Module 2 - Continuation

Price Elasticity of Demand

It measures the degree of responsiveness of demand of a product to the change in the price of the product.

$$\textbf{Price elasticity of Demand } (e_p) = \frac{\textbf{Percentage change in quantity demanded}}{\textbf{Percentage change in price}}$$

$$e_p = \left(\frac{\Delta Q}{Q} * 100\right) \div \left(\frac{\Delta P}{P} * 100\right)$$

$$\boxed{e_p = \frac{\Delta Q}{\Delta P} * \frac{P}{Q}}$$

Price Elasticity of Supply

It measures the degree of responsiveness of supply of a product to the change in the price of the product.

$$\textbf{Price elasticity of Supply } (E_s) = \frac{\textbf{Percentage change in quantity supplied}}{\textbf{Percentage change in price}}$$

$$E_s = \left(\frac{\Delta Q}{Q} * 100\right) \div \left(\frac{\Delta P}{P} * 100\right)$$

$$\boxed{E_s = \frac{\Delta Q}{\Delta P} * \frac{P}{Q}}$$

Numerical problems

1) The price elasticity of demand of a commodity is given as 2. Calculate percentage change in quantity demanded if price of the product increases by 10%.Will it be an increase or decrease?

We have $\textbf{Price elasticity of Demand } (e_p) = \frac{\textbf{Percentage change in quantity demanded}}{\textbf{Percentage change in price}}$

$$2 = \frac{\text{Percentage change in quantity demanded}}{10}$$

Percentage change in quantity demanded = 2*10 = 20%.

Since quantity demanded and price are inversely proportional , when price increases by 10%, the quantity demanded will decrease by 20%.

2) When the price of a commodity varied from Rs.10 to Rs.15, the quantity demanded changed from 100 units to 50 units. Calculate the price elasticity of Demand.

We have initial price (P) = Rs.10 Initial quantity (Q) = 100 units

We have final price = Rs.15 Final quantity = 50 units

Change in price ΔP = 15 -10 = 5 Change in Quantity ΔQ = 50 -100 = -50

" - " sign denotes decrease in quantity

$$\text{We have , } e_p = \frac{\Delta Q}{\Delta P} * \frac{P}{Q}$$

$$= (50/5) * (10/100) = 1$$

Price elasticity of demand = 1

Types of elasiticity of demand.

Table-4: Price Elasticity of Demand		
Numerical Value	**Type of Price Elasticity**	**Description**
$e_p = \infty$	Perfectly elastic demand	There is a greater change in demand in response to percentage or smaller change in the price. For example, the demand for a product decreases or completely stops, with a little change in its price and vice versa.
$e_p = 0$	Perfectly inelastic demand	Consumers do not respond to the demand for a product with increase or decreases in its price. This implies that the demand remains the same with change in the price.
$e_p > 1$	Relatively elastic demand	The percentage change in the quantity demanded of a product is greater than percentage change in its price. In such a case, consumers generally switch to new brands when the price of a particular brand increases. However, some consumers are loyal to the same brand.
$e_p < 1$	Relatively inelastic demand	The change in the demand of a product is less than that of change in its price.
$e_p = 1$	Unitary elastic demand	The change in the demand and change in the price of a product is same.

Exceptions to the law of demand

- Inferior goods/ Giffen goods

  A Giffen good is a good for which demand increases as the price increases, and falls when the price decreases, unlike the law of demand

- Goods having prestige value

  Few goods like diamond can be purchased only by rich people. The prices of these goods are so high that they are beyond the capacity of common people. The higher the price of the diamond the higher the prestige value of it.

  In this case, a consumer will buy less of the diamonds at a low price because with the fall in price, its prestige value goes down. On the other hand, when price of diamonds increase, the prestige value goes up and therefore, the quantity demanded of it will increase.

- Price expectation

  When the consumer expects that the price of the commodity is going to fall in the near future, they do not buy more even if the price is lower.

  On the other hand, when they expect further rise in price of the commodity, they will buy more even if the price is higher. Both of these conditions are against the law of demand.

- Fear of shortage

  When people feel that a commodity is going to be scarce in the near future, they buy more of it even if there is a current rise in price.

  For example: If the people feel that there will be shortage of L.P.G. gas in the near future, they will buy more of it, even if the price is high.

- Change in fashion

  The law of demand is not applicable when the goods are considered to be out of fashion.

  If the commodity goes out of fashion, people do not buy more even if the price falls. For example: People do not purchase old fashioned shirts and pants nowadays even though they've become cheap. Similarly, people buy fashionable goods in spite of price rise.

- Basic necessities of life

  In case of basic necessities of life such as salt, rice, medicine, etc. the law of demand is not applicable as the demand for such necessary goods does not change with the rise or fall in price.

Production function

Availability of any product in the market depends upon the production of that commodity. Production of commodities depends upon various inputs like capital, labour, land, materials, technology, time, managerial efficiency etc. In order to increase the level of output we have to increase the level of these input factors. Thus there exists a relationship between these input factors and the total output produced.

Production function is a mathematical expression that analyse the relationship between various input factors like capital, labour, land, materials, technology, time, managerial efficiency etc with the total quantity of output produced.

A General form of production function can be expressed as Q = f (K, L, T, t, e, etc), read as Total quantity of output (Q) is a function of capital(K), labour (L), technology (T), time (t), managerial efficiency (e) , etc.

In order to simplify the analysis we consider only capital and labour does the production function can be expressed as Q = f (K, L)

That means, we consider only capital and labour in our discussion.

Production function can be of two types → Short run production function / Long run production function

In the short run, labour is the only variable input, capital remains constant

In the long run, both capital and labour can be varied together or one at a time.

Short run laws of production or law of variable proportion

Law of variable proportion examines what will happen to the total output when more and more units of one input (labour) are combined with a fixed quantity of the other input.

Consider an example. A business unit has got 4 machines at their site. Let's see what will happen if more and more labours are used to work with these 4 machines. Here capital is kept constant and labour is varied.

Law of variable proportion says that when more and more units of a variable input is combined with fixed quantities of other inputs, the total product may increase on increasing rate at first but then increases at a diminishing rate and eventually the total output decreases.

Schedule for law of variable proportion

No. of labours (L)	Total product (TP)	Marginal product (MP)	Average product (AP) (Total product / No. of labours)	Stage of Production
1	29	29	29 (29/1)	I
2	72	43 (72-29)	36 (72/2)	
3	133	51 (133-72)	41 (133/3)	
4	176	53 (176-133)	44	
5	225	49 (225-176)	45	II
6	264	39	44	
7	287	23	41	
8	288	1	36	
9	261	-27	29	III
10	200	-61	20	

Here the total product increases at an increasing rate initially (stage 1), then increases at a diminishing rate (stage 2), reaches a maximum and then starts decreasing (stage 3).

- *Marginal product is the change in total output produced due to one unit change in the level of variable input (here labour).*

Marginal product of 8th unit of labour = Total output due to 8 labours – Total output due to 7 labours

= 288-287

= 1unit

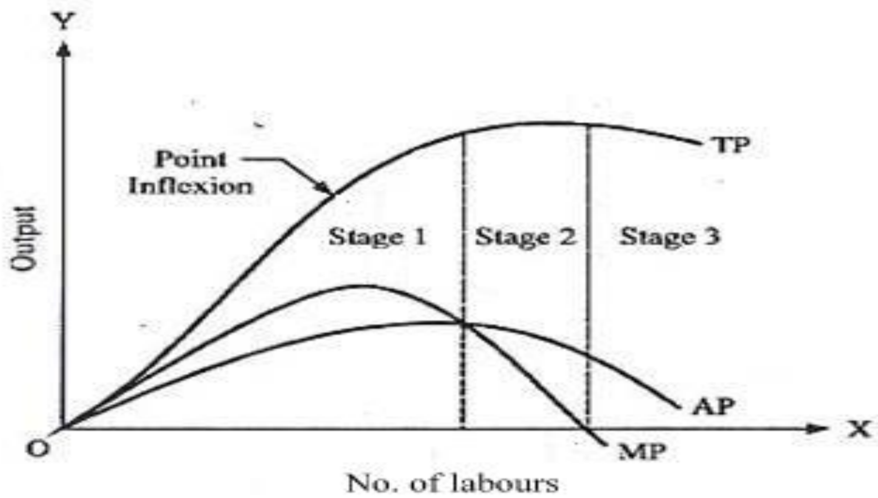
- Average product = Total output / No.of labours

  Average product of 7 labours = Total output of 7 labours / 7

  = 287/7

  = 41 units

Curve for Total product (TP) , marginal product (MP) and average product (AP) under law of variable proportion



Long run laws of production : Both labour and capital can be varied.

Cobb- Douglas Production function is a widely used production function when both capital and labour are varied.

Cobb- Douglas Production function

Imagine, a person had started a new business unit, producing packaged potato chips. The total packets of potato chips produced (or the total quantity of output) depend upon various factors (inputs) like number of machines (capital) used in the business unit, number of workers in the unit (labours) etc. So, it is necessary to derive a relationship between input factors capital and labour with the total output.

Cobb- Douglas Production function was proposed by two Economists named Charles Cobb and Paul Douglas. It is a widely used production function. It helps us to calculate how the variations in physical inputs like capital, labour etc can change the level of output in a business firm.

- *Cobb -Douglas production function is given by*

$$Q = AK^{\alpha} L^{\beta}$$

Q: Total units of output produced *A: Total productivity factor (taken as a constant)*

K: Units of capital *L: Units of labour employed*

α: output elasticity of capital *β: output elasticity of labour*

Also α+ β = 1

Consider the following examples.

i) A person has started an industry with 10 machines and 30 labours. If the production function of the company is given by $Q = 4K^{0.3} L^{0.7}$, find the total quantity of output produced.

Given ,

Capital (machines) K = 10 ; Labour L =30

Substituting in the equation $Q = 4K^{0.3} L^{0.7}$, we get

$Q = 4 (10)^{0.3} (30)^{0.7}$

Q = 86.03, approximately 86 units.

Total output = 86 units approximately.

ii) If the production function is given by $Q = 2K^{0.4} L^{0.6}$, find the total quantity of output produced if capital is 5 units and labour is 20 units

Given,

Capital K = 5 ; Labour L = 20

Substituting in the equation $Q = 2K^{0.4} L^{0.6}$, we get

$Q = 2 (5)^{0.4} (20)^{0.6}$

Q = 22.97, approximately 23 units.

Total output = 23 units approximately.

iii) If the production function is given by $Q = 4K^{0.5} L^{0.5}$. If the capital is given as 9 units, find the level of labour required to produce an output of 100 units.

Given ,

Capital K = 9 ; Labour L = L ; Total output Q = 100; we have to find the required labour.

Substituting in the equation $Q = 4K^{0.3} L^{0.7}$, we get

$100 = 4 (9)^{0.5} (L)^{0.5}$

$100/ 4 (9)^{0.5} = L^{0.5}$

$100/4*3 = L^{0.5} \Longrightarrow 100/12 = L^{0.5} \Longrightarrow (100/12)^2 = L \Longrightarrow L = 69.44$

Labour required = 69 units approximately.

iv) If the production function is given by $Q = 4K^{0.25} L^{0.75}$, calculate the percentage change in output produced, if the labour increases by 20%,keeping the capital as constant.

We have to find Percentage change in quantity = $\frac{dQ}{Q} * 100$

Given Percentage change in labour = $\frac{dL}{L} * 100 = 20$

Also $\frac{dK}{K} * 100$ or percentage change in capital = 0 (since K is constant)

We have $Q = 4K^{0.25} L^{0.75}$

$\log Q = \log (4K^{0.25} L^{0.75})$

$\log Q = \log 4 + 0.25 \log K + 0.75 \log L$ (log ab = log a+ log b)

($\log a^b = b \log a$)

Differentiating wrt to L (since L is varied in the question)

$$\frac{d(\log Q)}{dL} = \frac{d(\log 4)}{dL} + 0.25\frac{d(\log K)}{dL} + 0.75\frac{d(\log L)}{dL}$$

$$\frac{dQ}{dL} * \frac{1}{Q} = 0 + 0 + 0.75 * \frac{1}{L}$$

$$\frac{dQ}{Q} = 0.75 * \frac{dL}{L}$$

Multiplying by 100 gives $\frac{dQ}{Q} *100 = 0.75 * \frac{dL}{L} *100$

or percentage change in quantity = 0.75 * percentage change in labour

= 0.75* 20

Percentage change in quantity = 15 %

Marginal product of capital

In the first example, we had calculated the total output when the capital was 10 units and labour was 30 units. If we increase the **capital alone** by one unit, that means the capital is made to 11 units and labour is kept at 30 units, the total output will increase by a certain amount.

- ***Marginal product of capital*** *gives the measure of change in total output level due to one unit change in the* ***level of capital***

For example , when the capital was 10 units and labour was 30 units, we got the total output (Q) as 86 units.

when the capital is 11 units and labour is 30 units, we can calculate the total output (Q) as

$Q = 4\,(11)^{0.3}\,(30)^{0.7} \Longrightarrow Q = 89$ units.

Change in total output = 89-86 = 3 units

Here the marginal product of capital = 3 units.

Marginal product of capital **=** $\partial Q / \partial K$

Marginal product of labour

In the first example, we had calculated the total output when the capital was 10 units and labour was 30 units. If we increase the LABOUR alone by one unit, that means the capital is kept at 10 units and labour is increased to 31 units, the total output will increase by a certain amount.

- ***Marginal product of labour*** *measures the change in output level due to one unit change in the* ***level of labour***

For example, when the capital was 10 units and labour was 30 units, we got the total output (Q) as 86 units.

When the capital is 10 units and labour is 31 units, we can calculate the total output (Q) as

$Q = 4\,(10)^{0.3}\,(31)^{0.7}$ Q = 88 units.

Change in total output = 88-86 = 2 units

Here the marginal product of labour = 2 units.

Marginal product of labour **=** $\partial Q / \partial L$