[Academic Script]

Production Equilibrium

Subject:	Business Economics
Course:	B. A. (Hons.), 1st Semester, Undergraduate
Paper No. & Title:	Paper – 101 Microeconomics – I
Unit No. & Title:	Unit – 3 Production Equilibrium
Lecture No. & Title:	Lecture – 2 Production Equilibrium

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1. Introduction

We have already discussed about the law of variable proportion and returns to scale which underline the process of production. We have dealt with the way total output behaves to a change in all the factors of production is known as the law of returns according to scale of production. According to this law, when all factors units are increased, total product may increase at an increasing rate, later at a constant rate and finally at a diminishing rate- these three tendencies have come to be known as 'increasing returns to scale', 'constant returns to scale' and 'diminishing returns to scale'.

Further we will incorporate the study of factor pricing wherein there is optimum factor combination or we can even term it as the least cost combination of the factors of production. This will also include the expansion path showing the different choice of inputs. We have already discussed the concept ofIsoquants which in economic terminology means: A graph of all possible combinations of inputs that result in the production of a given level of output. It helps to measure the influence of inputs on the level of production or output that can be achieved.

We shall further discuss the isocostcurve which could be understood as the locus traced out by various combinations of L (labor)and K(capital), each of which costs the producer the same amount of money. The isocost line will shift to the right when money spent on factors increases or firm could buy more as the factor prices are given. In short the concept of isocost can be taken as the factor prices. Responsiveness of the buyers of a good or service to the price changes in its substitutes. It is measured as the ratio of proportionate change in the relative

demand for two goods to the proportionate change in their relative prices.

We will also discuss the concept of Elasticity of substitution that shows, to what degree two goods or services can be substituted for one another or Elasticity of substitution shows to what degree two goods or services can be substituted for one another. And lastly we can talk about the concept of cost function in brevity.

2. Optimum factor combination or least cost combination of the factors of production (expansion path): choice of inputs.

Factor prices:

The meaning of factor prices in economics can be taken as an effort to explain the principles by which a business firm decides how much of each commodity that it sells (its "outputs" or "products") it will produce, and how much of each kind of labor, raw material, fixed capital good, etc., that it employs (its "inputs" or "factors of production") it will use. The theory involves some of the most fundamental principles of economics. These include the relationship between the prices of commodities and the prices (or wages or rents) of the productive factors used to produce them and also the relationships between the prices of commodities and productive factors, on the one hand, and on the other hand are the quantities of these commodities and productive factors that are produced or used.

Optimum factor combination

The prices of factors are represented by the iso-cost line. It plays an important part in determining what combination of factors the firm will choose for production.

An iso-cost line is defined as the locus of various combinations of factors which a firm can buy with a constant outlay. It is also called the price line or outlay line.

Example: suppose that the firm has Rs 300 to spend on the factors labor and capital and price of labor is Rs 4 per labor hour and price of capital is Rs 5 machine hour. With outlay of Rs 300, he can buy 75 units of labor or 60 units of machine hours (capital).

Figure:1 (iso-cost line)

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Let OB represent 70 units of labor and OA represent 10 units of capital. Now suppose the firm spends the entire outlay of Rs 300 on capital then it buys 60 units or OA of machine hours. The straight line AB which joins points A and B will pass through all combinations of labor and capital which the firm can buy with the outlay of Rs 300.if it spends, the entire sum on them at the given prices.

Equation of Iso-cost line:

C=wl+rK

The total cost incurred on the factors of production for production of a commodity is equal to the sum of the payments made for labor and capital. The payment for the labor used is equal to the wage rate (w) multiplied by the amount of labor used (L). Thus w.L represents the total payment made for labor. Similarlyr.K is the total payment made for capital where r is the price per unit of

capital and K is the quantity of capital used.C is the total cost incurred by the firm on purchasing the quantities of factors used for production. The total cost equation can be written as follows:

C=wl+rK

Least-cost combination of factors: choice of inputs

An equal product map represents the production function of a product with two variable factors. An equal product map represents the technical conditions of production for a product. A family of iso-cost line represents the various levels of total cost or outlay, given the prices of two factors. The entrepreneur may desire to minimize his cost for producing a given level of output, or he may desire to maximize his output level for a given cost or outlay. To produce a given level of output the entrepreneur will choose the combination of factors which minimizes his cost of production, for only in this way he will be maximizing his profits. Thus a producer will try to produce a given level of output with least-cost combination of factors. This leastcost combination of factors will be optimum for him.

Example: suppose the entrepreneur has decided to produce 500 units of output which is represented by isoquant Q. the 500 units of output can be produced by any combination of labour and capital such as R,S,E,T and J lying on the isoquants. Let us understand this with the help of a figure.

Figure: 2 (minimizing cost for a given level of output)

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For producing the given level of output (500 units)the cost will be minimum at point E at which the iso-cost line CD is tangent to the given isoquant. At no other point like R, S, T and J, lying on

the isoquant Q the cost is minimum. All other points on isoquant Q such as R, S, T and J lie on higher iso-cost lines than CD and which will therefore mean greater total cost or outlay for producing the given output. The entrepreneur will not choose any of the combination R, S, T and J. the factor combination E is the least-cost combination of labor and capital for producing a given output. Hence the entrepreneur will choose factor combination E (that is, OM units of labor and ON units of capital) to produce 500 units of output. It is thus clear that the tangency point of the given isoquant with an iso-cost line represents the least-cost combination of factors for producing a given output.

Output maximization for a given level of outlay (i.e. Cost):

A rational producer will be interested in maximizing putput of the commodity.

Example: suppose the firm has decided to incur an outlay of Rs 5000 on labor and capital which is represented by the iso-cost line AB. The firm has a choice to use any factor combination of labor and capital such as R, S, E, T,J etc. lying on the given iso-cost line AB to produce the product, an isoquant mao showing a set of isoquants that represents various levels of output (200, 300, 400, 500 units) has been superimposed on the given iso-cost line AB. We can see from the figure 3 that the firm will choose the factor combination E consisting of ON of labor and OH of capital.

Figure 3 (maximization of output for a given outlay)

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This is because of all the factor combinations that lie on the given iso-cost line AB, only the factor combination E enables the firm to

reach the highest possible isoquant Q_3 and thus produce 400 units of output. All other combinations of labor and capital that lie on the given iso-cost line AB such as R, S, T, J etc. lie onlower isoquants showing lower levels of output than 400 units. Therefore at point E the entrepreneur will have maximized outputfor a given cost.

3. Expansion path

We have already explained which factor combination a firm will choose to produce a specified level of output, given the prices of the two factors .Now let us see how the entrepreneur will change his factor combination as he expands his output, given the factor prices.

Figure:4 (expansion path):

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Example: suppose the prices of the two factors, labor and capital are such that are represented by the slope of the iso-cost line AB. We can see from figure 4, that four iso-cost lines, AB, CD, UF and GH are drawn which shows different levels of total cost or outlay. All iso-cost lines are parallel to each other indicating that prices of the two factors remain the same, if the firm wants to produce the output level denoted by Q_1 (=100 units of output) it will choose the factor combination E_1 which minimizes cost of production; E_1 being the point of tangency between the isoquant Q_1 and the iso-cost line AB. Now, if a firm wants to produce a higher level of output denoted by the isoquant Q_2 (=200), it will then choose the factor combination E_2 which is the least cost combination for new output. For still higher output levels denoted

by Q_3 and Q_4, the firm will respectively choose tangency combination E_3 and E_4 which minimize cost for the given outputs. The line joining the minimum cost combination such as E_1, E_2, E_3, E_4 is called the expansion path because it shows how the factor combination with which the firm produces will alter as the firm expands its level of output. Thus the expansion path may be defined as the locus of the points of tangency between the ios product curves (i.e. isoquants) and the iso-cost lines. It is also known as c=scale line because it shows how the entrepreneur will change the quantities of the two factors when it increases the level of output.it has different shapes and slopes depending upon the relative prices of the productive factors used and the shape of isoquants.

Since expansion path represents minimum cost combinations for various levels of output, it shows the cheapest way of producing each output, given relative prices of the factors. It is certain that when both factors are variable and the prices of factors are given, a rational entrepreneur will seek to produce at one point or the other on the expansion path.

4. Elasticity of substitution

The isoquants illustrate an important economic phenomenon: that of factor substitution. This means that one variable factor can be substituted for others; as a general rule a more lavish use of one variable factor will permit an unchanged amount of output to be produced with fewer units of some or all of the others.

In the theory of production we are concerned with the elasticity of substitution between factors (or inputs) in the production of goods. It is also termed as elasticity of technical substitution in economics.

The marginal rate of technical substitution (MRTS) of factor X for Y declines as factor X is substituted for factor Y along an Isoquant. In other words the MRTS is different at different factor-proportion (i.e. input ratios)used in the production of a good.

Definition: The relative change in the factor-proportions (or input ratios) as a consequence of the relative change in the marginal rate of technical substitution (MRTS) is known as Elasticity of substitution between factors.

We can further explain the concept of elasticity of substitution with reference to capital and labor as factors of production. If K stands for the quantity of capital, L for the quantity of labor and σ for the elasticity of substitution, then in accordance with the above definition, elasticity of substitution of capital for labor can be expressed as follows:

$$\sigma = \frac{proportionate\ change\ in\ the\ ratio\ of\ inputs(K\ and\ L)USED}{proportionate\ change\ in\ the\ marginal\ rate\ of\ technical\ substitution\ of\ L\ for\ K}$$

Figure 5: MRTS of l for k and capital-labor ratios
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An isoquant or equal product curve q has been drawn. It will be seen that at point A in the given isoquant q, the capital-labor ratio used is K_1/L_1 which is equal to the slope of the of the ray OA. As labor is substituted for capital and therefore we move down on the isoquant q from pointA to B. capital takes place and we come down to point C on the isoquant q, capital-labour ratio

further falls to $K3/L_3$ which is equal to the slope of ray OC. It is therefore clear that as we substitute more labor for capital along the isoquant, capital-labor ratio isdecreasing.

Conclusion:

The concept of elasticity of substitution occupies an important place in the theory of distribution. The distributive shares of labor and capital in national income depend on the elasticity of substitution.

5. Cost Function

We have already studied the production function. Now we will further try to understand the meaning of the cost function. The cost of production of the firm depends on the nature of physical production function. The cost of production varies with the increase in the level of output of the firm in fact we can say that the cost and level of output are related to each other.

The cost function of the firm depends upon the physical production function, the prices of the factors used for production and the technology used for production. We can also say that the cost of production is the most important factor governing the supply of a product.

Definition: The cost function expresses a functional relationship between total cost and factors that determine it. The factors that determine the total cost of production of a firm are the output (Q), the level of technology (T), the prices of factors ($^{p}{}_{f}$) and the fixed factors (F). Symbolically, the cost function becomes:

C=f(Q,T,$^{p}{}_{f}$, F)

The economists draw distinction between the short-run and long-run costs.

Short run costs: The short run costs are those costs which are incurred by the firm during a period in which some factors, especially, capital equipment, land and management are held constant. It is incurred on the purchases of labor, raw materials, chemicals, fuel etc. which vary with the changes in the level of output.

The short run cost function can be written as:

$C= f(Q, T, P_F, K)$

Where,

Q= the level of output

K= the capital (and other fixed factors) which are held constant

T= the technology (taken as given)

P_f= factor prices (taken as given)

Long run cost:The long run costs are the costs incurred during a period which is sufficiently large to allow the variation in all factors of production including capital equipment, land and managerial staff to produce a level of output.

The long run cost function can be written as:

$C= f (Q, T, P_F)$ OR $C=f (Q)$

Where,

$C= f(Q, T, P_F)$

C= total cost of production

Q= the level of output

T= the technology

P_F= the prices of factors of production used for the production of a particular product.

The difference between the short run and long run cost function is that in short run the cost-output relation is studied with a certain amount of capital or land fixed, whereas the long run cost function examines the relation between cost and output when capital and land also vary along with the variable factors such as labor, raw materials. In fact in both the short run and long run cost functions we study the relation between the cost and level of output i.e. C=f(Q). In long run, the advancement in the technology and changes in factor prices cause a shift in the long run cost function and in short run besides technology and factor prices some fixed factors such as capital or land also bring about a shift in the cost-function.

Thus the long run cost function represents the use of optimum resource combination so as to ensure minimum cost of production for each level of output. And in the short run, it is assumed that given the size of the plant (i.e. capital equipment), the firms operate to minimize cost for producing various levels of output.

6. Summary

We can conclude here that the iso cost line depends upon two things: a) prices of the factors of production and b) the total

outlay which the firm has to make on the factors. Given these two things an iso cost line can be drawn.

In case of least cost combination we can conclude about the entrepreneur's choice of the quantities of the two factors, that the entrepreneur will be in equilibrium in regard to his use and purchases of the two factors when he is using such quantities of the two factors that the marginal physical products of the two factors are proportional to the factor prices. And in case of output maximization for a given level of outlay i.e. cost we can conclude that with the given level of outlay there will be a single iso-cost line that represents the outlay that firm has decided to spend and a rational producer will be interested in maximizing output of the commodity.

The expansion path represents minimum cost combinations for various levels of output, it shows the cheapest way of producing each output, given the relative prices of the factors and when both the factors are variable and the prices of factors are given, a rational entrepreneur will seek to produce at one point or the other on the expansion path.