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Module 2

Production Function

Production function: It describes an empirical relationship b/w inputs and output.

Types:

a) Fixed proportions production functions
b) Variable proportions production function.
c) Linear homogenous production function

Cobb – Douglas production function

It is the most widely used empirical production function. It is of the form $Q = AK^{\alpha}L^{\beta}$

$$Q = AK^{\alpha}L^{\beta}$$

Q → Total output
K → capital
L → Labour
A → Technology parameter
α → Elasticity of output wrt capital
β → Elasticity of output wrt labour.

On the basis of time, production function is classified into:

1) Short-Run explained by Law of variable proportions.
2) Long-run explained by Law of returns to scale.

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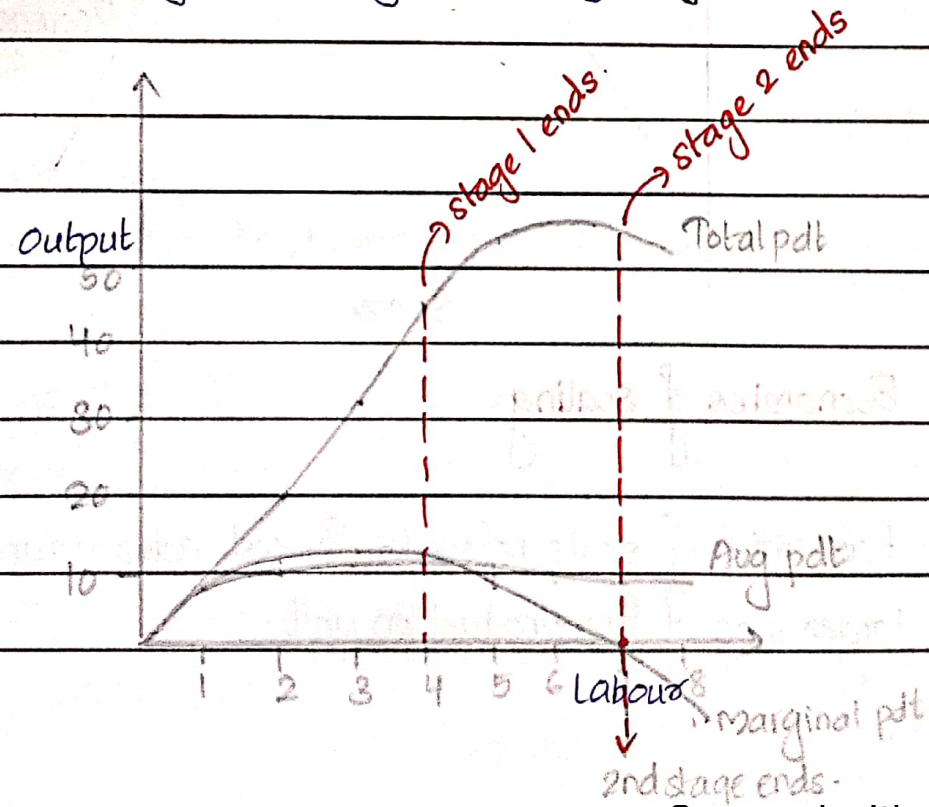
Law of variable proportions

(Law of diminishing marginal productivity)

Units of labour	Total product	Average product	Marginal product	Stages of the law
1	8	8	8	Increasing returns
2	20	10	12	"
3	34	11	14	"
4	46	11.5	12	"
5	54	11	8	Decreasing returns
6	56	9	2	
7	56	8	0	
8	54	7	−2	−ve returns

[Max employees company will employ = 6.]



→ The law states that as the proportion of one factor is increased after a point, first the marginal and then the average product of that factor will diminish.

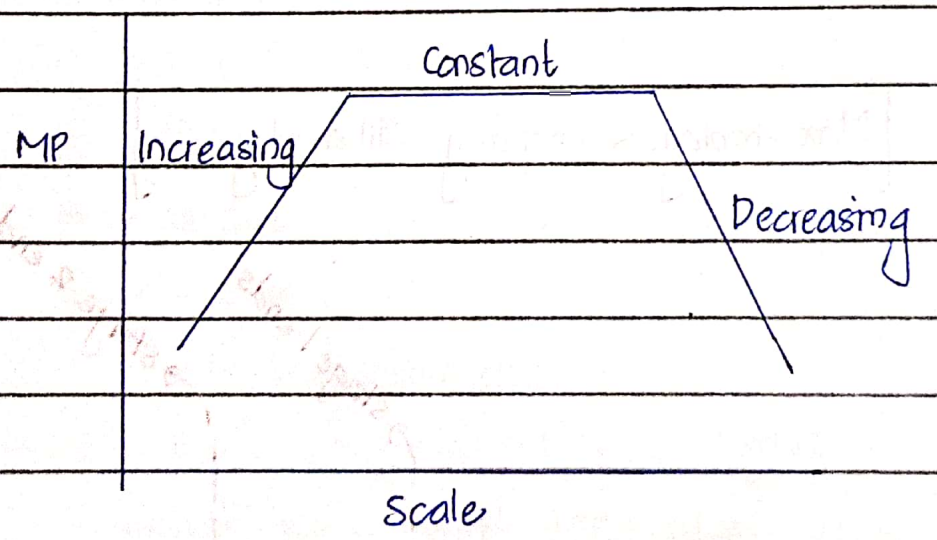
→ The law has 3 stages:

The law of returns to scale

→ In the long run, all factors can be changed. Returns to scale studies the change in op when all the factors are changed.

→ The law has 3 phases.

a) Increasing returns.
b) Constant returns to scale.
c) Diminishing returns



Economies of scaling

Economies of scale refers to the cost advantages due to a larger size of the production unit.

There are several advantages due to large scale production.

Types:

1) Internal economies: These are advantages enjoyed within the company. These are:
   (i) Technical economies
   (ii) Financial economies.
   (iii) Labour economies
2) Market
   (iv) Marketing economies
   (v) Diversification economies

2) External economies: This is the advantage enjoyed by all the firms in the industry due to structural growth.
   (i) Increased transport facilities.
   (ii) Development of banking facilities.
   (iii) Development of townships.
   (iv) Information and communication development.

Diseconomies of scale

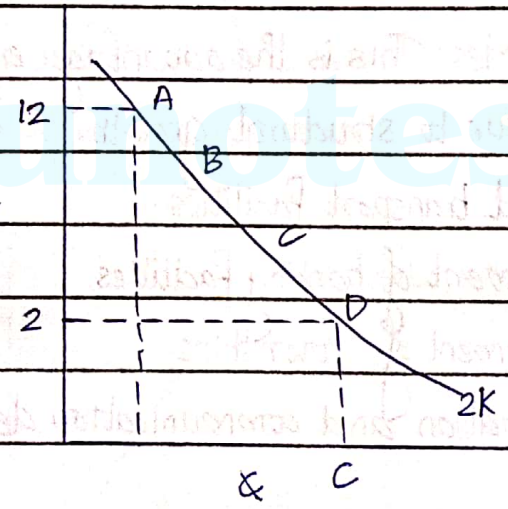
→ It refers to the disadvantages arising due to large scale production.

Producer's equilibrium

The eqbm of a firm can be studied with the help of isoquants and isocost lines.

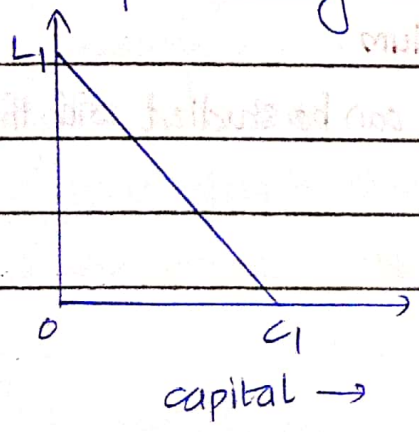
Isoquants: It is a curve that represents different combinations of two factors of production that give the same level of output.

Combination	Capital	Labour	Output
A	1	12	2000
B	2	8	2000
C	3	5	2000
D	4	3	2000
E	5	2	2000



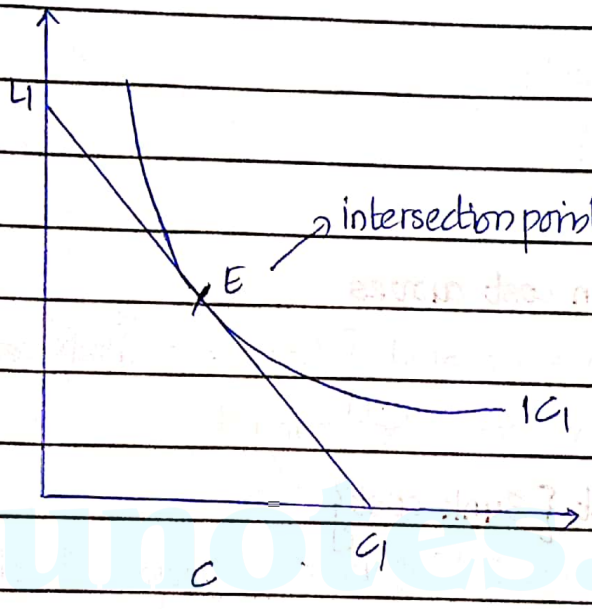
Isocost Line:

It is the locus of points representing various combinations of two factors which the firm can buy with a given outlay (expenditure).



Slope of the isocostline = $\frac{\text{price of capital}}{\text{price of labour}}$

Producer's equilibrium



Technical progress

Technical progress occurs when more o/p is produced with the same level of i/ps.

There are 3 types of technical progress.

a) Neutral technical progress
b) Labour augmenting technical progress
c) Capital augmenting

Cost concepts

1) Opportunity cost : It is the value of the next best alternative forgone
2) Explicit cost : These are payments made by the entrepreneur to the

suppliers of various factors.

3) Implicit cost : It is the cost of self-owned resources of the entrepreneur.

4) Private cost: It is the cost that the firm pays inorder to produce a product.

5) External cost:

6) Social cost

Short run cost curves

Short run is a period of time over which certain factors of production cannot be changed.

Fixed cost {Sunk cost}

These are costs that do not change with o/p.

Eg: Rent, Salary of permanent staff, interest.

Variable cost

These are costs that change with the level of o/p.

Eg: cost of raw materials, electricity, fuel.

Total cost

Total cost = fixed cost + variable cost

ie; $TC = TFC + TVC$.

Average fixed cost

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

Q is output

Average variable cost

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

Average cost

$$AC = \frac{TC}{Q} \quad \text{or} \quad AFC + AVC.$$

Marginal cost

Cost of producing last unit of the pdt.

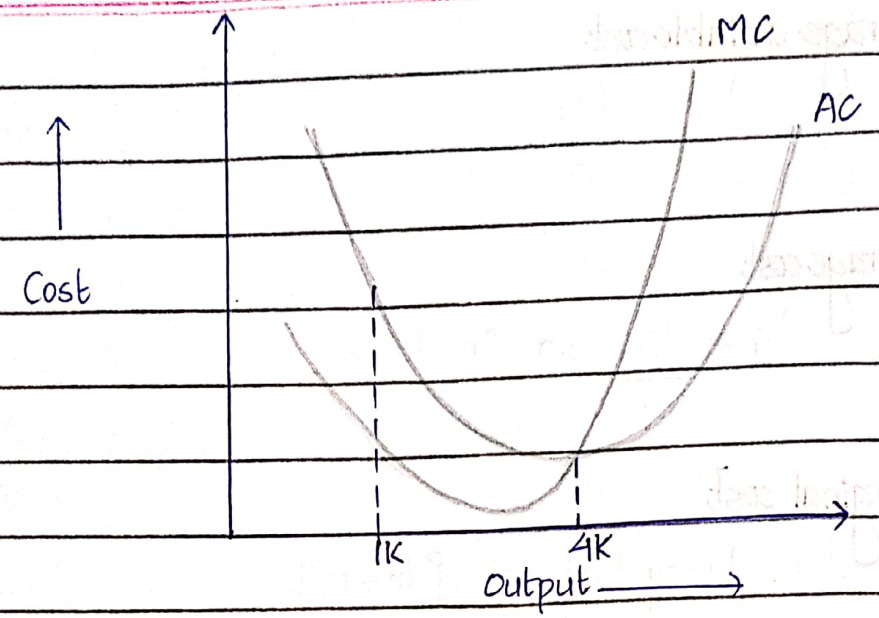
$$MC = TC(N) - TC(N-1)$$

Eg:

Output	TFC	TVC	TC	AFC	AVC	AC	MC
1	30	10	40	30	10	40	
2	30	18	48	15	9	24	
3	30	24	54	10	8	18	
4	30	32	62	7.5	8	15.5	
5	30	50	80	6	10	16	
6	30	72	102	5	12	17	
0	30	0	30	–	–	–	

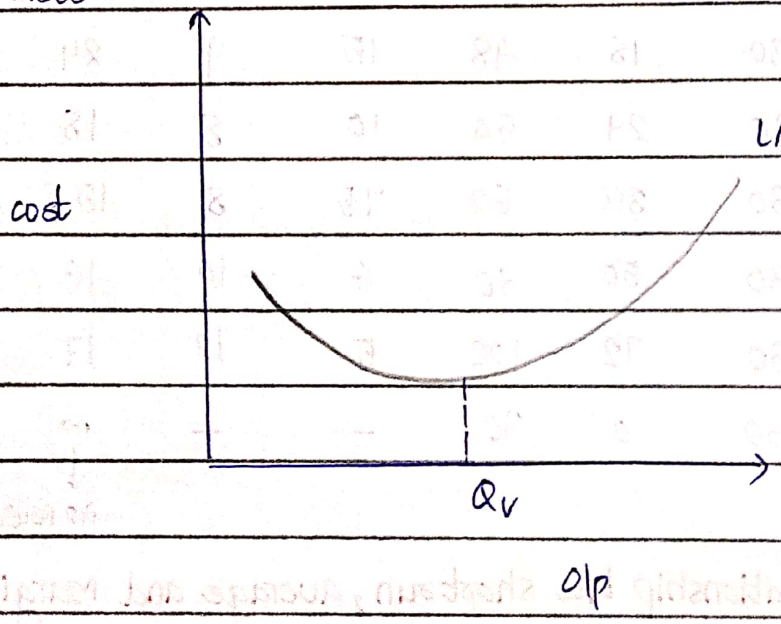
↓ no relevance

Relationship blw shoot run, average and marginal cost curves



Long run average cost curve

In the long run, all factors are variable. The LAC curve takes on the shape of a boat ∵ it initially falls but after a certain point, slowly rises.



Revenue

It is the amount of money that the firm receives from the sale of its output.

Total revenue:

$TR = P \times Q$ [price x output]

Average revenue: (price)

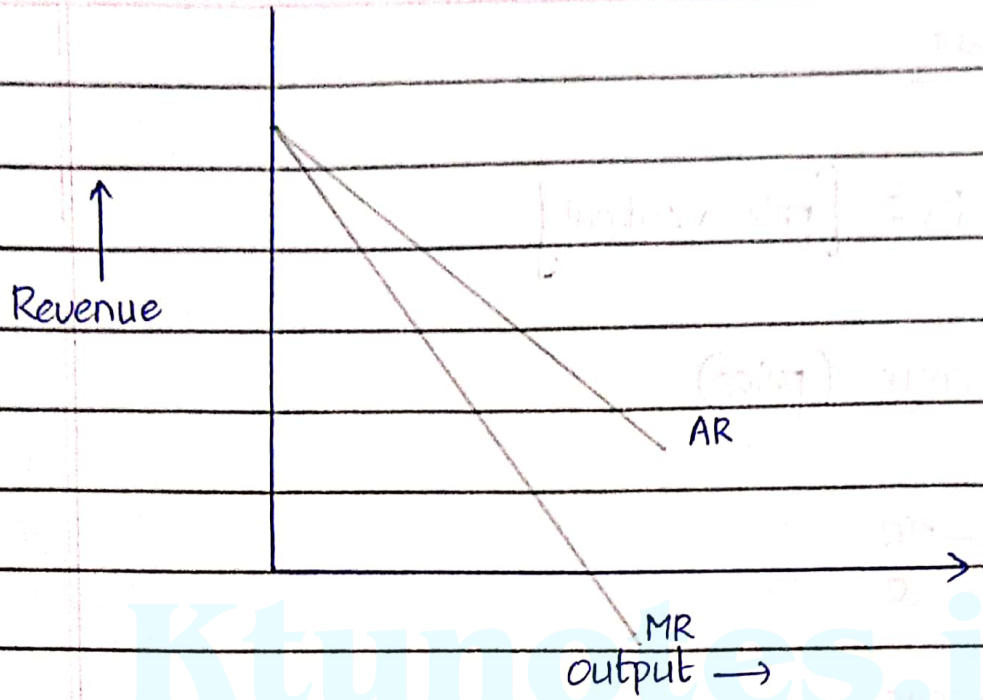
$$AR = \frac{TR}{Q}$$

Marginal revenue

$$MR = TR(N) - TR(N-1)$$

Relationship between AR and MR

Units sold	AR	TR	MR
1	10	10	10
2	9	18	8
3	8	24	6
4	7	28	4
5	6	30	2
6	5	30	0



Shut down point

It is the point at which the company earns just enough revenue to cover its total variable cost. It is the price at which a company would close down its operations rather than manufacture anything.

It occurs when P = ~~ADC~~ AVC

ie when Price = Average variable cost

Module 2 (Production and cost)

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves -long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

2.1 Production Function

A production function describes an empirical relationship between output and inputs. It specifies the maximum output that can be produced with a given quantity of inputs. It is the functional relationship between physical inputs and physical output for a given state of technology. Inputs refer to the factors used in production i.e. land, labour, capital and enterprise. Output refers to the quantity of commodities produced.

The production function is given as

$Q = f(x_1, x_2, x_3.....)$

Where Q is the output of a commodity and x_1, x_2, x_3…..are the various productive resources which go into the making of the quantity of the commodity.

Production depends on
1. Quantity of resources used
2. Level of technology
3. Size of the firm
4. Production processes used
5. Relative prices of factors
6. Manner in which factors are combined

Types of Production Functions

1. Fixed Proportions Production Function

Here the factors of production are used in definite fixed proportions. The firm cannot vary the proportion of the factors, say labour and capital no matter the level of output.

2. Variable Proportions Production Function

Here the ratio in which the factors of production are used is variable. A given quantity of output can be produced by several alternative combinations of factors.

3. Linear Homogenous Production Function

If all the factors of production are increased in some proportion, the output also increases in the same proportion. A doubling of all inputs will double output. The Cobb-Douglas Production Function is an example of a linearly homogeneous production function.

On the basis of time period, production function is classified into two:

1. Short-run production function which is explained by the Law of Variable Proportions and
2. Long-run production function which is explained by the Law of Returns to Scale

2.2 Cobb- Douglas Production Function

It is a well-known empirical production function and is widely used to represent the relationship of an output to inputs.

Charles Cobb and Paul Douglas published a study in which they modeled the growth of the American economy. They considered a simplified view of the economy in which production output is determined by the amount of labor involved and the amount of capital invested and their model proved to be remarkably accurate.

The function they used to model production was of the form:

$$Q = AK^{\alpha} L^{\beta}$$

Q = total production
K = capital input
L = labor input
A = technology parameter
α = elasticity of output with respect to capital
β = elasticity of output with respect to labour

Feature of Cobb-Douglas production function

The returns to scale in a Cobb-Douglas production function is revealed by the sum of the two parameters α and β.

a. If $(\alpha + \beta) = 1$, the function exhibits constant returns to scale.
b. If $(\alpha + \beta) > 1$, the function exhibits increasing returns to scale.
c. If $(\alpha + \beta) < 1$, the function exhibits decreasing returns to scale.

2.3 Law of Variable Proportions (Law of Diminishing Marginal Productivity)

This law is applicable to the short-run time period where only one factor is variable and the other factors are fixed. It shows the relationship between units of a variable factor and total product. The law states that 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. Accordingly, total physical product first increases at an increasing rate, then at a diminishing rate and finally it declines.

Total, Average and Marginal Product

Total product represents the total amount of output produced. In the table below, it starts at zero for zero labour and then increases as additional units of labour are applied. It reaches a maximum when 6 units of labour are used and then declines.

The marginal product of an input is the extra output produced by one additional unit of that input when other inputs are held constant. Here marginal unit means extra unit.

Average product is total product divided by total units of input.

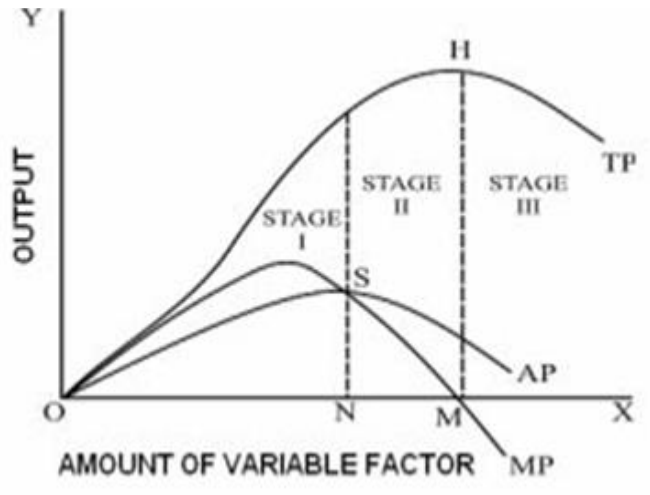
Assumptions of the law

1. Only one factor is made variable and other factors are kept constant.
2. This law does not apply in case all factors are proportionately varied. i.e. where the factors must be used in rigidly fixed proportions to yield a product.
3. The variable factor units are homogenous i.e. all the units of variable factors are of equal efficiency.
4. Input prices remain unchanged.
5. The state of technology does not change or remains the same at a given point of time.
6. The entire operation is only for short-run, as in the long-run all inputs are variable.

The Law

The law of variable proportions has three stages.

Units of Labour	Total Product	Average Product	Marginal Product	Stages
1	8	8	8	Increasing Returns
2	20	10	12	
3	34	11	14	
4	46	11.5	12	
5	54	11	8	Decreasing Returns
6	56	9	2	
7	56	8	0	
8	54	7	-2	Negative Returns



Stage I - Stage of increasing returns

In this stage, the total product, the average product and the marginal product are increasing. The marginal product in this stage increases but later it starts declining. Though marginal product starts declining, it is greater than the average product so that the average product continues to rise. It ends where the average product reaches its maximum point.

Stage II - Stage of decreasing returns

In the second stage, the total product continues to increase but at a diminishing rate. The marginal product and the average product are declining but are positive. At the end of the second stage, the total product is a maximum and the marginal product is zero.

Stage III - Stage of negative returns

In this stage the marginal product becomes negative. The total product and the average product are declining.

A firm will not choose to produce in stages I and III. In stage I since marginal product increases with the increase in a variable factor, there is scope for more efficient utilisation of fixed factors by employing more units of the variable factor. So, the firm will increase its production further. In stage III since the total product is declining and marginal product is negative, the firm has become very inefficient and it can increase its output by reducing the variable factor.

It will choose only the second stage where the total product is a maximum to produce. Thus, the second stage represents the range of rational production decisions.

Limitations of the Law

The law may not work properly in industries where technological changes are rapid. In agriculture too newer techniques like scientific rotation of crops, fertilisers, improved seeds, irrigation and modern implements have all given increasing returns.

Applications of the Law

1. The law applies to agriculture. Since the supply of fertile land is totally fixed, diminishing returns will set in agriculture more quickly than in other industries.
2. The law is applicable in extractive industries like mining, fishing and construction.
3. The law teaches developing countries like India that they are likely to run out of food, drinking water and other natural resources if population keeps on increasing.
4. The law tells businessmen the importance of an optimum plant size in manufacturing industries.

2.4 **Returns to Scale** (Long-run production function)

In the long run, all factors can be changed. Returns to scale studies the changes in output when all factors or inputs are changed. An increase in scale means that all inputs or factors are increased in the same proportion.

The changes in output as a result of changes in the scale can be studied in 3 phases.

1. Increasing returns to scale

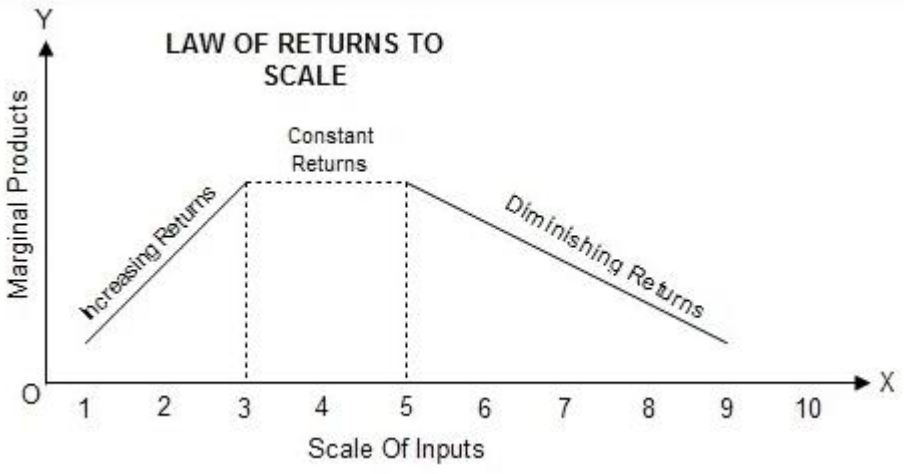
If the increase in all factors leads to a more than proportionate increase in output, it is called increasing returns to scale. For example, if all the inputs are increased by 5%, the output increases by more than 5%. In this case the marginal product will be rising. When a firm expands, increasing returns to scale are obtained in the beginning.

2. Constant returns to scale

If all the factors are increased in a given proportion and then the output increases in the same proportion it is constant returns to scale. i.e. a 5% increase in all the factors will result in an equal proportion of 5% increase in the output. Here the marginal product is constant.

3. Decreasing returns to scale

If the increase in all factors leads to a less than proportionate increase in output, it is called decreasing returns to scale i.e. if all the factors are increased by 5%, and the output increases by less than 5 %. In this phase marginal product will be decreasing. More and more of inputs are required to obtain equal increments of output.



The above figure explains the different phases of returns to scale. When marginal product increases, total product increases at an increasing rate. So, there is increasing returns to scale. When marginal product remains constant, total product increases at a constant rate and this stage is called constant returns to scale. When marginal product decreases, total product increases at a decreasing rate and returns to scale are decreasing.

2.5 Economies of scale

Economies mean advantages. *Scale* refers to the size of unit. Economies of scale refer to the cost advantages due to the larger size of production. As the volume of production increases, the overhead costs will come down. Bulk purchases of inputs will give a better bargaining power to the producer which will reduce the average variable cost too. All these advantages are due to the large-scale production and these advantages are called economies of scale.

There are two types of economies of scale

a. Internal Economies of Scale

Internal economies of scale are the advantages enjoyed within the production unit. These economies are enjoyed by a single firm independently of the action of the other firms. For instance, one firm may enjoy the advantage of good management; another may have the advantage of more up-to-date machinery. There are different types of internal economies. They are

1. Technical Economies: As the size of the firm is large, more capital is available and the firm can introduce up to date technologies. It is also possible to conduct research and development which will help to increase the quality of the product.
2. Financial Economies: Small firms have to borrow capital whereas large firms can buy capital. It is possible for big firms to float shares in the market and amass capital.
3. Labour Economies: Large Scale production paves the way for division of labour and specialisation. This will increase the quality and ability of the labour. The productivity of the firm increases.
4. Marketing Economies: In the case of big firms, the quantity bought is larger. This gives the producer a better bargaining power.
5. Diversification Economies: A large firm can have many products. Even if one product fails in the market, the loss incurred in that product can be managed by the profit earned from the other products.
6. Purchase Economies. A firm ordering bulk purchases get raw materials at the lowest possible cost.

b. External economies of scale

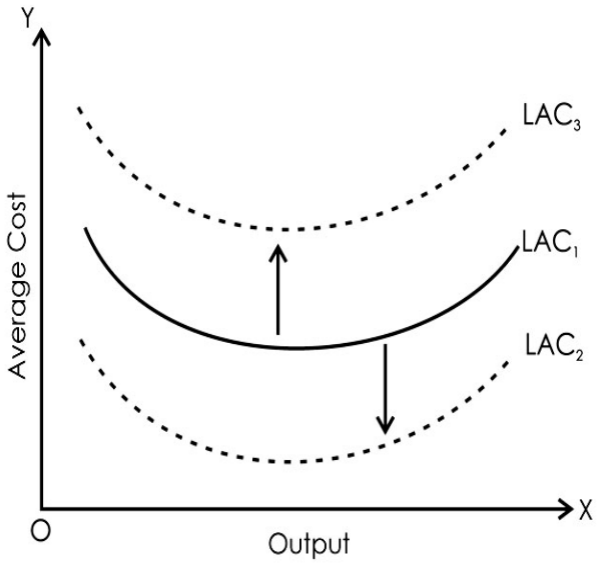
When many firms expand in a particular area, the industry grows and all of them enjoy a number of advantages which are known as external economies of scale. This is not the advantage enjoyed by a single firm but by all the firms in the industry due to structural growth. They are:
a) Increased transport facilities.
b) Banking facilities.
c) Development of townships.
d) Information and communication development.

All these facilities are available to all firms in an industrial region and result in all round development which finally benefits each one of the firms.

Factors Causing Economies of Scale:

There are various factors influencing the economies of scale of an organization.

1. Labour specialisation. If the labour force of a firm is specialized in a specific skill then the organization can achieve economies of scale due to higher labour productivity.
2. Selling different types of products in a large number of markets. A firm having a variety of products will be able to spread their risk and reduce losses.
3. Economies of scale in purchase. When the organization purchases raw material in bulk its cost is reduced. A uniform and better quality can also be ensured. Transportation cost would also be lower.
4. Better repair and maintenance facilities in the area.
5. Research and development facilities in the region.
6. The plant location plays a major role in cutting down the cost of materials, transport and other expenses.
5. Use of Information Technology.
6. Organizations can increase the economies of scale by minimizing waste and can be environmental responsible by promoting recycling.



As a result of external economies, the LAC curve of the firms shifts downwards from LAC_1 to LAC_2.

2.6 Diseconomies of Scale

Diseconomies of scale refer to the disadvantages arising to a firm or a group of firms due to large scale production.

a. Internal diseconomies of Scale

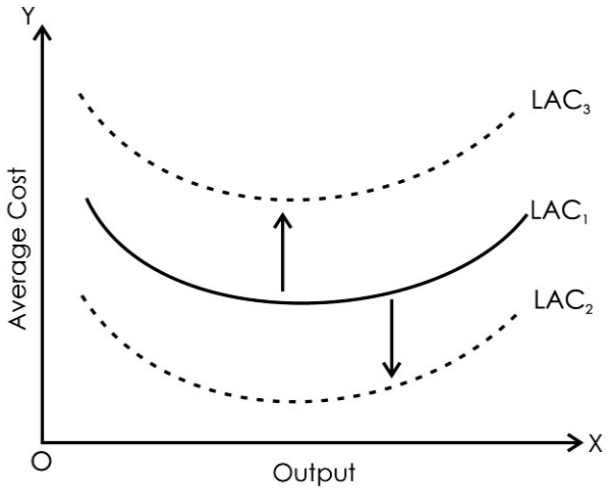
If a firm continues to grow and expand beyond the optimum capacity, the economies of scale disappear and diseconomies will start operating. For instance, if the size of a firm increases, after a point the difficulty of management arises to that particular firm which will increase the average cost of production of that firm. This is known as internal diseconomies of scale.

b. External diseconomies of scale

Beyond a certain stage, too much concentration and localisation of industries will create diseconomies in production which will be common for all firms in a locality. For instance, the expansion of an industry in a particular area leads to high rents and high costs. Pollution costs arising on account of concentration of industries is another example. These are the external diseconomies as this negatively affects all the firms in the industry located in that particular region.

Factors Causing Diseconomies of Scale:

1. Continuous labour problem and dissatisfaction can lead to diseconomies of scale.
2. Poor performance of the management team.
3. Lack of coordination between the various departments in the organisation.
4. Difficulties in fund raising reduce the scale of operation.
5. Delay in decision making due to managerial inability.
6. Scarcity of resources
7. Growing risk factors can cause diseconomies of scale in an organization.



As a result of external diseconomies, the LAC curve of the firms shifts upwards from LAC_1 to LAC_3.

2.7 Isoquant curve, Isocost line and Producer's Equilibrium

The equilibrium of a firm can be studied with the help of isoquant and isocost lines.

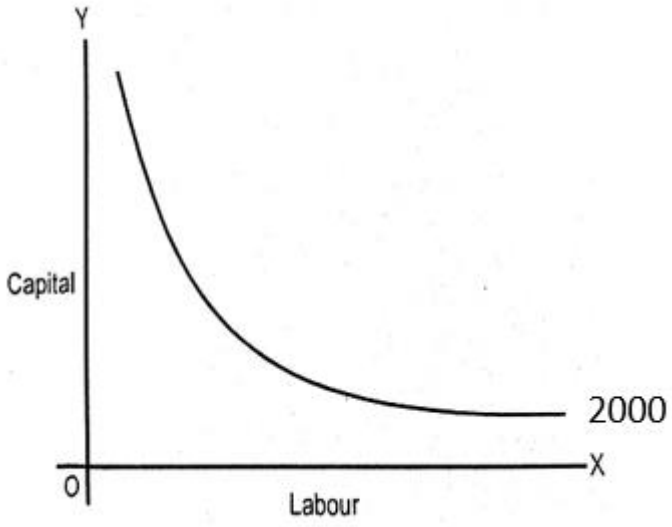
Isoquant

The isoquant curve represents different combinations of two inputs that give the same level of output. Isoquants are also called isoproduct or equal product curves.

Considering two factors of production, labour and capital, the following table shows various combinations of capital and labour that help a firm to produce 1000 units of a product.

Combination	Labour	Capital	Output
A	12	1	2000
B	8	2	2000
C	5	3	2000
D	3	4	2000
E	2	5	2000

The above table shows that all combinations with different quantities of labour and capital result in the same level of output of 2000 units.



The two axes measure the quantities of labour and capital and the curve IQ shows the different combinations that produce 2000 units of output. Any point on the curve shows a labour-capital combination that can produce 2000 units of output.

Characteristics of an isoquant

1. The isoquant is downward sloping from left to right i.e. it is negatively sloped.
2. Isoquants are always convex to the origin.
3. A higher isoquant represents a higher level of output.
4. Isoquants never intersect.

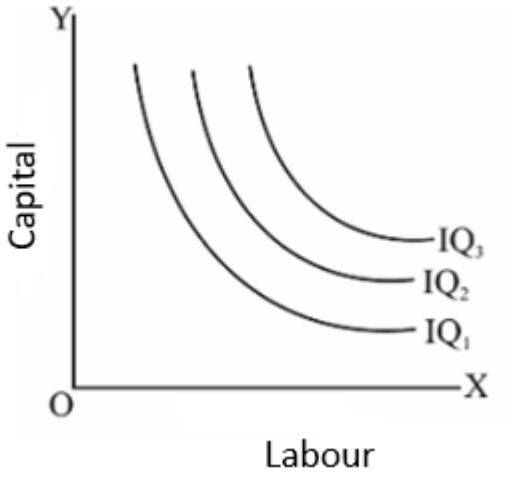
Marginal rate of technical substitution

Marginal rate of technical substitution is the rate at which one input is replaced by the employment of additional units of the other input, the level of output remaining the same. An isoquant is convex to the origin because of the diminishing marginal rate of technical substitution.

Slope of isoquant = $MRTS_{LK} = \frac{\Delta K}{\Delta L}$

Isoquant map

A set of isoquants which represents different levels of output is called isoquant map. In the isoquant map, the isoquants on the right side represent higher levels of output and those on the left represent lower level of output.



Isocost Line

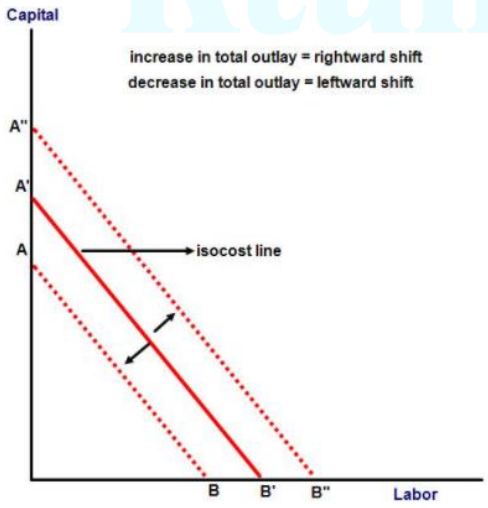
An isocost line is defined as locus of points representing various combinations of two inputs which the firm can buy for the same amount of money. A higher isocost line represent a higher expenditure. It plays an important role in determining the combination of factors that the firm will choose for production.

The isocost line depends on two things:

(1) Prices of the inputs and

(2) The total expenditure.

If the firm spends its entire money on capital it can purchase OA units of capital and if it spends on labour alone it can have OB units of labour. Upon drawing a line connecting points A and B the isocost line of the firm is obtained.

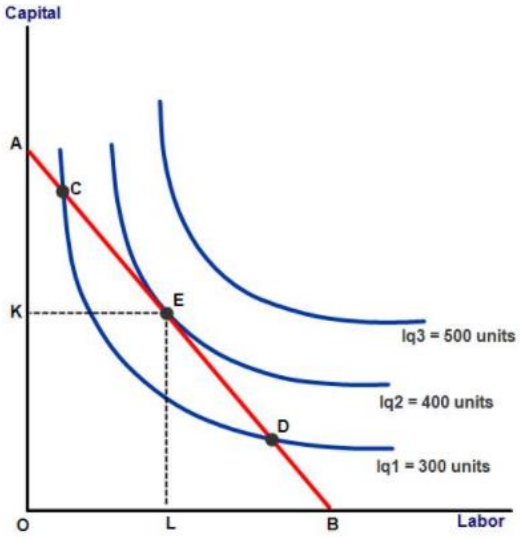


The slope of the isocost line is given by OA/OB. Since the price of labour determines how many units can be purchased to substitute for capital, the slope of the isocost line is the ratio of the price of labour to the price of capital.

$$Slope\ of\ isocost\ line = \frac{Price\ of\ Labour}{Price\ of\ Capital}$$

Producer's Equilibrium (Least cost factor combination)

By superimposing the isoquant curve on the isocost line, the equilibrium of the producer can be determined. A rational producer always tries to achieve maximum output by combining the factors in an optimal way. The firm will try to be on the highest possible isoquant. However, it is limited by its budget. It will be on the highest isocost line that its expenditure will allow.



The producer will choose that level of output, where a given isocost line is tangential to the highest possible isoquant. In the figure E is the point of equilibrium, where isoquant Iq_2 is tangential to isocost line AB. At this point, the slopes of the isoquant and isocost line are equal. The firm would not want to be at points C or D since they represent a lower level of output.

At the equilibrium point the marginal rate of technical substitution is equal to the price ratio of factors. The condition for producer's equilibrium is

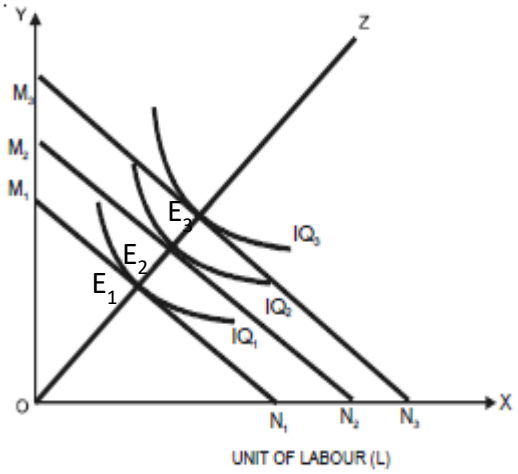
$$MRTS_{LK} = \frac{P_L}{P_K}$$

The combination E where the firm combines OL labour and OQ capital is called the least cost combination and it maximises the profits at this point.

2.8 Expansion Path

Expansion path is defined as the line formed by joining the tangency points between various isocost lines and the corresponding highest attainable isoquants. It is the locus of equilibrium points of the isoquant with the lowest possible isocost line.

A line can be drawn connecting all the points where the different isocost lines are tangent to the different isoquant curves. This is represented by the line OZ and is the expansion path of the firm. This line is also known as the scale line because it shows the way in which the firm will adjust the scale of its operations as it changes the scale of its output.



The isocost lines are tangent to isoquants at points E_1, E_2 and E_3. Joining the loci of these points, the expansion path OZ can be drawn. It indicates the manner in which the firm, tries to attain higher equilibrium points like E_1, E_2 and E_3 by increasing the factors of labour and capital and also its budget.

2.9 Technical Progress and its implications

Technical progress occurs when more output is produced with the same level of inputs. It is the result of improvements in technology and investment in research and development. It can be graphically represented by a downward shift of the isoquant since the same output is produced with a lesser quantity of inputs. There are three types of technical progress:

1. Neutral technical progress

It occurs when an equal reduction in both labour and capital causes a parallel downward shift of the isoquant. Here the change in the marginal product of labour and capital are the same.

2. Labour augmenting technical progress

It occurs when as a result of a reduction in labour and capital the downward shifting isoquant becomes steeper. Here the marginal product of labour increases faster than the marginal product of capital.

3. Capital augmenting technical progress

It occurs when as a result of a reduction in labour and capital the downward shifting isoquant becomes flatter. Here the marginal product of capital increases faster than the marginal product of labour.

2.10 Cost Concepts

The term 'cost' means expenses incurred in the production of a commodity. It refers to the total amount of money spent on the production of a commodity. The determinants of cost of production are: the size of plant, the level of production, the nature of technology used, the quantity of inputs used, managerial and labour efficiency.

Kinds of Costs

Money Cost

Money cost is the total monetary expenses incurred by a firm in producing a commodity. The money paid for securing the factors of productions is money cost. Examples includes cost of raw materials, salaries, expenditure on machinery, interest, advertisement, insurance premium, taxes etc.

Real Cost

Real cost expresses the pains and sacrifices involved in producing a commodity. It is a subjective concept. The efforts and sacrifice made by the owners for investment, by the workers in foregoing leisure etc. constitute real costs.

Opportunity Cost

The opportunity cost of any good is value of the next best alternative forgone. For example, a farmer who is producing wheat can produce potatoes with the same factors. Therefore, the opportunity cost of a quintal of wheat is the amount of output of potatoes given up. It is also known as alternative cost or transfer cost.

Explicit cost

Explicit costs are paid out costs. These are payments made by the entrepreneur to the suppliers of various productive factors. These are directly paid out for by the producer e.g. salaries, prices for the raw materials, rent, interest, taxes etc.

Implicit cost

Implicit costs are costs of self-owned and self-employed resources such as salary of the entrepreneur or return on his own investment. These costs are sometimes ignored in calculating the expenses of production.

Private cost

Private cost is the cost that the firm pays in order to produce a product. It includes both implicit costs and explicit costs.

External Cost

External cost or externalities arises when a business influences the well-being of an external person who neither pays nor receives any compensation for that effect. The exhaust gases released into the environment from an automobile is an example.

Social cost

The social cost is the sum of private cost and external cost. Due to the existence of external cost, the cost to society of producing a product is larger than the cost to the firm. The cost of producing oil includes the private cost of the firm plus the cost to society adversely affected by pollution.

2.11 Short run cost curves

Short run is a period of time over which certain factors of production cannot be changed. The factors whose quantity cannot be changed in the short run are fixed factors and the costs incurred on fixed factors are fixed costs. The factors whose quantity can be changed in the short run are variable factors and the costs incurred on variable factors are called variable costs.

Fixed cost (**Sunk Cost**)

Fixed costs are those which are independent of output, that is, they do not change with changes in output. These costs are a fixed amount, which must be incurred by a firm in the short run whether the output is small or large. Fixed cost is also called sunk cost since it is sunk into the business and cannot be easily retrieved.

e.g. Rent, interest on capital invested, salaries to the permanent staff, insurance premium and certain taxes.

Variable cost

Variable costs are those costs, which are incurred on the employment of variable factors of production. Variable costs change with the level of output. It rises when output expands and falls when output contracts. When output is nil, variable cost becomes zero.

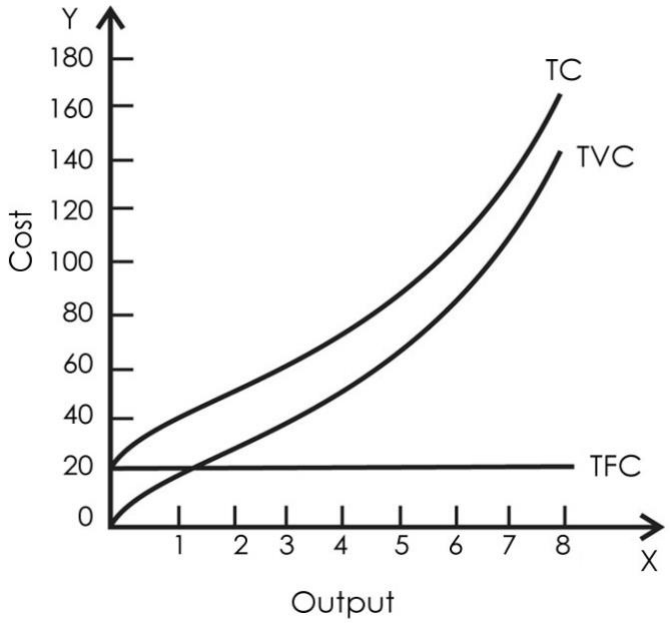
e.g. salary of employees on contract, prices of raw materials, electricity, fuel, transport costs etc.

Total cost

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

TC = TFC + TVC

Total fixed cost is the same irrespective of the level of output. Therefore a change in total cost is influenced by the change in variable cost only. The relationship between total fixed cost, total variable cost and total cost is clear from the below figure.



Average Fixed Cost (AFC)

The average fixed cost is the fixed cost per unit of output. It is obtained by dividing the total fixed cost by the number of units of the commodity produced.

AFC = TFC / Q

Since total fixed cost is a constant quantity, average fixed cost will steadily fall as output increases.

Average Variable cost (AVC)

Average variable cost is the variable cost per unit of output. It is the total variable cost divided by the number of units of output produced.

AVC = TVC / Q

Average variable cost curve is 'U' Shaped. As the output increases, the AVC will fall up to the normal capacity output due to the operation of increasing returns. But beyond the normal capacity output, the AVC will rise due to the operation of diminishing returns.

Average Cost (AC)

Average cost is the total cost divided by the number of units of output produced.

AC = TC / Q

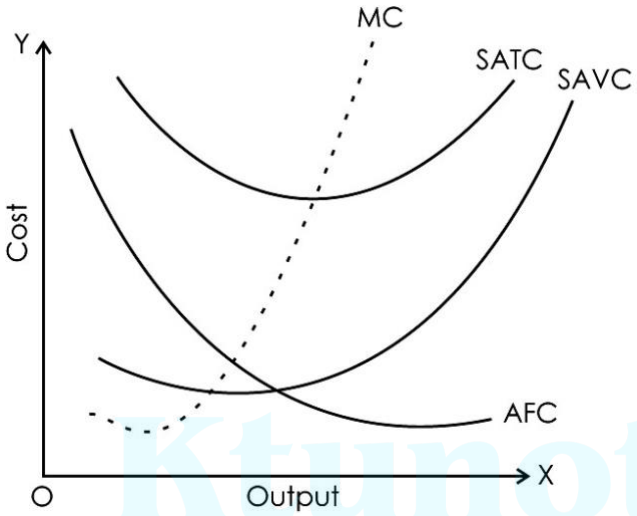
Average cost is also given by,

AC = AFC+AVC

The average cost is also known as the unit cost since it is the cost per unit of output produced.

Units of Output	TFC	TVC	TC	AFC	AVC	AC	MC
0	30	0	30	-	-	-	-
1	30	10	40	30	10	40	10
2	30	18	48	15	9	24	8
3	30	24	54	10	8	18	6
4	30	32	62	7.5	8	15.5	8
5	30	50	80	6	10	16	18
6	30	72	102	5	12	17	22

Diagram



Reasons for the U shape of the AC curve

The behaviour of the AC curve depends on the behaviour of the average variable cost and average fixed cost curves. The AC curve is U shaped due to:

(a) In the beginning both AFC and AVC curves fall. The AC curve therefore falls sharply in the beginning.

(b) When the AVC curve begins to rise, the AFC curve is falling steeply and the AC curve continues to fall. This is because during this stage the fall in the AFC curve is more than the rise in the AVC curve.

(c) But as output increases further, there is a sharp rise in AVC which more than offsets the fall in AFC. Hence AC begins to rise after a point.

Thus, the AC curve declines at first, reaches its minimum and then rises taking on a U-shape.

Marginal Cost

Marginal cost is defined as the addition made to the total cost by the production of one additional unit of output.

For example, when a firm produces 100 units of output, the marginal cost would be equal to the total cost of producing 100 units minus the total cost of producing 99 units.

$MCn = TCn – TC_{n-1}$

The marginal cost curve is U shaped. The shape of the cost curve is determined by the law of variable proportions. If increasing returns are in operation, the marginal cost curve will

be declining, as the cost will be decreasing with the increase in output. When the diminishing returns (diseconomies of scale) are in operation, the MC curve will be increasing as it is the situation of increasing cost.

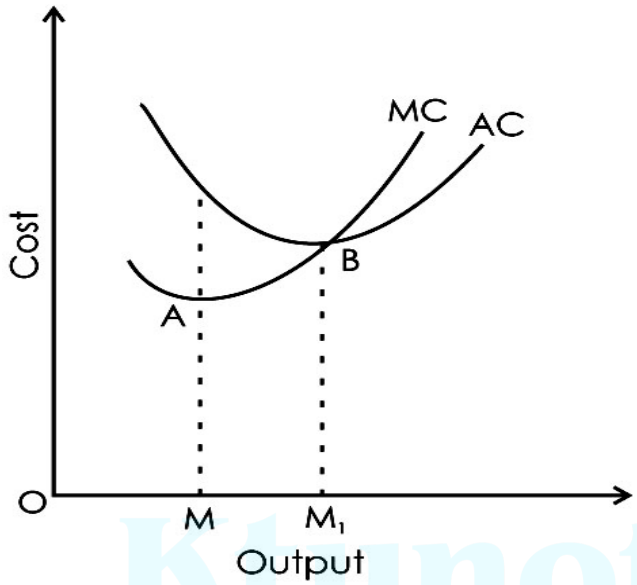
Relationship between short-run average and marginal cost curves

The relationship can be given as follows:

a. When marginal cost is less than average cost, average cost is falling

b. When marginal cost is greater than the average cost, average cost is rising

c. The marginal cost curve must cut the average cost curve at its minimum point from below. Thus at the minimum point of AC, MC is equal to AC.

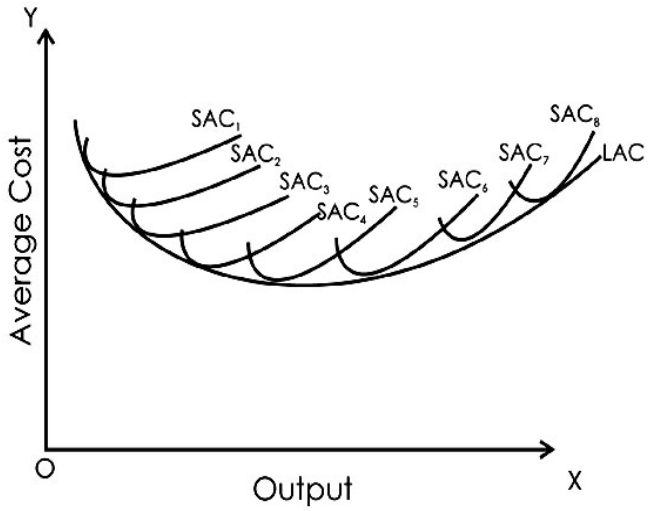


2.12 Long run cost curves

Long run Average Cost Curve (LAC)

In the long-run all factors are variable. Therefore, the firm can change the size of the plant to meet the changes in demand. A long-run average cost curve depicts the relationship between output and the long-run cost of production. The long-run cost of production is the least possible cost of production of any given level of output, when all inputs become variable, including the size of the plant.

The long run average cost curve is called *planning curve* of a firm as it helps in choosing a plant on the decided level of output. The long run average cost curve is also called *envelope curve* as it supports or envelops a group of short-run cost curves. The long run average cost curve initially falls with increase in output and after a certain point it rises making a boat shape.



2.13 Revenue

The amount of money, which the firm receives from the sale of its output in the market, is known as its revenue.

Total Revenue

Total Revenue refers to the total amount of money that a firm receives from the sale of its products.

Total Revenue = P x Q, where P is price and Q is quantity sold

Average Revenue

Average revenue is the revenue per unit of the commodity sold. It is calculated by dividing the total revenue by the number of units sold.

AR = TR / Q

Thus average revenue means price of the product.

Marginal Revenue

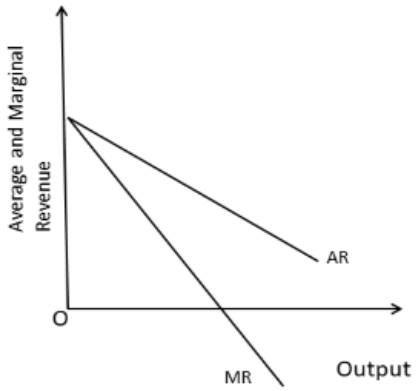
Marginal Revenue is the addition made to the total revenue by selling one more unit of a commodity.

For example, if 5 units of a product are sold at the price of Rs 20 and 6 units are sold at Rs19, the marginal revenue will be Rs. 4.

$MR_n = TR_n - TR_{n-1}$

Relationship between AR and MR curves

Units Sold	AR	TR	MR
1	10	10	10
2	9	18	8
3	8	24	6
4	7	28	4
5	6	30	2
6	5	30	0



Both AR and MR decline as a firm increases its output. This is because a firm can sell large quantities only at lower prices. In that case, the average revenue (price) of the product falls. When AR falls MR will also fall. But fall in MR will be more than the fall in the AR. Hence the marginal revenue curve will always lie below the average revenue.

If the average revenue (price) remains constant, the marginal revenue will also remain constant and will coincide with the average revenue.

The slope of the MR is twice that of the AR.

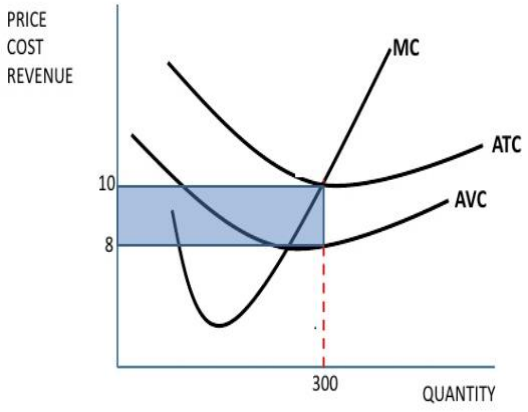
2.14 Shutdown point

The shutdown point is the minimum market price at which a company would prefer to close down its operations rather than manufacture anything. At this price, the company earns just enough revenue to cover its total variable costs.

The shutdown point is that at which P = AVC

It can also be stated as the point at which the firm recovers all of its variable costs.
ie. TR = TVC

This is because, in the short run, all fixed costs have already been incurred. By shutting down, a firm avoids all variable costs. However, the firm must still pay fixed costs. Since these must be paid regardless of whether a firm operates or nor, the loss per unit would be greater if the firm were to shut down.



The shutdown price is the minimum price a business needs to justify remaining in the market in the short run. In the figure, firm is at its shut down point when the price of its product becomes Rs.8. The shaded area represents the fixed cost of the firm. At this price, the firm is not covering any of its fixed cost. At any price between Rs.8 and Rs.10, it will be able to pay off some of its fixed costs, so it makes sense to keep operating.

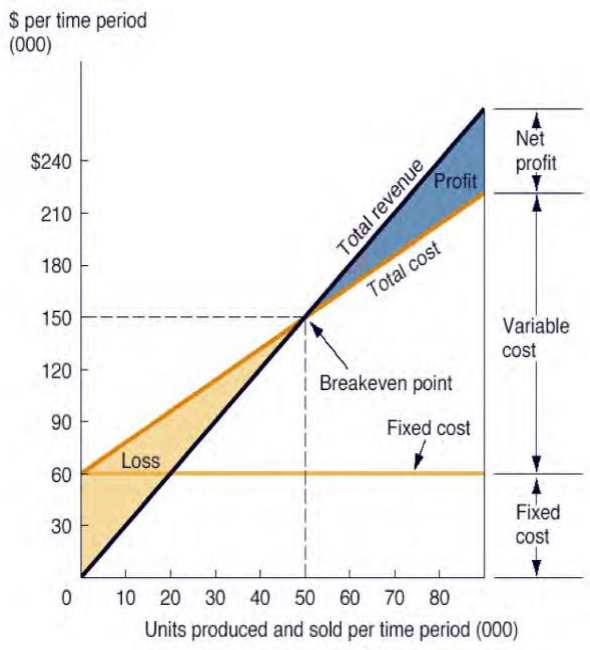
2.15 Break-even point

Breakeven analysis is a study of cost, revenues and sales of a firm to find out the level of output and sales volume at which the firm's costs and revenues will be equal. There is no profit and no loss. The total revenue is equal to the total cost of production. It means the revenues are sufficient to cover all costs of production.

At the breakeven point, TR = TC

Various managerial decisions of firms are taken by the managers based on the break-even point.

Units sold	FC	VC	TC	TR
0	60	0	60	0
10	60	15	75	20
20	60	30	90	60
30	60	60	120	90
40	60	70	135	120
50	**60**	**90**	**150**	**150**
60	60	105	165	180
70	60	120	180	210



The above graph shows the break- even point of an organization. When the firm produces 50 units, it is able to equalise TR and TC and it breaks even. When the firm produces

less than 50 units the revenue earned is less than the cost of production and in the initial period the firm incurs loss. When it is selling more than 50 units the revenue increases more than the cost of production and provides profit to the firm.

Importance of Break-Even Analysis:

1. Product planning: It helps the firm in planning the addition of new products in their product line.
2. Activity planning: It helps the firm to decide upon the expansion of production capacity.
3. Targeted sales decision: By estimating the targeted sales quantity with the help of breakeven analysis, the firm is able to decide the purchase of raw materials.
4. Price and cost decision: Decision regarding fixing the price so as to cover their cost of production.
5. Safety margin decision: It helps to understand the extent to which the firm can withstand a fall in its sales.
6. Profit decision: The selling price can be fixed based on its expected revenue or profit.
7. Promotional decision: The firm can decide how much money could be spent on sales promotion and advertisement.

At the breakeven point the following formulas hold:-

I. $At\ breakeven\ point, PQ = AVC \times Q + FC$

$$= Q(P - AVC) = FC$$

$$Breakeven\ quantity, Q = \frac{FC}{P - AVC}$$

II. $Sales = Cost + Profit$

$S = F + V + P$

$S - V = F + P$

C = F + P where C is contribution and S – V = C

III. Breakeven quantity $= \frac{F}{C}$

$$= \frac{F}{S - V} \quad \text{or} \quad \frac{F}{F + P}$$

Breakeven sales volume = Breakeven quantity x price

IV. P/V ratio $= \frac{Contribution}{Sales} = \frac{C}{S}$

$$= \frac{S-V}{S} \text{ or } \frac{F+P}{S}$$

V. Breakeven sales $= \frac{F}{P/V\ ratio} = \frac{FS}{S-V}$

VI. Value of sales to earn a desired profit $= \frac{F+dP}{P/V\ ratio} = \frac{(F+dP)S}{C}$

VII. Margin of Safety $= \frac{Profit}{P/V\ ratio}$

$$= \text{Actual Sales} - \text{Breakeven Sales}$$

Problems:-

1. Let the production function of a firm be $Q = 5\ L^{1/2}\ K^{1/2}$. Find out the maximum possible output that the firm can produce with 100 units of *L* and 100 units of *K*. Also find out the average and marginal product of labour from the function.

2. Suppose the production function is $Y = 2K^{1/4}L^{3/4}$ and K = L = 1. How much output is produced? If the company reduced L by 10%, how much would K need to be increased to produce the same output?

3. A firm sells its product at Rs.200 per unit. To produce a unit, it needs raw materials for Rs. 80, labour for Rs.40 and incurs other variable expenses for Rs. 20.The firms fixed expenses are Rs.12, 00,000. Find
(a) The breakeven quantity of the firm.
(b) If the actual production quantity is 25000, what will be the profit?

4. A company has total sales of Rs. 10000 in a year. Its variable costs are Rs. 6000 while its fixed costs are Rs.3000 for that year. Find (a) P/V ratio (b) Breakeven point (c) Margin of safety at this level (d) If it sells each unit at Rs. 10, how many should it sell at the breakeven point? (e) Find out the sales required to earn a profit of Rs. 1500.

5. The following values of a firm are available.

Output (units)	500	1000	1500
FC (Rs.)	1000	1000	1000
VC (Rs.)	500	1000	1500
TC (Rs.)	1500	2000	2500
TR (Rs.)	1000	2000	3000

Draw a breakeven chart of the firm and mark the breakeven quantity and breakeven sales.

6. Complete the following short run cost schedule.

Output (units)	**TC**	**TFC**	**TVC**	**MC**
0	100	--	--	--
1	--	--	50	--
2	--	--	--	40