

Theory of production

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 or exchange in a market economy. This can include manufacturing, storing, shipping, and packaging. Some economists define production broadly as all economic activity other than consumption. They see every commercial activity other than the final purchase as some form of production.

Production is a process, and as such it occurs through time and space. Because it is a flow concept, production is measured as a "rate of output per period of time". There are three aspects to production processes:

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.

A production process can be defined as any activity that increases the similarity between the pattern of demand for goods and services, and the quantity, form, shape, size, length and distribution of these goods and services available to the market place.

Production is a process of combining various material inputs and immaterial inputs (plans, know-how) in order to make something for consumption (the output). It is the act of creating output, a good or service which has value and contributes to the utility of individuals.

Production Function

- In economics, a production function relates physical output of a production process to physical inputs or factors of production.
- It is a mathematical function that relates the maximum amount of output that can be obtained from a given number of inputs - generally capital and labor.
- The production function, therefore, describes a boundary or frontier representing the limit of output obtainable from each feasible combination of inputs.
- 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 use to produce given the price of capital and labor.
- Increasing marginal costs can be identified using the production function. If a firm has a production function $Q=F(K,L)$ (that is, the quantity of output (Q) is some function of capital (K) and labor (L)), then if $2Q < F(2K,2L)$, the production function has increasing marginal costs and diminishing returns to scale. Similarly, if $2Q > F(2K,2L)$, there are increasing returns to scale, and if $2Q = F(2K,2L)$, there are constant returns to scale.

Examples of Common Production Functions

- One very simple example of a production function might be $Q=K+L$, where Q is the quantity of output, K is the amount of capital, and L is the amount of labor used in production. This production function says that a firm can produce one unit of output for every unit of capital or labor it employs. From this production function we can see that this industry has constant returns to scale - that is, the amount of output will increase proportionally to any increase in the amount of inputs.
- Another common production function is the Cobb-Douglas production function. One example of this type of function is $Q=K^{0.5}L^{0.5}$. This describes a firm that requires the least total number of inputs when the combination of inputs is relatively equal. For example, the firm could produce 25 units of output by using 25 units of capital and 25 of labor, or it could produce the same 25 units of output with 125 units of labor and only one unit of capital.
- Finally, the Leontief production function applies to situations in which inputs must be used in fixed proportions; starting from those proportions, if usage of one input is increased without another being increased, output will not change. This production function is given by $Q=\text{Min}(K,L)$. For example, a firm with five employees will produce five units of output as long as it has at least five units of capital.

Factors of production

- Economic resources are the goods or services available to individuals and businesses used to produce valuable consumer products.
- The classic economic resources include land, labor and capital. Entrepreneurship is also considered an economic resource because individuals are responsible for creating businesses and moving economic resources in the business environment.
- These economic resources are also called the factors of production. The factors of production describe the function that each resource performs in the business environment.

Land

- Land is the economic resource encompassing natural resources found within the economy.
- This resource includes timber, land, fisheries, farms and other similar natural resources.
- Land is usually a limited resource for many economies. Although some natural resources, such as timber, food and animals, are renewable, the physical land is usually a fixed resource.
- Nations must carefully use their land resource by creating a mix of natural and industrial uses.
- Using land for industrial purposes allows nations to improve the production processes for turning natural resources into consumer goods.

Labor

- Labor represents the human capital available to transform raw or national resources into consumer goods.

- Human capital includes all individuals capable of working in the economy and providing various services to other individuals or businesses.
- This factor of production is a flexible resource as workers can be allocated to different areas of the economy for producing consumer goods or services.
- Human capital can also be improved through training or educating workers to complete technical functions or business tasks when working with other economic resources.

Capital

- Capital has two economic definitions as a factor of production.
- Capital can represent the monetary resources companies use to purchase natural resources, land and other capital goods.
- Monetary resources flow through a economy as individuals buy and sell resources to individuals and businesses.
- Capital also represents the major physical assets individuals and companies use when producing 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.

Entrepreneurship

- Entrepreneurship is considered a factor of production because economic resources can exist in an 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 economic resources into consumer products.
- Entrepreneurship is 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.

The law of variable proportions

- If one input is variable and all other inputs are fixed the firm's production function exhibits the law of variable proportions.
- If the number of units of a variable factor is increased, keeping other factors constant, how output changes is the concern of this law.
- Suppose land, plant and equipment are the fixed factors, and labour the variable factor.
- When the number of labors is increased successively to have larger output, the proportion between fixed and variable factors is altered and the law of variable proportions sets in.

- The law states that as the quantity of a variable input is increased by equal doses keeping the quantities of other inputs constant, total product will increase, but after a point at a diminishing rate.
- The law of variable proportions (or the law of non-proportional returns) is also known as the law of diminishing returns.
- But, as we shall see below, the law of diminishing returns is only one phase of the more comprehensive law of variable proportions.

Assumption

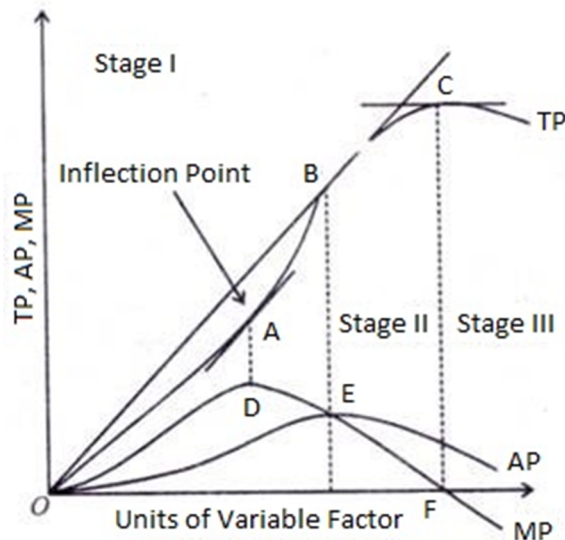
1. Only one factor is variable while others are held constant.
2. All units of the variable factor are homogeneous.
3. There is no change in technology.
4. It is possible to vary the proportions in which different inputs are combined.
5. It assumes a short-run situation, for in the long-run all factors are variable.
6. The product is measured in physical units, i.e., in quintals, tones, etc. The use of money in measuring the product may show increasing rather than decreasing returns if the price of the product rises, even though the output might have declined.

Example

No. of Workers	Total Product	Average Product	Marginal Product	
1	8	8	8	Stage I
2	20	10	12	
3	36	12	16	
4	48	12	12	Stage II
5	55	11	7	
6	60	10	5	
7	60	8.6	0	Stage III
8	56	7	-4	

- Given these assumptions, let us illustrate the law with the help of Above Table, where on the fixed input land of 4 acres, units of the variable input labor are employed and the resultant output is obtained.
- The production function is revealed in the first two columns. The average product and marginal product columns are derived from the total product column.

- $Average\ Product = \frac{Total\ Product}{No.\ of\ Workers}$
- Marginal Product is change in total production when we increase one worker. For example in table 3 worker produce 36 units and 4 worker produce 48 unit then marginal product is $(48 - 36) = 12$.
- An analysis of the Table shows that the total, average and marginal products increase at first, reach a maximum and then start declining.
- The total product reaches its maximum when 7 units of labor are used and then it declines.
- The average product continues to rise till the 4th unit while the marginal product reaches its maximum at the 3rd unit of labor, then they also fall. It should be noted that the point of falling output is not the same for total, average and marginal product.
- The marginal product starts declining first, the average product following it and the total product is the last to fall.
- This observation points out that the tendency to diminishing returns is ultimately found in the three productivity concepts.
- The law of variable proportions is presented diagrammatically in Figure below The Total Product (TP) curve first rises at an increasing rate up to point A where its slope is the highest. From point A upwards, the total product increases at a diminishing rate till it reaches its highest point C and then it starts falling.



- Point A where the tangent touches the TP curve is called the **inflection point** up to which the total product increases at an increasing rate and from where it starts increasing at a diminishing rate.
- The marginal product curve (MP) and the average product curve (AP) also rise with TP.
- The MP curve reaches its maximum point D when the slope of the TP curve is the maximum at point A.
- The maximum point on the AP curves is E where it coincides with the MP curve. This point also coincides with point B on TP curve from where the total product starts a gradual rise.
- When the TP curve reaches its maximum point C the MP curve becomes zero at point F.

- When TP starts declining, the MP curve becomes negative.
- It is only when the total product is zero that the average product also becomes zero.
- The rising, the falling and the negative phases of the total, marginal and average products are in fact the different stages of the law of variable proportions which are discussed below.

Three Stages of Production

Stage-I: Increasing Returns

- In stage I the average product reaches the maximum and equals the marginal product when 4 workers are employed, as shown in the Table Above.
- This stage is shown in the figure from the origin to point E where the MP curve reaches its maximum and the AP curve is still rising. In this stage, the TP curve also increases rapidly.
- Thus this stage relates to increasing returns.
- Here land is too much in relation to the workers employed. It is, therefore, profitable for a producer to increase more workers to produce more and more output.
- It becomes cheaper to produce the additional output. Consequently, it would be foolish to stop producing more in this stage. Thus the producer will always expand through this stage I.

Causes of Increasing Returns

1. The main reason for increasing returns in the first stage is that in the beginning the fixed factors are larger in quantity than the variable factor. When more units of the variable factor are applied to a fixed factor, the fixed factor is used more intensively and production increases rapidly.
2. In the beginning, the fixed factor cannot be put to the maximum use due to the non-applicability of sufficient units of the variable factor. But when units of the variable factor are applied in sufficient quantities, division of labor and specialization lead to per unit increase in production and the law of increasing returns operate.
3. Another reason for increasing returns is that the fixed factors are indivisible which means that they must be used in a fixed minimum size. When more units of the variable factor are applied on such a fixed factor, production increases more than proportionately. It points towards the law of increasing returns.

Stage-II: Diminishing Returns

- It is the most important stage of production. Stage II starts from point E where the MP curve intersects the AP curve which is at the maximum.
- Then both continue to decline with AP above MP and the TP curve begins to increase at a decreasing rate till it reaches point C.
- At this point the MP curve becomes negative when the TP curve begins to decline, table above shows this stage when the workers are increased from 4 to 7 to cultivate the given land.
- In figure, it lies between BE and CF. Here land is scarce and is used intensively. More and more workers are employed in order to have larger output.

- So in this stage the total product increases at a diminishing rate and the average and marginal product decline.
- This is the only stage in which production is feasible and profitable because in this stage the marginal productivity of labor, though positive, is diminishing but is non-negative.
- Hence it is not correct to say that the law of variable proportions is another name for the law of diminishing returns. In fact, the law of diminishing returns is only one phase of the law of variable proportions.
- The law of diminishing returns in this sense has been defined by Prof. Benham thus: "As the proportion of one factor in a combination of factors is increased, after a point, the average and marginal product of that factor will diminish."

Causes of Diminishing Returns

- But the law of diminishing returns is not applicable to agriculture only, rather it is applicable universally.
- It is called the law in its general form, which states that if the proportion in which the factors of production are combined, is disturbed, the average and marginal product of that factor will diminish.
- The distortion in the combination of factors may be either due to the increase in the proportion of one factor in relation to others or due to the scarcity of one in relation to other factors.
- In either case, diseconomies of production set in, which raise costs and reduce output.
- For instance, if plant is expanded by installing more machines, it may become unwieldy. Entrepreneurial control and supervision become lax, and diminishing returns set in. Or, there may arise scarcity of trained labor or raw material that leads to diminution in output.
- In fact, it is the scarcity of one factor in relation to other factors which is the root cause of the law of diminishing returns. The element of scarcity is found in factors because they cannot be substituted for one another.
- According to Wicksteed, the law of diminishing returns "is as universal as the law of life itself." The universal applicability of this law has taken economics to the realm of science.

Stage-III: Negative Marginal Returns

- Production cannot take place in stage III either. For in this stage, total product starts declining and the marginal product becomes negative.
- The employment of the 8th worker actually causes a decrease in total output from 60 to 56 units and makes the marginal product minus 4.
- In the figure, this stage starts from the dotted line CF where the MP curve is below the A'-axis. Here the workers are too many in relation to the available land, making it absolutely impossible to cultivate it.

The Best Stage

- In stage I, when production takes place to the left of point E, the fixed factor is excess in relation to the variable factors which cannot be used optimally. To the right of point F, the variable input is used excessively in Stage III. Therefore, no producer will produce in this stage because the marginal production is negative.
- Thus the first and third stages are economically not feasible.
- So production will always take place in the second stage in which total output of the firm increases at a diminishing rate and MP and AP are the maximum, then they start decreasing and production is optimum. This is the optimum and best stage of production.

The Law of Returns to Scale

- The law of returns to scale describes the relationship between outputs and scale of inputs in the long-run when all the inputs are increased in the same proportion.
- In the words of Prof. Roger Miller, "Returns to scale refer to the relationship between changes in output and proportionate changes in all factors of production.
- To meet a long-run change in demand, the firm increases its scale of production by using more space, more machines and labors in the factory'.

Assumptions

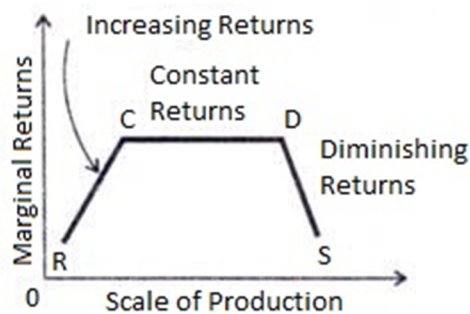
1. All factors (inputs) are variable but enterprise is fixed.
2. A worker works with given tools and implements.
3. Technological changes are absent.
4. There is perfect competition.
5. The product is measured in quantities.

Example

Given these assumptions, when all inputs are increased in unchanged proportions and the scale of production is expanded, the effect on output shows three stages: increasing returns to scale, constant returns to scale and diminishing returns to scale. They are explained with the help of Table and Figure below.

Unit	Scale of production	Total Returns	Marginal Returns
1	1 worker+2 acres Land	8	8
2	2 worker+4 acres Land	17	9
3	3 worker+6 acres Land	27	10
4	4 worker+8 acres Land	38	11
5	5 worker+10 acres Land	49	11
6	6 worker+12 acres Land	59	10
7	7 worker+14 acres Land	68	9
8	8 worker+16 acres Land	76	8

} **Increasing Returns** (Units 1-3)
} **Constant Returns** (Units 4-5)
} **Diminishing Returns** (Units 6-8)



Increasing Returns to Scale

- Returns to scale increase, because the increase in total output is more than proportional to the increase in all inputs.
- The table shows that in the beginning with the scale of production of (1 worker + 2 acres of land), total output is 8. To increase output when the scale of production is doubled (2 workers + 4 acres of land), total returns are more than doubled. They become 17. Now if the scale is trebled (3 workers + 6 acres of land), returns become more than three-fold, i.e., 27.
- It shows increasing returns to scale. In the figure RS is the returns to scale curve where R to C portion indicates increasing returns.

Causes of Increasing Returns to Scale

1. **Indivisibility of Factors:** Indivisibility means that machines, management, labor, finance, etc. cannot be available in very small sizes. They are available only in certain minimum sizes. When a business unit expands, the returns to scale increase because the indivisible factors are employed to their maximum capacity.

2. **Specialization and Division of Labor:** When the scale of the firm is expanded there is wide scope of specialization and division of labor. Work can be divided into small tasks and workers can be concentrated to narrower range of processes. For this, specialized equipment can be installed. Thus with specialization, efficiency increases and increasing returns to scale follow.
3. **Internal Economies:** As the firm expands, it enjoys internal economies of production. It may be able to install better machines, sell its products more easily, borrow money cheaply, procure the services of more efficient manager and workers, etc. All these economies help in increasing the returns to scale more than proportionately.
4. **External Economies:** When the industry itself expands to meet the increased long-run demand for its product, external economies appear which are shared by all the firms in the industry. When a large number of firms are concentrated at one place, skilled labor, credit and transport facilities are easily available. Subsidiary industries crop up to help the main industry. Trade journals, research and training centers appear which help in increasing the productive efficiency of the firms. Thus these external economies are also the cause of increasing returns to scale.

Constant Returns to Scale

- Returns to scale become constant as the increase in total output is in exact proportion to the increase in inputs.
- If the scale of production is increased further, total returns will increase in such a way that the marginal returns become constant.
- In the table, for the 4th and 5th units of the scale of production, marginal returns are 11, i.e., returns to scale are constant.
- In the figure, the portion from C to D of the RS curve is horizontal which depicts constant returns to scale.
- It means that increments of each input are constant at all levels of output.

Causes of Constant Returns to Scale

1. **Internal Economies and Diseconomies:** As the firm expands further, internal economies are counterbalanced by internal diseconomies. Returns increase in the same proportion so that there are constant returns to scale over a large range of output.
2. **External Economies and Diseconomies:** The returns to scale are constant when external diseconomies and economies are neutralized and output increases in the same proportion.
3. **Divisible Factors:** When factors of production are perfectly divisible, substitutable, and homogeneous with perfectly elastic supplies at given prices, returns to scale are constant.

Diminishing Returns to Scale

- Returns to scale diminish because the increase in output is less than proportional to the increase in inputs.

- The table shows that when output is increased from the 6th, 7th and 8th units, the total returns increase at a lower rate than before so that the marginal returns start diminishing successively to 10, 9 and 8.
- In the figure, the portion from D to S of the RS curve shows diminishing returns.

Causes of Diminishing Returns to Scale

1. Indivisible factors may become inefficient and less productive.
2. Business may become unwieldy and produce problems of supervision and coordination.
3. Large management creates difficulties of control and rigidities.
4. These arise from higher factor prices or from diminishing productivities of the factors.
5. As the industry continues to expand, the demand for skilled labor, land, capital, etc. rises. There being perfect competition, intensive bidding raises wages, rent and interest.
6. Prices of raw materials also go up. Transport and marketing difficulties emerge. All these factors tend to raise costs and the expansion of the firms leads to diminishing returns to scale so that doubling the scale would not lead to doubling the output.

Short Run and Long Run Cost

In economics, "short run" and "long run" are not broadly defined as a rest of time. Rather, they are unique to each firm.

Long Run Costs

- Long run costs are accumulated when firms change production levels over time in response to expected economic profits or losses.
- In the long run there are no fixed factors of production.
- The land, labor, capital goods, and entrepreneurship all vary to reach the long run cost of producing a good or service.
- The long run is a planning and implementation stage for producers. They analyze the current and projected state of the market in order to make production decisions.
- Efficient long run costs are sustained when the combination of outputs that a firm produces results in the desired quantity of the goods at the lowest possible cost.
- Examples of long run decisions that impact a firm's costs include changing the quantity of production, decreasing or expanding a company, and entering or leaving a market.

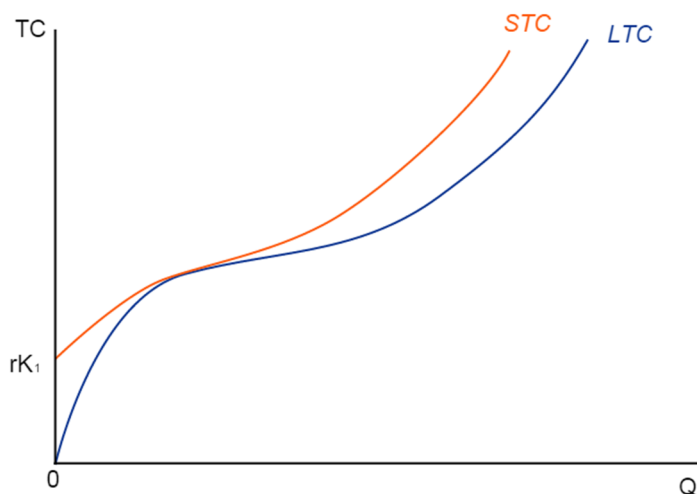
Short Run Costs

- Short run costs are accumulated in real time throughout the production process.
- Fixed costs have no impact of short run costs, only variable costs and revenues affect the short run production.

- Variable costs change with the output. Examples of variable costs include employee wages and costs of raw materials. The short run costs increase or decrease based on variable cost as well as the rate of production.
- If a firm manages its short run costs well over time, it will be more likely to succeed in reaching the desired long run costs and goals.

Comparison between Short Run and Long Run Cost

- The main difference between long run and short run costs is that there are no fixed factors in the long run; there are both fixed and variable factors in the short run.
- In the long run the general price level, contractual wages, and expectations adjust fully to the state of the economy. In the short run these variables do not always adjust due to the condensed time period.
- In order to be successful a firm must set realistic long run cost expectations. How the short run costs are handled determines whether the firm will meet its future production and financial goals.
- This graph shows the relationship between long run and short run costs.



Fixed Cost / indirect costs / overheads

- In economics, fixed costs are business expenses that are not dependent on the level of goods or services produced by the business. They tend to be time-related, such as salaries or rents being paid per month, and are often referred to as overhead costs.
- Fixed costs are not permanently fixed; they will change over time, but are fixed in relation to the quantity of production for the relevant period.
- For example, a company may have unexpected and unpredictable expenses unrelated to production, and warehouse costs and the like are fixed only over the time period of the lease.
- By definition, there are no fixed costs in the long run, because the long run is a sufficient period of time for all short-run fixed inputs to become variable.

Variable Cost

- Variable costs are costs that change in proportion to the good or service that a business produces.
- Variable costs are also the sum of marginal costs over all units produced.
- They can also be considered normal costs. Fixed costs and variable costs make up the two components of total cost.
- For example, variable manufacturing overhead costs are variable costs that are indirect costs, not direct costs. Variable costs are sometimes called unit-level costs as they vary with the number of units produced.

Example

Assume a business produces clothing. A variable cost of this product would be the direct material, i.e., cloth, and the direct labor. If it takes one laborer 10 ft. of cloth and 5 hours to make a garment, then the cost of labor and cloth increases if two garments are produced.

	1 Garment	2 Garment	3 Garment
Cloth (Direct Materials)	10 ft.	20 ft.	30 ft.
Labor (Direct Labor)	5 hrs	10 hrs	15 hrs

The amount of materials and labor that goes into each garment increases in direct proportion to the number of garments produced. In this sense, the cost "varies" as production varies.

Total Fixed Cost

- Total cost for all fixed inputs of the firm per time is called total fixed cost.
- For example firm taking land on lease Rs. 1 lack per month and borrowed money from other for that they have to pay interest Rs. 20000 per month which is not change with production it is fixed whether production is increasing or decreasing. So total fixed cost per month is Rs. 120000 per month

Total Variable Cost

- Total variable cost is calculated by adding variable cost of all variable inputs.
- It is varies with output.
- For example if material required for construction of one building is double if we construct two building.

Total Cost

- Total cost is sum of total fixed cost and total variable cost.

$$\text{Total Cost (TC)} = \text{Total Fixed Cost (TFC)} + \text{Total Variable Cost (TVC)}$$

- Note that change in total cost is influenced by the change in variable cost only.

Average Cost

- The average cost is the average obtained by dividing the total cost of producing a given volume of a product by the volume of production of that product. This is the average cost of a product per unit.
Average Cost (AC) = Total Cost (TC)/Total Volume Produced (TVP)
- For example if a company requires Rs. 100000 for producing 10 machine than the average cost is Rs. 10000.

Marginal Cost

- The benefit of mass production can be seen in marginal cost.
- If V1 volume of product is manufactured in X1 cost and it requires X2 cost for producing V1 + 1 volume then the marginal cost of production is X2 – X1 with reference to production volume V1.
- For example if 1000 toy is manufactured in Rs. 50000 and 1001 toy requires Rs. 50030 then the marginal cost is 30.

Opportunity Cost

- In real practice if alternative (X) is selected from a set of competing alternatives (X, Y), then the corresponding investment in the selected alternative is not available for any other purpose. If the same money is invested in some other alternative (Y) it may fetch some return. Since the money is invested in the selected alternative (X), one has to forget the return from the other alternatives (Y).the amount that is forgotten by not investing in the other alternative (Y) is known as the opportunity cost of the selected alternative (X).
- For example if you have Rs. 50000 to invest and have two option share market and real estate and you selected share market and got Rs, 4000 return in one year and same time if you invest it in real estate then it will give Rs. 5000 return then you have to forget Rs. 1000 due to not selecting real estate this 1000 is called Opportunity Cost.

Break-Even Analysis

- The main objective of break-even analysis is to find the cut-off production volume from where a firm will make profit. Let
 $s = \text{selling price per unit}$
 $v = \text{variable cost per unit}$
 $FC = \text{fixed cost per period}$
 $Q = \text{volume of production}$
- Total sales revenue (S) of the firm is given by the following formula:
 $S = s * Q$

- Total cost (TC) of the firm for a given production volume is given by:
 $TC = \text{Total variable cost} + \text{Fixed cost}$
 $TC = v * Q + FC$
- The linear plot of above two equations is:

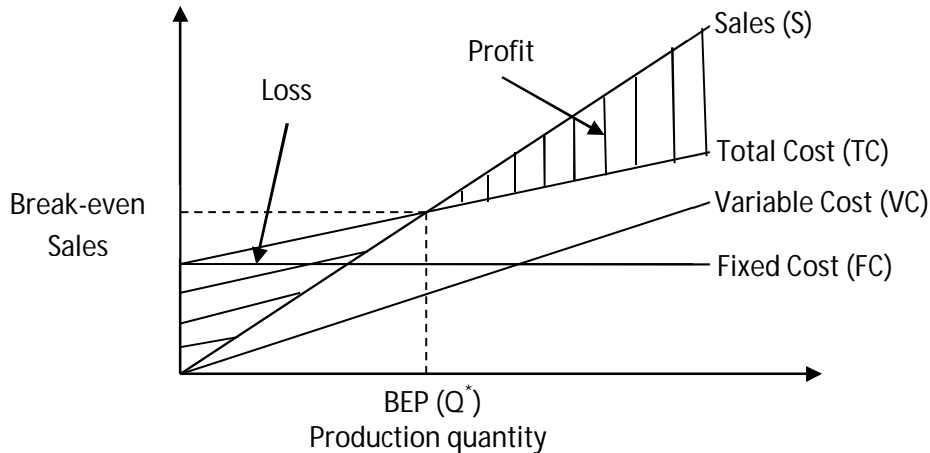


Fig.:- Break-even chart

- The intersection point of the total sales revenue line and the total cost line is called the break-even point.
- On X-axis volume of production at BEP is called break-even sales quantity and on Y-axis at BEP we get break-even sales.
- At break-even point revenue is equals to total cost and so it is also called No profits No loss situation.
- Quantity less then break-even quantity will put firm in loss as total cost is more than total revenue. Similarly quantity greater than break-even quantity will make profit.
- Profit is calculated as follows:
 $\text{Profit} = \text{Sales} - (\text{Fixed cost} + \text{Variable costs})$
 $\text{Profit} = s * Q - (FC + v * Q)$
- Break-even quantity and break-even sales can be calculated as follows:

$$\text{Break even quantity} = \frac{\text{Fixed Cost}}{\text{Selling price/unit} - \text{Variable cost/unit}}$$

$$\text{Break even quantity} = \frac{FC}{s - v} \text{ (in units)}$$

$$\text{Break even sales} = \frac{\text{Fixed Cost}}{\text{Selling price/unit} - \text{Variable cost/unit}} * \text{Selling price/unit}$$

$$\text{Break even sales} = \frac{FC}{s - v} * s \text{ (in Rs.)}$$
- The contribution is the difference between the sales and the variable cost.

Contribution = Sales – Variable costs

Contribution/unit = Selling price/unit – Variable cost/unit

- The margin of Safety (M. S.) is the sales over and above the break-even sales. It can be calculated by two methods and one can be derived from other.

- Method I:

$$M. S. = \frac{\text{Profit}}{\text{Contribution}} * \text{sales}$$

- Method II derived from method I:

$$M. S. = \frac{\text{Profit}}{\text{Contribution}} * \text{sales}$$

$$M. S. = \frac{s * Q - (FC + v * Q)}{\text{Sales} - \text{Variable costs}} * \text{sales}$$

$$M. S. = \frac{s * Q - (FC + v * Q)}{(s * Q) - (v * Q)} * (s * Q)$$

$$M. S. = \frac{(s * Q - v * Q - FC)}{(s * Q) - (v * Q)} * (s * Q)$$

$$M. S. = \frac{(s * Q - v * Q) - (FC)}{(s * Q) - (v * Q)} * (s * Q)$$

$$M. S. = (s * Q) - \frac{FC}{s - v} * s$$

M. S. = Sales – Break even sales

- Now M.S. as a percent of sales:

$$M. S. \text{ as a percent of sales} = \frac{M. S.}{\text{Sales}} * 100$$

Example

Alpha Associates has the following details:

Fixed cost = Rs. 20,00,000

Variable cost per unit = Rs. 100

Selling price per unit = Rs. 200

Find

(a) The break-even sales quantity

(b) The break-even sales

(c) If the actual product quantity is 60,000, find (i) contribution; and (ii) margin of safety by all methods.

Solution

Fixed cost (FC) = Rs. 20,00,000

Variable cost per unit (v) = Rs. 100

Selling price per unit (s) = Rs. 200

(a) Break even quantity = $\frac{FC}{s-v} = \frac{20,00,000}{200-100} = 20,000 \text{ units}$

(b) Break even sales = $\frac{FC}{s-v} * s = \frac{20,00,000}{200-100} * 200 = 40,00,000$

(c) (i) Contribution = Sales – Variable costs = $s * Q - v * Q = 200 * 60,000 - 100 * 60,000$
Contribution = 60,00,000

(c) (ii) margin of safety

Method I

$$\text{M. S.} = \frac{\text{Profit}}{\text{Contribution}} * \text{sales} = \frac{\text{Sales} - (\text{FC} + v * Q)}{\text{Contribution}} * \text{sales}$$

$$\text{M. S.} = \frac{60,000 * 200 - (20,00,000 + 100 * 60,000)}{60,00,000} * 1,20,00,000 = 80,00,000$$

Method II

$$\text{M. S.} = \text{Sales} - \text{Break even sales} = 60,000 * 200 - 40,00,000 = 80,00,000$$

$$\text{M. S. as a percent of sales} = \frac{\text{M. S.}}{\text{Sales}} * 100 = \frac{80,00,000}{1,20,00,000} * 100 = 67\%$$