Project Evaluation Methods

Future value (FV) of the investment and present value (PV)of the investment is important part of the project evaluation.

Future Value of the Investment

What is the future value of the investment or compounded value of an investment?

FV_n= PV $(1+r)^n$

Where

PV= Present value

FV_n= The future value or compounded value of an investment after 'n' years

i = Interest rate

Future value of the investment is calculating assuming that reinvesting the interest earned. The process of investing money as well as reinvesting the interest earned theorem is called compounding.

Example-

We deposited 1000 rupees in a bank at 10% annual interest rate. Assume that interest earned is reinvested. What is the future value of our investment after 3 years?

r = 1+10/100

=110/100

=1.1

Year	Amount of investment	Interest rate (10%)	Future value
0	1000	1.000	1000
1	1000	1.1	1100
2	1000	$(1.1)^2$ =1.21	1210
3	1000	$(1.1)^3$= 1.331	1331

After 3 years we can earn Rs. 1331

Present Value of the Investment

We can use following formula to calculate the present value of investment.

$PV= FV_n \{1/(1+r)^n\}$

Where

PV = Present value

FV= Future value

$\{1/(1+r)^n\}$ = Discounting factor

Example

what is the present value of the Rs 1000 after 6 years? Discount rate 10% is used.

Year	Amount(Rs)	Discount factor	Present value (Rs)
0	1000	1	1000
1	1000	0.909	909
2	1000	0.826	826
3	1000	0.751	751
4	1000	0.683	683
5	1000	0.621	621
6	1000	0.564	564

Present value of Rs 1000 after 6 years is Rs 564

Let's look at an example of how to calculate the present value of a series of cash flows. Assume that an investment will return $10,000 per year over a period of 10 years, and discount rate is 10%.

Discount Rate 10.0%

Year	1	2	3	4	5	6	7	8	9	10
Discount Factor	0.91	0.83	0.75	0.68	0.62	0.56	0.51	0.47	0.42	0.39
Undiscounted Cash Flow	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Present Value	9,091	8,264	7,513	6,830	6,209	5,645	5,132	4,665	4,241	3,855

Net Present Value **61,446**

The value of this investment is worth $61,446 today. It means a rational investor would be willing to pay up to $61,466 today to receive $10,000 every year over 10 years.

When we calculate the present value of the investment we have to select appropriate discount rate. How do we select the appropriate discount rate? When we select the appropriate discount rate we have to pay attention for following factors

1. Interest rate in the market
2. Opportunity cost of the capital
3. Average interest rate in the economy

Net Present Value

Net Present Value (NPV) is the value of all future cash flows (positive and negative) over the entire life of an investment discounted to the present. NPV analysis is a form of intrinsic valuation and is used extensively across finance and accounting for determining the value of a business, investment security, capital project, new venture, cost reduction program, and anything that involves cash flow. In short, NPV is used in capital budgeting and investment planning to analyze the profitability of a projected investment or project.

$$\mathbf{NPV = \sum_{t=1}^{n} C_t/(1+r)^t - Initial\ investment} \qquad \mathbf{(1)}$$

Where

C_t= Net cash flow at the end of year t

n= Life of the project

r= discount rate

Decision rule

If...	It means...	Then...
NPV > 0	the investment would add value to the firm	the project may be accepted
NPV < 0	the investment would subtract value from the firm	the project may be rejected
NPV = 0	the investment would neither gain nor lose value for the firm	We should be indifferent in the decision whether to accept or reject the project. This project adds no monetary value. Decision should be based on other criteria, e.g., strategic positioning or other factors not explicitly included in the calculation.

Money in the present is worth more than the same amount in the future due to inflation and to earnings from alternative investments that could be made during the intervening time. In other words, a dollar earned in the future won't be worth as much as one earned in the present. The discount rate element of the NPV formula is a way to account for this.

For example, assume that an investor could choose a $100 payment today or in a year. A rational investor would not be willing to postpone payment. However, what if an investor could choose to receive $100 today or $105 in a year? If the payer was reliable, that extra 5% may be worth the wait, but only if there wasn't anything else the investors could do with the $100 that would earn more than 5%.

An investor might be willing to wait a year to earn an extra 5%, but that may not be acceptable for all investors. In this case, the 5% is the discount rate which will vary depending on the investor. If an investor knew they could earn 8% from a relatively safe investment over the next year, they would not be willing to postpone payment for 5%. In this case, the investor's discount rate is 8%.

The cash flows of NPV are discounted for two main reasons,

(1) To adjust for the risk of an investment opportunity

(2) To account for the time value of money (TVM)

The first point (to adjust for risk) is necessary because not all businesses, projects, or investment opportunities have the same level of risk. Put another way, the probability of receiving cash flow a US Treasury bill is much higher than the probability of receiving cash flow from a young technology startup.

To account for the risk, the discount rate is higher for riskier investments and lower for safer one. The US treasury example is considered to be the risk-free rate, and all other investments are measured by how much more risk they bear relative to that.

The second point (to account for the time value of money) is required because due to inflation, interest rates, and opportunity costs, money is more valuable the sooner it's received. For example, receiving $1 million today is much better than $1 million received five years from now. If the money is received today, it can be invested and earn interest, so it will be worth more than $1 million in five years' time.

The NPV rule assumes that the intermediate cash flows of a project that is cash flows that occur between the initiation and the termination of the project are reinvested at a rate of return equal to the cost of capital.

Example

To illustrate the calculation of net present value, consider a project which has following cash flow stream

Year	Cash Flow
0	10 00000
1	200000
2	200000
3	300000
4	300000
5	350000

Because the equipment is paid for up front, this is the first cash flow included in the calculation. There is no elapsed time that needs to be accounted for so today's outflow of $1,000,000 doesn't need to be discounted.

The cost of capital 'r' for the firm is 10%. The NPV of the proposal is

NPV= $200000/(1.1)+ 200000/(1.1)^2+300000/(1.1)^3+300000/(1.1)^4+350000/(1.1)^5 - 1000000$= Rs -5273

Since NPV is negative the project is financially not profitable.

The NPV represents the net benefit over and above the compensation for time and risk. Hence the decision rule associated with the NPV criterion is accept the project if the NPV is positive and reject the project if the NPV is negative. (If the NPV is zero, it is matter of indifference).

NPV Calculation Permits Time Varying Discount Rate

In above example we have assumed that the discount rate remains constant over time. This need not always be the case. The NPV can be calculated using time varying discount rates. The general formula of NPV is as follows

NPV $= \sum_{t=1}^{n} C_t / \prod_{j=1}^{t}(1+r_j)$ **– Initial investment** **(2)**

C_t = Cash flow at the end of year t

r_j = One period discounted rate

n= Life of the project

NPV of a simple project decreases as the discount rate increases.

A simple project involves an initial cash outflow or a series of initial cash out flows followed by cash inflows. The NPV of a simple project steadily decreases as the discount rate increases. The decrease in NPV however is at a decreasing rate.

The discount rate may change over time for the following reasons

1. The level of interest rates may change over time- the term structure of interest rates sheds light on expected rates in the future
2. The risk characteristics of the project may change over time, resulting in changes in the cost of capital
3. The financing mix of the project may vary over time causing changes in the cost of capital

Example

To illustrate that you are evaluating a 5-year project involving software development. You believe that the technological uncertainty associated with this industry leads to higher discount rates in the future.

Initial investment	Cash Flow (CF)	Discount rate%	Discount Factor (DF)	Present value = CF/DF
-12000				
	4000	14	1.14	3509
	5000	15	1.14*1.15	3814
	7000	16	1.14*1.15*1.16	4603
	6000	18	1.14*1.15*1.16 *1.18	3344
	5000	20	1.14*1.15*1.16 *1.18*1.2	2322

NPV of Project = 3509+3814+4603+3344+2322-12000 = Rs. 5592

Advantages and disadvantages of the Net Present Value

Advantages:

- Considers time value of money
- Considers all cash flows
- Good decision criteria

Disadvantages:

- NPV will be erroneous if cash flow estimates are incorrect (requires accurate cash flow estimations)

Although NPV offers insight and a useful way to quantify a project's value and potential profit contribution, it does have its drawbacks. Since no analyst has a crystal ball, every capital budgeting method suffers from the risk of incorrectly estimated critical formula inputs and assumptions, as well as unexpected or unforeseen events that can affect a project's costs and cash flows.

- NPV is a dollar return but percent returns are easier to communicate and understand
- The NPV calculation relies on estimated costs, an estimated discount rate, and estimated projected return. It also can't factor in unforeseen expenses, time delays, and any other issues that come up on the front or back end, or during the project.
- Also, the discount rate and cash flows used in an NPV calculation often don't capture all of the potential risks, assuming instead the maximum cash flow values for each period of the project. This leads to a false sense of confidence for investors, and firms often run different NPV scenarios using conservative, aggressive, and most-likely sets of assumptions to help mitigate this risk.

Internal Rate of Return (IRR)

The internal rate of return (IRR) of a project is the discounted rate which makes its NPV equal to zero. Put differently, it is the discount rate which equates the present value of future cash flows with the initial investment. It is the value of 'r' in the following equation

Investment= $\sum^{n}_{t=1} C_t/(1+r)^t$ **(3)**

Where

C_t= cash flow at the end of year t

r = internal rate of return

n = life of the project

In the NPV calculation we assume that the discount rate (cost of capital) is known and determine the NPV. In IRR calculation we set the NPV equal to zero and determine the discount rate satisfies this condition.

A positive IRR means a project or investment is expected to return some value to the organization. A negative IRR would mean that the proposed project or investment is expected to cost more than it returns, or lose value for the company.

Example

To illustrate the calculation of IRR, consider the cash flows of a project being considered by ABC company

Year	Cash flow
0	100000
1	30000
2	30000
3	40000
4	45000

The IRR is the value of ‘r’ which satisfies the following equation

$100000= 30000/(1+r) + 30000/(1+r)^2 + 40000/(1+r)^3 +45000/(1+r)^4$

The calculation of ‘r’ involves a process of trial and error. We try different values of ‘r’ till we find that the right hand side of the above equation is equal to 100000. Let us, to begin with try r = 15%. This makes the right hand side equal to

$30000/(1.15) + 30000/(1.15)^2 + 40000/(1.15)^3 +45000/(1.15)^4 = 100802$

This value is slightly higher than our target value, 100000. So we increase the value of ‘r’ from 15% to 16%. (In general, a higher ‘r’ lowers and a smaller ‘r’ increases the right hand side value). The right hand side becomes:

$30000/(1.16) + 30000/(1.16)^2 + 40000/(1.16)^3 +45000/(1.16)^4 = 98641$

Since this value is now less than 100000, we conclude that the value of ‘r’ lies between 15% and 16%. For most of the purposes this indication suffices.

If a more refined estimate of ‘r’ is needed, use the following procedure

1. Determine the difference between NPV of two closest discount rate and initial investment

   Increased value of the NPV at 15% = 100802-100000 = 802

   Reduced value of the NPV at 16% = 98641-100000 = -1359

2. Find the sum of the absolute values of the NPV obtained in step 1.

   802+1359 = 2161

3. Calculate the ratio of the net present value of the smaller discount rate, identified in step 1, to the sum obtained in step 2

   802/2161 =0.37

4. Add the number obtained in step 3 to the smaller discount rate

   15+0.37 = 15.37%

To explain IRR we have calculated it by hand. In practice, you will find it convenient to use the EXCEL function IRR.

Decision rule

Accept : If the IRR is greater than the cost of capital

Reject: If the IRR is less than the cost of capital

Example: Mutually exclusive projects

Often firms have to choose from two or more mutually exclusive projects. In such case IRR can be misleading

Consider project P and Q

Project	C_0	C_1	IRR	NPV (12%)
P	-10000	20000	100%	7857
Q	-50000	75000	50%	16964

Both the projects are good, but Q with its higher NPV contributes more to the value of the firm. Yet from an IRR point of view P looks better than Q. Hence the IRR rule seems unsuitable for ranking projects of different scales.

The IRR rule, of course can be salvaged in such cases by considering the IRR on the incremental cash flow. Here is how we do it. Looking at P, the project which requires the smaller outlay, we find that it is highly attractive because its IRR is 100%, far above the cost of capital which is 12%. Now we ask, what is the rate of return on the incremental cash flow if we switch from P (the low outlay project) to Q (the high outlay project?). The incremental cash flow associated with such a switch is

C_0/-40000, C_1/55000

The IRR of this cash flow stream is 37.5%, much above the cost of capital. Hence it is desirable to switch from P to Q.

Advantages of the IRR

- IRR is the rate of growth a project is expected to generate. So, IRR gives good picture about the investment with certain limitation
- The IRR is a good way of judging different investments.
- IRR considered the time value of money
- IRR takes into account whole cash flow of the investment or project

Limitations of the IRR

- While IRR is a very popular metric in estimating a project's profitability, it can be misleading if used alone. Depending on the initial investment costs, a project may have a low IRR but a high NPV, meaning that while the pace at which the company sees returns on that project may be slow, the project may also be adding a great deal of overall value to the company.
- A similar issue arises when using IRR to compare projects of different lengths. For example, a project of short duration may have a high IRR, making it appear to be an excellent investment, but may also have a low NPV. Conversely, a longer project may have a low IRR, earning returns slowly and steadily, but may add a large amount of value to the company over time.
- Another issue with IRR is one not strictly inherent to the metric itself, but rather to common misuse of IRR. People may assume that, when positive cash flows are generated during the course of a project (not at the end), the money will be reinvested at the project's rate of return. This can rarely be the case.

  Rather, when positive cash flows are reinvested, it will be at a rate that more resembles the cost of capital. Miscalculating using IRR in this way may lead to the belief that a project is more profitable than it actually is. This, along with the fact that long projects with fluctuating cash flows may have multiple distinct IRR values, has prompted the use of another metric called modified internal rate of return (MIRR).

MIRR adjusts the IRR to correct these issues, incorporating the cost of capital as the rate at which cash flows are reinvested, and existing as a single value. Because of MIRR's correction of the former issue of IRR, a project's MIRR will often be significantly lower than the same project's IRR.

- The need for the use of NPV in conjunction is considered to be a big drawback of IRR. Although considered an important metric, it can't be useful when used alone. The problem arises in situations where the initial investment gives a small IRR value but a greater NPV value. This happens on projects which give profits at a slower pace, but these projects may benefit in enhancing the overall value of the organization.
- A similar problem is when a project gives a faster-paced result for a short period of time. A small project may seem like giving a large profit in a short time, giving a greater IRR value, but a lower NPV value. The project length has a greater significance in this case.