Quantitative Investment Management
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Lecture No. 16
Yield Spreads Contd…

Welcome back. So, let us continue, now I will talk about the impact of interest rate volatility on option adjusted spread. Let me explain the underlying philosophy.

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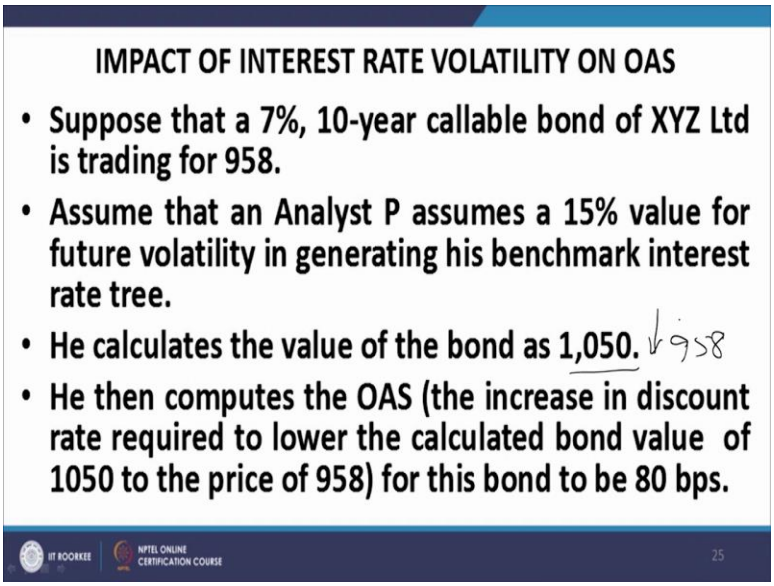

You see, higher the volatility of the interest rate tree on the basis of which we are doing the computation, lower would be the value of the callable bond. Why is that? Because higher would be the value of the call option. And because in the callable bond the investor is short in the call option, higher the value of the call option, lower is the value of the callable bond that is one fundamental feature, at higher.

So, if lower is the value of the callable bond, what happens to the option adjuster spread? Lower is the add-on which constitutes the optional adjustment spread that you have to add to the risk-free rate in order to arrive at the current market price. And let me repeat lower the value of the callable bond, lower is the discount rate that you need to arrive at the current market price.

And that means what? That means lower is the add-on through the risk-free rate that you require for arriving at the current market price. And that means what? That simply means that the lower

is the option adjusted spread. So, higher the interest rate volatility, higher the volatility that goes into the calibration of the interest rate tree, lower would be the option adjusted spread.

Let me now explain this by an example. Suppose that a 7 percent, 10 year callable bond of XYZ is currently trading at 958. Assume that an analyst P assumes a 15 percent value for future volatility in generating the benchmark interest rate tree. He calculates the value of the bond as 1050. He then computes the option adjusted spread, the increase in discount rate.

What is the option adjustment? It is the add-on to the risk-free rate which is required to lower the calculated value from 1050 to the market value which is 958. Let us assume that he the add-on that is required is 80 basis points. Then this 80 basis first constitutes this option adjusted spread.

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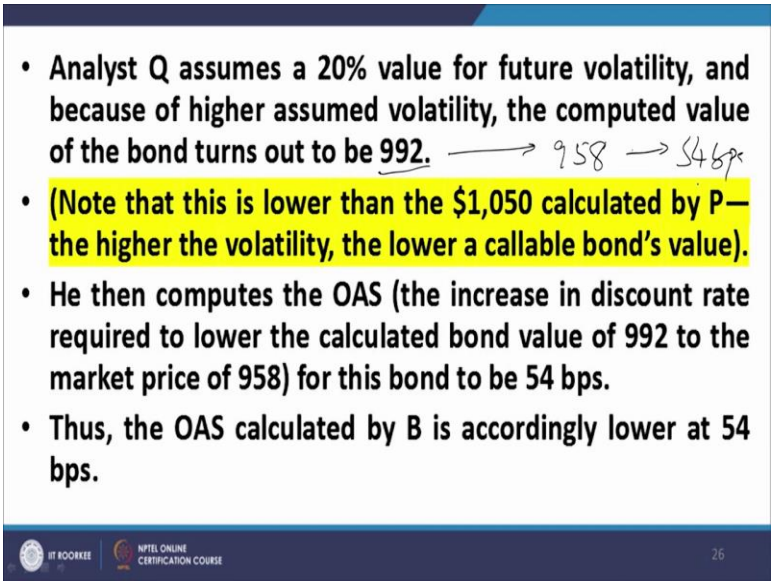

Now suppose another analyst Q assumes a 20 percent value of future volatility in calibrating his interest rate tree. Then what will happen to the computed value? As I mentioned the value of the call option will increase because of greater volatility and because the investor is short and they call on a callable bond, the value of the callable bond will decrease.

Let us assume that the computed value of the callable bond on this new tree on the 20 percent volatility tree turns out to be 992. So, now what happens now if I try to work out that add-on figure to bring this 992 back to 958 it will be lower than 80 basis points that I computed earlier. Let us say it is 54 basis points. So, the option adjusted spread has reduced from 80 basis point to

50 basis point. So, higher is the volatility that is used for calibrating the interest rate tree, lower would be the optional adjusted spread.

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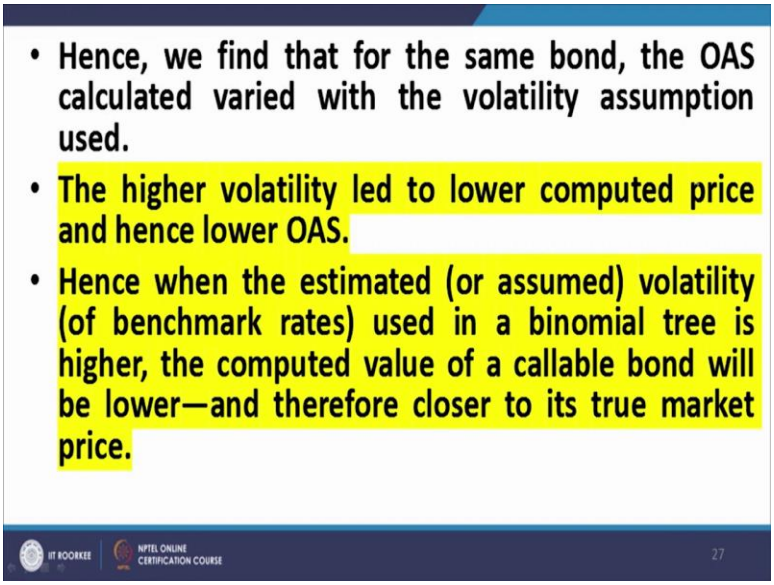

Hence, you find that for the same bond the option adjusted spread calculated varies with the volatility assumption used. The higher volatility led to lower computed value and hence to lower optional adjusted spread. Hence, when the estimated or assumed volatility of benchmark rates used in a binomial tree is higher the computed value of a callable bond will be lower. And therefore, closer to the true market price.

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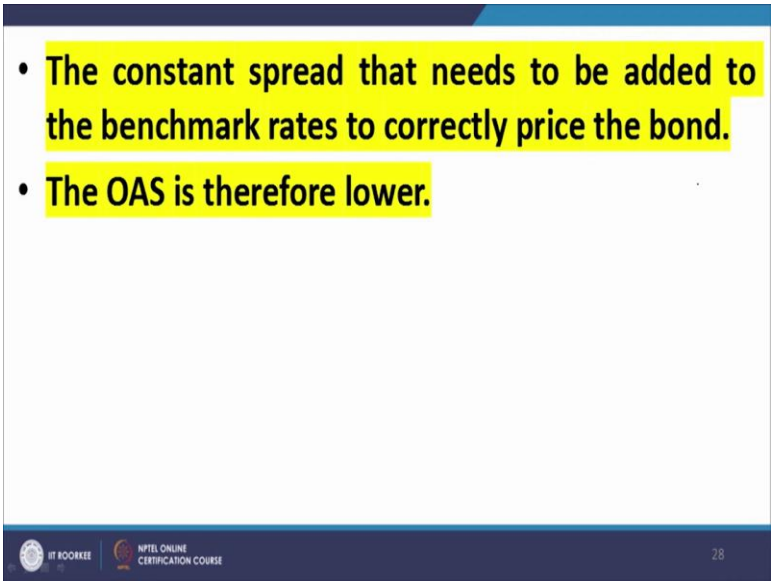

The constant spread that needs to be added to the benchmark rates to correctly price the bond the option adjustment spread is lower. So, that is what it is, that is how it operates.

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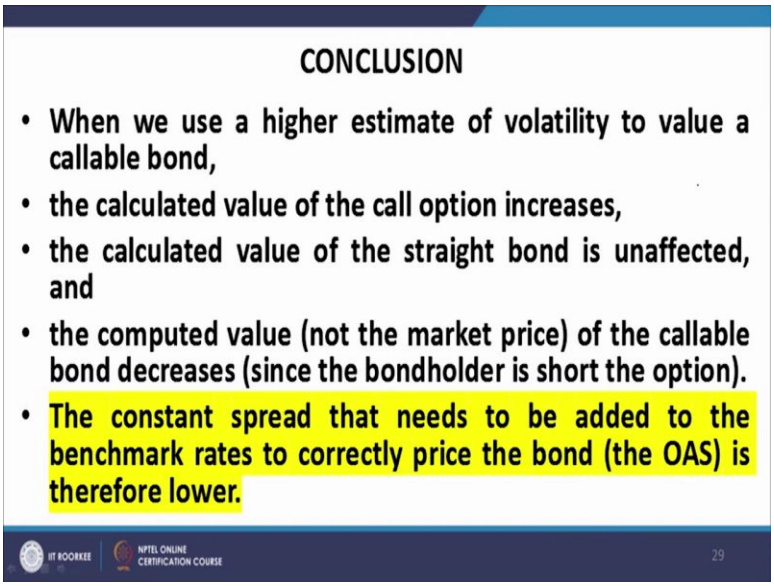

Conclusion when we use a higher estimate of volatility to value a callable bond, the calculated value of the call option increases as I mentioned. The calculated value of the straight bond is unaffected; the computed value not the market price of the callable bond decreases. Because the investor is short in the call option. And the constant spread that needs to be added to the risk free rates to the benchmark rates to arrive at the correct market price of the instrument therefore

decreases. And this is nothing but the option adjusted spread. Therefore, the option adjusted spread decreases.

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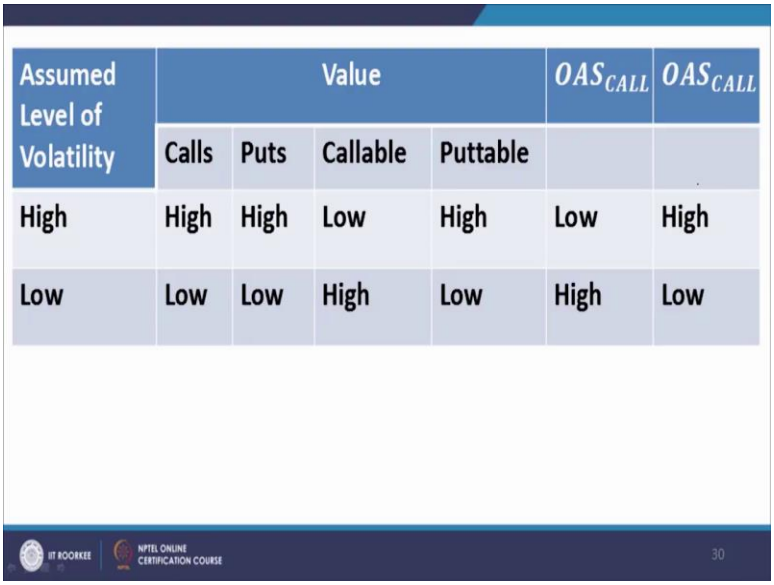

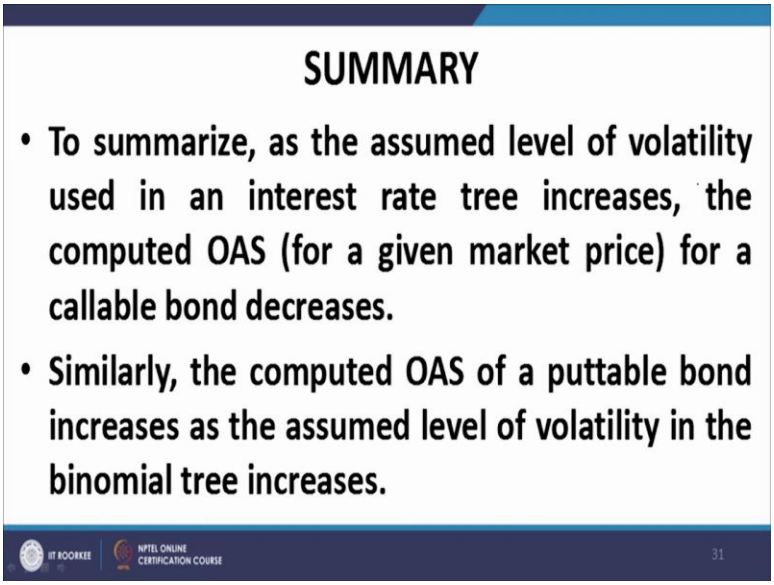

Now this is a summary of what I have talked about a calls and for puts. To summarize as the assumed level of volatility used in the interest rate tree increases, the computed option adjusted spread for a given market price for a callable bond decreases. Similarly, the computed option adjusted spread for a puttable bond increases as the assumed level of volatility in the binomial tree increases.

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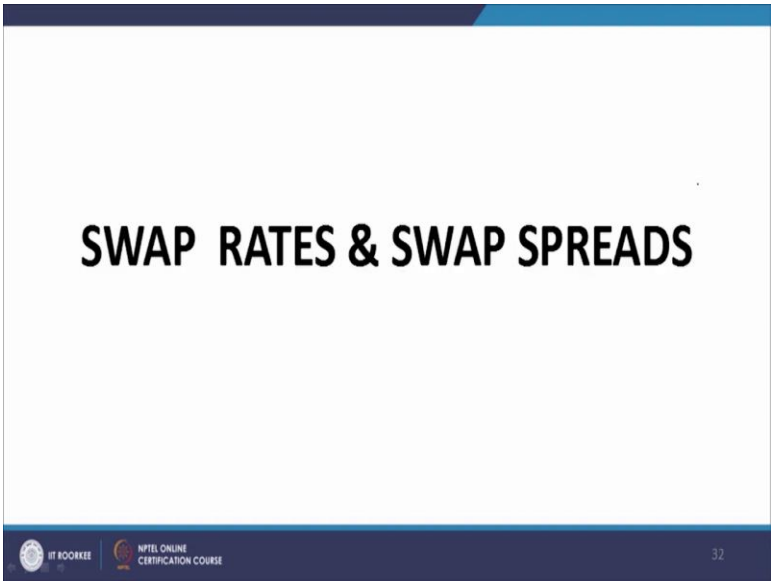

Swap rates and swap spreads: What is the swap? A swap is basically an exchange of cash flows, a swap is an exchange of a sequence of cash flows rather let me be more precise, it is a sequence of it is an exchange of a sequence of cash flows. Usually what happens is that the value of each cash flow in a in the one leg of the cash flows is determined with reference to a particular market variable and the other leg of the cash flows is independent of that market variable.

For example, one leg may be determined by the current interest rates which is called usually called the floating leg, the other leg may be independent of current interest rates may be based on and in a predetermined fixed interest rate and that is called the fixed leg.

So, typically the in fact the most important the most common swap that we have in existence that is freq, that is traded the most is the interest rate swap where the one of the legs is of cash flows is based on a fixed rate of interest and the other leg of the cash flows is based on floating leg. And interest rate which is reset at periodical intervals in line with the provisions contained in the swap contract.

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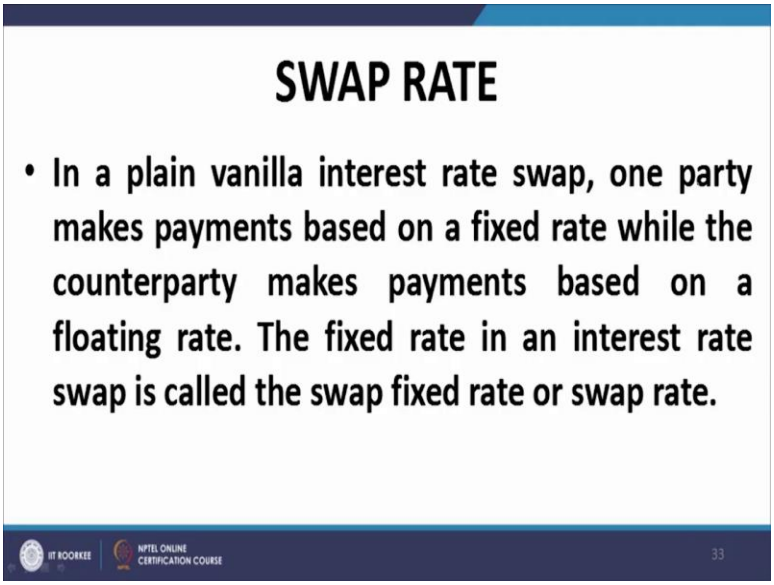

So, in a plane (when) vanilla interested swap, one party makes payments based on a fixed rate, while the counterparty makes payments based on a floating rate. The fixed rate in an interest rate swap corresponding to the floating rate is called the swap fixed rate or swap rate. So, let me repeat, in the case of a swap or our interest rate swap, which is the most common type of swap, we have currency swaps also, we have equity swaps also.

But let us stick to the simplest swap time permitting I shall talk about other types of swaps as well. But for the moment let us restrict ourselves to interest rate swap. Interest rate swaps involve an exchange of cash flows, such that one of the cash flows is determined or is determined on the basis of a rate, which is fixed at t equal to 0.

And the second cash stream of cash flow the second leg of cash flows is reviewed at periodical intervals based on the then prevailing interest rate and accordingly the cash flows may change over the life of the swap contract. So, the fixed rate corresponding to the floating rate that is agreed upon in the swaps is called this swap rate.

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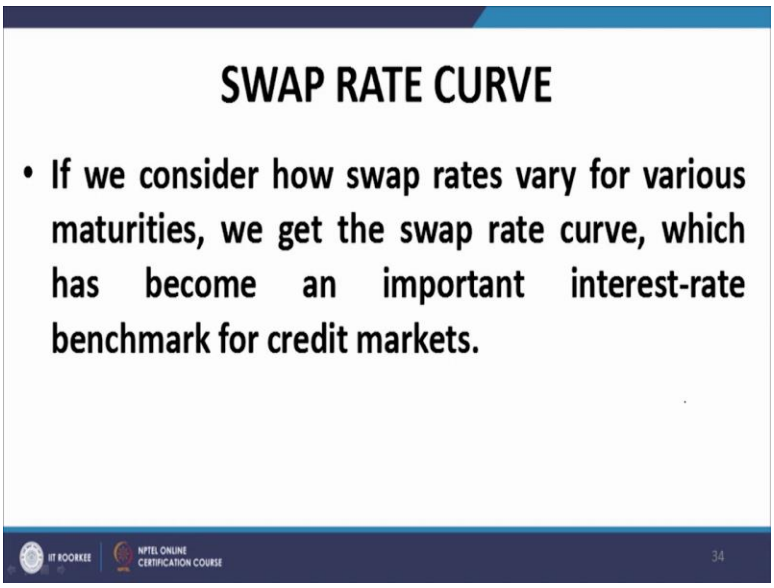

Swap rate curve: If we consider how swap rates vary for various maturities, we get the swap rate curve. So, if at any point in time, we plot a curve with the maturities along the x axis as usual and the swap rates along the y axis, what we get is the swap rate curve. The swap rate curve has become an important interest rate benchmark for credit markets.

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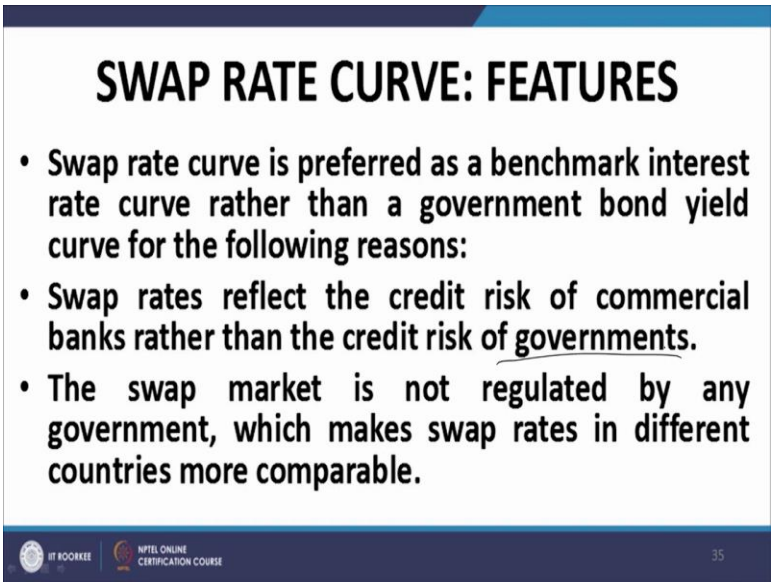

Swap rate curve features: swap rate curve is preferred as a benchmark interest rate curve rather than a government bond which we have been using so far as the Benchmark. But now we come

to know that we know, what is swap rate, we shall also talk about its relevance in so far as valuations are concerned and in so far the utility is concerned.

So, swap rate curve is preferred as a benchmark interest rate curve rather than a government bond yield curve for the following reasons. Number one swap rates reflect the credit risk of commercial banks rather than that of governments. Swap rates reflect the credit risk of commercial banks rather than that of governments. The swap Market is not regulated by any government which makes swap rates in different countries more comparable.

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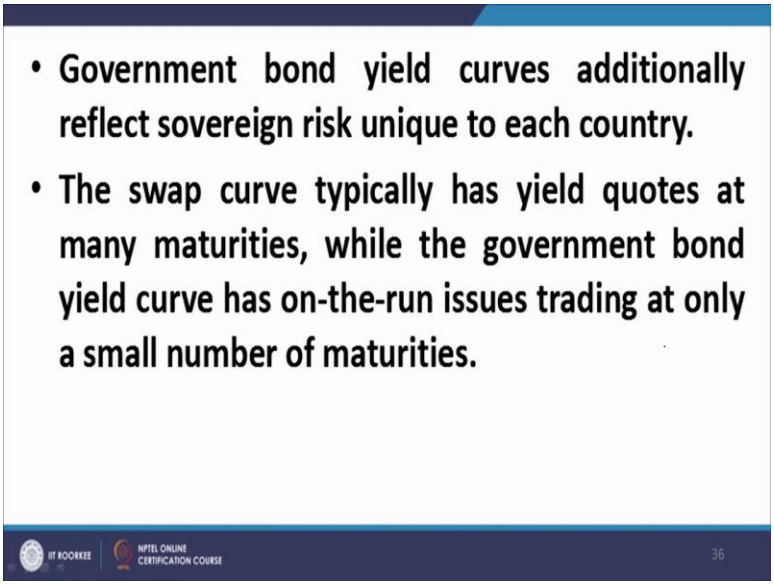

Government bond yield curves additionally reflects sovereign risk unique to each country. So, swap rates do not have that particular feature. The swap curve typically has yield quotes at many maturities while the government bond yield curve has on-the-run issues trading at only a small number of maturities.

So, the spectrum of government interest rates or spectrum of interest rates that can be that are available for plotting the government spot rate curve is usually limited. Swap rates are available for more closer maturities or for more closely spaced maturities.

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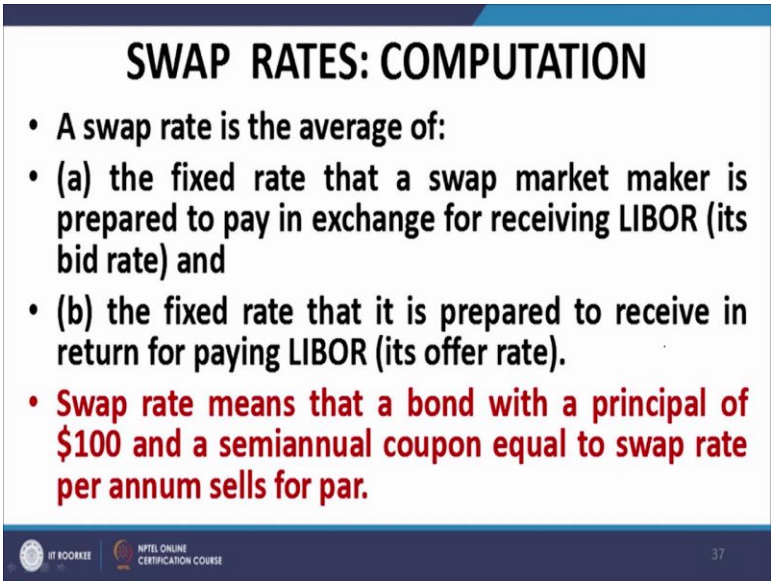

Now the more technical definition of swap rate. A swap rate is the average of the fixed rate that a swap market maker is prepared to pay in exchange for receiving LIBOR that is the, its bid rate and the fixed rate that it is prepared to receive in return for paying LIBOR that is the offer rate. So, the technical definition of swap rates an improvement on what I mentioned a few minutes back, is that it is the average of the bit rate and the offer rate where the bit rate, is the rate that the is the fixed rate that the market maker is willing to pay in exchange of LIBOR and the offer rate is the rate that the market maker is willing to receive a in exchange for the LIBOR rate.

Now swap rate means that a bond with a principle of dollars hundred and semi-annual coupon equal to the swap rate per annum sells at par. So, if x is the swap rate, then if you have a coupon of x by 2 at intervals of 6 months. Then it is, the bond with this kind of Interest payment should be selling at par.

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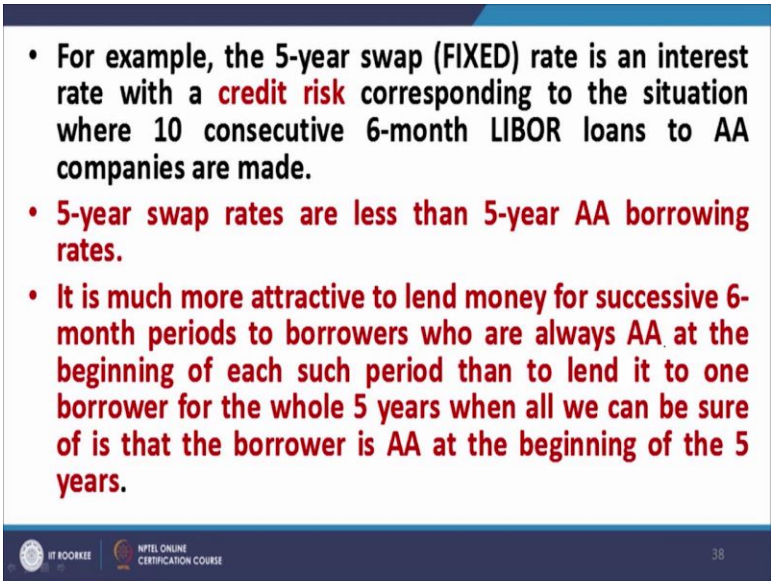

For example, the 5 years up rate is an interest rate with a credit risk corresponding to the situation where 10 consecutive 6 month LIBOR loans are made to companies whether AA credit rating. 5 years evaporates are less than 5 year AA borrowing rates. Why is that?

Because you see when you are talking about a 5 year AA borrowing rate, that rate is determined at t equal to 0 and that rate is fixed for the entire 5 year tenure of the loan. I repeat when we talk about the AA borrowing rate for 5 years, what we are trying to say is that, this interest rate will hold irrespective of what happens in the next 5 year period. The lender does not have discretion to modify that rate over the life of the loan.

However, in the case of a swap rate what is happening in the swap rate you are basically giving a loan on the premise that the interest rates would be this the rates prevailing at 6 month intervals of companies that have credit worthiness of AA at all times during this at all times at all times of review of this 6 monthly intervals.

Let me explain it a bit more in detail suppose you have made a loan at t equal to 0, then the company should have an AA rating at t equal to 0 for 6 months or for a 6 month loan that is. Then at t equal to 6 months when you review that loan that loan company should have AA rating for that 6 months and so on. So, this rate this 5 years for swap rate corresponds to the rate over the 5 year period with 6 monthly review points.

So, let me read it out now it is much more attractive to lend money to successive for successive 6 month periods it is more attractive to lend money for successive 6 month periods to borrows for always AA at the beginning of each such period, this is important. AA at the beginning of each such period then to lend it to one borrower for the whole 5 years. When all we can be sure of is that the borrower is AA at the beginning of the 5 year period.

So, that is basically the difference. In the case of a swap rate, you are making loans at 6 months inter or you are deemed to be making loans. You, the present, the rate is fixed on that premise that you will we have made a 5 year loan but that loan is such that at every 6 months you review the credit rating or you make the loan to a party not necessarily the same party to a party who has AA rating at that point at which you make the loan.

In the case of the fixed rate loan, that review of credit rating is only a t equal to 0 and not subsequently up to t equal to 5 years. In the case of the swap rate, the review is at 6 monthly intervals and that loan need not necessarily be to the same party it will be to deemed to be parties at who have the credit rating of AA at the beginning of his 6 monthly period.

Now that is important please note this, these are deemed lendings in both cases they are not real lendings. So, that is the reason that is the reason why when you fix the interest rate for 5 years in one go obviously you have greater risk attached to that loan that credit risk of the party may deteriorate over the five years and you cannot do anything about it.

So, naturally you will demand a higher rate compared to the swap rate where the review is at 6 monthly intervals and it the loan may also not be deemed to be to the same party but to a company whichever company that is that has a credit rating of AA at that point at that review point which are 6 months apart. So, naturally the interest rate would be slightly less compared to the 5 year fixed rate.

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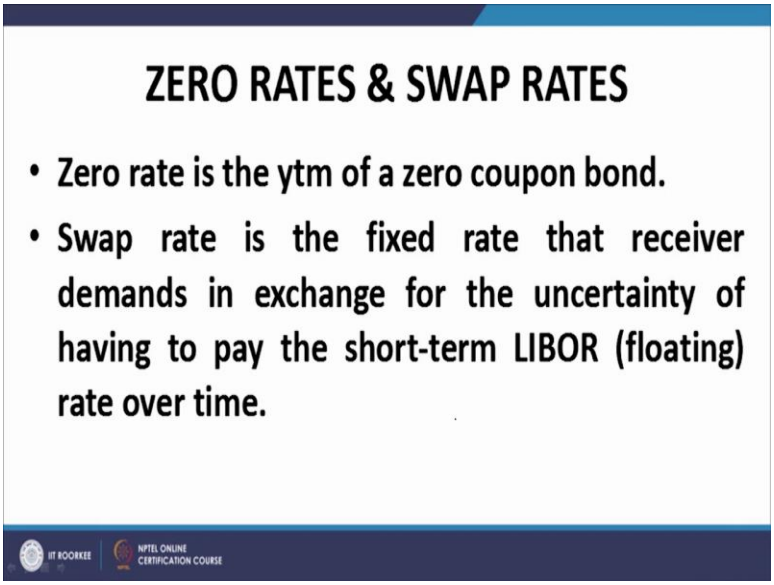

Zero rates and swap rate: zero rates or ytms. Zero rate is the ytm of a zero coupon bond as I mentioned. Swap rate is the fixed rate that the receiver demands in exchange for the uncertainty of having to pay the short-term LIBOR rate over time. So, that is the rate that the fixed rate corresponding to the floating rate which is the library rate 6 monthly intervals.

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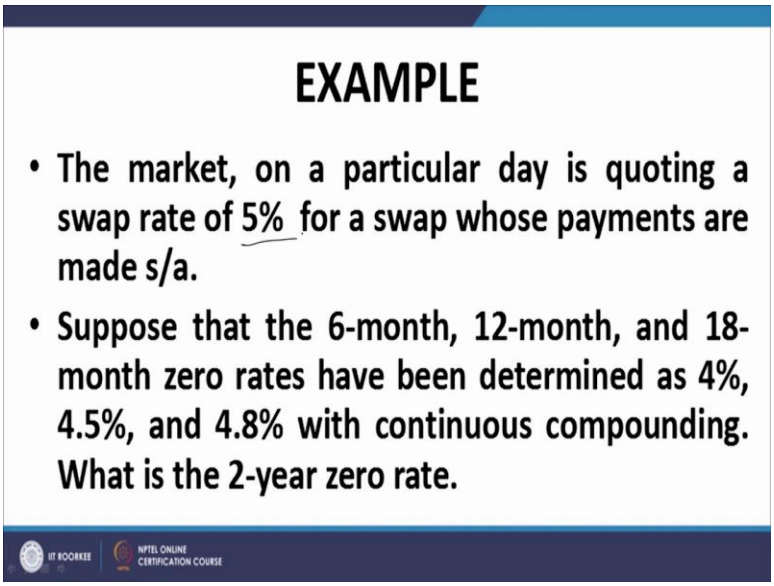

Let us do this example. The market on a particular day is quoting a swap rate of 5 percent for a swap whose payments are made semi-annually. Suppose the 6 month, 12 month, and 18 month

zero rates have been determined and are 4 percent, 4.5 percent, and 4.8 percent with continuous compounding. What is the 2 year zero rate?

Now the swap rate of 5 percent means what? Means if the face value is 100 then a coupon of 2.5 at the end of 6 months and coupon of 2.5 at the end of 1 year would mean that the bond would be quoting at par. So, that is what is meant by the swap rate. The swap rate is that rate at which if semi annual payments are made at half of that rate the bond would be quoting at par.

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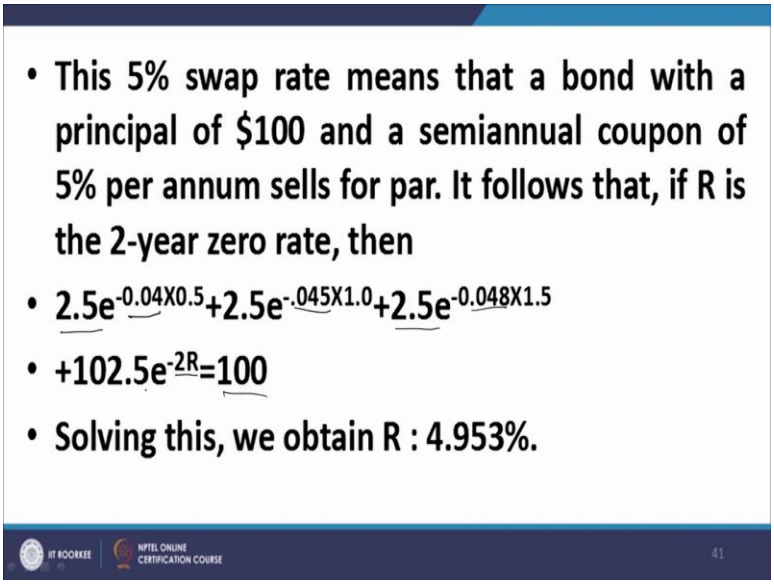

So, here is the solution if you look at the solution 2.5 at the end of 6 months, this is being discounted at the 6 month zero rate which is 4 percent. This is here the 2.5 that is occurring at the end of 1 year is being discounted at 4.5 percent, which is there for 1 year and then you are getting 2.5 at the end of 18 months, which is being discounted at the 18 months spot rate which is 4.8.

And then you have a cash flow, final cash flow of 100 of principal and 2.5 of the coupon and that is being discounted for 2 years. We have 2R, where R is the 2 years spot rate. Now on solving this equation and this must be equal to 100 as I mentioned if there are semi-annual payments equal to half of the swap rate, then the bond should quote at par. And that is precisely what we are saying half of the coupon payments coupon rate is 5.

So, half of this is 2.5 and it is being made semi-annually and then of course the repayment is made at the end of the life of the bond and the bond should be quoting at par when we solve this equation for R we get 4, R is equal to 4.953 percent.

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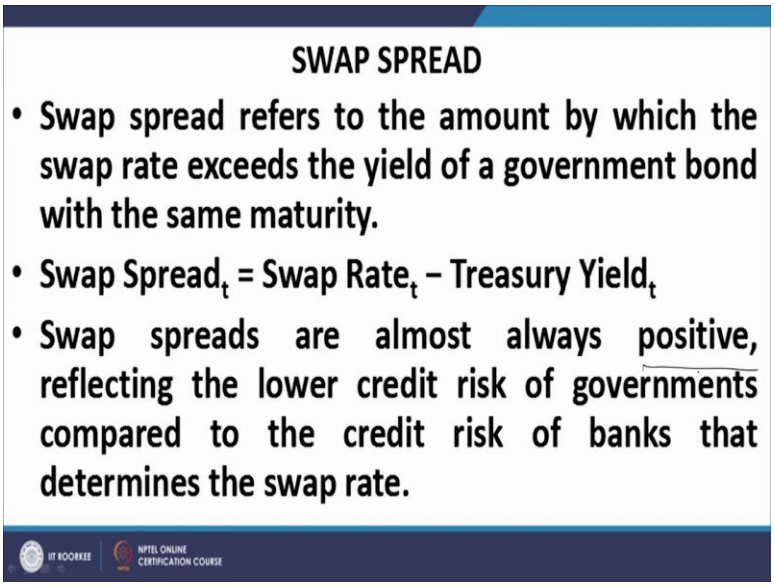

Swap spread, swap spread refers to the amount by which the swap rate exceeds the yield on a government bond. So, this is simple. Swap spread refers to the amount by which this swap rate exceeds yield on the government bond with the same maturity. Swap rates is equal to swap rate minus treasury rate or treasury yield.

Swap spread are almost always positive. Why should they be positive? Because the swap the swap rates refer to risk which is greater than that for government instruments the greater than government treasury instruments. Swap rates are almost always positive reflecting the lower credit risk of the government compared to the credit risk of banks that determine the swap rate. So, naturally because the swap rates pertain to banks, which have a higher credit risk, the rate would be higher compared to that for the government, which has a lower credit risk.

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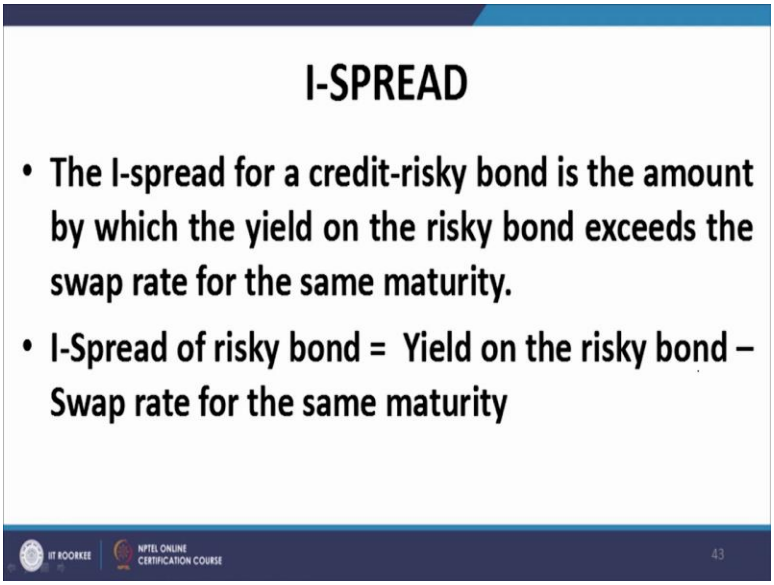

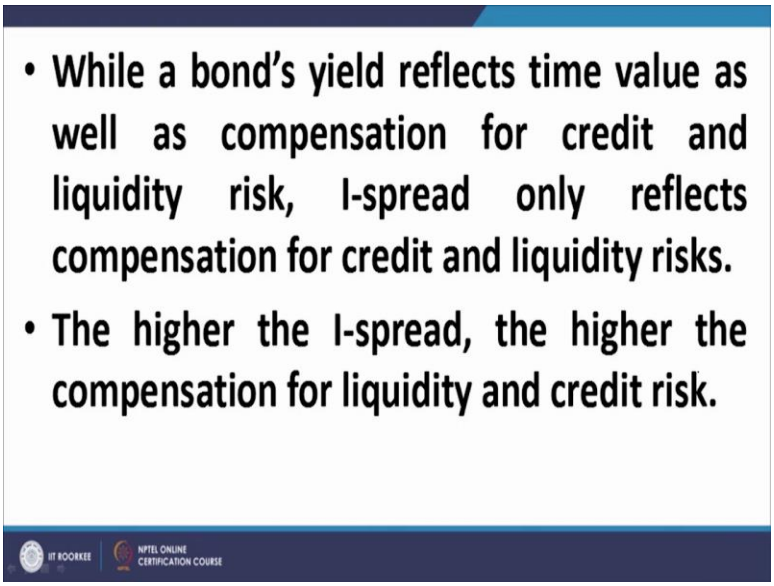

I-spread, the I-spread for a credit risky bond is the amount by which the yield on the risky bond exceeds the swap rate for the same maturity. So-I spread of risky bond is equal to yield on the risky bond minus swap rate for the same maturity. While a bond shield reflects time value of money as well as compensation for credit and liquidity risk. The I-spread reflects only what the time value is eliminated by deducting the government the yield on the government bond. This particular part that we have here the swap rate for the same maturity this eliminates. What risk?

This eliminates the time value risk and therefore when you remove this risk from the yield of the risky bond the I-spread of the risky bond is a measure of the credit and liquidity risk alone not of

the time value. The time value is eliminated either by the government treasury rate or the swap rate in the case of the I-spread. We use the swap rate as a measure of the time value and therefore when we are deducting the swap rate from the yield on the risky instrument. We are eliminating the time value impact and we are retaining the riskiness and so far as the credit and liquidity is concerned.

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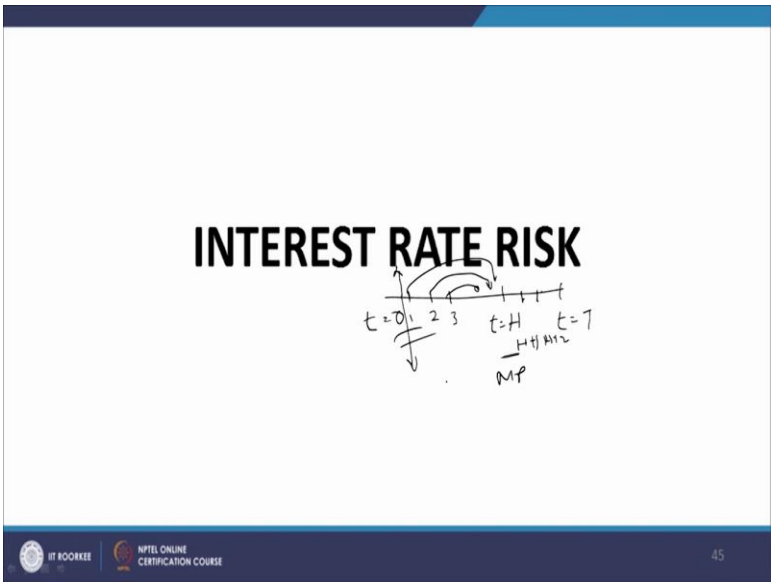

Now we start a new chapter which is interest rate risk. Now when we make an investment in a bond. Let us assume that t equal to 0, t equal to 0 I have made an investment in a bond. Let us say the maturity of the bond is t equal to capital T. And let us assume that my holding period of the instrument is not equal to, is not equal to the maturity of the bond.

Let us assume that my holding period is less than the maturity of the bond. Let us see it is somewhere here t equal to H. So, because my investment horizon or my holding period is less than the maturity of the bond, what will happen? At t equal to H, which is that culmination of my holding period, I would like to dispose of the bond in the market. And whatever proceeds I will get that I will that will determine the yield that I have on my instrument.

In addition to that, in addition to that I would also be receiving coupons at t equal to 1, t equal to 2, t equal to 3 and so on. I would obviously as a prudent investor, if I do not need the money at t equal to 1, or at t equal to 2, but I receive a certain amount of money I am not going to keep it idle in my cash box. I would reinvest it somewhere.

So, this t the coupon that I receive at t equal to 1 would be reinvested until H. The coupon that I received at t equal to 2, will be reinvested until H in this way. In other words what I am trying to say is that all the coupons that I receive at t equal to 1, 2, 3 upto t equal to H minus 1 will be reinvested until t equal to H and then when t equal to H arrives, I will sell the bond in the market and get the disposal process sell proceeds.

So, that will all these two things the value or the proceeds of the reinvested coupon that I have and in addition to that the market value of the bond the aggregate of this will determine the and will determine the return of the yield that I have obtained on my investment in this bond. Now so far so good.

Now suppose at a certain point in time. Let us say very soon after I after I make the investment. The interest rates make a change, the interest is change, let us say the interest rates increase. Let me say that the interest rates increase. Now if the interest rate increase, what will happen? The in the coupon that I will invest at t equal to 1 will obviously be at a higher rate compared to the rate that I have planned at t equal to 0.

Similarly, the coupon at t equal to 2, will also be at a higher rate because compared to the rate that I have planned at t equal to 0. In other words what will happen is, that the reinvestment income the value of the reinvested coupons that I received at t equal to 1 and invested for H minus 1 years that I received at t equal to 2 and invested for H minus 2 years all the pre-investment proceeds of all these intermediate coupons will increase.

Because the reinvestment rate has increased, and why is that? Because we are assuming that the market rate has increased. So, obviously reinvestment would be at the relatively higher market rate. But what about the sell proceeds? They say as far as the sell proceeds are concerned, what will happen? How do we determine the value of a bond?

We discount all future cash flows at, we discount all future cash flows. Let us say this is H, this is H plus 1, H plus 2, H plus 1, H plus 2 and so on. This is capital T all the couples that are going to be paid at t equal to H plus 1, H plus 2, H plus 3 upto t equal to capital T, this would be discounted. And when they are discounted the value that we will get at t equal to H will determine the market price of the bond.

Now what happens if the market rates have increased? If the market rates have increased what does it mean? It means that the discount rate has increased. Because the market is not demanding a higher return. So, the discount rate has increased, if the discount rate has increased, what happens to the market price? The market price which has determined how, which is determined by discounting all future cash flows at the relevant risk adjusted market rate.

So, if the market rates have increased the interest the discounted value will decrease and as a result of which the market price will decrease. So, there are two opposing effects if there is a change in interest rate that is the important thing. That is the fundamental thing that we need to understand. If there is no change in interest rates well and good very fine, we continue as per projected.

But we know that interest rates do change, interest rates do have volatility. So, therefore if there is a change in interest rates two opposing factors come into play. The first factor is due to the reinvestment income, if interest rates increase the reinvestment income increases, if the interest has declined the reinvestment income decreases. However, there is another thing called the capital gain.

The capital gain is the profit in some sense that you in a very simplistic sense, capital gains is the profit and that you make on the on the investment. And if interest rates increase that capital gain decreases, if interest rates increase the capital gain decreases. And conversely, if interest rates decrease the capital gain increases.

Because the price at which you are going to liquidate the bond increases, if the interest rates increase the price decreases, therefore the capital gains not naturally decrease. If the interest rates decrease the price, increases and the capital gains increases. So, these are two opposing effects and they would take place, if interest rate changes during the life of your investment should continue from here in the next lecture. Thank you.