CHAPTER FIVE

5. CAPITAL BUDGETING INVESTMENT DECISION MAKING

5.1. Nature of investment decision

The investment decisions of a firm are generally known as the capital budgeting, or capital expenditure decisions. A capital budgeting decisions may be defined as the firm's decisions to invest its current funds most efficiently in the long-term assets in anticipation of an expected flow of benefits over a series years. The long term assets are those that affect the firm's operations beyond the one year period.

The following are the features of investment decisions:

- The exchange of current funds for future benefits.
- The funds are invested in long-term assets.
- The future benefits will occur to the firms over a series of years.

In the investment analysis, it is cash flow, which is important, not the accounting profit. The firm's value will increase if investments are profitable & add to shareholder's wealth.

5.2. Importance of investment decisions

- They influence the firm's growth in the long-run.
- They affect the risk of the firm.
- They involve commitment of large amounts of funds.
- They are irreversible, or reversible at substantial loss.
- They are among the most difficult decisions to make.

5.3. Types of investment decisions

1. Expansion of existing business.

2. Expansion of new business.

3. Replacement & modernization

- ✓ A Co. may add capacity to its existing product line to expand existing operations.
- ✓ Expansion of a new business requires invest in new product & anew kind of production activity within the firm.

- ✓ The main objective of modernization & replacement is to improve operating efficiency & reduce costs.

  Yet another useful way to classify invest is as follows.

1. **Mutually exclusive investments:** serve the same purpose & compete with each other. If one investment under taken, others will have to be excluded.
2. **Independent investments:** serve different purposes & do not compete with each other.
3. **Contingent invests:** are dependent projects; the choice of one investment necessitates under taking one or more other investments.

5.4. Investment evaluation criteria

Three steps are involved in the evaluation of an investment

1. Estimation of cash flows.
2. Estimation of the RRR(cost of capital)
3. Application of a decision rule for making the choice.

There are two project evaluation techniques

5.4.1. The traditional criteria (technique)

They are called the traditional techniques because they do not consider the time value of money concepts in ranking investments proposals. Two methods are included under the traditional technique, namely the payback period & the accounting rate of return.

5.4.1.1. The payback period

The payback period is the number of years that is required for 5the business firm to recover from the project the amount of the initial investment in total. If the cash flows from the project are in annuity form, the payback period can easily be determined by dividing the initial investment by the annual cash flow in the annuity.

That is, payback period (in years) $= \frac{Initial\,investment}{Annual\,cash\,flow}$

When the cash flows from the project are not in an annuity, the payback period is computed as follows: payback period = year before full recovery

$$+\frac{Un\,recovered\,cost}{Annual\,flow\,during\,the\,next\,year}$$

To illustrate the computation of the payback period when the cash flows from the project is an annuity form, suppose the project requires an initial investment of 24,000 birr & the annual after-tax cash flows of 6,000 birr for five years. The payback period is, therefore,

Payback period = 24000/6000 = 4 years

This to mean that the initial investment amount of this particular project will be recovered with in the first four years of the project life (i.e. 6000 for four years is 24, 000).

To illustrate the computation of the payback period when the cash flows from the project are not in an annuity form, assume the project requires an initial investment of 60,000 birr. The after-tax cash flows from the project are 8,000 birr during year 1, 15,000 birr during year 2, 22,000 birr during year 3, 20,000 birr during year 4, & year 5 each. Here, the cash flows are not uniform. In this case, we first need to compute the cumulative.

Year	annual cash flow	cumulative cash flow
1	8,000	8,000
2	15,000	23,000
3	22,000	45,000
4	20,000	65,000*
5	20,000	85,000

Looking at the cumulative cash flows, the cumulative cash flows at the end of year 3, which is 45,000, is less than the initial investment where as the cumulative cash flows at end of year 4 that is 65,000 is slightly greater than the initial investment. This implies that the payback period for this project is greater than 3 years but less than 4 years. The exact payback period can be computed as follows:

Payback period = 3 years + (15,000/20,000) years = 3 years +0.75 years= 3.75 years, or

= 3 years + (0.75) (12 months) =3 years & 9 months.

This is true if the cash flows of 20,000 birr during year four are uniformly distributed over the entire year. Otherwise, the payback period is different from 3 years & 9 months. For instance, if the cash flow of 20,000 birr is expected to occur only once at the end of year 4, the payback period will be 4 years. As a general rule, the shorter the payback period required, the better the project. Thus, the project is accepted if its payback period is less or equal to the period required by the management of the business firm. If two projects are mutually exclusive (i.e. if the acceptance of one project precludes the acceptance of the other), a project with the shorter payback period selected even if both of them fulfill the acceptance criteria. On the other hand, if two projects are independent (i.e. the cash flows of one of the project do not influence the cash flows of the other), both the projects can be accepted as long as their payback periods are less than the planned payback period.

Advantages of payback period:

The payback period is an easy & an in expensive method to evaluate & rank project alternatives.

Disadvantages of payback period:

1. It ignores the cash flows beyond the computed payback period though they are important for acceptance or rejection decisions.
2. It ignores the time value of money which is an important variable that demands consideration in evaluating the desirability of a given project.

5.4.1.2. The accounting rate of return(ARR)

The accounting rate of return (ARR) is the rate of return that is calculated by dividing the projects expected annual net profit by the average investment outlays. The average investment outlay, on the other hand, is

computed by dividing the sum of original cost of the project & the salvage value of return (ARR) can be expressed with the algebraic equation as follows.

$$\text{ARR} = \frac{Expected\,average\,annual\,net\,profit}{average\,cost\,of\,investment}$$

$$Average\,cost\,of\,investment = \frac{original\,costs + salvage\,value}{2}$$

To illustrate the accounting rate of return consider the project that has the original investment of 70,000birr, the life of 4 years, & the salvage value of 6,000 birr at the end of year 4. The straight line method of depreciation is used. Income before depreciation & taxes are 40,000 birr for year 1, 42,000 birr for year 2, 36,000 birr for year 3, & 50,000 birr for year 4. Determine the accounting rate of return if income tax rate on the project is 40%. To compute the accounting rate of return (ARR) for this project, first we have to determine the average investment & the annual depreciation amount.

Average investment = (70,000+6,000)/2 = 38,000 birr

Annual depreciation = (70,000-6,000)/4 = 16,000 birr

To compute the new profit for each year during the four years.

	Year 1	**Year 2**	**Year 3**	**Year 4**
Income before depn. & taxes	40,000	42,000	36,000	50,000
Less: annual depreciation	16,000	16,000	16,000	16,000
Income before taxes	24,000	26,000	20,000	34,000
Less: income taxes (40%)	9,600	10,400	8,000	13,600

Then we compute the average net profit during the four years. That is:

Average net profit = (14,400+15,600+12,000+20,400)/4

=15,600 birr

Hence, ARR $¿ \frac{Average\,annual\,net\,profit}{Average\,cost\,of\,investment} = \frac{15{,}600}{38{,}000} = 0.41 \text{or} 41\%$

This is to mean that an average of 1 birr invested in this project, there is an average return of 41% in the form of net profit per year over the entire four years of the life of the project. The accounting rate of return method project evaluation, like the payback period method, ignores the timing of cash flows or the time value of money. Moreover, the accounting rate of return ignores the fluctuation of cash flows over the life of the project as it assumes an average cash flows every during the project's life.

5.4.2. The Discounting cash flow (DCF) criteria (techniques)

The Discounting cash flow (DCF) techniques are other methods of evaluating & ranking investment project proposals. These techniques employ the time value of money concept; unlike the traditional methods. Four DCF techniques are discussed in the section that follows.

5.4.2.1. The discounting payback period

The discounting payback period is defined as the number of years that is required to recover the amount of money invested in a project at the beginning after discounting the future cash flows to their present values. Discounting payback period in computed in the same manner as that of the regular payback period except the discounted cash flows are used in the case of the former one. The expected future cash flows are discounted by the projects cost of capital. To illustrate the computation of the discounted payback period, suppose that a given capital budgeting alternative is expected to have an initial of 30,000 birr & the life of 5 years. The after-tax cash flows from the project during years 1,2,3,4 & 5 are 15,000 birr, 18,000 birr, 12,000 birr, 20,000 birr, & 22,000 birr respectively. The cost of capital (the4 required rate of return) is %. What is the discounted payback period for this project? To this question, first we have to compute the discounted cash flows & the cumulative cash flows for each year which help buys to

locate the discounted payback period for this project. Hence, the discounted cash flows & the cumulative cash flows year by year are show as follows.

Year	cash flows	discount factor	present value	cumulative CF
1	15,000	0.909	13,635	13,635
2	18,000	0.826	14,868	28,503
3	12,000	0.751	9,012	
4	20,000	0.683	13,660	
5	22,000	0.621	13,662	

As you can see from the cumulative discounted cash flows the discounted payback period for project is b/n 2 & 3 years. This is because the cumulative discounted cash flow at the end of year 2 is less than the initial investment of 30,000 birr & the cumulative discounted cash flows at the end of year 3 is greater than the same initial net investment. The exact payback period (discounted) can be computed as: discounted payback period =2 years+ (1,497/9,012) years

=2 years+0.17 years = 2.17 years

= or 2 years + (0.17) (12 months)

= 2 years & 2 months.

It requires the project a period of 2 years & 2 months to recover its initial net investment taking the time value money into account. This is true only if the cash flows assumed to occur uniformly throughout the year. But the cash flows are discounted back to their present cash equivalents by considering that the cash flows are occurring at the end of every year. Hence, the project needs to wait for one more years after year 2 in order to recover the remaining present value equivalent amount of 1,497 birr at the end of year 2. Therefore, the discounted payback period of this project is 3 years instead.

5.4.2.2. The net present value(NPV) method

The net present value (NPV) method is an investment project proposals evaluating & ranking method using the net present value, w/c is the difference b/n the present values of future cash inflows & the present values of future cash out flows, discounted at the given cost of capital, or opportunity cost of capital. In order to use this method properly, the following procedures are followed.

1. Find the present values of each cash flow, including both inflows & out flows using the cost of capital of the project for discounting.
2. Sum the discounted cash outflows & the discounted cash outflows separately.
3. Obtain the difference b/n the sum of the cash inflows & the sum of cash out flows.

In all the cash out flows for the project occur at time zero, i.e. at the beginning of year 1, the present value of the cash outflows is the same as to the net investment amount.

Decision rule for the net present value (NPV) Method

If the projects are independent, the projects with positive net present values are the ones whose

implementation maximizes the wealth of shareholders. Hence, such projects should be accepted for implementation. If the projects, on the other hand, are mutually exclusive, the one with the higher positive NPV should be accepted leading to the rejection of the projects with thee lower positive NPV. Projects with negative NPV should not be considered for acceptance in the first place. The rational for the net present value method is that a NPV of zero signifies that the cash flows of the project are just sufficient to repay the invested capital & to provide the required rate of return, no more no less. If the project has a positive NPV, it is generating more cash than needed to service its debts & to provide the require rate of return to the shareholders, & this excess cash accrues solely to the firm’s shareholders. Therefore, if the firm takes on a project with a positive NPV, the wealth of the shareholders will improved as indicated above. To illustrate the NPV as

a method of project proposals ranking assume that a given project is expected to have an initial investment & project life of 40,000 & 5 years respectively. The annual after-tax cash flow is estimated at 12,000 birr for each one of the five years. Using the required rate of return of 10%, What is the NPV of the project? How do you judge the acceptability of this project? In order to answer this question, it is wise to identify the cash inflows & cash out flows. In the case of this project, there are annuity cash inflows of 12,000 every year for five years & single cash outflows of 40,000 at time zero. The present value of the annuity cash outflows is:

Present value of annuity = 12,000(annuity factor)

The annuity factor given the period of 5 years& discount rate of 10% is3.791 substituting the factor I the equation above.

PVA = 12,000(3.791) = 45,492 birr

Present value of cash flows = 40,000 birr

Hence, the net present value (NPV) = PV of inflows less PV of out flows

=45,492-40,000 = 5,492 birr

Since the project makes the net present value (NPV) of positive 5,492 birr, it should be accepted.

Consequently, the wealth of the shareholders would increase by 5,492 birr in total as the result of accepting & running this project. Thus, the project can be judged as an acceptable one. To further illustrate the NPV method, consider the following mutually exclusive project alternatives, together with their cash flows.

Alternative	**Year 0**	**Year 1**	**Year 2**	**Year 3**	**year 4**	**Year 5**
A	(80,000)	20,000	25,000	25,000	30,000	20,000
B	100,000	25,000	20,000	30,000	35,000	40,000

The required rate of return on both projects is 12%. Then, evaluate these projects using the net present value method. The evaluation of these two

projects requires the computation of the net present values for both projects. As you can see the cash flows from both projects are not in annuity forms. The cash flows are irregular for both projects. Hence, we need to discount each of the cash flows individually. Then the individual discounted cash flows are added. The cash outflows at time zero will be deducted from the sum of the discounted cash inflows in order to get the net present value of the project. The net present value (NPV) for project A is:

Year	**cash flows**	**discount factor (12%)**	**present values**
1	20,000	0.893	17,860
2	25,000	0.797	19,925
3	25,000	0.712	17,800
4	30,000	0.636	19,080
5	25,000	0.567	11,340

PV of cash inflows (sum) 86,005

PV of cash outflows 80,000

Net present value (NPV) **6,005 birr**

The net present value (NPV) for project B is:

Year	**cash flows**	**discount factor (12%)**	**present values**
1	25,000	0.893	22,325
2	20,000	0.797	15,940
3	30,000	0.712	21,360
4	35,000	0.636	22,260
5	40,000	0.567	22,680

PV of cash inflows (sum) 104,565

PV of cash outflows 100,000

Net present value (NPV) **4,565 birr**

Since the two projects are mutually exclusive, the one with the higher NPV has to be accepted. Thus, project A is selected as its NPV is higher than that of project B. Had the two project been independent of one another, both of them would be accepted because both projects have positive net present values (NPVs).

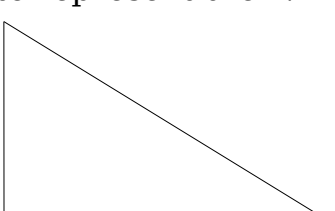
The NPV profile

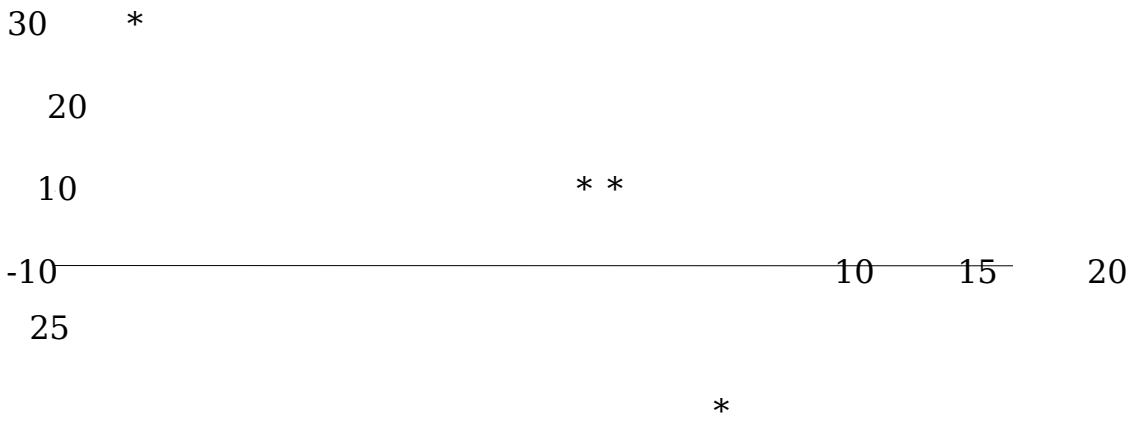
As indicated above, the net present value of the project depends solely on the size & timing of the cash flows, the investment out lays, & the discount rate. A simple graphic device that visualizes this dependence is called the NPV profile.

To illustrate the NPV profiles suppose that a project is expected to have an initial investment of 200 birr & the first year cash flow of 230 birr. The net present value of this simplified project using four alternative discount rates of 0, 10, 15 & 20% is shown as follows.

Discount rate	**discount factor**	**Present value of 230 birr**	**less net investment**	**net present value**
0	1.00	230	200	30.00
10%	0.909	209.07	200	9.07
15%	0.870	200.01	200	0.00
20%	0.833	191.59	200	-8.41

The NPV profile can be shown with the x-y coordinate plane where the y-axis is to represent the NPVs & the x-axis is to represent the discount rates.





The discount factor is when the discount rate is zero. This reflects the fact that 0 birr received tomorrow is equal to a birr received today in a world where there is no other profitable alternative of using money. At the discount rate of 15At the discount rate of 15% The NPV is zero, which means that this project is earning exactly 15% returns. The above graph indicates that the NPV of the project under consideration is positive when the discount rates are less than 15%, $ negative when the discount rates are greater than 15%. Therefore, this project should be accepted if & only if the opportunity cost of is below 15%.

5.4.2.3. The Internal rate of Return(IRR)

The internal rate of return is the discount rate which equates the present value the expected cash flows with the initial investment outlays. In other words, IRR is a method of ranking investment projects proposals using the rate of return on an asset (investment). At IRR, the sum of the present values of all cash inflows is equal to the sum of the present values of all cash out flows. That is: PV (cash inflows) =PV (cash out flows). Hence, the net present value of any project at a discount rate that is equal to the IRR is zero.

Computing the internal rate of return

1. **Uniform cash inflows over the life of the project:**

In this case, the present value table of an annuity can be used to calculate the IRR since the cash inflows are in annuity form. The following steps can be followed to calculate IRR for constant cash inflows.

Step 1: find the critical value of discount factor

$$\text{Discount factor} = \frac{initial\,investment}{annual\,cash\,inflow}$$

Step 2: find the_IRR by looking along the appropriate line (year) of the present value of annuity table until the column which contains the critical discount factor (i.e. the discount factor computed under step 1) is located. To illustrate the calculation of IRR when the cash flows are in an annuity form, assume that a project has a net investment of 26,030 birr & annual net cash inflows of 5000 birr for seven years. What is the IRR of this project? In order to answer this question, we need to follow the two steps discussed above.

Step 1 compute the critical discount factor. That is

$$\text{Discount factor} = \frac{26{,}030}{5{,}000} = 5.206$$

Step 2 after determining the critical discount facto, we look for the value that is equal to this factor in the present value of annuity table across the line corresponding of 7 years (i.e. n=7). The discount factor of 5.206 appears in the 8% column on the line/row of 7 years. Therefore, the IRR IS 8%.

Fluctuating cash inflow over the life of the project

When the cash inflows from the project are not in annuity form, IRR is calculated through an interactive process or through “trial & error”. It may be difficult to identify from which discount rate to start. A good first guess can be made by estimating the discount factor.

In general, the following procedures are used to calculate the IRR of the non-uniform net cash flows.

Step 1: find the critical value of discount factor. In fact, if the fluctuations I the cash inflows is very large, the estimated discount factor doesn't help you much in locating the IRR in the present value of annuity table.

$$\text{Estimated discount factor} = \frac{net\,investment}{average\,cash\,inflow}$$

Step 2: look at the present value of annuity table to obtain the nearest discount rate for the estimated discount factor determined in step 1.

Step 3: calculate the NPV using the discount rate identified in step 2.

Step 4: If the resulting NPV is positive, choose the higher discount rate & repeat the procedure. Choose the lower discount rate if the NPV is negative, & repeat the same procedure until you find the discount rate that equates the NPV to zero.

To illustrate the IRR computation under fluctuating cash inflows from the project assume a project that has an initial investment of 40,000 birr & the following net cash inflows;

Year 1, 15,000 birr; Year 4, 15,000 birr;

and

Year 2, 10,000 birr; Year 5, 15,000 birr.

Year 3, 10,000 birr;

What is the IRR of this project?

In order to estimate the discount factor, you need to give weight to the cash flows over the life of the project. Larger weights should be given to the cash flows towards the beginning of the life of the project than to the cash flows that occur towards the end of the project life.

Hence,

Year	weights	cash flow x weights
1	5	75,000
2	4	40,000
3	3	30, 000
4	2	30,000
5	1	15,000
	15	190,000

Average net cash flow $= \frac{190,000}{15} = 12,667$

Estimated discount factor $= \frac{40,000}{12,667} = 3.158$

By looking up in the present value table for annuity, the approximate the discount factor of 3.158 online 5(n=5) is 18%. Thus, the starting point of the iterative process is 18%. The NPV of the project using the discount rate of 18% is:

NPV =(15,000)(0.847)+(10,000)(0.718)+(10,000)(0.609)+(15,000)(0.516)+(15,000)(0.437)-40,000 =270

Since the NPV computed using a discount rate of 18% is positive, are have to take a discount rate higher than 18% in search for the NPV of zero. So the second guess can be 19%. The NPV of the project using the discount rate of 19% is:

NPV =(15,000)(0.840)+(10,000)(0.706)+(10,000)(0.593)+(15,000)(0.499)+(15,000)(419)-40,000 =-640

As per the above calculations, NPV is negative when the discount rate of19 % is used & positive when the discount rate of 18% is used. Thus, the IRR for this project falls b/n 18 & 19%. If the exact IRR is needed, the interpolation method it can be used. That is:

Step 1: obtain the NPV of the smaller rate by the absolute sum & add the resulting quotient to the smaller rate, or divide the NPV of the larger rate by the absolute sum & subtract the resulting quotient from the larger rate.

Step 2: divide the NPV of the smaller rate by the absolute sum & add the resulting quotient to the smaller rate, or divide the NPV of the larger rate by the absolute sum & subtract the resulting quotient from the larger rate.

By following the above two steps, the exact IRR for this project is thus:

The absolute sum of the NPVs =|270|+|-640| = 270+640 =910

Then, dividing the NPV of the smaller rate by the absolute sum, you get 270/910 = 0.30 to the nearest two digits after the decimal point, & add this figure to the smaller rate.

IRR = 18%+0.30% = 18.30%

Or you can divide the NPV of the larger rate by the absolute sum, & you get:

-640/910-0.70 t0 the nearest two digits after the decimal point, & subtract this figure from the larger rate to obtain the exact IRR.

IRR = 19%-0.70% = 18%

In both cases, you arrive at the same IRR value of 18.3%

The rational for the IRR method is that the IRR on a project is its expected rate of return. If the IRR of a given investment project exceeds the cost of the funds used for financing the project(cost of capital), there is the remaining surplus after paying for the capital, & this surplus adds up on the wealth of the shareholders of the firm. Therefore, selecting the project with the IRR less than the cost of capital imposes an unnecessary cost on current shareholders. The return from the project will to cover even the cost of capital.

Decision rule for IRR

A project whose IRR is greater than its cost of capital, or required rate of return (RRR) is accepted & whose IRR is less than the RRR of the project is rejected.

5.4.2.4. Profitability index(PI)

Profitability index is the ratio of the present value of the expected net cash flow of the project & its initial investment outlay.

$$PI = PV/IO$$

Where, PV = Present value of expected net cash flows

IO = initial investment outlay

PI = profitability index

Profitability index provides or measure of profitability in a more readily understandable terms. It simply converts the NPV criteria into a relative measure.

NPV VS PI

The NPV & the PI criteria reach the same acceptance-rejection decisions for independent projects. The PI is greater than 1 if the NPV of the project is positive. However, in the case of mutually exclusive projects, NPV & PI will result in different acceptance-rejection decisions. One advantage of NPV in this case is that it reflects the absolute size of alternative investment proposals. PI does not reflect difference in investment size. Therefore, the NPV is more appropriate for mutually exclusive projects than PI. Consider the following two mutually exclusive projects.

	PV of cash flows	initial investment	NPV	PI
Project A	200	100	100	2.0
Project B	3000	2000	1000	1.50

From the above example Project A is accepted using PI B/C its PI is greater than that of Project B. however, NPV of the project B is greater than that of Project A. Thus, even though the PI of a project is a very useful tool, it should not be used as a decision rule when mutually exclusive projects of different size are being considered.

NPV Vs IRR

The NPV & IRR project ranking techniques lead to the same acceptance-rejection decisions for independent projects. However, these methods may lead to different decisions when it is impossible to undertake all investment opportunities. In other words, when investment opportunities are mutually exclusive, NPV & IRR may result in contradicting decisions. If this is the case, which one of the two methods should be used to select b/n among the mutually exclusive projects? What are the reasons for the difference b/n the two methods? Let us first discuss the reasons for the difference. These reasons can be classified into two. These are:

5.5. Difference in the size of investment

All investments do not usually require the same amount of initial outlay. One investment may have larger initial investment than its alternatives. In this case, NPV leads to better investment decision b/c it ensures that the firm will reach the optimal scale of investment. NPV automatically examines & compares the incremental cash flows against the cost of capital. The IRR criteria ignore this important aspect of an investment decision b/c the return is expressed in a percentage. To illustrate, the difference b/n the NPV & IRR as project ranking techniques consider the following mutually exclusive projects, project A & project B.

	0	1	2	3	4	5
Project *A*	*(50,000)*	*17,000*	*17,000*	*17,000*	*17,000*	*17,000*
Project B	*(32,000)*	*12,000*	*12,000*	*12,000*	*12,000*	*12,000*

The required rate of return for this project is 8%. Which one of these two projects should be selected? From the above illustrative example, we can see that the lives of both projects are the same. However, the initial investment of project A is greater than that of project B. thus, one can learn that there is a difference in the size or scale of investment. In order to identify the project to be selected, the NPV & IRR for both projects have to be calculated. Since the cash flows for both projects are in an annuity form, the IRR can be easily determined from the present value table of annuity after determining the discount factors.

Therefore, the discount factor for project A = $\frac{50,000}{17,000}$ = 2.941

Looking in the present value table of annuity in the raw of 5 years, the discount factor of 2.941 corresponds to 20.8%.

The discount factor for project A = $\frac{32,000}{12,000}$ = 2.667

Looking in the present value of annuity table across the 5 year (n=5) row, the discount factor of 2.667 corresponds to 25.5% &

The NPV of project A = (17,000) (the discount factors of annuity at the required rate of 8%)-50,000

= (17,000) (3.993)-50,000

= 17,881 birr

The NPV of project B = (12,000) (the discount factors of annuity at the required rate of 8%)-50,000

= (12,000) (3.993)-50,000

=15,916 birr

The above calculations indicate that both projects are acceptable if they are independent projects. However, those projects are mutually exclusive. As a result, IRR ranks project B first, but NPV ranks project A first. Thus, there is a paradox b/n the two methods. In order to clarify such paradoxical result, it is advisable involved. Then the internal rate of return (cross over rate) is determined on the incremental cash flows & additional investment. Additional investment is the difference b/n the investment outlays of the two projects. Cross over rate is the discount rate at which the NPV profiles of the two projects cross, & thus, at which the projects' NPVs are equal. Thus, the internal rate of return on incremental cash flows is the same as the cross over rate. The cross over rate for the illustration under consideration is calculated in the same, procedures as IRR for the project, i.e.

Discount factor = 18,000/5,000 = 3.600

From the present value of annuity table, the discount factor of 3.600 corresponds to the 12% column. Thus, the cross over rate is 12%. The cross over rate indicates that the NPV gives priority to projects A at discount rates below cross over rate of 12%, but IRR supports project B for a discount rate above the cross over rate. Since the cost of capital is 8%, the incremental cash flow represents a profitable opportunity. Therefore, the larger project which incorporates these additional cash flows should be accepted. If the cross over rate is less than the cost of capital (IRR), the project with the smaller investment should be selected b/c the additional commitment of resources will not be compensated. Therefore, by examining

& comparing the incremental cash flows against the cost of capital, the NPV method ensures that the firm will reach the optimal scale or size of investment.

5.6. Difference in timing of cash flows

The NPV & the IRR can still give contradictory ranking even when initial investment outlays are the same b/c of the difference in the timing of the cash flows. Most of the cash flows one project may occur in the early years & most of the cash flows from the other project may occur during the later years. The critical issue is that “how useful is the project if it generates cash flows sooner than later?” so, which method should be sued?

Basically, the cash flows that occur sooner are better than the cash flows that occur later b/c early cash flows can be reinvested. In fact, we cannot use the scale of investment project argument discussed earlier to justify the preference of NPV & IRR. However, we can still use the same incremental cash flow technique. So, how can we justify the use of NPV as a project ranking & evaluating method when differences in the scale of investment do not exist?

In order to justify the superiority of NPV rule over that of the IRR, we need to consider the reinvestment rate assumption of early cash flows. According to the reinvestment rate assumption, NPV method implicitly assumes that the cost of capital (RRR) is the rate of which cash flows can be reinvested, where as the IRR method assumes that the business firm has the opportunity to reinvest at the IRR. which assumption do you think is better?

The best assumption is the one that considers the reinvestment of cash flows at the cost of capital, i.e. NPV method, the IRR method incorrectly penalizes the receipts of more distant years by using high discount rate (IRR) B/C IRR is greater than required rate of return (RRR). Thus, the best reinvestment rate assumption is the cost of capital which is consistent with NPV method.

To illustrate, let us assume that project A & project B have the same initial investments, 10,000 birr. The RRR is for the firm 10%.

Year	project A	project B
0	(10,000)	(10,000)
1	-	6,000
2	13,924	7,200
IRR	18%	20%
NPV	1,501	1,401

Which project should be selected?

IRR singles that project B is better than project A, where as NPV signals that project A is better than project B. Since NPV method is the superior top the IRR method in selecting b/n two mutually exclusive projects, project A is selected. Project A will provide the most wealth to the shareholders. To prove the soundness of this decision, we can calculate the terminal value of each project using future value technique. Thus, terminal value of:

Project A = 13,924 birr

Project B = 7,200 birr + (6,000) (1.1) birr = 13,800 birr

Since the terminal value of project A is greater than the terminal value of project B, the former project is selected which is in line with the NPV decision rules.

5.7. Projects with unequal lives

Earlier in this chapter, we assumed that mutually exclusive projects have equal lives. But there are many situations in which alternative investment have unequal lives. The most common example of such situation is unequal replacement decision. Since it is not appropriate to compare projects of unequal lives adjustment must be made. Even though there are different methods (approaches) of dealing with mutually exclusive alternatives with different lives, there of them are introduced in this chapter.

5.7.1. The replacement chain approach

Replacement chain, which is called common life approach, is the method of comparing projects of unequal lives which assumes that each project can be repeated as many times as necessary to reach a common life span. Then, the NPV or the other method is used to evaluate the project.

To illustrate the comparison off projects with unequal lives consider two mutually exclusive projects whose cash flows are summarized below. The discount rate for both projects is 10%.

	0	1	2	3	4	5	6
Project *A*	*(40,000)*	*10,000*	*12,000*	*15,000*	*11,000*	*9,000*	*11,000*
Project B	*(30,000)*	*12,000*	*14,000*	*13,000*	-	-	-

Two projects are incomparable. Thus, according to replacement chain approach, project B will be repeated in the three years. Assuming that cash flow & the discount rates will not change. Thus, if project B is repeated, its year 4, years 5, & year 6 cash flows are 12,000 birr, 14,000 birr, & 13,000 birr respectively. In this way, the two projects have the same life. If project B is repeated, its cash flows will be:

	0	1	2	3	4	5	6
Project B	*(30,000)*	*12,000*	*14,000*	*13,000*		*12,000*	*14,000*	*13,000*

The present value computation of the repeated project B requires a two-step process. These are:

Step 1: you compute the present values at t=0 for project B & at t=3 for the repeated project B.

present values at time zero(t=0)=(12,000)(0.909)+ (14,000)(0.826)+ (13,000)(0.751)=32,235 birr

present values at time three(t=3)=(12,000)(0.909)+ (14,000) (0.826)+ (13,000)(0.751)=32,235 birr

Step 2: discount the present value of repeated project B at time three (t=3) to the present values at time zero (t=0). That is, present value of repeated project B at time zero = (32,235) (0.751) = 24,208 birr

Then, add the present value of the first three years cash flows to the present value of the repeated project after three years. That is:

Total present value = 32,235+24,208 = 56,443 birr. Hence, the NPV of the repeated project

B =56,443-30,000 = 26,443 birr

The NPV of project A is calculated as follows.

Year	cash flows		discount factor	present value
1	10,000	0.909	9,090	
2	12,000	0.826	9,912	
3	15,000	0.751	11,265	
4	11,000	0.683	7,513	
5	9,000	0.621	5,589	
6	11,000	0.564	10,204	
		PV of cash inflows (sum	49,573	
		PV of cash outflows	40,000	
		NPV of project A		**9,573 birr**

Therefore, using the NPV method for project comparison of the two projects, project B should be selected. Under the replacement chain approach of comparing projects with unequal lives, the least common factor of the projects lives is used to find the common useful life. For instance, if the life of project A is 5 years & that of project B is 3 years, project A is repeated 3 times & project B is repeated 5 times b/c the least common factor for the two project lives(i.e.3 & 5) is 15 years.

5.7.2. Equivalent Annual Annuity(EAA) Method

This method enables us to calculate the annual payments a project would provide if it were an annuity. When comparing projects of unequal lives, the one with higher equivalent annual annuity should be chosen. Three steps are followed under this method:

Step 1: find each project's NPV over its initial life. The NPV for the above projects are as follows:

Project A = 9,573 birr (as computed before)

Project B = (12,000) (0.909) + (14,000) (0.826) + (13,000) (0.751) =32,235 birr

Step 2: find the equivalent annual annuity that has the same present value as the project's N

Equivalent annual annuity can be calculated as follows.

Project A NPV = PV of cash flows – PV of initial outlays.

9,573 = PV of cash flows – 40,000

9,573 + 40,000 = PV of cash flows

PV of cash flows=49,573. By looking up in the present value of annuity table at n=6 & I=10%, the discount factor is 4,355. As you know PV of cash flows = cash flow x discount factor.49, 573= (4.355) (x)

Where, x is the equivalent annual annuity.

X= 49,573/4.355 = 11,383 birr

For project B NPV = PV of cash flows – PV of initial outlays

2,235 = PV of cash flows – 30,000

2,235 + 30,000 = PV of cash flows

PV of cash flows=32,235. By looking up in the present value of annuity table for the discount that corresponds to n=3 & I=10% is 2.487. Hence

2.487(y) 32,235 where, y is represents the equivalent annual annuity amount for the project. Solving for y we get. Y = 32,235/2.487 = 12,961 birr

Step 3: the project with the higher equivalent annual annuity will always have the higher NPV when extended out to any common life. Therefore, project B's equivalent annual annuity (EAA) is larger than project A's, project B would be chosen.

5.8. Capital rationing

Capital rational is a situation in which a constraint is placed on the total size of the firm's capital budget. Capital ration is said to exist when we have profitable (positive NPV) investments available but we can't get the needed fund to undertake all of them. Two main reasons can be mentioned. One is what is called soft rationing which is the situations that occurs when units are allocated a certain amount of financing for capital budgeting. Such allocation is primarily a means of controlling & keeping track of overall spending. Soft rationing doesn't mean that the business firm as a whole is not short of capital. The other reason is hard rationing. Hard rationing is the situation that occurs when a business cannot raising finance or funds for a project under any circumstances.

A business firm with a sound financial status does not face hard rationing.

1. The timing & magnitude of the cash flows of all projects (all project alternatives) are known.
2. The cost of capital is known.
3. All projects are strictly independent.
4. The total investment outlay of all those projects that have a positive NPV exceeds the firm's budget constraints. Taking these assumptions into account, the problem under capital rationing is how to choose a subset of desirable projects in such a way that total investment does not exceed the budget.

In order to solve this problem, the sound procedures are as follows.

1. Rank all projects with positive NPVs in accordance with their profitability index.
2. Select projects from the top of the list (with the highest profitability index) until the fixed budget are exhausted.

To illustrate how to select project alternatives when the company has a limited capital amount (i.e. when there is capital rationing) suppose that

affirm has a fixed capital budget of 600,000 birr & has the following investment alternatives.

Project	initial investment	NPV	PI
A	150,000	40,000	1.50
B	190,000	40,000	1.40
C	120,000	70,000	1.80
D	180,000	50,000	1.30
E	330,000	60,000	2.00

The question is that which of these projects should the firm select & implement give the fixed amount of capital budget indicated above?

To answer these question, first we have to rank these project based on the value of their profitability index. Hence, their arrangement according to their profitability index is E-C-A-B-D. This is to mean that project E is with highest profitability index & project D is with the lowest profitability index. Therefore, given the capital budget constraint of 600,000 birr, projects F, C & A are selected. The initial capital requirements for these projects are the sum of the initial investment costs of these projects F, C & A are selected. The initial capital requirement for these projects is 600,000. (i.e. 330,000+120,000+150,000 = 600,000). So the total initial investment cost of the three projects is exactly equal to the total capital budget of the firm. This implies that the rest of the project alternatives cannot be implemented b/c of the lack of capital though they are all acceptable ones. The total net present (NPV) of the projects that were selected is 60,000+70,000+40,000 = 170,000 birr

5.9. Capital budgeting under risk

Up to this point, we have ignored risk in capital budgeting; that is we have discounted expected cash flows back to their present values & ignored any uncertainty that might surround the expected cash flows. In reality, the future cash flows associated with introduction of a new sales outlet or anew product are estimates of what is expected to happen in the future, not necessarily what will happen in the future. But, these cash flows discounted to their present values have only been our best estimate of the expected cash flows. In this section, we will assume that under conditions of risk we don't know beforehand what cash flows will actually result from the new project. However, we do have expectations concerning the outcomes & are able to assign probabilities to these outcomes. Stated in another way, although we do not know the exact cash flows resulting from the acceptance of anew project, we can formulate the probability distributions from which the flows will be drawn. Risk, here, is defined as the potential variability in the future cash flows.

5.9.1. Relevant risk in capital budgeting

In capital budgeting, a project's risk can be looked at in three levels. First, there is a total project risk, which is a project's risk ignoring the fact that much of this risk will be diversified away as the project is combined with the firm's other projects & risks. Second, we have the projects. Contribution to firm's risk, which is the amount of risk that the project contributes to the firm as a whole; this measure considers the fact that some of the project's risks will be diversified away as the project is combined with the firm's other projects & assets, but ignores the effects of diversification of the firm's shareholders. Finally, there is what is known as a systematic risk of the project from the view point of a well diversified shareholder; this measure considers the fact that some of the project's risk will be diversified away as the project is combined with the firm's other projects, & in addition some of the reaming risk will be diversified away by shareholders as they combine this stock with other stocks in the portfolio.

5.9.2. Risk, return & net present value

When a financial manager is considering asset of risky alternatives, one important consideration involves the choice of the required rate of return. Given the risk aversion nature of managers, the required rate of return of each project is the function of its risk. The riskier the project the higher the required rate of return is selecting the appropriate required rate of return involves subjective judgments. Given the general patterns of managerial risk aversion, which shows the direct relationship b/n risk & return, the following guidelines can be established.

1. The coefficient of variation can be used as the measure of risk per birr return. As such, it can be used to rank the riskiness of probability distributions of cash values.
2. The required rate of return can be set to the sum of the risk-free rate plus some additional return to compensate for risk.

5.9.2.1. The risk adjusted Net P resent Value (RANPV)

The risk adjusted net present value (RANPV) services as a capital budgeting decision criteria under conditions of risk & is defined as the sum of the present values of the expected cash values discounted at the required rate of return. The RANPV coefficient that is positive or zero indicates that the project earns at least the risk adjusted required rate of return & that adopting such project can increase the value of the firm & thus the shareholders' wealth. When a risky investment to be evaluated on accept or reject basis, the RANPV criteria provides the following decisions rule: Accept the risky project if it's RANPV is positive or zero; reject it if the project's RANPV is negative. To illustrate how to evaluate a project under condition of risk(i.e. when the cash flows are not certainly know rather given probability distributions under different setae of the economy) suppose a risky project that has a life of four years. The estimated risk adjusted rate of return is 10%. The initial investment of the project is 29,000 birr.

Year	state of economy	cash flow	probability

	Boom	12,000	0.20
1	Average	10,000	0.50
	Recession	7,000	0.30
2	Boom	18,000	0.10
	Average	15,000	0.50
	Recession	13,000	0.40
3	Boom	15,000	0.30
	Average	14,000	0.40
	Recession	12,000	0.30
4	Boom	19,000	0.30
	Average	16,000	0.50
	Recession	14,000	0.20

Compute the payback period for this risky project. What is the RANPV of the project? Compute the IRR of the project. Calculate the profitability index of the project. Before we answer each one of the questions, let us computed the expected each flows for each year of the project life as follows:

Year 1 :(12,000) (0.20) + (10,000) (0.50) + (7,000) (0.30) =9,500 birr

Year 2: (18,000) (0.10) + (15,000) (0.50) + (13,000) (0.40) =14,500 birr

Year3: (15,000) (0.30) + (14,000) (0.40) + (12,000) (0.30) =13,700 birr

Year 4: (19,000) (0.30) + (16,000) (0.50) + (14,000) (0.20) =16,500 birr

Using these expected cash flows for the project, the payback period can be computed as follows:

Year	expected cash flow	cumulative cash flows
1	9,500	9,500
2	14,500	24,000
3	13,700	37,700
4	16,500	54,200

The payback period for this project is longer than 2 years & shorter than 3 years because the initial investment of 29,000 birr is greater than the

cumulative cash flows at the end of year 2 of 24,000 birr & less than the cumulative cash flows at the end of year 3. If the cash flows are expected to occur only at the end of years, the payback period of the project will be 3 years. This because the amount of the initial investment not paid back at the end of year 2 (i.e. 29,000 birr less 24,000 birr which is 5,000 birr) will not paid back till the end of year 3. On the other hand, if the expected cash flows occur uniformly throughout the year, the payback period will be b/n 2 year & 3 years. The exact payback period is computed as follows.

$$\text{Payback period} = 2 \text{ years} + \frac{Amount\ of\ initial\ investment\ not\ paid\ back}{expected\ cash\ flow\ during\ year\ 3}$$

$$= 2 \text{ years} + \frac{5{,}000\ years}{13{,}700} = 2 \text{ years} + 0.36 \text{ years} =$$

2.36 years, or

$$= 2 \text{ years} + (0.36)\ (12 \text{ months}) = 2 \text{years \& } 4$$

months

The risk adjusted Net Present Value (RANPV) of the project can computed by using the expected cash flows determined above. These expected cash flows are discounted at the risk adjusted discounting rate of 10%. The initial investment amount is subtracted from the sum of the discounted expected cash flows & difference is what is known as the risk adjusted net present value (RANPV).

RANPV = (9,500) (0.909) + (14,500) (0.826) + (13,700) (0.751) + (16,500) (0.683)-29,000

= 8,635.50+11,977+10,288.70+11,269.50-29,000 = 13,170.70

The IRR of this project is determined through an iterative process because the expect cash flows are not in an annuity form. To identify the starting point, we assign a weight, the highest weight to the cash flows of the first year & the lowest weight to the cash flows of the last year in the project life.

Year	expected cash flow	weight	cumulative cash flows x weight
1	9,500	4	38,000

2	14,500	3	43,500
3	13,700	2	27,400
4	16,500	1	16,500
		10	

125,400

The weighted average cash flows = 125,400/10 =12,540

The estimated discount factor =29,000/12,540 2.313

The estimated discount factor of 2.313 is near to the present value of annuity table value of 2.320 which is found in the 26% column in year 4 row. Hence, the first guess is 26%.

The RANPV using 26% as the risk adjusted discounting factor:

RANPV (26%) = 9,500(0.794) + (14,500) (0.630) + (13,700) (0.500) + (16,500) (0.0.397)-29,000= 7,543+9135+6850+6,550.50-29,000 = 1,078 birr

Since the RANPV using a discount rate of 29% is large positive, we have to try larger discount rates. Second guess: let us try 29% b/c the NPV corresponding to 26% is far from zero. Hence, it seems reasonable to consider 29% than 27 or 28%.

RANPV (29%) = 9,500(0.775) + (14,500) (0.601) + (13,700) (0.446) + (16,500) (0.361)-29,000

=7,362.50+8,714.50+6,384.20+5,956.50-29,000 = -582.30 birr

Since the net present value at a discount rate of 29% is negative, the IRR for this project must be less than 29% & greater than 26%. Therefore, the interactive process continues. The third guess can be either 27% or 28% let the third guess be 28%.

RANPV (28%) = 9,500(0.781) + (14,500) (0.610) + (13,700) (0.477) + (16,500) (0.373)-29,000

7,419.50+8,845+6,543.90+6,154.50-29,000 = -46.10 birr

Still the NPV of the project is negative at the discount rate of 28%, which implies that the IRR is b/n 28% & 26%. There is a difference of 2% b/n these two percentages. Hence, the IRR of this project can be computed as follows.

The sum of the absolute sum of the RANPV of two rates is =/1,078.50/+/-46.20/ = 1,124.60

$$\text{IRR} = 26\% + \frac{1{,}078.50}{1{,}124.60}(2\%) = \underline{27.92\%}$$

Or, we can make the fourth guess, that is 27% & compute RANPV using 27% as the discount rate. That is:

RANPV (27%) = 9,500(0.787) + (14,500) (0.620) + (13,700) (0.488) + (16,500) (0.384)-29,000

= 7,476.50+8,990+6,685.60+6336-29,000 = <u>488.10</u> birr

Therefore, IRR of this project is b/n 27% & 28% b/c when we move from27% to 28%, the NPV moves from positive 488.10 to negative 46.10. This implies that at some point b/n27% & 28%, the NPV touched upon the value of zero that is the IRR of the project. In order to determine the exact IRR, we may use the following steps.

<u>Step 1:</u> obtain the absolute sum of the net present values.

The absolute sum = /-46.10/+/488.10/ =<u>534.20</u>

<u>Step 2:</u> divide the RANPV of the smaller rate by the absolute sum & the quotient to the smaller rate or divided the RANPV of the larger rate by the absolute sum & subtract the quotient from the larger rate. IRR =

$$27\% + \frac{488.10}{543.20}(1\%) = \underline{27.91\%}$$