

1. Details of Module and its structure

| Module Detail | |
|-------------------|--|
| Subject Name | Economics |
| Course Name | Economics 03 (Class XII, Semester - 1) |
| Module Name/Title | Production Function – Part 1 |
| Module Id | leec_10301 |
| Pre-requisites | Knowledge about Producer Behaviour |
| Objectives | After going through this lesson, the learners will be able to understand the following: <ol style="list-style-type: none">1. Behaviour of Producer in relation to production.2. Production Function- Relation between physical inputs and physical output.3. Optimum utilization of resources i.e. factors of production to minimize cost during production process4. Scale of production during short period and long period with the help of factor inputs and non factor inputs.5. Explaining the terms total product, average product, marginal product. |
| Keywords | Production Function, Short period & Long period, Total Product, Average Product, Marginal Product. |

2. Development Team

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1. Producer Behaviour

Behaviour of producer is rational and he tries to maximize his profits through minimizing cost of production.

Least cost of production depends on the best combination of inputs or factors which a producer uses in the process of production. Here resources are traditionally known as factors of production (Land, Labour, Capital & Entrepreneur)

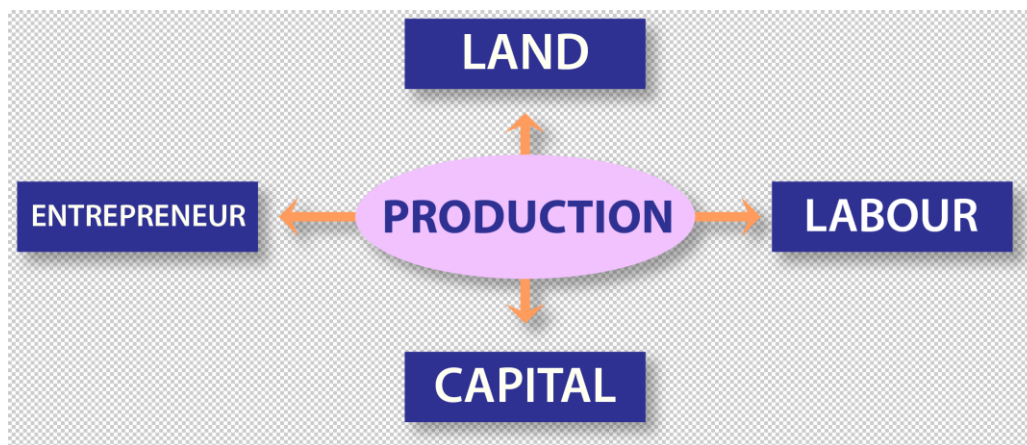


Figure 1

This chapter deals with Production and cost concepts i.e. it studies the changes in efficiency in the production process and its effect on cost of production for producing a given commodity. Production is the process of transformation of physical inputs into physical output. It is an economic process that uses resources to create a commodity that is suitable for exchange. In other words, production

represents the process through which different factor inputs combine, in order to create or add utility, with the non-factor inputs to produce goods and services which are used to satisfy human wants. Non-factor inputs are typically the raw materials and intermediary goods that the firm uses in production.

Production Function

Production function is defined as the mathematical or algebraic expression which represents the functional and technical relationship between physical inputs used in the production process and the physical output produced. It can be mathematically expressed as :

$$Q = f(\text{Labour, Capital})$$

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

Q = Output produced in the production process

L = Labour employed as variable factor

K = Capital employed

In other words, Production function represents the *maximum* production level that can be achieved from the given level of employment of inputs in the production process, and a given state of technology. Firm's output depends upon the labour employed and capital used up in the production. Let us assume a firm wants to increase its output, it cannot continue to change the quantities of labour and capital at the same proportions. Generally labour units can be employed at a short notice easily but it takes more time to install machinery or equipment i.e. capital. It means in the short period certain factors remain fixed or constant and others can be changed during the production process.

Example:

Production function can be explained with the help of an example. Suppose a firm is manufacturing wooden furniture with the help of two inputs – capital (K) and labour (L). If it produces 20 tables by using 10 units of capital and 5 units of labour then the relationship between physical inputs (10 units of capital + 5 units of labour) and physical output (i.e. 20 tables) is called production function. Here, the money values of inputs and outputs are not considered.

Note that it is the technology used that determines the maximum levels of output which can be produced by using different combinations of inputs. With the advanced technology, more can be produced with less amount of inputs. We then have a new production function.

2. Features of Production Function

The main features of production function are as follows:

- **Physical Technical Relation:** Production function signifies the functional and technical relationship between inputs and outputs. It is purely a physical technical relation and not economic relation. It has nothing to do with the money value of output produced and prices of factors of production used.
- **Determined by the level of Technology:** The quantity of factors of production to be employed and the manner in which they shall be combined depend upon the state of technology. The state of technological knowledge and managerial ability of the firm is treated as given for a production function.
- **Economic Time Period:** The relationship between output produced and inputs used in the production process depends on the economic time period under study. The variability of inputs used in the production process depends on the time period. Some inputs cannot be changed during short run (i.e.: some inputs are fixed) and hence output can only be changed by changing the units of variable inputs during short run.

In the production function, changes in total output by changing the units of all inputs is possible only in the long run whereas the changes in total output by varying the unit of single input may be possible even in the short run.

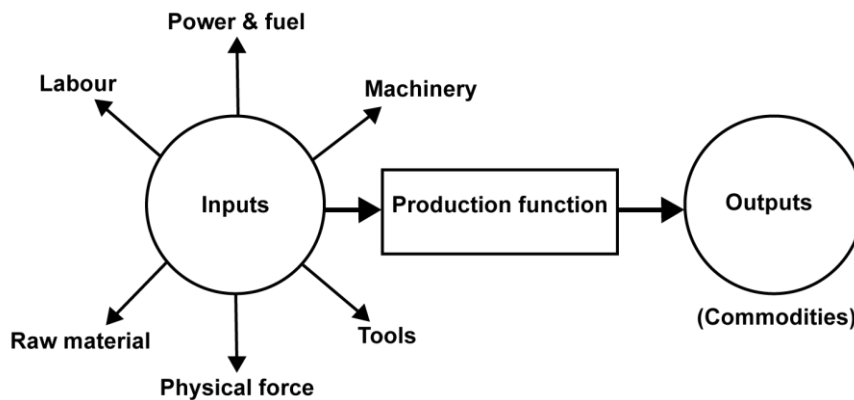


Figure 2

We can further define production function using the short-run and long-run.

3. Short Run Production Function

The short run is a period in which at least one factor will remain fixed and will not change. However, the production can be increased with the use of inputs or factors which are variable. So basically during short period, production takes place with the help of factor inputs namely fixed factors and variable factors. Short run production function ~~where~~ is represented as

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

where L is variable factor and K is constant factor.

Fixed Factors are those inputs ~~which~~ that remain fixed and ~~does~~ do not change with the change in the level of production. They remain constant say Land, Machinery, equipments etc.

Variable Factors are those inputs which keeps on changing with the change in the level of production means with every additional input is applied along with fixed inputs there will a significant change in level of production.

Lets take an example to understand the fixed inputs and variable inputs under short run:

Suppose a manufacturer produces socks in his unit where Land used is say 2000sq ft and machinery is installed. Now here land and machinery can be considered as fixed factors as producer is not going to change these fixed factors every time he produces some units of socks. Along with these fixed

factors the production requires variable factors as well say Labour and non factor input say - raw material, power, fuel etc. Now keeping fixed factors fixed with every employment of one variable factor say labour the production will increase.

In the short run, the total production usually responds to the increase on the use of variable factors. How does output change when the variable factor is increased in the short run? This depends on the 'returns to factor'

Three Phases under 'Returns to Factor' are as under;

- **Increasing Returns to factor:** In this phase, increase in output is *more* than proportionate to the increase in input. So if input doubles, output more than doubles.
- **Diminishing Returns to factor:** In this phase, increase in output is *less* than proportionate to the increase in input. So if input doubles, output less than doubles.
- **Negative Returns to factor:** In this phase, increase in input actually causes output to fall.
-

Long Run Production Function

In the *long run* the output can be changed by changing all the factors of production.

Long run production function is represented as $Q = f(L, K)$ where both L and K are variable factors.

As all the factor inputs are variable in the long period, the ratio between various inputs can remain the same at different levels of output.

Increasing all inputs in the same proportion is called scaling up the inputs. The change in output that results from a scaling up of inputs is described under 'returns to scale'. Three Phases under which 'Returns to Scale' operates are:

- **Increasing Returns to Scale:** In this phase, increase in output is *more* than proportionate to the increase in inputs. So if all inputs are doubled, output more than doubles
- **Constant Returns to Scale:** In this phase, increase in output is *exactly proportionate* to the increase in inputs. So if all inputs are doubled, output also exactly doubles.
- **Diminishing Returns to Scale:** In this phase, increase in output is *less* than proportionate to the increase in inputs. So if all inputs are doubled, output *less* than doubles

| Basis | Short Period | Long Period |
|-----------------------|---|--|
| Meaning | Short run is a time period in which output can be changed only by changing the units of variable factors. | Long run is a time period in which output can be changed by changing the units of all the factors. |
| Factors of production | Factors of production are classified into variable factors and fixed factors in the short run. | All factors are variable in the long run. |
| Variation | In the short run, the fixed factors remain constant they do not change but variable factors changes. | In the long run, all the factors become variable since no factor stays constant. |

4. Concepts of Product

In the context of production, three concepts of product are being discussed below: Total Product, Average Product, Marginal Product.

Total Product

Total Product is also known as Total Physical Product (TPP) is defined as the total amount of output produced by a firm in the given inputs during a specific period of time. It means total quantity of commodity produced at a particular level of employment of variable factors (say Labour) keeping all other factors inputs constant (say capital). Alternatively, it signifies the relationship between the variable input and output when all the other inputs are held constant.

Average Product

Average Physical Product (APP) is per unit of total product of a variable factor say labour. Alternatively, “APP is the output per unit of the variable input,” it is obtained by dividing the total product by the total number of units of the variable factor. Symbolically:

$$APP = \frac{\text{total physical product}}{\text{total units of variable factor}}$$

If 5 units of a variable factor, say, Labour, produce 50 socks, average product will be equal to $50/5 = 10$ socks. It has been generally observed that when more units of a variable factors are employed for producing a commodity, the tendency of average product is first to increase and then to fall as revealed in the table given below. Average product is also called **Average Physical Product (APP)**.

Marginal Product

Marginal Physical Product (MPP) is an addition to the total product (output) when an additional unit of a variable factor is employed. Marginal product measures extra output per extra unit of input holding all other inputs fixed. Thus, the additional output added by the use of an additional unit of input, say, labour, is called the marginal product of Labour. For instance, with a given amount of capital, if 10 labourers make 50 socks and 11 Labourers make 54 socks, then MPP will be equal to 4 socks ($=54 - 50$) which is the addition to the total product (50 chairs) by employing an additional unit of a variable factor (i.e., 11th Labourer).

$$MPP = \frac{\Delta \text{ total product}}{\Delta \text{ input}}$$

Or $MP_n = TP_n - TP_{n-1}$ (n is number of units of input employed).

Notice that

$TPP = \sum MPP$ (here MPP is Marginal Physical Product)

$TPP = APP \times N$ (here APP is Average Physical Product and N is number of units of Variable Factor)

General Information about Production curves:

The total product curve measures the level of production on vertical axis as measured against the amount of a particular factor input on horizontal axis.

Both the curves Average Physical Product (APP) and the Marginal Physical Product (MPP) are ultimately based on the Total Physical Product curve.

And the relationship between the two is that the MPP measures the rate of change of output when additional unit of variable factor is employed keeping fixed factor fixed while the APP measures the average amount of output from each unit of variable input employed. It is MPP that acts as a driver for the APP since the rate of change in marginal production will directly affect the average production. That is why whatever the MPP curve it will affect the APP. So, it is the MPP which pulls the APP up or down. If MPP is more than APP it will pull up APP and vice versa.

5. Production Schedule

Production Schedule: A Production Schedule is a table that describes the changes in TPP, APP and MPP as the amount of input used changes.

Table 1: Relationship between TP and MP

| Land (Fixed Factor) | Labour (Variable Factor) | TP | MP |
|---------------------|--------------------------|----|----|
| 1 | 0 | 0 | 0 |
| 1 | 1 | 2 | 2 |
| 1 | 2 | 6 | 4 |
| 1 | 3 | 12 | 6 |
| 1 | 4 | 17 | 5 |
| 1 | 5 | 20 | 3 |
| 1 | 6 | 21 | 1 |
| 1 | 7 | 21 | 0 |
| 1 | 8 | 19 | -2 |

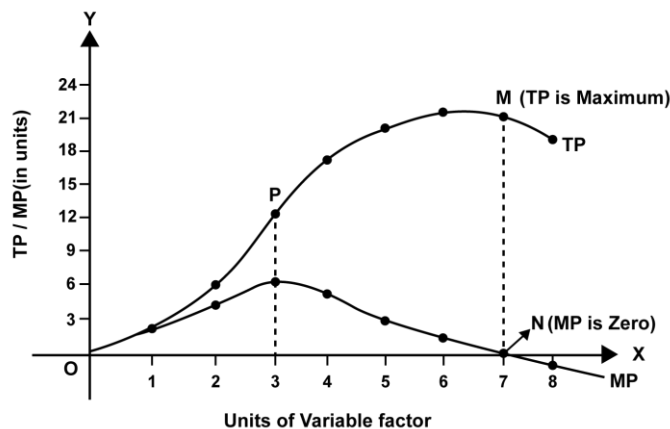


Figure 3:
Relationship between
TP and MP

The relationship between TP and MP is discussed with the help of above diagram. On the X axis we have taken the units of variable factors and on the Y axis we have taken production curves as TP and MP.

1. With employment of 1st unit of variable factor, labour, keeping land fixed, , TPP is increasing at an increasing rate till the point P. Beyond P, TPP is increasing at a decreasing rate. The point ‘P’ is a point of inflexion i.e. **It indicates the point at which TP curve changes its shape from increasing rate of increase to a decreasing rate of increase**, MPP increases till P, where it reaches its maximum.
2. After employment of 2nd unit, TPP is increasing at diminishing rate, MPP decreases i.e. MPP starts falling after 2 units of labour are employed. Although MPP continues to fall till 5 unit of the variable factor i.e. labour are employed, it is still positive. The TPP continues to increase, but at a diminishing rate..
3. When TPP reaches its maximum point (point ‘M’) MPP becomes zero (shown as point ‘N’) i.e. at the 5th unit of labour.
4. After further employment of 5th unit when total product starts falling after point M, marginal product becomes negative i.e. from 6th unit of variable factor onwards.

Table 2: Relationship between AP and MP

| Land (Fixed Factor) | Labour (Variable Factor) | Average Product (AP) | Marginal Product (MP) |
|---------------------|--------------------------|----------------------|-----------------------|
| 1 | 0 | 0 | 0 |
| 1 | 1 | 2 | 2 |
| 1 | 2 | 3 | 4 |
| 1 | 3 | 4 | 6 |
| 1 | 4 | 5 | 8 |
| 1 | 5 | 5 | 5 |
| 1 | 6 | 4.16 | 0 |
| 1 | 7 | 3 | −4 |

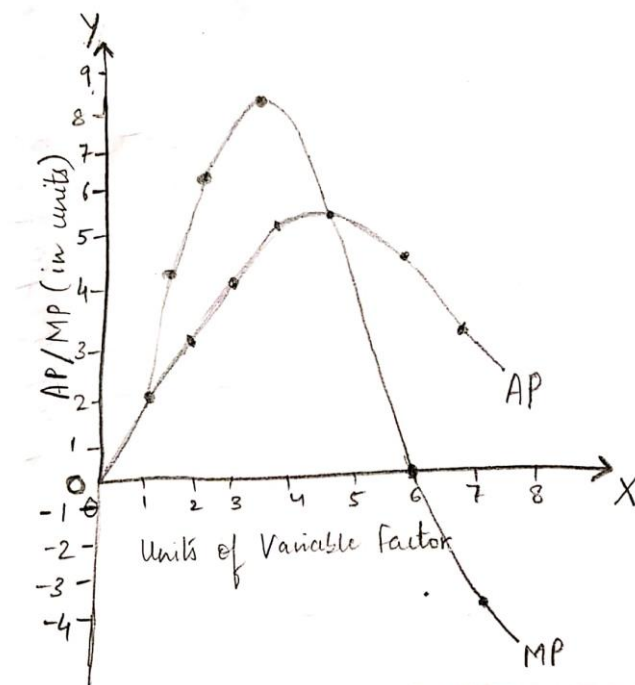


Figure 4: Relationship between AP and MP

The relationship between AP and MP is discussed with the help of above diagram where on X axis we have taken the units of variable factors and on Y axis we have taken production curves as AP and MP. Given diagram is further explained as:

1. MP is increasing upto 4th unit of variable factor and then, it starts decreasing. AP has been increasing upto 5th unit of variable factor. MP curve lies above the AP curve upto 5th unit of variable factor.
2. At 5th unit of variable factor, MP equals AP and at this point, AP is at its maximum.
3. At 6th unit of variable factor, MP becomes zero and AP starts decreasing.
4. After 5th unit of variable factor, AP curve and MP curve, both have been falling but the fall in MP is faster than that in AP. The MP curve now lies below the AP curve, which signifies that AP is more than MP.
5. At 7th unit of variable factor, MP becomes negative and AP is still decreasing.

6. Summary

- Production process is the process of transforming the inputs into output by utilising their services and making production of goods and services.
- The firm's behavior is to maximize profits by organizing the production activities.
- Production function is the functional and technical relationship between physical inputs used in the production process and the physical output produced.
- Production is the outcome of the combined efforts of all the resources i.e. land, labour, capital and entrepreneurship.
- The short run is a period in which at least one factor will remain fixed and will not change until it is been fully and efficiently utilized. However, the production can be increased with the use of inputs or factors which are constantly demanded by the producer generally known as variable factors.
- The long run behaviour of firm's production is when the units of all the factors or production are changed simultaneously and in fixed proportion. Scale of production is said to be changed when all inputs in the production process are changed simultaneously as all the inputs are variable.
- Fixed Factors are those inputs which remain fixed and does not change with the change in the level of production they remain constant say Land, Machinery, equipments etc.
- Variable Factors are those inputs which keeps on changing with the change in the level of production means with every additional input is applied along with fixed inputs there will a significant change in level of production.
- Total Product (TP) refers to the total quantity of output of a commodity at a particular level of employment of an input, say labour, when the employment of all other inputs is unchanged.
- Average Product (AP) is the output per unit of a variable input, say labour.
- Marginal Product (MP) may be defined as increase or decrease in TP resulted due to addition of one extra unit of labour, keeping all other inputs unchanged.