Theory of Production

What is 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 activities other than consumption. They see every commercial activity other than the final purchase as some form of production.

What is 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 distribution of the good or service produced.

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 (good or service) which has value and contributes utility to the life of individuals.

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.

Rent is paid for land being used in the production process.

Labor

Labor represents the human capital available to transform raw or natural 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.

Labor receives wages as reward.

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.

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.

Interest rate is paid as reward on the capital.

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.

Entrepreneur gets profits as reward of his/her services.

What is 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. 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.

The production function may be as follows:

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

Short Run time Period vs Long Run Time period

Short run is the time period in which at least one factor of production is fixed. Short run time period is not fixed and it varies from business to business. For a simple and small scale business this period is very short. However, for complex and large scale businesses duration of short run time period is relatively more.

On the other hand long run is a time period in which all the factors of production are variable.

Production Function in Short Run

As stated above short run is a time period in which at least one factor of production is fixed. In this regard the above production function is reduced to $Q=f(L)$ as other factors of production are usually considered fixed in short run due to one reason or the other.

Concepts of Total Product of Labor (TP_L), Marginal Product of Labor (MP_L) and Average Product of Labor (AP_L)

Total Product of Labor

The total output by employing various units of labor along with other fixed inputs is called total product.

$TP_L=Q$

Average Product of Labor

Average Product is the per unit product of labor. It is calculated by dividing total product by total units of labor employed

$AP_L=TP_L/L$

Marginal product of Labor

Marginal Product is the rate of change in total product. i.e. change in total output due to employment of one additional unit of input (labor)

$MP_L=\Delta TP_L/\Delta L$

Derivation TP, MP_L and AP_L through table and Graph

TP, MP_L and AP_L can be explained with the help of following table

L	$TP_L= Q$	MP_L	AP_L
0	0	-	-
1	3	3	3
2	8	5	4
3	12	4	4
4	14	2	3.5
5	14	0	2.8
6	12	-2	2

The above table depicts various output levels by employing various units of labor. The Total Product initially increases, reaches at a maximum, remains constant and then starts decreasing. The marginal product is also shown in the above table. MP_L initially increases, reaches at a maximum and then decreases. MP even becomes negative after certain level of units of labor are employed. Average Product of labor shows the same behaviour as of MP_L.

The curves can be derived from the above table as follows:
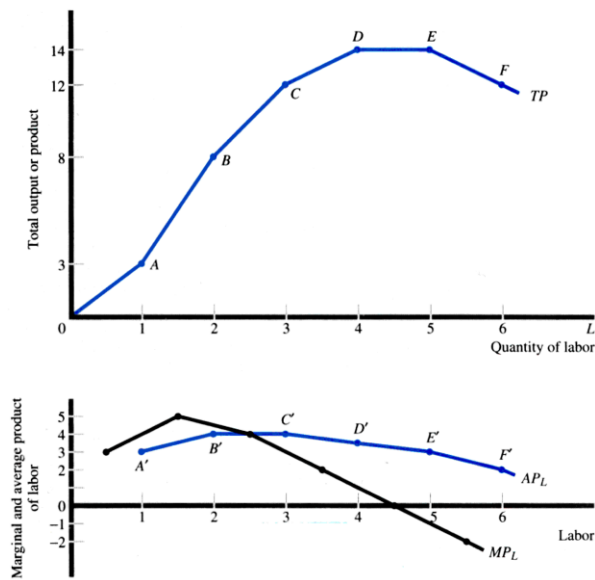
Important points about relation b/w TP$_L$ and MP$_L$

1. When MP$_L$ is rising, TP$_L$ is increasing at an increasing rate
2. When MP$_L$ is decreasing, TP$_L$ is increasing at a deceasing rate
3. When MP$_L$ is zero, TP$_L$ is at maximum
4. When MP$_L$ is negative, TP$_L$ is decreasing

The behaviour/pattern of TP, MP$_L$ and AP$_L$ depicted in table and graph is due to the variable proportions.

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.

Suppose land, plant and equipment are the fixed factors, and labour is the variable factor.

When the number of labor 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 initially at an increasing rate afterwards it increases at a decreasing rate then it reaches a maximum point and starts falling after that.

Stages of Production

The stages of production are illustrated with the help of the following figure:
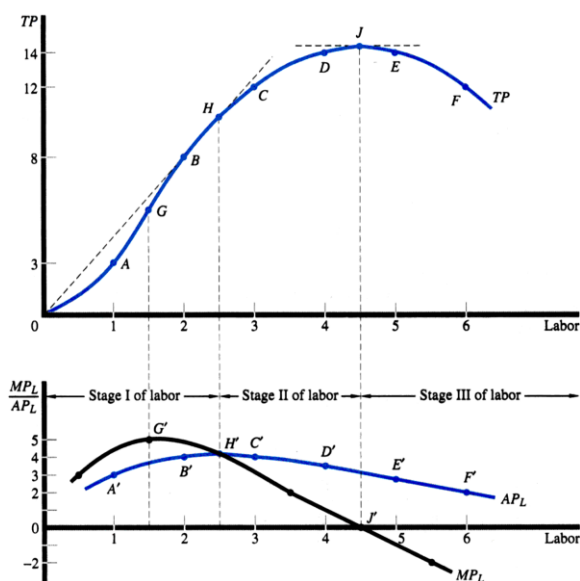
Stage-I: Increasing Returns

In stage I the average product reaches the maximum and equals the marginal product.

This stage is shown in the figure from the origin to point H where the MP curve is decreasing after reaching 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 fixed factors are 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.

The reasons for increasing returns are that the fixed factor being abundant in this stage is used more intensively and production increases rapidly, fixed factors are indivisible so they must be used in fixed minimum size so more labor results in more returns, division of labor and specialization is taking place

Stage-II: Diminishing Returns

It is the most important stage of production. Stage II starts from point H 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 J.

At this point the MP curve becomes negative when the TP curve begins to decline.

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.

This may be due to scarcity of one factor in relation to other factors, Entrepreneurial control and supervision become lax or scarcity of trained labor or raw material may arise that leads to diminution in output.

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 additional labor actually causes a decrease in total output and makes the marginal product negative.

In the figure, this stage starts from the point J where the MP curve is below the A'-axis. Here the labor is too many in relation to the available fixed factors, making it absolutely impossible to get positive marginal output.

The Best Stage

In stage I, when production takes place to the left of point H, the fixed factor is excess in relation to the variable factors which cannot be used optimally. To the right of point J, 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.

Optimal Use of Variable input

The decision of how much input to be used is made by comparing the cost of each additional unit of labor being employed and the contribution made by that additional unit of labor. The cost of each additional unit of labor is Marginal Resource Cost of Labor (MRC_L) i.e. change in total cost of production due to one additional unit of labor. The contribution of each additional unit of labor is Marginal Revenue Product of Labor (MRP_L) i.e. Marginal Revenue multiplied by Marginal Product of that additional unit of labor.

Marginal Revenue Product of Labor (MRP_L)

MRP_L is derived by multiplying Marginal Revenue by Marginal Product of each additional unit of labor. As Marginal revenue is equal to price of that product so MRP_L can be calculated as follows:

$$MRP_L = MR \times MP_L \qquad \text{or} \qquad MRP_L = P \times MP_L$$

Marginal Resource Cost of Labor (MRC_L)

MRC_L is the change in total cost of production due to each additional unit of labor. It can be calculated as follows:

$$MRC_L = \Delta TC/\Delta L$$

As we know that the cost of each additional is the wage paid to the labor so MRC_L is equal to wage.

The decision regarding optimal use of variable input is illustrated in the following table and figure:

L	TP_L	MP_L	MR=P	MRP_L	MRC_L=Wage	MRP_L vs MRC_L
4	14	4	10	40	20	$MRP_L > MRC_L$
5	17	3	10	30	20	$MRP_L > MRC_L$
6	19	2	10	20	20	$MRP_L = MRC_L$
7	20	1	10	10	20	$MRP_L < MRC_L$
8	20	0	10	0	20	$MRP_L < MRC_L$

The above table shows that the optimal units of labor to be hired are 6. Because after that though total product is rising but the cost of each additional unit is greater than the contribution of each additional unit of labor. Thus the condition of optimality is $MRP_L = MRC_L$

This can also be observed in the following graph
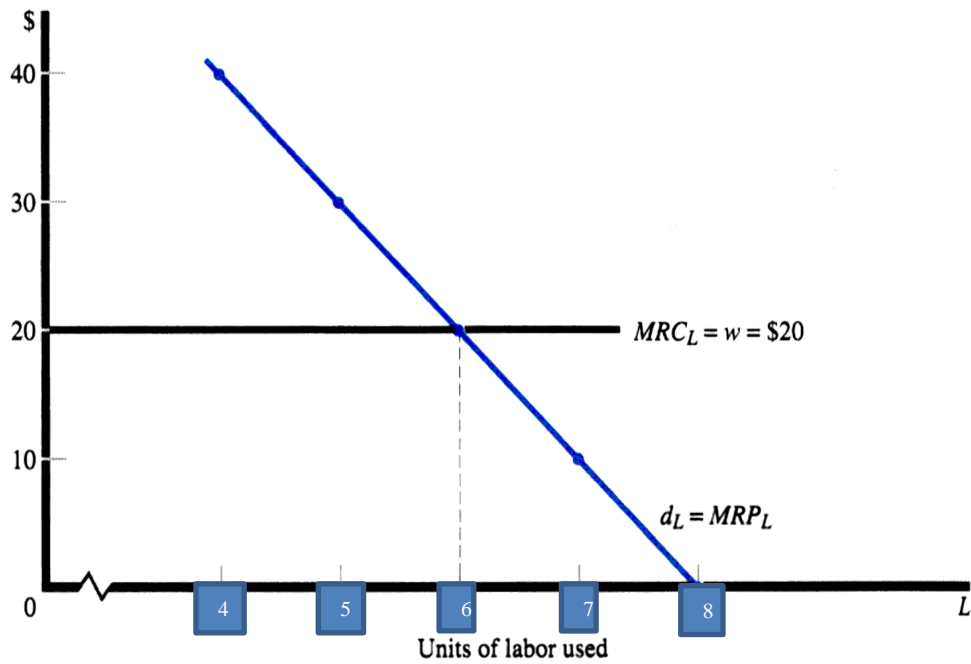
Elasticity of Production

Percentage change in output due to percentage change in input. In the short run as labor is the only variable input so elasticity of production w.r.t labor is derived as follows:

$E.Q_L = \%\Delta Q / \%\Delta L$

$E.Q_L = \Delta Q / \Delta L \div Q/L$

It is to be noted that $\Delta Q/\Delta L$ is equal to Marginal Product and Q/L is equal to Average Product so the above formula can also be written as:

$E.Q_L = MP_L / AP_L$