Managerial Economics

M.Com. IV Sem.

Mr. Abhi Dutt Sharma

Date: 21/04/2020

Laws of Production

CONTENTS

Objectives

Introduction

7.1 Law of Diminishing Returns to Factor (Law of Variable Proportions)

7.1.1 Three Stages of Production

7.1.2 Optimal use of Variable Input

7.2 Returns to Scale (Law of Returns to Scale)

7.3 Summary

7.4 Keywords

7.5 Self Assessment

Objectives

After studying this unit, you will be able to:

- Discuss law of diminishing returns to factor and returns to scale
- Explain the law of returns of Scale

Introduction

In this unit, we will discuss the laws of production. In the short run, the law of diminishing returns states that as we add more units of a variable input (i.e. labour or raw materials) to fixed amounts of land and capital, the change in total output will at first rise and then fall. Diminishing returns to labour occurs when marginal product of labour starts to fall. This means that total output will still be rising - but increasing at a decreasing rate as more workers are employed. In the long run, all factors of production are variable. How the output of a business responds to a change in factor inputs is called returns to scale.

7.1 Law of Diminishing Returns to Factor (Law of Variable Proportions)

If all inputs of a firm are fixed and only the amount of labour services differs, then any decrease or increase in output is achieved with the help of changes in the amount of labour services used. When the firm changes the amount of labour services only, it changes the proportion between the fixed input and the variable input. As the firm keeps on changing this proportion by changing the amount of labour, it experiences the law of variable proportion or diminishing marginal returns. This law states that, As more and more of the factor input is employed, all other input quantities remaining constant, a point will finally be reached where additional quantities of varying input will produce diminishing marginal contributions to total product.

This underlines the short run production function. It can be shown in a Table 7.1 and Figure 7.1 as follows.

Table 7.1: Production Function with One Variable Input

Number of Labour Units (L) (1)	Total Product of Labour (TP_L) (2)	Average Product of Labour (AP_L) (3= 2÷1)	Marginal Product of Labour (MP_L) (4)
1	100	100	–
2	210	105	110
3	330	110	120
4	430	107.5	100
5	520	104	90
6	600	100	80
7	670	95.7	70
8	720	90	50
9	750	83.3	30
10	760	76	10

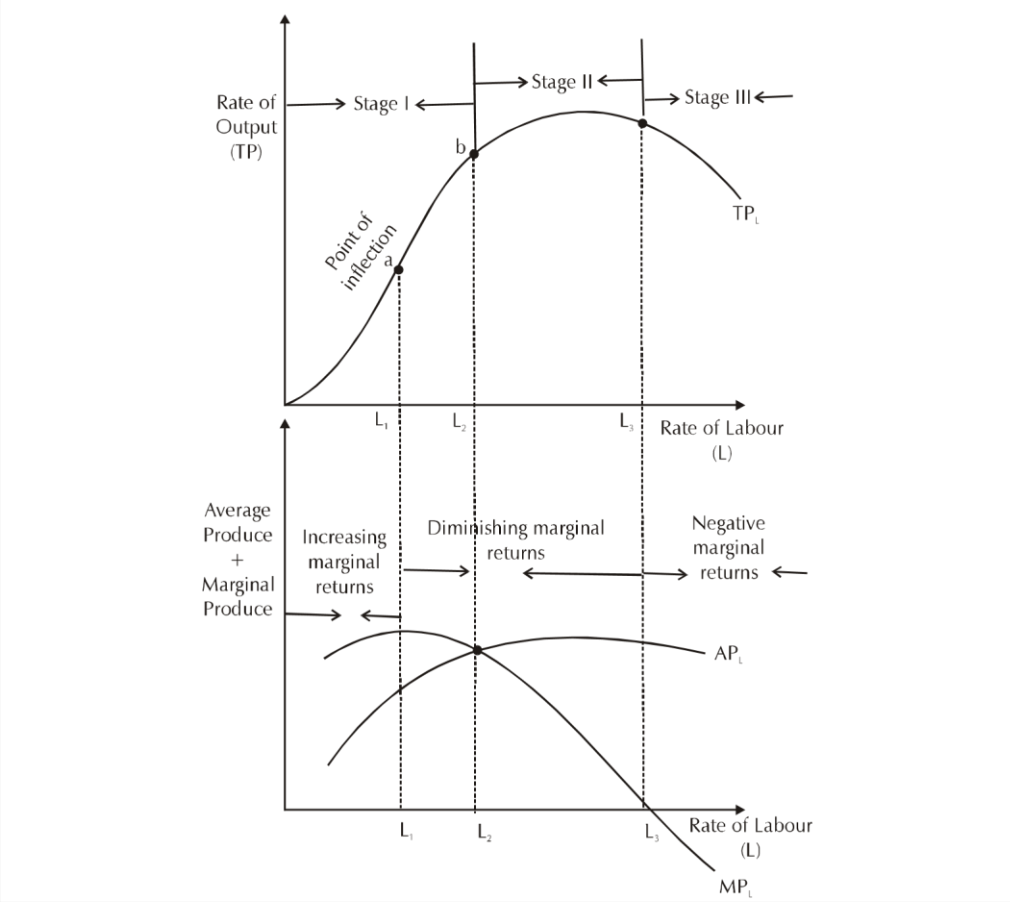
In Table 7.1 labour is assumed to be the only variable input. Columns 1 and 2 together represent the production function of the firm. Column 3 shows the average combination of labour units involved. Column 4 lists the amount of increase in output as a result of each additional unit of labour, e.g., the marginal physical product of 5th unit of labour is the total physical product of 5 units of labour minus the total physical product of 4 units. Column 4 shows that the marginal physical product starts decreasing from 4th unit of labour onward. If labour units employed increase beyond 10, the marginal physical product will become zero and later become negative. The stage from where the marginal physical product starts decreasing shows the law of diminishing returns or law of variable proportions.

MP begins to fall before the AP does. The reason is that the AP attributes the increase in TP equally to all the units of the variable factor whereas the MP, by definition, attributes the increase in TP to the marginal unit of the variable factor.

If the MP is greater than the AP, the AP rises and if the MP is less than the AP, then the AP falls. For example if the batsman's next (or marginal) score is greater than his average score, then his average score rises and if his next (or marginal) score is less than his average score, the average score falls.

From this it follows, that when the MP is equal to the AP, the AP is at its maximum. The reason is that when AP is increasing, MP is above AP, pulling it up; when the AP is at its maximum and constant, AP is equal to MP; when AP is falling, MP is below AP, pulling it down.

Figure 7.1



7.1.1 Three Stages of Production

Diminishing returns to a factor can be graphically understood with the help of total and marginal product curves. In Figure 7.1, the TPP curve rises first to an increasing rate in stage I and later at a diminishing rate in stage II. At stage II, the TPP remains constant. Thus, the total output increases more than proportionately until X units of labour are employed; between X units and Y units of labour used, the total output rises with every additional unit of labour but this increase is less than proportionate. If labour units increase beyond level Y, the total output eventually starts decreasing. Correspondingly when TPP is rising at an increasing rate, MPP and APP curves are rising; and when total product is rising at a diminishing rate, the MPP and APP curves are declining. At Y, where TPP becomes constant, the MPP becomes zero, and additional labour beyond Y makes MPP negative. These three phases of TPP curve are called the three stages of production and are summarized in Table 7.2.

No firm will choose to operate either in Stage I or Stage III. In Stage I the marginal physical product is rising, i.e., each additional unit of the variable factor is contributing to output more than the earlier units of the factor; it is therefore profitable for the firm to keep on increasing the use of labour. In Stage III, marginal contribution to output of each additional unit of labour is negative; it is therefore, not advisable to use any additional labour. Even if cost of labour used is zero, it is still unprofitable to move into Stage III. Thus, Stage II is the only important range for a rational firm in a competitive situation. However, the exact number of labour units hired can be found only when the corresponding data on wage rates is available.

Table 7.2: Stages of Production

Total Physical Product	Marginal Physical Product	Average Physical Product	Additional Information
Stage I Increases at an increasing rate	Increases and reaches its maximum	Increases (but slower than MPP)	Fixed inputs grossly under utilised, specialisation and team work cause APP to increase when additional input is used
Stage II Increases at a diminishing rate and becomes maximum	Starts diminishing and becomes equal to zero	Starts diminishing	Specialisation and teamwork continue and result in greater output when additional input is used, fixed input is being properly utilised
Stage III Reaches its maximum, becomes constant and then starts declining	Keeps on declining and becomes negative	continues to diminish but must always be greater than zero	Fixed inputs capacity is reached, additional input causes output to fall

7.1.2 Optimal use of Variable Input

It is important for the firm to decide how much labour it should use in order to maximize profits. The firm should employ an additional unit of labour as long as the extra revenue generated from the sale of the output produced exceeds the extra cost of hiring the unit of labour, i.e., until the extra revenue equals the extra cost.

Thus, if an additional unit of labour generates ₹ 300/- in extra revenue and costs an extra ₹ 200 then it pays for the firm to hire this unit of labour as its total profit increases. This is an example of application of the general optimization principle.

The extra revenue generated by the use of an additional unit of labour is called the Marginal Revenue Product of Labour (MRP_L). This equals the Marginal Product of Labour (MP_L) times the Marginal Revenue (MR) from the sale of the extra output produced. Thus,

$$MRP_L = (MP_L)\ (MR)$$

The extra cost of hiring an additional unit of labour or Marginal Resource Cost of Labour (MRC_L) is equal to the increase in the total cost to the firm resulting from hiring the additional unit of labour. Thus,

$$MRC_L = \frac{\Delta TC}{\Delta L}$$

A firm should continue to hire labour as long as $MRP_L > MRC_L$ and until

$$MRP_L = MRC_L$$

This is applicable to any variable input and not just labour.

7.2 Returns to Scale (Law of Returns to Scale)

If all inputs are changed at the same time (possible only in the long run), and suppose are increased proportionately, then the concept of returns to scale has to be used to understand the behaviour of output. The behaviour of output is studied when all factors of production are changed in the same direction and proportion.

In the long run, output can be increased by increasing the ‘scale of operations ’. When we speak of increasing the ‘scale of operations’ we mean increasing all the factors at the same time and by the same proportion. For example, in a factory, in the long run, the scale of operations may be increased by doubling the inputs of labour and capital. The laws that govern the scale of operation are called the laws of returns of scale.

The laws of returns to scale always refer to the long run because only in the long run are all the factors of production variable. In other words, only in the long run is it possible to change all the factors of production. Thus the laws of returns to scale refer to that time in the future when changes in output are brought about by increasing all inputs at the same time and in same proportion.

Returns to scale are classified as follows:

1. Increasing Returns to Scale (IRS): If output increases more than proportionate to the increase in all inputs.
2. Constant Returns to Scale (CRS): If all inputs are increased by some proportion, output will also increase by the same proportion.
3. Decreasing Returns to Scale (DRS): If increase in output is less than proportionate to the increase in all inputs.

For example, if all factors of production are doubled and output increases by more than two times, then the situation is of increasing returns to scale. On the other hand, if output does not double even after a cent per cent increase in input factors, we have diminishing returns to scale.

The general production function is

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

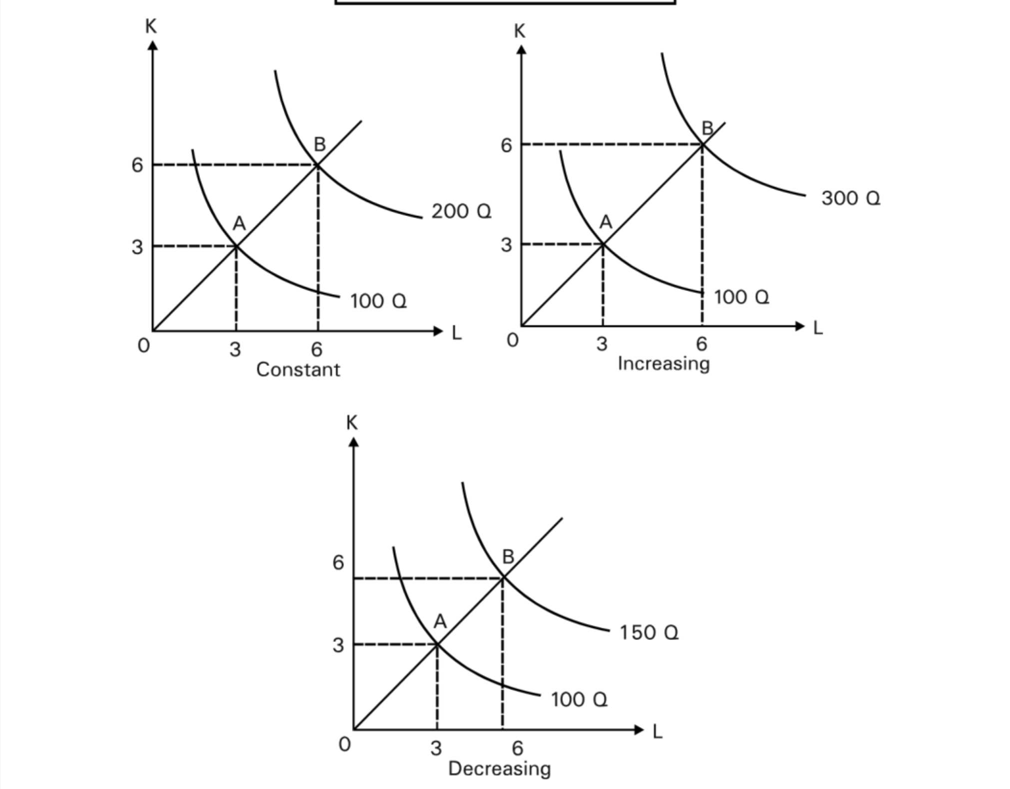
If land, K, and labour, L, is multiplied by h and Q increases by λ, we get, $\lambda Q = f(hL, hK)$

We have constant, increasing or decreasing returns to scale, respectively depending upon, whether $\lambda = h$, $\lambda > h$ or $\lambda < h$.

For example, if all inputs are doubled, we have constant, increasing or decreasing returns to scale, respectively, if output doubles, more than doubles or less than doubles.

The firm increases its inputs from 3 to 6 units (K, L) producing either double (point B), more than double (point C) or less than double (point D) output (Q) as shown in Figure 7.2.

Figure 7.2: Returns to Scale

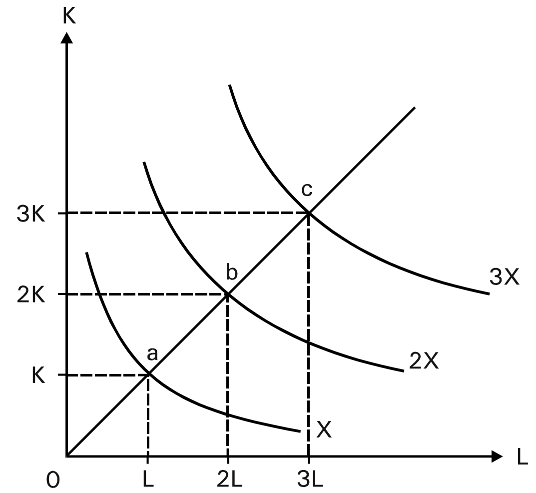


Increasing returns to scale arise because as the scale of operation increases, a greater division of labour and specialization can take place and more specialised and productive machinery can be used. Decreasing returns to scale arise primarily because as the scale of operation increases, it becomes more difficult to manage the firm. In the real world, the forces for increasing or decreasing returns to scale often operate side by side, with the former usually overpowering the latter at small levels of output and the reverse occurring at very large levels of output.

If all the factors of production are increased in a particular proportion and the output increases in exactly that proportion then the production function is said to exhibit CRS. Thus if labour and capital are increased by 10% and the output also increases by 10% then the production function is CRS.

If you look at Figure 7.3, to produce X units of output, L units of labour and K units of capital are needed (point a). If labour and capital are now doubled (as is possible in the long run), so that there are 2L units of labour and 2K units of capital, the output is exactly doubled i.e., equals 2X (point b). Similarly, trebling input achieves treble the output and so on.

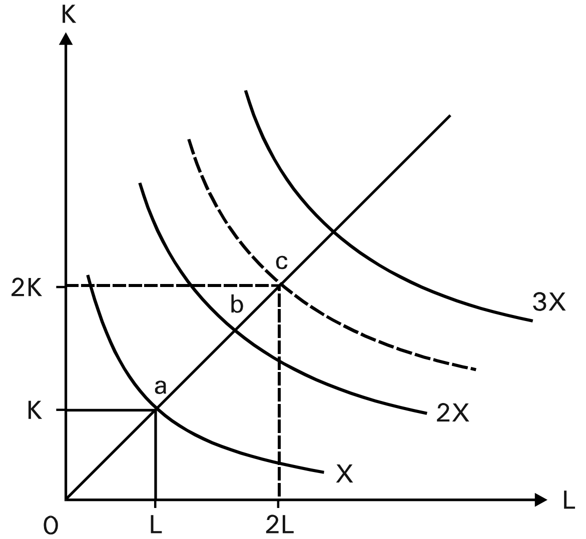
Figure 7.3: CRS Production Function



If all the factors of production are increased in a particular proportion and the output increases by more than that proportion then the production function is said to exhibits IRS. For example, in many industrial processes if all inputs are doubled, factories can be run in more efficient and effective ways, there by actually more than doubling output. This is shown in Figure 7.4. To produce X units of output, L units of Labour and K units of output are needed. If labour is doubled to 2L units and capital to 2K units, an output greater than 2X is produced (point c lies on a higher isoquant than point b).

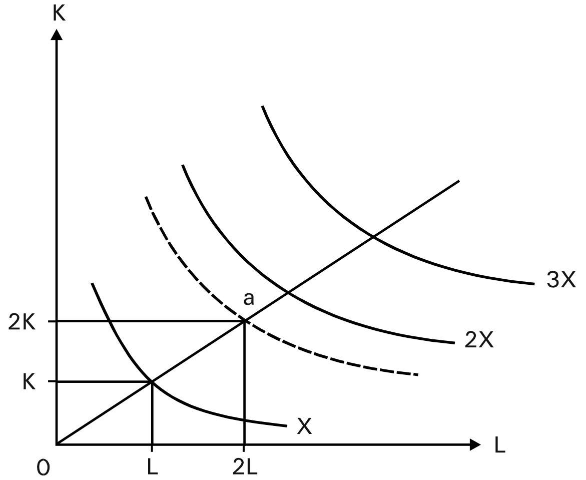
If the factors of production are increased in a particular proportion and the output increases by less than that proportion than the production function is said to exhibit DRS. For example, if capital and labour are increased by 10% and output rises by less than 10% the production function is said to exhibit decreasing returns to scale.

Figure 7.4: IRS Production Function



If you look at Figure 7.5, to produce X units of output L units of labour and K units of capital are required. By doubling the input, the output increases by less than twice its original level. For example, if inputs are 2L and 2K, output level 'a' is reached, which lies below the one showing 2X.

Figure 7.5: DRS Production Function



It is also necessary for students to know the causes for increasing and decreasing returns to returns to scale.

Contd...

7.3 Summary

- The law of variable proportion of says that as more and more of the factor input is employed, all other input quantities remaining constant, a point will eventually be reached where additional quantities of varying input will yield diminishing marginal contributions to total product.
- Returns to scale are classified as: (a) Increasing Returns to Scale (IRS), (b) Constant Returns to Scale (CRS) and (c) Decreasing Returns to Scale (DRS).

7.4 Keywords

Fixed inputs: Inputs that cannot be readily changed during the time period under consideration

Inputs: Resources used in the production of goods and services

Long-run: The time period when all inputs become variable

Short-run: The time period during which at least one input is fixed

Variable inputs: Inputs that can be varied easily and on very short notice

7.5 Self Assessment

Fill in the blanks:

1. As we added more and more of variable input to a fixed input, the amount of extra product will.................
2. Under decreasing return to scale increase in output is .... than proportionate to the increase in input.
3. Increasing return to scale are due to .... and/or managerial indivisibilities.
4. Technical indivisibilities cause................ returns to scale.
5. In the long run, output can be .... by increasing the scale of operations.
6. As per Law of Variable Proportions, when MP is equal to AP, AP is at its…………………….
7. In the third stage of Law of Diminishing Returns, there are …………….marginal returns.
8. A sensible firm would like to operate in the………………stage of production.
9. In ………………stage of production, any additional input employed would lead to a fall in output.
10. In………………..returns to scale, the proportionate increase in input is not equal to the proportionate change in output.

Answers: Self Assessment

1.	fall off	2.	less	3.	technical
4.	increasing	5.	increased	6.	Maximum
7.	Negative	8.	Second	9.	Third
10.	Increasing and Decreasing				