Project Management: Planning, Execution, Evaluation and Control

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Welcome to the course Project Management Planning, I am Professor Sanjeev Choudhury from Indian Institute of Technology, Kharagpur. In continuation with the module 7 that is Project Risk Management, this lecture we will discuss the Risk Assessment of Capital Project. So long we have discussed many all the other aspects of risk management including operations risk. The concept that will be covered in this lecture is risk assessment of capital project that is the investment risk. Actually the healer that yes healer he has proposed a model for the risk assessment and generally this is you know statistical variations of net present value is used for the risk assessment of the cash flows cash flows and how it is done usually the risk associated with project healer says as per his model he asserts that the project the risk is of the project can be assessed through the standard deviations of expected cash flows. The that is the variations that is the dispersions of cash flows of different years different over a long period of time.

So, what it does generally it computes the standard deviations of the cash flow the cash flow that over several period of period or ranges of a firm that determine the uncertainty involved in the future projects that is his contention. For this he has taken two types of things one is uncorrelated cash flow another is the correlated cash flow at this cash flows are the variations of the NPV for uncorrelated first we will talk about the uncorrelated cash flow. We all know that is what does uncorrelated cash flow means that the cash flows are independent. Say cash flow at the point of time t does not depend on the previous cash flow or any point in time say cash flow at t does not depend on t minus n if t minus n it does not depend on that it is independent and, in that case, what is the NPV and standard deviations of NPV? NPV all we know net present value we have discussed it in the module 2 extensively NPV is sigma cash flow over the period t divided by 1 plus i, i is the interest rate to the power to the power to minus initial investment.

These are the this is the initial investment all of we have discussed it in detail in earlier then what is the sigma standard deviations of NPV is sigma is the that is we know the it is the summations of 1 t equal to 1 ton that sigma square sigma t square that is the each years sigma that the square that is the variance because variance are additive variance divided by 1

plus i that is the interest rate to the power 2 t twice the t is the year 1 year 2 t equal to 1 2 3 4 that is the year 1 year 2 year 3 it is given ok. t equal to 1 2 3 4 it is years it is given. So, all of we know about this formula. So, then another is the correlated cash flow that is the cash flows are dependent on the other year like cash flows are the same for each year. That means, if you the if you determine the cash flow of 1 year that all other year's cash flow will be alike.

So, in that case what are the NPV and NPV is the same for both for related or unrelated NPV are the same NPV are the same, but the for here the standard deviation of this is different say t equal to 1 if this is sigma t divided by 1 plus t to the power t that is the year my ok. This is these are the this is different from the uncorrelated one and what else are there where c t we have talked about it is the expected cash flow of the year t and what is sigma t is the standard deviations of cash flow for the year t and i is the risk free rate you do not make it a risk adjusted risk adjusted rate then you will be doing the things twice then risk treatment is being done twice double stick. So, you avoid it. So, this is risk free rate i and this i 0 is the initial investment for the for you require it for what for the NPV calculations. We have discussed all these in module 2 this Hiller models and the how to assess risk assessment capital project this will be clarified if you solve some numerical then now we will be going to solve some numerical then this risk assessment of capital projects or the investment will be clarified.

So, go through this problem then we will be solving it. So, it says two mining expansion projects are being considered with the following capital outlays and cash inflows which project is less risky which project would you select in terms of NPV and in NPA in net present asset and risk actually it will be NPV consider risk free discount rate as 6 percent and project cash flows are uncorrelated. So, uncorrelated we will be using that which one this formula the NPV are the same for both NPV are the same for both, but this uncorrelated we will be using this formula ok. Now let us solve this problem how to go about it. So, this is the these are the two projects here what is given here 0 1 2 3 4 is given 0 here is your investment here cash flow is the negative then probability you take 0.

3 0.4 0.3 there are three probabilities of happening. So, we have to find out which project is riskier on the whose NPV is high the project A and project B we have to do that. So, these are the probabilities of cash flows you know probabilities of cash flows different. So, we have to find out this which project is less risky and it is given risk free discount rate as 6 percent of project.

So, let us solve the problem you can solve it in a on a note pad or note sheet you can solve it I will be solving to show you solving it in the excel sheet. Project A project B whatever is

been given we have we have done it here we have reflected it here. So, these are now what we have to find out we have to find out the NPV and the sigma t say suppose here now these are the cash flows year 1 probability of cash flows 0.3 is 4000 then 0.4 probability is 5000 0.

3 is 6000. So, this probability. So, we have to find out the what is x bar or the average this we have to find out x say x bar this we have to find out and this we put it here and also sigma t we have to find out this two we will be finding out. So, how do you find x dash that is the average of 4000 5000 6000 we have to find it out know these will be what sigma pi into this 0.3 into this 4000 plus 0.4 into 5000 plus 0.

3 into 6000 this will give you the x dash that is the average cash flow. So, we just do it equal to this 0.3 into 4000 plus 0.4 this into 5000 plus 0.

3 into 6000. So, what you get this is the 5000 is the average we get it. Now what we will be doing this B 3 B 4 this we make it constant because now we will be calculating for the others other cells also B 3 B 6 then C 3 these are the probability these are the this make it fixed 5000. So, now we have to find out similar way what is the probability for what is the average cash flow of year 2-year 3-year 4 year 5. What you do this 0.

3 into 6000 0.4 into 6000 0.3 into 9000 you get the year 2. So, I drag it. So, we get this is the 6900 is the is for year 2 6700 for year 7. So, we get this value.

Now we have to find out find out similarly we can also do it for the project B control C we have to find out for project B also know. So, project B so, we what we have to do here we can I can we can we copy this let us see ok. I think we can copy this know 8000, 9900, 9700, 12500, 12000 this. So, we have done the average the average this cash flow for each year. Now we have to find out the standard deviations of this cash flow.

How we will be doing it standard deviations the formula we have seen it know formula is that it is standard deviation sigma say sigma standard deviations smaller than that variance that is the S d standard deviation square for t divided by divided by 1 plus i to the power to the power is 2 t and square root. So, we have done that. So, we now we have to find out what is your that interest rate interest rate has been given. So, we have to i, i is the interest rate equal to i is equal to that is interest free that risk free interest rate it is given 6 percent 0.06 because you will be requiring it for the NPV calculation it is given 6 percent is your rate of interest for risk free.

So, now we have to find out sigma t. How do I find sigma t? How do I find sigma t? We have to follow the that formula which is given here which is given here. What is the formula? Let us go through it. This is the formula for related and correlated know this is the formula sigma NPV is t sigma t square divided by 1 plus i to the power 2 t and whole square root.

We will be doing that. Now we will be finding the sigma t. So, this is 7, how do we do that? Sigma t is yeah equal to equal to how do we do? Is 0.3, 0.3 into what you take? Is minus 5000 that average to the power to the power 2 square sorry to the power 2 to the power 2 then plus this into this into this minus what is minus? This is E 6 minus E 6 to the power 2 minus E 6 plus this plus no not this plus this d 3 into this d 6 minus E 6 ok. This will to the power to the power root over know it will give you then it you have to do a root over 1 by 2.

This root over you have to root over 1 by 2 is 0.5, 0.5 1 by 2 is 0.05. So, what I did? I did this probability into this into 4000 minus x dash square c 3 probability into this minus average c is E 6 square plus d 3 and all to the power 1 by 2 that is 0.

5. So, let us see how much did we get 547 something wrong 0.3, 0.4, 0.6 6000 0.3 is the b 3 into b 6 b 6 b 6 minus E 6 E 6 square plus c 3 into c 6 c 6 is this into c 6 into c 6 is this.

There was a small mistake like I did not put the square that d 6 minus E 6 square. So, if you put this now the formula has been corrected. So, you are getting we are getting this like 774.5967. So, we so, this is the sigma t for year 1 for now for the rest of the rest of the year for rest of the year we will be calculating by dragging it anyway.

So, what we have to do now? We have to this b 3 b 4 b c 3 this we have to fix it the make it fixed otherwise we cannot drag it to get the other values. So, let us put the fixing sign ok. Now if we drag we will be getting the sigma t these are the sigma t for different years we are getting all of you are can see. Now similarly now we have to find out the sigma t for the project b for the project b we will follow the same formula say same procedure this into this this into this first years 1 minus the x dash to the power 2 to the power 2 plus c 14 into c 3. So, c 17 minus e 17 e 17 minus e 17 to the power 2 to the power 2 plus hm ah d 14 into 10000 d 17 minus 8000 that is e 17 square to the power 2 this we get then whole to the power square root this square root.

So, what we get to the power 0.5. So, we get how much 1549.2 this we get now we fix this b 14 and all the we fix this b 14 c this positions we fix 14 d 14 we fix this ok. Now we can find out you drag and find out the other years ok these are the other years 15492071 this and we found it. Now let us make it a 2 digit this will be better. Now we have to find out the NPV of a say and NPV of b then sigma a sigma NPV of a sigma NPV of b.

Now let us find out the NPV ah NPV of an NPV a. So, what it should be NPV of a we have also found the formula know we did this work also previously equal to NPV. So, we get NPV this is the rate the rate is this discount rate is we have to put it this discount rate comma then the values what are the values for NPV's the values will be taking from this to this this value ok. Then values then what we do plus i 0 these are the plus i 0 i 0 is how much i 0 is this 15000.

So, this is all negative. So, we put b 5. So, what we get see we get 15733 is the NPV of a 15000 733 we get the NPV of a. Similarly, we have to find out the NPV of b let us find out NPV of b project. So, it is equal to NPV of rate is 0.06 comma then these are the your cash flow cash flow is given this plus cash flow plus you get what you get the i 0.

What is i 0 for here i 0 is that is the initial investment it is b 16 it is minus because it is an outflow. So, how much do you get you get 18370. So, which one is better because that this NPV b is higher than NPV a. So, it is better NPV b is better to you choose, but now we have to find out which one is the less risky risk is associated with it.

So, we have to find out the risk. How do we find out find out the risk? Now we will be finding out the sigma that is the standard deviations of NPV a. How will you find it out? We have already found out the each years NPV 7 each years NPV we have found out. So, from here we will be finding out it is a tedious calculation like equal to. So, what is this? This 774 know say it will be this is sigma square remember that formula it is sigma square. So, 7 these to the power to the power 2 f 6 square divided by divided by 1.

1.06 1.06.06 that is the rate 1 plus i 1 plus i is 1.06 to the power 1. So, you do not do anything. So, then plus what you do plus NPV the second year second year it is how much second year of 6 is f sorry this was the first year is this a f 6 second year is this f 7 to the power to the power 2 f 7 to the power 2 divided by divided by 1.06 to the power to the power this will be 4 2 t.

You remember that 2 t is 2 t is 2 square 2 t is 2 square no 774 square 1.06 this will be square 1.06 to the power 2 that is that if it is a square because a sigma a is t equal to 1 to 5 sigma t square by 1 this is square then f 7 divided by this is 2 t 2 into t equal to 2 2 into equal to 4 this will be 4 plus this f 8 f 8 it will be square to the power 2 divided by 1.06 to the power this will be 6 3 2 into t is 3 it will be 6 6 yeah this is 6 plus f 9 to the power 2 2 divided by 1.06 to the power this was 6 this is year 4 year 4 2 into 4 is 8 to the power 8 plus f 10 this 10 to the power 2 divided by 1.

06 to the power 5 years now 2 into 5 is 10 oks. This is this now let us see then what is the risk associated with to the power to the power square it is the square. So, it is square root not square root square root is point to the power 0.5 square root. So, how much it comes it is coming 2 2 2 2 6 8 2 2 6 8.

9. So, it is coming as 2 2 6 9 say it is coming 2 2 6 9. Now, we have to find out the similar way for NPV of B not NPV it is the standard deviations of NPV B it is the standard deviations of B we have to find out similar way this is 2 2 6 9. Now, similar way we have to do it. So, what we do same equal to equal to this square divided by 1.

06 to the power 2 1 2 t no 2 2. So, this plus this 2 2 divided by 1.06 to the power 4 2 t plus f 458. So, f 458 that is the third year this to the power 2 square divided by 1.06 to the power 6 plus this square this square divided by 1.

06 1.06 raise to the power 8 because 4 t 4 t is t equal to 4 2 t is 8 2 into 4 8 plus this is 0. So, f 21 is 0 means everything will be 0 whatever we do is 0, but for the sake of this let us put the formula this divided by 1.06 raise to the power 10 5 t. So, we have got and you have to square root of this square root of this is raise to the power 0.

5 0.5 0.5. So, how much did we get 2 996 no 2 996. So, which one is which one is risky 2 996 standard deviations of A standard deviations of this and standard deviations of this B standard deviations of NPV is 2269 and this is 2 996. So, if the standard deviations are high means what uncertainty is more uncertainty is more means riskier. So, if you take the standard deviations of NPV B is riskier than A. So, we will choose A in terms of in less risky we will choose A, but if you see the net worth in a net present value B is preferred, but if you see the risk point of view A is less risky it gives you less net present value, but less risky and B is riskier.

So, we will prefer project A capital project A. So, it is clear. So, we will now the another problem. So, this is very you can solve it at you're at your space and all at your laser ok. Now, the so, we have found out that A project A using uncorrelated cash flow is less risky than project B.

So, this we have found out. So, now the next problem we will be solving it if the cash flows as shown in example 1 are perfectly correlated then which project would be less risky and hence preferred. The same problem this problem we will now with the same data given data we will be seeing which one is less risky if it is the correlated. The correlated means that you have to follow this NPV will remain same NPV no NPV will remain same there is no change in NPV for related and correlated. So, we have to find out now only correlated standard deviations of NPV that is instead of sigma t square it will be sigma t plus 1 plus t to the power t not to the power 2 t and you do not have to do any square root it will be much simpler. So, let us find out correlated cash flows standard deviations ok.

So, let us find out those correlated things now for the correlated ok NPV A for these are uncorrelated now for correlated NPV this thing we will be finding out. Now for correlated what is the formula this is uncorrelated this is correlated. Correlated formula is we have found out that equal to 7 7 F 6 7 7 4 divided by 1.06 t plus is this divided by 1.

06 raise to the power 2 square plus this divided by 1.06 raise to the power 3 plus F 9 divided by divided by 1.06 raise to the power 4 no 4 what F 6 1 plus F 7 plus F 8 plus F 9 plus this divided by 1.06 raise to the power 5 raise to the power 5. So, what does it come the 4 8 6 7 it is much simpler no 4 8 6 7.3 it is coming for sigma standard deviations of NPV this is correlated cash flow correlated cash flow this is uncorrelated cash flow ok.

This now this is correlated and this is this is uncorrelated and now we will be finding the correlated ok. Similarly, let us find the correlated cash flow equal to same way equal to this is this divided by 1.06 plus 1.06 plus then this divided by 1.06 raise to the power 2 because year 2 plus then this this is divided by 1.

06 raise to the power 2 raise to the power 3 raise to the power 3 because it is it is a year 3 then plus F 20 divided by 1.06 raise to the power 4 year 4 plus 5 this is 0. So, it will be 0, but for sake of simplicity we just follow it raise to the power raise to the power 5 5 ok. This will be then what is the coming what is it is coming it is coming uncorrelated is coming 5506 this is correlated cash flow control C this is correlated cash flow. So, this is which one you will

take here correlated also see that sigma that is standard deviations of NPV A for correlated cash flow 4867 and for B 5507.

That means, B is riskier than A, A is less risky it is found in both. So, this way we have completed. So, as this point of view either correlated cash flow uncorrelated cash flow both are less risky than B, but NPV of B is higher than A. So, we will go for project A.

So, we solve both the problems today for this. So, let us come to here we have solved this problem example 1 we have solved example 2 also which one is preferred we have already discussed. So, to sum up today these lectures this session we have discussed the risk assessment of capital projects and capital projects and investment risk. Statistically statistical variations of net present value are used to assess cash flow risk in projects. Generally, correlation between past project cash flow cash flow and S curve cumulative project cost curve over the baseline and over the life of the project are used to assess cash flow risk. Now, in this lecture we have discussed Hiller model with which essentially assess the risk associated with the project through the standard deviations of expected cash flows.

It computes standard deviations of several ranges of cash flows to determine the uncertainty involved in the future projects. Finally, few a couples of numerical were solved illustrating risk assessment of capital project and selections of project. So, these are some of the reference books you can go through and work on this numerical and all further on specially the last these two books last two books will help you to solve this Hiller models and the risk assessment capital project these two books. So, I thank you for attending today's lecture.