

**Subject: Management**

Production of Courseware  
-Content for Post Graduate Courses

ज्ञान-विज्ञान विमुक्तये

**Paper: 11, Managerial Economics**

**Module: 15, Break Even Analysis**



**Principal Investigator**

**Prof. S P Bansal**  
Vice Chancellor  
Maharaja Agrasen University, Baddi

**Co-Principal Investigator**

**Prof. Yoginder Verma**  
Pro-Vice Chancellor  
Central University of Himachal Pradesh, Kangra, H.P.

**Paper Coordinator**

**Prof. S K Garg**  
Former Dean & Director,  
H.P. University, Shimla (H.P.)

**Content Writer**

**Mohinder Singh**  
Assistant Professor,  
**Dept. of Accounting and Finance, SBMS**  
Central University of Himachal Pradesh, Kangra, H.P.

Items	Description of Module
<b>Subject Name</b>	Management
<b>Paper Name</b>	Managerial Economics
<b>Module Title</b>	Break Even Analysis
<b>Module Id</b>	Module no.-15
<b>Pre- Requisites</b>	Basic understanding of Various Cost and Revenue concepts, Cost output relationship and Short run cost analysis.
<b>Objectives</b>	To enable learners to understand concept of Break Even Analysis and its application in decision making process.
<b>Keywords</b>	Break Even Point, P/V Ratio, Fixed cost, Variable Cost and Margin of safety

### QUADRANT-I

Module 15: Break Even Analysis
1. Break Even Analysis
2. Break Even Point
3. Assumptions of Break-Even Analysis
4. Methods to calculate Break-Even Point
5. Break Even Point Equation
6. Break Even Chart
7. Contribution and P/V Ratio
8. Margin of Safety
9. Managerial Application of Break Even Analysis
10. Break Even Analysis

#### 1. Learning Outcome:

After completing this module the students will be able to:

- Understand the various concepts of Break-Even Analysis.
- Use the concept of Break-Even Analysis in taking make or buy decisions, shut or continue business, output, pricing and costing decisions.

## 1.0 Introduction

Traditionally the basic objective of the firm is to maximise profits. Economic profit of the production of a commodity is the difference between its cost of production and the revenue earned by its sale. In Economics, the profit earned by a firm is divided into the following two parts<sup>1</sup>.

- (1) **Economic or Super Normal Profit:** The amount by which the total revenue earned by the sale of a given quantity of output exceeds its total cost i.e TR-TC (explicit cost + implicit cost) is called Economic or Super normal profit. For instance, if the total cost of making a chair is ₹400 and the total revenue earned by its sale is Rs. 500 than ₹ 100/- (₹500-400) will be called as super normal profit. Thus, Economic profit  $AR > AC$ .
- (2) **Normal or Zero Economic Profit:** Normal Profit is that minimum amount which an entrepreneur must get so as to retain him in that occupation. It is the implicit cost of the functions of an entrepreneur. It is also called zero economic profit. This situation arises when the total revenue earned by the sale of a commodity is equal to its total costs. In other words, zero economic profit or normal profit = Total Revenue = Total cost. The point, at which the total cost of producing a commodity by the firm is equal to its total revenue, is called Break-even point. Thus, break-even point is that point at which a firm gets only zero economic profit or normal profit. Each firm desires to earn maximum economic profit by rising above this point. The technique that a firm adopts to achieve this objective is called Break-even analysis.

Profit maximisation is not only the function of cost minimisation but can also be done by optimization of firm's output level. The profit is maximum at a specific level of output which is difficult to know in advance. Even if it is known, it cannot be achieved at the outset of the production. Firms started their business even at a loss with expectation of profits in future. However, the firm can plan their production in a better way by knowing the level of output where total cost is equal to total revenue or in break even. This can be done with a breakeven analysis.

A Break-Even Analysis also known as *cost volume & profit analysis* or *profit contribution analysis* is an important profit planning technique that illustrates at what level of output in the short run, the total revenues just cover total costs. In Break-Even analysis the mutual relations between the

volume of production and cost of production, on the one hand and sale proceeds and profit i.e. Revenue, on the other are analysed.

*“Break-Even Analysis is that technique which shows how to identify the level of output and sales of volume at which the firm 'breaks even', which revenues being sufficient to cover all its costs”,*

**Howard Devies.**

The Relationship between cost and output and between price and output may be linear or non linear in nature but relationship can be analysis in both the case. In this chapter we will discuss it in case of linear relationship only.

### **1.1 Break Even Point**

Break-even point is that point of output level of the firm where firms total revenues are equal to total costs ( $TR = TC$ ). As discussed earlier economic profit is the excess of total revenue than the total costs i.e.  $(TR - TC)$  or  $(TR > TC)$ , so at break-even point when  $TR = TC$ , the firm neither earns profit nor incurs loss or is a situation of zero economic profit.

In break even analysis Costs can be classified as either a *fixed cost* or a *variable cost*. A fixed cost is one that is independent of the level of sales; rather, it is related to the passage of time. Examples of fixed costs include rent, salaries and insurance. A variable cost is one that is directly related to the level of sales, such as cost of goods sold and commissions. Thus;

Total Costs (TC) = Total Fixed Costs (TFC) + Total Variable Costs (TVC)

Total Revenue (TR) = Total Output (Q) \* Price per unit of output (P) = QP

Economic Profit or loss = Total Revenue (TR) - Total Costs (TC)

Break-even Point =  $TR = TC$  or  $TR - TC = \text{zero}$

The firm will incurs loss if it operates below this point and will earn profit if it operates beyond this point. It may however be noted that by producing at the level of break-even point, a firm covers only its cost of production. Normal profit is included in the cost of production. Thus, at break-even point a firm gets only normal profit or zero economic profit.

### **1.2 Assumptions of Break-Even Analysis**

Break-even analysis is based on following assumptions;

- (1) Total Costs can be classified in fixed cost or a variable cost and total fixed costs (TFC) remain constant at each level of output. Variable cost per unit remains constant at all level of output but the total variable costs (TVC) vary with the level of output.
- (2) Technique of production and returns to a factor of production remains constant. Law of constant returns applies to firm's factor of production. In other words, variable costs change at a constant rate.
- (3) Price of the output of the firm or sales price (AR) remains constant. Thus, change in total revenue and total output is at constant ratio.
- (4) The volume of output of a firm and the volume of sales are identical.

### 1.3 Methods to calculate Break-Even Point

The break-even point can be computed mainly by following methods;

- (1) Algebra or Mathematical Equation Method
- (2) Graphic Method
- (3) Contribution Margin Method.

#### 1. Algebra or Mathematical Equation Method

As mentioned above;

Total Revenue (TR) = Total Output (Q) \* Price per unit of output (P) = Q (P) and

Total Costs (TC) = Total Fixed Costs (TFC) + Total Variable Costs (TVC)

Total Variable Costs (TVC) = Total Output (Q) \* Variable Costs per unit (Average variable Cost i.e AVC)

$TC = TFC + Q (AVC)$

Break-Even Point (B) = (TR =TC)

Or  $Q (P) =TFC+ Q (AVC)$

Or  $Q (P) - Q (AVC) =TFC$

Or  $Q (P-AVC) =FC$

$$Q = \frac{FC}{P - AVC} \text{ -----(equation-1)}$$

Or Break Even Quantity (Q) =

$$\frac{\text{FIXED COST}}{\text{Price} - \text{Average Variable Cost}}$$

**For Example-1:**

The fixed cost of producing Moto-E mobile is ₹1, 00,000 and variable cost per Moto-E mobile is ₹3,500 and the selling price of the same is ₹4,500. Company's break event quantity (Q) as per equation -1 will be calculated as follow;

$$Q = \frac{FC}{P - AVC} = 1,00,000 / (4,500 - 3,500) = 100 \text{ units}$$

If company produced 100 units of Moto-E than company's

TR (i.e.  $100 \times 4,500$ ) = TC (i.e.  $1,00,000 + 100 \times 3,500$ ) or  $4,50,000 = 4,50,000$

Economic profit = TR - TC (i.e.  $4,50,000 - 4,50,000$ ) = Zero

**2. Graphic Method**

Under graphic method efforts are made to explain Break-Even with the help of Break Even Chart. Break Even Chart is that graph which shows the extent of profit or loss to the firm at different levels of sales or production. Break Even chart is explained with the help of the following table and diagram. On the basis of example given above, the chart has been prepared.

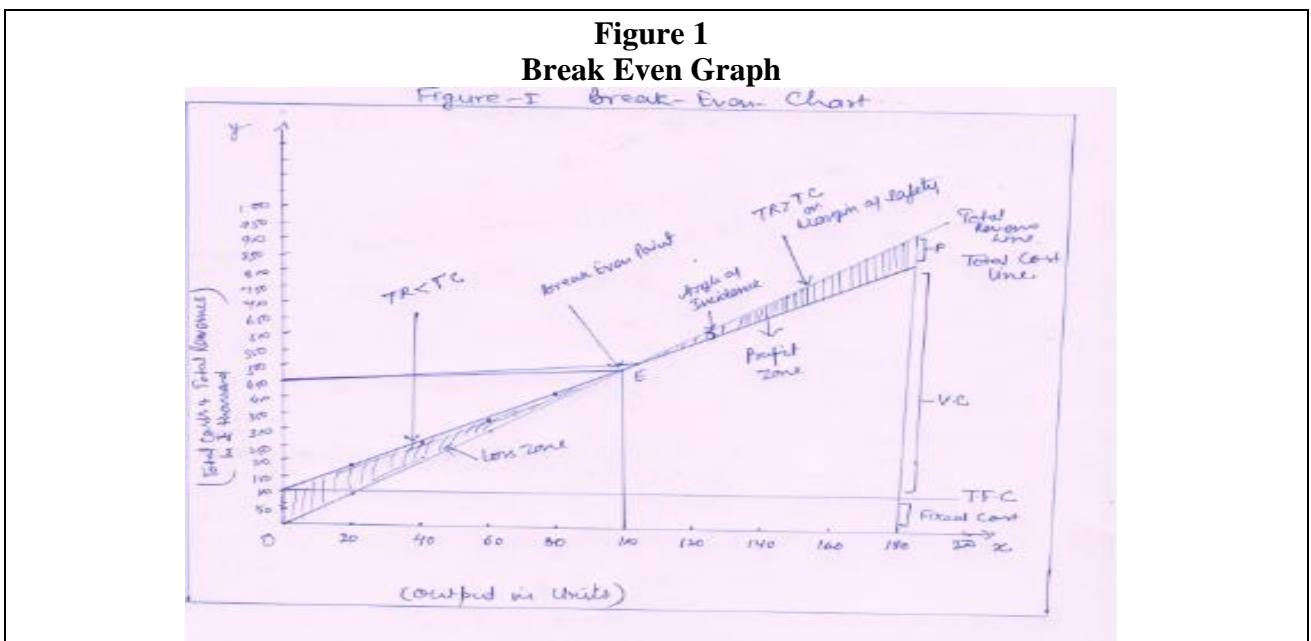
**Table-1**  
**Break Even Chart**

(₹thousand)						
Output (units)	Total Fixed cost (TFC)	Total Variable cost (TVC)	Total cost (TFC + TVC)	Total Revenue	Profit or Loss (TR-TC)	
0	100	$0 \times 3.5 = 0$	$100 + 0 = 100$	$0 \times 4.5 = 0$	-100	Loss
20	100	$20 \times 3.5 = 70$	$100 + 70 = 170$	$20 \times 4.5 = 90$	-80	
40	100	$40 \times 3.5 = 140$	$100 + 140 = 240$	$40 \times 4.5 = 180$	-60	
60	100	$60 \times 3.5 = 210$	$100 + 210 = 310$	$60 \times 4.5 = 270$	-40	
80	100	$80 \times 3.5 = 280$	$100 + 280 = 380$	$80 \times 4.5 = 360$	-20	
100	100	$100 \times 3.5 = 350$	$100 + 350 = 450$	$100 \times 4.5 = 450$	0	BEP
120	100	$120 \times 3.5 = 420$	$100 + 420 = 520$	$120 \times 4.5 = 540$	20	Profit

140	100	$140 \times 3.5 = 490$	$100 + 490 = 590$	$140 \times 4.5 = 630$	40	
160	100	$160 \times 3.5 = 560$	$100 + 560 = 660$	$160 \times 4.5 = 720$	60	

The above table shows that when firm produces 100 units, its total cost (₹450 thousand) is equal to its total revenue (₹450 thousand). At this level of output, the firm neither incurs any loss nor earns any super normal profit. This quantity of output, at which total cost and total revenue are equal and the firm gets neither any super-normal profit nor incurs any loss at the quantity of output prior to this point and enjoys profit at the quantity of output after this point.

Break Even Point is also explained with the help of Figure-1. Quantity of output is shown on OX-axis and cost and revenue on OY-axis. TR represents total revenue curve, TC total cost curve and FC fixed cost curve. The vertical difference between TC and FC shows VC (Variable Cost). Point 'E' indicates Break Even Point and at this point TR and TC curves intersect each other, i.e., TR=TC. Break Even Point 'E' Points out that the firm is producing 100 units of mobile sets and at this level of output total cost is equal to total sales (₹450 thousands). Prior to break-even point E, firm is running into loss and production after point E yields profit.



### 3. Contribution or P/V Ratio Method



In Contribution or P/V Ratio Method we use the contribution i.e. excess of firm's TR (total revenue) over TVC (total variable costs). The Ratio of Contribution to TR is known as P/V ratio.

$$\text{P/V ratio} = (\text{TR} - \text{TVC or Contribution} / \text{TR}) * 100$$

$$\text{Break Even point (in volumes)} = \text{Fixed costs} / \text{P/V ratio}$$

In above example, if the total sale proceeds of 20 Units of Moto-E is ₹90 thousands and total variable cost is ₹70 thousands, then the total contribution of the firm is ₹20 thousands (₹90 - ₹70). P/V ratio is 22.22 percent (₹20/₹90 \* 100). The fixed costs are ₹100 thousands and the breakeven point sales will be;

$$\begin{aligned} &= \text{Fixed costs} / \text{P/V ratio i.e. } ₹100 / 22.22 \text{ percent} \\ &= ₹450 \text{ thousands or } 100 \text{ units (i.e } ₹450/₹4.5) \end{aligned}$$

#### 1.4 Applications of Break-Even Analysis in Managerial Decisions

Break-Even analysis helps the managers in taking following decision;

1. **Calculation of Volume of Sales to Attain Target Profit:** Break-Even analysis is used to know the volume of sales necessary to achieve a given profit. Required volume of sales is calculated with the help of the following formula:

$$(i) \text{ Required Volume of Sales} = \frac{\text{Fixed cost} + \text{Profit Target}}{\text{Contribution Margin Per Unit}}$$

$$= \frac{F + PT}{C} = \frac{F + PT}{S - V}$$

$$(ii) \text{ Required Sale Price} = \frac{(F + PT)^S}{S - V}$$

(Hence  $F$  = Fixed Cost;  $PT$  = Target Profit;  $C$  = Contribution Margin per unit ;  $S$  = Sale price,  $V$  = Variable Cost.)

For Example:

The fixed cost of producing Moto-E mobile is ₹1, 00,000 and variable cost per Moto-E mobile is ₹3,500 and the selling price of the same is ₹4,500. What should be the sales volume of the company to get ₹20,000 profits?

$$\text{Required Volume of Sales} = \frac{\text{Fixed cost} + \text{Profit Target}}{\text{Contribution Margin Per Unit}}$$

$$= (\text{₹}1,00,000 + \text{₹}20,000) / \text{₹}4,500 - \text{₹}3,500 = 120 \text{ units}$$

$$\text{or } 120 * \text{₹}4,500 = \text{₹}5,40,000$$

## 2. Margin of Safety

The margin of Safety represents the difference between the sales at breakeven point and the total actual sales i.e

Margin of Safety = Actual Sales - Break Even Sales

It is the limit to which the sales may fall yet the firm may have no fear of loss. Three method of measuring of margin of safety are as follow;

1. Margin of Safety = (Profit\* sales)/ PV ratio
2. Margin of Safety = (Actual Sales- Break Even Sales)/ Actual Sales
3. Margin of Safety = Profit/ PV ratio

The margin of safety can be increased (i) by increasing the selling price in case the demand for the product is inelastic, (ii) by increasing the production or sales up to capacity of the plant or by reducing selling price in case demand is elastic and (iii) by reducing fixed costs or variable costs or having a product mix with greater share of one having relatively more contribution per unit or higher PV ratio.

## 3. Taking Make or Buy Decisions

Some time firms have the option to decide whether to manufacture itself, all the parts and components of the finished product, say, scooter, or to purchase the same from ancillary units. Break-even analysis helps the firm arrive at the above decision. The variable cost or marginal costs are compared with the prices of that product, if the variable costs of a product is more than its buying price or contribution (S-VC) is negative than a decision as to buying it from the market is taken or vice versa.

## 4. Accepting of price below the total costs

Sometimes process have to fixed below the total costs of the product especially during depression. Prices may be fixed at a level above the variable costs though it may not be enough

to cover the total costs. This is because in such periods any marginal contribution towards recovery of fixed cost is good enough rather than not to have any contribution at all.

A price less than total cost is sometime accepted in case of additional order or export order. In this case additional revenue should be compared with additional costs (it will be only variable costs) and if the contribution is positive, the order should be accepted. It is done only in case company is operating below its capacity.

For example:

Particulars	₹ in Lakhs	
Sales (1,00,000 units)		500
Variable costs (1,00,000 units)	300	
Fixed Costs	100	
Total Costs		400

Company is at present working at its 60 % capacity. It received an export order at a price below the current market i.e at ₹3.50 per unit (rather than current price i.e. ₹5.0) for 10,000 units.

Solution:

In this case if company accepted this order it will earn an extra profit of rupees ₹20 lakhs. As additional sales i.e ₹50 Lakhs is more than the additional costs i.e. ₹30 lakhs (only variable costs will increased and fixed costs will remain content). Thus total profits of the company will increased from ₹200 Lakhs to ₹220 Lakhs.

	₹ in Lakhs					
	1,00,000 units		10,000 units		1,10,000 units	
Sales		500		50		550
Variable costs	300		30		330	
Fixed costs	100		0		100	
Total Costs		400		30		430
Contributions (S-VC)		200		20		220

- 5. Sales Required Offsetting Price Reduction:** If due to certain reasons, a firm reduces its sale price, then to avoid the resultant loss, the firm will have to raise the quantity of sales. The required increase in the quantity of sales can be determined with the help of the following formula:

$$Q_n = \frac{F + PT}{SP_n - V}$$

Here  $Q_n$  = new quantity of sales;  $F$ = Fixed Cost;  $PT$ = Profit Target;  $SP_n$  = new sales price ;  $V$  = Variable Cost.

**6. Sales required meeting the proposed expenditure:** Break Even point analysis also informs a firm how much increase in sales would be required to meet the proposed expenditure on expenditure, etc. It means that proposed expenditure can be met by increasing the sales. Increase to be made in the sales, for this purpose, can be calculated with the help of the following formula.

$$\text{Additional Sales} = \frac{\text{Proposed Expenditure}}{\text{contribution per unit}}$$

$$= \frac{\text{Proposed Expenditure}}{\text{Price - Variable cost per unit}}$$

- 7. Change in Production Capacity:** Break Even analysis helps the firm in taking the decision whether to increase or reduce its existing production capacity. In this respect, several factors are taken into account, such as, possibility of change in profit; possibility of change in quantity for sale or sales price, etc. If any change has positive impact on contribution of the firm the change will accepted or vice versa.
- 8. Effect of Alternative Prices:** The positions of profit at different price- levels under given conditions of demand and costs can be shown with the help of Break Even Chart.
- 9. Decision Regarding Adding of New Products or Dropping of Old Ones:** Break-Even Analysis enables a firm to arrive at a final decision whether to introduce any new product or not. It also helps a firm to decide whether to continue the production of the existing goods or to discontinue it by comparing the contributions in both the cases. Alternative having more contribution may be preferred. In case company wants to drop one of its products, break even analysis makes it easy to the firms to take this decision. Product with lowest contribution should be dropped and firm should concentrate on profitable ones.
- 10. Choosing Promotion Mix:** In order to promote the sales of its product, a firm may take resort to different kinds of incentives; e.g., advertisement, prizes, after-sales-service, salesmanship, etc, in different proportions. The firms can find out from break-even analysis as to which of the

promotion-mix they should choose so as to get maximum profit. The promotion mix that gives the maximum contribution may be adopted.

### 11. Choice of Most Profitable Alternate

A firm may choose the most profitable alternative from among the different alternatives of the factors of production with the help of Break- Even analysis. It means that the firm can choose the most economical alternative on the basis of information regarding cost of two production techniques, two machines, two factors, etc. However, this choice is possible only when (i) fixed cost of the alternatives is different and (ii) the variable cost of the alternative with more fixed cost is less than the variable cost of the alternative with less fixed cost.

We calculate the Following formula may be used for this purpose.

$$\text{Break-Even Point of costly alternative (in units)} = \frac{F - F_1}{V_1 - V}$$

(Here F = Fixed cost of costly alternative.  $F_1$ = Fixed cost of cheap alternative,  $V_1$ = Variable cost per unit of alternative with less fixed cost; V= Variable cost per unit of alternative with more fixed cost)

Contribution from different alternatives is compared than alternative with higher contribution is preferred first over others. Even ranking of various alternatives may be done on the basis of contribution.

### 12. Inter firm Comparison

The break even analysis also helps in inter- firm comparison of profitability. Firm having higher P/V ratio is better than the lower one.

### 13. Target Capacity

It is with the help of break even analysis that a firm can determine target capacity to take advantage of minimum cost of production. The capacity at which firms earns maximum contribution will be the target capacity of the firm.

## 1.5 Limitations of Break Even analysis

Main limitations of break even analysis are as under:

### (1) Ignores changes in input prices

Prices of inputs like raw materials wages etc are liable to change constantly. Since break even analysis is based on past data it becomes necessary to adjust this data in the context of changes in the prices of inputs however, it is not so done. As a result , the use of break even analysis becomes limited.

### (2) Ignores changes in product prices

Break even chart is prepared on the bases of the current product prices. But, in real life, product prices undergo change regularly. However, in break even chart changes in product prices are not included because it becomes difficult to make the correct estimate of the quantity of sale at different prices. As a result, break even analysis is rendered unrealistic.

### (3) Static

Break even analysis is static in so far as it is based on the assumption of constant relationship between cost, quantity of production and sale proceeds. In real life, their relationship is never constant.

### (4) Unrealistic Assumptions of Linear relationship

The assumption of break even analysis that the relationship between cost and revenue is linear is unrealistic. In real life, their relationship is non-linear.

(5) **Profit is not a Function of Output only:** The assumption that profit is a function of output only is unrealistic. In Real life, profit is a function of many other factors like technological changes, efficient management, scale of production etc.

(6) **Limitations of Accounting Data:** Break even analysis depends upon Accounting Data. It therefore, suffers from all the limitations of this data, namely, ignoring of imputed costs calculating depreciation in an arbitrary manner, etc. All this restricts the scope of break even analysis.

### (7) Unsuitable for Long- term Analysis

Break even analysis is not suitable for long term analysis. It has relevance for short term analysis only.

### (8) Ignores imperfect competition

In this analysis, revenue curve is drawn parallel to OX-Axis. According to this revenue curve, any amount of output can be sold at the prevailing price. Such a revenue curve is possible only under perfect competition. In real life, we are faced with imperfectly competitive market. As such, break-even analysis ignores the revenue curves under imperfect competition.

(9)**Unsuitable for Multi-products:** Break-even analysis is suitable for a few products. Simultaneous analysis of several products, several plants and several departments is very complex. Thus, this analysis is far from suitable for multi-products.

In short, notwithstanding several of its limitations, break-even analysis is the cheapest and the simplest guide for policy determination in the short period.

## 1.6 Summary

A Break-Even Analysis also known as *cost volume & profit analysis* or *profit contribution analysis* is an important profit planning technique that illustrates at what level of output in the short run, the total revenues just cover total costs. In Break-Even analysis the mutual relations between the volume of production and cost of production, on the one hand and sale proceeds and profit i.e. Revenue, on the other are analysed. Break-Even analysis is used to know the volume of sales necessary to achieve a given rate of return on capital given and helps in appraising the effect of change in the volume of sales, sale price, cost of production, production mix and making choices of products from the alternatives available. It helps in computing the breakeven point and effects of level of output on fixed costs, variable costs, total costs and total revenue of a firm.