

CHAPTER ONE

Cost Volume-Profit relationship (CVP)

The study of the interrelations of sales, costs, and net income is usually called CVP analysis. CVP analysis is a tool for management planning, control and decision making. Managers should know their costs and classify as fixed and variable when making decisions that affect the volume of output. Decisions on volume of output will affect costs and revenues. Although many factors in addition to volume of output will affect cost, yet it is a useful starting point in the manager's decision process to specify the relationship between the volume of output, costs, and revenue.

CVP analysis helps to answer questions such as:

- How much does a firm have to sell just to cover its total cost?
- How much does a firm have to sell to reach its target profit?
- How will a change in a firm's fixed costs affect its net income? etc

The study of CVP relationships is often called break-even analysis. Break-even is a point of zero profit (i.e. no profit, no loss).

Assumptions of CVP analysis

- The selling price per unit remains constant.
- The total expense can be separated into variable expense and fixed expenses.
- The variable cost (expense) per unit remains constant.
- The fixed expenses do not change as sales volume change.
- For a multi-product firm the sales tax rate remain constant.
- Production volume and sales volume are equal.

Note:

Contribution Margin (CM)

The contribution margin is the difference between sales revenue and variable costs. It is a measure of the amount available to cover fixed costs and there after to provide profits for an organization.

- Contribution margin is used first to cover the variable expenses and then whatever remains goes toward profit.

Break-even point Analysis (BEP)

- The point where total revenue equals total costs is called the break-even point (BEP).
- At BEP the company's revenues simply cover its costs, thus profit/loss is zero.
- Break-even analysis is one important element of CVP analysis.

There are three techniques or methods for computing BEP

- i. Equation (formula) technique
- ii. Contribution margin technique
- iii. Graphic technique

i. Equation method:

This method uses algebraic method to make CVP analysis and to determine break even point, target profit, etc

Let: Q= number of units produced and sold

TC= Total cost of producing and selling 'Q' units
 TR= Total sales revenue from selling 'Q' units
 P= Selling price per unit
 VC= Variable expenses per unit
 F= total fixed expenses

To drive the sales revenue and total cost formula.

$$Q = \frac{F}{(P-Vc)} \quad \text{This formula gives the BEP in number of units}$$

The BEP in sales birr can be computed by multiplying the BEP quantity (units) by the selling price per unit. However, it is possible to drive a formula in the equation form.

We know that break even quantity (Q)= $\frac{F}{(P-Vc)}$, if we multiply both sides by price (P) the result will be:

'p'

$$TR = \frac{FP}{P-Vc}, \text{ if we divide both the numerator and denominator by 'p'}$$

$$TR \text{ at BEP} = \frac{F}{1-\frac{vp}{p}}$$

This gives BEP in terms of sales birr

$$BEP \text{ sales} = \frac{F}{\frac{P-Vc}{P}}$$

Example: Use Top Company's data above and using the equation method:

- Compute the number of bottles of shampoo the company should produce and sale per year so as to break even
- Determine the break even sales in birr.

Solution

a. Qat BEP= $\frac{FC}{P-Vc} = \frac{\$120,000}{\$100-80} = 6,000$ bottles, which represent 60% of the plant capacity.

b. BEP in sales = BEP.Q × P = 6000 × \$100 = \$600,000

Or

$$BEP \text{ in sales} = \frac{F}{\frac{P-Vc}{P}} = \frac{120,000}{\frac{100-80}{100}} = \underline{\$600,000}$$

ii. The contribution margin method (Approach)

This method is actually just a shortcut version of the equation method. According to this method:

$$BEP \text{ in units} = \frac{F}{\text{CM per unit}} \quad \text{and}$$

$$BEP \text{ in sales} = \frac{F}{\text{CM ration}}$$

$$CM \text{ ration} = \frac{\text{CM per unit}}{P}$$

P

Example: Using the data of Top co, compute BEP in units and in sales birr following the contribution margin method.

Solution

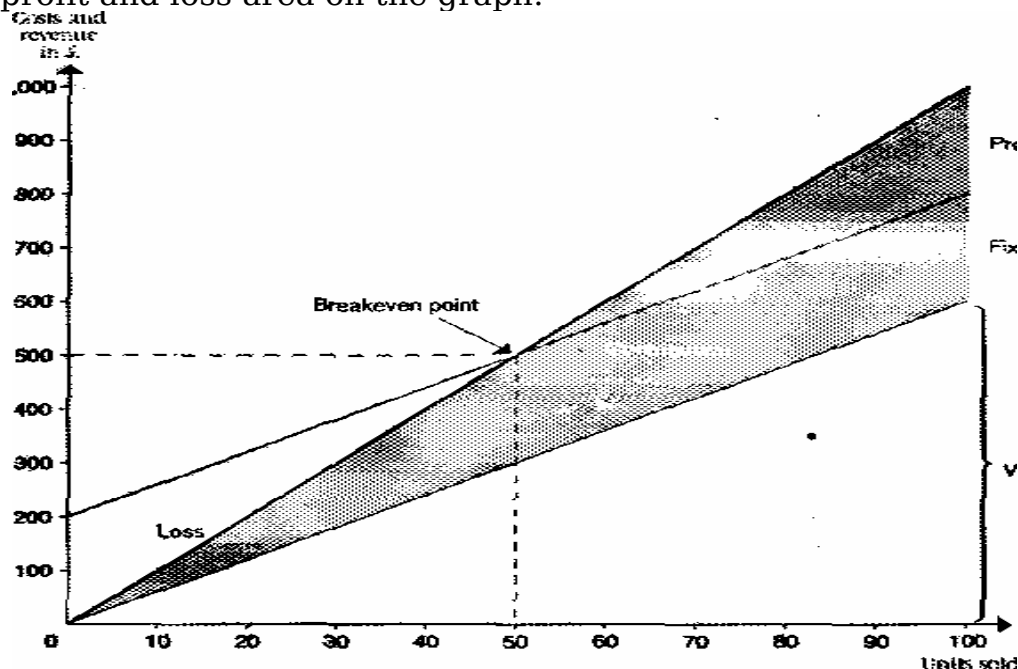
$$\begin{aligned} \text{BEP in units} &= \frac{F}{\text{Unit cm}}, & \text{but unit Cm} &= p/u - V_c/u \\ & & &= \$100 - \$80 \\ &= \frac{\$120,000}{\$20} = \underline{6000 \text{ bottle}} & &= \underline{\$20} \\ \text{BEP in sales} &= \frac{F}{\text{CM ration}}, & \text{but cm ration} &= \text{cm}/p \times 100\% \\ & & &= 20/100 \times 100 = \underline{20\%} \\ &= \frac{\$120,000}{0.2} \\ &= \underline{\$600,000} \end{aligned}$$

iii. Graphing or Graphic method

Information may be presented to management in a more visual format, such as graphs. A chart called CVP graph (or break-even chart) can be prepared to depict the relationships among revenue, cost, volume and profit. The break even point on the break even chart is located at the point where the total revenue and total cost lines cross or intersect.

Example: Using Top Company data graph the cvp relationship on the break even chart and determine/show:

- The BEP in units and in birr
- The profit and loss area on the graph.



BEP Graph

Reading the BEP Graph

BEP- BEP is determined by the intersection of the total revenue line and the total expense line. The company in our example breaks even at 6000 units, or \$600,000 of sales.

Profit and loss area - The CVP graph discloses more information than the BEP calculation. From the graph, a manager can see the effects on profits of changes in volume. The vertical distance between the lines on the graph represents the profit and loss area at a particular sales volume. If sales are fewer than 6000 units, the organization will suffer a loss. The organization will have a profit if sales exceed 6000 units a year.

Implications of the Breakeven Point - The position of the breakeven point within the organization's relevant range of activity provides important information to management.

Target Profit Analysis

Organizations need to earn operating profits. In this regard CVP analysis can help to answer:

- How much sales (quantity and birr) should a company sell if a fixed amount of profit before and /or after tax is desired?
- Target profit or planned profit is the level of profit that managers need to achieve in a particular period of time.
- BEP can be said a point to earn a target profit of zero.

The number of units to be sold and the sales in birr to be earned to generate a target profit could be computed using either of the methods used to determine BEP.

The equation method (approach)

- Here the sales volume should not only cover total expenses but also provide the anticipated profit.
- Target profit could be: Profit before tax (PBT) or Profit after tax (PAT)
- To drive a formula for determining sales units to generate a target PBT.

$$Q_t = \frac{F + \text{PBT}}{P - V_c} \quad Q \text{ at target profit before tax}$$

- If management is in need of a target profit after tax (PAT), the formula would be:

$$\text{PBT} = \frac{\text{PAT}}{1 - t}$$

- From the above equation

$$Q_t = \frac{F + \frac{\text{PAT}}{1 - t}}{P - V_c}$$

- The sales volume in birr required to achieve a target before tax profit would be : Target quantity (Qt) × Selling price Or

$$\begin{array}{lcl} \text{Sales volume in birr} & = & \frac{F + \text{PBT}}{P - V} \quad \text{Or For PAT} = \frac{F + \frac{\text{PAT}}{1 - t}}{P - V} \\ \text{Required to achieve} & & \\ \text{target PBT} & & \end{array}$$

Example: Assume that the management of Top Company has planned that the companies operation should produce a profit before tax of \$40,000 by the

year 2008 and a profit after tax of \$90,000 by the year 2009, given this, determine:

- a) The number of bottles of shampoo the company should produce and & sale to achieve its target profit
 - i. By the year 2008
 - ii. By the year 2009 (assume a 40% tax rate)
- b) The sales volume in Birr, which the company should generate to attain its target profits for the two years.

Solution

$$\text{a) i. } Q_t = \frac{F + \text{PBT}}{P - V_c} = \frac{\$120,000 + \$40,000}{\$20} = \underline{8,000} \text{ bottle}$$

$$\text{ii. } Q_t = \frac{F + \text{PAT}}{P - V_c} = \frac{120,000 + \$90,000}{\$20 \times 0.6} = \underline{13,500} \text{ bottles}$$

b) Target sales = $Q_T \times P$

Thus, for the year 2008, Target sales = $8,000 \times \$100 = \underline{\$800,000}$

For the year 2009, Target sales = $13,500 \times \$100 = \underline{\$1,350,000}$

Or use the formula

$$\text{Year 2008, Target sales} = \frac{F + \text{PBT}}{P - V} = \frac{\$120,000 + \$40,000}{\$20} = \underline{\$800,000}$$

$$\text{Year 2009, Target sales} = \frac{F + \text{PAT}}{P - V} = \frac{\$120,000 + \$90,000}{\$20 \times 0.6} = \underline{\$1,350,000}$$

The margin of safety

The margin of safety is a measure of risk as it indicates (show) the number of units or amount of sales birr that can decline before a firm suffers a loss.

Absolute margin of safety = Total budgeted (actual) sales - BEP sales

Relative margin of safety = $\frac{\text{Total budgeted (actual) sales} - \text{BEP sales}}{\text{Total budgeted (actual) sales}} \times 100\%$

Total budgeted (or actual) sales

Example. Assume Xyz Company (in the previous example) is currently selling 7,500 bottles of shampoo.

Required:

- a) compute and interpret the absolute margin of safety
- b) Compute and interpret the relative margin of safety

Solution

BEP in sales = \$600,000

BEP in bottles = 6000

Actual sales

Current sales in birr ($7,500 \times \$100$) = \$750,000

Current bottles sold = 7,500

a) Absolute margin of safety = Total actual sales - BEP-sales
= \$750,000 - 600,000
= \$150,000

In units : Absolute margin of safety = 7,500 - 6,000
= 1,500 bottles

b) Relative margin of safety = $\frac{\$150,000}{750,000} \times 100\% = 20\%$

Based on the given data (cost, price, units sold) a decline in sales 1,500 bottles or \$150,000 birr or by 20% from the current sale would result in zero profit.

Sensitivity Analysis

Sensitivity analysis refers to investigating a multitude of what if questions regarding simultaneous changes in cvp variables (variable cost, fixed cost, Price and sales volume).

CVP analysis with multiple products

- For organizations selling multiple products, the relative proportion of each type of product sold is called the sales mix. Because all products are not equally profitable, net income of such organization depend on their sales mix.
- Profits will be greater if the high margin rather than low margin items make up relatively large proportion of total sales.
- Change in the sales mix can change a company's profit.

Example: Suppose ABC Company produces and sales products x and y and budgeted to sell 15,000 units of product x and 5,000 units of product y per year. This sales mix is estimated to remain constant. The companies annual fixed costs is \$246,500.

	Product X	Product Y
Sales price per unit	\$30	\$10
Variable costs per unit	12	6

Given this you are required to:

1. Determine the total break even point in units for the two product
2. Determine the number of units of each product that must be sold so as to break even

3. Compute the break even point in sales birr for the company as a whole and for each product.

Solution

1. First we have to compute the weighted average unit contribution margin of the company.

Weighted average unit CM = $\Sigma(\text{CM/unit of each product} \times \text{sales mix of each product})$
(WAVCM)

From the given data the sales mix can be computed as follows:

Product Budgeted sales in Units Budgeted sales = $\frac{\text{Budgeted sales of each product}}{\text{total budgeted sales of all Products}} \times 100\%$

Units	mix in units	
X.....15,000.....	75%	
Y..... <u>5,000</u>	<u>25%</u>	
Total..... <u>20,000</u>	<u>100%</u>	

Weighted average unit CM = $(\$18 \times 0.75) + (4 \times 0.25)$
= \$14.50

Then break even point in units = $\frac{\text{Fixed expenses}}{\text{Weighted average unit CM}} = \frac{\$246,500}{\$14.50} = \underline{17,000 \text{ units}}$

2. Product X = 75% of the units at BEP
= $0.75 \times 17,000 = 12,750 \text{ units}$
Product Y = $0.25 \times 17,000 = 4,250 \text{ units}$
Absolute margin of safety (product X = $15,000 - 12,750 = 2,250 \text{ units}$
Product Y = $5,000 - 4,250 = 750 \text{ units}$

3. BEP in birr = $\frac{\text{FC}}{\text{CM ratio}}$
= $\frac{\$246,500}{0.58}$
= \$425,000

but since there are two products the CM ratio = $\frac{\text{Weighted average unit CM}}{\text{Weighted average unit selling price}} \times 100\%$

Weighted average unit selling price = $\frac{\$14.5}{(30 \times 0.75) + (10 \times 0.25)} = \text{WASP}$
= $\frac{14.5}{25} = \underline{58\%}$

WASP = Weighted average unit selling price

Sales mix in birr

Products	Budgeted sales In Birr (PQ)	Sales mix in birr	CM ratio of each product	Overall CM
X	\$450,000	90%	60%	54%
Y	<u>50,000</u>	<u>10%</u>	<u>40%</u>	<u>4%</u>
Total	<u>\$500,000</u>	<u>100%</u>		<u>58%</u>

So, BEP in sales birr for

Product X = BEP sales of birr of $\times$ Sales mix in birr of P.x

All products
= \$425,000 × 90% = \$382,500
Product Y = \$425,000 × 10% = 42,500