

HSS 201: Economics for Engineers

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All about Production Decisions

- ① Production Technology: A practical way to convert inputs into outputs.
- ② Cost Constraints: Prices of the factors (or inputs) used in production.
- ③ Input Choices: Given the production technology, and the factor prices, the producer must know how much of each input to use in producing its output.

The Production Function

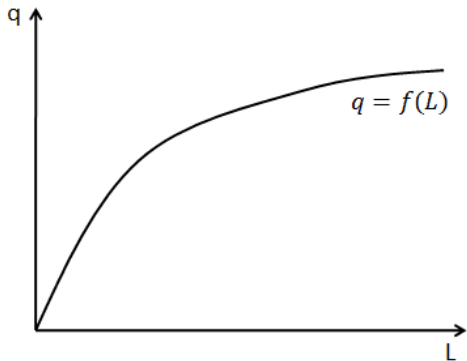
A production function indicates the highest output q that a firm can produce for every specified combination of inputs.

To keep our analysis simple, we focus only on two inputs, Labour (L) and Capital (K). We then write the production function as: $q = F(K, L)$.

The production function allows inputs to be combined in varying proportions, so that output can be produced in many ways. In other words, it also tells us about the underlying technology.

Production function defines what is technically feasible when firms operate efficiently

The Production Function



L : Labour; q : Output

The Concept of Short Run and Long Run

Production plans that are *immediately* feasible and those that are *eventually* feasible.

The **short run** refers to a period of time in which the quantities of one or more factors of production cannot be changed. In other words, there is at least one factor of production that is fixed.

The **long run** refers to a period of time in which the quantities of all factors are variable. In other words, there is no fixed input.

Technological Change

It refers to a change in the underlying techniques of production. A product can be innovated in the following ways:

- 1 Process Innovation: It refers to a change in the method of production.
E.g., Use of new Equipment
- 2 Product Innovation: it refers to the introduction of a good or service that is new or has significantly improved characteristics or intended uses.
E.g., Mobile Phones

The Production Analysis in the Short Run

In the short run, assuming that out of the two inputs (labour and Capital) required to produce quantity q , one is fixed. Mathematically,

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

Total Product: For each level of L , the maximum amount of output that is produced.

Marginal Product: It is the change in output produced as the variable input is increased by one unit. Mathematically,

$$MP_L = \frac{dq}{dL}$$

Average Product: It is the output per unit of the variable input.

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

An Example

Let $q = K^{0.25}L^{0.75}$ and $K = 16$ in the short run. What is the equation for *total*, *marginal* and *average* product?

Total product is $q = 2L^{0.75}$.

Marginal product is $1.5L^{-0.25}$.

Average product is $2L^{-0.25}$

Production with One Variable Input (Or, in the Short Run)

Labor	Capital	TP	AP_L	MP_L
0	10	0	-	-
1	10	10	10	10
2	10	30	15	20
3	10	60	20	30
4	10	80	20	20
5	10	95	19	15
6	10	108	18	13
7	10	112	16	4
8	10	112	14	0
9	10	108	12	-4
10	10	100	10	-8

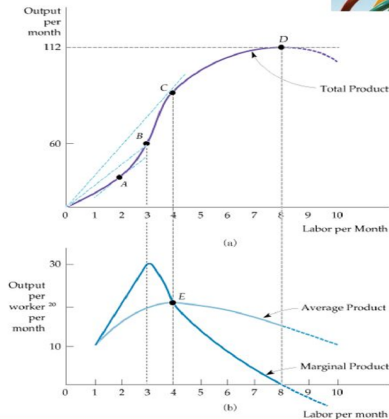
The Slopes of Product Curves

PRODUCTION WITH ONE VARIABLE INPUT

To the left of point *E* in (b), the marginal product is above the average product and the average is increasing; to the right of *E*, the marginal product is below the average product and the average is decreasing.

As a result, *E* represents the point at which the average and marginal products are equal, when the average product reaches its maximum.

At *D*, when total output is maximized, the slope of the tangent to the total product curve is 0, as is the marginal product.



The Law of variable Proportion

It is also known as the law of diminishing returns. It shows that in a given state of technology, with at least one input factor is variable, additional units of that particular variable input will yield increasing returns up to a certain point. After that additions of the variable input will yield diminishing returns.

The Three Stages of Production

Stage I: At first Total product increases at an increasing rate and then it starts to increase but at an decreasing rate. The point of inflection in Total product curve corresponds to the maximum point on the Marginal product curve. After that Marginal product curve starts to fall. While the Average product curve increases. Also, here the marginal and average product curve are equal when the average product curve is maximum.

Stage II: This stage begins when Stage I ends. The Total product curve continues to increase at an diminishing rate and reaches the maximum. Correspondingly, the marginal product curve continues to diminish rapidly and reaches zero when the Total product curve is at maximum. the average product curve starts to decline.

Stage III: The Total product decreases. The Marginal product is negative. The average product falls also.

The Production Analysis in the Long Run

Returns to Scale is the rate at which output increases as inputs are increased proportionately.

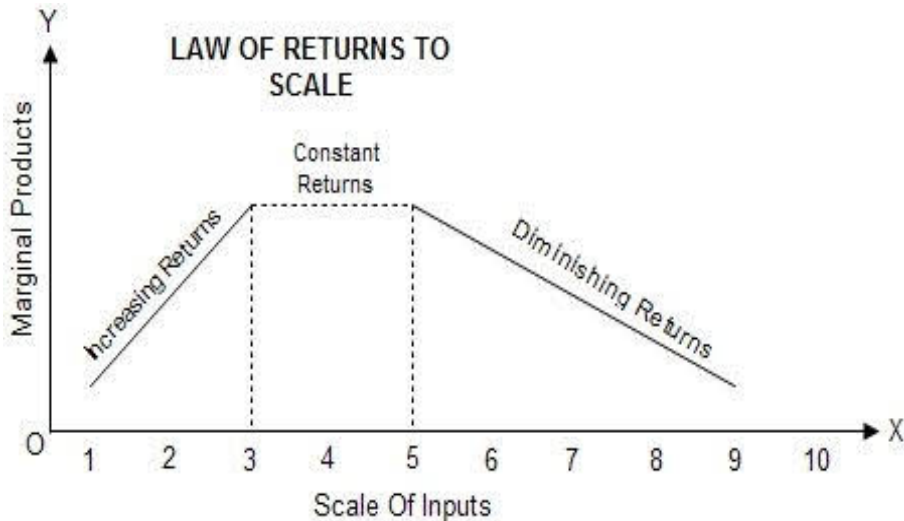
Increasing Returns to Scale (IRS): If output more than doubles when inputs are doubled. This arises when larger scale of operation allows employees of firms to work according to their specialization. If a firm is experiencing IRS then that firm can produce at a relatively less cost. Because of this the firm which is experiencing IRS, it can control the price.

Constant Returns to Scale (CRS): If output doubles when inputs are doubled. With CRS, the size of the firms operation does not affect the productivity of its factors. As one plant using a particular production process can easily replicated, two plants produce twice as much output.

The Production Analysis in the Long Run

Decreasing Returns to Scale (DRS): If output less than doubles when inputs are doubled. There is a decrease in productivity of all inputs. DRS is likely to be related with the problems of coordinating tasks and maintaining a useful line of communication between management and workers.

The Production Analysis in the Long Run



Some Practice Questions

Identify which among the following production functions exhibit IRS, CRS and DRS? Compute the Marginal Productivity of Labor also.

① $q = 3L + 2K$

② $q = (2L + 2K)^{\frac{1}{2}}$

③ $q = 3LK^2$

④ $q = L^{\frac{1}{2}}K^{\frac{1}{2}}$

⑤ $q = 4L^{\frac{1}{2}} + 4K$

What causes IRS?

- 1 Specialization and Division of Labor
- 2 Internal Economies of Scale: The firm adopts better technologies, better efficiency.
- 3 External Economies of Scale: Trading centers, Credit and Transport facilities.

Economies of Scale

As output increases, the firm's average cost of producing that output is likely to decline. Types of Economies of Scale

- 1 Internal Economies of Scale: The benefits of firm when it expands are restricted to itself only.
- 2 External Economies of Scale: The benefits are shared by other firms too.

Forms of Internal Economies of Scale

- 1 Division of Labor: Greater specialization of inputs
- 2 New technologies of production
- 3 Financial economics: Credit at cheaper rates
- 4 Managerial Economics: Large output, larger employees can be managed with better management techniques.

Forms of External Economies of Scale

- 1 Localization
- 2 Information
- 3 Vertical Disintegration: For instance, near a sugar mill, farmland of sugarcane