Theory of Production

Production: .

Production is a process of combining various inputs to produce an output, goods and services for consumption. And contributes to the utility of individuals. Production is thus transformation of inputs or resources into output.

- In economics, production is not limited to bring about physical transformation but also covers rendering services like education, medicine, banking, communication, transportation etc.
- There are basically four factors of production or inputs, land, labour, capital and entrepreneurship, which can be used together for producing a good, which can be consumed and has a utility.
- Inputs can also be classified as fixed and variable inputs.
- Fixed inputs are those which can not be changed in the short period of time. Eg. Equipment and plant.
- The variable inputs can be changed and varied easily in the short period of time. Eg raw material, labour.

Production Function

- Production is the result of co-operation of four factors of production viz., land, labour, capital and enterprenuership in a technical proportion.
- The aim of the producer is to maximize his profit. For this sake, he decides to maximize the production at minimum cost by means of the best combination of factors of production, and production function explains this relationship.
- Thus the production function refers to the functional relationship between the quantity of a good produced (output) and factors of production (inputs).

- The production function is not only a relation between inputs and outputs but a relation in which a given set of inputs produce a maximum output. Therefore production function includes all the technically efficient methods of producing an output.
- In a production function, output is the dependent variable and the inputs are independent variables. We can write a production function as

$Q = f(N,I,K,E,T)$

Where Q = Quantity produced

N = Natural resources

I = Labour

K = Capital

E = Entrepreneur

T = Technology

For simplicity, we consider only two inputs capital and labour as independent variables. Therefore

$Q = f(L,K)$

Production function assumes that the rate of technology is given and remain constant, because an improvement in technical knowledge will lead to larger output by using the same quantity of inputs.

Isoquants (Iso-product)

- The term Iso-quant or Iso-product is composed of two words, Iso = equal, quant = quantity or product = output.
- An isoquant is a curve on which the various combinations of labour and capital show the same output.
- An isoquant curve slops downwards from left to right.

Isoquant Schedule and Isoquant curve

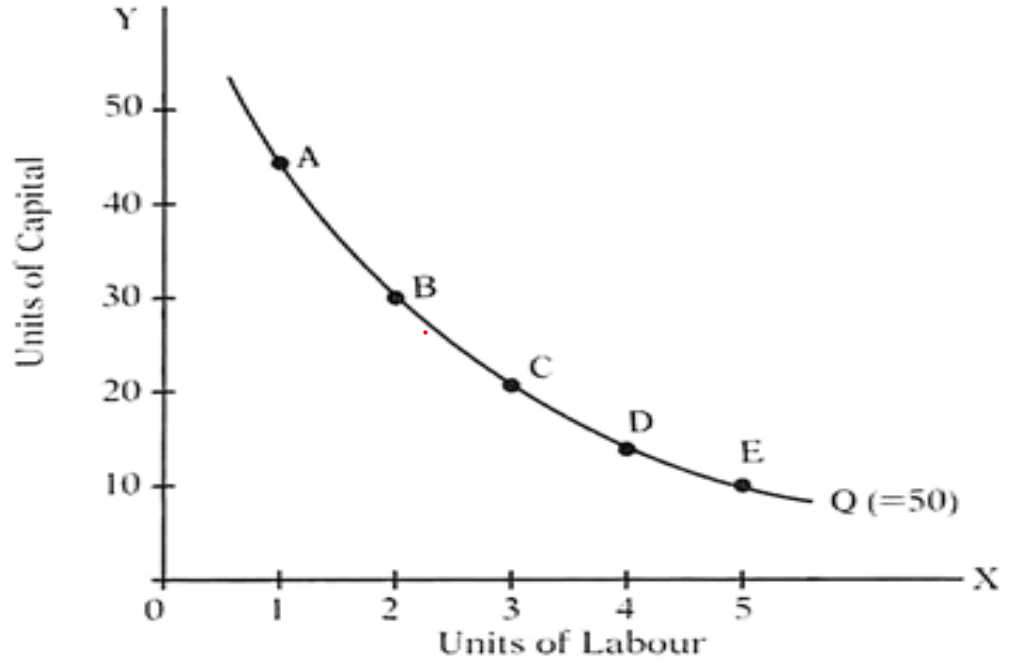
An isoquant schedule is a table showing all those combination of two factors labour and capital, which are substitutable and equally technically efficient to produce same amount of output.

Isoquant Schedule

Combination	Labour (units)	Capital (units)	Marginal capital labour ratio ($\Delta K/\Delta L$)
A	1	45	-
B	2	30	01:15
C	3	21	01:09
D	4	15	01:06
E	5	11	01:04

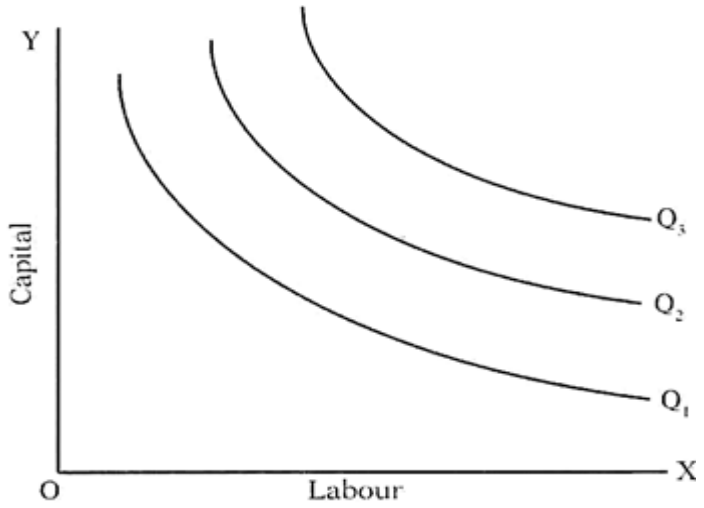
The above table shows that 50 kilograms of tea can be produced by any combination ranging from A to E. The combination A uses more of capital (45 units) and less of labour (1 unit) while combination E other way round.

All these combinations are plotted in the figure by taking labour on X-axis and capital on Y-axis. It provides a curve, the isoquant, which is downward sloping and convex to the origin. It shows all the technically efficient alternative methods of production facilitating production of the same 50 kilograms of tea.



Isoquant Map:

An isoquant map, as shown in the figure is a cluster of isoquants, each one of which represents production of a specific quantity of output. As we move on an isoquant map, away from the point of origin or on a higher isoquant, it will show a higher level of output. In other words, an isoquant closer to the point of origin will indicate a lower level of output. In the figure, isoquant Q_1 represents a lower level of output as compared to isoquant Q_2 and Q_3.



Types of Isoquants:

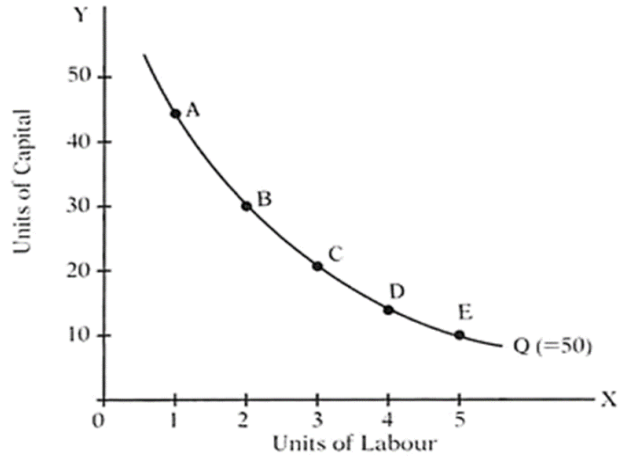
The isoquant may assume various shapes depending upon the degree of substitutability of factors**.** These are –

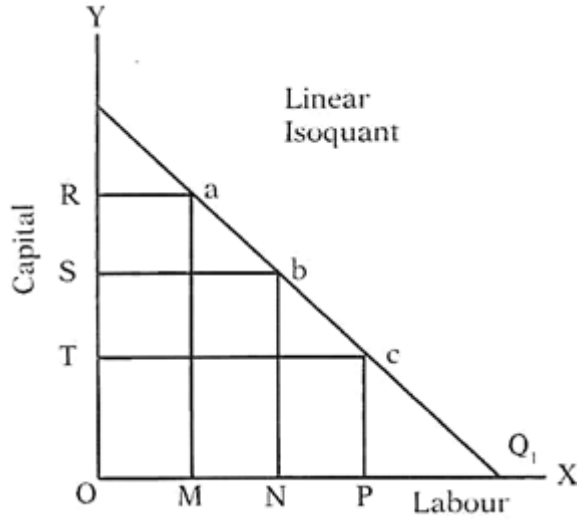
1. Smooth and convex isoquant

It is a downward sloping isoquant.

2. Linear Isoquant:

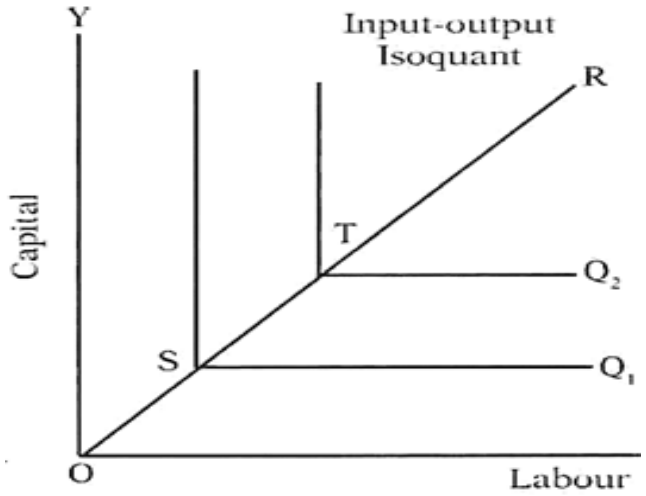
This type of isoquant is a straight line sloping downward from left to right. It indicated a perfect and unlimited substitutability between two factors implying that the product may be produced even by using only capital or labour or by infinite combinations of the two factors.





3. Input-Output Isoquant:

Input-output isoquants are L-shaped curve and also known as Leontief isoquants. They assume a perfect complementary nature between factors implying zero substitutability. Factors are jointly used in a fixed proportion. It means that there is only one method of production to produce a commodity. Hence, to increase output, both factors are to be increased holding the proportion constant.

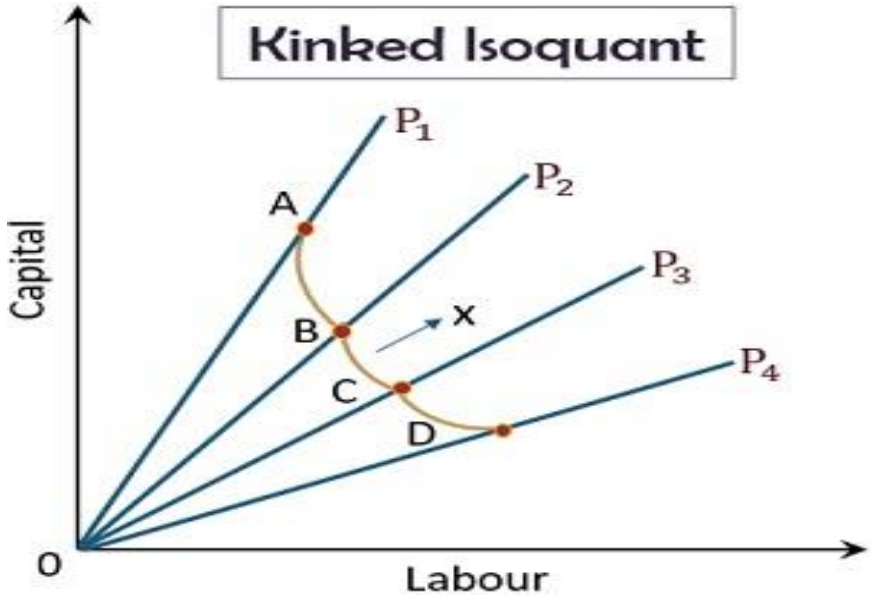


4. **Kinked Isoquant**

This isoquant assumes, that there is a limited substitutability between the factors of production. This shows that substitution of factors can be seen at the kinks since there are a few processes to produce any one commodity. Kinked iso-quant curve is also known as **activity analysis programming iso-quant** or **linear programming iso-quant**.

In the figure P1, P2 P3 and P4 show the production process and X is the kinked isoquant. In this case the substitutability of factors is possible only at the kinks, that is, at points A, B, C and D.

This is more realistic type of isoquant because engineers, managers and production executives consider the production process as a discrete rather than continuous process.



Properties of Isoquants

1. Slopes Downwards from Left to the Right:

An isoquant slopes downward from left to right or is negatively sloped.

Such a shape implies that if a firm employs more of labour, it will employ less of capital or vice versa, in order to maintain the level of output.

2. Isoquants are convex to the origin

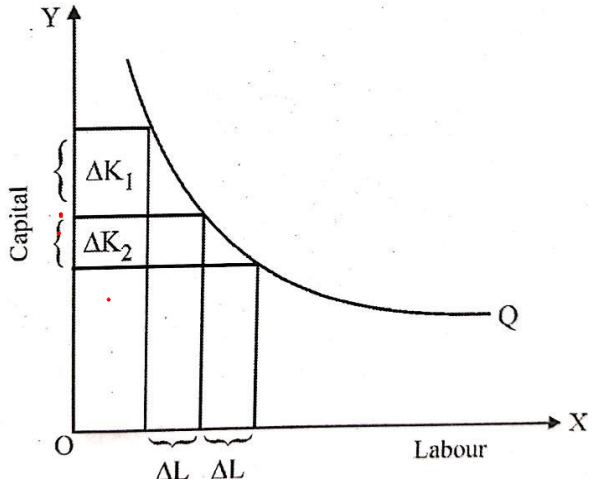
The convexity of isoquant curves means that as we move down the curve successively smaller units of capital are required to be substituted by a given increment of labour so as to keep the level of output unchanged.

Thus, the convexity of equal product curves is due to the diminishing marginal rate of technical substitution of one factor for the other. Thus, the slope of an isoquant is

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

Where ΔK is the change in capital, ΔL is the change in labour. $MRTS_{LK}$ is the marginal rate of technical substitution of labour for capital. MP_L is the marginal product of labour and MP_K is the marginal product of capital.

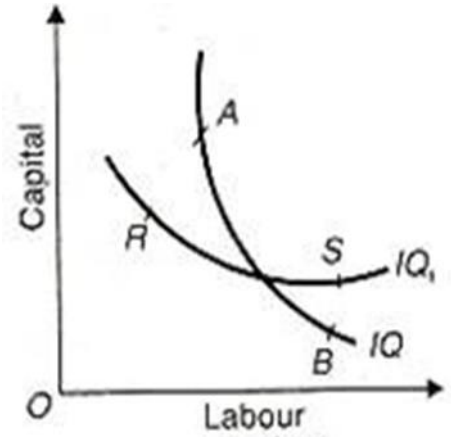
The convexity of isoquant means that as we move down the curve, less and less of the capital is given up for an additional unit of labour so as to keep constant level of output.



It is clear from the figure that as we increase labour at a constant rate, the amount of capital given up (ΔK) for an additional unit of labour goes on falling. Thus the convexity of an isoquant shows that the $MRTS_{LK}$ is diminishing ΔK1> ΔK2

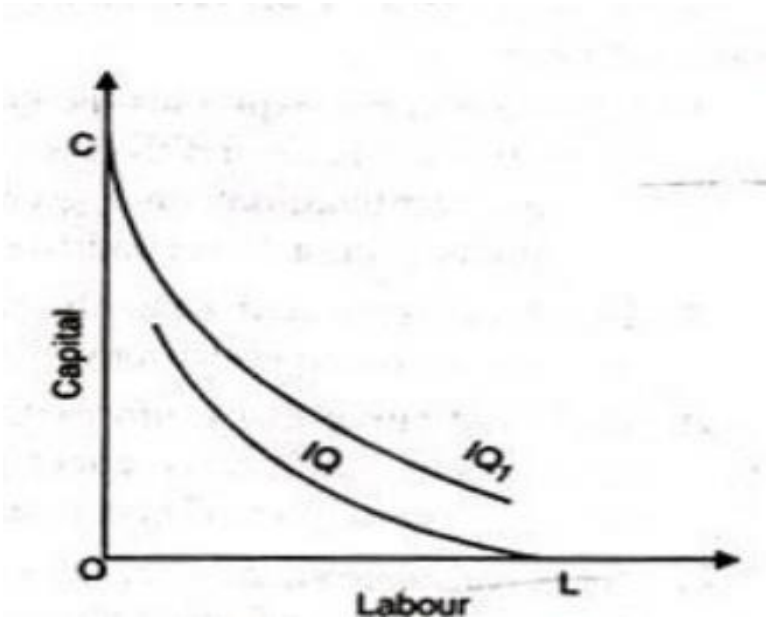
3. **Isoquant do not intersect**

Two isoquants cannot cut each other. In the figure , on the isoquant IQ, combination A =B. And on the isoquant IQ_1 combination R=S. But combination S is preferred to combination B, being on the higher portion of isoquant IQ_1. On the other hand, combination A is preferred to R, the former being on the higher portion of the isoquant IQ. To put it algebraically, it means that S> B and R< A. But this is logically absurd because S combination is as productive as R and A combination produces as much as B. Therefore, the same combination cannot both be less and more productive at the same time. Hence two isoquants cannot intersect each other.



4. Isoquant cannot touch either axis

If an isoquant touches X-axis, it would mean that the product is being produced with the help of labour alone without using capital at all.



Short- Run Production Function

The short-run is a period in which the firm can adjust production by changing variable factors such as raw materials and labour but cannot change fixed factors such as capital. The level of production can be increased within the limit of existing plant capacity during the short run. Thus the short run production function shows that in the short run, the output can be increased by changing the variable factors, keeping the fixed factors constant.

The behaviour of production in the short-run where the output can be increased by increasing one variable factor keeping other factors fixed is explained through the Law of Variable Proportions.

Law of Variable Proportions

The law of variable proportions examines the production function with one factor variable, keeping the quantities of other factors fixed. In other words, it refers to the input-output relation when output is increased by varying the quantity of one input.

Thus, this law states that if, with the given technology, successive units of an input are added to a constant physical quantity of another input (or fixed combination of other inputs) the total output obtained would vary in magnitude through three distinct phases.

Assumptions

1. Fixed factors

Some factors of production or inputs remain constant. They are called fixed factors. For Eg. Land in agriculture and capital in industry

2**. Variable Factors**

These are inputs whose supply can be increased in the short run and hence called variable factors. Increased production is possible by applying more of variable factors to a given number or quantity of fixed factors. Eg. Labour

3. **Homogeneity of variable factors**

All units of variable factors are of same efficiency, so that the rate of returns would not change due to difference in efficiency.

4. **State of Technology**

Technology is assumed to be given and constant.

Total Product:

Total product is the total amount of output produced by all the variable inputs applied in combination with the fixed input.

Average Product

It is obtained by dividing the total product by the units of total variable factor.

AP = TP / TVF

Marginal Product

It is the additional output produced by the additional unit of variable factor. It is equal to a change in total output divided by a change in total variable factor employed.

MP = ΔTP/ ΔTVF

Units of Labour (L)	Total Product (Q)	Marginal Product ($\Delta Q/\Delta L$)	Average Product (Q/L)
1	80		
2	170		
3	270		
4	368		
5	430		
6	480		
7	504		
8	504		
9	495		
10	480		

Marginal Product (Quintals)	*Average Product (Quintals)*
$\frac{\Delta Q}{\Delta L}$	$\frac{Q}{L}$
80	80
90	85
100	90
98	92
62	86
50	80
24	72
0	63
–9	55
–15	48

By keeping all factors constant and changing one of the variable factor we can show the total, marginal and average production and the three phases of law of variable proportions in the following table.

Units of Land	Units of Labour	Total Production
10 Acres	0	–
”	1	20
”	2	50
”	3	90
”	4	120
”	5	140
”	6	150
”	7	150
”	8	140

Phase /stage 1

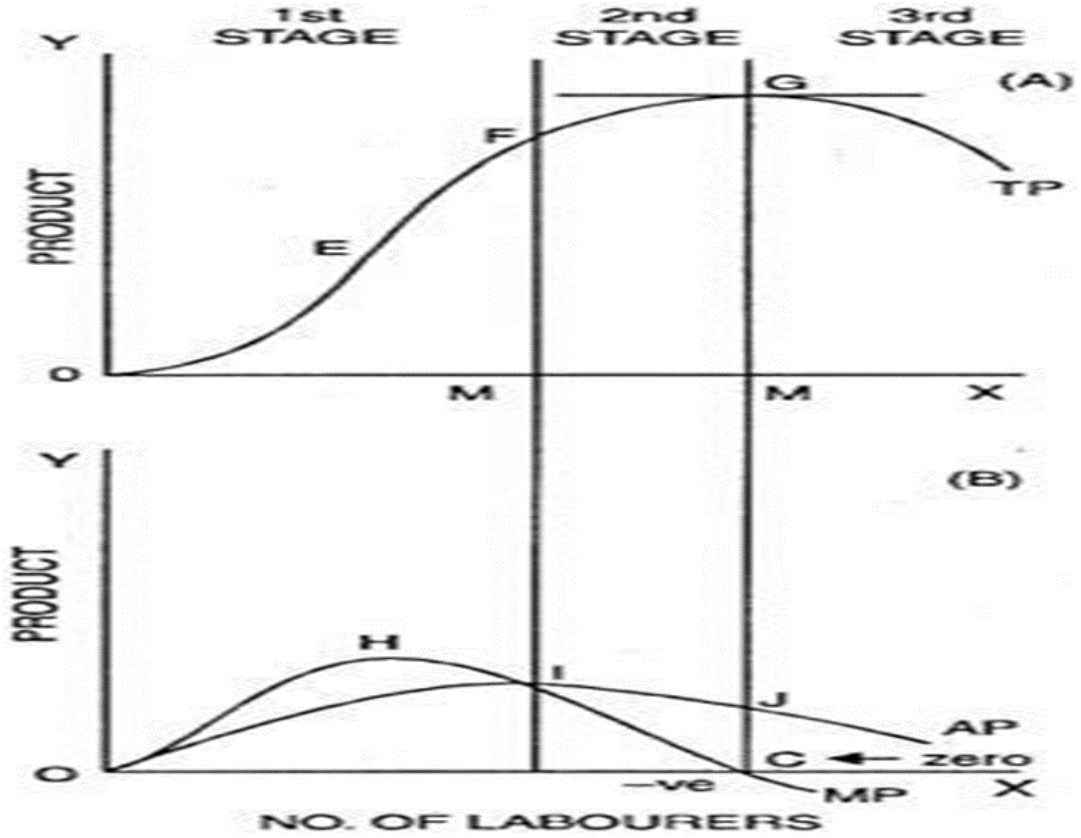
In the first stage average production increases as there are more and more number of labour employed with fixed factors (land). The total product, average product, and marginal product increases but average product and marginal product increases up to 40 units. Later on, both start decreasing because proportion of workers to land was sufficient and land is not properly used. This is the end of the first stage.

Phase/Stage 2

The second stage starts from where the first stage ends or where AP=MP. In this stage, average product and marginal product start falling. The marginal product falls at a faster rate than the average product. Here, total product increases at a diminishing rate. It is also maximum at 70 units of labour where marginal product becomes zero while average product is never zero or negative.

Phase/Stage 3

The third stage begins where second stage ends. This starts from 8th unit. Here, marginal product is negative and total product falls but average product is still positive. At this stage, any additional labour leads to positive nuisance because additional labour leads to negative marginal product.



1. First Stage:

First stage starts from point ‘O’ and ends up to point F. At point F average product is maximum and is equal to marginal product. In this stage, total product increases initially at increasing rate up to point E. between ‘E’ and ‘F’ it increases at diminishing rate. Similarly marginal product also increases initially and reaches its maximum at point ‘H’. Later on, it begins to diminish and becomes equal to average product at point T. In this stage, marginal product exceeds average product (MP > AP).

2. Second Stage:

It begins from the point F. In this stage, total product increases at diminishing rate and is at its maximum at point ‘G’ correspondingly marginal product diminishes rapidly and becomes ‘zero’ at point ‘C’. Average product is maximum at point ‘I’ and thereafter it begins to decrease. In this stage, marginal product is less than average product (MP < AP).

3. Third Stage:

This stage begins beyond point ‘G’. Here total product starts diminishing. Average product also declines. Marginal product turns negative. Law of diminishing returns firmly manifests itself. This happens because marginal product of the labour becomes negative. The employer will suffer losses by employing more units of labourers. However, of the three stages, a firm will like to produce up to any given point in the second stage only.

A producer has to make a decision about his production activity. A rational producer would not operate in the third stage where the marginal returns are negative. He would not stop his production in the first phase of increasing returns. Thus a producer would carry out his production in stage 2 till that part where MP is positive.

Reasons for the increasing, diminishing and negative marginal returns

Increasing returns

In the first stage, the returns to variable factors increase due to the abundance of fixed factor relating to variable factor. The fixed factor is efficiently used as additional units of variable factors are employed.

Diminishing Returns

Increasing returns come to an end where we reach the point of full and efficient use of fixed factor. The efficiency of the additional units of variable factor cannot be increased. The fixed factor is not adequate for the efficient use of additional units of variable factor. Every additional unit of variable factor contributes less output because the additional units of variable factor have less and less fixed factor to work.

Negative Returns

The stage 3 is of negative returns which is a result of abundance of variable factors working on fixed factors. For eg. Too many workers make the workers less efficient, resulting in negative contribution of each additional worker.

Law of returns to scale

The laws of returns to scale is a long-run production analysis. In the long run all factors of production are variable. No factor is fixed. Accordingly, the scale of production can be changed by changing the quantity of all factors of production.

In the long run, output can be increased by increasing all factors in the same proportion. Generally, laws of returns to scale refer to an increase in output due to increase in all factors in the same proportion. Such an increase is called returns to scale.

Returns to scale are of the following three types:

1. Increasing Returns to scale.

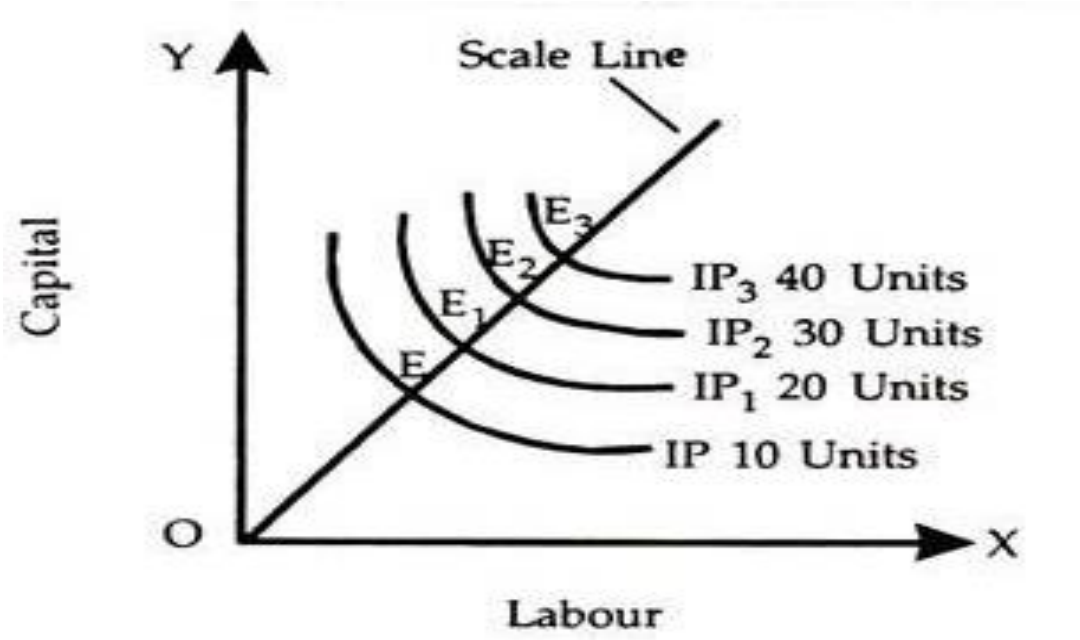
2. Constant Returns to Scale 3. Diminishing Returns to Scale

1. Increasing Returns to Scale:

When the change in output is more than in proportion to the equi-proportional change in all the factors of production, then the operating law is called the increasing returns to scale. Thus, the rate of increase in output is faster than the increase in factors of production.

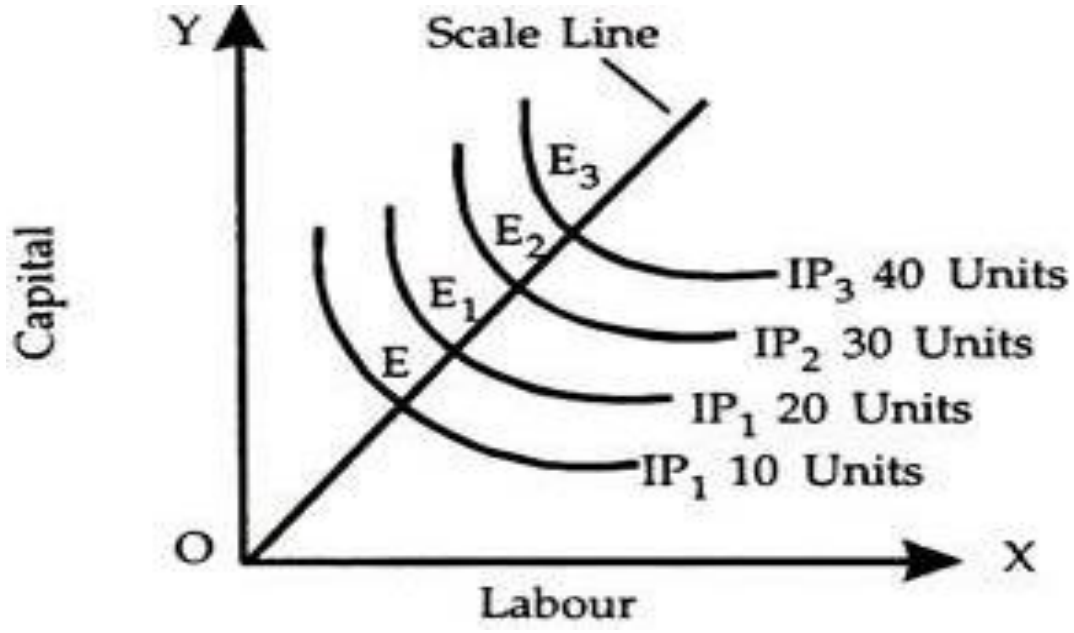
The distance between various iso-product curves decreases on the expansion path or scale line then the increasing returns to scale will operate. It reveals that the increase in output in the same proportion requires less ratio of labour and capital.

Capital and labour are shown on OY-axis and OX-axis respectively. IP, IP_1, IP_2 and IP_3 are different iso-product curves showing different levels of output, viz., 10 units, 20 units, 30 units and 40 units. The distance between successive iso-product curves diminishes as output is expanded by increasing the scale. The distance $OE > EE_1 > E_1E_2 > E_2E_3$ which reveals that for equal increase in output, firm has to employ less and less amount of labour and capital.



2. Constant Returns to Scale:

When the output of a firm increases in the same proportion in which the change in inputs takes place the law is called constant returns to scale. The proportion of two inputs remains constant. When all iso-product curves showing the same level of output have the equal distance between them on the expansion path or scale line, the law operating is called constant returns to scale.

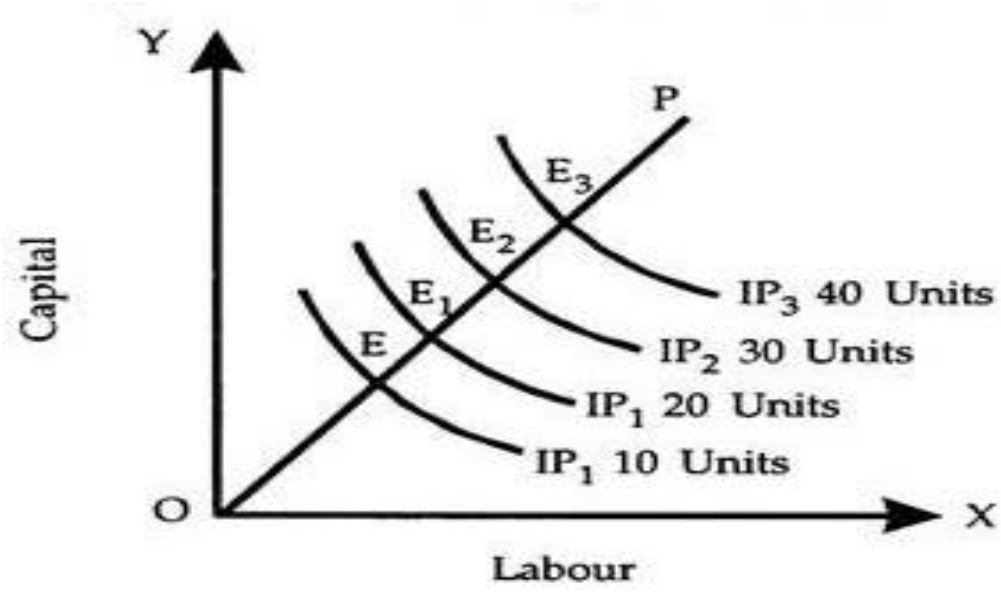


The distance between iso-product curves is indicated by E, E_1, E_2 and E_3. The distance on scale line (OP) are equal. OE = EE_1 = E_1E_2 = E_2E_3. The distance between all iso-product curves remains constant which reveal that the production increases in the same proportion in which inputs are changed.

3. Diminishing Returns to Scale:

When proportionate change in output is less than the proportionate change in all the factors of production their (inputs) ratio being equal, the diminishing returns to scale will operate. The distance between various iso-product curves on the scale line increases because for getting the same level of output we have to employ more of all inputs.

Labour and capital are employed on OX-axis an OY-axis. OP is the scale line on which E, E_1, E_2 and E_3 different iso-product curves are showing different levels of output. The distance between these curves are increasing on the scale line which show that we have to employ more of inputs and the resultant output is less than in proportion to the change in inputs. $OE<EE_1<E_1E_2<E_2E_3$ which show the diminishing returns to scale.

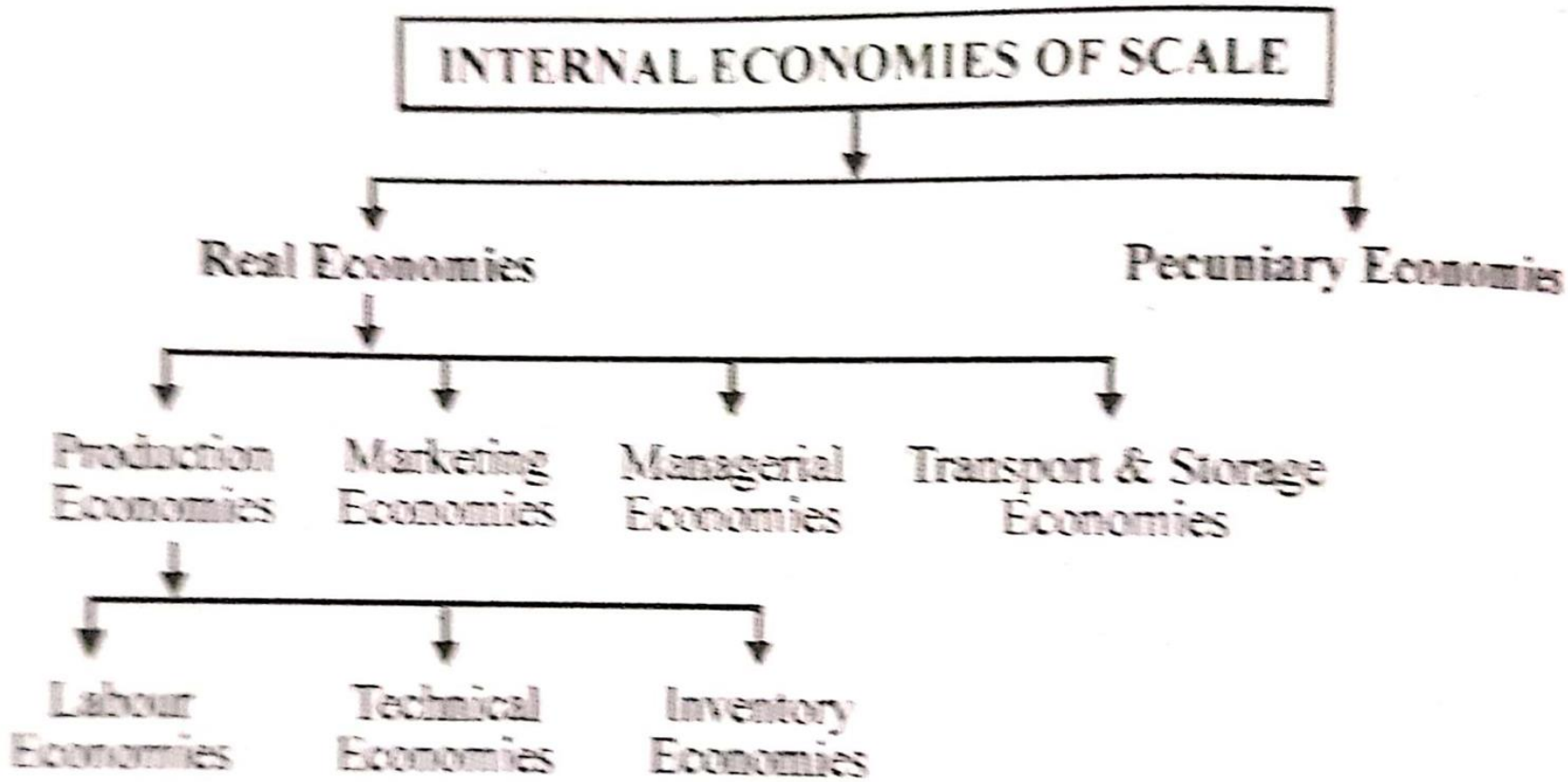


Factors responsible for returns to scale are the economies and diseconomies to scale.

Economies to scale

Economies are the advantages of large scale production of the organization and is a long term concept. Economies of scale are achieved when there is an increase in the sales of an organization. As a result, the savings of the organization increases, which further enables the organization to obtain raw materials in bulk. This helps the organization to enjoy discounts. The cost advantages are achieved in the form of lower average costs per unit These benefits are called as economies of scale.

The economies of scale are divided into internal economies and external economies discussed as follows:



i. Internal Economies:

- real economies
- arise from the expansion of the plant size of the organization.
- Arise because of the actions of the firm itself
- Affect the shape of the long-run average cost curve
- Responsible for increasing returns to scale because of indivisibility of some of the factors of production.

The internal economies of scale are classified into two

A. Real economies of scale, and

B. Pecuniary (monetary) economies of scale

A. Real Economies

- Associated with the reduction in physical quantity of inputs.
- Associated with the indivisibility of factors of production
- Are of following types

1. Production economies
2. Marketing economies
3. managerial economies
4. Transport and storage economies

Indivisibility of factors

Many fixed factors of production are indivisible in the sense that they must he used in a fixed minimum size. Such “factors of production can be most efficiently employed at a fairly large output, but work less efficiently at small outputs because they cannot be divided into smaller units.” Thus as output increases, the indivisible factors which were being used below capacity can be utilised to their full capacity thereby reducing costs. Such indivisibilities arise in the case of labour, machines, marketing, finance and research.

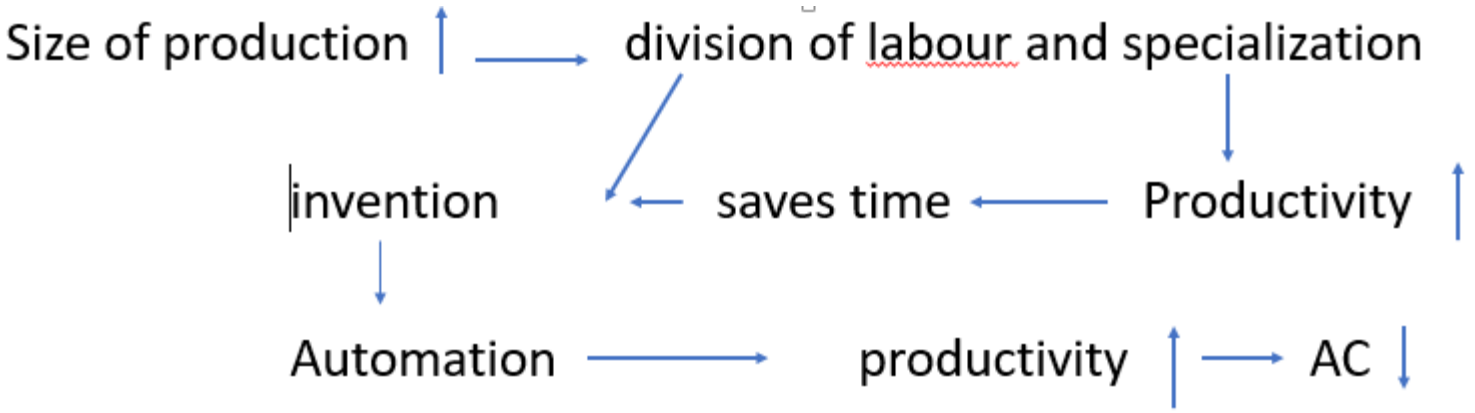
Production economies

These arise from the use of factors of production in the form of labour economies, technical economies and inventory economies

(i) **Labour economies**

As the size of output increases the firm enjoys labour economies due to

a. Specialization
b. Time-saving
c. Automation of the production process
d. Cumulative volume economies



(ii) **Technical Economies**

- These arise to a firm from the use of better machines and techniques of production.
- These also arise from indivisibilities.
- As the scale of production increases, the firm reaps the advantage of mechanization of using mass production methods. This will reduce the unit cost of production.

(iii) **Inventory Economies**

- Inventories help the firm to meet the random changes in the input and the output sides of the operations of the firm.
- It helps to smooth out the supply of inputs and supply of outputs.
- Inventories of spare parts, raw materials and finished products increase with the scale of production. But they do not increase proportionately with the increase in the size of output..
- Thus, as the size of output increases, the firm can hold smaller percentage of inventories to meet random changes.

Marketing Economies

- A large firm also reaps the economies of buying and selling.
- It buys its requirements of various inputs in bulk and is, therefore, able to secure them at favourable terms in the form of better quality inputs, prompt delivery, transport concessions, etc.
- Because of its larger organisation, it produces quality products which are offered for sale in attractive packing by its packing department.
- It may also have a sales department manned by experts who carry on salesmanship, propaganda and advertisement through the various media efficiently.
- Thus a large firm is able to reap the economies of marketing through its superior bargaining power and efficient packing and sales organisation.

Managerial Economies

- A large firm can afford to put specialists to supervise and manage the various departments.
- There may be a separate head for manufacturing, assembling, packing, marketing, general administration, etc.
- This leads to functional specialisation which increases the productive efficiency of the firm.
- These managerial economies also reduce per unit cost of management because with expansion of the firm, the various departmental managers will manage large output as efficiently as they were managing small output at the same salary.

Transport and Storage Economies

Output ↑ → cost of transportation of raw materials, intermediate and finished products and storage cost ↓

B. Pecuniary Economies (Monetary economies)

- Paying lower prices for he factors of production used and distribution of the product due to bulk buying by the firm.
- The firm may acquire discounts due to large scale production.
- It reduces the money cost of the factor for a particular firm.
- These economies are realized by a firm in the following ways

(i) Raw material at lower price due to bulk buying

(ii) Funds at lower cost due to reputation in the money market

(iii) Lower advertising rates, if advertise in a large scale

(iv) Lower transport cost, as large amount of commodities are transported

Internal Diseconomies of Scale

- Diseconomies of scale occur when the long run average costs of the organization increases.
- It may happen when an organization grows excessively large.
- Thus the diseconomies of scale cause larger organizations to produce goods and services at increased costs.
- The diminishing returns to management. As output increases beyond a certain level, the top management becomes overburdened, hence less efficient.
- And the second cause is exhaustible natural resources.

External Economies and Diseconomies of Scale

- The external economies are the advantages a firm enjoys as a result of improvement in the industrial environment in which the firm operates.
- They are external to the firm but internal to the industry to which the firm belong.

- The external economies arise when an increase in a firm’s expansion produces favourable effects on other firms.
- In other words, benefits of increased production spread on other firms in the industry or in the region, i.e. **positive externalities**.
- Due to this the cost of the factors of production is going to be affected and so the short-run and long-run costs of the firm.
- Some of the external economies are

1. Cheapening of material and equipment

Expansion of an industry increases the demand for raw material and capital equipments. This will lead to large-scale production of materials and equipments and reduce the cost of production and therefore their prices.

2. **Growth of Technical Know-how**

Expansion of industry → discovery of new technical know how

↓

improved and better machinery → productivity ↑ → cost of production ↓

3. **Development of Skilled Labour**

Industry ↑ → training for labour ↑ → skilled labour ↑ → productivity ↑

4. **Growth of subsidiary and ancillary industries**

Industry ↑ → subsidiaries and ancillaries ↑ → cost and prices ↓

Firms may transform the waste of the industry into useful products, this will reduce the cost of production.

5. **Development of Transportation and Marketing Facilities**

6 **Development of Information Services**

With the expansion of an industry, the firms may give the information about the technical knowledge through the publication of trade and technical journals which can be interchanged with the other firms. The firms may also set up jointly research institutes to develop new improved techniques.

External Diseconomies

These may be generated with the expansion of an industry.

(a). Diseconomies of Pollution:

The localization of an industry in a particular place or region pollutes the environment. The polluted environment acts as health hazard for the labourers. Thus, the social cost of production rises.

(b). Diseconomies of Strains on Infrastructure:

The localisation of an industry puts excessive pressure on transportation facilities in the region. As a result of this, the transportation of raw materials and finished goods gets delayed. The communication system in the region is also overtaxed. As a result of the strains on infrastructure, monetary as well as the real costs of production rise.

c). Diseconomies of High Factor Prices:

The excessive concentration of an industry in a particular industrial area leads to keener competition among the firms for the factors of production. As a result of this, the prices of the factors of production go up. Hence, the expansion and growth of an industry would lead to rise in costs of production.

d) Rise in prices of some factors

An expansion in the size of an industry may raise the prices of some factors like raw materials and capital goods which are in short supply.

Resources

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