Managerial Economics

M.Com. IV Sem.
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Production Theory

CONTENTS

Objectives

After studying this unit, you will be able to:

- Describe production function with one and two variables
- State the concept of producers equilibrium and expansion path
- Explain the behaviour of total, average and marginal revenue curves

Introduction

The production analysis of the firm brings into focus the process of production and related costs of production. We must take inputs into consideration applied for production and resulting into output. There are different methods to produce a commodity. The firm has to identify the technically efficient production processes for avoiding any wastage of resources. These technically efficient production processes provide a choice for choosing the least-cost process.

Major portion of goods and services consumed in a modern economy are produced by firms. A firm is an organisation that combines and organises resources for the purpose of producing goods and services for sale at a profit. The most important reason for a firm or business enterprises exist is that firms are specialised organisation devoted to manage the process of production.

6.1 Meaning of Production

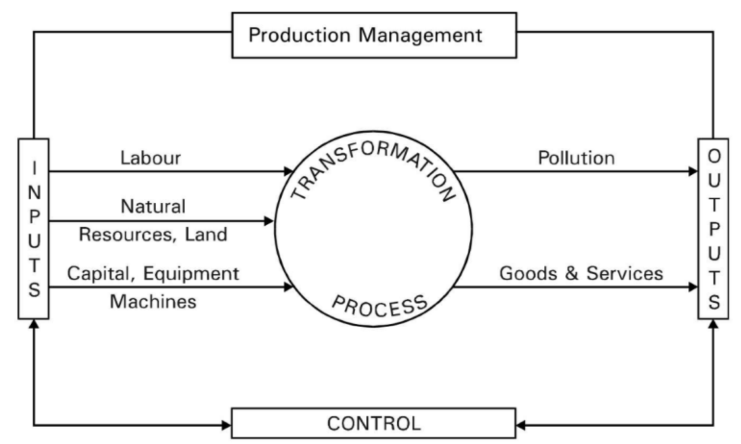
Production refers to the transformation of inputs or resources into outputs or goods and services. Production is a process in which economic resources or inputs (composed of natural resources like labour, land and capital equipment) are combined by entrepreneurs to create economic goods and services (outputs or products).

Firms are required to take different but interrelated production decisions like:

1. Whether or not to actually produce or shut down?
2. How much to produce?
3. What input combination to use?
4. What type of technology to use?

Figure 6.1 depicts a simple production process.

Figure 6.1: Production Process



In fact, production theory is just an application of constrained optimization technique. The firm tries either to minimize cost of production at a given level of output or maximize the output achievable with a given level of cost.

Inputs are the resources used in the production of goods and services and are generally classified into three broad categories – labour, capital and land or natural resources. They may be fixed or variable.

Fixed Inputs are those that cannot be quickly changed during the time period under consideration except, perhaps at a very great expense, (e.g., a firms' plant).

Variable Inputs are those that can be changed easily and on very short notice (e.g., most raw materials and unskilled labour).

The time period during which at least one input is fixed is called the, short run, while the time period when all inputs are variable is called, the long run. The length of the long run depends on the type of industry, e.g., the long run for a dry cleaning business may be a few weeks or months. Generally, a firm operates in the short run and plans increases or reductions in its scale of operation in the long run. In the long run, technology generally improves so that more output can be obtained from a given quantity of inputs, or the same output can be obtained from fewer inputs.

6.2 Production Function with One Variable Input

A production function is a function that specifies the output of a firm, an industry, or an entire economy for all combinations of inputs. In other words, it shows the functional relationship between the inputs used and the output produced. Mathematically, the production function can be shown as:

$$Q = f(X_1, X_2 \ldots\ldots\ldots\ldots\ldots\ldots X_K)$$

where Q = Output, X_1 .... X_K = Inputs used.

For purposes of analysis, the equation can be reduced to two inputs X and Y. Restating,

$Q = f(X, Y)$ where Q = Output

X = Labour

Y = Capital

A more complete definition of production function can be:

'A production function defines the relationship between inputs and the maximum amount that can be produced within a given period of time with a given level of technology'.

A production function can be stated in the form of a table, schedule or mathematical equation. But before doing that, two special features of a production function are given below:

1. Labour and capital are both unavoidable inputs to produce any quantity of a good, and
2. Labour and capital are substitutes to each other in production.

A form of production functions is the Constant Elasticity of Substitution, CES function,

$Q = B[gL^{-h} + (1 - g)K^{-h}]^{-1h}$ where $h > -1$ and B, g and

h are constants.

If h is assumed to be a variable, then the above function may be called the variable elasticity of substitution, VES function.

Still another form is the fixed proportion production function also called the Leontief function. It is represented by

Q = minimum, $\left(\frac{K}{a}, \frac{L}{b}\right)$, where a and b are constants and 'minimum' means that Q equals the

smaller of the two ratios.

Finally there is a very simple linear production function. Assuming that the inputs are perfect substitutes so that all factors may be reducible to one single factor, say, labour, L, than the linear production function may be, $Q = aL$, where 'a' is the constant term and L stands for labour.

In order to analyse the relationship between factor inputs and outputs, economists classify time periods into short runs and long runs.

Before further discussion it is necessary to conceptualize three terms: total product, average product and marginal product.

1. Total product is the total quantity produced by that many units of a variable factor (i.e., labour). For example, if on a farm 2000 Kg. of wheat were produced by 10 men, the total product would be 2000 Kg.
2. Average product is the total output divided by the number of units of the variable factor (or the number of men). Thus AP = TP/L. On the same farm, the average product would be 2000/10 = 200 Kg.

3. Marginal product is the change in total output resulting from the change (using one more or one less unit) of the variable factor. If an eleventh man is now added to this farm and the output rose to 2,100 Kg, the marginal product (of labour) would be 100 Kg. Thus, MP = d(TP)/dL.

For a two-input production process, the total product of labour (TP_L) is defined as the maximum rate of output coming up from combining varying rates of labour input with a fixed capital input$(\bar{K})$. (Note: A bar over K or over any other variable means, that variable has been fixed, and therefore is no more variable.)

$TP_L = f(\bar{K}, L)$ and total product of capital

function is

$TP_K = f(K, \bar{L})$

Marginal product (MP) is the change in output per unit change in the variable input. Thus the marginal product of labour and capital is

$$MP_L = \frac{\Delta Q}{\Delta L}$$

$$MP_K = \frac{\Delta Q}{\Delta K}$$

For the Cobb-Douglas production function, $Q = AK^aL^b$

The marginal products are

$$MP_K = \frac{dQ}{dK} = aAK^{a-1}L^b \text{ and } MP_L = \frac{dQ}{dL} = bAK^aL^{b-1}$$

Average product (AP) is total product per unit of variable input. It is found by dividing the rate of output by rate of variable input, i.e.,

$$AP_L = \frac{TP_L}{L} \text{ and } AP_K = \frac{TP_K}{K}$$

By holding the quantity of input constant and changing the other, we can derive TP of the variable input.

Example: By holding capital constant at one unit (K = 1) and increasing units of labour used from 0 to 6 units, we get total product of labour as in column (2) in Table.

TP, MP and AP of Labour

(1) Labour (No. of workers)	(2) Output or TP	(3) MP of Labour	(4) AP of Labour	(5) Output Elasticity of Labour
0	0	-	-	-
1	3	3	3	1
2	8	5	4	1.25
3	12	4	4	1
4	14	2	3.5	0.57
5	14	0	2.8	0
6	12	-2	2	-1

Marginal product (MP) of labour (MP_L) is the change in total product or extra output per unit change in labour used. Average product of labour (AP_L) equals total product divided by the quantity of labour used.

$$MP_L = \frac{\Delta TP}{\Delta L}$$

$$AP_L = \frac{TP}{L}$$

Output elasticity of labour (E_L) measures the percentage change in output divided by percentage change in quantity of labour used.

$$E_L = \frac{\%\Delta Q}{\%\Delta L}$$

or

$$E_L = \frac{\Delta Q / Q}{\Delta L / L} = \frac{\Delta Q / \Delta L}{Q / L} = \frac{MP_L}{AP_L}$$

This means that from zero units of labour (and with K = 1), TP or output grows proportionally to the growth in the labour input. For the second unit of labour E_L = 1.25 (that is, TP or output grows more than proportionally to the increase in L), and so on.

Short Run and Long Run Production Function

The above features show that some quantity of both the inputs is required to produce a given quantity of output. A two input long run production function for quantities of labour and capital upto 10 units can be expressed as in Table 6.1.

Table 6.1: Long Run Production Function

Labour (L)	**Capital (K)**										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
0	0	0	0	0	0	0	0	0	0	0	0
1	0	5	15	35	47	55	62	61	59	56	52
2	0	12	31	49	58	66	72	77	72	74	71
3	0	35	48	59	68	75	82	87	91	89	87
4	0	48	59	68	72	84	91	96	99	102	101
5	0	56	68	76	85	92	99	104	108	111	113
6	0	55	72	83	91	99	107	112	117	120	122
7	0	53	73	89	97	104	111	117	122	125	127
8	0	50	72	91	100	107	114	120	124	127	129
9	0	46	70	90	102	109	116	121	125	128	130
10	0	40	67	89	103	110	117	122	126	129	131

If capital was the fixed input in the short run, then each column of the table represents a short run production function with respect to a specific quantity of the fixed (Capital) input.

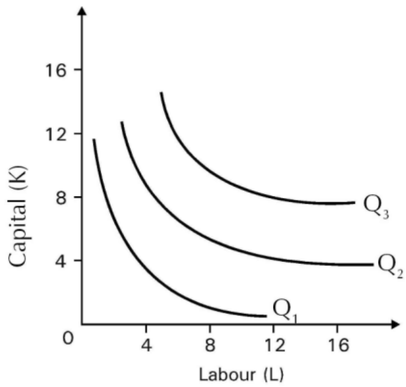
Example: For K = 2, the short-run production function would be as in Table.

Short Run Production Function

Labour (L)	0	1	2	3	4	5	6	7	8	9	10
Output (Q)	0	15	31	48	59	68	72	73	72	70	67

The above functions can be shown on a two dimensional diagram with a family of production curves, one for each production level. Figure below gives such a representation for two selected levels of production, Q = 91 and Q =

122. Table shows that there are four alternative ways of producing 91 units and three for producing 122 units of output.



Long Run Production Function

Contt..