RISK ANALYSIS 6

6.1 Origin/ Source of Project Risks

Project Risk

- Risk is a condition where there is a possibility of deviation between desired and expected outcomes.
- The term project risk means variability in project's net present worth.
- Greater project risk means greater variability in project's net present worth and risk is the potential for loss.
- Profitability estimate of an investment depends on cash flow estimations which are generally uncertain.
- It is vital to consider some of the factors that affect the uncertainty involved in the analysis of the future economic consequences of an engineering project.

Sources of Project Risk

- Inaccuracy of cash flow used in the study.
- Nature of the business involved in the economy.
- Length of the study period used in the economy.
- Rate of interest.
- Type of physical plant and equipment used.

6.2 Methods of Describing Project Risks

Methods

1. **Sensitivity Analysis**

It is a means of identifying the project variables which, when varied, have the greatest effect on project acceptability.

2. **Break-Even Analysis**

It is a means of identifying the value of a particular project variable that causes the project to exactly break even.

3. **Scenario Analysis**
It is a means of comparing a "base case" to one or more additional scenarios, such as best and worst case, to identify the extreme and most likely project outcomes.

- Because money changes value over time, it is risky to invest it.
- If you need money to do something, you will need to convince someone to finance your project. **Investor will want something in return as:**
  - **Equity Financing:** Investor owns part of assets, gets part of the profit or gets (part) of their asset.
  - **Debt Financing:** Investor gets a specified amount of money for their risk within a specified time.
  - **Angel Financing:** Investor gets a token they value.
  - **The Expectation is:** Higher Risk means Higher Return.

6.2.1 Sensitivity Analysis

It is a means of identifying the project variables which, when varied, have the greatest effect on project acceptability.

- The purpose of sensitivity analysis is to refine the decision model.
  - What makes a difference in each decision?
  - Provide guidance for the development of a requisite decision model.
- Eagle Airlines Example.

Engineering economy estimates of parameters such as costs and other cash flow are only an approximation of reality. The realized future value of a parameter will be generally different from its estimated value.

Sensitivity analysis:

- Attempts to measure the effect of this uncertainty (variability) in parameters estimates.
- Identifies parameters that have the most impact on an economic decision.
- Identifies the parameters with the highest sensitivity.
- Sensitivity of a parameter is the effect of changing the parameter value on the economic criteria such as PW value.

Graphical Sensitivity Analysis

- Sensitivity analysis is often done graphically by plotting the economic criteria as a function of a parameter.

- The plot is over the range where the parameter is most likely to vary.
- A flat plot indicates insensitivity.
- That is, the parameter has little effect on the economic decision. No need to get very precise estimates for its value.
- A highly variable plot indicates high sensitivity.
- That is, the parameter has a significant impact on economic decision. Estimating its value should be handled with care.

Example 6.1

A proposal is described by the following estimates, P= Rs 20,000, SV=0, N= 5 and net annual receipt= Rs7,000. A rate of return of 10% is desired on such proposals. Construct a sensitivity graph of the life, annual receipts and rate of return for deviations over a range of ± 20%. To which element is the decision most sensitive. **TU-2069**

Solution: We have given,
Initial Investment = P = Rs 20,000
Salvage value = SV = 0
Useful life = n = 5
Net annual receipt = R = Rs 7,000

1. Present Worth When Useful Life (n) Varies

SN	Deviation % d	n = d × n = (1 ± d) × 5	Present Worth (PW) $= -P + R\,(P/A, i\%, n)$ $= -20{,}000 + 7{,}000\,\frac{(1+0.1)^n - 1}{0.1(1+0.1)^n}$
1.	+ 20%	6	10,487
2.	0	5	6,536
3.	− 20%	4	2,189

2. Present Worth When Annual Receipt (R)) Varies

SN	Deviation % d	R = (1 ± d) × R = (1 ± d) × 7,000	Present Worth (PW) $= -P + R\,(P/A, i\%, n)$ $= -20000 + R\,(P/A, 10\%, 5)$ $= -20000 + R \times 3.7908$
1	+ 20%	8,400	11,843
2	0	7,000	6,536
3	− 20%	5,600	1,228

3. Present Worth When Rate of Return (i)) Varies

S N	Deviation % d	i = (1 ± d) × R = (1 ± d) ×10%	Present Worth (PW) = − P + R (P/A, i%, n) $= -20{,}000 + 7{,}000 \frac{(1+i)^n - 1}{i(1+i)^n}$ $= -20{,}000 + 7{,}000 \frac{(1+i)^5 - 1}{i(1+i)^5}$
1	+ 20%	12%	5,233
2	0	10%	6,536
3	− 20%	8%	7,949

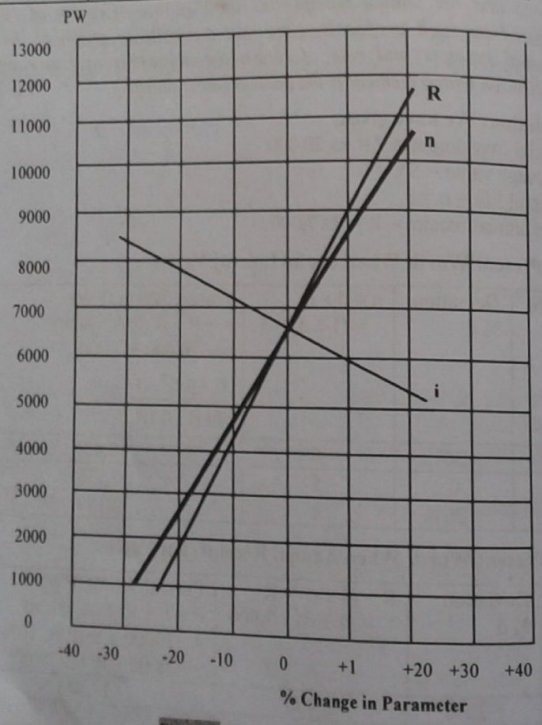


Fig. 6.1: *Sensitivity Graph..*

Result

Since, revenue (R) parameter of the project is highly steeper followed by useful life (n) and interest (i). Therefore, R and n are sensitive.

6.2.2 Break Even Analysis

- Breakeven point is the point at which revenue is exactly equal to costs.
- Corresponding to the breakeven point, profit or loss can be determined.
- Breakeven point governs the economic acceptability of the project or the alternative.
- The breakeven point between expenditure and revenue for a single alternative is shown in figure below.
- Where, 'Q' is the factor that mainly affects the expenditure and revenue of the alternative.

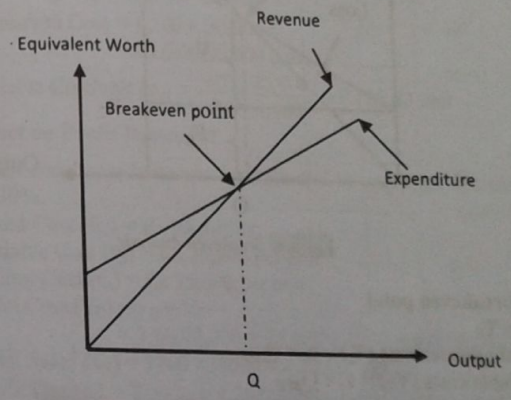


Fig. 6.2: *Breakeven Point of a Single Alternative.*

Breakeven Analysis for a Single Project

Breakeven analysis is based on two types of costs as:

Fixed Costs (F_C)

- If costs do not change appreciably with fluctuations in business activity, they are fixed costs.
- For example land costs, equipments costs, buildings costs, plants costs, insurance costs, taxes on facilities, administrative salaries, rental payments and initial setup or installation, etc.

Variable Costs (V_C)

- If costs change appreciably with fluctuations in business activity, they are variable.
- For example labour costs, raw materials costs, fuel costs, unit transportation costs, etc.

Total Costs (T_C)

- It is the sum of fixed cost and variable costs.
- Total Costs = Fixed Costs + Variable Costs ($T_C = F_C + V_C$)

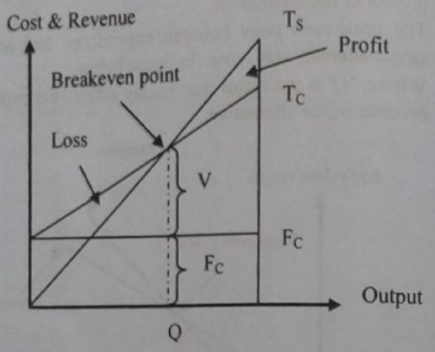


Fig. 6.3. *Breakeven Analysis.*

At breakeven point

$T_C = T_S$

Total sales revenue (T_s) = $c_s \times Q_{BEP}$

Variable costs (V_C) = $v_c \times Q_{BEP}$

$T_C = F_C + V_C$

Or, $c_s \times Q_{BEP} = F_C + v_c \times Q_{BEP}$

$$Q_{BEP} = \frac{FC}{cs - vc}$$

Where, T_C = total cost.

F_C = fixed cost.

V_C = variable cost.

c_s = selling price/unit.

v_c = variable cost/unit

Example 6.2

Find BEP both in units and values. What would be the effect on profit/loss when fixed cost increases by 20% and selling price decreases by 30%.

Fixed Cost = Rs 30 million

Variable Cost = Rs 25,000 per unit

Selling Price = Rs 50,000 per unit

Solution: Given,

Fixed Cost (F_C) = Rs 30 million

Variable Cost (V_c) = Rs 25,000 per unit

Selling Cost (c_s) = Rs 50,000 per unit

a. Breakeven Point (Q_{BEP}) =?

We have,

$$Q_{BEP} = \frac{F_C}{C_s - V_c} = \frac{30,000,000}{50,000 - 25,000} = \textbf{1,200 units Ans.}$$

Breakeven Cost = 1,200 × 50,000

= Rs 6,00,00,000 **Ans.**

$$\text{Variable Cost/unit } (v_c) = \frac{VC}{Q} = \frac{25,000}{1,200} = \text{Rs } 20.83 \text{ unit}$$

b. **Effect on Profit Desired=?**

When fixed cost increases by 20% and selling price decreases by 30%.

Fixed Cost (F_C) = Rs 36 million

Variable Cost (v_c) = Rs 25,000 per unit

Selling Cost (c_s) = Rs 35,000 per unit

Total Cost (T_C) = $F_C + V_C$

= 3,60,00,000 + 25,000 × 1200 = 6,60,00,000

Total Sales (T_S) = 1200 ×35000 = 4,20,00,000

Profit Desired = $T_S - T_C$ = 4,20,00,000 – 6,60,00,000

= – Rs 2,40,00,000

There would be loss when fixed cost increase by 20% and selling price decreases by 30% **Ans.**

Breakeven Analysis for Comparing Two Alternatives

- The breakeven analysis is also used for comparing two alternatives by determining the breakeven point.
- The examples of some of the factors which are used in the breakeven analysis are quantities produced per year, hours of

operation per year, rate of return per year, useful life, salvage value, equipment life, annual revenue and expenses, etc.

- The breakeven values of these factors are calculated to find out the economical acceptability of a single alternative or to select the best one between the alternatives.

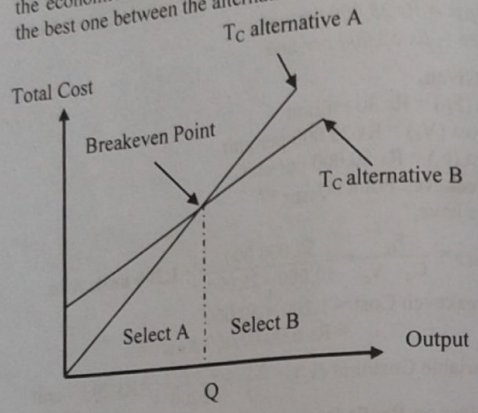


Fig. 6.4: *Breakeven Analysis of Mutually Exclusive Projects.*

Procedure to Determine Breakeven Point of Common Variable

- Define common variables and its dimensional units.
- PW and AW analysis is used to the total cost of each alternative.
- Equate the two relations and solve for breakeven value of variable.
- **If anticipated level is:**
  - Below than the breakeven value then select the alternative with the higher variable cost.
  - Above than breakeven value then select the alternative with lower variable cost.

Example 6.3

From the following information, find that how many hours/ year would the motors have to be operated at full load for annual costs to be equal? If annual operation hour is 50 hours which motor should be selected?

	Motor A	Motor B
Purchase Cost	1,25,000	Rs 1,60,000
Efficiency	74%	92%
Life	10 Years	10 Years
Maintenance Cost	Rs 5,000/ Year	Rs 2,500/ Year

Annual tax and insurance 1.5% of investment for both motors and electricity cost Rs 5/ KW hours. Power of both motors =100 hp. Use MARR= 12%.

Solution:

For Motor A

Investment = Rs 1,25,000
Insurance = 1,875 year
Maintenance cost = Rs 5,000/ Year
We have,

$$\text{Efficiency } (\eta) = \frac{\text{Input}}{\text{Output}}$$

$$\text{Or, Input} = \frac{\text{Output}}{\text{Efficiency}}$$

Let us consider number of hours of operation per year = x
Electricity cost = Rs 5/ kwhr.

$$\text{Operating expenses for power} = \text{Input} \times \text{Rate} \times \text{Hour}$$

$$= \frac{\text{Output}}{\text{Efficiency}} \times \text{Rate} \times \text{Hour}$$

$$= \frac{100}{0.74} \times 0.746 \times 5 \times x$$

$$= 504.05\ x$$

Calculation of Annual Equivalent Cost (AW)

AW_A= 1,25,000 (A/P, 12%, 10) + 5,000 + 1,875+ 504.05x
= 1,25,000 (0.177) + 5,000 + 1,875+ 504.05x
= 29,000 + 504.05x.....(1)

For Motor B

Investment = Rs 1,60,000
Insurance = Rs 2,400
Maintenance cost = Rs 2,500/ Year
We have,

$$\text{Efficiency } (\eta) = \frac{\text{Input}}{\text{Output}}$$

$$\text{Or, Input} = \frac{\text{Output}}{\text{Efficiency}}$$

Let us consider number of hours of operation per year = x
Electricity cost = Rs 5/ kwhr.

$$\text{Operating expenses for power} = \text{Input} \times \text{Rate} \times \text{Hour}$$
$$= \frac{\text{Output}}{\text{Efficiency}} \times \text{Rate} \times \text{Hour}$$
$$= \frac{100}{0.92} \times 0.746 \times 5 \times x$$
$$= 405.43\ x$$

Calculation of Annual Equivalent Cost (AW)

AW_B= 1,60,000 (A/P, 12%, 10) + 2,500 + 2,400+ 405.43x
= 1,60,000 (0.177) + 2,500 + 2,400+ 405.43x
= 33,220 + 405.43x .....(2)

At breakeven point
$AW_A = AW_B$
Or, 29,000 + 504.05x = 33,220 + 405.43x
Or x= 42.8

Therefore, 42.8 hours/ year would the motors have to be operated at full load for annual costs to be equal **Ans.**

If x = 50 hours
AW_A = 29,000 + 504.05x = 29,000 + 504.05 × 50
= **Rs 54,202.5**

AW_B = 33,220 + 405.43x = 33,220 + 405.43× 50
= **Rs 53,491.5**

Here AW is terms of cost.

Since, $AW_B < AW_A$. Therefore, motor B be selected **Ans.**

6.2.3 Scenario Analysis

- A procedure of comparing a "base case" to one or more additional scenarios, such as best and worst cases, to identify the extreme and most likely project outcomes.
- The objective of scenario analysis is to get a feel of what happens under the most favorable or the most adverse configuration of key variables, without bothering much about the internal consistency of such configurations.

Procedure

The steps involved in scenario analysis are as follows:

1. Select the factor around which scenarios will be built.
2. The factor chosen must be the largest source of uncertainty for the success of the project. It may be the state of the economy or interest rate or technological development or response of the market.
3. Estimate the values of each of the variables in investment analysis (investment outlay, revenues, costs, project life, and so on) for each scenario.
4. Calculate the net present value and/or internal rate of return under each scenario.

Example 6.4

From the information given below calculate the NPV for each scenario use MARR=20%.

	Scenario 1	*Scenario 2*	*Scenario 3*
Initial Investment (Rs)	*400*	*400*	*400*
Unit Selling Price (Rs)	*50*	*30*	*80*
Demand (Units)	*40*	*80*	*20*
Variable Costs (Rs / Unit)	*24*	*24*	*24*
Fixed Cost (Rs)	*100*	*100*	*100*
Depreciation (Rs)	*40*	*40*	*40*
Tax (%)	*@ 35%*	*@ 35%*	*@ 35%*
Project Life (year)	*20*	*20*	*20*

Solution:

	Scenario 1	**Scenario 2**	**Scenario 3**
Initial Investment	400	400	400
Unit Selling Price	50	30	80
Demand (Units)	40	80	20
Sales Revenue	2,000	2,400	1,600
Variable Costs (Rs / Unit)	24	24	24
Variable Cost	960	1920	480
Fixed Cost	100	100	100
Depreciation	40	40	40
Pre- tax profit	900	340	980
Tax @ 35%	315	119	343
Profit After Tax	585	221	637
Net Cash Flow	625	261	677
Project Life	20	20	20

Scenario 1
NPV = – 400 + 625 (P/A, 20%, 20) = – 400 + 625 (4.869)
= Rs 2643.12

Scenario 2
NPV = – 400 + 261 (P/A, 20%, 20) = – 400 + 261 (4.869)
= Rs 870.80

Scenario 3
NPV = – 400 + 677 (P/A, 20%, 20) = – 400 + 677 (4.869)
= Rs 2,896.31

Best and Worst Case Analysis

In the above illustration, an attempt was made to develop scenarios in which the values of variables were internally consistent. For example, high selling price and low demand typically go hand in hand. Firms often do another kind of scenario analysis are considered: Best case and worst case analysis. In this kind of analysis the following scenarios are considered:

Best Scenario: High demand, high selling price, low variable cost, and so on.

Normal scenario: Average demand, average selling price, average variable cost, and so on.

Worst Scenario: Low demand, low selling price, high variable cost, and so on.

Evaluation

- Scenario analysis may be regarded as an improvement over sensitively analysis because it considers variations in several variables together.
- It is based on the assumption that there are few well-delineated scenarios. This may not be true in many cases. For example, the economy does not necessarily lie in three discrete states, viz., recession, stability, and boom. It can in fact be anywhere on the continuum between the extremes. When a continuum is converted into three discrete states some information is lost.
- Scenario analysis expands the concept of estimating the expected values. Thus in a case where there are 10 inputs the analyst has to estimate 30 expected values (3 x 10) to do the scenario analysis.

6.3 Decision Tree and Sequential Investment Decision

- A decision tree is a graphical device that shows a sequence of strategic decisions and the expected consequences under each possible set of circumstances.
- It is constructed from left to right and includes each possible decision and outcome.
- It facilitates the analysis of important problems that involve sequential series of conditional decisions and variable outcomes over time.
- Decision trees help companies determine their options by showing the various choices and outcomes as:
  - The option to avoid a loss or produce extra profit has value.
  - The ability to create an option thus has value that can be bought or sold.

Components of Decision Tree

Decision Node: A square represents a decision node for making decision by a decision maker.

Branch: It is a line connecting nodes from the left to the right of the diagram.

Probability Node: A circle represents probability node with the possible outcomes and estimated probabilities on the branches.

Procedure for Solving Decision Tree

- Draw the decision tree diagram.
- Determine PW for each outcome branch starting form right top of the tree.
- Calculate the expected value for each decision alternatives.
- Select the best alternative.

Probability Tree Approach

- It is a graphic or tabular approach for organizing the possible cash-flow streams generated by an investment.
- The presentation resembles the branches of a tree.
- Each complete branch represents one possible cash-flow sequence.

Example 6.5

A company establishing three sell branches each will have establishment cost of Rs 90,000. From the preliminary survey following data are obtained. Determine the best decision.

Sell Branch 1		Sell Branch 2		Sell Branch 3	
Probability	Income	Probability	Income	Probability	Income
0.1	4,000	0.35	9,000	0.1	5,000
0.6	4,000	0.4	6,000	0.5	1,000
0.3	9,000	0.25	3,000	0.4	7,000

Solution:

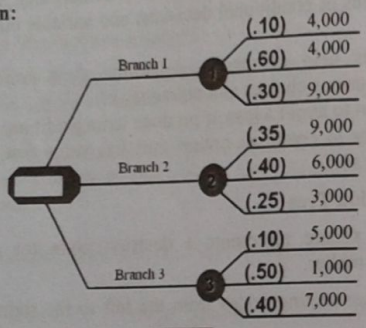


Fig. 6.5: *Decision Tree Diagram.*

Branch 1		Expected Return	Branch 2		Expected Return	Branch 3		Expected Return
Prob.	Income		Prob.	Income		Prob.	Income	
0.1	4,000	400	0.35	9,000	3,150	0.1	5,000	500
0.6	4,000	2,400	0.4	6,000	2,400	0.5	1,000	500
0.3	9,000	2,700	0.25	3,000	750	0.4	7,000	2,800
Expected Return from branch1		**5,500**	Expected Return from branch 2		**6,300**	Expected Return from branch 3		**3,800**

Since sell branch 2 has largest expected return. Therefore, select sell branch 2 **Ans.**

Example 6.6

Perform sensitivity analysis by IRR using FW formulation (With increment of 10%) over a range of ± 30% in

a. Useful life
b. Investment

Take MARR=10%

Project	First Cost	Annual Benefits	Annual Expenses	Salvage Value	Useful Life
A	Rs 3,00,000	Rs 1, 50,000	Rs 25,000	10% of 1st cost	10 Years

Solution: Given
First Cost = I= Rs 3, 00,000
Annual Benefits = Rs 1, 50,000
Annual Expenses = Rs 25,000
Salvage Value = Rs 30,000
Useful Life = 10years

$$FW = -3,00,000\,(F/P, i\%, n) + (1,50,000-25,000)\,(F/A, i\%, n) + 30,000$$

$$= -3,00,000\,(1+i)^n + 1,25,000\left\{\frac{(1+i)^n-1}{i}\right\} + 30,000$$

a. IRR When Useful Life (n) Varies

SN	Deviation % d	n = d × n = (1 ± d) × 10	$FW = -3,00,000\,(1+i)^n + 1,25,000\left\{\frac{(1+i)^n-1}{i}\right\} + 30,000 = 0$
1.	+ 30%	13	41.25%
2.	+ 20%	12	41.07%
3	+ 10%	11	40.79%
4	0%	10	40.40%
5	– 10%	9	39.85%
6	– 20%	8	38.95%
7	– 30%	7	37.63%

b. IRR When Investment (I)) Varies

SN	Deviation % d	i = (1 ± d) × I =(1 ± d) 3,00,000	$FW = -I\,(1+i)^{10} + 1,25,000\left\{\frac{(1+i)^{10}-1}{i}\right\} + 30,000 = 0$
1.	+ 30%	3,90,000	29.85%
2.	+ 20%	3,60,000	32.84%

3	+ 10%	3,30,000	36.25%
4	0%	3,00,000	40.4%
5	−10%	2,70,000	45.26%
6	− 20%	2,40,000	51.36%
7	− 30%	2,10,000	59.03%

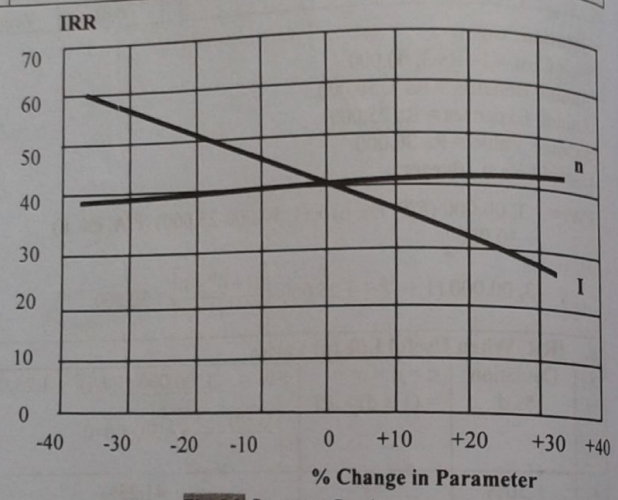


Fig. 6.6: *Sensitivity Graph.*

Result

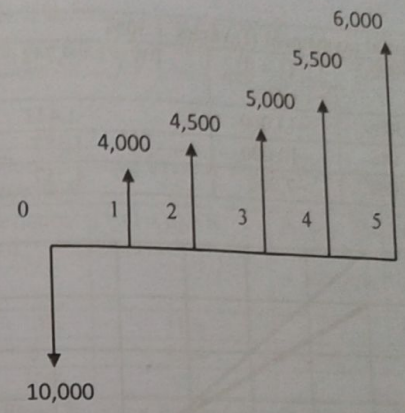
Since, investment (I) curve is steeper than useful life (n). Therefore, I is sensitive than n.

Additional Solved Examples

Example 6.1

Draw sensitivity chart using PW formulation of the following cash information. It is desired to evaluate the sensitivity of PW to ± 30% changes on: **TU-2072**

i. Interest
ii. Investment



Solution:

Let MARR = 30%

PW = −10,000 + 4,000 (P/A 30%, 5) + 500 (P/G, 30%, 5)

$$= -10,000 + 4,000 \left\{\frac{(1+i)^n - 1}{i(1+i)^n}\right\} + 500 \left\{\frac{(1+i)^n - 1 - ni}{i^2(1+i)^n}\right\}$$

= −10,000 + 4,000 (2.4355) + 500 (3.63)

= − 10,000 + 9,742 + 1815 = 1557

i. When Rate of Return (i)) Varies ± 30%

S N	Deviation % d	i = (1 ± d) × ROR = (1 ± d) × 30%	Present Worth (PW) = − 10,000 + 4,000 $\left\{\frac{(1+i)^5 - 1}{i(1+i)^5}\right\}$ + 500 $\left\{\frac{(1+i)^5 - 1 - 5i}{i^2(1+i)^5}\right\}$
1	+ 30%	39%	= − 10,000 + 4,000 (2.07) + 500 (2.836) = − 302
2	0%	30%	= − 10,000 + 4,000 (2.4355) + 500 (3.63) = 1557
3	− 30%	21%	= − 10,000 + 4,000 (2.926) + 500 (4.7537) = 4,080.85

ii. When initial investment (I) varies ± 30%			
SN	Deviation % d	I = (1 ± d) × −10,000	PW = I + 9,742 + 1,815
1	+ 30%	−13,000	−1,443
2	0%	−10,000	1,557
3	− 30%	−7,000	4,557

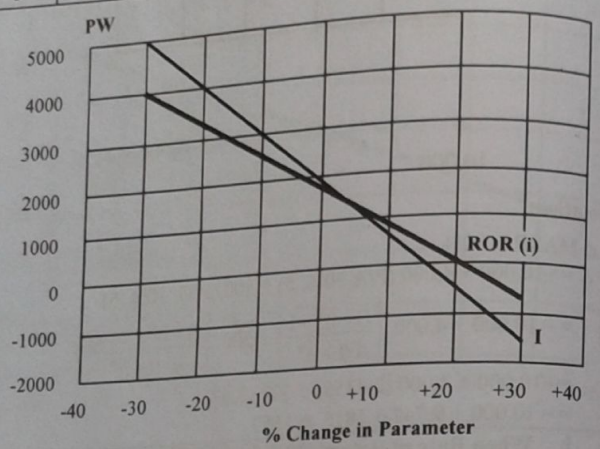


Fig. 6.7: *Change in Parameter..*

Result

Since, investment (I) curve is steeper than rate of return (ROR). Therefore, I is sensitive than ROR.

Example 6.2

A real-state developer seeks to determine the most economical height for a new office building which will be sold after five years. The relevant net annual revenues and net resale values are given below. **TU-2070**

	Height	
	4 Floors	*5 Floors*
First Cost	*12,50,00,000*	*20,00,00,000*
Annual Revenues	*1,99,10,000*	*3,78,15,000*
Net resale Value	*2,00,000,000*	*30,00,00,000*

The developer is uncertain about the interest rate i to use, but is certain that it is in the range of 5 to 30%. For each building height, find the range of values of i for which that building height is the most economical.

Solution:

1. For 4 Floor Building Present Worth When Rate of Return (i)) Varies (000000)			
SN	Deviation % d	i = (1 ± d) × R = (1 ± d) ×10%	Present Worth (PW) = −125 +19.91 (P/A, i%, 5) + 200 (P/F, i%, 5)
1	+ 10%	11%	67
2	0	10%	75
3	− 10%	9%	82

2. For 5 Floor Building Present Worth When Rate of Return (i)) Varies (000000)			
SN	Deviation % d	i = (1 ± d) × R = (1 ± d) ×10%	Present Worth (PW) = − 200 + 37.815 (P/A, i%, 5)+ 300 (P/F, i%, 5)
1	+ 10%	11%	117
2	0	10%	130
3	−10%	9%	141

Examples 6.3

A company has decided to build a factory on a particular site. There are two mutually exclusive proposals that have been developed for the main factory. There are also three secondary proposals for the main project. The present worth of the benefits and costs are shown below. Which combinations of projects are best if the company can only spend Rs 4,00,000?

Main Proposal

Project	*Benefits*	*Costs*	*B/C Ratio=Benefit/Cost*
A	*3,00,000*	*1,50,000*	*2.0*
B	*4,50,000*	*2,50,000*	*1.8*

Secondary Proposal

Project	*Benefits*	*Costs*
1	*75,000*	*50,000*
2	*1,40,000*	*1,00,000*
3	*3,00,000*	*1,50,000*

Solution:

All the possible combinations with cost less that Rs 4,00,000 are ranked in order in the following table:

Combination	Benefits	Costs	B-C	B/C Ratio = Benefit/Cost
C_1 (A,1,2)	A + 1 +2 = 5,15,000	A + 1 + 2 = 3,00,000	215000	1.72
C_2 (A, 3)	6,00,000	3,00,000	3,00,000	2
C_3 (A,1,3)	6,75,000	3,50,000	3,25,000	1.93
C_4 (A, 2,3)	7,40,000	4,00,000	3,40,000	1.85
C_5 (B,1,2)	6,65,000	4,00,000	3,65,000	1.66
C_6 (B, 3)	7,50,000	4,00,000	3,50,000	1.87

Since all B/C ratios of all combinations are greater than one, then we will compare all alternatives.

Since alternatives C_1 and C_2 have the same costs while benefits of alternative C_2 is greater, then choose C_2.

$C_3 - C_2$

$$\text{B/C ratio} = \frac{\Delta B}{\Delta C} = \frac{75,000}{50,000} = 1.5$$

Accept C_3

$C_4 - C_3$

$$\text{B/C ratio} = \frac{\Delta B}{\Delta C} = \frac{65,000}{50,000} = 1.3$$

Accept C_4

$C_6 - C_3$

$$\text{B/C ratio} = \frac{\Delta B}{\Delta C} = \frac{75,000}{50,000} = 1.5$$

Accept C_6

Examples 6.4

Calculate breakeven volume of a cable manufacturing company from the following data: **TU-2069**

Total Cost = Rs 12,00,000

Variable Cost = Rs 4,00,000

Income from sale = Rs 15,00,000 at production of 5,000 units

Solution: Given,

Total Cost (T_C) = Rs 12,00,000

Total Variable Cost (V_C) = Rs 4,00,000

Total Sales (T_S) = Rs 15,00,000

Production Quantity (Q) = 5,000 units

Breakeven Point Quantity (Q_{BEP}) =?

We know,

$T_C = F_C + V_C$

Or, $F_C = T_C - V_C$

$= 12,00,000 - 4,00,000 = \text{Rs } 8,00,000$

Again,

$$\text{Per Unit Variable Cost } (C_V) = \frac{VC}{Q} = \frac{4,00,000}{5,000} = \text{Rs } 80/\text{unit}$$

$$\text{Per unit Selling Cost } (C_S) = \frac{TS}{Q} = \frac{15,00,000}{5,000} = \text{Rs } 300/\text{unit}$$

$$Q_{BEP} = \frac{F_C}{C_s - C_V} = \frac{8,00,000}{300 - 80}$$

$= 3636.3$ units **Ans.**

Example 6.5

A company produces an electronic timing switch that is used in consumer and commercial products made by several other manufacturing firms. The fixed cost and the total cost are Rs 40,000 and Rs 85,000 respectively. The total sales are Rs 1,05,000 and sales volume is 15,000 for this situation. **TU-2072**

a. Find breakeven point in terms of number of units

b. What should be the output if the profit desired is Rs 50,000?

Solution: Given,

Fixed Cost (F_C) = 40,000

Total Cost (T_C) = 85,000

Total Sales (T_S) = 1,05,000

Sale Volume (Q) = 15,000 units

a. Breakeven Point (Q_{BEP}) =?

We know,

$T_C = F_C + V_C$

Or, $V_C = T_C - F_C$

$= 85,000 - 40,000$

$= 45,000$

Again,

Variable Cost/unit (V_c) = $\frac{VC}{Q} = \frac{45,000}{15,000}$ = Rs 3/unit

Selling Cost/ unit (S_c) = $\frac{TS}{Q} = \frac{1,05,000}{15,000}$ = Rs 7/unit

$Q_{BEP} = \frac{F_C}{C_S - C_V} = \frac{40,000}{7-3}$

= 10,000 units **Ans.**

b. Profit Desired = 50,000

Output (Q) = ?

Total Sales (T_S) = $Q \times S_c = 7Q$

Total Cost (T_C) = $F_C + V_C$

$= 40,000 + Q \times V_c$

$= 40,000 + 3Q$

Profit Desired= $T_S - T_C$

Or, $50,000 = 7Q - 40,000 - 3Q$

Or, $Q = 22,500$

Therefore, desired output = Q = 22,500 units **Ans.**

Questions

1. Perform sensitivity analysis of the following project over a range of ± 30 in
   a. Initial investment
   b. Net annual revenue
   c. Useful life in year.

   Draw also sensitivity diagram.

Initial Investment	5,00,000
Net annual revenue	1,20,000
Salvage Value	80,000
Useful life in year	6
MARR	10%

2. An investor is considering buying some land for Rs 1,00,000 and constructing an office building on it. Three different buildings are being analyzed.

	Building Height		
	2stories	3 stories	10 stories
Cost of building (excluding cost of land)	4,00,000	8,00,000	2,01,00,000
Resale value * of land and building at the end of 20 year analysis period	2,00,000	3,00,000	4,00,000
Annual rental income after deducting all operating expenses	7,00,000	1,05,000	2,56,000

*Resale value to be considered a reduction in cost, rather than a benefit.

Using benefit cost ratio analysis and an 8% MARR, determine which alternative should be selected.

3. Perform sensitivity analysis over a range of ± 30% in i. Initial investment ii. Annual net revenue iii. Useful life.

Initial Investment Rs	1,00,000
Annual Benefits Rs	25,000
Annual Expenses Rs	3,000
Salvage Value Rs	10,000
Useful Life	10 years
MARR	10%

Draw sensitivity diagram and interpret the result.

4. What do you understand by breakeven analysis? Explain with a suitable example.
5. What is breakeven point? Explain the uses of breakeven point analysis in the business.
6. What is breakeven analysis? Explain why a manufacturing company needs to determine the breakeven point quantity?
7. Write Short notes.
   a. Break even analysis.
   b. Scenario analysis.
   c. Decision Tree.