expenses incurred on those inputs that remain same at different levels of output. Total fixed cost is graphically shown in Fig. 8.1. It is a straight line parallel to

output or x-axis. TFC is the total fixed cost curve parallel to x-axis indicating that it remains constant at all levels of output.



Total Variable Cost (TVC)

Total variable cost is the sum of expenses incurred on those factor inputs whose quantity varies with a change in the level of output. Total variable cost curve TVC is shown in the following Fig. It has inverse-S shape. Total variable costs increase as the level of output increases.

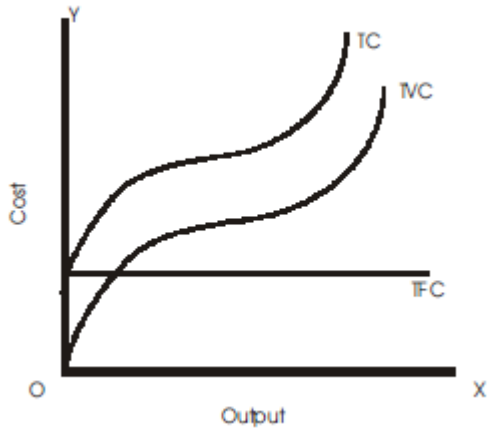


Total Cost (TC)

Total cost to a producer for the various levels of output is the sum of total fixed costs and total variable costs, i.e.,

$$TC = TFC+TVC$$

The adjacent Fig. shows total cost of production which is the sum of total variable cost and total fixed cost.



Average Fixed Cost (AFC)

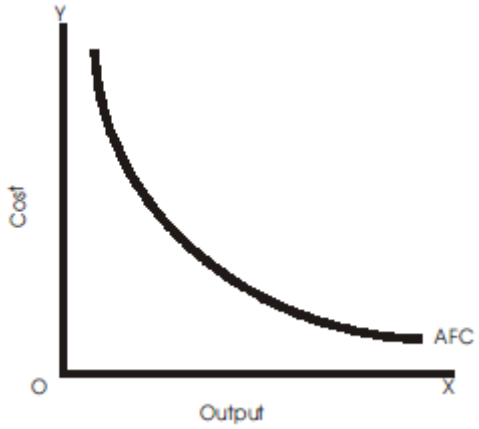
Average fixed cost is total fixed cost divided by total output. It is per unit cost on fixed factors.

Symbolically,

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

Where, TQ is the total output.

Average fixed cost is shown as under. AFC curve is a rectangular hyperbola, indicating same magnitude at all points as TFC remains constant throughout. This is shown in the Fig. below:

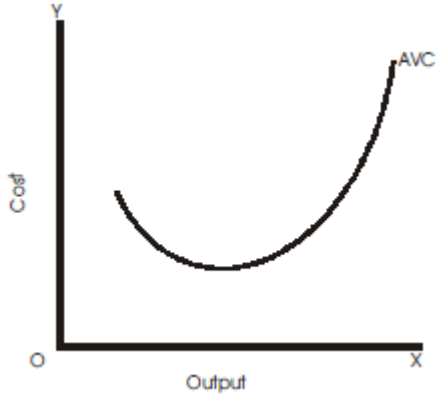


Average Variable Cost (AVC)

The average variable cost is found by dividing the total variable costs by the total units of output, i.e., it is per unit cost of the variable inputs. Symbolically,

$$AVC = \frac{TVC}{TQ}$$

Average variable cost falls initially, reaches a minimum when the plant is operated optimally and rises after the point of normal capacity has been reached. This is shown graphically below in Fig.



Average Total Cost (ATC/AC)

ATC is the per unit cost of both fixed and variable inputs. Average total cost of production can be obtained by dividing total cost by the units of output, i.e.,

$$AC = \frac{TC}{TQ}$$

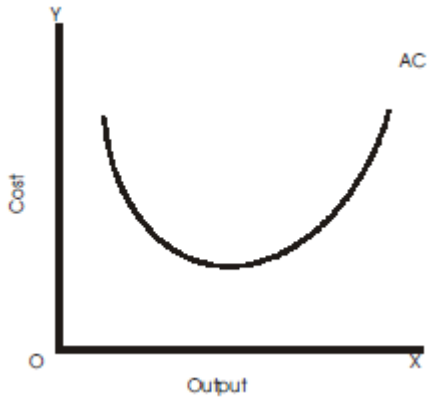
or

$$= \frac{TFC + TVC}{TQ}$$

or

$$= AFC + AVC$$

Average total cost or ATC curve has the similar shape as that of AVC, that is, U-shaped. The figure below shows AC curve.



Marginal Cost

Marginal cost is the addition to the total cost as a result of a unit (one unit) increase in the output. It is expressed as:

$$MC_N = TC_N - TC_{N-1}$$

Where, N is the number of units of output. Alternatively, marginal cost can also be expressed as follows:

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

Where, ΔTC stands for the change in total cost and ΔTQ for total output.

Graphically, MC curve is the slope of the TC curve, which is shown in Fig. 8.7. MC curve also has U-shaped. It first falls, goes to a minimum and then rises sharply.

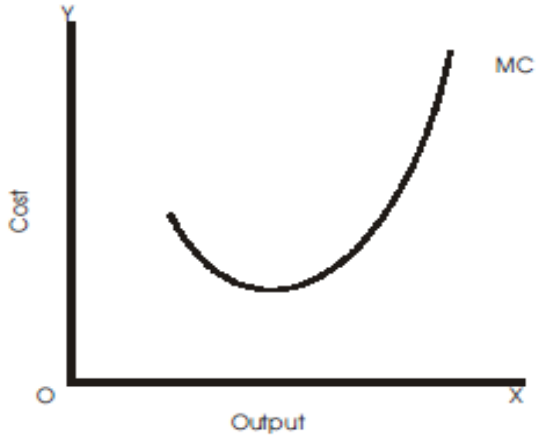


Fig. 8.7

The table below shows the relationship among fixed, variable costs, total, average and marginal costs.

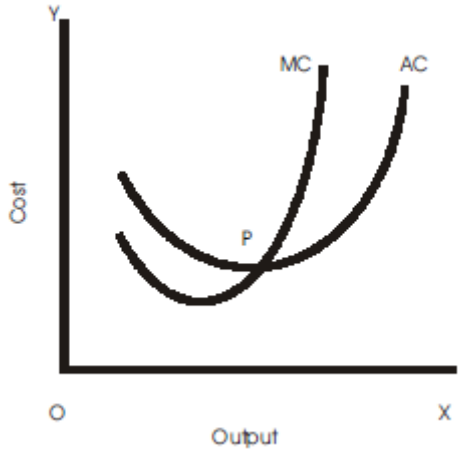
Units of output	*TFC*	*TVC*	*TC*	*AFC*	*AVC*	*AC*	*MC*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	10	0	10	-	-	-	-
1	10	4	14	10	4	14	4
2	10	7	17	5	3.5	8.5	3
3	10	9	19	3.3	3	6.3	2
4	10	11	21	2.5	2.7	5.2	2
5	10	14	24	2	2.8	4.8	3
6	10	19	29	1.6	3.1	4.7	5

Relationship between Average Cost and Marginal Cost

Average cost is obtained by dividing total costs by the units of output. Marginal cost is the change in total costs resulting from a unit increase in output. The relationships between the two are as follows:

1. When average cost falls with an increase in output, marginal cost is less than the average cost (before point P).
2. When average cost rises, marginal cost is greater than the average cost (after point P).
3. Marginal cost curve cuts the average cost curve at its minimum point (minimum point on the average cost curve is also the point of optimum capacity) i.e., at the point of optimum capacity, MC = AC (at point P).

With increase in average cost, marginal cost rises at a faster rate. This relationship between AC and MC is illustrated in the adjacent Fig.



Example

The following table- presents the AFC, AVC, AC, and MC schedules derived from the TFC, TVC, and TC schedules. The AFC schedule (column 5) is obtained by dividing TFC (column 2) by the corresponding quantities of output produced (*Q* in column 1). The AVC schedule (column 6) is obtained by dividing TVC (column 3) by *Q*. The AC schedule (column 7) is obtained by dividing TC (column 4) by *Q*. The MC schedule (column 8) is obtained by subtracting successive values of TC (column 4) or TVC (column 3). Thus, MC does not depend on the level of TFC.

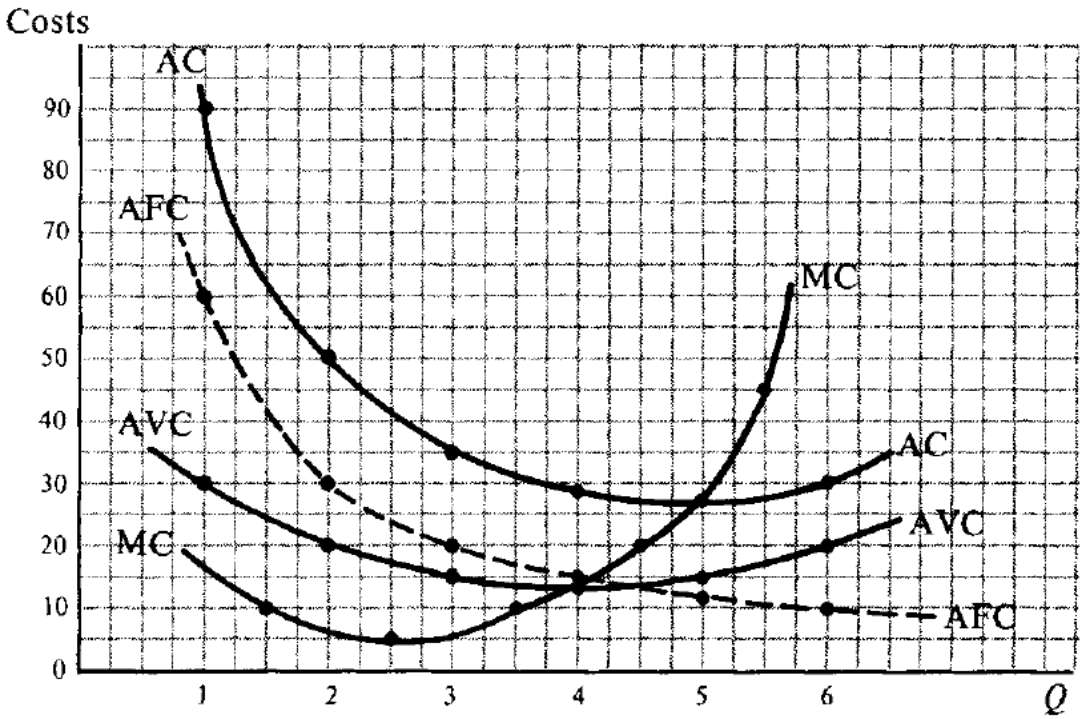
Table- (Value in Rupees)

(1) *Q*	(2) TFC	(3) TVC	(4) TC	(5) AFC	(6) AVC	(7) AC	(8) MC
1	60	30	90	60	30	90	10
2	60	40	100	30	20	50	5
3	60	45	105	20	15	35	10
4	60	55	115	15	13.75	28.75	20
5	60	75	135	12	15	27	45
6	60	120	180	10	20	30	

The AFC, AVC, AC, and MC schedules of above table- are graphed in the following figure-

Note that the values of the MC schedule (from column 8) are plotted halfway between successive levels of output. Also note that while the AFC curve falls continuously as output is expanded, the AVC, AC, and MC curves are U-shaped. The MC curve reaches its lowest point at a lower level

of output than either the AVC curve or the AC curve. Also, the rising portion of the MC curve intersects the AVC and AC curves at their lowest points. This will always be the case.



Long Run Cost Curves

The long-run is a period of time during which the firm can vary all its inputs. None of the factors is fixed and all can be varied to expand output. Long-run is a period of time sufficiently long to permit the changes in plant, that is, in capital equipment, machinery, land etc. in order to expand or contract output. The long-run cost of production is the least possible cost of production of producing any given level of output when all inputs are variable including the size of the plant. In the long-run there is no fixed factor of production and hence there is no fixed cost.

If $Q = f(L, K)$
$TC = L.P_L + K.P_K$

In the long run, there are no fixed factors, and a firm can build a plant of any size. Once a firm has constructed a particular plant, it operates in the short run. A plant size can be represented by its short-run average cost (SAC) curve. Larger plants can be represented by SAC curves, which lie further to the right. The long-run average cost (LAC) curve shows the minimum per-unit costs of producing each level of output when any desired size of plant can be built. The LAC curve is thus formed from the relevant segment of the SAC curves.

Example

The following Figure - shows four hypothetical plant sizes that a firm could build in the long run. Each plant is shown by a SAC curve. To produce up to 300 units of output, the firm should build and utilize plant 1 (given by SAC1). From 300 to 550 units of output, it should build the larger plant given by SAC2, etc. Note that the firm could produce an output of 400 with plant 1, but only at a higher cost than with plant 2. The irrelevant portions of the SAC curves are dashed. The remaining (undashed) portions form the LAC curve. By drawing many more SAC curves, we would get a smoother LAC curve.

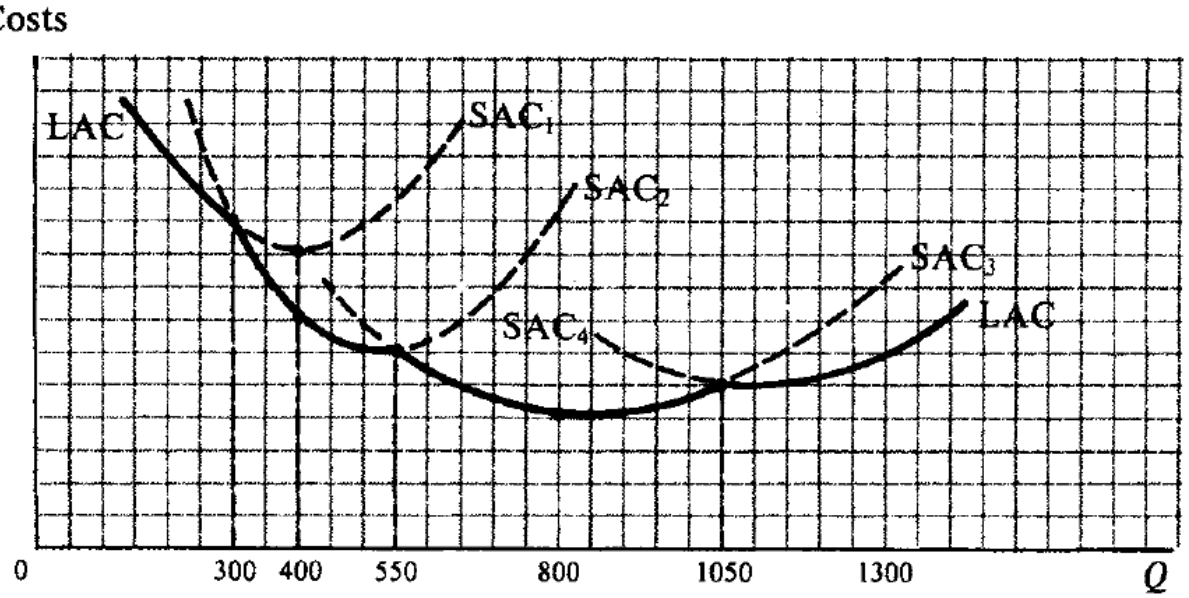


Figure-

If in the long run we increase all factors used in production by a given proportion, there are three possible outcomes: (1) output increases in the same proportion, so that there are constant returns to scale or constant costs; (2) output increases by a greater proportion, giving increasing returns to scale or decreasing costs; and (3) output increases in a smaller proportion, giving decreasing returns to scale or increasing costs. Increasing returns to scale or economies of mass production may result because of division of labor and specialization in production. Beyond a certain size, however, management problems resulting in decreasing returns to scale may arise.

Break Even Analysis

The break even analysis indicates at what level total cost and total revenue are in equilibrium. It is an analytical technique that is used to identify the level of output and sales volume at which the firm has no profit- no loss. Break even analysis establishes the relationship among fixed and variable cost of production, volume of production, value of output, sales value and profit. It is, therefore, also known as Cost-Volume Profit Analysis.

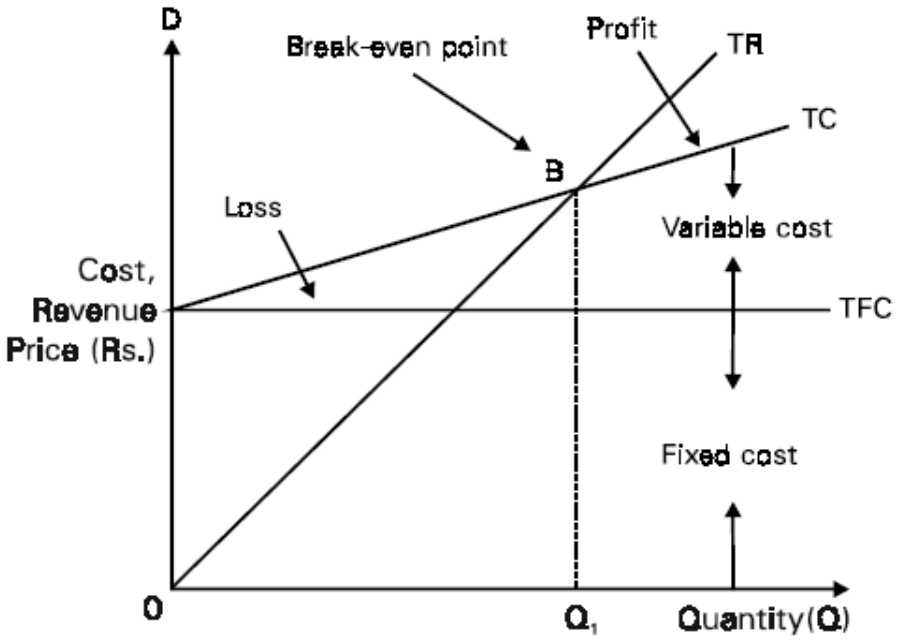
Assumptions of Break even Analysis

The break even analysis is based on certain assumptions, namely

- The cost and revenue functions are linear.
- Total cost is divided in to fixed and variable costs.
- All costs are either perfectly variable or absolutely fixed over the entire period of production but this assumption does not hold good in practice.
- The volume of production and the volume of sales are equal; but in reality they differ.
- All revenue is perfectly variable with the physical volume of production and this assumption is not valid.
- The assumption of stable product mix is unrealistic.

The break even chart shows the extent of profit or loss to the firm at different levels of activity. A break even chart may be defined as an analysis in graphic form of the relationship of production and sales to profit. The Break even analysis utilizes a break even chart in which the

total revenue (TR) and the total cost (TC) curves are represented by straight lines, as in the following figure



In the figure total revenues and total costs are plotted on the vertical axis whereas output or sales per time period are plotted on the horizontal axis. The slope of the TR curve refers to the constant price at which the firm can sell its output. The TC curve indicates total fixed costs (TFC) (The vertical intercept) and a constant average variable cost (the slope of the TC curve). This is often the case for many firms for small changes in output or sales. The firm breaks even (with TR=TC) at Q1 (point B in the figure) and incurs losses at smaller outputs while earnings profits at higher levels of output.

Both the total cost (TC) and total revenue (TR) curves are shown as linear. TR curve is linear as it is assumed that the price is given, irrespective of the output level. Linearity of TC curve results from the assumption of constant variable costs.

Marginal Rate of Technical Substitution

The principle of marginal rate of technical substitution is based on the production function where two factors can be substituted in variable proportions in such a way as to produce a constant level of output. Salvatore defines MRTS thus: “The marginal rate of technical substitution is the amount of an output that a firm can give up by increasing the amount of the other input by one unit and still remain the same isoquant.”

According to the principle of diminishing *MRTS*, the value of the *MRTS* diminishes as one moves along an isoquant down towards right. This is shown in Table-1 and Figure -1. The labour and capital have been taken as inputs. It has been assumed that this isoquant refers to 5 units production of commodity Z.

Equal Product Combinations of Labour and Capital

Combination	*Unit of Labour (L)*	*Units of Capital (K)*	$MRTS_{LK}$ =
1	1	16	—
2	2	11	5
3	3	7	4
4	4	4	3
5	5	2	2
6	6	1	1
	Production of Commodity Z = 5 Units		

TABLE-1

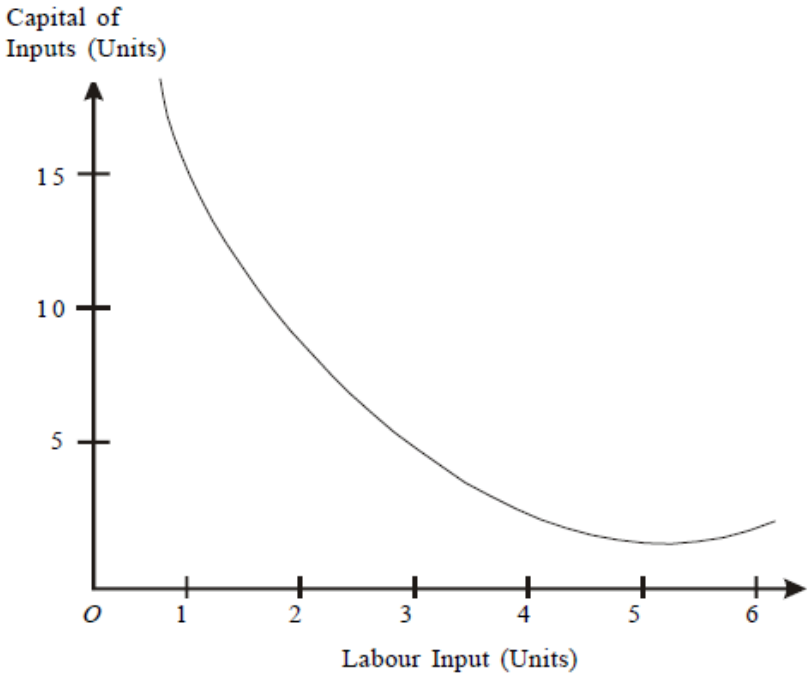


FIGURE-1

The isoquant slopes downward and is convex to origin. In combination 1, the capital is too much in comparison to labour and the labour is relatively very insignificant. As one moves towards combination 2, the addition of one unit of labour can compensate for the loss of 5 units of capital. On the other hand, when the capital becomes too less in comparison to labour, an addition of one unit of labour can compensate for the loss of only one unit of capital as one moves from combination 5 to 6. The *MRTS* of labour for capital diminishes from 5 to 1 from combination 1 to 6.

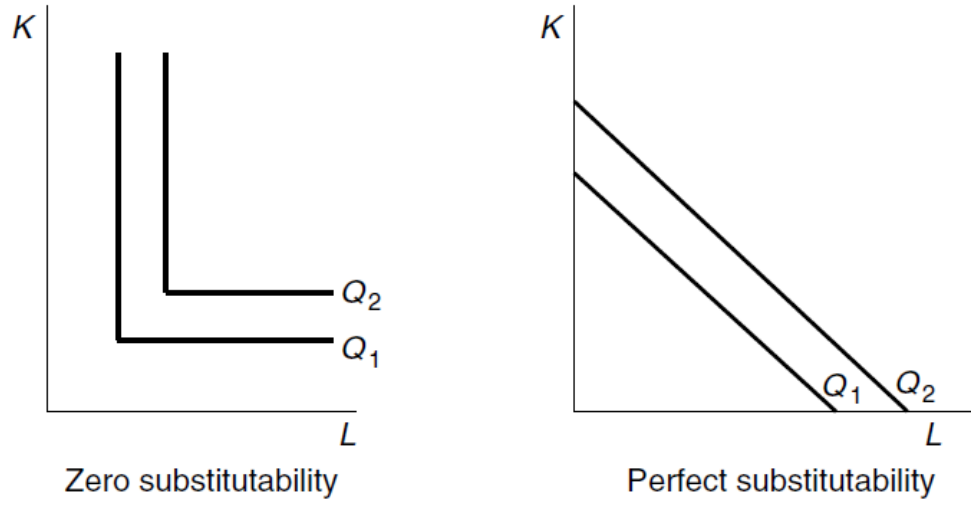
It can be shown that the marginal rate of technical substitution of labour for capital (*MRTSLK*) is equal to the ratio of marginal productivities of labour and capital. In a change from combination 3 to 4 in the Fig. above let D*L* (=1) be the increase in labour employed and D*K* (=3) be the decrease in capital employed. Since the output remains the same at combinations 3 and 4, the gain in output due to increase in labour employed must neutralize the loss in output due to decrease in capital employed. Let *MPL* and *MPK* be the marginal productivities of labour and capital, respectively, then

$$\Delta K \times MP_K = \Delta L \times MP_L$$

$$\Rightarrow \frac{\Delta K}{\Delta L} = \frac{MP_L}{MP_K} = MRTS_{LK}$$

Laws of Return to Scale

We frequently want to analyse the effects on output of an increase in the scale of production. An increase in scale involves a proportionate increase in all the inputs of the firm. The resulting proportionate increase in output determines the physical returns to scale for the firm. Two points need to be explained before moving on to the description and measurement of returns to scale:



1 Proportionate increase in all the inputs. It is always assumed in referring to returns to scale that all inputs increase by the same proportion. This is not necessarily optimal for the firm in terms of economic efficiency. If inputs increase by different proportions we have to talk about returns to outlay (measured in money terms).
2 Physical returns to scale. Returns to scale can be described in physical terms or in money terms, as will become clear in the next chapter. The two meanings do not necessarily coincide; for example, it is possible for a firm to experience constant physical returns to scale yet have increasing returns to scale in money terms (better known as economies of scale).

Types of returns to scale

Returns to scale, in physical or money terms, can be of three types. The following are the three types of physical return:
1 Constant returns to scale (CRTS). This refers to the situation where an increase in inputs results in an exactly proportional increase in output.

2 Increasing returns to scale (IRTS). This refers to the situation where an increase in inputs results in a more-than-proportional increase in output.

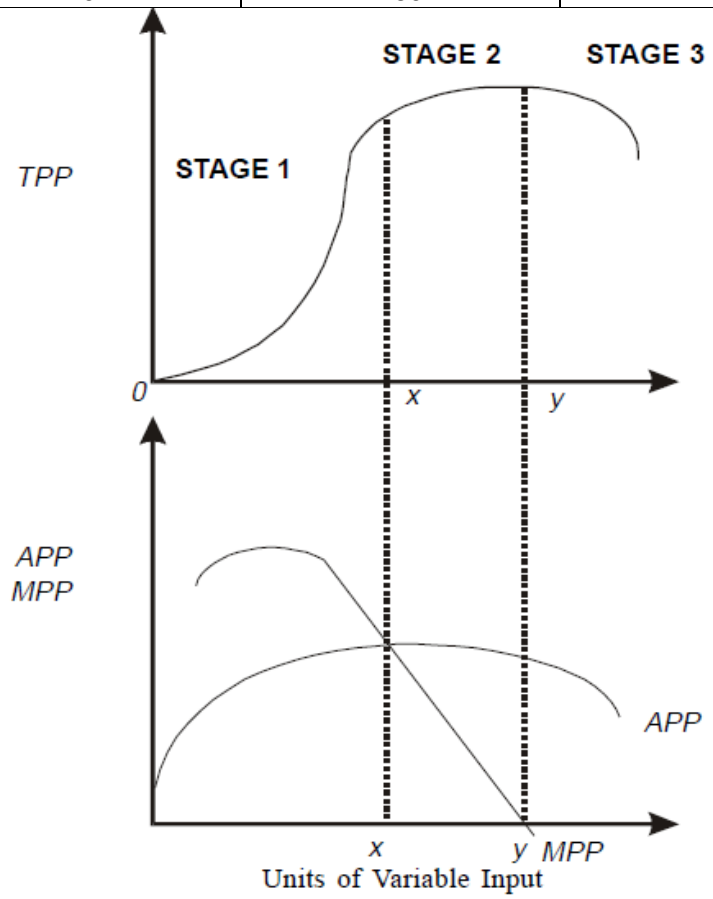
3 Decreasing returns to scale (DRTS). This refers to the situation where an increase in inputs results in a less-than-proportional increase in output.

Laws of Diminishing Return to Scale

If all inputs of a firm are fixed and only the amount of labour services vary, then any decrease or increase in output is achieved with the help of changes in the amount of labour services used. When the firm changes the amount of labour services only, it alters the proportion between the fixed input and the variable input. As the firm keeps on altering this proportion by changing the amount of labour, it experiences the law of variable proportion or diminishing marginal returns. This law states:

"As more and more of the factor input is employed, all other input quantities constant, a point will eventually be reached where additional quantities of varying input will yield diminishing marginal contributions to total product."

Number of Labour Units	Total Physical Product	Average Physical Product	Marginal physical Product
1	2	3 (1+2)	4
1	100	100	100
2	210	105	110
3	330	110	120
4	430	107.5	100
5	520	104	90
6	600	100	80
7	670	95.7	70
8	720	90	50
9	750	83.3	30
10	760	76	10



In the above table labour is assumed to be the only variable input. Columns 1 and 2 together represent the production function of the firm. Column 3 shows the average combination of labour units involved. Column 4 lists the amount of increase in output as a result of each additional unit of labour, e.g., the marginal physical product of 5th unit of labour is the total physical product of 5 units of labour minus the total physical product of 4 units. Column 4 shows that the marginal physical product starts declining from 4th unit of labour onward. If labour units employed increase beyond 10, the marginal physical product will become zero and later become negative. The stage from where the marginal physical product starts declining shows the law of diminishing returns or law of variable proportions.