Infrastructure Finance
Prof. A. Thillai Rajan
Department of Management Studies
Indian Institute of Technology, Madras

Lecture - 11
Analysis of Project Viability Capital Budgeting Techniques

Hi, welcome back to the course on infrastructure finance. This is lecture 11 and we will continue our discussion on analysis of project viability. For the past 2 lectures we have been discussing this topic on how do we actually analysis project viability. And we have looked at 2 topics; first was the time value of money, where we said that all cash flows that occur in the future as to be discounted in the present, and only then we could actually add up that cash flows occurred in different time periods.

So, we discussed this concept of the time value of money, the second was you will have to discuss the future cash flows to the present, and when we actually have two discounted, you will have to use the discount rates? And what is the discount rate? Essentially we said that the discount rate is nothing but the cost of capital, and we also discussed on how we actually determine the cost of capital for broadly different sources of finance, which should be equity debt. And normally we also understand that companies have a funding from a mixture of both debt and equity.

So, therefore we will have to determine what is called as your weighted average cost of capital. And we also saw how we actually determine the weighted average cost of capital. So, in today's lecture we will talk about what are the different techniques that we can normally use for doing a capital budgeting decision. So, when we talk about capital budgeting, it is nothing but how do we actually make investment decisions in long term projects.

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And before we actually get down to this topic, we will discuss that thought questions that we put forward in the previous lecture. So, question number one is, why is debt generally cheaper than equity? When we look at the cost of equity and the cost of debt, we find equity to be more expensive as compared to the cost of debt. So, we should kind of really understand the fundamental reasons behind, why we normally find the cost of debt to be cheaper. So, let us look at from first principles.

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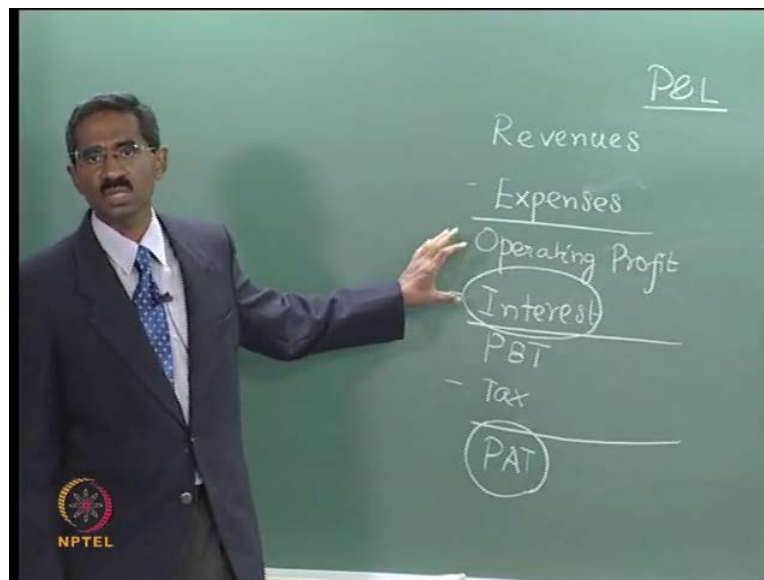
So, if we look at the companies a profit and loss account, the sequence that we have will be something like this, the top line would be your revenues and then net of all expenses would gave, what is called as your operating profit. And from the operating profit we pay what is called as your interest, so if the company has any debt then the companies need to service the debt by way of interest payment and we pay the interest from the operating profit.

The next we have what is called as your profit before tax and then the account for tax payments and then finally, we get what is called as your profit after tax. Now, the payments or the returns equity holders or essentially the profit after tax that the company makes and the returns to the debt holders are nothing but interest that the company pays. So, if we look at the sequence we find interest being paid before the profit after tax, so that means there is seniority to which debt holders with their payments.

And the profit after tax is actually the net amount that company makes after taking care of all the expense. So, in the sense it is consider being a residuals payment, since the equity holders are eligible only to receive or a residual payment after all the other claims have been satisfied, they are consider to be, what is known as juniors claims on the firms. So, given the fact that debt holders receive the payments much before the equity holders get there is a certain amount of priority that debt holders get in terms of receiving the payments.
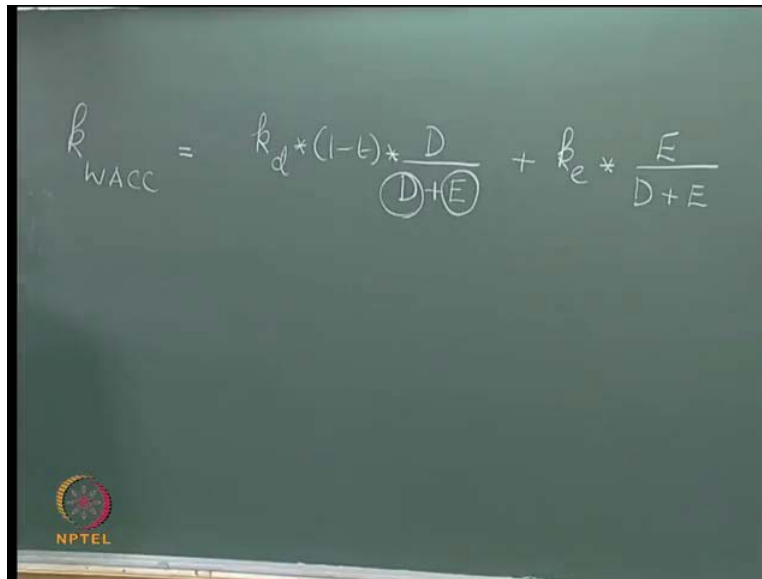
And this in essence gives you certain amount of comfort factor for the debt holders. So, given this seniority that, they have in terms of enjoying the claims from the firm, they actually are able to provide funds to the firm at a lower rate of interest. So, the reason why debt cheaper than the equity because of fact that the seniority they enjoy, they are able to give source of funds at a lower rate of interest. There are other reasons as well, when the firm is not able to generate adequate cash flow to pay the interest, then it is considered to be a state of bankruptcy.

So, whenever there is a bankruptcy, whenever the company is not in a position to pay back the interest then the lenders can actually tack position of assets liquidated and recover their moneys. So, in those cases again there is a priority to the lenders in terms of recovering their capital. Therefore, in both the cases what you actually find is, the seniorities lenders that enjoy in terms of receiving their payments helps them to actually invest in the firm at a lower cost of capital as compared to the equity.

And equity holders being the residual claimants on the firms' cash flows, they are subject to the highest form of risk. As we seen earlier risk is directly correlated to returns, since equity holders are exposed to maximum risk among all the investor in the firm. They are actually expected to get the highest amount of return and that is a reason why we normally find debt to the cheaper than equity. Now, what is the implication of this, the implication of this is that most projects would naturally get as much debt funding as possible because the cost of capital becomes lower.

And if the cost of capital becomes lower then the discount rate is also becomes lower. So, it is very important to actually to get a project funded with as much debt is possible. On the other hand if we fund the project beyond the capacity for which it can hole debt then it also increases the bankruptcy risk of the firm, so this also needs to be remembered. So, while it is advantages for the company to get as much funding debt because it is cheaper, we should also ensure that the company is not over leveraged because excess leverage can push the firm towards bankruptcy. And as projects sponsors we want to be not employing a strategy, which will increase the threat of firms bankruptcy. The second question that we put forward is how actually the values of equity do new and debt for calculating the weighted average cost of capital.

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$$k_{WACC} = k_d * (1-t) * \frac{D}{D+E} + k_e * \frac{E}{D+E}$$

So, if you look at the weighted average of capital, the expression will goes something like this, after tax cost of debt multiplied by the proportion of capital invested by death plus your cost of equity multiplied by proportion of capital invested in a form of equity. So, essentially the question is how we actually get the values of D and E. So, if it is a new project obviously, we have the value of equity that we are going to rise, we have the value of debt that we are going to rise.

And we are naturally going to substitute those values, but if is an existing company and if the company is planning to invest in a new project then it will have to calculate weighted average cost of capital. And in that scenario the equity value is normally assume to be the market value, so we will have to tack the equity value not from the balance sheet, but we will have to consider the equity value from the market values. Now, we know how we actually calculate the market value of the equity, it is nothing but the market price of a share multiplied by the number of outstanding shares would give you the market value of equity.

So, if you are actually planning to find out, what is the cost of capital for a company that is listed in the stock exchange then it is very important for us to find out and use the market values debt and equity in determining your weighted average cost of capital. If we actually use the value of

equity and debt from the firm financial statements, we may not get the appropriate value for weighted average cost of capital.

So, it is very important for us to understand that in a weighted average cost of equation, the values of debt and equity are not the book values that are market values. If the firm is not listed, if the firm is its inception then the book value will be equal to the market value. So, in those circumstances we actually use the value of equity at the price, which we made actually make the investments, but in all other circumstances when the book value is different from the market value, we will have to use the market values of equity and debt. Now, let us get down to the topic today, which is to really look at what are the different types of capital budgeting technique that we have and what are the feathers of these technique.

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I am not going to talk about all the major capital budgeting techniques, but I am going to talk about the few that we most commonly see in a being employed in infrastructure finance. The first technique is what is called as your payback period? Remember when you are making in investment as an investor, we need to actually make decision, whether the investment worthwhile or not. So, there are various criteria that we will have to use and using that determine whether the investment is worthwhile, so that means whether the investment is profitable or we going to actually get our returns back and so on.

So, the payback periods talks about the time that it takes for the investor to recover to their initial cost outlay of the project. Remember when you are making initial investment, there is certain amount of capital that is needed, so how long would it take for the investors to recover their capital, so that is called as your payback period. How long does it take for the project to pay back it is initially investment is the fundamental principal behind this capital budgeting technique. So, if you are using this technique, what are the decision criteria that we have to deploy, when we have to decide?

So, the decision criteria would be, we accept the project if the project payback period is less than the decide payback period. Now, the decide payback period could be a very subjective; it could depend on investor to investor. So, an investor A might have payback period and investor B might have different payback period, but whatever it may be, if the project payback period that, we calculate from identifying the firms from project cash flows is the project payback period is lesser than the decide payback period then we go ahead and accept the project. So, this is a simple rule by which the payback method operates.

So, let us take a simple illustration to find out how do we calculate the project payback period. So, we have a project and the product cash flows, as I have indicated in your table. So, normally what happens is, when we actually identify the cash flows. We identify the period in which the cash flows occurred. So, we always denote year 0 to be the present and in this case year 0, there is a cash flow of negative 10000, so that means there is the investment being made in year 0. So, that is what essentially we mean by a negative cash flow and then subsequently in each of the years, there are some positive cash flows from the projects.

So, in year 1 there is a 6000, in year 2 there is 4000, in year 3 there is 3000, in year 4 there is 2000 and in year 5 there is 1000. So, what does it indicate? This indicates that this project has a life of 5 years and these are the cash flows that occur in each of the 5 years. So, it is also important for us to understand about when the cash flows actually occurred. So, in reality the cash flows do not occur at one single 10 or a higher, but it occurs uniformly throughout the year. But when we are doing actually calculations for the sake of simplicity, we are assumed that cash flows occurred at the end of the year.

So, when we say that the cash flows in year 1 is 6000, we assume that the cash flows of 6000 in the year one occurred at the end of year 1. So, that means today we are making an investment of 10000, at the end of one year there is a cash inflow of 6000, at the end of two years there is a cash inflow 4000. So, it is very important to understand and generally it is a common thing to denote that each of the cash flows occurs at the end of the year. Now, if we have the project with cash flows like this what is the payback period, that is we have to consider how long does it take for us to actually recover our initial investment of 10000.

So, at the end of one year project would have given a cash flow of 6000, we initially made an investment of 10000. So therefore, at end of year 1, the project is able to give back 6000 and the investor is been able to recover 6000 of the 10000 investment that he has made. At the end of year 2, the project gives cash flow of 4000 and therefore, by year 2 the investor is able to recover the entire capital of 10000 that he has invested. So, in this case project payback period is 2 years because by the end of the second year, the investor is been able to recover the entire investment of 10000 in the project.

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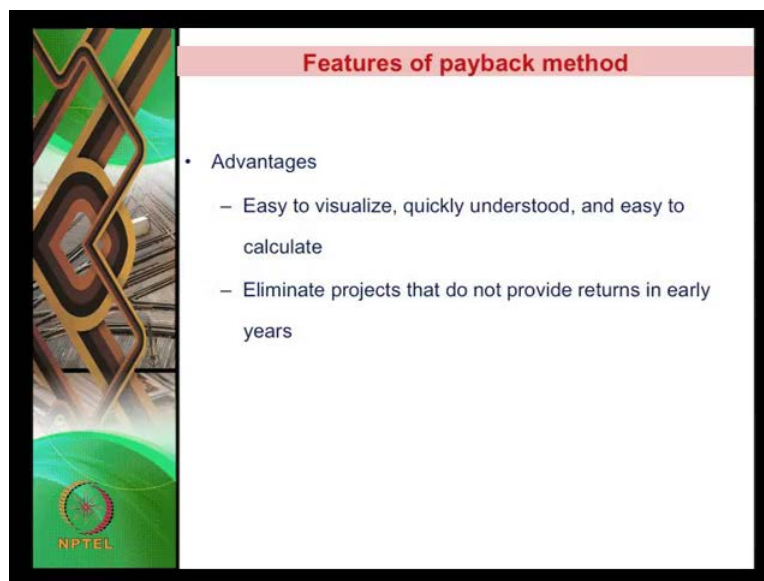
Now what are the features of this payback method? Let us look at some of the advantages and short comings. So, the first advantages is that very easy to visualize, there are no complex calculation here and which just simply say how long does it take for the investor to recover in his

initial capital. And since there is not much complexity in word calculations, it is quickly understood and more importantly it is also easy to calculate, we just need to know what initial investment is? We just need to know what are the cash flows occur in different time periods and with this two information will be able to calculate your payback period.

The second is a payback period gives importance to projects cash flows that occur early in the project life. It is a another important concept that we have to understand in financing a project of that, cash flows that are occur in the early years are compared to be more safer, less riskier as compared to cash flows occur in the later years of the project life. Therefore, an investor it is looking at two projects would actually prefer a project that has cash flows in the early part as compared to a project as that actually cash flows in the later part of its life cycle.

Now, when we actually use the payback method, a payback method stresses on cash flows that occur in the early years therefore, it helps to eliminate projects that do not provide returns in early years. Now, let us actually go back to the illustration that we discussed previously. So, we have projects something like this cash flow 6000 in year 1, 4000 in year 2, 3000 in year 3 and so on, but what happened if the entire cash flows the cash inflows particularly reverse?

For example, the year 1 cash flow of 6000 as not occur in year 1, but it actually occurred in years 5, but the year cash flow of 1000 does not occur in year 5, but occurs in year 1. So, we flip the entire cash flows, so what happens to the payback period when we flipped the cash flows. So, when we actually flip the clash flows, the payback does not occur till the fourth year. In fact if we look at it for the first 4 years, the project gives a total cash flow of 10000, so it takes 4 years for the investor to recover the entire investment of 10000, but in the example that we have just now the investor is able to recover in is investment 2 years.

So, naturally same project a payback period methods favors projects that actually results in early cash flows. Why a project to the early cash flows will have lesser payback period and investor will actually prefer a project with a lesser payback period as compared to payback period which is longer.

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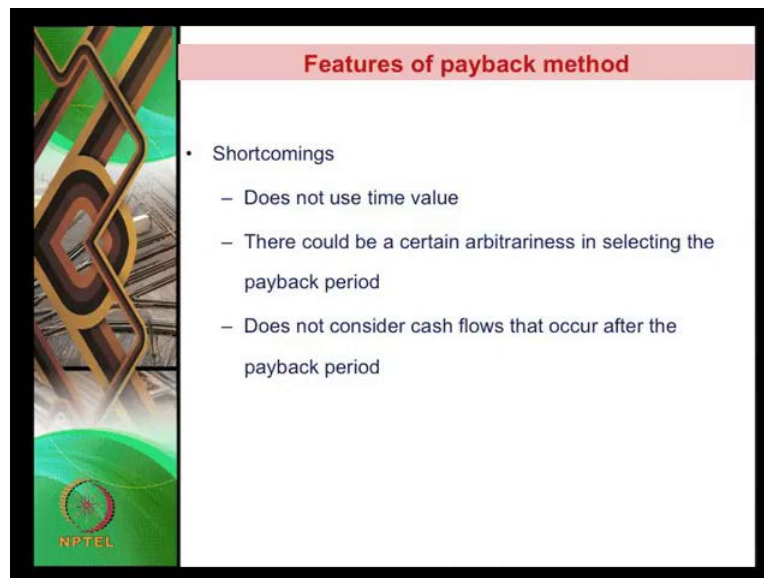
Let us look at some of the limitations of the payback method. The first major shortcoming is that is not used the time value of money concept. Remember we discussed it the time value of money is very important concept and cash flows that are occur in different time periods cannot consider to be equal. And if they have to be added up then there will have to be discounted to the present before they can added up.

So, payback method, the traditional simple payback period method does not consider the time value of money concept and this is the biggest shortcoming or biggest failing of this method. Second is there could be orbit trainer in selecting payback period, so the decision is we accept a project, when the payback period is lesser than the decide payback period. When the project payback period is lesser than the decide payback period then we accept the project, but how do we actually determine what is a decide payback period.

So, the decide payback period can differ from investor to investor and there is no clear cut rationale by which, we can actually determine what should be decide payback period. Since, there are difficulties in determining and decide payback period, it could also result certain amount of arbitrariness in selecting projects with the specific payback period. So, if we have actually have a rule saying that we will actually select the projects that have payback period of 3 years, why should we actually chose a 3 years period, why not 4 years, why not 2 years?

So, the criteria that we will use to select projects can be little arbitrary and this is one of the shortcomings of payback method. The third and again a very important shortcoming is payback method does not consider that cash flows that occur after the payback period. Remember a project has a the payback period in this case project actually had a payback period of 2 years, in the first example that we saw, but it does not consider any cash flows that are occur after payback period.

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Pay back period - Illustration

- Project A has the following cash flows

Year	0	1	2	3	4	5
Cash flow	-10,000	6000	4000	3000	2000	1000

- Project B has the following cash flows

Year	0	1	2	3	4	5
Cash flow	-10,000	5000	5000	0	0	0

Let me give an example to illustrate this point. So, project A was the first project that we discussed, so let us say there is a project B, which again involves investment in 10000 and it actually gives cash flow of 5000 each in year 1 and 2. So, as we can see both the projects have a payback period of 2 years. So, in those circumstances, which of the projects we actually choose, it is going to be very difficult to differentiate these two projects based on payback method because both of them give and equal payback period.

But somebody who is actually looking at cash flows will be able to find out that, project A is a lot more valuable because project A has cash flows beyond the payback period whereas, project B does not have any cash flows beyond the payback period. Therefore, sometimes a payback method will be a very difficult to actually deploy because of the fact that, we have no information. For example, if we really look at a company's top manager, who actually looking

that payback periods of different projects, it becomes very difficult for senior managers to go to the details of each and every project.

And simply going by the payback method to look at which projects should be implemented might not be arrived decision because; in many cases there are valuable projects for the cash flows that occur after the payback period. And as investors one should always consider all the cash flows from the project. Remember we talked about sum of all the benefits net of all the costs. So, payback method does not give us an indicator of sum of all the project cash flows and this is an important shortcoming.

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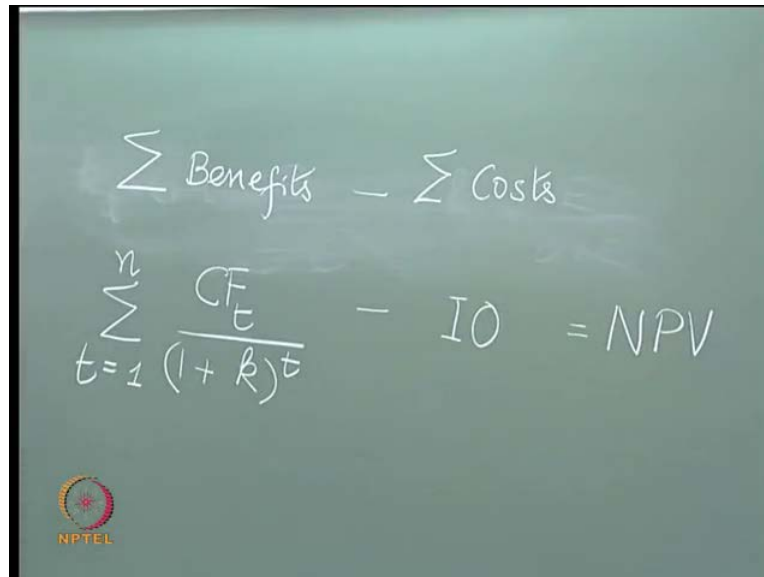
So, we will actually go to the next capital budgeting technique, which is your net present value. So, what is this a net present value?

$$\sum Benefits - \sum Costs$$

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

So, net present value nothing but a sum of present value of project cash flows minus your investment outlay. So, we initially started with sum of all the benefits net of all the costs. So, sum of all the benefits is essentially what is called as your sum of all the cash flows from the project. So, we have cash flows that occurring in different time period t. So, let us assume that there is a cash flow occurring different time periods t and we actually use a discount rate to discounted to the present one pulse a discount rate.

And we actually have to use the discount rate depending on what time period the cash flow occurs so therefore, we actually discounted to the power of t, t indicate that the time period at which the cash flows occurred. So, summation of this entire where, t can range from 1 to n, so this actually gives you a pleasant value of all the project cash flows. And then we have what is called as your project cost, project cost is nothing but your initial investment, so this is called as your investment outlay.

Generally assumed that the investment outlay occurs at years 0, in many cases the investment can occur over a period of time, but since we are starting the discussion let us assume that the entire investment occurs at time 0. So, the present value of the project cash flows net of the initial outlays, so that means if we subtract initial outlay from the present value of all the project cash flows, the value that we get is your net present value. Why it is called as net because it is

net of the initial investment that we made and the present value is the sum of all the project cash flows.

So, this is the expression of what is your net present value? As you probably see in the later part of the course, net present value is a very-very powerful tool to make our capital budgeting decision, it is considered to be more robust, it is considered to be seeking to some fundamental principles that we have learned such as time value of money. So, what is the decision criteria that we are use, the decision criteria to decide on projects on the basis of net present value is if the net present value is more than 0, we accept the project.

So, when can the net present value is more than 0, the net present value will be more than 0 when the present value of cash flows the greater than your initial outlay. So, that means the benefits are more than that cost then the net present value will be positive. So, when net present value is greater than 0, we accept the project and we reject the project if it is otherwise, the net present value is less than 0 we reject the project. So, this is a basic rule when we actually use a net present value criterion making a capital budgeting decision. Let us do a simple illustration on of net present value calculation.

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Net Present Value- Illustration

- Project A has the following cash flows

Year	0	1	2	3	4	5
Cash flow	-10,000	2000	4000	3000	3000	10000

So, we have a project with the following cash flows and initial outlay is 10000 because this is an investment, this is an out flow that occurs in year 0. So, we can consider this to an initial outlay and then we have cash flows that occur from years 1 2 3 4 and 5. Now, for a project with the following cash flows what is your net present value?

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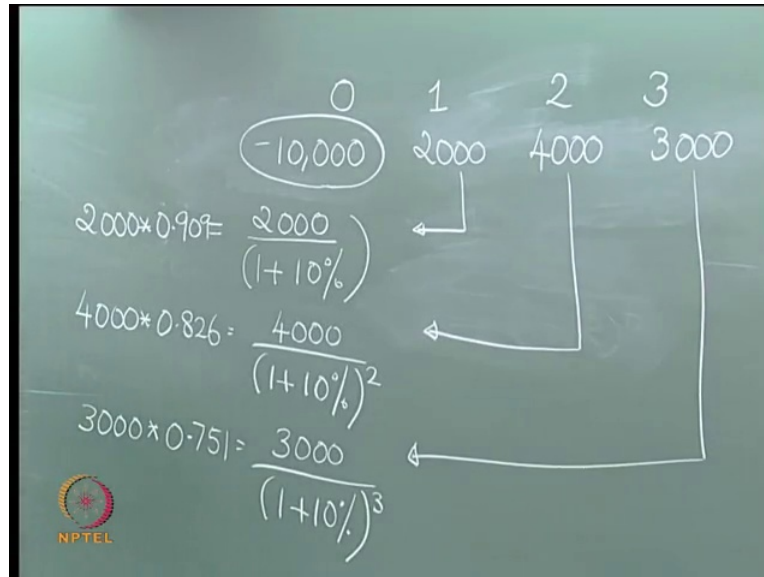
So, in year 0 there is an initial investment of 10000 and in year 1 there is the investment of 2000, year 2 there is a project cash flow 4000, year 3 there is a cash flow of 3000, year 4 there is a cash flow of 3000 and year 5 and there is a cash flow of 10000. How do we actually find out the net present values? So, let us discount in each of the project cash flows from year 1to 5 with the present. So, how do we actually discount it to the present, this is nothing but 2000 divided by your discount rate divided by your one plus discount.

So, if you are assumed the discount rate to be 10 percent for illustrative purposes, if we assume 10 percent to be the discount rate then the present value of a cash flow of 2000 in a year 1 is nothing but 2000 multiplied by 0.90. So, similarly, you discount the cash flows of 4000 in the year 2 to the present, you will get 4000 multiplied by 0.826 that is, we discount 4000 divided by one plus 10 percent raise to the power of 2 because it occurring in year 2. So, next we have 3000 so this will be 3000 multiplied by 0.751, which is nothing but 3001 plus 10 percent rise with to the power of 3.

Now, when we calculate all of this and add it up, the value that we get will be your net present value. Remember the initial investment of 10000 occurs at years 0 so that means, the present value of the initial investment is 10000. There is no need of discount because this is the investment that is happening today, this is the investment that is you happening year 0. Therefore, there is no discount that is applicable for the investment that is happening in the year 0.

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We discount all the future cash flows and when we add up the initial amount with the future cash flows. The net present value they will get remember you have a discount all of this likes, we did for the first 3 years.

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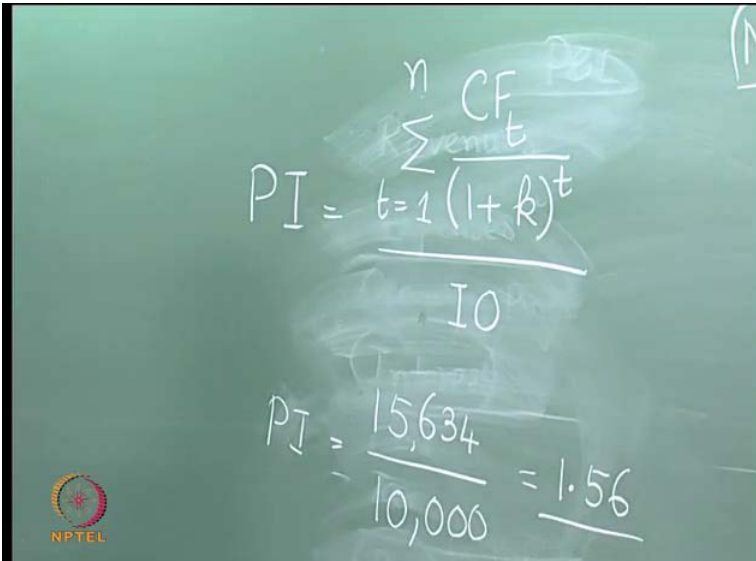
And then if we discount all these and added up, you will actually get a net present value of 5634. So, for a project with cash flow given in the table, the net present value is nothing but 5634. Now, let us look at another technique that is similar to the net present value, but calculates the project viability on the basis of a ratio this is called as your profitability index. So, profitability index is nothing but some of the present value of project cash flows divided by the initial outlay.

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So, in terms of a mathematic expression, the profitability index is written something like this, profitability index is nothing but a sum of the present value of the project cash flows. So, this will be the project cash flows occurring at different times period t and we divided by the discount rate, we get the present value and time period ranges from 1 to n and we divided by the initial outlay. So, the ratio that we get by dividing the sum of all projects cash flows discounted to the present by initial outlay is called as your profitability index.

Now, how do we actually decide how to use profitability index if the profitability index value more than 1 then we accepted projects. If it is more than one then the indication is that value numerator is more than and the denominator that means, the present value of cash flow is more than the investment outlay. So, therefore, we accept the project and if the profitability index is less than 1, we reject the project. So, if we look at the same example that we did for the net present value calculation then the value of the numerator, which will be the present value of all the project cash flows will be nothing but 15634.

So, the profitability index for the project will be some of the present value of all the cash flows which is 15634 and divided by your initial outlay, it will be a 10000. So, the profitability index value will be 1.56, so the value of profitability index is more than one therefore, we accept the project. And if we use the net value criteria and also the net present value criteria is positive therefore, we accept the project. So, generally we find that either we use profitability index or the net present value of the decision with more or less will be the same in terms of accepting a project or rejecting a project.
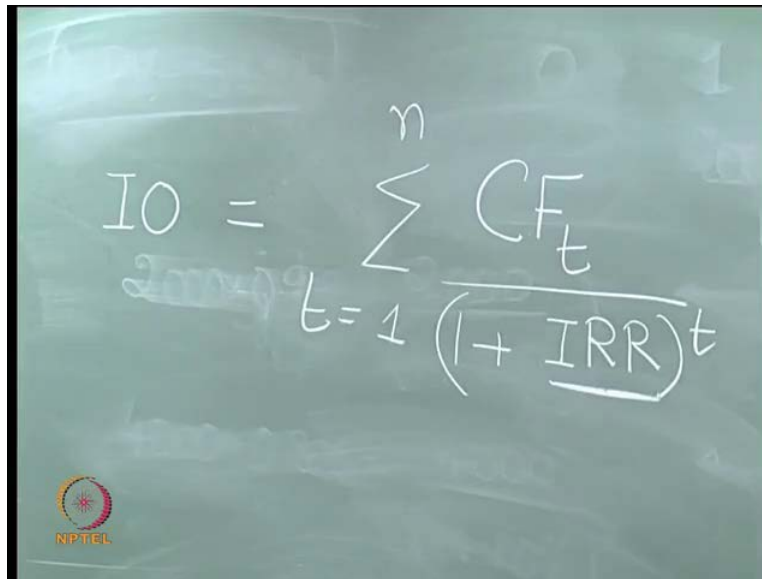
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Let us look at another important capital budgeting tool, which is called as your internal rate of return. Now, what is internal rate of return? So, internal rate of return is nothing but rate of return that the project earns on the investment is made. So, remember whenever we are using the profitability index or we actually using the net present value, where it is actually discounting the project cash flows by the cost of capital.

Generally the weighted average capital, but when you are trying to use IRR, we actually employing a slightly different technique that is, we are trying to find out how much return is a project give. We are not using the discount rate to discount the projects cash flows in a essence, we are trying do is what return has a project give over its lifetime. So, the internal rate of return is nothing but that discount rate that equates the present value of the projects a future cash flow with projects initial outlay.

So, let us try and see how the expression is for the internal rate of return. So, you have the initial outlay for the project, so the definitions of internal rate of return state that it is the discount at rate that equates the present value of project future cash flows with the project initial outlay, this is a project initial outlay.

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So, this is equal to the present value in the project cash flows occurring at different time periods t discounted at a discount rate. So, this discount rate be denoted by the internal rate of return IRR. Discounting talk for the cash flows occurred in different time period t where, t will range from 1 to n. Now, when we try and solve the equation, the value that we get, which make initial outlay equal to the present value of cash flow different time periods is known as your internal rate of return. What are the decision criteria? We accept a project when the internal rate of return is greater than the required rate of return.

Remember now, there is an in every investor as an expected or required rate of return, if a project provides a return that is higher than that then we accept the project in the sense a required rate of return is also nothing but the cost of capital is the project gives the return that is, higher than the cost of capital then we go ahead and accept the project. And if the higher is lesser than required rate of return then we reject the project, this is the decision making criteria, if we actually use the internal rate of return.

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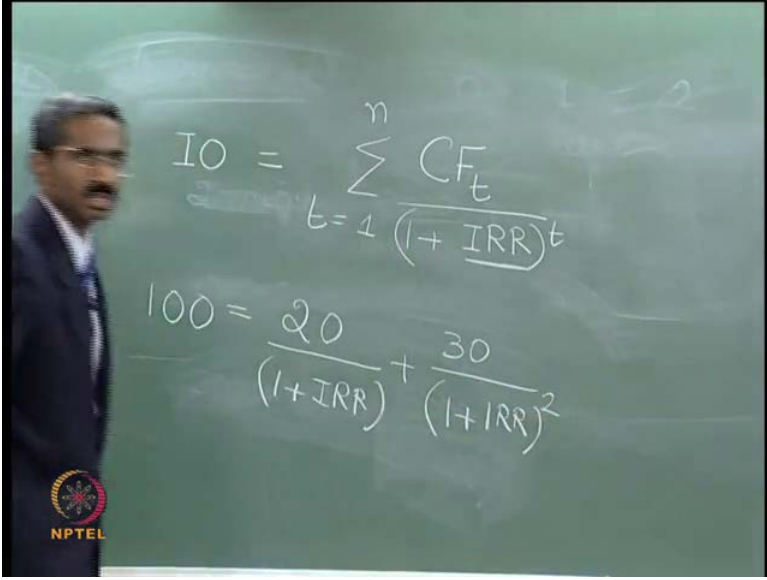
So, let us do a simple illustration for the internal rate of return, we have a project with cash flows of 4 years and an initial investment of 100. So, what is the internal rate of return for this project?

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So, if we have to formulate this equation then we have the initial investment of this 100 will be equal to the present value of the cash flows that occurred at different time periods. So, for the cash flow that occurring in year 1, 20 discounted to the present and the internal rate of return,

when the cash flows that are occurring in the year 2, 30 IRR ratio to the power of 2 because the cash flow are occurring year 2.

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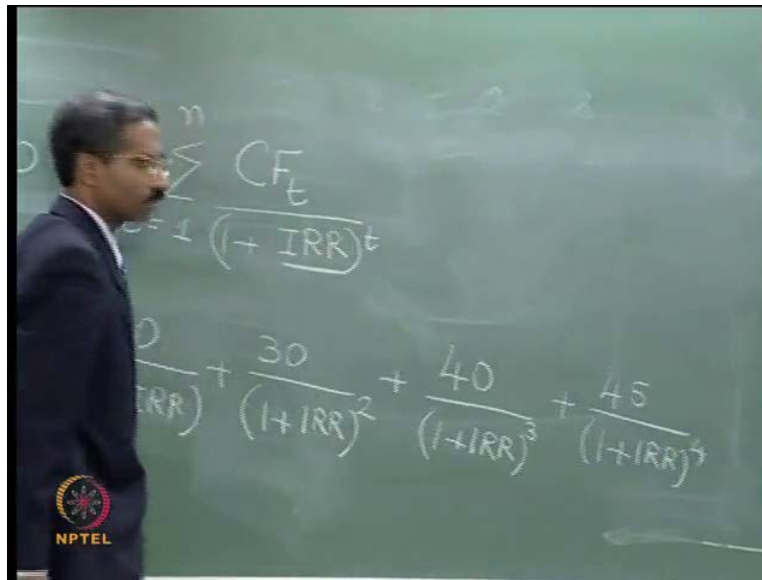
And then cash flow 40 in a year 3 divided by 1 plus IRR rice to the power 3 and then cash flow of 45 in year 4. Now, we will have to find out the value of IRR, which satisfies the equation. So, that is the project internal rate of return value of IRR of which, this equation is met is called as your internal rate of return. Let us find out the project NPV, if we lower discounting at 15 percent, when the net present value is 0.8. On the other hand if you are counting cash flows at the rate of 16 percent then the net present value is minus 1.36.

So, therefore, we can understand that the discount rate at which the question will be satisfied, which the equation will be satisfied will lie somewhere between 15 percent and 16 percent, because the direction of net present value changes has removed from at a discount rate of 15 percent to 16 percent. So, if you want to illustrate graphically, survey have a graph where, NPV is your y axis and then on x axis we have discount rate.
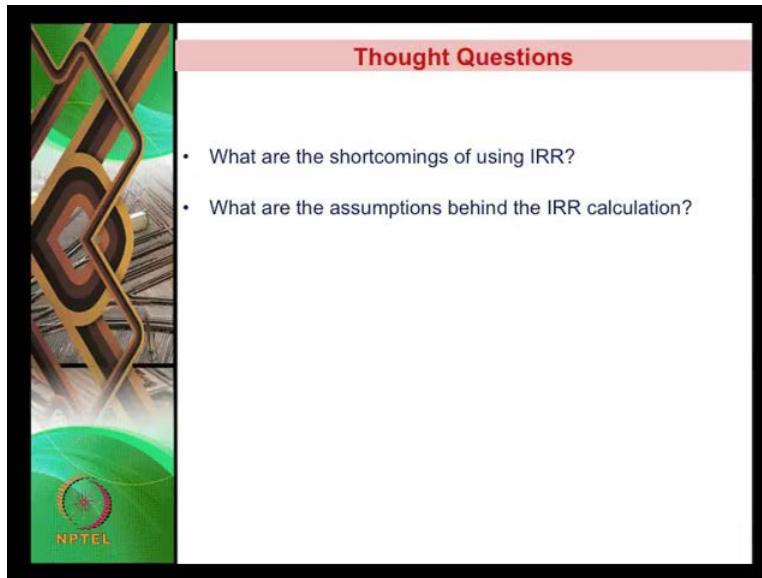
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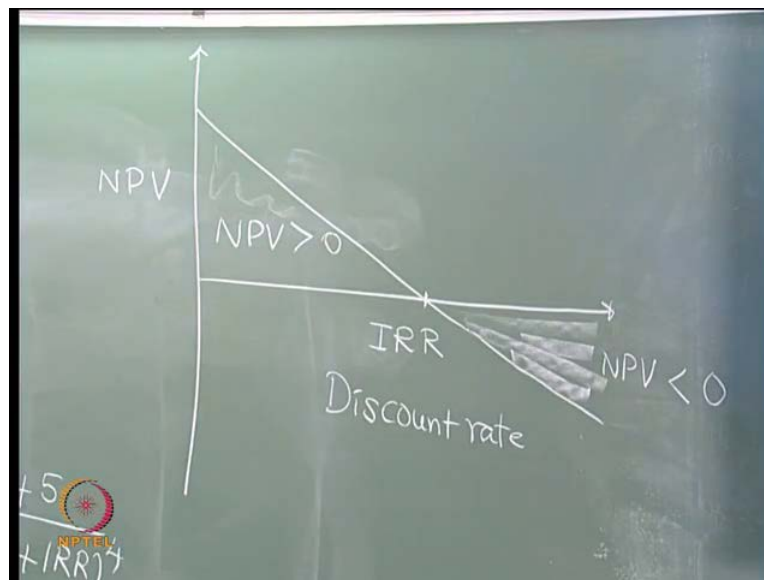
So, the net present value will be the highest when the discount rate is 0. As the discount rate keeps increasing, the net present value keeps on reducing on some point in time and high very discount rate, when net present value will come negative. So, this region is a region where net present value is less than 0 and this is a region where the net present value is greater than 0. The point at which the line crosses the x axis, so this is the point to where whether net present value is equal to 0 and this discount rate where the net present value is equal to 0 is your internal rate of return.

So, the internal rate of return is lie between the area where the net present value is positive and area where the net present value is negative. So, the net present value of the project are 15 percent discount 0.8 and net present value of 16 percent discount rate was minus 1.36, but if you calculate the IRR lies between 15 percent and 16 percent and it is actually 15.37 percent. Remember manually we can relate the IRR equation might be a little difficult because in this case, the project life is 4 years and this result in a polynomial for the degree and calculating is going to be very difficult.

And if you have a project that actually has even longer life then we are actually going to get an equation, which is even more complicated a polynomial or even higher order. So, the calculate IRR we simply use the technique available in scientific calculators are Microsoft excel where,

we have IRR function built in and we can use this function to estimate, the internal rate of return in reasonable in reasonably accurate it fashion.

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Today we end lecture and there are thought questions to founder on, one is what shortcomings of using internal rate of return then we have to decide on which projects to implement, which projects to select. Second is what are the assumptions behind the higher or calculations that we should be aware of? Remember we should not blindly go using a method without being aware some of the assumptions that go on behind of these techniques. And an amount IRR considered very attractive technique and it intuitively appeals to people because it gives return in terms of some percentage. Though it is very appealing, though it is intuitively makes a lot of sense, it is important for us to understand assumptions that lie behind in IRR calculations before we go had and starting in a extensive way. So, let us discuss these questions in the next class, but I would also encourage you to think about some of these aspects, and will see you in the next lecture.