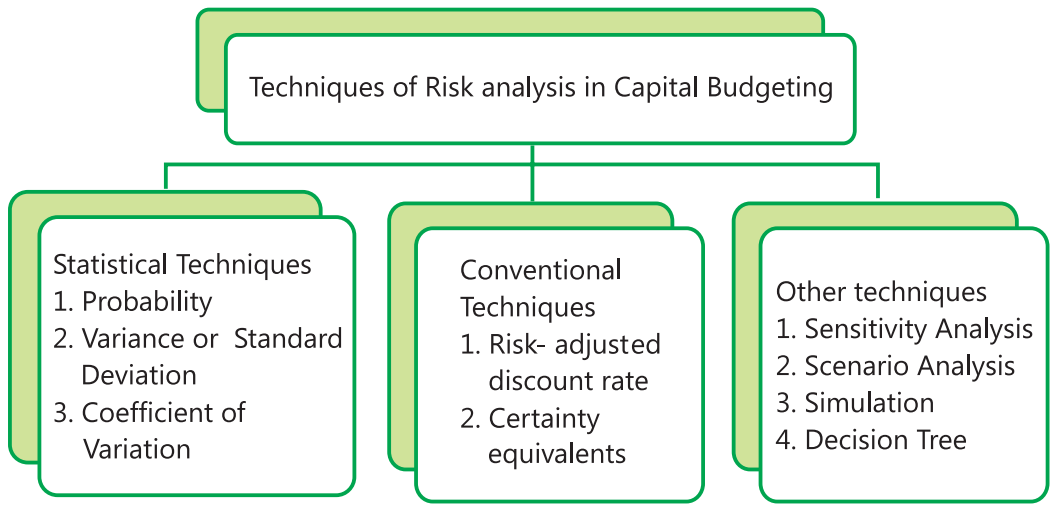
CHAPTER 8

RISK ANALYSIS IN CAPITAL BUDGETING

LEARNING OUTCOMES

- Discuss the concept of Risk and Uncertainty in Capital Budgeting.
- Discuss the Sources of Risk.
- Understand reasons for adjusting risk in Capital Budgeting.
- Understand various techniques used in Risk Analysis in Capital Budgeting.
- Discuss Concepts, Advantages and Limitations of various techniques of Risk analysis in Capital Budgeting.

CHAPTER OVERVIEW



8.1. INTRODUCTION TO RISK ANALYSIS IN CAPITAL BUDGETING

While discussing the capital budgeting techniques in chapter 7, we have assumed that the investment proposals do not involve any risk and cash flows of the project are known with certainty. This assumption was taken to simplify the understanding of the capital budgeting techniques. However, in practice, this assumption is not correct. In fact, investment projects are exposed to various degrees of risk. There can be three types of decision making:

(i) Decision making under certainty : When cash flows are certain

(ii) Decision making involving risk : When cash flows involve risk and probability can be assigned.

(iii) Decision making under uncertainty : When the cash flows are uncertain and probability cannot be assigned.

8.2. RISK AND UNCERTAINTY

Risk is the variability in terms of actual returns comparing with the estimated returns. Most common techniques of risk measurement are Standard Deviation and Coefficient of variations. There is a thin difference between risk and uncertainty. In case of risk probability distribution of cash flow is known. When no information is known to formulate probability distribution of cash flows, the situation is referred as uncertainty. However these two terms are used interchangeably.

8.3. SOURCES OF RISK

Risk arises from different sources, depending on the type of investment being considered, as well as the circumstances and the industry in which the organisation is operating. Some of the sources of risk are as follows

1. **Project-specific risk-** Risks which are related to a particular project and affects the project's cash flows, it includes completion of the project in scheduled time, error of estimation in resources and allocation, estimation of cash flows etc. For example, a nuclear power project of a power generation company has different risks than hydel projects.
2. **Company specific risk-** Risk which arise due to company specific factors like downgrading of credit rating, changes in key managerial persons, cases for violation of Intellectual Property Rights (IPR) and other laws and regulations, dispute with workers etc. All these factors affect the cash flows of an entity and access to funds for capital investments. For example, two banks have different exposure to default risk.

3. **Industry-specific risk-** These are the risks which effects the whole industry in which the company operates. The risks include regulatory restrictions on industry, changes in technologies etc. For example, regulatory restriction imposed on leather and breweries industries.
4. **Market risk –** The risk which arise due to market related conditions like entry of substitute, changes in demand conditions, availability and access to resources etc. For example, a thermal power project gets affected if the coal mines are unable to supply coal requirements of a thermal power company etc.
5. **Competition risk-** These are risks related with competition in the market in which a company operates. These risks are risk of entry of rival, product dynamism and change in taste and preference of consumers etc.
6. **Risk due to Economic conditions –** These are the risks which are related with macro-economic conditions like changes in monetary policies by central banks, changes in fiscal policies like introduction of new taxes and cess, inflation, changes in GDP, changes in savings and net disposable income etc.
7. **International risk –** These are risk which are related with conditions which are caused by global economic conditions like restriction on free trade, restrictions on market access, recessions, bilateral agreements, political and geographical conditions etc. For example, restriction on outsourcing of jobs to overseas markets.

8.4. REASONS FOR ADJUSTMENT OF RISK IN CAPITAL BUDGETING DECISIONS

Main reasons for considering risk in capital budgeting decisions are as follows

1. There is an opportunity cost involved while investing in a project for the level of risk. Adjustment of risk is necessary to help make the decision as to whether the returns out of the project are proportionate with the risks borne and whether it is worth investing in the project over the other investment options available.
2. Risk adjustment is required to know the real value of the Cash Inflows.

8.5. TECHNIQUES OF RISK ANALYSIS IN CAPITAL BUDGETING

Techniques of risk analysis in capital budgeting can be classified as below:

A. Statistical Techniques
   - Probability
   - Variance or Standard Deviation
   - Coefficient of Variation

B. Conventional techniques
   - Risk-adjusted discount rate
   - Certainty equivalents

C. Others techniques
- Sensitivity analysis
- Scenario analysis
- Simulation
- Decision tree

8.6. STATISTICAL TECHNIQUES

8.6.1. Probability

Meaning: Probability is a measure about the chances that an event will occur. When an event is certain to occur, probability will be 1 and when there is no chance of happening an event probability will be 0.

Example:

Assumption	Cash Flows (₹)	Probability
Best guess	3,00,000	0.3
High guess	2,00,000	0.6
Low guess	1,20,000	0.1

In the above example chances that cash flow will be 3,00,000, 2,00,00 and 1,20,000 are 30%,60% and 10% respectively.

(i) Expected Net Cash Flows

Expected Cash flows are calculated as the sum of the likely Cash flows of the Project multiplied by the probability of cash flows. Expected Cash flows are calculated as below:

$$E(R)/ENCF = \sum_{i=1}^{n} R_i \times P_i$$

Where, E (R)/ENCF = Expected Cash flows

P_i = Probability of Cash flow

R_i = Cash flows

Example:

Assumption (1)	Cash Flows (₹) (2)	Probability (3)	Expected cash flow(2*3)(₹)
Best guess	3,00,000	0.3	3,00,000 × .3= 90,000
High guess	2,00,000	0.6	2,00,000 × .6=1,20,000
Low guess	1,20,000	0.1	1,20,000 × .1=12,000
Expected Net cash flow (ENCF)			2,32,000

(ii) Expected Net Present Value

Expected net present value = Sum of present values of expected net cash flows

$$ENPV = \sum_{t=1}^{n} \frac{ENCF}{(1+k)^t}$$

Where, ENPV is the expected net present value, ENCF, expected net cash flows (including both inflows and outflows) in period t and k is the discount rate.

(a) Expected Net Present Value-Single period

ILLUSTRATION 1

Possible net cash flows of Projects A and B and their probabilities are given as below. Discount rate is 10 per cent for both the project initially investment is ₹ 10,000. Calculate the expected net present value for each project. Which project is preferable?

Project A			Project B	
Possible Event	Cash Flow (₹)	Probability	Cash Flow (₹)	Probability
A	8,000	0.10	4,000	0.10
B	10,000	0.20	20,000	0.15
C	12,000	0.40	16,000	0.50
D	14,000	0.20	12,000	0.15
E	16,000	0.10	8,0,000	0.10

Solution :

Calculation of Expected Value for Project A and Project B

Project A				Project B		
Possible Event	Net Cash Flow (₹)	Probability	Expected Value (₹)	Cash Flow (₹)	Probability	Expected Value (₹)
A	8,000	0.10	800	4,000	0.10	400
B	10,000	0.20	2,000	20,000	0.15	3,000
C	12,000	0.40	4,800	16,000	0.50	8,000
D	14,000	0.20	2,800	12,000	0.15	1,800
E	16,000	0.10	1,600	80,000	0.10	800
ENCF			12,000			16,000

The net present value for Project A is (0.909 × ₹ 12,000 – ₹ 10,000) = ₹ 908

The net present value for Project B is (0.909 × ₹ 16,000 – ₹10,000) = ₹ 4,544.

(b) Expected Net Present Value-Multiple period

ILLUSTRATION 2

Probabilities for net cash flows for 3 years a project are as follows:

Year 1		Year 2		Year 3	
Cash Flow (₹)	Probability	Cash Flow (₹)	Proba-bility	Cash Flow (₹)	Probability
2,000	0.1	2,000	0.2	2,000	0.3
4,000	0.2	4,000	0.3	4,000	0.4
6,000	0.3	6,000	0.4	6,000	0.2
8,000	0.4	8,000	0.1	8,000	0.1

Calculate the expected net cash flows. Also calculate the present value of the expected cash flow, using 10 per cent discount rate. Initial Investment is ₹ 10,000.

Solution :

Year 1			Year 2			Year 3		
Cash Flow	Proba-bility	Expected Value	Cash Flow	Proba-bility	Expected Value	Cash Flow	Proba-bility	Expected Value
(₹)		(₹)	(₹)		(₹)	(₹)		(₹)
2,000	0.1	200	2,000	0.2	400	2,000	0.3	600
4,000	0.2	800	4,000	0.3	1200	4,000	0.4	1,600
6,000	0.3	1,800	6,000	0.4	2400	6,000	0.2	1,200
8,000	0.4	3,200	8,000	0.1	800	8,000	0.1	800
ENCF		6,000			4,800			4,200

The present value of the expected value of cash flow at 10 per cent discount rate has been determined as follows:

Present Value of cash flow $= \frac{ENCF_1}{(1+k)^1} + \frac{ENCF_2}{(1+k)^2} + \frac{ENCF_3}{(1+k)^3}$

$$\frac{6,000}{(1.1)^2} + \frac{4,800}{(1.1)^2} + \frac{4,200}{(1.1)^3}$$

= (6,000 × 0.909) + (4,800 × 0.826) + (4,200 + 0.751)

= 12,573

Expected Net Present value = Present Value of cash flow - Initial Investment

= ₹ 12,573 – ₹10,000 = ₹2,573.

8.6.2. Variance

Meaning

Variance is a measurement of the degree of dispersion between numbers in a data set from its average. In very simple words, variance is the measurement of difference between the average of the data set from every number of the data set. Variance is calculated as below :

$$\sigma^2 = \sum_{j=1}^{n} (NCF_j - ENCF)^2 P_j$$

σ^2 is variance in net cash flow, P is probability, ENCF expected net cash flow.

Variance measures the uncertainty of a value from its average. Thus, variance helps an organization to understand the level of risk it might face on investing in a project. A variance value of zero would indicate that the cash flows that would be generated over the life of the project would be same. This might happen in a case where the company has entered into a contract of providing services in return of a specific sum. A large variance indicates that there will be a large variability between the cash flows of the different years. This can happen in a case where the project being undertaken is very innovative and would require a certain time frame to market the product and enable to develop a customer base and generate revenues. A small variance would indicates that the cash flows would be somewhat stable throughout the life of the project. This is possible in case of products which already have an established market.

8.6.3. Standard deviation

Standard Deviation is a degree of variation of individual items of a set of data from its average. The square root of variance is called Standard Deviation. For Capital Budgeting decisions, Standard Deviation is used to calculate the risk associated with the estimated cash flows from the project.

ILLUSTRATION 3

Calculate Variance and Standard Deviation on the basis of figure given in illustration1.

Solution :

Project A :

Variance(σ^2) = $(8,000 - 12,000)^2 (0.1) + (10,000 - 12,000)^2 (0.2) + (12,000 - 12000)^2 (0.4) + (14,000 - 12,000)^2 (0.2) + (16000 - 12,000)^2 (0.1) = 48,00,000$

Standard Deviation(σ) = $\sqrt{48,00,000}$ = 2190.90

Project B :

Variance(σ^2) = $(24,000 - 16,000)^2 (0.1) + (20,000 - 16,000)^2 (0.15) + (16,000 - 16,000)^2 (0.5) + (12,000 - 16,000)^2 (0.15) + (8,000 - 16,000)^2 (0.1) = 44,00,000$

Standard Deviation (σ) = $\sqrt{76,00,000}$ = 4195.23

8.6.4. The Coefficient of Variation

The standard deviation is a useful measure of calculating the risk associated with the estimated cash inflows from an Investment. However in Capital Budgeting decisions, the management in several times faced with choosing between many investments avenues. Under such situations, it becomes difficult for the management to compare the risk associated with different projects using Standard Deviation as each project has different estimated cash flow values. In such cases, the Coefficient of Variation become useful.

The Coefficient of Variation calculates the risk borne for every percent of expected return. It is calculated as:

$$\text{Coefficient of variation} = \frac{\text{Standard Deviation}}{\text{Expected Return / Expected Cash Flow}}$$

The Coefficient of Variation enables the management to calculate the risk borne by the concern for every unit of estimated return from a particular investment. Simply put, the investment avenue which has a lower ratio of standard deviation to expected return will provide a better risk – return trade off. Thus, when a selection has to be made between two projects, the management would select a project which has a lower Coefficient of Variation.

ILLUSTRATION 4

Calculate Coefficient of Variation based on the figure of Illustration 1 and Illustration 3

Solution :

Projects	Coefficient of variation	Risk	Expected Value
A	$\frac{2190.90}{12,000} = 0.1826$	Less	Less
B	$\frac{4195.23}{16,000} = 0.2622$	More	More

8.7. CONVENTIONAL TECHNIQUES

8.7.1. Risk Adjusted Discount Rate

The use of risk adjusted discount rate is based on the concept that investors demands higher returns from the risky projects. The required return of return on any investment

should include compensation for delaying consumption equal to risk free rate of return, plus compensation for any kind of risk taken on. The case, risk associated with any investment project is higher than risk involved in a similar kind of project, discount rate is adjusted upward in order to compensate this additional risk borne.

$$NPV = \sum_{t=0}^{n} \frac{NCF_t}{(1+k)^t} - I$$

Where,

NCF_t = Net cash flow

K = Risk adjusted discount rate.

I = Initial Investment

A risk adjusted discount rate is a sum of risk free rate and risk premium. The Risk Premium depends on the perception of risk by the investor of a particular investment and risk aversion of the Investor.

So Risks adjusted discount rate = Risk free rate+ Risk premium

Risk Free Rate : It is the rate of return on Investments that bear no risk. For e.g., Government securities yield a return of 6 % and bear no risk. In such case, 6 % is the risk-free rate.

Risk Premium : It is the rate of return over and above the risk-free rate, expected by the Investors as a reward for bearing extra risk. For high risk project, the risk premium will be high and for low risk projects, the risk premium would be lower.

ILLUSTRATION 5

An enterprise is investing ₹ 100 lakhs in a project. The risk-free rate of return is 7%. Risk premium expected by the Management is 7%. The life of the project is 5 years. Following are the cash flows that are estimated over the life of the project.

Year	*Cash flows (₹ in lakhs)*
1	*25*
2	*60*
3	*75*
4	*80*
5	*65*

Calculate Net Present Value of the project based on Risk free rate and also on the basis of Risks adjusted discount rate.

Solution:

The Present Value of the Cash Flows for all the years by discounting the cash flow at 7% is calculated as below:

Year	Cash flows ₹ in lakhs	Discounting Factor@7%	Present value of Cash Flows ₹ in lakhs
1	25	0.935	23.38
2	60	0.873	52.38
3	75	0.816	61.20
4	80	0.763	61.04
5	65	0.713	46.35
Total of present value of Cash flow			244.34
Less Initial investment			100
Net Present Value (NPV)			144.34

Now when the risk-free rate is 7 % and the risk premium expected by the Management is 7 %. So the risk adjusted discount rate is 7 % + 7 % =14%.

Discounting the above cash flows using the Risk Adjusted Discount Rate would be as below :

Year	Cash flows ₹ in Lakhs	Discounting Factor@14%	Present Value of Cash Flows ₹ in lakhs
1	25	0.877	21.93
2	60	0.769	46.14
3	75	0.675	50.63
4	80	0.592	47.36
5	65	0.519	33.74
Total of present value of Cash flow			199.79
Initial investment			100
Net present value (NPV)			99.79

Advantages of Risk-adjusted discount rate

(1) It is easy to understand.

(2) It incorporates risk premium in the discounting factor.

Limitations of Risk-adjusted discount rate

(1) Difficulty in finding risk premium and risk-adjusted discount rate.

(2) Assumption that investors are risk averse is always not true.

8.7.2. Certainty Equivalent (CE) Method for Risk Analysis

Certainty equivalent method –Definition : As per CIMA terminology, "An approach to dealing with risk in a capital budgeting context. It involves expressing risky future cash flows in terms of the certain cashflow which would be considered, by the decision maker, as their equivalent, that is the decision maker would be indifferent between the risky amount and the (lower) riskless amount considered to be its equivalent."

The certainty equivalent is a guaranteed return that the management would accept rather than accepting a higher but uncertain return. This approach allows the decision maker to incorporate his or her utility function into the analysis. In this approach a set of risk less cash flow is generated in place of the original cash flows.

Steps in the Certainty Equivalent (CE) approach

Step 1 : Remove risk by substituting equivalent certain cash flows from risky cash flows. This can be done by multiplying each risky cash flow by the appropriate α_t value (CE coefficient)

$$\alpha_t = \frac{\text{Certain cash flow}}{\text{Risky or expected cash flow}_t}$$

Suppose on tossing out a coin, if it comes head you will get ₹ 10,000 and if it comes out to be tail, you will win nothing. Thus, you have 50% chances of winning and expected value is ₹ 5,000. In such case if you are indifferent at receiving ₹ 3,000 for a certain amount and not playing then ₹ 3,000 will be certainty equivalent and 0.3 (*i.e.* 3,000/10,000) will be certainty equivalent coefficient.

Step 2 : Discounted value of cash flow is obtained by applying risk less rate of interest. Since you have already accounted for risk in the numerator using CE coefficient, using the cost of capital to discount cash flows will tantamount to double counting of risk.

Step 3 : After that normal capital budgeting method is applied except in case of IRR method, where IRR is compared with risk free rate of interest rather than the firm's required rate of return.

Certainty Equivalent Coefficients transform expected values of uncertain flows into their Certainty Equivalents. It is important to note that the value of Certainty Equivalent Coefficient lies between 0 & 1. Certainty Equivalent Coefficient 1 indicates that the cash flow is certain or management is risk neutral. In industrial situation, cash flows

are generally uncertain and managements are usually risk averse. Under this method

$$NPV = \sum_{t=0}^{n} \frac{\alpha_t NCF_t}{(1+k_f)^t} - I$$

Where,

NCF_t = the forecasts of net cash flow without risk-adjustment

α_t = the risk-adjustment factor or the certainly equivalent coefficient.

K_f = risk-free rate assumed to be constant for all periods.

ILLUSTRATION 6

If Investment Proposal is ₹ 45,00,000 and risk free rate is 5%, calculate Net present value under certainty equivalent technique.

Year	Expected cash flow (₹)	Certainty Equivalentcoefficient
1	10,00,000	0.90
2	15,00,000	0.85
3	20,00,000	0.82
4	25,00,000	0.78

Solution :

$$NPV = \frac{10,00,000 \times (0.90)}{(1.05)} + \frac{15,00,000 \times (0.85)}{(1.05)^2} + \frac{20,00,000 \times (0.82)}{(1.05)^3} + \frac{25,00,000 \times (0.78)}{(1.05)^4}$$

$$- 45,0000 = ₹\ 5,34,570$$

Advantages of Certainty Equivalent Method

(1) The certainty equivalent method is simple and easy to understand and apply.

(2) It can easily be calculated for different risk levels applicable to different cash flows. For example, if in a particular year, a higher risk is associated with the Cash Flow, it can be easily adjusted and the NPV can be recalculated accordingly.

Disadvantages of Certainty Equivalent Method

1. There is no Statistical or Mathematical model available to estimate certainty Equivalent. Assumption of risk being subjective, it varies on the perception of the risk by the management because of bias and individual opinions involved.
2. There is no objective or mathematical method to estimate certainty equivalents. Certainty Equivalent are subjective and vary as per each individual's estimate.

3. Certainty equivalents are decided by the management based on their perception of risk. However the risk perception of the shareholders who are the money lenders for the project is ignored. Hence it is not used often in corporate decision making.

Risk-adjusted Discount Rate Vs. Certainty-Equivalent

Certainty Equivalent Method is superior to Risk Adjusted Discount Rate Method as it does not assume that risk increases with time at constant rate. Each year's Certainty Equivalent Coefficient is based on level of risk impacting its cash flow. Despite its soundness, it is not preferable like Risk Adjusted Discount Rate Method. It is difficult to specify a series of Certainty Equivalent Coefficients but simple to adjust discount rates.

8.8. OTHER TECHNIQUES

8.8.1. Sensitivity Analysis

Definition of sensitivity analysis: As per CIMA terminology," A modeling and risk assessment procedure in which changes are made to significant variables in order to determine the effect of these changes on the planned outcome. Particular attention is thereafter paid to variables identifies as being of special significance"

Sensitivity analysis put in simple terms is a modeling technique which is used in Capital Budgeting decisions which is used to study the impact of changes in the variables on the outcome of the project. In a Project, several variables like Weighted average cost of capital, consumer demand, price of the product, cost price per unit etc. operate simultaneously. The changes in these variables impact the outcome of the project. It therefore becomes very difficult to assess change in which variable impacts the project outcome in a significant way. In Sensitivity Analysis, the project outcome is studied after taking into change in only one variable. The more sensitive is the NPV, the more critical is that variable. So, Sensitivity analysis is a way of finding impact in the project's NPV (or IRR) for a given change in one of the variables.

Steps involved in Sensitivity Analysis

Sensitivity Analysis is conducted by following the steps as below:

1. Finding variables, which have an influence on the NPV (or IRR) of the project
2. Establishing mathematical relationship between the variables.
3. Analysis the effect of the change in each of the variables on the NPV (or IRR) of the project.

ILLUSTRATION 7

X Ltd is considering its New Product 'with the following details

Sr. No.	Particulars	Figures
1	Initial capital cost	₹ 400 Cr
2	Annual unit sales	₹ 5 Cr
3	Selling price per unit	₹ 100
4	Variable cost per unit	₹ 50
5	Fixed costs per year	₹ 50 Cr
6	Discount Rate	6%

1. *Calculate the NPV of the project.*
2. *Find the impact on the project's NPV of a 2.5 per cent adverse variance in each variable. Which variable is having maximum effect.*

Solution :

1. Calculation of Net Cash Inflow per year:

	Particulars	Amount (₹)
A	Selling Price Per Unit (A)	100
B	Variable Cost Per Unit (B)	50
C	Contribution Per Unit (C = A-B)	50
D	Number of Units Sold Per Year	5 Cr.
E	Total Contribution (E = C X D)	₹ 250 Cr.
F	Fixed Cost Per Year	₹ 50 Cr.
G	Net Cash Inflow Per Year (G =E - F)	₹ 200 Cr.

Calculation of Net Present Value (NPV) of the Project:

Year	Year Cash Flow (₹ in Cr.)	Discounting @ 6%	Present Value (PV) (₹ in Cr.)
0	-400	1.000	-400
1	200	0.943	188.60
2	200	0.890	178
3	200	0.840	168
Net Present Value (188.60+178+168)-400=			134.60

Here NPV represent the most likely outcomes and not the actual outcomes. The actual outcome can be lower or higher than the expected outcome.

2. Sensitivity Analysis considering 2.5 % Adverse Variance in each variable

	Changes in variable	Base	Initial Cash Flow increased to ₹ 410 crore	Selling Price per Unit Reduced to ₹ 97.5	Variable Cost Per Unit increased to ₹ 51.25	Fixed Cost Per Unit increased to ₹ 51.25	Units sold per year reduced to ₹ 4.875 crore
	Particulars	Amount ₹	Amount ₹	Amount ₹	Amount ₹	Amount ₹	Amount ₹
A	Selling Price Per Unit (A)	100	100	97.5	100	100	100
B	Variable Cost Per Unit (B)	50	50	50	51.25	50	50
C	Contribution Per Unit (C = A-B)	50	50	47.5	48.75	50	50
D	Number of Units Sold Per Year (in Crores)	5	5	5	5	5	4.875
E	Total Contribution (E = C × D)	250	250	237.5	243.75	250	243.75
F	Fixed Cost Per Year (in Crores)	50	50	50	50	51.25	50
G	Net Cash Inflow Per Year (G =E - F)	200	200	187.5	193.75	198.75	193.75
H	(G × 2.673)	534.60	534.60	501.19	517.89	531.26	517.89
I	Initial Cash Flow	400	410	400	400	400	400
J	NPV	134.60	124.60	101.19	117.89	131.26	117.89
K	Percentage Change in NPV		-7.43%	-24.82%	-12.41%	-2.48%	-12.41%

The above table shows that the by varying one variable at a time by 2.5% while keeping the others constant, the impact in percentage terms on the NPV of the project. Thus it can be seen that the change in selling price has the maximum effect on the NPV by 24.82 %.

Advantages of Sensitivity Analysis :

Following are main advantages of Sensitivity Analysis

(1) **Critical Issues :** This analysis identifies critical factors that impinge on a project's success or failure.

(2) **Simplicity :** This analysis is quite simple.

Disadvantage of Sensitivity Analysis :

Following are main disadvantages of Sensitivity Analysis

(1) Assumption of Independence: This analysis assumes that all variables are independent i.e. they are not related to each other, which is unlikely in real life.

(2) Ignore probability: This analysis does not look to the probability of changes in the variables.

(3) Not so reliable: This analysis provides information on the basis of which decisions can be made but does not point directly to the correct decision.

8.8.2. Scenario Analysis

Although sensitivity analysis is probably the most widely used risk analysis technique, it does have limitations. Therefore, we need to extend sensitivity analysis to deal with the probability distributions of the inputs. In addition, it would be useful to vary more than one variable at a time so we could see the combined effects of changes in the variables.

Scenario analysis provides answer to these situations of extensions. This analysis brings in the probabilities of changes in key variables and also allows us to change more than one variable at a time.

This analysis begins with base case or most likely set of values for the input variables. Then, go for worst case scenario (low unit sales, low sale price, high variable cost and so on) and best case scenario.

So, in a nutshell Scenario analysis examine the risk of investment, so as to analyse the impact of alternative combinations of variables, on the project's NPV (or IRR).

ILLUSTRATION 8

XYZ Ltd. is considering a project "A" with an initial outlay of ₹ 14,00,000 and the possible three cash inflow attached with the project as follows :

(₹000)

Particular	*Year 1*	*Year 2*	*Year 3*
Worst case	*450*	*400*	*700*
Most likely	*550*	*450*	*800*
Best case	*650*	*500*	*900*

Assuming the cost of capital as 9%, determine NPV in each scenario. If XYZ Ltd is certain about the most likely result but uncertain about the third year's cash flow, what will be the NPV expecting worst scenario in the third year.

Solution

The possible outcomes will be as follows :

Year	PVF @ 9%	Worst Case		Most likely		Best case	
		Cash Flow (₹ 000)	PV (₹ 000)	Cash Flow (₹ 000)	PV (₹ 000)	Cash Flow (₹ 000)	PV (₹ 000)
0	1	(1400)	(1400)	(1400)	(1400)	(1400)	(1400)
1	0.917	450	412.65	550	504.35	650	596.05
2	0.842	400	336.80	450	378.90	500	421.00
3	0.772	700	540.40	800	617.60	900	694.80
NPV			-110.15		100.85		311.85

Now suppose that CEO of XYZ Ltd. is bit confident about the estimates in the first two years, but not sure about the third year's high cash inflow. He is interested in knowing what will happen to traditional NPV if 3rd year turn out the bad contrary to his optimism.

The NPV in such case will be as follows:

$$= -₹14,00,000 + \frac{5,50,000}{(1+0.09)} + \frac{4,50,000}{(1+0.09)^2} + \frac{7,00,000}{(1+0.09)^3}$$

= −₹14,00,000 + ₹ 5,04,587 + ₹ 3,78,756 + ₹ 5,40,528 = ₹ 23,871

Scenario Analysis Vs Sensitivity Analysis

Sensitivity analysis and Scenario analysis both help to understand the impact of the change in input variable on the outcome of the project. However, there are certain basic differences between the two.

Sensitivity analysis calculates the impact of the change of a single input variable on the outcome of the project viz., NPV or IRR. The sensitivity analysis thus enables to identify that single critical variable that can impact the outcome in a huge way and the range of outcomes of the project given the change in the input variable.

Scenario analysis, on the other hand, is based on a scenario. The scenario may be recession or a boom wherein depending on the scenario, all input variables change. Scenario Analysis calculates the outcome of the project considering this scenario where the variables have changed simultaneously. Similarly, the outcome of the project would also be considered for the normal and recessionary situation. The variability in the outcome under the three different scenarios would help the management to assess the risk a project carries. Higher deviation in the outcome can be assessed as higher risk and lower to medium deviation can be assessed accordingly.

Scenario analysis is far more complex than sensitivity analysis because in scenario analysis all inputs are changed simultaneously considering the situation in hand while in sensitivity analysis only one input is changed and others are kept constant.

8.8.3. Monte Carlo Simulation

Monte Carlo simulation ties together sensitivities and probability distributions. This analysis starts with carrying out a simulation exercise to model the investment project. It involves identifying the key factors affecting the project and their inter relationships. This analysis specifies a range for a probability distribution of potential outcomes for each of model's assumptions. Monte Carlo simulation is a computerized mathematical technique that allows decision makers to calculate risk and uncertainty in decision making. Monte Carlo simulation generates a range of possible outcomes and their probabilities associated with those outcomes. It also shows the probabilities of extreme possibilities like the probability of best case and the worst case along with the probabilities of a range of outcomes. The technique is widely used in fields as finance, project management, Portfolio Management, Stock Return Analysis etc. Under Simulation NPV can be calculated as

$$NPV = \sum_{t=0}^{n} \frac{NCF_t}{(1+k_t)^t} - I$$

NCF_t = Net cash flow

K_f = Risk free rate

I =Initial Investment

Steps for Simulation Analysis:

1. Identification of variables that influence cash inflows and outflows.
2. Specify values of parameters and probability distributions of variables.
3. Select a value at random from probability distribution of each of the variables.
4. Determine NPV corresponding to the randomly generated value of variables.
5. Repeat steps (3) & (4) a large number of times to get a large number of simulated NPVs.
6. Plot probability distribution of NPVs.

ILLUSTRATION 9

Annual Net Cash Flow & Life of the project with their probability distribution are as follows :

Annual Cash Flow		Project Life	
Value (₹)	Probability	Value (Year)	Probability
10,000	0.02	3	0.05
15,000	0.03	4	0.10
20,000	0.15	5	0.30
25,000	0.15	6	0.25
30,000	0.30	7	0.15
35,000	0.20	8	0.10
40,000	0.15	9	0.03
		10	0.02

Risk free rate is 10%, and Initial Investment is ₹ 1,30,000.

Various Random Number generated are as follows:

53479	81115	980z36	12217	59526
97344	70328	58116	91964	26240
66023	38277	74523	71118	84892
99776	75723	03172	43112	83086
30176	48979	92153	38416	42436
81874	83339	14988	99937	13213
19839	90630	71863	95053	55532
09337	33435	53869	52769	18801
31151	58295	40823	41330	21093
67619	52515	03037	81699	17106

Calculate NPV in each Run.

Solution :

Correspondence between Values of Variables and two Digit Random Numbers:

Annual Cash Flow				Project Life			
Value (₹)	Proba-bility	Cumu-lative Proba-bility	Two Digit Random No.	Value (Year)	Proba-bility	Cumulative Probability	Two Digit Random No.
10,000	0.02	0.02	00 – 01	3	0.05	0.05	00 – 04
15,000	0.03	0.05	02 – 04	4	0.10	0.15	05 – 14
20,000	0.15	0.20	05 – 19	5	0.30	0.45	15 – 44
25,000	0.15	0.35	20 – 34	6	0.25	0.70	45 – 69
30,000	0.30	0.65	35 – 64	7	0.15	0.85	70 – 84
35,000	0.20	0.85	65 – 84	8	0.10	0.95	85 – 94
40,000	0.15	1.00	85 - 99	9	0.03	0.98	95 – 97
				10	0.02	1.00	98 - 99

For the first simulation run we need two digit random numbers (1) For Annual Cash Flow (2) For Project Life. The numbers are 53 & 97 and corresponding value of Annual Cash Flow and Project Life are ₹ 30,000 and 9 years respectively and so on.

Calculation of NPV through Simulation

Annual Cash Flow			Project Life			
Run	Random No.	Annual Cash Flow (1)	Random No.	Project Life	PVAF @ 10% (2)	NPV (1)x(2) – 1,30,000
1	53	30,000	97	9	5.759	42,770*
2	66	35,000	99	10	6.145	85,075
3	30	25,000	81	7	4.868	(8,300)
4	19	20,000	09	4	3.170	(66,600)
5	31	25,000	67	6	4.355	(21,125)
6	81	35,000	70	7	4.868	40,380
7	38	30,000	75	7	4.868	16,040
8	48	30,000	83	7	4.868	16,040
9	90	40,000	33	5	3.791	21,640
10	58	30,000	52	6	4.355	650

*(30,000 × 5.759 – 1,30,000), Cumulative PV @ 10% for 9 years is 5.759, NPV of other runs are calculated similarly.

Application of Simulation Analysis

1. It is used in Project Finance to model the random Variables with which uncertainty is associated viz., Cash flows, Variable expenses
2. It is used for Options Pricing where the various factors like implied volatility, price of the underlying asset are the random variables and the different ranges of these individual random variables can be calculated using Monte Carlo Simulation.
3. It is used for making a judgment of the return out of a Stock or a Stock Portfolio. Thus it is of significant importance in Portfolio Management and Retirement Planning.

Advantages of Simulation Analysis :

Monte Carlo simulation has the following advantages for analysis of results where uncertainty is associated:

1. Monte Carlo simulation provides useful inputs for Sensitivity Analysis by helping to understand variability in which inputs affects the outcome to the biggest extent.
2. Using Monte Carlo simulation, a judgment can be made as to the range in which the input lied under a particular scenario. Thus using the results of Monte Carlo Simulation, different scenarios can be studied.
3. The results produced by Monte Carlo Simulation also show the associated probability of the results occurring. Thus it simplifies the decision making process of the management.
4. In a complex decision making environment, different variables are inter-dependent on each other and that impacts the end result out of a project. Monte Carlo simulation, helps to understand the interdependency between input variables. Understanding this inter dependability, enables to reduce the complexity of decision

Limitation of Simulation Analysis

1. Difficult to model the project and specify probability distribution of various variables.
2. Simulation provides only rough approximation of probability distribution of NPV.
3. Simulation model is complex and can be constructed by management expert and not by the decision maker.
4. Determine NPV in simulation run, risk free discount rate is used which may not give correct picture.

8.8.4. Decision Tree Analysis

So far we have discussed accept-or-reject decisions which view current investmentsin isolation of subsequent decisions. However, practically investment decisions may have implications for future or further investment decisions, and may also impact future

decision and events. Such situation can be handled by taking a sequence of decisions over a period of time. The technique to handle this type of sequential decisions is done through "Decision Tree" technique.

A Decision tree is a graphical representation of relationship between future decisions and their consequences. The sequence of events is shown in a format resembling branches of tree, each branch representing a single possible decision, its alternatives and the probable result in terms of NPV, ROI etc. The alternative with the highest amount of expected monetary value is selected.

Assumption in Decision Tree Analysis

This approach assumes that there are only two types of situation that a finance manager has to face.

1. The first situation is where the manager has control or power to determine what happens next. This is known as "Decision", as he can do what he desires to do.
2. The second situation is where finance manager has no control over what happens next. This is known as "Event". Since the outcome of the events is not known, a probability distribution needs to be assigned to the various outcomes or consequences.
3. When a finance manager faced with a decision situation, he is assumed to act rationally. For example, in a commercial business, he will choose the most profitable course of action and in non-profit organization, the lowest cost may be rational choice.

Steps involved in Decision Tree analysis:

Step 1- Define Investment : Decision three analysis can be applied to a variety of business decision-making scenarios. Normally it includes following types of decisions.

- Whether or not to launch a new product, if so, whether this launch should be local, national, or international.
- Whether extra production requirement should be met by extending the factory or by out sourcing it to an external supplier.
- Whether to dig for oil or not if so, upto what height and continue to dig even after finding no oil upto a certain depth.

Step 2- Identification of Decision Alternatives : It is very essential to clearly identity decision alternatives. For example, if a company is planning to introduce a new product, it may be local launch, national launch or international launch.

Step 3- Drawing a Decision Tree : After identifying decision alternatives, at the relevant data such as the projected cash flows, probability distribution expected present value etc. should be put in diagrammatic form called decision tree.

While drawing a decision tree, it should be noted that NPVs etc. should be placed on the branches of decision tree, coming out of the decisions identified.

While drawing a decision tree, it should be noted that:-

- The decision point (traditionally represented by square □), is the option available for manager to take or not to take. This is known as **decision node.**
- The event or chance or outcome (traditionally represented by circle ○) which are dependent on chance process, along with the probabilities thereof, and monetary value associated with them. This is known as **chance node**
- This diagram is drawn from left to right.

Step 4- Evaluating the Alternatives : After drawing out the decision the next step is the evaluation of alternatives. The various alternatives can be evaluated as follows:

(i) This procedure is carried out from the last decision in the sequence (extreme right) and goes on working back to the first (left) for each of the possible decision.

(ii) At each final stage decision point, select the alternative which has the highest NPV and truncate the other alternatives. Each decision point is assigned a value equal to the NPV of the alternative selected at the decision point.

(iii) Proceed backward in the same manner calculating the NPV at chance or event or outcome points (○) selecting the decisions alternative which has highest NPV at various decision points [□] rejecting the inferior decision option, assigning NPV to the decision point, till the first decision point is reached.

ILLUSTRATION 10

A firm has an investment proposal, requiring an outlay of ₹ 80,000. The investment proposal is expected to have two years' economic life with no salvage value. In year 1, there is a 0.4 probability that cash inflow after tax will be ₹ 50,000 and 0.6 probability that cash inflow after tax will be ₹ 60,000. The probability assigned to cash inflow after tax for the year 2 is as follows :

Year	Cash Flows (₹)	Probability	Cash Flows (₹)	Probability
Year-1	₹ 50,000	0.6	₹ 60,000	0.4
Year- 2				
	₹ 24,000	0.2	₹ 40,000	0.4
	₹ 32,000	0.3	₹ 50,000	0.5
	₹ 44,000	0.5	₹ 60,000	0.1

The firm uses a 10% discount rate for this type of investment.
Required:

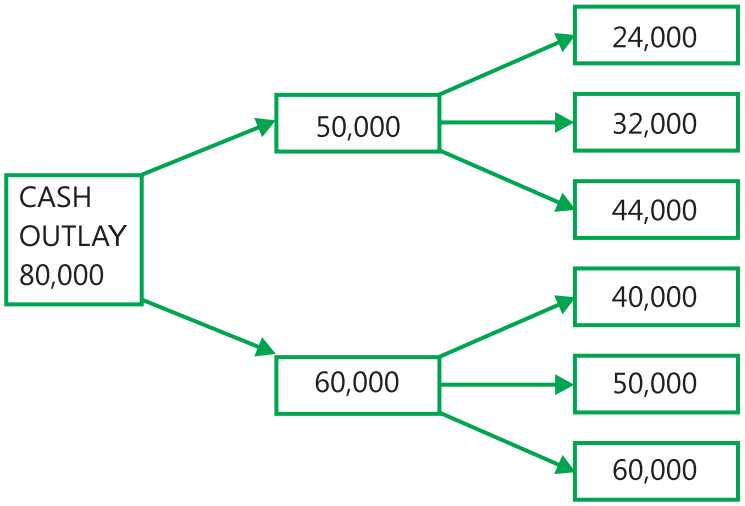
(i) Construct a decision tree for the proposed investment project and calculate the expected net present value (NPV).

(ii) What net present value will the project yield, if worst outcome is realized? What is the probability of occurrence of this NPV?

(iii) What will be the best outcome and the probability of that occurrence?
(iv) Will the project be accepted?
(Note: 10% discount factor 1 year 0.909; 2 years 0.826)

Solution

(i) The decision tree diagram is presented in the chart, identifying various paths and outcomes, and the computation of various paths/outcomes and NPV of each path are presented in the following tables:



Path No.	Joint probability Year 1 x year 2
1	.08
2	0.12
3	0.20
4	0.24
5	0.30
6	0.06
	1.00

The Net Present Value (NPV) of each path at 10% discount rate is given below:

Path	Year 1 Cash Flows	Year 2 Cash Flows	Total Cash Inflows (PV)	Cash Outflows	NPV
	(₹)	(₹)	(₹)	(₹)	(₹)
1	50,000 × 0.909 = 45,450	24,000 ×0.826 = 19,824	65,274	80,000	(14,726)
2	45,450	32,000 × 0.826 = 26,432	71,882	80,000	(8,118)
3	45,450	44,000 × 0.826 = 36,344	81,794	80,000	1,794
4	60,000 × 0.909 = 54,540	40,000 × 0.826 = 33,040	87,580	80,000	7,580

5	54,540	50,000 × 0.826 = 41,300	95,840	80,000	15,840
6	54,540	60,000 × 0.826 = 49,560	1,04,100	80,000	24,100

Statement showing Expected Net Present Value

z	NPV (₹)	Joint Probability	Expected NPV (₹)
1	(14,726)	0.08	(1,178.08)
2	(8,118)	0.12	(974.16)
3	1,794	0.20	358.80
4	7,580	0.24	1,819.20
5	15,840	0.30	4,752.00
6	24,100	0.06	1,446.00
			6,223.76

(ii) If the worst outcome is realized the project will yield NPV of – ₹ 14,726. The probability of occurrence of this NPV is 8% and a loss of ₹ 1,178 (path 1).

(iii) The best outcome will be path 6 when the NPV is at ₹ 24,100. The probability of occurrence of this NPV is 6% and an expected profit of ₹ 1,446.

(iv) The project should be accepted because the expected NPV is positive at ₹ 6,223.76 based on joint probability

Advantages of using decision trees

1. The Decision nodes enable to set out the various options available thus ensuring that no option is left out to be considered.
2. All the options available can are considered simultaneously thus allowing comparison.
3. Risk is addressed in an objective manner by use of probabilities.
4. Decision Trees enable the evaluation of the options by considering the Cash Outflows and the Cash Inflows. Thus it enables to evaluate the different options on the basis of the Net benefit arising out of that project.
5. Simple to understand and apply.

Limitations of using decision trees

1. Probabilities cannot be calculated objectively.
2. Decision Trees use only that data which can be quantified. It ignores qualitative aspects of decisions.
3. Assignment of probabilities and expected values do not have any relevant basis as it pertains to a future outcome which is uncertain.

Miscellaneous Illustration

ILLUSTRATION 11

Shivam Ltd. is considering two mutually exclusive projects A and B. Project A costs ₹ 36,000 and project B ₹ 30,000. You have been given below the net present value probability distribution for each project.

Project A		Project B	
NPV estimates (₹)	Probability	NPV estimates (₹)	Probability
15,000	0.2	15,000	0.1
12,000	0.3	12,000	0.4
6,000	0.3	6,000	0.4
3,000	0.2	3,000	0.1

(i) Compute the expected net present values of projects A and B.
(ii) Compute the risk attached to each project i.e. standard deviation of each probability distribution.
(iii) Compute the profitability index of each project.
(iv) Which project do you recommend? State with reasons.

Answer

(i) Statement showing computation of expected net present value of Projects A and B:

Project A			Project B		
NPV Estimate (₹)	Proba-bility	Expected Value	NPV Estimate	Proba-bility	Expected Value
15,000	0.2	3,000	15,000	0.1	1,500
12,000	0.3	3,600	12,000	0.4	4,800
6,000	0.3	1,800	6,000	0.4	2,400
3,000	0.2	600	3,000	0.1	300
	1.0	EV = 9,000		1.0	EV = 9,000

(ii) Computation of Standard deviation of each project

Project A

P	X	(X – EV)	P (X- EV)^2
0.2	15,000	6,000	72,00,000
0.3	12,000	3,000	27,00,000
0.3	6,000	- 3,000	27,00,000
0.2	3,000	- 6,000	72,00,000
		Variance = 1,98,00,000	

Standard Deviation of Project A = $\sqrt{1,98,00,000}$ = ₹4,450

Project B

P	X	(X – EV)	P (X- EV)^2
0.1	15,000	6,000	36,00,000
0.4	12,000	3,000	36,00,000
0.4	6,000	- 3,000	36,00,000
0.1	3,000	- 6,000	36,00,000
		Variance = 1,44,00,000	

Standard Deviation of Project B = $\sqrt{1,44,00,000}$ = ₹ 3,795

(iii) Computation of profitability of each project

Profitability index = Discount cash inflow / Initial outlay

In case of Project A : PI = $\frac{9,000+36,000}{36,000}=\frac{45,000}{36,000}=1.25$

In case of Project B : PI = $\frac{9,000+30,000}{30,000}=\frac{39,000}{30,000}=1.30$

(iv) Measurement of risk is made by the possible variation of outcomes around the expected value and the decision will be taken in view of the variation in the expected value where two projects have the same expected value, the decision will be the project which has smaller variation in expected value. In the selection of one of the two projects A and B, Project B is preferable because the possible profit which may occur is subject to less variation (or dispersion). Much higher risk is lying with project A.

ILLUSTRATION 12

From the following details relating to a project, analyse the sensitivity of the project to changes in initial project cost, annual cash inflow and cost of capital :

Initial Project Cost (₹)	*1,20,000*
Annual Cash Inflow (₹)	*45,000*
Project Life (Years)	*4*
Cost of Capital	*10%*

To which of the three factors, the project is most sensitive if the variable is adversely affected by 10%? (Use annuity factors: for 10% 3.169 and 11% ... 3.103).

Answer

Calculation of NPV through Sensitivity Analysis

	(₹)
PV of cash inflows (₹ 45,000 × 3.169)	1,42,605
Initial Project Cost	(1,20,000)
NPV	22,605

Situation	NPV	Changes in NPV
Base(present)	₹ 22,605	
If initial project cost is varied adversely by 10%	(₹ 1,42,605 - ₹ 1,32,000) = ₹ 10,605	(₹ 22,605 – ₹ 10,605)/ ₹ 22,605 = (53.08%)
If annual cash inflow is varied adversely by 10%	[₹ 40,500(revised cash flow) × 3.169) – (₹ 1,20,000)] = ₹ 8,345	(₹ 22,605 – ₹ 8,345) / ₹ 22,605=63.08%
If cost of capital is varied adversely by 10% i.e. it becomes 11%	(₹ 45,000 × 3.103) – ₹ 1,20,000 = ₹ 19,635	(₹ 22,605 – ₹ 19,635) / ₹ 22,605 = 13.14%

Conclusion : Project is most sensitive to 'annual cash inflow'

SUMMARY

- **Risk :** Risk denotes variability of possible outcomes from what was expected. Standard Deviation is perhaps the most commonly used tool to measure risk. It measures the dispersion around the mean of some possible outcome.
- **Risk Adjusted Discount Rate Method :** The use of risk adjusted discount rate is based on the concept that investors demands higher returns from the risky projects. The required return of return on any investment should include compensation for delaying consumption equal to risk free rate of return, plus compensation for any kind of risk taken on.
- **Certainty Equivalent Approach :** This approach allows the decision maker to incorporate his or her utility function into the analysis. In this approach a set of risk less cash flow is generated in place of the original cash flows.
- **Sensitivity Analysis:** Also known as "What if" Analysis. This analysis determines how the distribution of possible NPV or internal rate of return for a project under consideration is affected consequent to a change in one particular input variable. This is done by changing one variable at one time, while keeping other variables

(factors) unchanged.

- **Scenario Analysis :** Although sensitivity analysis is probably the most widely used risk analysis technique, it does have limitations. Therefore, we need to extend sensitivity analysis to deal with the probability distributions of the inputs. In addition, it would be useful to vary more than one variable at a time so we could see the combined effects of changes in the variables.
- **Simulation Analysis (Monte Carlo) :** Monte Carlo simulation ties together sensitivities and probability distributions. The method came out of the work of first nuclear bomb and was so named because it was based on mathematics of Casino gambling. Fundamental appeal of this analysis is that it provides decision makers with a probability distribution of NPVs rather than a single point estimates of the expected NPV. Following are main steps in simulation analysis:
- **Decision Trees :** By drawing a decision tree, the alternations available to an investment decision are highlighted through a diagram, giving the range of possible outcomes.

TEST YOUR KNOWLEDGE

Multiple Choice Questions

1. Project Analysis can be done using:
   (a) Sensitivity Analysis
   (b) Scenario Analysis
   (c) Monte Carlo Simulation
   (d) All of the Above
2. Which from the following is not a part of Monte Carlo Simulation
   (a) Modeling the Project
   (b) Simulating Results
   (c) Calculating NPV
   (d) Specifying Probabilities
3. Variance Measures
   (a) How far each number in the set is from the mean
   (b) The mean of a given data set
   (c) Return on Investment
   (d) level of risk borne for every percent of expected return

4. Certainty Equivalent
   (a) Is a guaranteed return from an Investment after adjusting for risk
   (b) Is the return that is expected over the lifetime of a project
   (c) Is equivalent to Net Present Value
   (d) Is an important component in Decision Tree Analysis
5. For a project, where the cash flows are ₹ 90,00,000, rate of return is 15% , risk free rate is 4 %and risk premium is 9%, the Certainty Equivalent is
   (a) 78,26, 087
   (b) 86,53,846
   (c) 82,56, 881
   (d) 81,08,108
6. Risk Premium
   (a) is the extra rate of return expected by the Investors as a reward for bearing extra risk
   (b) is equivalent to the rate of Government Securities
   (c) is the return provided to equity shareholders
   (d) is over and above expected rate of return
7. In Decision Tree Analysis, the Problem / decision is the
   (a) Decision Node
   (b) Root Node
   (c) Event Node
   (d) End Node
8. Scenario Analysis is considered under scenarios such as
   (a) Worst Case Scenario
   (b) Base Case Scenario
   (c) Best Case Scenario
   (d) All of the above
9. Sensitivity analysis is useful in decision making because
   (a) It shows the probabilities associated with each outcome
   (b) It tells the user how much critical each input is for the Output value
   (c) It allows to calculate the probable results under different scenarios
   (d) The results of Sensitivity Analysis are reliable

10. Monte Carlo Simulation involves
    (a) Identification of key variables on which outcome of the experiment would depend.
    (b) Fixing of the range of values within which the results are expected to vary
    (c) Assigning Probability Distribution after a large number of random samples is performed.
    (d) All of the above

Theoretical Questions

1. Explain Certainty Equivalent.
2. What is Risk Adjusted Discount rate?
3. Briefly explain the steps involved in Decision Tree Analysis.
4. What are the drawbacks of using Decision Trees?
5. What are the Benefits of using Decision Trees?
6. Explain Scenario Analysis.
7. Explain the different scenarios under which Scenario Analysis is considered.
8. What are the two approaches to Sensitivity Analysis?
9. What is Sensitivity Analysis used for?
10. Distinguish between Scenario Analysis & Sensitivity Analysis.

Practical Problems

1. The Textile Manufacturing Company Ltd., is considering one of two mutually exclusive proposals, Projects M and N, which require cash outlays of ₹ 8,50,000 and ₹ 8,25,000 respectively. The certainty-equivalent (C.E) approach is used in incorporating risk in capital budgeting decisions. The current yield on government bonds is 6% and this is used as the risk free rate. The expected net cash flows and their certainty equivalents are as follows:

Project M			Project N	
Year-end	Cash Flow (₹)	C.E.	Cash Flow (₹)	C.E.
1	4,50,000	0.8	4,50,000	0.9
2	5,00,000	0.7	4,50,000	0.8
3	5,00,000	0.5	5,00,000	0.7

Present value factors of ₹ 1 discounted at 6% at the end of year 1, 2 and 3 are 0.943, 0.890 and 0.840 respectively.

Required :

(i) Which project should be accepted?

(ii) If risk adjusted discount rate method is used, which project would be appraised with a higher rate and why?

2. Determine the risk adjusted net present value of the following projects:

	X	Y	Z
Net cash outlays (₹)	2,10,000	1,20,000	1,00,000
Project life	5 years	5 years	5 years
Annual Cash inflow (₹)	70,000	42,000	30,000
Coefficient of variation	1.2	0.8	0.4

The Company selects the risk-adjusted rate of discount on the basis of the coefficient of variation:

Coefficient of Variation	Risk-Adjusted Rate of Return	P.V. Factor 1 to 5 years At risk adjusted rate of discount
0.0	10%	3.791
0.4	12%	3.605
0.8	14%	3.433
1.2	16%	3.274
1.6	18%	3.127
2.0	22%	2.864
More than 2.0	25%	2.689

ANSWERS/ SOLUTIONS

Answers to the MCQs based Questions

1. (d) **2.** (c) **3.** (a) **4.** (a) **5.** (d) **6.** (a) **7.** (b)
8. (d) **9.** (b) **10.** (d)

Answers to the Theoretical Questions

1. Please refer paragraph 8.7.2
2. Please refer paragraph 8.7.1
3. Please refer paragraph 8.8.4
4. Please refer paragraph 8.8.4
5. Please refer paragraph 8.8.4
6. Please refer paragraph 8.8.2
7. Please refer paragraph 8.8.2
8. Please refer paragraph 8.8.1
9. Please refer paragraph 8.8.1
10. Please refer paragraph 8.8.2

Answers to the Practical Problems

1. (i) **Statement Showing the Net Present Value of Project M**

Year end	Cash Flow (₹) (a)	C.E. (b)	Adjusted Cash flow (₹) (c) = (a) × (b)	Present value factor at 6%(d)	Total Present value (₹) (e) = (c) ×(d)
1	4,50,000	0.8	3,60,000	0.943	3,39,480
2	5,00,000	0.7	3,50,000	0.890	3,11,500
3	5,00,000	0.5	2,50,000	0.840	2,10,000
					8,60,980
Less: Initial Investment					8,50,000
Net Present Value					10,980

Statement Showing the Net Present Value of Project N

Year end	Cash Flow (₹) (a)	C.E. (b)	Adjusted Cash flow (₹) (c) = (a) × (b)	Present value factor (d)	Total Present value (₹) (e) = (c) × (d)
1	4,50,000	0.9	4,05,000	0.943	3,81,915
2	4,50,000	0.8	3,60,000	0.890	3,20,400
3	5,00,000	0.7	3,50,000	0.840	2,94,000
					9,96,315
Less: Initial Investment					8,25,000
Net Present Value					1,71,315

Decision : Since the net present value of Project N is higher, so the project N should be accepted.

(ii) Certainty - Equivalent (C.E.) Co-efficient of Project M (2.0) is lower than Project N (2.4). This means Project M is riskier than Project N as "higher the riskiness of a cash flow, the lower will be the CE factor". If risk adjusted discount rate (RADR) method is used, Project M would be analysed with a higher rate.

2. **Statement showing the determination of the risk adjusted net present value**

Projects	Net cash outlays	Co-efficient of variation	Risk adjusted discount rate	Annual cash inflow	PV factor 1-5 years	Dis-counted cash inflow	Net present value
	(₹)			(₹)		(₹)	(₹)
(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii) = (v) × (vi)	(viii) = (vii) − (ii)
X	2,10,000	1.20	16%	70,000	3.274	2,29,180	19,180
Y	1,20,000	0.80	14%	42,000	3.433	1,44,186	24,186
Z	1,00,000	0.40	12%	30,000	3.605	1,08,150	8,150