

Management Accountancy

Unit 5

Cost Volume Profit (CVP) Analysis under Condition of Uncertainty

Structure

- CVP analysis under condition of uncertainty

After the completion of this unit, you should be able to:

- Apply CVP analysis under condition of uncertainty

5.1 Cost-Volume-Profit (CVP) Analysis under Uncertainty

The major short coming of cost-volume-profit (CVP) analysis is unadjustment for risk and uncertainty. Risk and uncertainty are a part of business decision making. However, it has been found that traditional cost-volume-profit analysis ignores risk and uncertainty. The traditional CVP assumes that price, cost, profit and sales are known with certainty. This is seldom the case. The decision situation with reference to risk analysis can be divided into three types :

(i) Certainty

If the future estimates are certain, that is, they can be forecast precisely with cent percent accuracy, there will be no risk in such a situation. This condition is generally known as certainty.

(ii) Uncertainty

When the future outcome cannot be predicted with any degree of confidence from a knowledge of past or existing events, that is known as uncertainty.

(iii) Risk

It occurs where it is not known what the future outcome will be, but where the various possible outcomes may be expected with some degrees of confidence from a knowledge of past or existing events. Though the meaning of risk and uncertainty seems to be different, these two terms are used interchangeably.

5.2 Risk Analysis Techniques Applied in CVP Analysis

For incorporating risk factor in cost-volume-profit-analysis, the following techniques are used :

- (i) Probability Distribution
- (ii) Standard Deviation of Random Variables
- (iii) Normal Distribution

(i) Probability Distribution

A manager has to make decision for future. However, future is uncertain. Hence, managerial decision must be prepared either on the basis of past experience or on the basis of proper guess. Probability plays an important role in decision making.

A theoretical probability distribution is related to frequently distribution. It is generally used to make decision logically. It estimates the future values on the basis of limited information on

theoretical consideration. Thus the probability distribution is to assign probability to different values. Those different values are the results of the outcome of a random experiment which is known as random variable. After assigning the probability to different values, the mean or the expected value of random variable is ascertained. The mean or expected value of random variable is the sum of the product of the different values of random variable and their respective probabilities. Symbolically, it is written as ' μ '. The expected value is determined in following ways:

Step 1 :	Multiply different estimated values by their respective probabilities.
Step 2 :	Sum the products of step 1, which is known as expected value.

Mainly, there are four different factors in cost-volume-profit analysis. They are selling price, variable cost, fixed cost and sales units. All of these four factors are uncertain. However, variable cost, fixed cost and selling price are quite certain than sales units. Hence sales volume in units is treated as random variable and uncertain as under in illustration 1.

ILLUSTRATION 1

A company produces a single product with a sales price of Rs. 50 per unit and variable cost Rs. 30 per unit. Fixed costs are Rs. 30,000 per annum. The manager expects five different possibilities happening in the coming year, which are as follows :

Sales Units	Probability
1,000	0.2
1,500	0.1
2,000	0.3
2,500	0.3
3,000	0.1

- Required : (i) Break-even units.
(ii) Expected sales unit (Mean sales units).
(iii) Expected profit.

SOLUTION:

(i) Break-even Units = $\frac{\text{Fixed Cost}}{\text{Unit Contribution Margin}} = \frac{30,000}{50 - 30} = 1,500$ units

(ii) Calculation of Expected Sales Value:

Sales Units	Probability	Expected Value = (Sales units X Probability)
1,000	0.2	200
1,500	0.1	150
2,000	0.3	600
2,500	0.3	750
3,000	0.1	300
Expected Sales Units (μ)		2,000

- (iii) Expected Profit :
 = (Expected Sales Units × Contribution Margin per Unit) – Fixed Cost
 $\pi = \mu (SP - UVC) - FC$
 Now, Expected Profit = $[2,000 \times (50 - 30)] - 30,000 = \text{Rs. } 10,000$

Where,

π = Expected Profit

μ = Expected Sales Value or Mean of Random Variable Sales

SP = Unit Selling Price

UVC = Unit Variable Cost

FC = Total Fixed Cost

(ii) Standard Deviation of Random Variable (σ)

The mean or expected value of random variable is not sufficient to study the actual behaviour of random variable. The dispersion of random variable about its expected value should be measured and standard deviation provides measures of this dispersion.

In statistical terms, standard deviation is defined as the square root of the mean of squared deviation, where deviation is the difference between an outcome and the expected values of all outcomes. Further more, to calculate the value of standard deviation, we provide weight to the square of each deviation by its probability of occurrence.

The following steps are required for the calculation of standard deviation (σ) :

Step 1 :	To find out expected sales value (μ)
Step 2 :	To find out deviation (dv) by deducting expected sales value from expected sales

Deviation (dv) = Sales Value - Expected Sales Value

Symbolically, $dv = S - \mu$

Step 3 :	To obtain the square of deviation (dv^2)
Step 4 :	Multiply the square deviation by assigned probability and find out the product of each item $\text{Product} = dv^2 \times P$
Step 5 :	Sum the products from step 4 and find out the standard deviation (σ) $\sigma = \sqrt{\sum (dv^2 \times P)}$

LLUSTRATION 2

A company plans to introduce a new product P. The company anticipated the demand for new product along with their probability as under :

Demand Units	Probability
4,000	0.1
5,000	0.2
6,000	0.2
7,000	0.3
8,000	0.2

The Cost data for the product are :

Selling Price per unit = Rs. 30

Variable Cost per unit = Rs. 20

Fixed Cost for the period = Rs. 50,000

- Required :
- Expected Demand.
 - Expected Contribution Margin.
 - Expected Profit.
 - Standard Deviation of Demand units.
 - Standard Deviation of Profit.
 - Break-even Sales in Rs.

SOLUTION:

- (i) Calculation of expected demand :

Demand Units	Probability	Expected Value
4,000	0.1	400
5,000	0.2	1,000
6,000	0.2	1,200
7,000	0.3	2,100
8,000	0.2	1,600
Expected Demand (μ)		6,300

- (ii) Expected Contribution Margin = $\mu \times \text{CMPU} = 6,300 \times 10 = \text{Rs. } 63,000$

- (iii) Expected Profit = $(\mu \times \text{CMPU}) - \text{Fixed Cost}$
 $= 63,000 - 50,000$
 $= \text{Rs. } 13,000.$

- (iv) Standard Deviation of Demand units :

Demand	μ	$dv/100$	dv^2	P	$dv^2 \times P$
4,000	6,300	- 23	529	0.1	52.9
5,000	6,300	-13	169	0.2	33.8
6,000	6,300	-3	9	0.2	1.8
7,000	6,300	7	49	0.3	14.7
8,000	6,300	17	289	0.2	57.8

$$\frac{\sum (dv^2 \times P)}{161}$$

$$\sigma_Q = \sqrt{\sum (dv^2 \times P)} \times 100 = \sqrt{161} \times 100 = 1269 \text{ units (Approximately)}$$

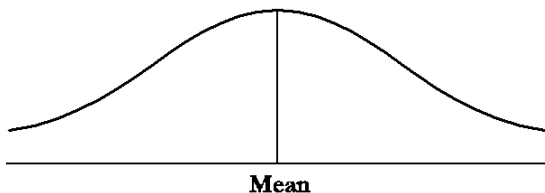
$$\begin{aligned} \text{(v) Standard Deviation of Profit } \sigma_P &= \sigma_Q \times \text{CMPU} \\ &= 1269 \times 10 = \text{Rs. } 12690 \end{aligned}$$

$$\begin{aligned} \text{(vi) Break-even Sales in Rs.} &= \frac{FC}{1 - \frac{V}{S}} = \frac{50,000}{1 - \frac{20}{30}} \\ &= \frac{50,000}{\frac{1}{3}} = \text{Rs. } 1,50,000. \end{aligned}$$

(iii) Normal Distribution

Normal distribution is the most important and frequently used continuous probability distribution. This distribution is well fitted in many types of problems. Most of the data related to economic and business statistic can take a form of this distribution.

The normal probability distribution is a smooth, symmetric, continuous, bell shaped curve as shown below. The area under the curve sums to one, 50% each side of mean value, where mean value = median value = mode value



Normal probabilities can be read from a normal probability table. For the purpose of calculating the probabilities, variable x is stated as the variable z and it is worked out as under :

$$Z = \frac{X - \mu_Q}{\sigma_Q} \text{ OR } Z = \frac{X - \mu_P}{\sigma_P}$$

where,

Z = Standard variate (or number of standard) deviations
from x to the mean of the distribution)

x = value of the random variable under consideration

μ_Q = Expected sales units (mean of the distribution of random variable in units)

σ_Q = Standard deviation of the distribution in units

μ_P = Expected profit (mean of the distribution of random variable in amount)

σ_P = Standard deviation of the distribution in amount

Z would equal zero, when value $x = \mu$

Z would be positive, when value $x > \mu$

Z would be negative, when value $x < \mu$

5.3 Calculation of Probability

The following steps are required for the calculation of Probabilities :

Step 1 :	To find out expected sales units (μ_Q)
Step 2 :	To find out standard deviation in units (σ_Q)
Step 3 :	To find out expected profit (μ_P)
Step 4 :	To find out standard deviation in profit (σ_P)
Step 5 :	To find the probabilities $Z = \frac{X - \mu_Q}{\sigma_Q} \text{ OR } Z = \frac{X - \mu_P}{\sigma_P}$

ILLUSTRATION 3

The sales unit expected by a sales manager of a company for the one of its products are :

Sales Units	Probability
5,000	0.1
6,000	0.4
7,000	0.3
8,000	0.2

The fixed costs are Rs. 6,00,000. The selling price per unit is Rs. 300 and variable cost per unit is Rs. 200.

- Required :
- (i) Break-even Sales units.
 - (ii) Expected Sales units.
 - (iii) Standard Deviation of expected units.
 - (iv) Expected Contribution Margin.
 - (v) Expected Profit.
 - (vi) Standard Deviation of Profit.
 - (vii) Probability of at least Break-even.
 - (viii) Probability of incurring Losses.
 - (ix) Probability of making at least Rs. 75,000 profit.

SOLUTION:

$$\begin{aligned}
 \text{(i) Break-even Sales units} &= \frac{\text{Fixed Cost}}{\text{Unit Selling Price} - \text{Unit Variable Cost}} \\
 &= \frac{6,00,000}{300 - 200} \\
 &= 6,000 \text{ units}
 \end{aligned}$$

(ii) Expected Sales unit :

Sales Units	Probability	Expected Value
5,000	0.1	500
6,000	0.4	2,400
7,000	0.3	2,100
8,000	0.2	1,600
μ_Q , Expected Sales Units		6,600

(iii) Standard Deviation of expected units :

Sales Units	μ	$dv/100$	dv^2	P	$dv^2 \times P$
5,000	6,600	- 16	256	0.1	25.6
6,000	6,600	- 6	36	0.4	14.4
7,000	6,600	4	16	0.3	4.8
8,000	6,600	14	196	0.2	39.2
$\Sigma (dv^2 \times P) =$					84

$$\begin{aligned}\sigma_Q &= \sqrt{\Sigma (dv^2 \times P)} \times 100 \\ &= \sqrt{84} \times 100 \\ &= 916.52 \text{ or } 917 \text{ (Approx)}\end{aligned}$$

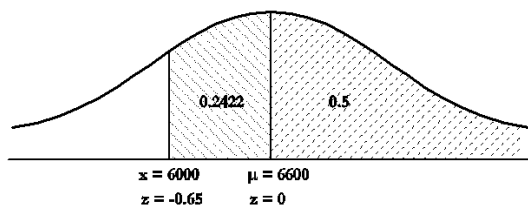
$$\begin{aligned}\text{(iv) Expected Contribution Margin} &= \mu_Q \times \text{CMPU} \\ &= 6,600 \times (300 - 200) \\ &= \text{Rs. } 6,60,000\end{aligned}$$

$$\begin{aligned}\text{(v) Expected Profit, } \mu_P &= (\mu_Q \times \text{CMPU}) - \text{FC} \\ &= 6,60,000 - 6,00,000 \\ &= \text{Rs. } 60,000\end{aligned}$$

$$\begin{aligned}\text{(vi) Standard Deviation Profit, } \sigma_P &= \sigma_Q \times \text{CMPU} \\ &= 917 \times 100 = \text{Rs. } 91,700\end{aligned}$$

(vii) Probability at Least Break-even units

$$\begin{aligned}Z &= \frac{X - \mu_Q}{\sigma_Q} \\ &= \frac{6,000 - 6,600}{916.52} \\ &= - 0.65\end{aligned}$$



From z table, the probability of sales units lies in between 6,000 units to 6,600 units = 0.2422

$$\begin{aligned}\therefore \text{Probability at least break-even sales} &= 0.50 + 0.2422 \\ &= 0.7422 \text{ or } 74.22\%.\end{aligned}$$

(viii) Probability of Incurring Losses

The probability of at least break-even = 0.7422 (From vii).

This is the probability of profit being greater than zero. The probability of incurring losses is the case of probability of profit less than zero i.e. loss. Hence, the probability will be :

$$= 1 - 0.7422$$

$$= 0.2578 \text{ or } 25.78\%$$

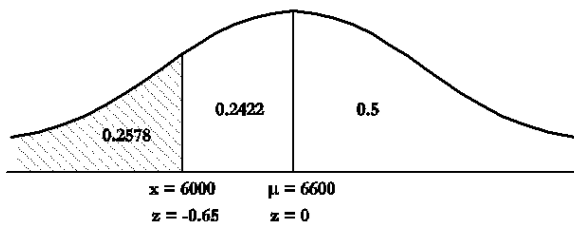
Alt.method:

$$Z = \frac{x - \text{Expected Profit}}{\sigma_P}$$

$$Z = \frac{X - \mu_P}{\sigma_P}$$

$$= \frac{0 - 60,000}{91,700}$$

$$= -0.65$$



From z table, the probability of profit lies in between Rs.0 to Rs. 60,000 = 0.2422

$$\therefore \text{Probability atleast BEP} = 0.50 + 0.2422$$

$$= 0.7422 \text{ or } 74.22\%$$

$$\therefore \text{Probability of incurring losses} = 0.50 - 0.2422$$

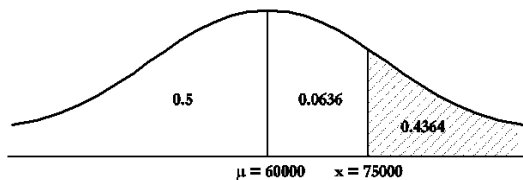
$$= 0.2578 \text{ or } 25.78\%$$

(ix) Probability of making at least Rs. 75,000 profit

$$Z = \frac{X - \mu_P}{\sigma_P}$$

$$= \frac{75,000 - 60,000}{91,700}$$

$$= 0.16$$



From z table, the probability of profit lies in between Rs.60,000 to Rs. 75,000 = 0.0636.

$$\therefore \text{Probability of making at least Rs. 75,000 profit} = 0.50 - 0.0636$$

$$= 0.4364 \text{ or } 43.64\%$$

References

Anthony, R.N., Hawkins, D.F. & Merchant, K.A. (2012). *Accounting: Text and cases*. The McGraw-Hill Companies

- Atkinson, A. A., Kaplan, R. S., Matsumura, E. M., Young, S. M., & Kumar, G. A. (2104). *Management accounting: Information for decision-making and strategy execution*. Pea\$on Education
- Colin, D. (1995). *Management and cost accounting*. ELBS, London
- Dangol, R. M. & Dangol, J. (2019). *Management accountancy*. Taleju Prakashan, Kathmandu
- Hilton. R. W. & Platt, D. E. (2014). *Managerial accounting: Creating value in a global business environment*. McGraw-Hill Education
- Horngren, C. T., Datar, G. F., Rajan, M. V., & Lttner, C. (2011). *Cost accounting: A managerial emphasis*. Pea\$on Education
- Horngren, C. T., Sundem, G. L., & Stratton, W. O. (1999). *Introduction to management accounting*. Prentice Hall India