The Institute of Finance Management
Accounting and Finance Department
Lecture Notes
Cost- Volume Profit (CVP) Analysis
BACC 3 and BAIT 3
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Learning Objectives

After studying this chapter, readers will be able to understand

- Evaluate the nature of CVP analysis
- Evaluate the assumptions of CVP analysis
- Calculate the contribution to sales ratio, in single and multiproduct situations, and demonstrate an understanding of its use
- Compute and interpret the breakeven point
- Calculate the level of sales needed to achieve targeted profit
- Compute and interpret the margin of safety
- Prepare break-even charts, contribution breakeven charts, and profit volume charts and interpret the information contained within each, including multiproduct situations
- Compute the degree of operating leverage and interpret it
- Compute the breakeven point for multiple product firm
- Describe the difference between the accountant's and economics model of CVP analysis
- Discuss the limitations of CVP analysis for planning and decision-making.

1.1 Introduction

Profit is an important factor in any business transaction. The main motive of engaging in any business is to make a profit. There is the necessity, therefore, to understand the exact nature of this relationship to;

(i) Control the level of costs and
(ii) Manipulate volume

Cost-volume-profit analysis is a study of the inherent relationship between cost and profit at various levels of volumes of activity.

Cost volume profit (CVP) analysis involves the analysis of how total costs, total revenues, and total profits are related to sales volume. Therefore, CVP analysis is concerned with predicting the effects of changes in costs and sales volume on profits i.e. This is the term given to the study of the interrelationships between costs, volume and profit at various level of activity.

CVP analysis is one of the most powerful tools that managers have at their command. It helps them understand the interrelationship between cost, volume and profit in an organization by focusing on interactions among the following five elements.

- Prices of products
- Volume of level activity
- Per unit variable costs
- Total fixed costs
- Mix of products sold

Because CVP analysis helps managers to understand the interrelationships, among cost, volume, and profit, it is a vital tool in many business decisions. These decisions include, for example

- What products to manufacturer or sell
- What pricing policy to follow
- What marketing strategy to employ
- What type of productive facilities to acquire

Cost-volume- profit analysis can answer several analytical questions. Some of the questions are as follows:

- What is the breakeven revenue of an organization?
- How much revenue does an organization need to achieve a budgeted profit?
- What level of price change affects the achievement of budgeted profit?
- What is the effect of cost changes on the profitability of an operation?

Cost-volume-profit analysis can also answer many other "what if" type of questions. Cost-volume-profit analysis is one of the important techniques of cost and management accounting.

1.2 Cost-Volume-Profit (CVP) Analysis Assumptions

- The sale price per unit is constant (i.e. set by management decision) over the entire relevant range of output.
- There are no stock level changes, so production output and sales levels in units may be treated as the same volumes.
- All costs can be resolved into fixed and variable elements.
- That the only factor affecting costs and revenue is volume.
- That technology, production methods, and efficiency remain unchanged.
- Fixed costs will remain constant and variable costs vary proportionately with activity
- Over the activity range being considered costs and revenues behave in a linear fashion
- The sales mix is constant at all levels of activity, where more than one product is included in the analysis.

1.3 The Concept of Contribution Margin

- An important concept in CVP analysis is that of the contribution margin (sometimes referred to simply as contribution).
- If we can divide total costs into a component that is fixed and independent of output over a particular range and a component that is variable and proportionate to output over that range, then the contribution margin is calculated by deducting variable costs from revenue
- Contribution margin is equal to sales minus variable costs. Because the variable cost per unit and selling price per unit are assumed to be constant the contribution margin per unit is also assumed to be constant.

Hence: Contribution margin = sales value – variable costs

- The size of the unit contribution margin (and the size of the P/V ratio) is very important.
- The greater the unit contribution margin, the greater the amount that the company will be willing to spend to increase unit sales.
- This concludes why the firms with high unit contribution margins such as automobile manufacturers advertise so heavily, while firms with low unit contribution margins such as dishware manufacturers tend to spend much less for advertising.
- In short, the effect on the contribution margin holds the key to many decisions

1.4 Contribution Margin Ratio (CM or P/V ratio)

- The contribution margin as a percentage of total sales is referred to as the contribution margin ratio (P/V ratio)
- It shows the relationship between contribution margins and the sales value
- Better P/ V ratio is an index of sound 'financial health' of a company's product.
- This ratio reflects a change in profit due to volume change.
- Broadly speaking, it shows how large the contribution will appear if it is expressed on equal footing with sales.
- P/V ratio is used in cost-volume profit calculations; this ratio is calculated as follows;

P/V ratio = Contribution margin/ Sales revenue

1.4.1 Importance of P/V ratio

- It assists management in determining the break-even point
- It assists management in determining profit at different sales levels
- It assists management in calculating the sales volume to earn the desired profit objectives
- It helps management to determine the relative profitability of different products, processes and departments

1.4.2 Improvement of P/V Ratio

P/ V ratio can be improved, if the contribution is improved, the contribution can be improved by any of the following steps:

- Increase in selling price.
- Reducing marginal cost by efficient utilization of labour, material, and machines
- Concentrating on the sale of products with relatively better P/ V ratio, will help to improve the overall P/ V ratio

1.4.3 Limitations of P/V Ratio

There is a growing trend among companies to use the profit-volume ratio in deciding the product-worthy additional sale efforts and productive capacity and a host of other managerial exercises. Following are the limitations of the use of P/ V Ratio

- P/ V ratio heavily leans on excess revenues over variable costs.
- The P/ V ratio fails to take into consideration the capital outlays required by the additional productive capacity and the additional fixed costs that are added.
- Inspection of the P/ V ratio of products can suggest profitable product lines that might be emphasized and unprofitable lines, which may be re-evaluated or eliminated. Mere inspection of P/ V ratio will not help to take final decision. For this purpose, analysis has to be broadened to take into consideration different cost of the decision and opportunity costs, etc. Thus, it indicates only the area to be probed. .
- The P/ V ratios has been referred to as the questionable device for-decision-making because it only indicates the relative profitability of the products/ product lines that too if other things are equal.

1.5 The Break-Even Analysis

- The breakeven point is the quantity of output where total revenues equal total costs i.e. that is where the operating profit is zero.
- That is the total contribution is equal to the total fixed cost and so the profit is zero.
- Break-even point may be expressed either in term of units of sale or in terms of sales revenue.
- Managers would be interested in the break-even point, mainly because they want to avoid operating losses.
- Knowing the break-even point will enable the management to be aware, on a daily, weekly or monthly basis of the likely level of profitability.
- If the sales level is level the break-even point, the managers will need to re-consider the position and take remedial action.

1.5.1 Calculating the breakeven point

(i) Equation Method

Profits = (Sales – Variable costs) – Fixed costs

Rearranging this equation slightly yield the following equation, which is widely used in CVP analysis;

(SP x Q) = (VC x Q) +TFC + OP ***1***

At the breakeven point, profit is zero; therefore the breakeven point can be computed by finding that point where sales just equal the total of the variable costs plus the total fixed costs.

(i) Contribution Margin method

The contribution margin method is actually just a shortcut version of the equation method already explained

- **Breakeven point in units** $= \dfrac{Total\ Fixed\ Cost}{Contribution\ Per\ Unit}$

- **Breakeven point in Sales values** $= \dfrac{Total\ Fixed\ Cost}{P/V\ Ratio}$

1.6. Target Profit Analysis

Cost -Profit-Volume (CVP) formulas can be used to determine the sales volume needed to achieve a target profit

1. **Sales in units to earn a required profit=** $\dfrac{Total\ Fixed\ Cost + \text{Re}quired\ \text{Pr}ofit}{Contribution\ Per\ Unit}$

2. **Sales Revenue to earn a required profit=** $\dfrac{Total\ Fixed\ Cost + \text{Re}quired\ \text{Pr}ofit}{P/V\ Ratio}$

- If the component of tax is introduced the formula for computation of break- even point would expressed as follows

3. **Sales in units to earn a required profit=** $\dfrac{Total\ Fixed\ Cost + [(\text{Re}quired\ \text{Pr}ofit)/(1-t)]}{Contribution\ Per\ Unit}$

1.7 The Margin of Safety

- The Margin of safety is the excess of budgeted (or actual) sales over the break-even volume of sales.
- It states the amount by which sales can drop before losses begin to be incurred
- The higher the margin of safety, the lower the risk of not breaking even
- The larger the margin of safety, the more likely it is that a profit will be made, that is, if sales start to fall there is more leeway before the organization begins to incur losses.
- It indicates the extent to which a fall in demand could be absorbed before the firm begins to sustain losses. Thus, the soundness of a business can be measured by a margin of safety.
- This concept is very important to management in making policy decisions like reduction in price to face the competitors.

Margin of safety percentage = *Margin of safety in monetary value x 100*
Total budgeted (or actual) sales

Illustration 3.1

The following information is related to BM Company of product XA

Selling price per unit	Shs. 25,000
Variable cost per unit	Shs 20,000
Total fixed cost	Shs 50,000,000

Suppose the BM Company budgets to sell 13,000 units of Product XA.

Here, contribution per unit is calculated as Shs 25,000 – Shs 20,000 = Shs 5,000 per unit; break-even point will therefore be Shs 50,000,000 / Shs 5,000, or 10,000 units.
Its margin of safety would be calculated as follows:
Margin of safety = 13,000 - 10,000 = 3,000 units;
In terms of sales revenue, this is 3,000 x Shs 25,000 = Shs 75,000,000;
As a percentage of the budget, this is (3,000 units / 13,000 units) x 100 %, i.e. 23.1%

1.7.1 How to Improve the Margin of Safety

The margin of safety can be improved in the following ways;

- By increasing the selling price, if it is not possible to increase the sales volume level, the selling price can be increased to improve the margin of safety; however, this can have a negative impact on the sales volume, also this depend upon the price elasticity demand of the product
- Increasing the sales volume, will increase the difference between the actual sales level and the sales level at breakeven; however, this will have a negative effect in the selling price
- By reducing the variable costs, it increases the margin of safety by improving contribution margin ratio
- By changing the product mix thereby increasing the contribution margin, will lead to improvement in the margin of safety, because it increases the gap of sales at specified activity level and sales at the breakeven point.

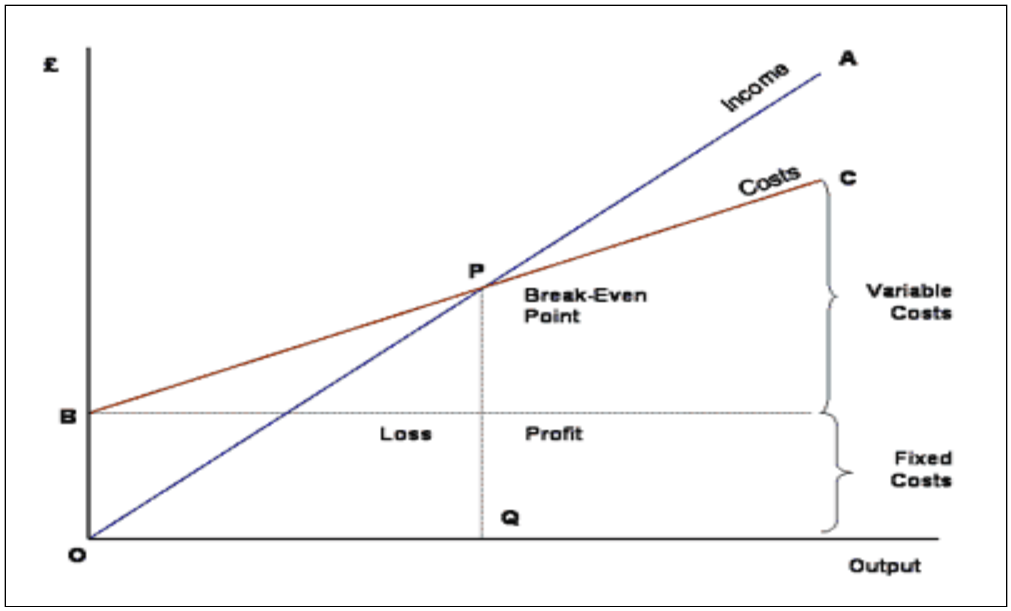
1.8 Graphical Presentation of Cost- Volume- Profit (C-V-P) Analysis

- Graphic charts furnish an effective means of presenting cost volume profit relationship.
- In graphic presentation, a diagram of the relationship among various factors, revenue, volume level, profit and cost is presented.
- This pictorial presentation makes this relationship easy to understand and interpret.
- The graphical presentation of C-V-P analysis can be expressed into three ways

3.8.1 A basic breakeven charts

A basic break-even chart is a graphical representation of costs at various levels of activity shown on the same chart as the variation of income (or sales, revenue) with the same variation in activity. The point at which neither profit nor loss is made is known as the "break-even point" and is represented on the chart below by the intersection of the two lines:

Figure 1.1 Basic Break Even Chart



In the diagram above, the line OA represents the variation of income at varying levels of production activity ("output"). OB represents the total fixed costs in the business. As output increases, variable costs are incurred, meaning that total costs (fixed + variable) also increase. At low levels of output, Costs are greater than Income. At the point of intersection, P, costs are exactly equal to income, and hence neither profit nor loss is made.

1.8.2 The contribution breakeven chart

- One of the problems with the conventional or basic breakeven chart is that it is not possible to read contribution directly from the chart.
- A contribution breakeven chart is based on the same principles but it shows the variable cost line instead of the fixed cost line.
- The same lines for total cost and sales revenue are shown so the breakeven point and profit can be read off in the same way as with a conventional chart.
- However, it is also possible also to read the contribution for any level of activity

1.8.3 The profit – Volume (P/V) chart

- Another form of breakeven chart is the profit–volume chart.
- This chart plots a single line depicting the profit or loss at each level of activity.
- The breakeven point is where this line cuts the horizontal axis
- The main advantage of the profit–volume chart is that it is capable of depicting clearly the effect on profit and breakeven point of any changes in the variables

1.9 The Concept of Sales Mix

- The term sales mix refers to the relative proportions in which a company's products are sold.
- The idea is to achieve the combination, on mix that yield the greatest amount of profits.

- Most companies have many products and often these products are not equally profitable. Hence, profits will depend to some extent on the company's sales mix.
- Profits will be greater if high contribution margin rather than low contribution margin products make up a relatively large proportion of total sales

1.9.1 Multi Products and Break-Even Analysis

- The basic breakeven model can be used satisfactorily for a business operation with only one product.
- However, most companies sell a range of different products, and the model has to be adapted when one is considering a business operation with several products
- CVP Analysis assumes that, if a range of products is sold, sales will be by a predetermined sales mix.
- When a predetermined sales mix is used, it can be depicted in the CVP Analysis by assuming average revenues and average variable costs for the given sales mix
- However, the assumption has to be made that the sales mix **remains constant**.
- This is defined as the relative proportion of each product's sale to total sales.
- It could be expressed as a ratio such as 2:3:5, or as a percentage as 20%, 30%, and 50%.
- The calculation of the breakeven point in a multiproduct firm follows the same pattern as in a single product firm.
- While the numerator will be the same fixed costs, the denominator now will be the weighted average contribution margin.
- In multiproduct situations, a weighted average P/V ratio is calculated by using the formula :

$$\textbf{Weighted Average P/V ratio} = \frac{Total\ Contribution}{Total\ \text{Re}venue}$$

The Weighted Average P/V ratio is useful in its own right, as it tells us what percentage each Shs of sales revenue contributes towards fixed costs; it is also invaluable in helping us to quickly calculate the breakeven point in sales revenue :

$$\textbf{Breakeven Revenue} = \frac{Total\ Fixed\ Cost}{Weighted\ Average\ P/V\ Ratio}$$

1.9.2 Target Profit for Multiple Products

The approach is the same as in single product situations, but the weighted average contribution to Sales Ratio is now used so that:

$$\textbf{Sales Revenue to earn a required profit} = \frac{Total\ Fixed\ Cost + \text{Re}quired\ \text{Pr}ofit}{Weighted\ Average\ P/V\ Ratio}$$

1.9.3 The Multi Product Profit Volume Graph Step By Step

In a multiproduct environment, two lines must be shown on the profit volume graph:

- One straight line, where a constant mix between the products is assumed; and

- one bow shaped line, where it is assumed that the company sells its most profitable product first and then its next most profitable product and so on

STEP 1: Calculate the C/S ratio of each product being sold, and rank the products in order of profitability.

Illustration 1.2

BM Company produces two products XA and XB. The following information is available for both products:

	Product XA	**Product XB**
Sales price	Shs 50,000	Shs 60,000
Variable cost	Shs 30,000	Shs 45,000
Contribution per unit	Shs 20,000	Shs15,000
Budgeted sales (units)	20,000	10,000

Total fixed cost Shs 200,000,000
The targeted profit of the Company is Shs 300,000,000:
Required to calculate

a) **The** weighted average C/S (P/V) ratio and explain the importance of this ratio
b) The break-even sales revenue
c) The sales revenue at a targeted profit

Solution
The weighted average C/S ratio can be calculated by dividing the total expected contribution by the total expected sales:
(20,000 x Shs 20,000) + (10,000 x Shs 15,000) / (20,000 x Shs 50,000) + (10,000 x Shs 60,000) = 34.375%

The C/S ratio is useful in its own right as it tells what percentage each Shs of sales revenue contributes towards fixed costs; it is also invaluable in helping to quickly calculate the break-even point in Shs sales revenue, or the sales revenue required to generate a target profit.

(b) The break-even point can now be calculated as follows:
Fixed costs / contribution to sales ratio = Shs 200,000,000/0.34375 = Shs 581,819,000 of sales revenue.

(c) The sales revenue at targeted profit
Fixed costs + required profit /contribution to sales ratio = Shs 200,000,000 + Shs 300,000,000/0.34375 = Shs 1,454,546,000.

It should be noted that the above calculations provide only estimated information because they assume that products XA and XB are sold in a constant mix of 2XA to 1XB. In reality, this constant mix is unlikely to exist and, at times, more XB may be sold than XA. Such changes in the mix throughout a period, even if the overall mix for the period is 2:1, will lead to the actual break-even point being different than anticipated

3.10 Limitations of breakeven analysis

Cost behaviour is affected by the interplay of a number of factors.

- Physical volume is only one of these factors;
- Others include unit prices of input, efficiency, changes in production technology, wars, strikes, legislation, and so forth.
- Any CVP analysis is based on assumptions about the behaviour of revenue, costs and volume.
- A change in expected behaviour will alter the breakeven point; In other words, profits are affected by changes in other factors besides volume.
- A CVP chart must be interpreted in the light of the limitations imposed by its underlying assumptions.
- The real benefit of preparing CVP charts is in the enrichment of understanding of the interrelationships of all factors affecting profits, especially cost behaviour patterns over ranges of volume.

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:

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

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