

# Industrial-Economics-Module-2-Important-Topics

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  - Q1 In the production function  $Q = 2L^{1/2} K^{1/2}$  if  $L=36$  how many units of capital are needed to produce 60 units of output?
  - Q2 Given below are the production function of firm A,  $Q = 2K^{0.25} L^{0.75}$ . The firm uses 5 units of labour (L) and 5 units of capital (K). Calculate the output. If we reduce L by 10%, how much K would be increased to produce the same output.
  - Q3 In a production function,  $Q = 2L^{1/2} K^{1/2}$ . If  $L = 36$
- 8. TC, TFC, TVC, AC, AFC, AVC, MC Problems
  - Q1. Suppose in the short run AVC 4. Suppose in the short run AVC
  - Q2 Total cost function of a firm is given as  $TC = 100 + 50Q - 11Q^2 + Q^3$  Find the marginal cost when output equals 5 units.
  - Q3 The total cost function of firm is given as  $TC = 500 + 5Q - 4Q^2 + Q^3$ . Estimate TVC, TFC and MC when output equals 10 units
  - Q4 A firm's total cost function is given by the equation,  $TC = 4500 + 10Q + 25Q^2$ . Write the expression for the following cost concepts. (a) AFC (b) AVC (c) AC (d) MC
- 9. Shutdown and Breakeven Problems
  - Q1 Suppose a firm pays Rs.10000 as monthly rent and Rs.10000 as interest payment. Its monthly expenditure on raw materials is Rs.40000 and it get monthly sales revenue of Rs.80000. The price of one unit of output is Rs.40. Estimate i) P/V Ratio ii) Break even sales iii) Break-even output iv) Profit earned v) Margin of safety.
  - Q2 Consider the following data of a company for the year 2022. Sales Rs. 80000, Fixed Cost is Rs. 15000, Variable cost is Rs. 35000. Find the following (a) Breakeven Sales (b) Contribution (c) Margin of safety (d) Profit.



## 1. Factors of Production

## There are 4 major factors of production

### 1. Land:

1. In economies it includes not only the surface area but also the vegetation, air, water, minerals etc around it.
2. The reward of land in production is rent

### 2. Labour:

1. It is the physical or mental effort that put in production. Labour is perishable because labour power cannot be stored
2. If a worker is not working one day, that days labour is lost forever
3. The reward of labour is wages

### 3. Capital:

1. It is the produced means of production
2. It can be in the form of machinery, equipment, building
3. Reward of capital is interest
4. Human capital is the stock of knowledge, skill, experience. Can be increased by education and training

### 4. Entrepreneurship:

1. Entrepreneur is the person who combines the services of other factors and organize production. Production involves risk and risk is taken by the entrepreneur.
2. Reward of entrepreneurship is profit



## 2. Law of Variable Proportion

- **Law of variable proportion describes the changes in output when more and more units of one variable factor is employed while keeping the quantities of other factors constant**
- To understand this law better, we need to know the following terms
  - **Total product of a factor(TP)**
    - It is the total physical output produced by employing a certain quantity of that factor
    - For example:

- Total product of labour means that when a certain amount of labour is combined with fixed quantities of other factors, the total output produced is the total product of labour
- **Marginal product of a factor**
  - It is the addition to total product by employing one more unit of that factor
  - For example, marginal product of labour means addition to TP(Total product) when one more labour is employed
- **Average product of a factor**
  - It is the output per unit of that factor employed
  - Its obtained by dividing the Total product by the number of units of that factor employed
- **The law states that when more and more units of one variable factor is employed with fixed quantities of other factors, initially MP(Marginal product) increases, then it decreases and finally it becomes negative\***
- In other words
  - Total product increases at an increasing rate, then TP increases at a decreasing rate and finally it starts declining

## Assumptions of the law

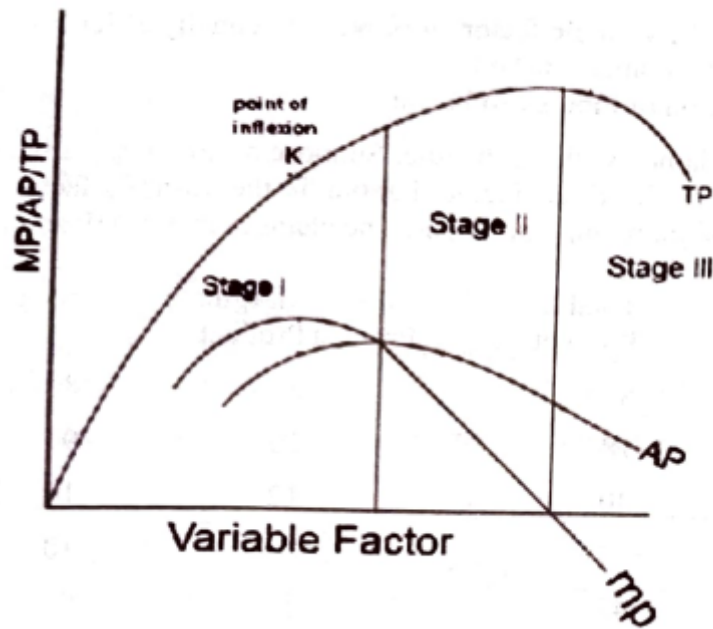
- All units of the variable factor employed are equally efficient
- Technology remains constant
- The proportion of inputs can be varied

## Example of the law

No. of units of Labour	Total Product	Marginal Product	Average	
1	8	8	8	
2	18	10	9	
3	30	12	10	<b>Increasing returns</b>
4	40	10	10	
5	45	5	9	
6	48	3	8	
7	49	1	7	
8	49	0	6.1	<b>Diminishing returns</b>
9	45	-4	5	
10	40	-5	4	<b>Negative returns</b>

- This example is of a farmer
  - Farmer has 2 things, land and labour
  - Here Land is a fixed factor
  - Labour is a variable factor as it can be changed
- **The farmer here decides to employ more and more labour**
- So as more and more of one variable factor (Labour) is employed, the Marginal product is decreasing
  - Initially it was 8
  - At the end it reached -5
- Similarly Total product is increasing and decreasing
  - Initially its 8
  - It peaked at 49
  - Now its diminishing and reached 40

## Law of Variable Proportion Diagram



The diagram shows 3 stages

- **Stage 1:**
  - This is stage of increasing returns
  - During this stage while MP (Marginal Product) increases, TP (Total Product) increases at an increasing rate
  - First stage continues till  $MP = AP$  (Average Product)
- **Stage 2**
  - This is the stage of diminishing returns
  - MP decreases, which causes TP to increase at a diminishing rate
  - Second stage ends when  $MP = 0$
  - When MP touches the x axis ( $MP = 0$ ), TP curve has its highest point
  - When  $MP = 0$ , TP is the maximum
- **Stage 3**
  - This is the stage of negative returns where MP becomes negative and TP starts declining
  - TP declines, TP curve comes down
  - MP curve goes below the x axis

## Relations

### Relation between MP and TP

- When MP increases, TP increases
- When MP decreases but positive, TP increases at a decreasing rate
- When MP becomes negative, TP declines

#### **Relation between MP and AP**

- When  $MP > AP$ , AP increases
- When  $MP = AP$ , AP is maximum
- When  $MP < AP$ , AP decreases



### **3. Isoquant, Isocost, Producer Equilibrium and Expansion path**

#### **Isoquant**

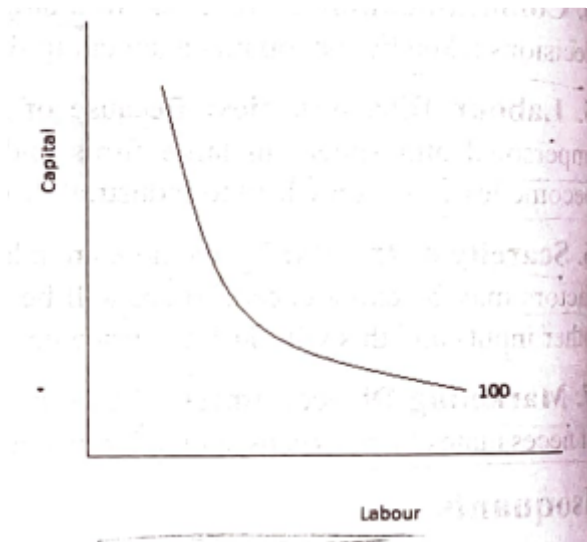
- An isoquant is a curve which shows various combinations of two inputs which give the same level of output.
- **Iso** means equal and **quant** means quantity, That is, Equal quantity of output
- Isoquants are also called isoproduct curves or equal product curves

#### **Example**

<b>Combinations of Labour and Capital</b>	<b>Units of Labour (L)</b>	<b>Units of Capital (K)</b>	<b>Output of Cloth (meters)</b>
<b>A</b>	5	9	100
<b>B</b>	10	6	100
<b>C</b>	15	4	100
<b>D</b>	20	3	100

- Here labour and capital are taken as the 2 inputs
- All the given combinations of labour and capital produce the same level of output, that is 100 meter of cloth.

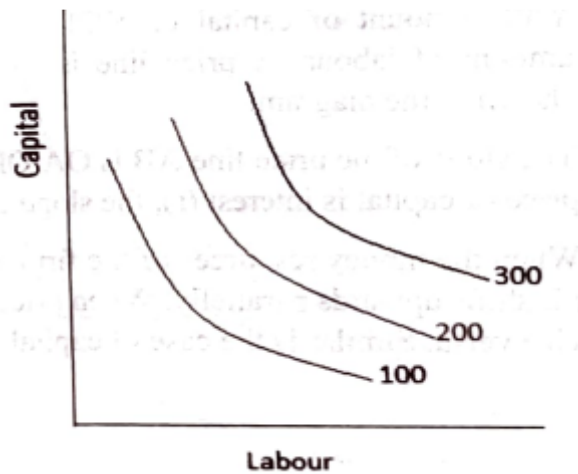
- The graphical representation of the schedule gives an isoquant.



### Properties of isoquant

- **Isoquants are negatively Sloped**
  - When quantity of one factor input is increased, quantity of other input has to be decreased to keep the output constant
  - Therefore isoquants are negatively sloped
- **Isoquants are convex to the origin**
- **Two isoquants never intersect**
  - Each isoquant represent a particular level of output
  - When two isoquants intersect, the intersecting point will be common and it can be two different levels of output, logically its not correct
- **Higher isoquants represents higher levels of output**
  - A set of isoquants drawn is called an isoquants map.
  - In isoquants map higher isoquant represents higher levels of output

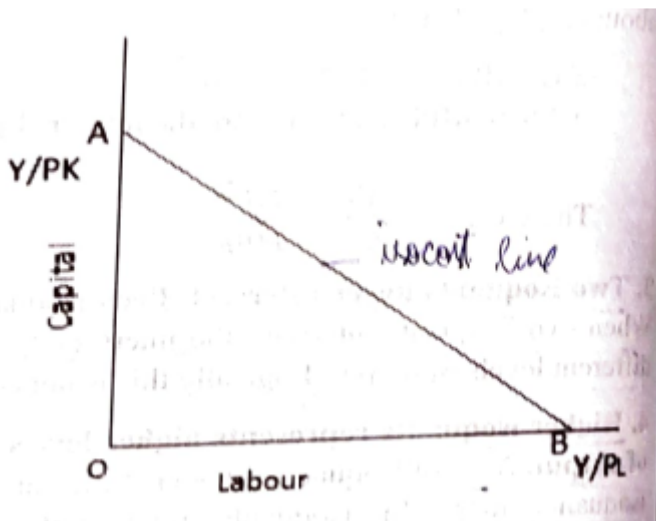




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## Isocost

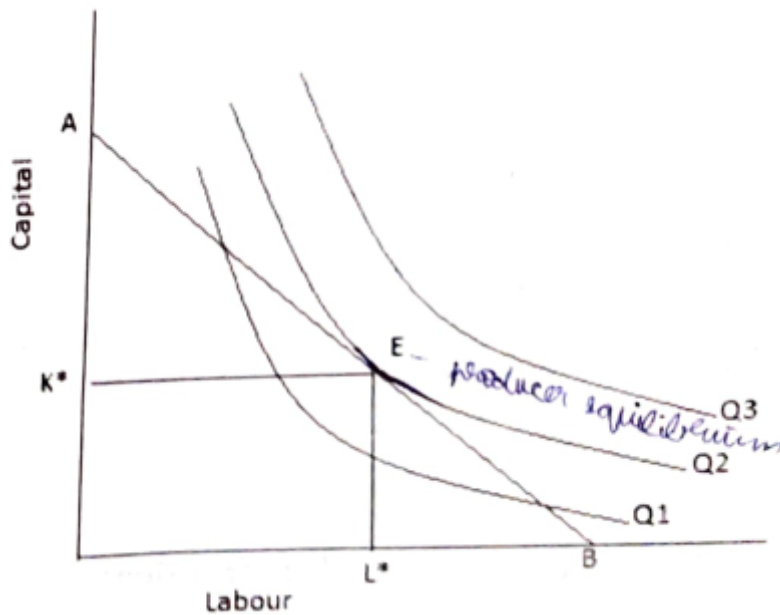
- An isocost line shows various combinations of labour and capital (two inputs) that can be purchased for a given expenditure of the firm
- It shows various combinations of labour and capital that is available to the firm at the same cost and at given prices of the inputs



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## Producers Equilibrium

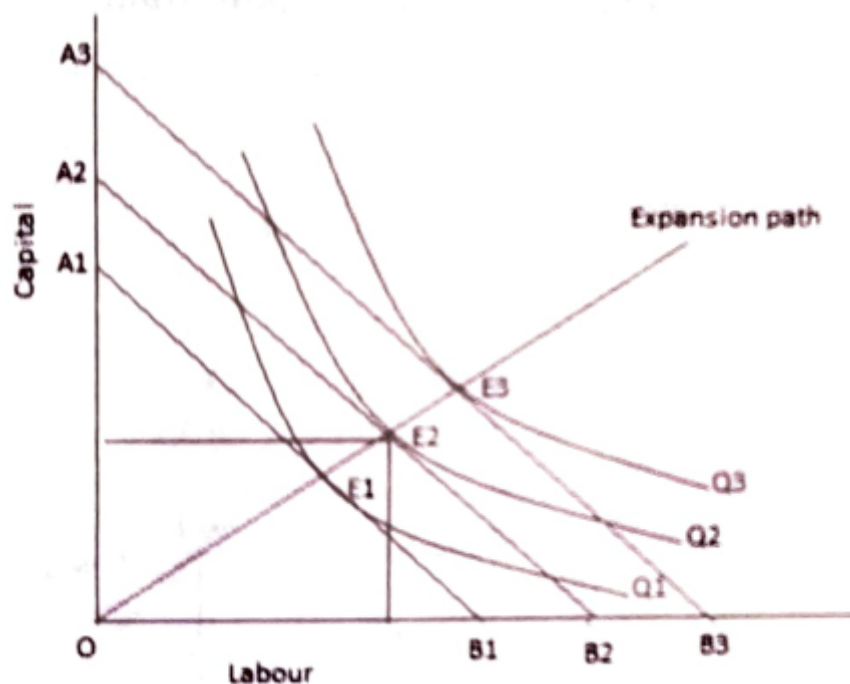
- A producer will be in equilibrium when he is able to produce a given quantity of output with least cost or when he produces maximum output with a given amount of inputs
- It is attained at that point where the isoquant is tangent to the isocost line



- Here isoquant is tangent to isocost at E, Which makes E the equilibrium point
- Q2 Isoquant will be produced with the least cost

## Expansion Path

- Expansion path is a line connecting optimal input combinations as the scale of production expands
- We can obtain the expansion path by joining the point of tangency between isoquants and isocost lines of a firm



## 4. Cobb Douglas Production Function

- Cobb Douglas production function is widely used to represent the technological relationship between the amounts of 2 inputs, particularly capital and labour and the amount of output that can be produced
- The function is written as  $Q = AL^{\alpha}K^{\beta}$ 
  - Q=Total output
  - L = Labour
  - K = Capital
  - A = Total factor productivity
  - $\alpha$  and  $\beta$  are the output elasticities of labour and capital respectively



## 5. Cost curves (TFC, TVC, TC, AFC, AVC, AC, MC)

### Total Fixed Cost (TFC)

- Its the cost which does not vary with the level of output
- Example: Rent of factory building, Salary of permanent employees, interest payment

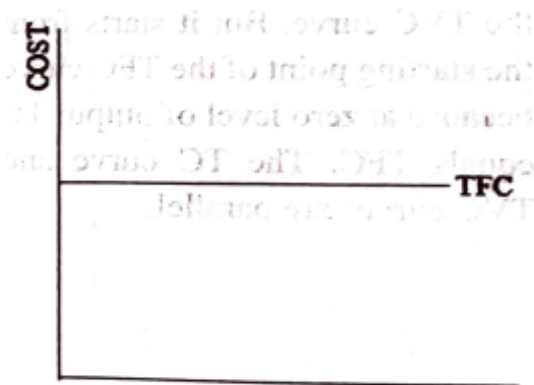
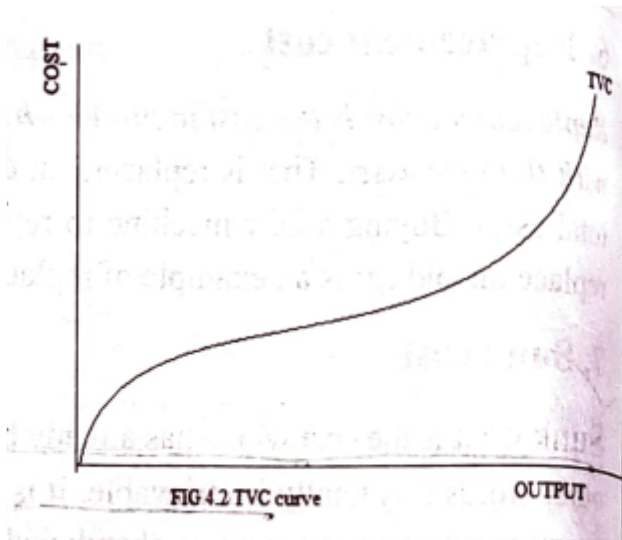


Fig. 4.1 TFC curve COST

### Total variable cost(TVC)

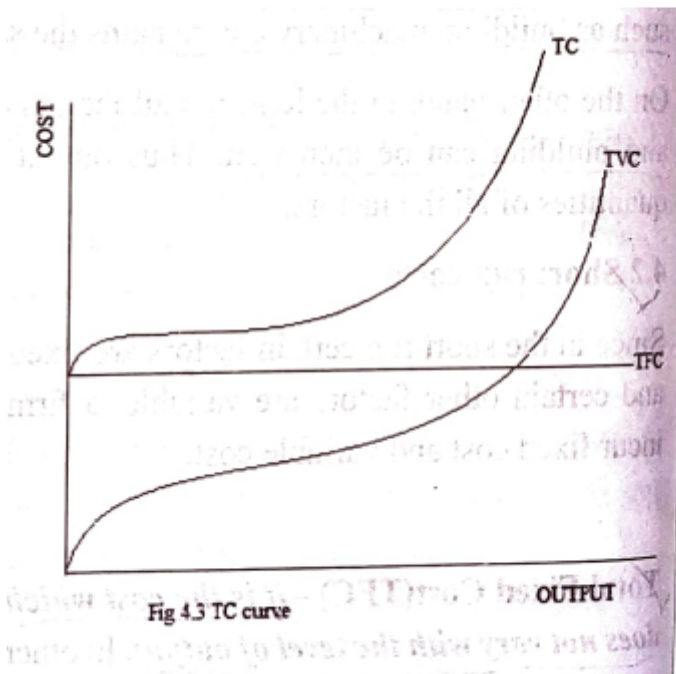
- Variable cost is the cost that vary with the level of output
  - When output is zero, variable cost is also zero
  - When output increases, cost also increases
- Examples

- Cost of raw materials, wages of workers, transportation cost, fuel charges are examples of variable cost



## Total Cost(TC)

- Total cost is the sum of total fixed cost and total variable cost
- $TC = TFC + TVC$



## Average Fixed Cost(AFC)

- It is the variable cost per unit of output

$$AFC = \frac{TFC}{Q}$$

- AFC is obtained by dividing TFC by number of Units of output

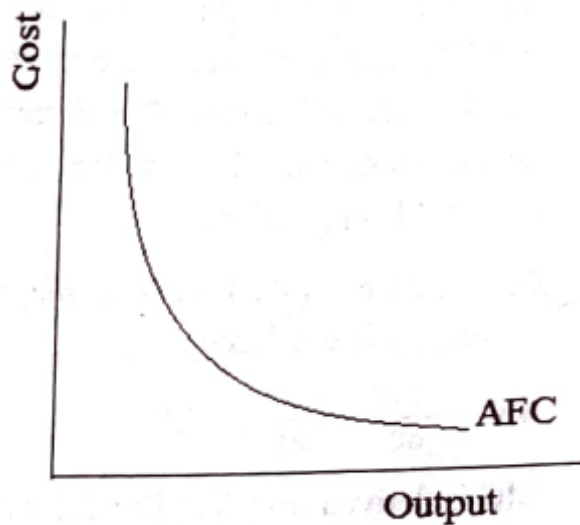


Fig. 4.4 AFC curve

### Average Variable Cost(AVC)

- AVC is obtained by dividing TVC by the number of units of output

$$\text{AVC} = \frac{\text{TVC}}{Q}$$

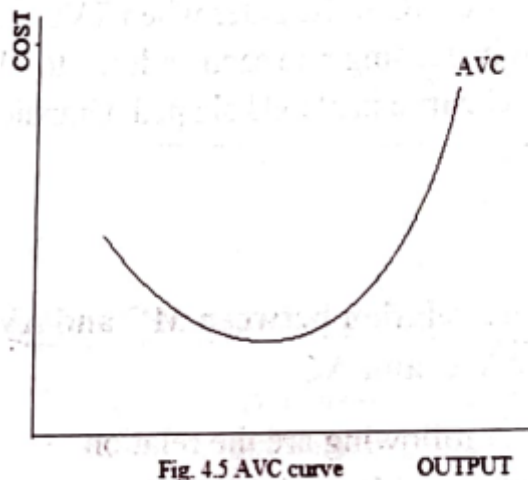
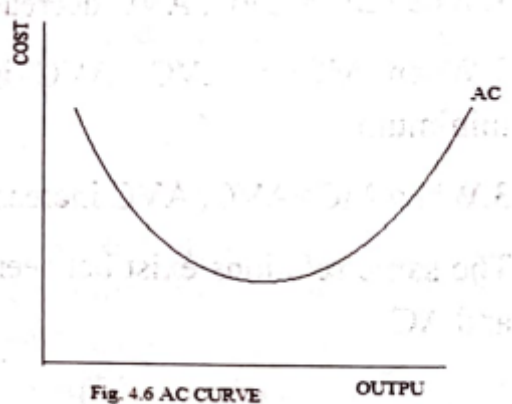


Fig. 4.5 AVC curve

### Average Cost(AC)

- AC is the cost per unit of output produced
- AC is the sum of AFC and AVC
- $AC = AFC + AVC$

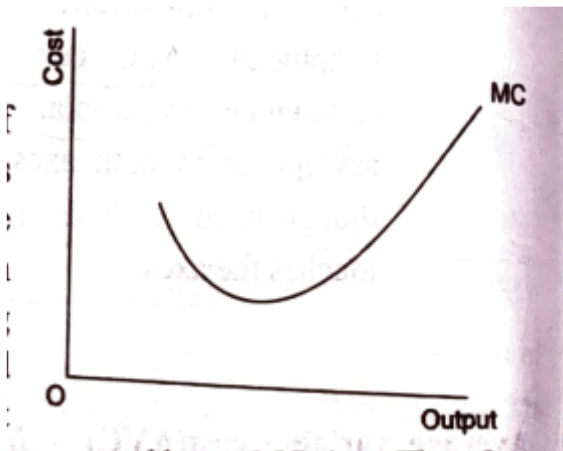
$$AC = \frac{TC}{Q} = \frac{TFC}{Q} + \frac{TVC}{Q} = AFC + AVC$$



## Marginal cost(MC)

- MC is the addition to total cost when one more unit of output Q is produced

$$MC = \frac{\Delta TC}{\Delta Q} \text{ or } \frac{dTC}{dQ} \text{ or } MC_n = TC_n - TC_{n-1}$$



## 6. Shutdown and Breakeven point

### Shutdown point

- Suppose the price of a product is less than AC, It is still beneficial for the firm to continue production till price is greater than AVC

- price = AVC is the shutdown point of the firm
- That is the minimum point of the AVC curve

## Break even Analysis

- Break even analysis is a method that is used to analyse the relationship between total cost, total revenue and profit of an organization at different levels of output
- The most important aspect of break even analysis is identifying the **break-even point**.
- Break even point is the point at which total revenue of a firm equals total cost
- It is the point at which total revenue of a firm equals total cost
- Its a point where there is no profit or loss for the firm

## P/V Ratio

- P/V ratio(Profit Volume Ratio) is the ratio of contribution to sales which indicates the contribution earned with respect to one rupee of sales
- PV Ratio = Contribution / Sales
- Contribution = Sales - Variable Cost

## Break even point formula

$$\cancel{BEP} = \frac{TFC}{PV \text{ Ratio}} \quad \text{OR} \quad \cancel{BEP} = \frac{TFC * S}{S - V}$$

When this formula is applied, we get break-even point in rupees

## Margin of Safety

- Margin of safety is sales beyond break-even point. It is calculated as the difference between total sales and break even sales
- Margin of safety = Sales - Break Even Sales



## 7. Cobb Douglas Production Function Problems

**Q1** In the production function  $Q = 2L^{1/2}K^{1/2}$  if  $L=36$  how many units of capital are needed to produce 60 units of output?\*

## Cobb Douglass Production Function

- The function is written as  $Q = AL^\alpha K^\beta$ 
  - Q=Total output
  - L = Labour
  - K = Capital
  - A = Total factor productivity
  - $\alpha$  and  $\beta$  are the output elasticities of labour and capital respectively
- $Q = 2L^{1/2}K^{1/2}$
- Given L = 36
- Given Total Output Q = 60
- Subbing the values
- $60 = 2 * 36^{1/2} K^{1/2}$
- We need to find the capital K
- $60 = 2 * 6 * K^{1/2}$
- $60 = 12 * K^{1/2}$
- $5 = K^{1/2}$
- $25 = K$

**So the capital needed is 25**

**Q2 Given below are the production function of firm A,  $Q = 2K^{0.25}L^{0.75}$ .**

**The firm uses 5 units of labour (L) and 5 units of capital (K). Calculate the output. If we reduce L by 10%, how much K would be increased to produce the same output.**

### Calculate Output

- Given Labour L = 5
- Capital K = 5
- Subbing the values in the Cobb doublas production
- $Q = AL^\alpha K^\beta$
- $Q = 2 * 5^{0.25} * 5^{0.75}$
- $Q = 2 \times 5$
- $Q = 10$



## Reducing L by 10%

- Reducing L by 10% we get  $5 \times 0.9 = 4.5$
- To produce the same output, K needs to be calculated
- $10 = K^{0.25} * 4.5^{0.75}$
- On calculating we will get  $K = 6.86$  units

## Q3 In a production function, $Q = 2L^{1/2}K^{1/2}$ . If $L = 36$

### 1. How many units of capital are needed to produce 60 units of output

- When  $Q = 60$  and  $L = 36$
- The production function becomes
  - $60 = 2 * 36^{1/2} K^{1/2}$
  - $60 = 2 * 6 * K^{1/2}$
  - $5 = K^{1/2}$
  - $K = 25$

**\*\*2.** In the production function  $Q = 2L^{1/2}K^{1/2}$  determine the percentage increase in output if labour is increased by 10% assuming capital is held constant

- Labour increased by 10%
- $L = 36$
- $L = L * 1.1 = 36 * 1.1 = 39.6$
- Capital is constant, let's take it as 25
- $2 * 36^{1/2} * 25^{1/2} = 60$
- $2 * 39.6^{1/2} * 25^{1/2} = 2 * 6.29 * 5 = 62.9$

$$\text{Percentage increase} = \frac{Q_2 - Q_1}{Q_1} \times 100$$

- $\frac{62.9 - 60}{60} \times 100$
- $\frac{2.9}{60} \times 100$
- $290/60 = 4.83 = 5\%$
- **5% percentage increase in output**



## 8. TC, TFC, TVC, AC, AFC, AVC, MC Problems

**Q1. Suppose in the short run  $AVC < P < AC$ . Will this firm produce or shut down? Give reason.**

- The firm will produce because  $P$  (Selling Price) is greater than Average Variable Cost ( $AVC$ )

**Q2 Total cost function of a firm is given as  $TC = 100 + 50Q - 11Q^2 + Q^3$ . Find the marginal cost when output equals 5 units.**

- Given Output  $Q = 5$
- Given  $TC = 100 + 50Q - 11Q^2 + Q^3$
- We need to find the marginal cost
  - Marginal cost formula
  - $MC = \frac{dTC}{dQ}$
  - $\frac{d}{dQ}(100 + 50Q - 11Q^2 + Q^3) = 50 - 22Q + 3Q^2$
- Now let's sub  $Q=5$  in the equation
- $= 50 - 22 * 5 + 3 * 5^2$
- $MC = 15$

**Q3 The total cost function of firm is given as  $TC = 500 + 5Q - 4Q^2 + Q^3$ . Estimate TVC, TFC and MC when output equals 10 units**

### TFC and TVC Calculation

- Total Cost (TC) formula
  - $TC = TFC + TVC$
- Given  $TC = 500 + 5Q - 4Q^2 + Q^3$
- By comparing the equations, we get
- **TFC = 500**
- $TVC = 5Q - 4Q^2 + Q^3$
- Given, Output  $Q = 10$  units
- Subbing for  $Q$
- $TVC = 50 - 400 + 1000$
- **TVC = 650**

## MC Calculation

- MC formula is
  - $MC = \frac{dTC}{dq}$
  - $TC = 500 + 5Q - 4Q^2 + Q^3$ .
- Taking derivative
  - $MC = 5 - 8Q + 3Q^2$
  - Subbing  $Q = 10$
  - $MC = 5 - 80 + 300$
- **MC = 225**

**Q4 A firm's total cost function is given by the equation,**

**$TC = 4500 + 10Q + 25Q^2$ . Write the expression for the following cost concepts. (a) AFC (b) AVC (c) AC (d) MC**

$$TC = 4500 + 10Q + 25Q^2.$$

$$TC = TFC + TVC$$

Comparing equations we get

- $TFC = 4500$
- $TVC = 10Q + 25Q^2$

### Finding AFC

- $AFC = TFC / Q$
- $AFC = 4500/Q$

### Finding AVC

- $AVC = TVC/Q$
- $AVC = 10 + 25Q$

### Finding AC

- $AC = TC/Q$
- $AC = 4500 + 10Q + 25Q^2 / Q$

### Finding MC

- $MC = \frac{dTC}{dq}$
- Finding derivative

- $MC = 10 + 50Q$



## 9. Shutdown and Breakeven Problems

**Q1** Suppose a firm pays Rs.10000 as monthly rent and Rs.10000 as interest payment. Its monthly expenditure on raw materials is Rs.40000 and it get monthly sales revenue of Rs.80000. The price of one unit of output is Rs.40. Estimate i) P/V Ratio ii) Break even sales iii) Break-even output iv) Profit earned v) Margin of safety.

### P/V Ratio

- $P/V \text{ Ratio} = \text{Contribution Margin} \div \text{Selling price per unit}$
- $\text{Contribution Margin} = \text{Total Sales} - \text{Variable Costs}$
- Given
  - Total Sales = Rs 80,000
  - Variable Costs = Expenditure on Raw Materials = Rs 40,000
  - $\text{Contribution Margin} = 80,000 - 40,000 = 40,000$
- $P/V \text{ Ratio} = 40000 / 80000 = 0.5$

### Break even sales

- $BEP = \text{Fixed costs} / \text{Contribution margin per unit}$
- $\text{Contribution Margin per unit} = \text{Contribution Margin} / \text{Number of units sold}$
- $\text{Fixed cost} = \text{Rent} + \text{Interest} = 10,000 + 10,000 = 20,000$
- $\text{Contribution margin per unit} = 40,000 / 80,000 - 40,000 = 1$
- $BEP = 20,000 / 1 = 20,000$
- $\text{Break even sales} = BEP / (P/V \text{ Ratio}) = 20,000 / 0.5 = 40,000$

### Break even output

- $\text{Break even output} = \text{Break even sales} / \text{price of one unit of output}$
- Given price of one unit of output = Rs 40
- $\text{Break even output} = 40000 / 40 = 1000$

## Profit Earned

- Profit = Total Sales - (Fixed Costs + Variable Costs)
- Total Sales = 80,000
- Fixed Costs = 20,000 (Interest + Rent)
- Variable cost = 40,000 (Raw material expenditure)

## Margin of safety

- Margin of safety = Profit / (P/V Ratio)
- Margin of safety = 20,000 / 0.5 = 40,000

**Q2 Consider the following data of a company for the year 2022. Sales Rs. 80000, Fixed Cost is Rs. 15000, Variable cost is Rs. 35000. Find the following (a) Breakeven Sales (b) Contribution (c) Margin of safety (d) Profit.**

- Sales = 80000, Fixed Cost = 15000, Variable cost = 35000.

## Breakeven Sales

- Breakeven sales = Fixed Cost / Contribution Margin Ratio
- Contribution Margin = Sales - Variable Costs
- Contribution Margin = 80,000 - 35,000
- Contribution Margin = 45000
- Contribution margin Ratio = Contribution Margin / Sales
- Contribution Margin Ratio = 45000 / 80000 = 0.5625
- Breakeven Sales = 15000 / 0.5625 = 26666.67

## Contribution

- Contribution = Sales - Variable Costs
- Contribution = 80,000 - 35,000
- Contribution = 45000

## Margin of Safety

- Margin of safety = Actual Sales - Breakeven sales

- $= 80,000 - 26666.67$
- $= 53333.37$

## Profit

- Profit = Contribution - Fixed Cost
- $= 45000 - 15000$
- Profit = 30000

