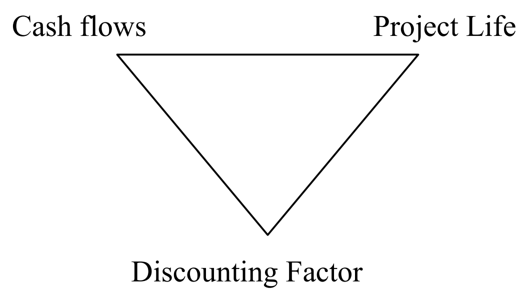
2. CAPITAL BUDGETING TECHNIQUES

Chapter 2 : CAPITAL BUDGETING TECHNIQUES

2.1 Introduction:

Any investment decision depends upon the decision rule that is applied under circumstances. However, the decision rule itself considers following inputs.



The effectiveness of the decision rule depends on how these three factors have been properly assessed. Estimation of cash flows require immense understanding of the project before it is implemented; particularly macro and micro view of the economy, polity and the company. Project life is very important, otherwise it will change the entire perspective of the project. So great care is required to be observed for estimating the project life. Cost of capital is being considered as discounting factor which has undergone a change over the years. Cost of capital has different connotations in different economic philosophies. Particularly, India has undergone a change in its economic ideology from a closed-economy to open-economy. Hence determination of cost of capital would carry greatest impact on the investment evaluation.

This chapter is focusing on various techniques available for evaluating capital budgeting projects. I shall discuss all investment evaluation criteria from its economic viability point of view and how it can help in maximizing shareholders' wealth. We shall also look for following general virtues in each technique[1].

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[1] Pandey I M, Financial Management, Vikas Publishing House Pvt Ltd, p.143

1. It should consider all cash flows to determine the true profitability of the project.

2. It should provide for an objective and unambiguous way of separating good projects from bad projects.

3. It should help ranking of projects according to its true profitability.

4. It should recognize the fact that bigger cash flows are preferable to smaller ones and early cash flows are preferable to later ones.

5. It should help to choose among mutually exclusive projects that project which maximizes the shareholders' wealth.

6. It should be a criterion which is applicable to any conceivable investment project independent of others.

A number of capital budgeting techniques are used in practice. They may be grouped in the following two categories: -

I. Capital budgeting techniques under certainty; and

II. Capital budgeting techniques under uncertainty

2.2 Capital budgeting techniques under certainty:

Capital budgeting techniques (Investment appraisal criteria) under certainty can also be divided into following two groups:

2.2.1 Non-Discounted Cash Flow Criteria: -

(a) Pay Back Period (PBP)

(b) Accounting Rate Of Return (ARR)

2.2.2 Discounted Cash Flow Criteria: -

(a) Net Present Value (NPV)

(b) Internal Rate of Return (IRR)

(c) Profitability Index (PI)

2.2.1 Non-Discounted Cash Flow Criteria:

These are also known as traditional techniques:

(a) Pay Back Period (PBP) :

The pay back period (PBP) is the traditional method of capital budgeting. It is the simplest and perhaps, the most widely used quantitative method for appraising capital expenditure decision.

Meaning:

It is the number of years required to recover the original cash outlay invested in a project.

Methods to compute PBP:

There are two methods of calculating the PBP.

(a) The first method can be applied when the CFAT is uniform. In such a situation the initial cost of the investment is divided by the constant annual cash flow: For example, if an investment of Rs. 100000 in a machine is expected to generate cash inflow of Rs. 20,000 p.a. for 10 years. Its PBP will be calculated using following formula:

$$PBP = \frac{Initial Investment}{Constant Annual Cash inflow} = \frac{100000}{20000} = 5 years$$

(b) The second method is used when a project's CFAT are not equal. In such a situation PBP is calculated by the process of cumulating CFAT till the time when cumulative cash flow becomes equal to the original investment outlays.

For example, A firm requires an initial cash outflow of Rs. 20,000 and the annual cash inflows for 5 years are Rs. 6000, Rs. 8000, Rs. 5000, Rs. 4000 and Rs. 4000 respectively. Calculate PBP. Here, When we cumulate the cash flows for the first three years, Rs. 19,000 is recovered. In the fourth year Rs. 4000 cash flow is generated by the project but we need to recover only Rs. 1000 so the time required recovering Rs. 1000 will be (Rs.1000/Rs.4000)× 12 months = 3 months. Thus, the PBP is 3 years and 3 months (3.25 years).

Decision Rule:

The PBP can be used as a decision criterion to select investment proposal.

- If the PBP is less than the maximum acceptable payback period, accept the project.
- If the PBP is greater than the maximum acceptable payback period, reject the project.

This technique can be used to compare actual pay back with a standard pay back set up by the management in terms of the maximum period during which the initial investment must be recovered. The standard PBP is determined by management subjectively on the basis of a number of factors such as the type of project, the perceived risk of the project etc. PBP can be even used for ranking mutually exclusive projects. The projects may be ranked according to the length of PBP and the project with the shortest PBP will be selected.

Merits:

1. It is simple both in concept and application and easy to calculate.
2. It is a cost effective method which does not require much of the time of finance executives as well as the use of computers.

3. It is a method for dealing with risk. It favours projects which generates substantial cash inflows in earlier years and discriminates against projects which brings substantial inflows in later years . Thus PBP method is useful in weeding out risky projects.

4. This is a method of liquidity. It emphasizes selecting a project with the early recovery of the investment.

Demerits:

1. It fails to consider the time value of money. Cash inflows, in pay back calculations, are simply added without discounting. This violates the most basic principles of financial analysis that stipulates the cash flows occurring at different points of time can be added or subtracted only after suitable compounding/ discounting.

2. It ignores cash flows beyond PBP. This leads to reject projects that generate substantial inflows in later years. To illustrate, consider the cash flows of two projects, "A" & "B":

Year	Project "A"	Project "B"
0	Rs. 2,00,000	Rs. 2,00,000
1	100,000	40,000
2	60,000	40,000
3	40,000	40,000
4	20,000	80,000
5		60,000
6		70,000

The PB criterion prefers A, which has PBP of 3 years in comparison to B, which has PBP of 4 years, even though B has very substantial cash flows in 5&6 years also. Thus, it does not consider all cash flows generated by the projects.

3. It is a measure of projects capital recovery, not profitability so this can not be used as the only method of accepting or rejecting a project. The organization need to use some other method also which takes into account profitability of the project.

4. The projects are not getting preference as per their cash flow pattern. It gives equal weightage to the projects if their PBP is same but their pattern is different. For example, each of the following projects requires a cash outlay of Rs. 20,000. If we calculate its PBP it is same for all projects i.e. 4 years so all will be treated equally. But the cash flow pattern is different so in fact, project Y should be preferable as it gives higher cash inflow in the initial years.

CASH INFLOWS

YEAR	Project X	Project Y	Project Z
1	5000	8000	2000
2	5000	6000	4000
3	5000	4000	6000
4	5000	2000	8000
5	5000	-	-

5. There is no logical base to decide standard PBP of the organization it is generally a subjective decision.

6. It is not consistent with the objective of shareholders' wealth maximization. The PBP of the projects will not affect the market price of equity shares.

Uses:

The PBP can be gainfully employed under the following circumstances.

1. The PB method may be useful for the firms suffering from a liquidity crisis.

2. It is very useful for those firms which emphasizes on short run earning performance rather than its long term growth.

3. The reciprocal of PBP is a good approximation of IRR which otherwise requires trial & error approach.

Payback Reciprocal and the Rate of Return:

Payback is considered a good approximation of the rate of return under following two conditions.

1. The life of the project is too large or at least twice the pay back period.

2. The project generates constant annual cash inflow.

Though pay back reciprocal is a useful way to estimate the project's IRR but the major limitation of it is all investment project does not satisfy the conditions on which this method is based. When the useful life of the project is not at least twice the PBP, it will always exceed the rate of return. Similarly, if the project is not yielding constant CFAT it can not be used as an approximation of the rate of return.[2]

Discounted Payback Period:

One of the major limitations of PBP method is that it does not take into consideration time value of money. This problem can be solved if we discount the cash flows and then calculate the PBP. Thus, *discounted payback period* is the number of years taken in recovering the investment outlay on the present value basis. But it still fails to consider the cash flows beyond the payback. For example, one project requires investment of Rs. 80,000 and it generates cash flow for 5 years as follows.

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[2] ibid. pg.150-151

Table 2.1

Simple PBP and Discounted PBP

Years	0	1	2	3	4	5	Simple PBP	Discou -nted PBP
Cash flow	(80000)	22000	30000	40000	32000	16000	2.7 years	
PV@ 5%		0.833	0.694	0.579	0.482	0.402		
PV		18326	20820	23160	15424	6432		
Cumulative PV of cash flow		18326	39146	62306	77730	84162		4.03 years

The simple pay back of the project is 2.7 years while discounted pay back is 4.03 years which is higher than simple pay back because the discounted payback is using cash flow after discounting it with the cost of capital.

(b) Accounting/Average Rate of Return (ARR):

This method is also known as the return on investment (ROI), return on capital employed (ROCE) and is using accounting information rather than cash flow.

Meaning:

The ARR is the ratio of the average after tax profit divided by the average investment.

Method to compute ARR:

There are a number of alternative methods for calculating ARR. The most common method of computing ARR is using the following formula:

$$ARR = \frac{Average Annual\ Profit After Tax}{Average Investment} \times 100$$

The average profits after tax are determined by adding up the PAT for each year and dividing the result by the number of years.

The average investment is calculated by dividing the net investment by two. Thus,

$$ARR = \frac{\left[\sum_{t=1}^{n} EBIT_t(1-T)\right] \div n}{(I_0 + I_n) \div 2}$$

Where, EBIT is earnings before interest and taxes, T tax rate, I_0 book value of investment in the beginning, I_n book value of investment at the end of n years.

For example, A project requires an investment of Rs. 10,00,000. The plant & machinery required under the project will have a scrap value of Rs. 80,000 at the end of its useful life of 5 years. The profits after tax and depreciation are estimated to be as follows:

Year	1	2	3	4	5
PAT (Rs)	50000	75000	125000	130000	80000

We shall calculate ARR using above formula.

$$ARR = \frac{(50000 + 75000 + 125000 + 130000 + 80000) \div 5}{(1000000 + 80000) \div 2} = 17.04\%$$

Decision Rule:

The ARR can be used as a decision criterion to select investment proposal.

- If the ARR is higher than the minimum rate established by the management, accept the project.
- If the ARR is less than the minimum rate established by the management, reject the project.

The ranking method can also be used to select or reject the proposal using ARR. It will rank a project number one if it has highest ARR and lowest rank would be given to the project with lowest ARR.

Merits:

1. It is simple to calculate.

2. It is based on accounting information which is readily available and familiar to businessman.

3. It considers benefit over entire life of the project.

Demerits:

1. It is based upon accounting profit, not cash flow in evaluating projects.

2. It does not take into consideration time value of money so benefits in the earlier years or later years cannot be valued at par.

3. This method does not take into consideration any benefits which can accrue to the firm from the sale or abandonment of equipment which is replaced by a new investment. ARR does not make any adjustment in this regard to determine the level of average investments.

4. Though it takes into account all years income but it is averaging out the profit.

5. The firm compares any project's ARR with the one which is arbitrarily decided by management generally based on the firm's current return on assets. Due to this yardstick sometimes super normal growth firm's reject profitable projects if it's ARR is less than the firm's current earnings.

Use:

The ARR can better be used as performance evaluation measure and control devise but it is not advisable to use as a decision making criterion for capital expenditures of the firm as it is not using cash flow information.

2.2.2 Discounted Cash Flow Criteria:

These are also known as modern or time adjusted techniques because all these techniques take into consideration time value of money.

(a) Net Present Value (NPV):

The net present value is one of the discounted cash flow or time-adjusted technique. It recognizes that cash flow streams at different time period differs in value and can be computed only when they are expressed in terms of common denominator i.e. present value.

Meaning:

The NPV is the difference between the present value of future cash inflows and the present value of the initial outlay, discounted at the firm's cost of capital.

The procedure for determining the present values consists of two stages. The first stage involves determination of an appropriate discount rate. With the discount rate so selected, the cash flow streams are converted into present values in the second stage.

Method to compute NPV:

The important steps for calculating NPV are given below[3].

1. Cash flows of the investment project should be forecasted based on realistic assumptions. These cash flows are the incremental cash inflow after taxes and are inclusive of depreciation (CFAT) which is assumed to be received at the end of each year. CFAT should take into account salvage value and working capital released at the end.

2. Appropriate discount rate should be identified to discount the forecasted cash flows. The appropriate discount rate is the firm's opportunity cost of capital

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[3] ibid, pg. 143

which is equal to the required rate of return expected by investors on investments of equivalent risk.

3. Present value (PV) of cash flows should be calculated using opportunity cost of capital as the discount rate.

4. NPV should be found out by subtracting present value of cash outflows from present value of cash inflows. The project should be accepted if NPV is positive (i.e. NPV >0)

The NPV can be calculated with the help of equation.

NPV = Present value of cash inflows – Initial investment

$$W = \frac{A_1}{(1+K)^1} + \frac{A_2}{(1+K)^2} + \ldots\ldots + \frac{A_n}{(1+K)^n} - C$$

$$NPV = \sum_{t=1}^{n} \frac{A_t}{(1+K)t} - C \qquad \textbf{OR} \qquad NPV = \sum_{t=1}^{n} \left(CF_t \times PVIF_{k,t}\right) - CF_0$$

Where,

$\mathbf{A_1, A_2}$ … represent the stream of benefits expected to occur if a course of action is adopted,

C is the cost of that action &

K is the appropriate discount rate to measure the quality of A's.

W is the NPV or, wealth which is the difference between the present worth of the stream of benefits and the initial cost.

$\mathbf{CF_t}$ is the cash flow for t period

PVIF is the present value interest factor

Decision Rule:

The present value method can be used as an accept-reject criterion. The present value of the future cash streams or inflows would be compared with present value of outlays. The present value outlays are the same as the initial investment.

- If the NPV is greater than 0, accept the project.
- If the NPV is less than 0, reject the project.

Symbolically, accept-reject criterion can be shown as below:

$PV > C \rightarrow$ Accept [NPV > 0]

$PV < C \rightarrow$ Reject [NPV < 0]

Where, PV is present value of inflows and C is the outlays

This method can be used to select between mutually exclusive projects also. Using NPV the project with the highest positive NPV would be ranked first and that project would be selected. The market value of the firm's share would increase if projects with positive NPVs are accepted.[4]

For example,

Calculate NPV for a Project X initially costing Rs. 250000. It has 10% cost of capital. It generates following cash flows:

[4] Van Horne, J.C., Financial Management and Policy, Prentice-Hall of India, 1974, p.74

Year	Cash flows	PV @ 10%	PV
1	90000	0.909	81810
2	80000	0.826	66080
3	70000	0.751	52570
4	60000	0.683	40980
5	50000	0.621	31050
		ΣPV	272490
	Less:	NCO	250000
		NPV(Rs.)	22490

As the project has positive NPV, i.e. present value of cash inflows is greater than the cash outlays*, it should be accepted.*

Merits:

This method is considered as the most appropriate measure of profitability due to following virtues.

1. It explicitly recognizes the time value of money.
2. It takes into account all the years cash flows arising out of the project over its useful life.
3. It is an absolute measure of profitability.
4. A changing discount rate can be built into NPV calculation. This feature becomes important as this rate normally changes because the longer the time span, the lower the value of money & higher the discount rate. [5]

[5] Jain P K & Khan M Y, Financial Management (4th ed),Tata McGraw-Hill Publishing Company Ltd, pg 10.25

5. This is the only method which satisfies the value-additivity principle. It gives output in terms of absolute amount so the NPVs of the projects can be added which is not possible with other methods. For example, NPV (X+Y) = NPV (X) + NPV (Y). Thus, if we know the NPV of all project undertaken by the firm, it is possible to calculate the overall value of the firm. [6]

6. It is always consistent with the firm's goal of shareholders wealth maximization.

Demerits:

1. This method requires estimation of cash flows which is very difficult due to uncertainties existing in business world due to so many uncontrollable environmental factors.

2. It requires the calculation of the required rate of return to discount the cash flows. The discount rate is the most important element used in the calculation of the present values because different discount rates will give different present values. The relative desirability of the proposal will change with a change in the discount rate.[7]

3. When projects under consideration are mutually exclusive, it may not give dependable results if the projects are having unequal lives, different cash flow pattern, different cash outlay etc.

4. It does not explicitly deal with uncertainty when valuing the project and the extent of management's flexibility to respond to uncertainty over the life of the project.[8]

5. It ignores the value of creating options. Sometimes an investment that appears uneconomical when viewed in isolation may, in fact, create options that enable the firm to undertake other investments in the future should market conditions turn

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[6] Pandey I M, Financial Management, Vikas Publishing House Pvt Ltd, p.145
[7] op.cit.
[8] Madhani Pankaj M, RO-Based Capital Budgeting: A Dynamic Approach in New Economy, The ICFAI Journal of Applied Finance, November 2008, Vol. 14, No. 11, pg 48-67

favourable. By not accounting properly for the options that investments in emerging technology may yield, naive NPV analysis can lead firms to invest too little.[9]

Use:

NPV is very much in use capital budgeting practice being a true profitability measure.

(b) Profitability Index (PI):

Profitability Index (PI) or Benefit-cost ratio (B/C) is similar to the NPV approach. PI approach measures the present value of returns per rupee invested. It is observed in shortcoming of NPV that, being an absolute measure, it is not a reliable method to evaluate projects requiring different initial investments. The PI method provides solution to this kind of problem.

Meaning:

It is a relative measure and can be defined as the ratio which is obtained by dividing the present value of future cash inflows by the present value of cash outlays. Mathematically[10],

$$PI = \frac{\Pr esentvalueofcash\inf low}{Initialcashoutlay} = \frac{PV(C_t)}{C_0} = \sum_{t=1}^{n} \frac{C_t}{(1+K)^t} \div C_0$$

This method is also known as B/C ratio because numerator measures benefits & denominator cost.

Decision Rule:

Using the PI ratio,

- Accept the project when PI>1
- Reject the project when PI<1
- May or may not accept when PI=1, the firm is indifferent to the project.

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[9] ibid
[10] op.cit.

When PI is greater than, equal to or less than 1, NPV is greater than, equal to or less than 0 respectively.

The selection of the project with the PI method can also be done on the basis of ranking. The highest rank will be given to the project with the highest PI, followed by the others in the same order.

Merits:

1. PI considers the time value of money as well as all the cash flows generated by the project.

2. At times it is a better evaluation technique than NPV in a situation of capital rationing especially. For instance, two projects may have the same NPV of Rs. 20,000 but project A requires an initial investment of Rs. 1, 00,000 whereas B requires only Rs. 50,000. The NPV method will give identical ranking to both projects, whereas PI will suggest project B should be preferred. Thus PI is better than NPV method as former evaluate the worth of projects in terms of their relative rather than absolute magnitude.

3. It is consistent with the shareholders' wealth maximization.

Demerits:

Though PI is a sound method of project appraisal and it is just a variation of the NPV, it has all those limitation of NPV method too.

1. When cash outflow occurs beyond the current period, the PI is unsuitable as a selection criterion.

2. It requires estimation of cash flows with accuracy which is very difficult under ever changing world.

3. It also requires correct estimation of cost of capital for getting correct result.

4. When the projects are mutually exclusive and it has different cash outlays, different cash flow pattern or unequal lives, it may not give unambiguous results.

Use:

It is useful in evaluating capital expenditures projects being a relative measure.

(c) Internal Rate of Return (IRR):

This technique is also known as yield on investment, marginal productivity of capital, marginal efficiency of capital, rate of return, and time-adjusted rate of return and so on. It also considers the time value of money by discounting the cash flow streams, like NPV. While computing the required rate of return and finding out present value of cash flows-inflows as well as outflows- are not considered. But the IRR depends entirely on the initial outlay and the cash proceeds of the projects which are being evaluated for acceptance or rejection. It is, therefore, appropriately referred to as internal rate of return. The IRR is usually the rate of return that a project earns. [11]

Meaning:

The internal rate of return (IRR) is the discount rate that equates the NPV of an investment opportunity with Rs.0 (because the present value of cash inflows equals the initial investment). It is the compound annual rate of return that the firm will earn if it invests in the project and receives the given cash inflows.[12]

Mathematically, IRR can be determined by solving following equation for r[13]:

$$C_0 = \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \ldots\ldots + \frac{C_n}{(1+r)^n}$$

$$C_0 = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t}$$

$$IRR = \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} - C_0 = 0$$

where, r = The internal rate of return

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[11] Jain P K & Khan M Y, Financial Management (4th ed),Tata McGraw-Hill Publishing Company Ltd, pg 10.26
[12] Gitman Lawrence J., Principles of Managerial Finance,10th ed., PEARSON Education, pg. 403
[13] Pandey I M, Financial Management, Vikas Publishing House Pvt Ltd, p.146

C_t = Cash inflows at t period

C_0 = Initial Investment

Methods to compute IRR:

1. When any project generates ***uneven cash flow***, the IRR can be found out by trial and error. If the calculated present value of the expected cash inflow is lower than the present value of cash outflows a lower rate should be tried and vice versa. This process can be repeated unless the NPV becomes zero. For example, A project costs Rs. 32,000 and is expected to generate cash inflows of Rs. 16,000, Rs.14,000 and Rs. 12,000 at the end of each year for next 3 years. Calculate IRR. Let us take first trial by taking 10% discount rate randomly. A positive NPV at 10% indicates that the project's true rate of return is higher than 10%. So another trial is taken randomly at 18%. At 18% NPV is negative. So the project's IRR is between 10% and 18%.

Year	Cash flows	PV @ 10%	PV	PV @ 18%	PV
1	16000	0.909	14544	0.847	13552
2	14000	0.826	11564	0.718	10052
3	12000	0.751	9012	0.609	7308
		ΣPV	35120	ΣPV	30912
		NCO	32000	NCO	32000
		NPV	3120	NPV	(1088)

$$IRR = r + \left(\frac{PV_{co} - PV_{CFAT}}{\Delta PV} \times \Delta r \right)$$

Where,

PV_{co} = Present value of cash outlay

PV_{CFAT} = Present value of cash inflows at lower rate

r = Lower rate

Δr = Difference between higher and lower rate

ΔPV = Difference between PV of CFAT at lower rate and higher rate

Difference in Lower Rate & Higher Rate			Difference in CFAT at Lower rate & Higher rate	
		PV Required	Rs. 32000	Rs. 3120 (PV Required − PV at Lower rate)
8%	10%	PV at Lower rate	Rs. 35120	
	18%	PV at Higher rate	Rs. 30912	Rs. 4208 (PV at Lower rate − PV at Higher rate)

$\therefore$ IRR = 15.93% = 16%

2. When any project generates equal cash flows every year, we can calculate IRR as follows.

For example,

An investment requires an initial investment of Rs. 6,000. The annual cash flow is estimated at Rs. 2000 for 5 years. Calculate the IRR.

NPV = (Rs.6,000) +Rs.2,000 ($PVAIF_{5,r}$) = 0

Rs. 6,000 = 2,000 ($PVAIF_{5,r}$)

$$PVAIF_{5,r} = \frac{Rs.6,000}{Rs.2,000} = 3$$

The rate which gives a PVAIF of 3 for 5 years is the project's IRR approximately. While referring PVAIF table across the 5 years row, we find it approximately under 20% (2.991) column. Thus 20% (approximately) is the project's IRR which equates the present value of the initial cash outlay (Rs. 6000) with the constant annual cash flows (Rs. 2000 p.a.) for 5 years.

Decision Rule:

When IRR is used to make accept-reject decisions, the decision criteria are as follows:

- If the IRR is greater than the cost of capital, accept the project. (r >k)
- If the IRR is less than the cost of capital, reject the project. (r<k)

Table 2.2

NPV Profile

Cash Flow (Rs)	Discount Rate	NPV (Rs)
(6000)	0%	4000
2000	5%	2659
2000	10%	1582
2000	19%	115
2000	19.86%	0
2000	35%	(1560)

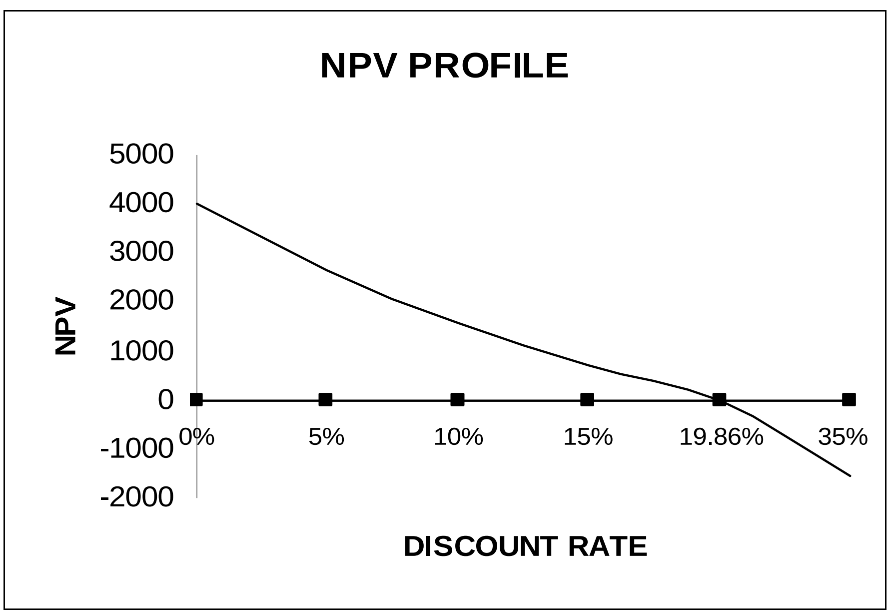

Figure 2.1

One can observe in the above table and figure that NPV of a project declines as the discount rate increases and NPV will be negative when discount rate is higher than the project's IRR. NPV profile of the project at various discount rates is shown above. When the discount rate is less than 19.86% IRR, then the project has positive NPV; if it is equal to IRR, NPV is zero; and when it greater than IRR, NPV is negative (at 35%). Thus, IRR can be compared with the required rate of return. When projects are independent and cash flows are conventional, IRR and NPV will give the same results if there is no funds constraint but when the projects are mutually exclusive both these methods may give conflicting results if the projects under consideration are having unequal lives, different cash outlays, and different cash inflow pattern.

Merits:

1. It considers the time value of money and it also takes into account the total cash flows generated by any project over the life of the project.

2. IRR is a very much acceptable capital budgeting method in real life as it measures profitability of the projects in percentage and can be easily compared with the opportunity cost of capital.

3. It is consistent with the overall objective of maximizing shareholders wealth.

Demerits:

1. It requires lengthy and complicated calculations.

2. When projects under consideration are mutually exclusive, IRR may give conflicting results.

3. We may get multiple IRRs for the same project when there are non-conventional cash flows especially.

4. It does not satisfy the value additivity principle which is the unique virtue of NPV. For example,

Project	C_0 (Rs)	C_1 (Rs)	NPV @ 10% (Rs)	IRR (%)
X	(200)	240	18.18	20.0%
Y	(300)	336	5.45	12.0%
X+Y	(500)	576	23.64	15.2%

2.3 Comparison of NPV and IRR:

Both NPV and IRR will give the same results (i.e. acceptance or rejections) regarding an investment proposal in following two situations.

1. When the project under consideration involve conventional cash flow. i.e. when an initial cash outlays is followed by a series of cash inflows.

2. When the projects are independent of one another i.e., proposals the acceptance of which does not preclude the acceptance of others and if the firm is not facing a problem of funds constraint.

The reasons for similarity in results in the above cases are simple. In NPV method a proposal is accepted if NPV is positive. NPV will be positive only when the actual rate of return on investment is more than the cut off rate. In case of IRR method a proposal is accepted only when the IRR is higher than the cut off rate. Thus, both methods will give consistent results since the acceptance or rejection of the proposal under both of them is based on the actual return being higher than the required rate i.e.

- NPV will be positive only if $r > k$,
- NPV will be negative only if $r < k$,
- NPV would be zero only if $r = k$

2.4 Problems with IRR:

➢ Non-conventional Cash Flows:

When IRR is used to appraise non-conventional cash flow, it may give multiple IRR. For example, A project has following cash flow stream attached with it:

Project	C_0	C_1	C_2	NPV @25%	NPV @400%
A (Rs)	(80000)	500000	(500000)	Rs.0	Rs.0

Table 2.3

Dual Internal rate of return

NPV (Rs.)	Discount rate (%)
(80,000.00)	0
(38,677.69)	10
0.00	25
31,111.11	50
45,000.00	100
40,000.00	150
31,111.11	200
22,040.82	250
13,750.00	300
6,419.75	350
0.00	400

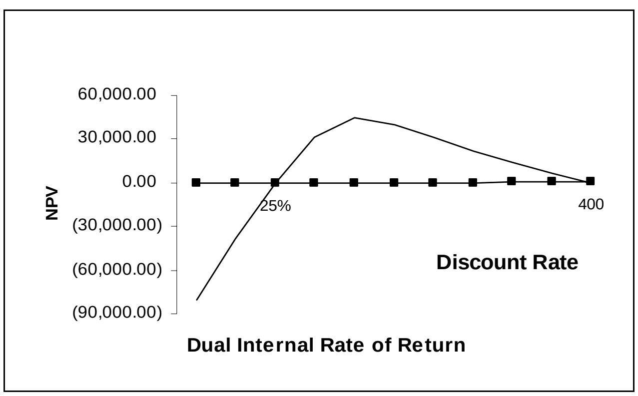

Figure 2.2

We can see in the above table and figure that NPV is zero at two discount rates 25% as well as 400%. Which of the two is appropriate? In fact, NPV is positive in between the two rates i.e. 25% and 400%. The number of rates of return depends on the number of times the sign of cash flow changes. In the above project, there are two reversals of sign (-+-) and we have two rates of return. So it is better to use NPV method for evaluating the projects instead of making modification in IRR and using it.[14]

➢ **Lending vs. Borrowing Projects:**

It is difficult to distinguish and select between lending and borrowing projects using IRR method. For example, Project P and Project Q have the following cash flow. It's NPV and IRR are as follows:

Project	C_0 (Rs)	C_1 (Rs)	NPV @ 10% (Rs)	IRR (%)
P	(20000)	30000	7,272.73	50.0%
Q	20000	(35000)	(11,818.18)	75.0%

Using IRR method Project Q is more lucrative than Project P, while NPV of Project P is higher than Project Q. It means Project P is better than Project Q. In fact, Project Q is not good because it requires borrowing Rs. 20,000 at a rate 75% Whereas Project P requires investing Rs. 20,000 at a rate of 50% so obviously P is better than Q but IRR method says Q is better than P.

➢ **Mutually Exclusive Projects:**

NPV and IRR methods may give conflicting results in case of mutually exclusive projects i.e. projects where acceptance of one would result in non-acceptance of other. Such conflicts of results may be due to any one or more of the following reasons.[15]

1. The projects require different cash outlays.

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[14] ibid, p.155
[15] Maheshwari Dr S N, Financial Management, Sultan Chand & Sons, pg D.253

2. The projects have unequal lives.

3. The project has different patterns of cash flows.

Let us understand each of the above mentioned reasons in detail for conflicting ranking of the projects using NPV and IRR.[16]

(1) Different Net Cash Outlay:

When the cash outlays required for different projects are of different size altogether, these two methods (NPV & IRR) may give conflicting results. For example, if we calculate NPV and IRR for the following two projects X and Y, Project X's NPV at 10% discount rate is Rs. 4450.79 and IRR is 28%. Project Y's NPV at 10% minimum required rate of return is Rs. 24,372.65 and IRR is 17%. If we calculate IRR using incremental approach, it is 16% which is higher than the 10% discount rate of the project. Therefore, Project Y should be selected.

Table 2.6

Different net cash out lay

Project	C_o (Rs.)	C_1 (Rs.)	C_2 (Rs.)	C_3 (Rs.)	NPV @ 10%(Rs.)	IRR (%)
X	(16000)	12000	7000	5000	4,450.79	28%
Y	(160000)	40000	70000	120000	24,372.65	17%
Y-X	(144000)	28000	63000	115000	19,921.86	16%

(2) Unequal Lives of the Projects:

When the two mutually exclusive projects are having different life spans, we may get conflicting results using NPV and IRR method. For example, in the following two

[16] op.cit.,pg. 155

projects IRR is higher for project A while NPV is higher for project B. Thus, both the projects give different ranking.

Table 2.5

Unequal lives of the projects

Years	C_0	C_1	C_2	C_3	C_4	NPV @10%	IRR
Project - A	(25,000)	30,000	0	0	0	2,273	20%
Project - B	(25,000)	0	0	0	43,750	4,882	15%

(3) Different Pattern of Cash flows:

When the projects under consideration are having different pattern of cash inflow it may give conflicting ranking of the projects under NPV and IRR. For example, Projects X and Y are having following pattern of cash flows:

Table 2.4 a

Different patterns of cash flow

Project	C_0 (Rs.)	C_1 (Rs.)	C_2 (Rs.)	C_3 (Rs.)	**NPV @ 10%** (Rs.)	**IRR (%)**
X	(16000)	(12000)	7000	2000	2,196.84	20%
Y	(16000)	4000	8000	12000	3,263.71	19%
Y-X	**0**	**-8000**	**1000**	**10000**	**1,066.87**	**18%**

Project Y has higher NPV at 10% cost of capital but the IRR of Project X is higher than Project Y. It means there is conflict in ranking between these two projects for selecting projects using NPV and IRR.

Table 2.4 b

NPV PROFILE

Discount rate	Project X NPV	Project Y NPV
(%)	(Rs)	(Rs)
0	6,191	8000
5	4,631	5432
10	**3,264**	**3264**
15	2,057	1418
20	984	(167)
25	26	(1536)
30	(835)	(2727)

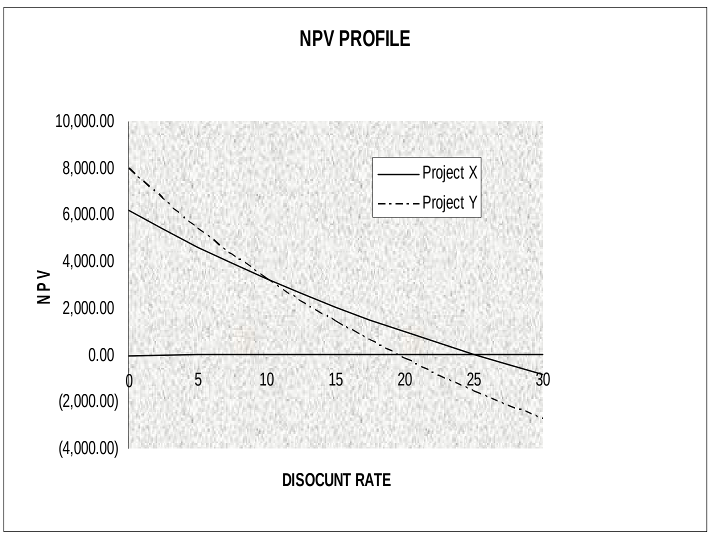

Figure 2.3

In the above graph, one can observe that IRR of the two projects are 20% and 19% respectively and the NPV profile of the two projects intersect at 10% which means that at this rate NPV of both the projects are same (Rs. 3264).

We can use **incremental approach** to select among mutually exclusive projects using IRR method. The IRR of incremental cash flows is 18% which is higher than our cost of capital 10%. Thus, Project Y can be accepted though it has IRR lower than Project X because it offers all the benefits of Project X at the same time IRR greater than cost of capital (i.e. 18% >10%).

- **Reinvestment of cash flow:**

Both the Net Present Value Method and Internal Rate of return Method presume that cash flows can be reinvested at the discounting rates in the new projects. But a reinvestment at the cut off rate is more realistic than at the internal rate of return. Hence Net Present Value is more realizable than the Internal Rate of Return Method for ranking two or more mutually exclusive capital budgeting projects. The result suggested by NPV Method is more reliable because of the objective of the company to maximize its shareholders wealth. IRR method is concerned with rate of return on investment rather than total yield on investment, NPV method considers the total yield on investment. Hence, in case of mutually exclusive projects, each having a positive NPV the one with largest NPV will have the maximum effect on shareholders wealth.

2.5 Comparison of NPV and PI[17]:

The NPV method and PI method will give same acceptance or rejection decision when the projects are independent and there is capital rationing because of the following reason:

- PI will be greater than one, only when NPV will be positive i.e. (PI>1 when NPV +ve
- PI will be less than one, only when NPV will be negative i.e. (PI<1 when NPV -ve)

But when the projects are mutually exclusive, there may be conflict in results between the two techniques.

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[17] Pandey I M, Financial Management(9th edition), Vikas Publishing House Pvt Ltd, p.158-159

	Project C	Project D	C-D
PV of cash inflows (Rs)	300000	150000	150000
Initial cash outflows (Rs)	150000	60000	90000
NPV (Rs)	150000	90000	60000
PI (times)	2	2.5	1.7

One can observe in the above table that if we use the NPV method, Project C should be accepted but if we use PI method Project D should be accepted. If we calculate incremental NPV as well as incremental PI, Project C should be accepted.

PI will be a useful technique when two mutually exclusive projects give same NPV but the costs of both these projects are different from each other. For example,

	X	Y	Y-X
PV of cash inflows (Rs)	400000	600000	200000
Initial cash outflows (Rs)	200000	400000	200000
NPV (Rs)	200000	200000	0
PI (times)	2.0	1.5	1.0

Here, the PI method gives relative answer and the project X having higher PI or lower initial cost is recommended.

(d) Modified Internal Rate of Returns (MIRR):

Despite NPV's conceptual superiority, managers seem to prefer IRR over NPV because IRR is intuitively more appealing as it is a percentage measure. The modified IRR or MIRR overcomes the shortcomings of the regular IRR.

The procedure for calculating MIRR is as follows:

Step 1 : Calculate the present value of the costs (PVC) associated with the project, using cost of capital (r) as the discount rate :

$$PVC = \sum_{t=0}^{n} \frac{\text{Cash outflow}^{t}}{(1+r)^{t}}$$

Step 2 : Calculate the terminal value (TV) of the cash inflows expected from the project :

$$TV = \sum_{t=0}^{n} \text{Cash inflow}_{t} (1+r)^{n-t}$$

Step 3 : Obtain MIRR by solving the following equation :

$$PVC = \frac{TV}{(1+\text{MIRR})^{n}}$$

To illustrate the calculation of MIRR let us consider an example. Pentagon Limited is evaluating a project that has the following cash flow stream associated with it :

Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Cash flow (Rs in million)	(120)	(80)	20	60	80	100	120

The cost of capital for pentagon is 15 percent. The present value of costs is :

$$120 = \frac{80}{(1.15)} = 189.6$$

The terminal value of cash inflows is:

$$20(1.15)^{4} + 60(1.15)^{3} + 80(1.15)^{2} + 100(1.15) + 120$$

$$= 34.98 + 91.26 + 105.76 + 115 + 120 = 467$$

The MIRR is obtained as follows:

$$189.6 = \frac{467}{(1 + \text{MIRR})^6}$$

$(1 + \text{MIRR})^6 = 2.463$

$1 + \text{MIRR} = 2.463^{1/6} = 1.1.62$

MIRR = 1.162 – 1 = 0.162 or 16.2 percent

Evaluation

MIRR is superior to the regular IRR in two ways.

1. MIRR assumes that project cash flows are reinvested at the cost of capital whereas the regular IRR assumes that project cash flows are reinvested at the project's own IRR. Since reinvestment at cost of capital (or some other explicit rate) is more realistic than reinvestment at IRR, MIRR reflects better the true profitability of a project.

2. The problem of multiple rates does not exist with MIRR.

Thus, MIRR is a distinct improvement over the regular IRR but we need to take note of the following:

- If the mutually exclusive projects are of the same size, NPV and MIRR lead to the same decision irrespective of variations in life.

- If the mutually exclusive projects differ in size, there may be a possibility of conflict between NPV and IRR. MIRR is better than the regular IRR in measuring true rate of return. However, for choosing among mutually exclusive projects of different size, NPV is a better alternative in measuring the contribution of each project to the value of the firm[18].

2.6 Capital budgeting Techniques under uncertainty:

Risk can be defined as the chance that the actual outcome will differ from the expected outcome. Uncertainty relates to the situation where a range of differing outcome is possible, but it is not possible to assign probabilities to this range of outcomes. The two terms are generally used interchangeably in finance literature. In investment appraisal, managers are concerned with evaluating the riskiness of a project's future cash flows. Here, they evaluate the chance that the cash flows will differ from expected cash flows, NPV will be negative or the IRR will be less than the cost of capital. In the context of risk assessment, the decision-maker does not know exactly what the outcome will be but it is possible to assign probability weightage to the various potential outcomes. The most common measures of risk are standard deviation and coefficient of variations. There are three different types of project risk to be considered[19]:

1. Stand-alone risk: This is the risk of the project itself as measured in isolation from any effect it may have on the firm's overall corporate risk.

2. Corporate or within-firm risk: This is the total or overall risk of the firm when it is viewed as a collection or portfolio of investment projects.

3. Market or systematic risk: This defines the view taken from a well-diversified shareholders and investors. Market risk is essentially the stock market's assessment of a firm's risk, its beta, and this will affect its share price.

Due to practical difficulties of measuring corporate and market risk, the stand-alone risk has been accepted as a suitable substitute for corporate and market risk. There are following techniques one can use to deal with risk in investment appraisal.

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[18] Chandra Prasanna, Financial Management (6th ed.), Tata McGraw-Hill, pg. 303-305
[19] McMENAMIN JIM, Financial Management (An Introduction), OXFORD University Press 2000, pg. 400

2.6.1 Statistical Techniques for Risk Analysis:

(a) Probability Assignment

(b) Expected Net Present Value

(c) Standard Deviation

(d) Coefficient of Variation

(e) Probability Distribution Approach

(f) Normal Probability Distribution

(a) Probability Assignment:

The concept of probability is fundamental to the use of the risk analysis techniques. It may be defined as the likelihood of occurrence of an event. If an event is certain to occur, the probability of its occurrence is one but if an event is certain not to occur, the probability of its occurrence is zero. Thus, probability of all events to occur lies between zero and one.

The classical view of probability holds that one can talk about probability in a very large number of times under independent identical conditions. Thus, the probability estimate, which is based on a large number of observations, is known as an objective probability. But this is of little use in analyzing investment decisions because these decisions are non-repetitive in nature and hardly made under independent identical conditions over time. The another view of probability holds that it makes a great deal of sense to talk about the probability of a single event without reference to the repeatability long run frequency concept. Therefore, it is perfectly valid to talk about the probability of sales growth will reach to 4%, the probability of rain tomorrow or fifteen days hence. Such probability assignments that reflect the state of belief of a person rather than the objective evidence of a large number of trials are called personal or subjective probabilities[20].

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[20] Pandey I M: Financial Management [9th ed.], Vikas Publishing House Pvt Ltd, pg. 244

(b) Expected Net Present Value:

Once the probability assignments have been made to the future cash flows, the next step is to find out the expected net present value. It can be found out by multiplying the monetary values of the possible events by their probabilities. The following equation describes the expected net present value.

$$ENPV = \sum_{t=0}^{n} \frac{ENCF_t}{(1+k)^t}$$

Where ENPV is the expected net present value, $ENCF_t$ expected net cash flows in period t and k is the discount rate. The expected net cash flow can be calculated as follows:

$$ENCF_t = NCF_{jt} \times P_{jt}$$

Where NCF_{jt} is net cash flow for j^{th} event in period t and P_{jt} probability of net cash flow for j^{th} event in period t[21].

For example, A company is considering an investment proposal costing Rs. 7,000 and has an estimated life of three years. The possible cash flows are given below:

Table 2.7
Expected net present value

Cash flow	Prob.	Expected Value	Cash flow	Prob.	Expected Value	Cash flow	Prob.	Expected Value
2000	0.2	400	3000	0.4	1200	4000	0.3	1200
3000	0.5	1500	4000	0.3	1200	5000	0.5	2500
4000	0.3	1200	5000	0.3	1500	6000	0.2	1200
		3100			**3900**			**4900**

[21] ibid, pg. 245

If we assume a risk free discount rate of 10%, the expected NPV for the project will be as follows.

Year	ENCF	PV@10%	PV
1	3100	0.909	2817.9
2	3900	0.826	3221.4
3	4900	0.751	3679.9
		$\sum PV$	9719.2
		Less: NCO	7000
		ENPV Rs.	2719.2

(c) Standard Deviation:

The assignment of probabilities and the calculation of the expected net present value include risk into the investment decision, but a better insight into the risk analysis of capital budgeting decision is possible by calculating standard deviation and coefficient of variation.

Standard deviation (σ) is an absolute measure of risk analysis and it can be used when projects under consideration are having same cash outlay. Statically, standard deviation is the square root of variance and variance measures the deviation about expected cash flow of each of the possible cash flows. The formula for calculating standard deviation will be as follows[22]:

[22] Jain P K & Khan M Y, Financial Management (4th ed),Tata McGraw-Hill Publishing Company Ltd, pg 13.7

$$\sigma = \sqrt{\sum_{i=1}^{n} P_i \left(CF_i - \overline{CF}\right)^2}$$

Thus, it is the square root of the mean of the squared deviation, where deviation is the difference between an outcome and the expected mean value of all outcomes and the weights to the square of each deviation is provided by its probability of occurrence. For example, the standard deviation of following project X and Y is as follows[23]:

Table 2.8

PROJECT-X (Standard deviation)

CF	$\overline{CF}$	$\left(CF_i - \overline{CF}\right)$	$\left(CF_i - \overline{CF}\right)^2$	Pi	$\left(CF_i - \overline{CF}\right)^2 P_i$	σ
4000	6000	-2000	4000000	0.1	400000	
5000	6000	-1000	1000000	0.2	200000	
6000	6000	0	0	0.4	0	
7000	6000	1000	1000000	0.2	200000	
8000	6000	2000	4000000	0.1	400000	
					1200000	1095

PROJECT Y (Standard deviation)

CF	$\overline{CF}$	$\left(CF_i - \overline{CF}\right)$	$\left(CF_i - \overline{CF}\right)^2$	Pi	$\left(CF_i - \overline{CF}\right)^2 P_i$	σ
12000	8000	4000	16000000	0.1	1600000	
10000	8000	2000	4000000	0.15	600000	
8000	8000	0	0	0.5	0	
6000	8000	-2000	4000000	0.15	600000	
4000	8000	-4000	16000000	0.1	1600000	
					4400000	2098

[23] op.cit., pg. 246

In the above example, Project Y is riskier as standard deviation of project Y is higher than the standard deviation of project X. However, the project Y has higher expected value also so the decision-maker is in a dilemma for selecting project X or project Y.

(d) Coefficient of Variation:

If the projects to be compared involve different outlays/different expected value, the coefficient of variation is the correct choice, being a relative measure. It can be calculated using following formula:

$$CV = \frac{S\tan darddeviation}{ExpectedValue} or \frac{\sigma}{\overline{\overline{CF}}}$$

For example, the coefficient of variation for the above project X and project Y can be calculated as follows[24]:

$$CV(X) = \frac{1095}{6000} = 0.1825$$

$$CV(Y) = \frac{2098}{8000} = 0.2623$$

The higher the coefficient of variation, the riskier the project. Project Y is having higher coefficient so it is riskier than the project X. It is a better measure of the uncertainty of cash flow returns than the standard deviation because it adjusts for the size of the cash flow.

(e) Probability Distribution Approach:

The researcher has discussed the concept of probability for incorporating risk in capital budgeting proposals. The concept of probability for incorporating risk in evaluating capital budgeting proposals. The probability distribution of cash flows over time provides valuable information about the expected value of return and the

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[24] ibid., pg. 247

dispersion of the probability distribution of possible returns which helps in taking accept-reject decision of the investment decision.

The application of this theory in analyzing risk in capital budgeting depends upon the behaviour of the cash flows, being (i) independent, or (ii) dependent. The assumption that cash flows are independent over time signifies that future cash flows are not affected by the cash flows in the preceding or following years. When the cash flows in one period depend upon the cash flows in previous periods, they are referred to as dependent cash flows.

(i) **Independent Cash Flows over Time**: The mathematical formulation to determine the expected values of the probability distribution of NPV for any project is as follows:

$$NPV = \sum_{t=1}^{n} \frac{\overline{CF_t}}{(1+i)^t} - CO$$

where $\overline{CF_1}$ is the expected value of net CFAT in period t and I is the risk free rate of interest.

The standard deviation of the probability distribution of net present values is equal to ;

$$\sigma = \sqrt{\sum_{t=1}^{n} \frac{\sigma t^2}{(1+i)^{2t}}}$$

where σt is the standard deviation of the probability distribution of expected cash flows for period t, σt would be calculated as follows:

$$\sigma t = \sqrt{\sum_{j=1}^{m} \left(CF_{jt} - \overline{CF_t}\right)^2 .P_{jt}}$$

Thus, the above calculation of the standard deviation and the NPV will produce significant volume of information for evaluating the risk of the investment proposal. For example, The standard deviation of the probability distribution of net present values under the assumption of the independence of cash flows over time for the above mentioned example of expected net present values can be calculated as follows:

Table 2.9

Probability distribution approach

Year 1						
CF	$\overline{CF}$	$(CF_i - \overline{CF})$	$(CF_i - \overline{CF})^2$	Pi	$(CF_i - \overline{CF})^2$	σ
2000	3100	-1100	1210000	0.2	242000	
3000	3100	-100	10000	0.5	5000	
4000	3100	900	810000	0.3	243000	
					490000	700
Year 2						
3000	3900	-900	810000	0.4	324000	
4000	3900	100	10000	0.3	3000	
5000	3900	1100	1210000	0.3	363000	
					690000	831
Year 3						
4000	4900	-900	810000	0.3	243000	
5000	4900	100	10000	0.5	5000	
6000	4900	1100	1210000	0.2	242000	
					490000	700

$$\sigma = \sqrt{\sum_{t=1}^{n} \frac{\sigma t^2}{(1+i)^{2t}}} = \sqrt{\frac{(700)^2}{(1.10)^2} + \frac{(831)^2}{(1.10)^4} + \frac{(700)^2}{(1.10)^6}} = \text{Rs. } 1073.7$$

where σ is the standard deviation of the probability distribution of possible net cash flows and σt^2 is the variance of each period. [25]

(ii) **Dependent Cash Flows[26]:** If cash flows are perfectly correlated, the behavior of cash flows in all periods is alike. This means that if the actual cash flow in one year is α standard deviations to the left of its expected value, cash flows in other years will also be α standard deviations to the left of their respective expected values. In other

[25] Khan M Y and Jain P K, Financial management(5th Ed.), Tata McGraw-Hill Publishing Company Limited, pg. 12.15
[26] Chandra Prasanna, Financial Management (Theory & Practice), 6th ed., Tata Mcgraw-Hill Publishing Co. Ltd., pg. 350-351

words, cash flows of all years are linearly related to one another. The expected value and the standard deviation of the net present value, when cash flows are perfectly correlated, are as follows:

$$\overline{NPV} = \sum_{t=1}^{n} \frac{\overline{CF_t}}{(1+i)^t} - I \qquad \sigma(NPV) = \sum_{t=1}^{n} \frac{\sigma t}{(1+i)^t}$$

Where,

$\overline{NPV} = Expected Net Present Value$

$\overline{CF_t} = Expected Cash Flow for year "t"$

I = Risk-free interest rate

$\sigma NPV = Standard deviation of Net Present Value$

$\sigma t = Standard deviation of the cash flow for year "t"$

For example, if we calculate $\overline{NPV}$ and σNPV for an investment project requiring a current outlay of Rs 10,000, assuming a risk free interest rate of 6 per cent. The mean and standard deviation of cash flows, which are perfectly correlated, are as follows:

Year	CF_t (Rs)	σ_t
1	5,000	1,500
2	4,000	1,000
3	5,000	2,000
4	3,000	1,200

$$\overline{NPV} = \frac{5000}{(1.06)^1} + \frac{4000}{(1.06)^2} + \frac{5000}{(1.06)^3} + \frac{3000}{(1.06)^4} - 10{,}000 = Rs 3{,}121$$

$$\sigma(NPV) = \frac{1500}{(1.06)^1} + \frac{1000}{(1.06)^2} + \frac{2000}{(1.06)^3} + \frac{1200}{(1.06)^4} = Rs 4{,}935$$

(f) Normal Probability Distribution:

The normal probability distribution can be used to further analyze the risk in investment decision. It enable the decision maker to have an idea of the probability of different expected values of NPV, that is, the probability of NPV having the value of zero or less, greater than zero and within the range of two values for example, within the range of Rs. 2000 and Rs. 3000 etc. If the probability of having NPV zero or less is low, eg. .01, it means that the risk in the project is negligible. Thus, the normal probability distribution is an important statistical technique in the hands of decision makers for evaluating the riskiness of a project.

The area under the normal curve, representing the normal probability distribution, is equal to 1 (0.5 on either side of the mean). The curve has its maximum height at its expected value i.e. its mean. The distribution theoretically runs from minus infinity to plus infinity. The probability of occurrence beyond 3σ is very near to zero (0.26 per cent).

For any normal distribution, the probability of an outcome falling within plus or minus.

1σ from the mean is 0.6826 or 68.26 per cent,

2σ from the mean is 95.46 per cent,

3σ from the mean is 99.74 per cent.

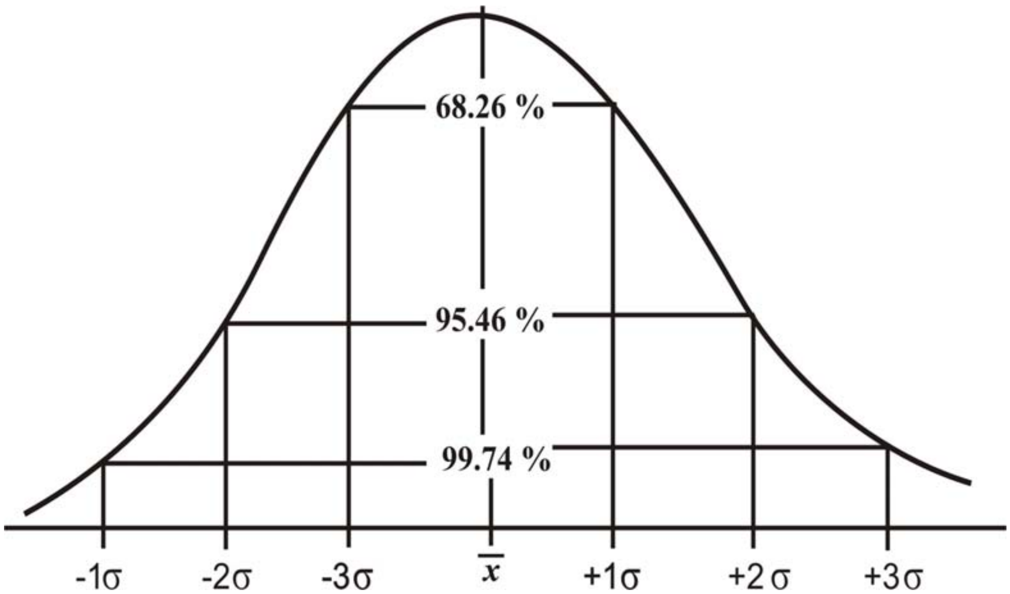

Figure 2.4

For example, If one needs to calculate for the above mentioned example the probability of the NPV being zero or less, the probability of the NPV being greater than zero and the probability of NPV between the range of Rs. 1500 and Rs. 3000, it can be calculated as follows using normal distribution.

- Probability of the NPV being zero or less:

$$Z = \frac{X - \overline{X}}{\sigma} = \frac{0 - 2719.2}{1073.7} = -2.533$$

According to Table Z, the probability of the NPV being zero is = 0.4943, therefore, the probability of the NPV being zero or less would be 0.5-0.4943=0.0057 i.e. 0.57 per cent.

- Probability of the NPV being greater than zero:

As the probability of the NPV being less than zero is 0.57 per cent, the probability of the NPV being greater than zero would be 1-0.0057=0.9943 or 99.43 per cent.

- Probability of NPV between the range of Rs. 1500 and Rs. 3000:

$$Z_1 = \frac{1500 - 2719.2}{1073.7} = -1.13$$

$$Z_2 = \frac{3000 - 2719.2}{1073.2} = 0.26$$

The area as per Table Z for the respective values of -1.13 and 0.26 is 0.3708 and 0.4803 respectively. Summing up, we have 0.8511 i.e., there is 85.11 per cent probability of NPV being within the range of Rs. 1500 and Rs. 3000. [27]

2.6.2 Conventional Techniques for Risk Analysis:

(a) Payback

(b) Risk-adjusted Discount Rate

(c) Certainty Equivalent

(a) Payback Period:

Payback as a method of risk analysis is useful in allowing for a specific types of risk only, i.e., the risk that a project will go exactly as planned for a certain period will then suddenly stop generating returns, the risk that the forecasts of cash flows will go wrong due to lower sales, higher cost etc. This method has been already discussed in detail above so it has not been repeated here.

(b) Risk Adjusted Discount Rate Method:

The economic theorists have assumed that to allow for risk, the businessmen required a premium over and above an alternative which is risk free. It is proposed that risk premium be incorporated into the capital budgeting analysis through the discount rate. i.e. If the time preference for the money is to be recognized by discounting estimated future cash flows, at some risk free rate, to there present value, then, to allow for the riskiness of the future cash

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[27] ibid, pg. 12.17

flow a risk premium rate may be added to risk free discount rate. Such a composite discount would account for both time preference and risk preference.

RADR = Risk free rate + Risk Premium OR $k = R_f + R_p$

The RADR accounts for risk by varying discount rate depending on the degree of risk of investment projects. The following figure portrays the relationship between amount of risk and the required k.

The following equation can be used:-

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

Where k is a risk-adjusted rate.

Thus projects are evaluated on the basis of future cash flow projections and an appropriate discount rate.

Decision Rule:

- The risk adjusted approach can be used for both NPV & IRR.
- If NPV method is used for evaluation, the NPV would be calculated using risk adjusted rate. If NPV is positive, the proposal would qualify for acceptance, if it is negative, the proposal would be rejected.
- In case of IRR, the IRR would be compared with the risk adjusted required rate of return. If the ‘r’ exceeds risk adjusted rate, the proposal would be accepted, otherwise not.

For example, if an investment project has following cash flows, its NPV using RADR will be as follows:

Risk free rate is 6% and Risk adjusted rate is 10%.

Year	CFAT (Rs.)	PV @ 10%	PV (Rs.)
1	50000	0.909	45450
2	40000	0.826	33040
3	45000	0.751	33795
		$\sum PV$	112285
	Less:	Investment	150000
		NPV	(37715)

Merits:

- It is simple to calculate and easy to understand.
- It has a great deal of intuitive appeal for risk-averse businessman.
- It incorporates an attitude towards uncertainty.

Demerits:

- The determination of appropriate discount rates keeping in view the differing degrees of risk is arbitrary and does not give objective results.
- Conceptually this method is incorrect since it adjusts the required rate of return. As a matter fact it is the future cash flows which are subject to risk.
- This method results in compounding of risk over time, thus it assumes that risk necessarily increases with time which may not be correct in all cases.
- The method presumes that investors are averse to risk, which is true in most cases. However, there are risk seeker investors and are prepared to pay premium for taking risk and for them discount rate should be reduced rather than increased with increase in risk.

- Thus, this approach can be best described as a crude method of incorporating risk into capital budgeting. [28]

(c) Certainty Equivalent Approach:

This approach to incorporate risk in evaluating investment projects, overcomes weaknesses of the RADR approach. Under this approach riskiness of project is taken into consideration by adjusting the expected cash flows and not discount rate. This method eliminates the problem arising out of the inclusion of risk premium in the discounting process.

The certainty equivalent coefficient (α_1) can be determined as a relationship between the certain cash flows and the uncertain cash flows. For example, if a company expected a risky cash flow of Rs. 90,000 and a risk free cash flow of Rs. 65,000 then its α_1 will be calculated as follows:

$$\alpha_t = \frac{NCF_t^*}{NCF_t} = \frac{Riskfreecashflow}{Riskycashflow} = \frac{65000}{90000} = 0.7222$$

The certainty equivalent coefficient (α_t) assumes a value between 0 and 1 and varies inversely with risk. The higher the risk, the lower the α_t and the lower the risk, the higher the α_t. The certainty equivalent approach can be expressed in the form of equation as follows:

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

where, NCFt = Net cash flow,

α_t = the certainty equivalent coefficient,

k_f = Risk free rate

[28] Pandey I M: Financial Management [9th ed.], Vikas Publishing House Pvt Ltd, pg. 248

For example, A project is costing Rs. 100000 and it has following estimated cash flows and certainty equivalent coefficients. If the risk free discount rate is 5%, its NPV can be calculated as follows.

Year	NCF (Rs.)	CE Coefficient	Adjusted NCF (Rs.)	PV @ 5%	PV (Rs.)
1	60,000	0.8	48,000	0.952	45696
2	70,000	0.6	42,000	0.907	38094
3	40,000	0.7	28,000	0.864	24192
			Less:	$\sum PV$	107982
				Investment	100000
				NPV	7982

Decision Rule:

- If NPV method is used, the proposal would be accepted if NPV of CE cash flows is positive, otherwise it is rejected.
- If IRR is used, the internal rate of return which equates the present value of CE cash inflows with the present value of the cash outflows, would be compared with risk free discount rate. If IRR is greater than the risk free rate, the investment project would be accepted otherwise it would be rejected.

Merits[29]:

- It is simple to calculate.
- It is conceptually superior to time-adjusted discount rate approach because it incorporates risk by modifying the cash flows which are subject to risk.

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[29] Khan M Y and Jain P K, Financial management(5th Ed.), Tata McGraw-Hill Publishing Company Limited, pg. 13.12

Demerits[30]:

- This method explicitly recognizes risk, but the procedure for reducing the forecast of cash flows is implicit and likely to be inconsistent from one investment to another.

- The forecaster expecting reduction that will be made in his forecast, may inflate them in anticipation. This will no longer give forecasts according to "best estimate".

- If forecast have to pass through several layers of management, the effect may be to greatly exaggerate the original forecast or to make it ultra conservative.

- By focusing explicit attention only on the gloomy outcomes, chances are increased for passing by some good investments.

These techniques attempts to incorporate risk but major shortcomings are that specifying the appropriate degree of risk for an investment project is beset with serious operational problems and they cannot be applied to various projects over time.

2.6.3 Other Techniques:

(a) Sensitivity Analysis

(b) Scenario Analysis

(c) Break Even Analysis

(d) Simulation Analysis

(e) Decision Tree Approach

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[30] op.cit.pg.249

(a) Sensitivity Analysis:

While evaluating any capital budgeting project, there is a need to forecast cash flows. The forecasting of cash flows depends on sales forecast and costs. The Sales revenue is a function of sales volume and unit selling price. Sales volume will depend on the market size and the firm's market share. The NPV and IRR of a project are determined by analyzing the after-tax cash flows arrived at by combining various variables of project cash flows, project life and discount rate. The behavior of all these variables are very much uncertain. The sensitivity analysis helps in identifying how sensitive are the various estimated variables of the project. It shows how sensitive is a project's NPV or IRR for a given change in particular variables.

The more sensitive the NPV, the more critical is the variables.

Steps[31]:

The following three steps are involved in the use of sensitivity analysis.

1. Identify the variables which can influence the project's NPV or IRR.

2. Define the underlying relationship between the variables.

3. Analyze the impact of the change in each of the variables on the project's NPV or IRR.

The Project's NPV or IRR can be computed under following three assumptions in sensitivity analysis.

1. Pessimistic (i.e. the worst),

2. Expected (i.e. the most likely)

3. Optimistic (i.e. the best)

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[31] ibid, pg. 250

For example, A company has two mutually exclusive projects for process improvement. The management has developed following estimates of the annual cash flows for each project having a life of fifteen years and 12% discount rate.

Table 2.10

Sensitivity analysis

Project – A				
Net Investment (Rs)	90,000			
CFAT estimates:		$PVAIF_{12\%, 15 \text{ years}}$	PV	NPV
Pessimistic	10,000	6.811	68110	(21890)
Most likely	15,000	6.811	102165	12165
Optimistic	21,000	6.811	143031	53031
Project – B				
Net Investment (Rs)	90,000			
CFAT estimates:		$PVAIF_{12\%, 15 \text{ years}}$	PV	NPV
Pessimistic	13,500	6.811	91948.5	1948.5
Most likely	15,000	6.811	102165	12165
Optimistic	18,000	6.811	122598	32598

The NPV calculations of both the projects suggest that the projects are equally desirable on the basis of the most likely estimates of cash flows. However, the Project – A is riskier than Project – B because its NPV can be negative to the extent of Rs. 21,890 but there is no possibility of incurring any losses with project B as all the NPVs are positive. As the two projects are mutually exclusive, the actual selection of the projects depends on decision maker’s attitude towards the risk. If he is ready to take risk, he will select Project A, because it has the potential of yielding NPV much higher than (Rs. 53031) Project B. But if he is risk averse, he will select project B.

Merits[32]:

- The sensitivity analysis has the following advantages:
- It compels the decision maker to identify the variables affecting the cash flow forecasts which helps in understanding the investment project in totality.
- It identifies the critical variables for which special actions can be taken.
- It guides the decision maker to concentrate on relevant variables for the project.

Demerits[33]:

The sensitivity analysis suffers from following limitations:

- The range of values suggested by the technique may not be consistent. The terms 'optimistic' and 'pessimistic' could mean different things to different people.
- It fails to focus on the interrelationship between variables. The study of variability of one factor at a time, keeping other variables constant may not much sense. For example, sales volume may be related to price and cost. One can not study the effect of change in price keeping quantity constant.

(b) Scenario Analysis:

In sensitivity analysis, typically one variable is varied at a time. If variables are inter-related, as they are most likely to be, it is helpful to look at some plausible scenarios, each scenario representing a consistent combination of variables.

[32 & 37] ibid, pg. 252

Procedure:

The steps involved in scenario analysis are as follows :

1. Select the factor around which scenarios will be built. 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.

2. Estimate the values of each of the variables in investment analysis (investment outlay, revenues, costs, project life, and so on) for each scenario.

3. Calculate the net present value and/or internal rate of return under each scenario.

Illustration:

A company is evaluating a project for introducing a new product. Depending on the response of the market - the factor which is the largest source of uncertainty for the success of the project - the management of the firm has identified three scenarios :

Scenario 1	:	The product will have a moderate appeal to customers across the board at a modest price.
Scenario 2	:	The product will strongly appeal to a large segment of the market which is highly price-sensitive.
Scenario 3	:	The product will appeal to a small segment of the market which will be willing to pay a high price.

The following table 2.11 shows the net present value calculation for the project for the three scenarios.

Table: 2.11

Scenario analysis

NPV Calculation for Three Scenario			
			(Rs in million)
	Scenario 1	Scenario 2	Scenario 3
Initial investment	400	400	400
Unit selling price (Rs)	50	30	80
Demand (Units)	40	80	20
Sales Revenue	2000	2400	1600
VC (Rs 12/- pu)	960	1920	480
Fixed costs	100	100	100
Depreciation	40	40	40
Pre-tax profit	900	340	980
Tax @ 35%	315	119	343
PAT	585	221	637
Net cash flow (PAT + Dep)	625	261	677
Project life	20 years	20 years	20 years
NPV @ 20% (Rs)	3043.487	1270.96	3296.70548

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.

The objective of such scenario analysis is to get a feel of what happens under the most favourable or the most adverse configuration of key variables, without bothering much about the internal consistency of such configurations.

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. [34]

(c) Break-even Analysis:

In sensitivity analysis one may ask what will happen to the project if sales decline or costs increase or something else happens. A financial manager will also be interested in knowing how much should be produced and sold at a minimum to ensure that the project does not 'lose money'. Such an exercise is called break even analysis and the minimum quantity at which loss is avoided is called the break-even point. The break-even point may be defined in accounting terms or financial terms.

Accounting Break-even Analysis

Suppose a company is considering setting up a new plant near Mumbai. The capital budgeting committee has given following projections.

[34] Chandra Prasanna, Financial Management (6th ed.), Tata McGraw-Hill, pg. 344

Table 2.12 (Accounting break-even analysis)

Cash Flow Forecast for New Project		
	(Rs.'000)	
	Year 0	Year 1-10
Investment	(60,000)	
Sales		54,000
Variable costs (60% of Sales)		32,400
Fixed costs		3,150
Depreciation		5,850
PBT		12,600
Tax @ 35%		4,410
PAT		8,190
Cash Flow from operation		14,040

One can observe from the above table that the ratio of variable costs to sales is 0.6 (32.4/54). This means that every rupee of sales makes a contribution of Rs. 0.4 or if we put it differently, the contribution margin ratio is 0.4, hence the break even level of sales will be:

$$\frac{\text{Fixed costs} + \text{Depreciation}}{\text{Contribution margin ratio}} = \frac{3.15 + 5.85}{0.4} = \text{Rs. } 22.5 \text{ million}$$

We can verify that the break-even level of sales is indeed Rs. 22.5 million.

	Amount (Rs in millions)
Sales	22.5
Variable costs (60%)	13.5
Fixed costs	3.15
Depreciation	5.85
Profit before tax	0
Tax	0
Profit after tax	0

A variant of the accounting break even point is the cash break even point which is defined as that level of sales at which the firm neither makes cash profit nor incurs a cash loss. The cash break even sales is defined as:

$$\frac{\text{Fixed costs}}{\text{Contribution margin ratio}}$$

It is to be noted that depreciation, a non-cash charge, has been excluded from the numerator of the above ratio.

The cash break even level of sales for the project is:

$$\frac{3.15}{0.40} = Rs.7.875 million$$

A project that breaks even in accounting terms is like a stock that gives you a return of zero percent. In both the cases you get back your original investment but you are not compensated for the time value of money or the risk that you bear. Put differently, you forego the opportunity cost of your capital. Hence a project that merely breaks even in accounting terms will have a negative NPV.

Financial Break-even analysis:

The focus of financial break-even analysis is on NPV and not accounting profit.

At what level of sales will be project have a zero NPV?

To illustrate how the financial break-even level of sales is calculated, let us go back to the above project. The annual cash flow of the project depends on sales as follows:

1.	Variable costs	:	60% of sales
2.	Contribution	:	40% of sales
3.	Fixed costs	:	Rs. 3.15 million

4.	Depreciation	:	Rs. 5.85million
5.	Pre-tax profit	:	(0.4 x sales) – Rs. 9 million
6.	Tax (@ 35 %)	:	0.35(0.4 sales - Rs. 9 million)
7.	Profit after tax	:	0.65 (0.4 sales - Rs. 9 million)
8.	Cash flow (4 + 7)	:	Rs. 5.85 million +0.65 (0.4 sales - Rs.9 million)
		:	= 0.26 Sales

Since the cash flow lasts for 10 years, its present value at a discount rate of 10% is:

PV (cash flows) = 0.325 sales x PVIFA $_{10 \text{ years}, 10\%}$

= 0.26 Sales x 6.145

= Rs. 1.5977 Sales

The project breaks even in NPV terms when the present value of these cash flows equals the initial investment of Rs. 60 million. Hence, the financial break-even occurs when

PV (cash flows) = Investment

1.5977 Sales = Rs. 60 million

Sales = Rs. 37.55398 million

Thus, the sales for the project must be Rs. 37.6 million per year for the investment to have a zero NPV. Note that this is significantly higher than Rs. 22.5 million which represents the accounting break-even sales. [35]

(d) Simulation analysis:

Sensitivity analysis and Scenario analysis are quite useful to understand the uncertainty of the investment projects. But both the methods do not consider the interactions between variables and also, they do not reflect on the probability of the change in variables.[36] The power of the computer can help to incorporate risk into capital budgeting through a technique called Monte Carlo simulation. The term "Monte Carlo" implies that the approach involves the use of numbers drawn randomly from probability distributions.[37] It is statistically based approach which makes use of random numbers and preassigned probabilities to simulate a project's outcome or return. It requires a sophisticated computing package to operate effectively. It differs from sensitivity analysis in the sense that instead of estimating a specific value for a key variable, a distribution of possible values for each variable is used.

The simulation model building process begins with the computer calculating a random value simultaneously for each variable identified for the model like market size, market growth rate, sales price, sales volume, variable costs, residual asset values, project life etc. From this set of random values a new series of cash flows is created and a new NPV is calculated. This process is repeated numerous times, perhaps as many as 1000 times or even more for very large projects, allowing a decision-maker to develop a probability distribution of project NPVs. From the distribution model, a mean (expected) NPV will be calculated and its associated standard deviation will be used to guage the project's level of risk. The distribution of

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[35] ibid, pg. 346
[36] Pandey I M, Financial Management, Vikas Publishing House Pvt Ltd, pg 253
[37] Lasher William R., Practical Financial Management(2nd edition), South-Western College Publishing, pg. 333

possible outcome enables the decision-maker to view a continuum of possible outcomes rather than a single estimate.[38]

Merits:

- An increasingly popular tool of risk analysis, simulation offers certain advantages:

- It facilitates the analysis and appraisal of highly complex, multivariate investment proposals with the help of sophisticated computer packages.

- It can cope up with both independence and dependence amongst variables. It forces decision-makers to examine the relationship between variables.

Demerits:

- Simulation is not always appropriate or feasible for risk evaluation.

- The model requires accurate probability assessments of the key variables. For example, it may be known that there is a correlation between sales price and volume sold, but specifying with mathematical accuracy the nature of the relationship for model purposes may be difficult.

- Constructing simulated financial models can be time-consuming, costly and requires specialized skills, therefore. It is likely to be used to analyze very important, complex, and large-scale projects.

- It focuses on a project's standalone risk. It ignores the impact of diversification, i.e., how a project's stand-alone risk will correlate with that of other projects within the firm and affect the firm's overall corporate risk.

- Simulation is inherently imprecise. It provides a rough approximation of the probability distribution of net present value (or any other criterion of merit).

[38] McMENAMIN JIM, Financial Management (An Introduction), OXFORD University Press, pg. 408-409

Due to its imprecision, the simulated probability distribution may be misleading when a tail of the distribution is critical.

- A realistic simulation model, likely to be complex, would most probably be constructed by a management scientist, not the decision maker. The decision maker, lacking understanding of the model, may not use it.

- To determine the net present value in a simulation run the risk-free discount rate is used. This is done to avoid prejudging risk which is supposed to be reflected in the dispersion of the distribution of net present value. Thus the measure of net present value takes a meaning, very different from its usual one, which is difficult to interpret.

(e) Decision-tree Approach:

Sometimes cash flow is estimated under different managerial options with the help of decision-tree approach. A decision tree is a graphic presentation of the present decision with future events and decisions. The sequence of events is shown in a format that resembles the branches of a tree.[39]

Steps in constructing decision tree:

The first step in constructing a decision tree is to define a proposal. It may be concerning either a new product or an old product entering a new market. It may also be an abandonment option or a continuation option, expansion option or no-expansion option, etc.

Second step is identifying various alternatives. For example, if a firm is launching a new product, it must chalk out the demand possibilities and on that basis it identifies different alternatives-whether to have a large factory or a medium-size or only a small plant. Each of the alternatives will have varying consequences on the cash flow.

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[39] Sharan Vyuptakesh, Fundamentals of Financial Management, Pearson Education, pg. 94

The third step is to lay out the decision tree showing the different alternatives through different branches. And finally, the estimates of cash flow with probabilities in each branch are made. The results of the different branches are calculated that show desirability of a particular alternative over the others.

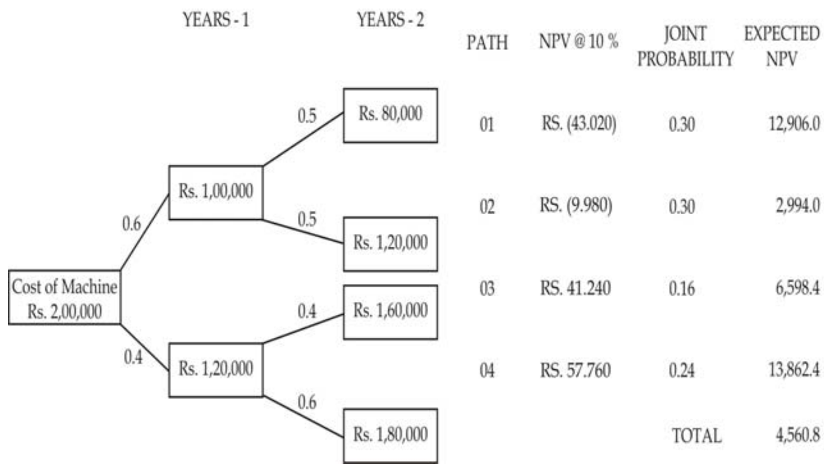

Figure 2.5

For example, a company is considering a new machine having estimated cash flows as follows. The machine is having a life of 2 years. The cost of machine is Rs. 60,000 and a company's required rate of return is 12%. If a company wants to use decision tree approach, recommend whether the machine should be bought or not.

Merits:

- Decision tree analysis gives the clarity of sequential investment decisions.
- It gives a decision maker to visualize assumptions and alternatives in graphic form which is easier to understand than the analytical form. It helps in eliminating the unprofitable branches and determines optimum decision at various decision points.

Demerits:

- The decision tree becomes more and more complicated if he includes more and more alternatives. It becomes more complicated if the analysis includes interdependent variables which are dependent on one another.

- It becomes very difficult to construct decision tree if the number of years expected life of the project and the number of possible outcomes for each year are large.

2.7 Some Supplementary Capital Budgeting Techniques:

The following are some other supplementary capital budgeting tools.

(a) Real Options:

Real options capture the value of managerial flexibility to adapt decisions in response to unexpected market developments. Companies create shareholder value by identifying, managing and exercising real options associated with their investment portfolio. The real options method applies financial options theory to quantify the value of management flexibility in a world of uncertainty. If used as a conceptual tool, it allows management to characterize and communicate the strategic value of an investment project. Traditional methods (e.g. net present value) fail to accurately capture the economic value of investments in an environment of widespread uncertainty and rapid change. The real options method represents the new state-of-the-art technique for the valuation and management of strategic investments. The real option method enables corporate decision-makers to leverage uncertainty and limit downside risk.

Real option (RO) is a method of evaluating and managing strategic investment decisions in an uncertain business environment. It seeks to quantify numerically each of the investment options available in a particular situation. A 'real option' represents a "right, to take an action in the future but not an obligation to do so". [40]

DCF and RO both assign a present value to risky future cash flows. DCF entails discounting expected future cash flows at the expected return on an asset of comparable risk. RO uses risk-neutral valuation, which means computing expected cash flows based on risk-neutral probabilities and discounting these flows at the risk-free rate. In cases where project risk and the discount rates are expected to change over time, the risk-neutral RO approach will be easier to implement than DCF (since adjusting cash flow probabilities is more straightforward than adjusting discount rates). The use of formal RO techniques may also encourage managers to think more broadly about the flexibility that is (or can be) built into future business decisions, and thus to choose from a different set of possible investments.[41]

Types of Real Options[42]:

The types of real/managerial options available include:

1. Option to expand (or contract) – An important option is one that allows the firm to expand production if conditions become favourable and to contract production if conditions become unfavourable.
2. Options to abandon – If a project has abandonment value, this effectively represents a put options to the project's owner.
3. Option to postpone – For some projects there is the option to wait and therby to obtain new information.

Sometimes these options are treated informally as qualitative factors when judging the worth of a project. The treatment given to these options may consist of no more than the recognition that "if such and such occurs, we will have the opportunity to do this and that." Managerial options are more difficult to value than are financial options.

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[40] Madhani Pankaj M, RO-Based Capital Budgeting: A Dynamic Approach in New Economy, The Icfai Journal of APPLIED FINANCE, November 2008, Vol. 14, No. 11, pg. 48-67

[41] McDonald Robert L, The Role of Real Options in Capital Budgeting: Theory and Practice, Journalof Applied Corporate Finance, Spring 2006,Vol. 18, No. 2, pg. 28-39

[42] Van Horna James C. and Wachowicz, JR. John, Fundamentals of Financial Management, 11th ed., pg. 378

Valuation Implications[43]:

The presence of managerial, or real, options enhances the worth of an investment project. The worth of a project can be viewed as its NPV, calculated in the traditional way, together with the value of any option(s).

Project Worth = NPV + Option(s) value

The greater the number of options and the uncertainty surrounding their use, the greater the second term in the above equation and the greater the project's worth.

Merits[44]:

There are several benefits for decision makers if they decide to use real option analysis. Some of the important benefits are:

1. It forces a change in the emphasis of decision makers (and the valuation process) from 'predicting the future outcome perfectly' (the NPV rule) to identifying what can (or rather should) be done about responding to business uncertainty;

2. It gives decision makers the ability to identify the optimal levels of flexibility; and

3. By focusing management's attention on responding optimally to uncertainty as it evolves, it promotes a sense of discipline in the management of assets that extends over the entire life of the project.

Limitations[45]:

Applying real options to a project is cumbersome and problematic. It has following limitations.

1. Finding an option model that has assumptions that match the project being analyzed i.e. the potential disconnect between financial and real options

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[43] Ibid

[44] Madhani Pankaj M, RO-Based Capital Budgeting: A Dynamic Approach in New Economy, The Icfai Journal of APPLIED FINANCE, November 2008, Vol. 14, No. 11, pg. 48-67

[45] ibid

because strategic options lack the precise meaning and measurements that financial options enjoy.

2. Determining the inputs to the option model correctly is critical to achieving accurate outputs.

3. Being able to mathematically solve the options pricing algorithm. But thanks to more powerful PCs and software, this problem has been made easier. The sophisticated mathematics such as partial differential equations of RO, and the consequent lack of transparency and simplicity are the real concerns.

Thus, RO analysis encourages firm to create various possibilities for the proposed investments. It is possible that traditional capital budgeting tools may not allow firm to adopt emerging new technologies if it does not earn its cost of capital but RO may suggests that it is necessary price to pay for now to earn well in future.

(b) **Economic Value Added[46] or EVA®** is an estimate of true economic profit after making corrective adjustments to GAAP accounting, including deducting the opportunity cost of equity capital. It measures managerial effectiveness in a given year or period (Net Operating Profit After Taxes (NOPAT) – After tax cost of capital required to support operations). It is a way to determine the value created, above the required return, for the shareholders of a company.

The basic formula is:

$$EVA = (r - c) \bullet K = NOPAT - c \bullet K$$

Where

$r = \frac{NOPAT}{K}$, called the Return on Invested Capital (ROIC).

46 http://en.wikipedia.org/wiki/Economic_value_added/accessed on 23.01.2008

NOPAT is the Net Operating Profit After Tax,

c is the Weighted Average Cost of Capital,

K is capital employed

Shareholders of the company will receive a positive value added when the return from the capital employed in the business operations is greater than the cost of that capital.

(b) The firm's **Market Value Added**, or MVA, is the discounted sum of all future expected economic value added:

$$MVA = V - K_0 = \sum_{t=1}^{\infty} \frac{EVA_t}{(1+c)^t}$$

MVA = NPV of company

(c) **Incremental IRR** is the IRR of the difference in cash flows of two comparison projects; commonly used in replacement decisions.

(d) **PERT/CPM** is the analysis and mapping of the most efficient financial decision.

(e) **Complex mathematical models** a general term inclusive of various option pricing model techniques, complex real options, and firm specific proprietary models and methods.

(f) **Linear programming** identifies a set of projects that maximizes NPV subject to constraints (such as maximum available resources)

(g) **Option pricing model** include either binomial option pricing model or the Black-Scholes option pricing model, the latter used by firms such as Merck with high R&D expenditures and relatively few, albeit large positive NPV investments.

2.8 Conclusion:

In this chapter, many techniques of capital budgeting under the assumption of certainty as well as uncertainty have been discussed, highlighting their relative strengths and weaknesses. The investment decision made by managers will determine a number of significant issues like the cash flows generated by the company, the dividends paid out by the company, the market value of the company, the survival of the company etc. Many managers talk about the “gut feel”, or special expertise, that enables them to say a project should be undertaken even though it does not appear to have a positive NPV. It is difficult to quantify their value, so the “gut feel” approach is often simply to “guesstimate” that the project is profitable and then to go ahead with it. In fact, the use of capital budgeting techniques allow for much more informed judgments with the caution that their application does become more problematic in a period of rapid technological and economic change. In such a situation, some form of computer based simulation approach may well turnout to be of great practical use. Though techniques like RO rewards flexibility but it can not replace the standard capital budgeting techniques (eg. NPV) rather it expands on and improves the insights of strategic valuation. However, virtually all capital budgeting methods are analyzed by computer, so it is easy to calculate and list all the decision measures, because each one provides decision makers with a somewhat different piece of relevant information.