2. CAPITAL BUDGETING TECHNIQUES

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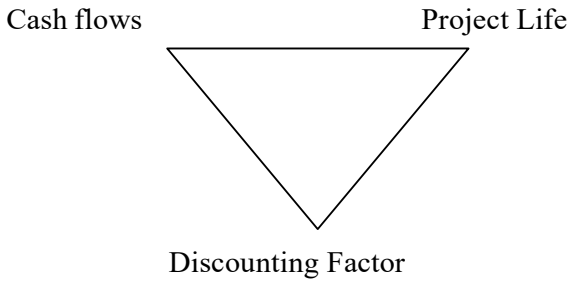
2.1 Introduction:

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].

[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.

[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		
Cumula tive 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:

$$ARR = \frac{Average\ Annual\ \text{Pr}ofit\ After\ Tax}{Average\ Investment} \times 100$$

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,

$$ARR = \frac{\sum_{t=1}^{n} EBIT(1-T) \div n}{(I_0 + I_n) \div 2}$$

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

[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

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

$$NPV = \sum_{t=1}^{n} \frac{A_t}{(1+K)t} - C \quad \textbf{OR} \quad NPV = \sum_{k,t}^{t} \left(CF \times PVIF\right)_{t=1} - CF_0$$

Where,

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.

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 →

Accept [NPV > 0]

PV < C → 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 shareholder's 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],

$$PI = \frac{\text{Present value of cash inflow}}{\text{Initial cash outlay}} = \frac{PV(C_t)}{C_0} = \sum_{t=1}^{n} \frac{C_t}{(1+K)^t} \div C_0$$

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]:

$$C_0 = \frac{C_1}{1+r} + \frac{C_2}{(1+r)} + \frac{C_2}{(1+r)} + \cdots + \frac{C_n}{(1+r)}$$

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

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

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)

$$IRR = r + \left[PV_{co} - PV_{CFAT} \times \Delta r \right] \div \Delta PV$$

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

$\therefore$ 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)

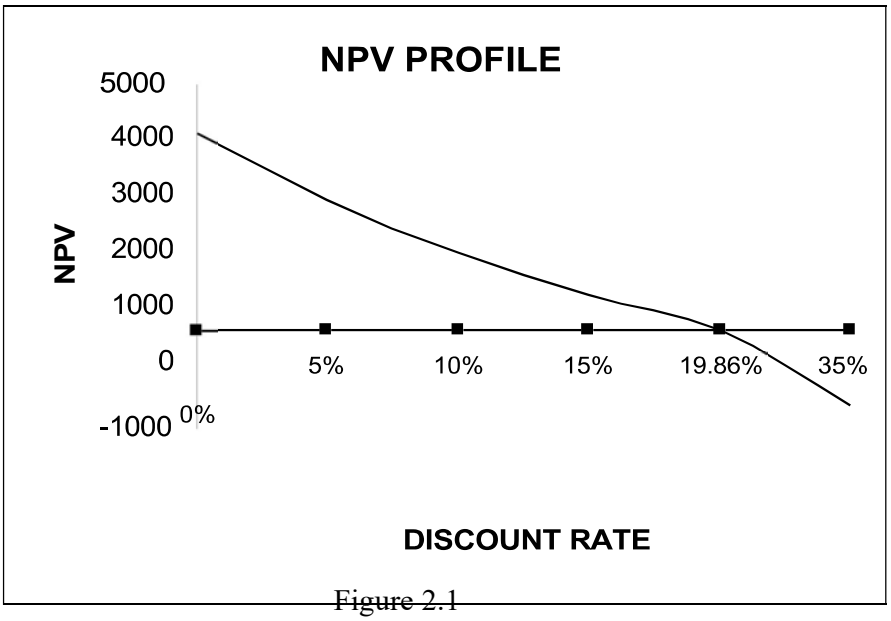

Figure 2.1

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_o (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

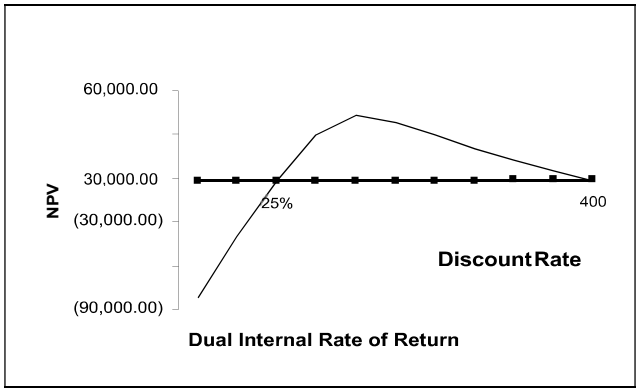

Figure 2.2

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.

[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)

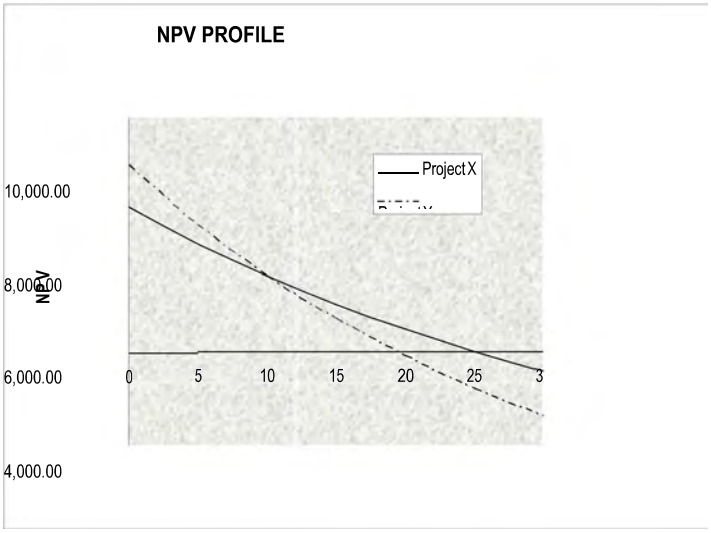

Figure 2.3

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.

[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 :

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

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:

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

$(1 + MIRR)^6 = 2.463$

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

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].