**Chapter – One**

1. **Cost-Volume-Profit (CVP) Analysis**

Cost-volume profit (CVP) analysis examines the behavior of total revenues, total cost and operating income as changes occur in the output level, selling price, variable costs per unit or fixed costs. Cost-volume-profit (CVP) analysis is one of the most powerful tool that help managers as they make decisions by facilitating quick estimation of net income at different levels of activity. In other words, it helps them to understand the interrelationship between cost, volume, and profit in an organization by focusing on interactions between the following five elements:

1. Prices of products,
2. Volume or level of activity,
3. Total variable costs,
4. Total fixed costs, and
5. Mix of products sold.

 Thus, CVP analysis examines the behavior of three different factors: cost-volume-profit and further, the total revenues, and the total costs, and operating income as changes occur in the output level, selling prices, variable costs, or fixed costs.

Because CVP analysis helps managers to understand the interrelationship between cost, volume, and profit, it is a vital tool in many business decisions. These decisions include, for example, what level of products to manufacture or sell, what pricing policy to follow, what marketing strategy to employ, what type of productive facilities to acquire, what level of profit is to be generated and what level of output is sold this year to reach at break-even sales?

**Cost-Volume Profit Assumptions**

Cost-Volume- Profit (CVP) analysis depends on several assumptions as described below.

1. Changes in the level of revenues and costs arise only because of changes in the number of product (service) units produced and sold-for example, the number of television sets produced and sold by Sony corporations.
2. Total costs can be divided in to a fixed component and a variable component with respect to the level of output.
3. The behavior of total cost and total revenue is linear in relation to output units within the relevant range and time period.
4. The unit selling price, unit variable costs, and fixed costs are known and constant.
5. The analysis either cover a single product or assumes that the sales mix when multiple products are sold will remain constant as the level of total units sold changes.
6. Time value of money is not considered.
	1. **Types of Cost Behavior and Patterns**

**Cost behavior** is the manner in which a cost changes as a related activity changes. The behavior of costs is useful to managers for a variety of reasons. For example, knowing how costs behave allows managers to predict profits as sales and production volumes change. Knowing how costs behave is also useful for estimating costs, which affects a variety of decisions such as whether to replace a machine.

Understanding the behavior of a cost depends on:

1. Identifying the activities that cause the cost to change. These activities are called **activity bases** (or *activity drivers*).

2. Specify the range of activity over which the changes in the cost are takes place. This range of activity is called the **relevant range.**

There are two main types of costs according to their behavior:

* + 1. **Variable Costs**

Variable costs change in direct proportion to the level of production. This means that total variable cost increase when more units are produced and decreases when less units are produced. Example: Direct material and direct labor costs. Variable costs have the following characteristics:-

* + *Cost per unit remains the same regardless of changes in the activity base*
	+ *Total cost changes* ***in proportion to*** *changes**in the activity base*

For example

|  |  |  |  |
| --- | --- | --- | --- |
| Total Variable Cost | $10,000 | $20,000 | $30,000 |
| ÷ Units Produced | 5,000 | 10,000 | 15,000 |
| Variable Cost per Unit | $2.00 | $2.00 | $2.00 |

* + 1. **Fixed Costs**

Fixed costs are those which do not change with the level of activity within the relevant range. These costs will be incurred even if no units are produced. Fixed costs are costs that in total are constant within the relevant range as the level of output increases or decreases. When the activity base is ***units produced***, many factory overhead costs such as rent expense and straight-line depreciation are classified as fixed costs.

* Fixed costs have the following characteristics:
	+ *Cost per unit changes* ***inversely*** *to changes in the activity base*
	+ *Total cost remains the same regardless of changes in the activity base*

Fixed cost per unit decreases with increase in production. Following example explains this fact:

|  |  |  |  |
| --- | --- | --- | --- |
| Total Fixed Cost | $30,000 | $30,000 | $30,000 |
| ÷ Units Produced | 5,000 | 10,000 | 15,000 |
| Fixed Cost per Unit | $6.00 | $3.00 | $2.00 |

* 1. **The Breakeven point (BEP)**

 The Break Even Point (BEP) is that quantity of output sold at which total revenues equal total costs i.e. the quantity of output sold (or sales volume) at which the operating income is Br zero. In that we say a firm breaks even by selling the break-even quantity of output (or sales volume). Managers are interested in breakeven point because they want to avoid operating losses. Below the BEP there is **loss** and above the BEP these is operating **profit** (income). The breakeven point tells them how much output they must produce and sell to avoid a loss.

The three methods for determining the breakeven point are:-

1. The equation method
2. The contribution margin method, and
3. The graph method

**The following abbreviations are useful in subsequent analysis.**

**USP** = Unit selling price

**UVC** = Unit variable costs

**UCM** = Unit contribution margin (USP-UVC)

**CM %** = Contribution margin percentage (UCM/USP)

**FC** = Fixed costs

**Q** = Quantity of outputs units sold or manufactured.

**OI** = Operating income

**TOI**= Target operating income

**TNI** = Target net income

**Example 1:**

Pet ram Company manufactures and sells pens. Currently, 5,000,000 units are sold per year at a selling price of $ 0.50 per unit. Fixed costs are $ 900,000 per year. Variable costs are $ 0.30 per unit.

1. **Equation method**

Revenues –Variable cost − Fixed cost = Operating income

(USP x Q) – (UVC x Q) – Fixed cost = 0

0.5 Q – 0.3 Q – 900,000 = 0



If pet ram sells fewer than 4,500,000 units, it will have a loss, if it sells 4,500,000 it will break even; and if it sells more than 4,500,000 it will mark a profit. The break even can be expressed in revenue (birr) as:

 = 4,500,000 X $0.5 selling price = **$2,250,000** is a breakeven revenue.

1. **Contribution margin method**

Operating Income = ((USP – UVC) X Quantity of units sold)) − FC

 0\* = UCM x Q – FC

 $Q=\frac{FC}{UCM}= \frac{Fixed Cost}{Unit Contribution Margin}$

\* Operating Income is zero at Breakeven Point (BEP)

- Breakeven point in Birr = BEP Q X USP

 OR = =, Where CM% = UCM/USP

1. **Graph method**

Plot a line of total costs and a line of total revenues. Their point of intersection is breakeven point. The graph also shows the profit or loss outlook for a wide range of output levels beside the breakeven point.

 Total revenue line

 **Profit**

**Total revenue line Total cost line**

 ***3000, 000*-**

 = 4,500,000

2,000,000- Breakeven point

1,000,000-

 **Loss**

 900,000

 Fixed cost

 0 1 2 3 4 5 6

 Units sold (in millions)

#### Target operating income

One of the key uses of CVP analysis is called target operating income analysis. In target profit analysis, For example, suppose that ABC business would like to know what sales would have to be to attain a target profit of $40,000 per month the unit contribution margin is $100, and the fixed expense is $35,000. To answer this question, we can proceed using the equation method or the formula method.

**Equation method**

We can use a basic profit equation to find the sales volume required to attain a target profit.

Profit =Unit CM \* Q -Fixed expense

$40,000 =$100 \* Q -$35,000

$100 Q = $40,000 +$35,000

Q = ($40,000 + $35,000) /$100

Q = 750, Thus, the target profit can be achieved by selling 750 units per month.

**The Formula Method**

The formula method is a short-cut version of the equation method. Using the above example the sales volume required to attain a specific target profit using the following formula:

Unit sales to attain the target profit

CVP analysis is used to determine the total sales, in units and dollars needed to reach a target profit.

**Target Revenue – Target Variable cost – Fixed cost = Target operating income**

 Target Q = 

($35,000+$40,000) /$100=**750**

**Target Net income and Income taxes**

Thus far, we have ignored the effect of income taxes in our CVP analysis. At times, managers want to know the effect of their decisions on income after taxes. Net income is operating income minus income taxes. CVP calculations for target income must then be stated in terms of target net income instead of target operating income.

 Revenues – Variable cost − Fixed cost = Target operating income

Furthermore,

***Target net income = Target operating income – (Target operating Income X tax rate)***

 Target operating income =$ \frac{Target net inome}{1-Tax rate }$

$$Q=\frac{FC+\frac{TNI}{1-TR}}{UCM}$$

Target revenue (in birr) = $\frac{FC+ \frac{TNI}{1-TR}}{CM\%}$

**Margin of Safety (MOS)**

The margin of safety is the excess of budgeted (or actual) sales dollars over the breakeven volume of sales dollars. It is the amount by which sales can drop before losses are incurred. The higher the margin of safety, the lower the risk of not breaking even and incurring a loss. It indicates the vulnerability of a business to a fall in demand. It is often expressed as a percentage of budgeted sales

 Budgeted sales – Break-even sales = Margin of safety

 MOS ratio = $\frac{MOS x 100 \%}{Budgeted/actual Sales}$

*Exercise*: Based on the following information, calculate margin of safety, margin of safety ratio

Budgeted Sales 700 units x $ 8 = $5,600

Variable cost 700 units x $ 6 = $4,200

Fixed cost = $1,000

**Sales Mix Analysis and Break-even Point Calculation**

Sales mix is the proportion in which two or more products are sold. For the calculation of break-even point for sales mix, following assumptions are made in addition to those already made for CVP analysis:

1. The proportion of sales mix must be predetermined.
2. The sales mix must not change within the relevant time period.

The calculation method for the break-even point of sales mix is based on the contribution approach method. Since we have multiple products in sales mix therefore it is most likely that we will be dealing with products with different contribution margin per unit and contribution margin ratios. This problem is overcome by calculating weighted average contribution margin per unit and contribution margin ratio. These are then used to calculate the break-even point for sales mix.

The calculation procedure and the formulas are discussed via following example:

Example: Formulas and Calculation Procedure

Following information is related to sales mix of product A, B and C.

|  |  |  |  |
| --- | --- | --- | --- |
| Product | A | B | C |
| Sales Price per Unit | $15 | $21 | $36 |
| Variable Cost per Unit | $9 | $14 | $19 |
| Sales Mix Percentage | 20% | 20% | 60% |
| Total Fixed Cost | $40,000 |

Calculate the break-even point in units and in dollars.

**Calculation**

**Step 1**: Calculate the contribution margin per unit for each product:

|  |  |  |  |
| --- | --- | --- | --- |
| Product | A | B | C |
| Sales Price per Unit | $15 | $21 | $36 |
| − Variable Cost per Unit | $9 | $14 | $19 |
| Contribution Margin per Unit | $6 | $7 | $17 |

**Step 2**: Calculate the weighted-average contribution margin per unit for the sales mix using the following formula:

Product A CM per Unit × Product A Sales Mix Percentage
+ Product B CM per Unit × Product B Sales Mix Percentage
+ Product C CM per Unit × Product C Sales Mix Percentage
= Weighted Average Unit Contribution Margin

|  |  |  |  |
| --- | --- | --- | --- |
| Product | A | B | C |
| Sales Price per Unit | $15 | $21 | $36 |
| − Variable Cost per Unit | $9 | $14 | $19 |
| Contribution Margin per Unit | $6 | $7 | $17 |
| × Sales Mix Percentage | 20% | 20% | 60% |
|   | $1.2 | $1.4 | $10.2 |
| Sum: Weighted Average CM per Unit | $12.80 |

**Step 3**: Calculate total units of sales mix required to break-even using the formula:

Break-even Point in Units of Sales Mix = Total Fixed Cost ÷ Weighted Average CM per Unit

|  |  |
| --- | --- |
| Total Fixed Cost | $40,000 |
| ÷ Weighted Average CM per Unit | $12.80 |
| Break-even Point in Units of Sales Mix | 3,125 |
|  |  |

**Step 4**: Calculate number units of product A, B and C at break-even point:

|  |  |  |  |
| --- | --- | --- | --- |
| Product | A | B | C |
| Sales Mix Ratio | 20% | 20% | 60% |
| × Total Break-even Units | 3,125 | 3,125 | 3,125 |
| Product Units at Break-even Point | 625 | 625 | 1,875 |

**Step 5**: Calculate Break-even Point in dollars as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| Product |  A |  B |  C |
| Product Units at Break-even Point | 625 | 625 | 1,875 |
| × Price per Unit | $15 | $21 | $36 |
| Product Sales in Dollars | $9,375 | $13,125 | $67,500 |
| Sum: Break-even Point in Dollars | $90,000 |

**Example-2:** Suppose Ramos Company has two products, wallets (W) and Belt (B). The income budget is as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Wallets (W)** | **Belt ( B)** |  **Total** |
| Sales in units |  300,000 |  75,000 | 375,000 |
| Sales @ $ 8, and $ 5 |  2,400,000 |  375,000 |  2,775,000 |
| Variable expenses @ $ 7 and $ 3 | 2,100,000 |  225,000 | 2,325,000 |
| Contribution margin @ $ 1 and $ 2 | 300,000 | 150,000 | 450,000 |
| Fixed costs  |  |  | 180,000 |
| Net income  |  |  | $270,000 |

***Required:*** Calculate the breakeven point. Assume that there is no change in sales mix and ignore income taxes.

**1.3 Limitations of CVP Analysis**

The CVP analysis is generally made under certain limitations and with certain assumed conditions, some of which may not occur in practice. Following are the main limitations and assumptions in the cost-volume-profit analysis:

1. It is assumed that the production facilities anticipated for the purpose of cost-volume-profit analysis do not undergo any change. Such analysis gives misleading results if expansion or reduction of capacity takes place.

2. In case where a variety of products with varying margins of profit are manufactured, it is difficult to forecast with reasonable accuracy the volume of sales mix which would optimize the profit.

3. The analysis will be correct only if input price and selling price remain fairly constant which in reality is difficult to find. Thus, if a cost reduction program is undertaken or selling price is changed, the relationship between cost and profit will not be accurately depicted.

4. In cost-volume-profit analysis, it is assumed that variable costs are perfectly and completely variable at all levels of activity and fixed cost remains constant throughout the range of volume being considered. However, such situations may not arise in practical situations.

5. It is assumed that the changes in opening and closing inventories are not significant, though sometimes they may be significant.