LESSON : 5

CAPITAL BUDGETING : UNDER RISK

OBJECTIVES :

The objectives of this lesson are to explain :

1) the meaning of risk and sources of risk in capital budgeting.

2) the conventional techniques to handle risk.

3) the use of statistical techniques in handling risk.

4) the concepts of standard deviation and Co-efficient of variation in measuring risk.

5) the various steps involved in constructing decision tree.

STRUCTURE:

5.1 INTRODUCTION

In the previous lessons you have learnt the meaning and the process of capital budgeting. along with the various techniques for evaluating capital budgeting proposals. The basic assumption was that the investment proposal did not involve any kind of risk. This assumption made simple the understanding of capital budgeting techniques. In real world situation the firm, in general, and its investment projects in particular, are exposed to different degrees of risk. The risk arises in capital budgeting projects since one cannot estimate the future cash flows with certainty. Consequently we can not predict, accurately, the cash flow sequence.

The objective of this lesson is to explain the meaning and sources of risk and various techniques both conventional and statistical to handle risk.

5.2 RISK ANALYSIS IN CAPITAL BUDGETING

It is possible to predict the outcome of some decisions with complete certainty because only one outcome can arise. However, there are many occasions when decisions can lead to more than one possible outcome, such situations are surrounded with uncertainty. The traditional difference between risk and uncertainty is that the uncertainty cannot be quantified while risk can be quantified. Risk is concerned with the use of quantification of the likelihood of future outcomes. The word uncertainty is to cover all future outcomes, which cannot be predicted with accuracy. People have different attitudes towards the future. Some welcome the opportunity to take risk they may be called risk takers or risk seekers and others are risk averse.

An organisation's performance is influenced by the elements contained within its environment. In turn the organisation also has an impact on its environment. The very survival of an organisation depends critically upon the willingness of its environment to sustain it. It is the role of the management to predict events that are likely to occur to meet the challenges and to take advantage of any new opportunity.

5.3 NATURE OF RISK

Risk analysis should be incorporated in capital budgeting exercise. The capital budgeting decisions are based on the benefits derived from the project. These benefits measured in terms of cash flows are estimates. The estimation of future returns is done on the basis of various assumptions. The actual return in terms of cash inflows depends on a variety of factors such as price, sales volume, effectiveness of advertising, competition, cost of raw materials, manufacturing cost and so on. Each of these in turn, depends on other variables like state of the economy, rate of inflation, etc. The accuracy of the estimates of future returns and the reliability of the investment decision would largely depend upon the accuracy with which these factors are forcasted. The actual return will vary from the estimated return, which is technically referred to as risk.

Thus risk with reference to investment decision is defined as "the variability in actual returns arise from a project in future over its working life in relation to the estimated return as forcast at the time of the initial capital budgeting decisions".

5.3.1 Types of Risk: The risk can be broken up into three types

1. **Certainty:** It is a situation where the returns are assured and no variability likely to occur in future returns. For example investment in Government bonds, fixed deposits in a nationalized bank.
2. **Uncertainty :** It is a situation where infinite number of outcomes are possible and probabilities can not be assigned.
3. **Risk:** Risk is the variability that is likely occur in future returns from the investment. In other words, risk is a situation in which the probabilities of future cash flows occuring are known.

5.3.2 Source of Risk : As explained above, risk is associated with the variability of future returns of a project. The factors which will influence the future returns of the projects may be explained as follows :

(a) **Size of the investment** : The size of the investment in terms of the amount required will determine the risk. Large scale projects are more risky than small scale projects example, a project involves for Rs. one crore investment involves more risk than a project with Rs.1,00,000/- investment.

(b) **Life of the Project** : The life of the project will determine the risk involved. Longer the life of projects more is the risk, shorter the life of the projects less is the risk.

(c) **Economic conditions** : There are certain conditions which will influence the general level of business activity. For example, economic and political situation in the country, Government monetary and fiscal policies, etc.

(d) **Industry Factors** : These factors effect all the companies of the industry in the same way. For example : industrial relations in the industry, innovation, material cost, etc.

(e) **Company Factors** : These are internal to the company which will effect a particular company only. For example, change in the management, strike in the company, fire accident in the company etc.

5.4 TECHNIQUES FOR MEASUREMENT OF RISK :

As seen above, various factors are responsible for variations in the returns of a proposed project. The greater the variability of the expected returns, the riskier the project. However, risk can be reduced (cannot be avoided) by using certain techniques in evaluating and selecting the projects. These techniques include (a) Conventional Techniques (b) Statistical Techniques.

5.4.1 Conventional Techniques :

A number of techniques to handle risk are used by managers in selecting capital budgeting projects. They range from simple rules of thumb to sophisticated statistical techniques. The following are the popular techniques to handle risk.

5.4.1.1 Pay Back Period

Pay back period is one of the oldest and commonly used methods for selecting capital budgeting projects. It is the period required to recover initial investment of the project. Firms using this method prefer short pay back period to longer pay back periods short period involves less risk compared to longer period. For example there are two projects A and B, project A pay back period is 3 years and project B pay back period is 6 years. If the pay back criteria is applied project A should be selected as its pay back period is less than project B. Thus the project A involves less risk than project B. Pay back period method makes an allowance for risk by emphasising liquidity of the firm and by favouring short-term projects.

5.4.1.2 Risk Adjusted Discount Rate

This method is based on the presumption that investors expect more rate of return on risky projects as compared to less risky projects. The required rate of return will be equal to risk free rate plus risk premium. This method is similar to the net present value method, except adding some percentage of risk premium to risk free rate of return. Net Present Value may be computed by using the following formula.

$$NPV = \sum_{t=1}^{n} \frac{A_t}{(1+k)^t} - Co$$

A_t	=	Cash inflows for period (t)
n	=	No. of years
k	=	Risk adjusted descount rate (Risk free rate + Risk premium)
Co	=	Cash outflow

The risk adjusted discount rate accounts for risk, by varying the discount rate, depending on the degree of risk of investment projects. A higher rate will be used for with high risk project and lower rate for less risky project. The net present value will decrease with increasing k, indicating that the risky project is perceived, the less likely it will be accepted. For example, consider an investment project costing Rs. 50,000/- and is expected to generate cash flows of Rs.25,000/- and Rs.20,000/-, Rs.10,000/-, Rs. 10,000/-. What is the NPV, if it is discounted at 15% rate of return (10% risk free rate + 5% risk, premium)

$$NPV = \frac{25000}{(1+.15)^1} + \frac{20000}{(1+.15)^2} + \frac{10000}{(1+.15)^3} + \frac{10000}{(1+.15)^4} - 50000 = (-)Rs.845$$

Since the projectís NPV is negative the project should be rejected.

Advantages

(a) It is easy to understand and simple to calculate
(b) It recognise the risk involved in projects.

Disadvantages

(a) There is no easy way to determine risk adjusted discount rate

(b) If does not make any adjustment in the numerator for the cash flows that are forecast over the future years.

(c) It is based on the assumption that investors are risk averse.

5.4.1.3 Certainty Equivalent Method

According to this method, the estimated cash flows are reduced to conservative level by applying a correction factor refered as a certainty equivalent coefficient. The correction factor is the ratio of riskless cash flow to risky cash flow.

$$Certainty\ Equivalent\ Coefficient\ (\alpha_t) = \frac{Riskless\ Cash\ flow}{Risky\ Cash\ flow}$$

For example, if one expected a risky cash flow of Rs. 80,000/- in period t and considers a certain cash flow of Rs. 60,000/- equally desirable, then a_t will be 0.75 = 60,000 / 80,000 under this method, certainty equivalent coefficients are calculated for cash flows of each year. They are then multiplied with the cash flows to ascertain cash flows which may be used for the purpose of determining NPV or IRR.

$$NPV = \sum_{t=1}^{n} \frac{\alpha t A_t}{(1+k_f)^t} - Co$$

Where

A_t	=	The forecast of net cash flow without risk adjustment.
a_t	=	Certainty equivalent coefficient for year t
K_f	=	risk less interest rate
C_o	=	Cash outflow.

A project costs Rs. 6,000 and it has cash flow of Rs. 4,000, Rs. 3,000, Rs. 2,000 and Rs. 1,000 in 1 to 4 years. Assumed that the associated certainty equivalent coefficient factors (α_t) are estimated to be $\alpha_0 = 1.00$, $\alpha_1 = 0.90$, $\alpha_2 = 0.70$, $\alpha_3 = 0.50$, and $\alpha_4 = 0.30$ and the risk free discount rate is 10 percent, the present value will be :

$$\text{NPV} = \frac{0.90x4,000}{(1+.10)^2} + \frac{0.70x3,000}{(1+.10)^2} + \frac{0.50x2,000}{(1+.10)^3} + \frac{0.30x1,000}{(1+.10)^4} - (1.00x6,000) = (-)Rs.37$$

If the IRR is to be calculated we will calculate the rate of discount which equates the present value of certain equivalent cash inflows with present value of certain equivalent cash outflows.

Risk adjusted discounted rate Vs. Certainty equivalent :

The certainty equivalent method recognises the risk in capital budgeting by adjusting estimated cash flows and employ risk free rate to discount the adjusted cash flows. On the other hand, the risk-adjusted discount rate adjusts for risk by adding some risk premium to risk free rate of return and arriving the discount rate. Certainty equivalent approach is theoretically superior technique over the risk adjusted discount approach. It can measure risk more accurately. The risk adjusted discount approach will yield the same results, as the certainty equivalent approach if the risk free rate is constant and the risk adjusted discount rate is same for all future periods.

5.4.1.4 Sensitivity Analysis :

It is a technique, which indicates exactly how much the NPV/IRR will change in response to a given change in an input variable other things held constant. It indicates how sensitive a project NPV or IRR is to changes in particular variables. (Sales volume, price, variable cost, fixed cost, investment, project life etc.). The more sensitive the NPV, the more critical the variable. The following three steps are involved in the use of sensitivity analysis.

(a). Identification of all the variables which have an influence on the projects NPV or IRR.
(b) Establish the relationship between the variables.

(c) Analyse the impact of change in each of the variables on the projects NPV or IRR

The decision maker, while conducting sensitivity analysis computes the projects NPV or IRR for each forecast under three assumptions with the probability of their occurrence. a) pessimistic b) expected, and c) optimistic. It allows him to ask "what if" questions. For example

What is the NPV, if volume increases or decreases ?

What is the NPV, if variable cost or fixed cost increases of decreases ?

What is the NPV, if selling price increase or decreases ?

What is the NPV, if the project is delayed or outlay increases or the projectís life is more or less than anticipated?

A whole range of questions can be answered with the help of sensitivity analysis. It examines the sensitivity of the variables (volume, cost, price, time, investment, life, etc.,) underlying the computation, NPV or IRR rather than attempting to quantify risk.

$$NPV = \sum_{t=1}^{n} \frac{[Q(P-V)-F-D](1-T)+D}{(1+r)^t} + \frac{S}{(1+r)^n} - I$$

Where

NPV	=	net present value of the project
Q	=	number of units sold annually
P	=	selling price per unit
V	=	variable cost per unit
F	=	total fixed cost, excluding depreciation and interest
D	=	annual depreciation charge
T	=	income tax rate
r	=	cost of capital / discount rate / required rate of return
n	=	project life in years
S	=	net salvage value
I	=	initial cost

Advantages :

1) It compels the decision maker to identity the variables which will influence projects NPV or IRR. This helps him in understanding the project in totality.
2) It indicates the critical variables which have negative impact on the project NPV or IRR.
3) It helps to expose in appropriate forecast and thus guides the decision maker to concentrate on relevant variables.

Limitations :

1) It does not provide clear cut results.
2) It fails to focus on the inter-relationship between variables, for example sales volume may be related to price, cost and expenditure over advertisement.

5.4.2 Statistical Techniques (Non-conventional)

In the above part of this lesson you have studied the meaning and sources of risk. In addition to this, conventional techniques to handle risk in capital expenditure projects are also explained. The purpose of this part is to explain the use of statistical techniques such as probability, standard deviation, coefficient of variation and decision tree in handling the risk of capital budgeting projects. These statistical techniques are analytical tools drawn from the fields of mathematics, logic, economics and psychology, enable the decision maker to make decision under certainty.

5.4.2.1 Probability Assignment

The concept of probability is one of the statistical techniques to handle risk in capital budgeting projects. It may be described as a "measure of some one's opinion about the likelihood that an event will occur". If an event is certain to occur, we can say that it has 100% probability of occurance one. If an event is certain not to occur, we can say that its probability of occurring is zero. Thus the probability of occur all events lies between 0 and 1.

A probability of distribution may consist of number of estimates. But in simple form it may consist of a few estimates. Some commonly used form are "high, low and best guess" estimates, or optimistic, most likely and pessimistic" estimates. For example, the annual cash flows expected from a project could be :

Assumption of guess	Annual Cash flows (Rs)
Best	10,000
High	8,500
Low	4,000

It can be seen that this is an improvement over the single forecast. Which is not sufficient. The forecaster should describe more accurately his degree of confidence in his forecasts, i.e., he should describe his feelings as to the probability of these estimates occurring. For example, he may assign the following probabilities to his estimates:

Assumption of guess	Annual Cash flow (Rs)	Probability
Best	10,000	0.20
High	8,500	0.60
Low	4,000	0.20

Once the probability assignments are given to the future cashflows, the next step is to find out the expected net present value. The expected net present value can be found out by multiplying the monetary values of the cash flows by their probabilities. Consider the above example (assume investment as Rs. 6,000).

Assumption of guess	Annual cash flow (Rs)	Probability	Expected cash flow (Rs.)
Best	10,000	0.20	2,000
High	8,500	0.60	5,100
Low	4,000	0.20	800
Total Expected Cash flow			**7,900**

The forecaster considers the chance or probability of annual cash flows being either Rs. 10,000/- (maximum) or Rs. 4,000/- (minimum) is 0.20 (20%) each. There is 0.60 (60%) probability that annual cash flows may be Rs. 8,500/-.

Example : 1 Opec Co.Ltd., has given the following possible cash inflows for two of their projects M and N both projects will require an equal investment of Rs. 5,000/-. You are required to suggest which project should be accepted at 10% discount rate.

Possible Events	Cash flow (Rs)	**Project:M** **Probability**	**Project : N** **Cash flow** (Rs)	**Probability**
A	4,000	0.10	12,000	0.10
B	5,000	0.20	10,000	0.15
C	6,000	0.40	8,000	0.50
D	7,000	0.20	6,000	0.15
E	8,000	0.10	4,000	0.10

Solution :

Calculation of expected cash flows for project M and N

Possible Event	Cash flow (Rs)	Project : M Probability	Expected Cash flow (Rs)	Cash Flow	Proejct : N Probability	Expected Cash flow (Rs.)
A	4,000	0.10	400	12,000	0.10	1,200
B	5,000	0.20	1,000	10,000	0.15	1,500
C	6,000	0.40	2,400	8,000	0.50	4,000
D	7,000	0.20	1,400	6,000	0.15	900
E	8,000	0.10	800	4,000	0.10	400
		Total	**6,000**		**Total**	**8,000**

The above calculations show that project Y has higher expected cash flow as compared to project X. If expected cash flows are discounted @ 10% the net present value for project X will be : Rs.(6,000 x .909)- 5,000/-= Rs.454/-. The net present value of project Y will be (8,000 x .909) - 5,000 = Rs. 2272/-. From these calculations it can be seen that NPV of project Y is more than that or project X. Therefore it is advisable to accept project Y.

5.4.2.2. Standard Deviation and Coefficient of Variation

The probability assignment approach to risk analysis in capital budgeting does not provide decision maker, about the variability of cash flows and therefore the risk. To overcome this limitation, standard deviation technique is used. Which is an absolute measure of risk. In case of capital budgeting this measure is used to compare the variability of possible cash flows of different projects from their respective mean. A project having larger standard deviation will be more risky as compared to a project having smaller standard deviation.

The following steps are involved in calculating standard deviation :

1) Mean value of possible cash flows is computed.
2) Deviations between the mean value and the possible cash flows are found out.
3) Deviations are squared.
4) Squared deviations are multiplied by the assigned probabilities which give weighted squared deviation.
5) The weighted squared deviations are totalled and their square root is found out. The resulting figure is the standard deviation.

Standard deviation is calculated by using the following formula.

$$\sigma_{NPV} = \sqrt{\sum_{t=1}^{n} (R-\bar{R})^2 p_i}$$

Where :

s = standard deviation
n = Number of years
R = expected cash flows
R = Mean of the cash flows
p_i = probability assignments

Example : 2 Consider the date given in example I and calculate the standard deviation

Solution :

Project : X

Events	Cash inflows (Rs)	(R-*R*)	(R-*R*)^2	Pi	(R-*R*)^{2}Pi
A	4,000	-2,000	40,00,000	0.10	4,00,000
B	5,000	-1,000	10,00,000	0.20	2,00,000
C	6,000	0	0	0.40	0
D	7,000	1,000	10,00,000	0.20	2,00,000
E	8,000	2,000	40,00,000	0.10	4,00,00
Total	**30,000**				**12,00,000**

$$R = \frac{\sum R}{N} = \frac{Rs.30,000}{5} = 6,000$$

Standard Deviation of Project "x" = $\sqrt{12,00,000} = Rs\ 1,095$

Project : Y

Events	Cash inflows (Rs)	(R-$\bar{R}$) R=8000	(R- $\bar{R}$)^2	Pi	(R- $\bar{R}$)^{2}Pi
A	12,000	4,000	1,60,00,000	.10	16,00,000
B	10,000	2,000	40,00,000	.15	6,00,000
C	8,000	0	0	.50	0.
D	6,000	-2,000	40,00,000	.15	6,00,000
E	4,000	-4,000	1,60,00,000	.10	16,00,000
Total	40,000				44,00,000

$$\bar{R} = \frac{\sum R}{N} = \frac{Rs.\ 40,000}{5} = Rs.8,000$$

Standard Deviation of Project y= $\sqrt{44,00,000} = Rs.2,098$

The standard deviation of project X is Rs.1,095 where as for the project Y is Rs.2,098. Thus variability of cash flows is more in case of project Y as compared to project X. Hence, project Y is more risky.

Coefficient of Variation

Coefficient of variation is a relative measure of risk. It is defined as the standard deviation of probability distribution devided by its expected value. Which is calculated as :

$$Coefficient\ of\ variation = \frac{Standard\ Deviation}{Expected\ (mean)\ value}$$

Consider the above example and calculate the coefficient of variation.

$$Project\ x = \frac{1095}{6000} = 0.1825$$

The coefficient variation of project Y is more as compared to project X. Hence,

$$Project\ y = \frac{2098}{8000} = 0.2623$$

Here, the project Y is more risky. Where as the acceptance of project X or Project Y will depend upon the investors attitude towards risk. He would prefer project Y if he is ready to bear more risk in order to get higher return, If he has aversion towards to risk, he would accept project X as it is less risky.

The coefficient of variation is a useful measure of risk when we are comparing the projects which have

i) same standard deviation but different expected values, or

ii) different standard deviations but same expected values, or

iii) different standard deviations but different expected values.

5.4.2.3. Probability Distribution Approach

In the earlier part of this lesson while dealing with basic concept of risk, the concept of probability was used for incorporating risk in evaluating capital budgeting proposals. The probability distribution of cash flows overtime provides valuable information about the expected value of return and dispersion of the probability distribution of possible returns. On the basis of this information, accept or reject decision can be taken.

5.4.2.4 Independent and Dependent Cash Flows :

The application of the theory in analysing risk in capital budgeting depends upon the behaviour of cash flows. From the point of view of behaviour, cash flows may be
i) independent or ii) dependent.

Independent Cash Flows : The assumption is that the cash flows are independent overtime. So that the future cash flows are not affected by cash flows of the preceding years. Thus, the cash flow in year 3 are not dependent on the cash flow of the year 2 and so on.

Dependent Cash Flows : When cash flows in one period depend upon the cash flows in previous periods they are referred to as dependent cash flows. Any of the decisions may be dependent on the outcome of preceding or the outcomes of trial. A decision tree is a diagrammatic representation of the relationship among the decision state of nature and pay-offs or outcomes.

5.4.2.5 Decision Tree Analysis:

Decision tree analysis is another technique of analysing the risk involved in capital budgeting proposals. Decision tree is a "graphic display of relationship between a present decision and possible future events, future decisions and their consequences. The sequence of event is mapped out over time in a format similar to the branches of tree". In other words, it is a pictorial representation in tree form which indicates the magnitude.

The following steps are taken for constructing a decision tree.

1) **Define investment** : The first step in constructing decision tree is to define the proposal. For example, entering a new market or introducing new product line.
2) **Identify decision alternatives** : The decision alternatives should be clearly identified. For example, a firm may be considering the purchase of new plant for manufacturing a new product. It may have three alternatives (a) Purchases a small plant (b) Purchases a large plant (c) Purchase a medium size plant.
3) **Draw a decision tree** : The decision tree is then laid down showing decision point and decision branches.
4) **Analyse data** : The results should be analysed and the best alternative should be selected.

Usefulness of Decision Tree Approach :

The decision tree approach useful in handling the sequential investments the working backwards from future to present, we are able to eliminate unprofitable branches and determine optimum decision at various decision points.

The merits of decision tree are :

i) It clearly brings out the implicit assumptions and calculations for all to see, question and revise.
ii) It allows decision maker to visualise assumptions and alternatives in graphic form, which is easier to understand than abstract form.

However, decision tree diagrams can become more complicated as the decision maker decides to include alternatives and more variables and look farther in time. If the analysis is extended to include interdependent alternatives and variables, it becomes more complicated further. So the diagram becomes cumbersome and calculations become very time consuming and difficult.

Example :3

Suppose a firm has an investment proposal, requiring an outlay of Rs. 20,000/- at present (t = 0). The investment proposal is expected to have 2 years economic life with no salvage value. In year 1, there is 0.3 probability that CFAT will be Rs. 8,000/- ; a 0.4 probability that CAFT will be Rs. 11,000/- and a 0.3 probability that CFAT will be Rs. 15,000/-. In year 2, the CFAT possibilities depend on the CFAT that occurs in year 1. That is, the CFAT for the year 2 are conditional on CFAT for year 1. Accordingly the probabilities assigned with the CFAT for the year 2 are conditional probabilities. The estimated conditional CFAT and their associated conditional probabilities are as under :

If $CFAT_1$ = Rs. 8,000		If $CFAT_2$ = Rs. 11,000		If $CFAT_3$ = Rs. 15,000	
$CFAT_2$ (Rs.)	Probability	$CFAT_2$ (Rs.)	Probability	$CFAT_2$ (Rs.)	Probability
4,000	0.2	13,000	0.3	16,000	0.1
10,000	0.6	15,000	0.4	20,000	0.8
15,000	0.2	16,000	0.3	24,000	0.1

Calculate the Net present value (NPV) with the help of a decision tree diagram.

Solution :

Time = 0	Year 1 Probability	Year 1 CFAT	Year 2 Probability	Year 2 CFAT	Path No.	Expected NPV	Joint Probability (Pj)	Expected NPV NPV x Pj
			0.2	4,000	1	-9,668	0.06	-580
	0.3	8,000	0.6	10,000	2	-4,886	0.18	-879
			0.2	15,000	3	-901	0.06	-54
			0.3	13,000	4	184	0.12	22
Cash Out Lay Rs.20,000	0.4	11,000	0.4	15,000	5	1,778	0.16	284
			0.3	16,000	6	2,575	0.12	309
			0.1	16,000	7	6,147	0.03	184
	0.3	15,000	0.8	20,000	8	9,335	0.24	2240
			0.1	24,000	9	12,523	0.03	376
							1.00	**Rs.1902**

Joint Probability = Product of Probabilities of CFAT for years 1 and 2.

The above Decision Tree (DT) covers all dimensions of the problem : i) Timing of the CFAT ii) The possible CFAT outcomes in each year and probabilities associated with these outcomes. The DT shows nine distinct possibilities, the project could assumed accepted. For example one possibility is that the CFAT for the 1st year may amount Rs. 8,000/- and for the second year Rs. 4,000/-. A close observation of the figure indicates that this is the worst event could happen. Assuming a 12% discount rate, the NPV could be negative in this situation. Likewise, the best outcome that could occur is $CFAT_1$ = Rs. 15,000/- and $CFAT_2$ = Rs. 24,000/-. The NPV would be the highest in this situation among all the nine possible combinations.

The expected NPV of the project is given by the following mathematical formula :

$$\overline{NPV} = \sum_{j=1}^{n} P_j \; NPV_j$$

Where

Pj = probability of *j*th path occurring which is equal to the joint probability along the path.

NPVj = NPV of *j*th path occurring.

5.5 SUMMARY :

The analysis of risk and uncertainty is an important element in capital budgeting decisions. The term risk refers to the variability of actual return from the expected returns in terms of cash flows.

The risk involved in capital budgeting can be measured in absolute as well as relative terms. The absolute measure of risk includes sensitivity analysis and standard deviation. The coefficient of variation is a relative measure of risk. There are four well recognised methods of calculation of risk in capital budgeting decision framework :

Risk-adjusted discount rate approach (RAD), Certainty equivalent approach (CEA), Probability distribution approach (PDA) and Decision tree approach (DTA).

5.6 KEYWORDS :

Certainty Equivalent : The return required with certainty to make investors indifferent between the certain return and a particular uncertain return.

Co-efficient of variation : A relative measure of variability of the outcomes associated with an event. It is calculated by dividing the standard deviation of a distribution by the mean.

Decision Tree : It is an analytical technique to set forth graphically the pattern of relationship between decisions and chance events. It is used to handle risk situations.

Risk Adjusted Discount Rate : A discount rate used in capital expenditure decisions that has been adjusted for risk it determines by adding an appropriate risk premium to the risk less rate of return.

Risk Premium : It is the difference between expected rate of return on a risky project and the rate of return on a risk less project.

Sensitivity Analysis : It is the analysis about the effect of the change in certain variable on an outcome, to estimate the variability of the outcome, or risk associated with a project.

5.7 SELF ASSESSMENT QUESTIONS :

1) Why do you measure risk ? Explain the types and sources of risk.
2) "Risk is measured by the possible variation of outcomes around the expected value" Discuss.
3) What makes risk important in the selection of projects ? Explain briefly the various methods of evaluating risky projects ? Can you think of a capital budgeting project that would have perfectly certain returns ?
4) What is risk adjusted discount rate ? Explain its Merits and demerits?
5) Define the certainty equivalent method. Explain the significance of certainty equivalent method.

6) Compare and contrast risk adjusted discount rate and certainty equivalent method.

7) "Risk and uncertainty are quite inherent in capital budgeting decisions" comment.

8) Explain the concept of sensitivity analysis. How it can take care of risk and uncertainty in capital investment decisions?

9) What are the various statistical techniques to handle risk in capital budgeting decisions ? Explain?

10) How is risk assessed for a particular investment by using probability distribution ?

11) What is Decision Tree? Explain the process of constructing a decision tree. Also explain its merits and demerits.

5.8 FURTHER READINGS :

Pandey I.M. : "Financial Management", Vikas Publishers, New Delhi

Khan & Jain : "Financial Management" Tata Mc Graw Hill publishing co., New Delhi.

Maheswari S.N. : "Financial Management", Sultan Chand and sons, New Delhi.

Van Horne J.C. : "Financial Management and Policy" prentice-Hall of India, New Delhi.

Solomon E. : "Theory of Financial Management" Columbia University press, New York.

Weston J.F. and Brigham E.F. : "Managerial Finance", Holt, Rinehart and Winston

Prasanna Chandra : 'Financial Management' Tata Mc Graw Hill Publishing co New Delhi.