Management of Fixed Income Securities
Prof. Jitendra Mahakud
Department of Humanities and Social Science
Indian Institute of Technology, Kharagpur

Lecture - 57
Fixed Income Securities Derivatives - II

Welcome back. So, in the previous class we started the discussion on the fixed income securities derivatives. So, in that part we discussed about the instruments like futures and optionsor mostly we discussed about the futures and the forwards like the forward rate agreements then as well as the how the future contract look like, how the pricing of the different fixed income futures or the forwards are basically always done.

So, all these things we have discussed in the previous class. So, today we will be continuing with the discussion.

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And in today's session we will be discussing about another major instrument on derivatives that is basically called the options. So, in today's session you will generally always come across certain kind of concepts like your options, the moneyness then options on futures like called the futures options then your T bond future options, euro dollar and T bill future options and the over the counter derivatives instrument what we call it the OTC derivatives. So, these are the different concepts what we will be discussing in today's session.

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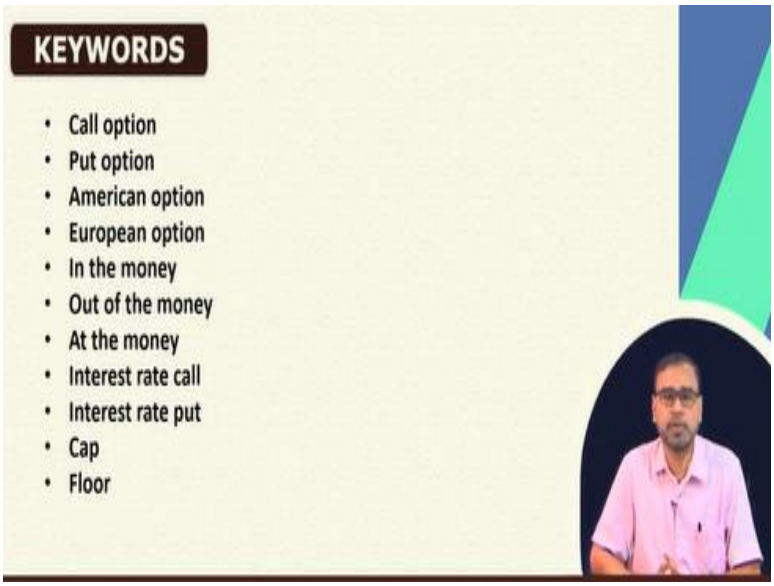

So, then there are certain keywords, there are many keywords you will come across while discussing about this particular concept or this particular topic. Some of the keywords already you must be aware about if you have already studied the subject on derivatives. But these are the things what commonly used whenever any type of device derivatives instrument, we analyse or we discuss like your call options, put option, American option, European option, concept of in the money, out of the money, at the money, interest rate call, interest rate put, cap, floor all kinds of concepts are all kind of keywords will be discussing in today's session or you will come across while discussing about the different issues related to the options.

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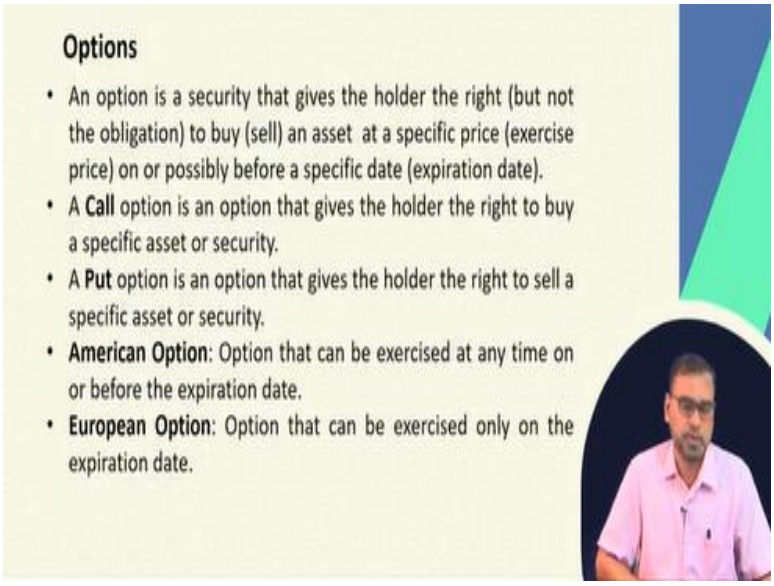

So, let us first little bit understand about what the option is all about. So, option is basically nothing but kind of security particularly whether it is a financial market security or any other commodity market security. So, depending upon the underlying asset the name can be given. So, the option is basically kind of security which gives the holder the right but not the obligation to buy or sell an asset at a specific price and that price is basically called the exercise price on or possibly before a specific date and that date is called the expiration date.

So, the here the option holder has the right but not the obligation to exercise that particular kind of option. So, that is the general definition of option generally always we use whenever we discuss about the instrument like options. Then here there are two types of options one is your call option another one is the put option. So, what basically the call option is defined and how the call option is defined.

The call option is basically the option which gives the holder right to buy a specific asset or a security in a future date. And the put option if you say it gives the holder the right to sell a specific asset or the security. So, here the call option means it gives the holder the right to buy and put option means it gives the holder the right to sell. So, that is the basic difference between a call option and a put option.

Then broadly whether it is call option or put option another classification of options also always we see. One is called the American option another one is the European option. So, if you talk about the American option, the American option can be exercised at any time on or before the expiration date, at any point of time this particular option can be exercised. But if you talk about the European option, the European option only can be exercised at the expiration date.

Whichever date is mentioned in that particular option contract only that option can be exercised on that particular date. So, before that date this option cannot be exercised. So, that is called basically the Europeanoption.So, these are the basic understanding or basic notions which are related to the options.

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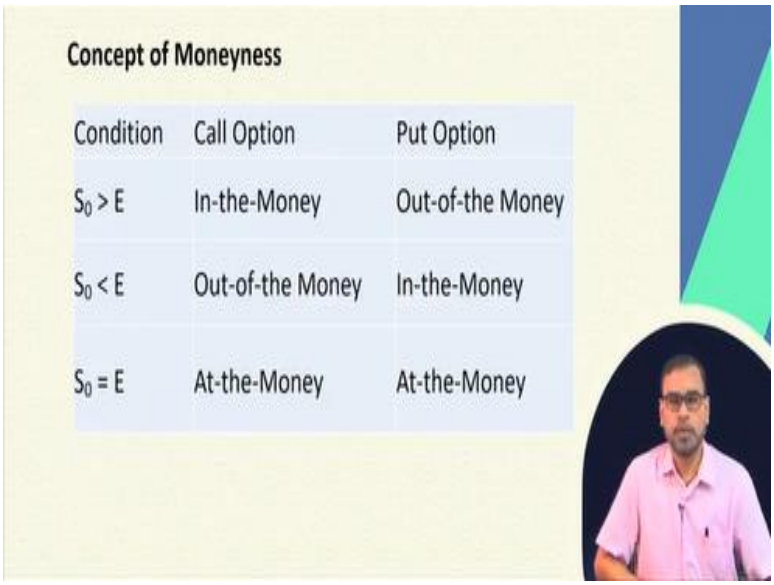

Then another thing also you should know about the concept of the moneyness. So, what this moneyness is all about?

Condition-1-: The moneyness means here the S_0 represents the market price; E means basically the strike price or the exercise price. So, if you are talking about a call option if the market price will be basically greater than the exercise price then obviously the option holder is going to exercise that option that's why we can say that it is in-the-money. But in that case the put option holder may not exercise that option that's why in that case we can say that that option is out-of-the-money.

Condition-2-:So, like that if the reverse thing if you see that if your S_0 the market price is less than the exercise price then your call option will be in out of money and the put option will be in the money that means this option is going to be exercised.

Condition-3-: If both are same then we can say that whether it is a call option or put option if your market price is equal to your exercise price. Then we can say that the option is basically at the money. So, these are the concepts what we always use whenever we discuss about the option market and the concept of the moneyness.

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Then you see there are certain options which are also made on the futures. So, all of you know thatwhat do you mean by the future that already we have discussed in the previous class. So, whenever you talk about the futures options the futures options basically again gives the holder the right to take a position in the future contract. So, here the future option basically gives the holder the right to take a position in the future contract.

So, if you have a call option then if you talk about the call option on a future contract it gives the holder the right to take a long position in the underlying future contract. If it is a put option on a future option then it gives the holder the right to take a short position in the underlying future contract. That means in the first case it is a long means it is the buying position and short means it is basically the selling positions.

So, that means the options are basically based upon the future contracts. So, here if you see that whenever you talk about the only the call option and put option just now whatever we have discussed these are basically we can say that the instruments of this spot options market. So, this one is basically the futures options market. So, if the spot options and future options they may be equivalent.

If the options and future contracts are expiring at the same time and the carrying cost model or the cost of carry model holds and the options are basically European. Because the European options only can be exercised at the expiration date before that this particular option cannot be

exercised. So, if the three conditions will satisfy then we can say that the spot options and future options are equivalent.

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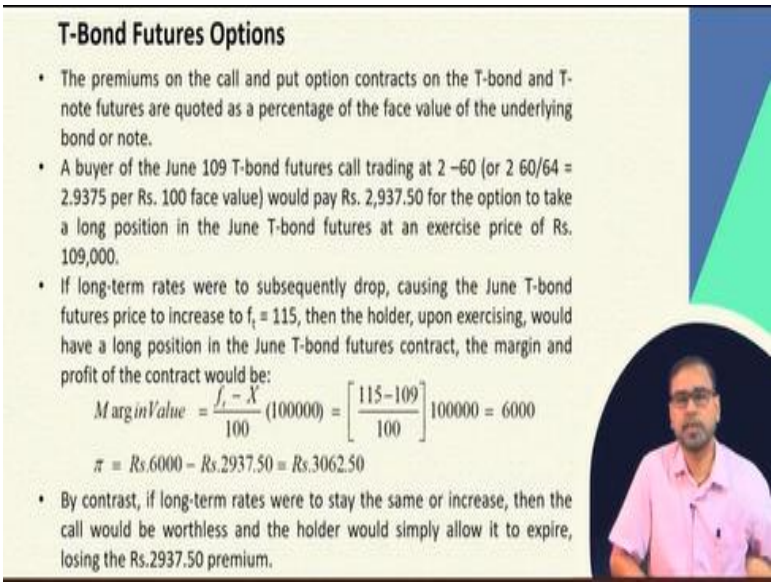

Then let us see that different type of fixed income derivatives what basically always the major focus of this particular subject, how those particular instruments or those particular assets are linked to these derivatives or how the T bond future options or T bill future options basically looks like and what are the different characteristics related to that.So, if you talk about a T bond future options so here the premium on the call and put option contracts on a T bond or the T note futures.

T notes are basically the medium term in nature and T bonds are basically long term in nature. These are generally quoted as a percentage of the face value of the underlying bond or the note. So, for example if you say that a buyer of the June 109 T bond futures call trading at 2-60 (2-60 means we are talking about 260 by 64 that means it is 2.9375 perface value of the hundred) then that would pay basically your 2937.50 for the options to take a long position in the June T bond future at an exercise price of 109000.

So, if you assume that the long-term interest rates are subsequently drop then what will happen.It will cause the June T bond future price to increase obviously because there is an inverse relationship between interest rate and the price of this particular bond. Then let the future price

has increased to 115 then the holder of that particular option of an exercising would have a long position in the June T bond future contract.

The margin and the profit basically if you want to calculate from that then how much basically you will find? The margin value will be your f_t-X, X is the exercise price divide by hundred into your 100000 that will be basically nothing but 115-109 divided by 100 into your 100000 that will give you 6000. So, premium you have paid 2937.50 and basically your cash flow whatever you are getting that is 6000.

Margin Value = $\frac{f_t - X}{100}(100000) = [\frac{115-109}{100}]\ 100000 = 6000$

π = Rs.6000-Rs.2937.50 = Rs.3062.50

So, effectively you are generating a profit of 6000 minus your 2937.50 that will give you your 3062.50. By contrast if the long term rates were to stay in the same or increase then call would be worthless and the holder would simply allow it to expire losing this premium amount that is 2937.5. So, the option will not be exercised. So, whatever premium the buyer has given that particular premium has to be forgo from that. So, that is what basically the T bond future options generally look like.

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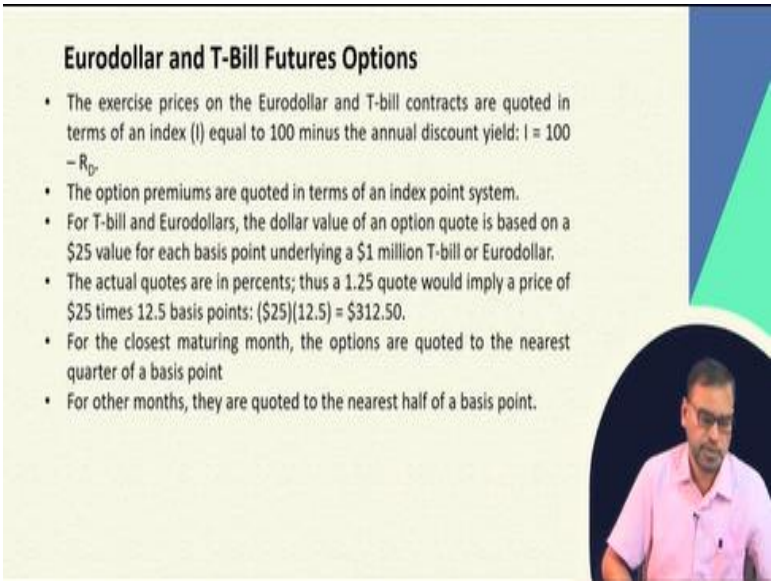

So, then we can see that the euro dollar and your T bill futures options. If you look at the euro dollar and T bill future options then the exercise price on the euro dollar or the T bill contracts

are generally quoted in terms of an index. Already we know that that is equal to 100 minus the discount rate that means 100 - R_D, R_D is equal to the discount yield. So, option premiums are generally quoted in terms of the index point system and for the T bill and euro dollars.

The dollar value of an option quote is generally based on the 25 dollar value for each basis point that the general rule underlying the one million T bill or the euro dollar. So, the actual quotes are in percentage like 1.25 quote for example if you take that would imply a price of 25 times 12.5 basis point that means 1.25 into 10. So, that means 25 dollars into 12.5 that will give you basically 312.50 dollar. So, this is the basically where the particular options are quoted.

Options Quoted= ($25)(12.5) = $312.50

So, for the closest maturing month the options are quoted to the nearest quarter of the basis point. So, for other months they are generally quoted to the nearest half of the basis point. So, these are the general rules signal we follow whenever the euro dollar or T bill future options are quoted in the market.

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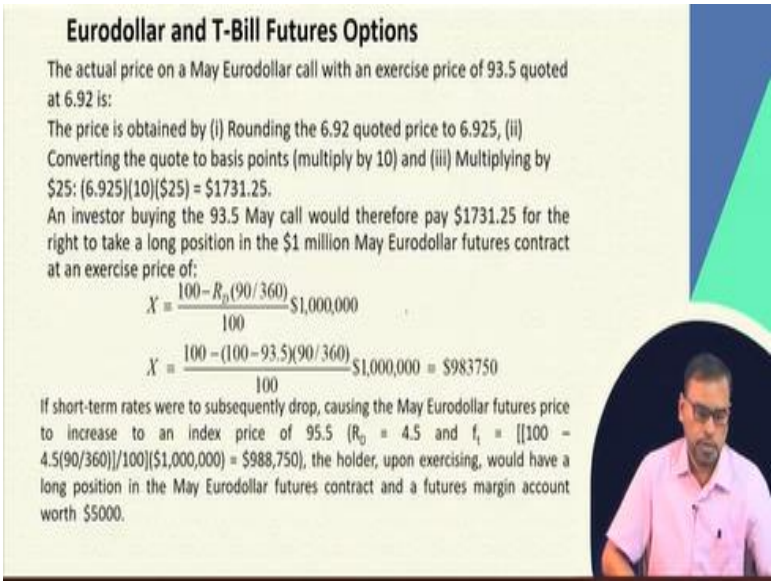

So, if you talk about this euro dollar and the T bill future options for example if you take the actual price on a may euro dollar contract with an exercise price of 93.5 quoted at 6.92 then how you can find out the price? First of all, you can rounding off to nearest point that is 6.92 is quoted price to 6.925 then convert that code to a basis point you can multiply by 10 then multiply that with 25 dollar. So, then you will find 6.925 into 10 into 25 dollar that will give you 1731.25.

$25 :(6.925) (10) ($25) = $1731.25.

So, the investor who is buying this 93.5 may call have to pay 1731.25 dollar for the right to take a long position in the one million may euro dollar future contract with an exercise price. How much will be the exercise price? That will be 100 minus your R_D into 90 by 360 divided by 100 into 1 million then that will give you 983750. So, if the short term rates were to subsequently drop then what will happen?

$$X = \frac{1000 - R_{D(90/360)}}{100} \$100{,}000$$

$$X = \frac{100 - (100 - 93.5)(90/360)}{100} \$100{,}000 = \$983750$$

The May euro dollar future prices will increase let the index price has increased to 95.5 and R_D we have taken 4.5 then your f_t become basically 988750. So, in that case the holder if they will go for exercising that option would have a long position in the May euro dollar future contract and the future margin account will be 5000 in that case.

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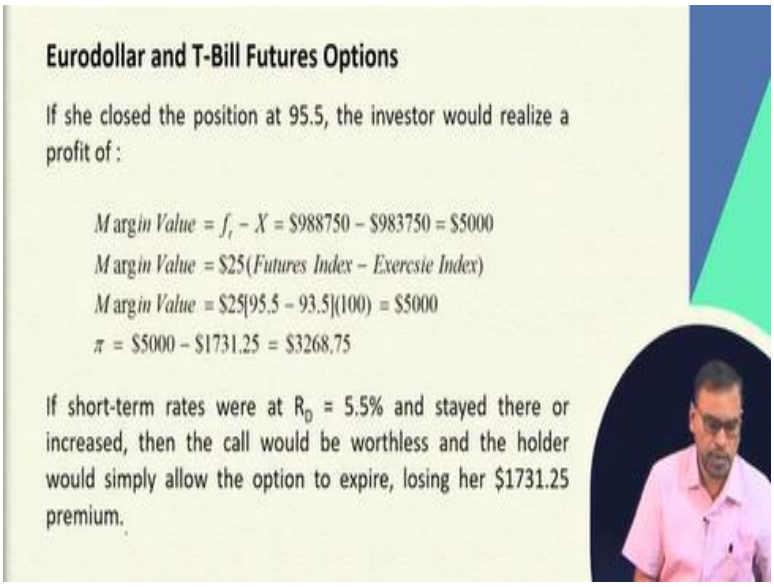

So, then if you see that; if she close the position in 95.5 then the investor will realize a profit. How much will be the profit? That is your f_t -X that means 988750 -983750 that will give you 5000 dollar that already we have discussed and the margin value if you really calculate that will

basically is nothing but your 25 dollar which is the base into future index minus the exercise index. That is 25 into 95.5 - 93.5 into 100 that will give you 5000.

So, already you have paid 1731.25 past the premium then the profit basically you can get that is 5000 - 1731.25 that will be 3268.75.

Margin Value = f_{t-X}=$988750−$983750=$5000

Margin Value = $25*(Future Index –Exercise Index*)

Margin Value = $25[95.5-93.5] (100) = $5000

π = $5000-$1731.25 = $3268.75

So, if the short term rates were at 5.5% and stayed there or increased then the call would be worthless and the holder would simply allow the option to expire losing this 1731.25 premium. That is what basically we can found from this example.

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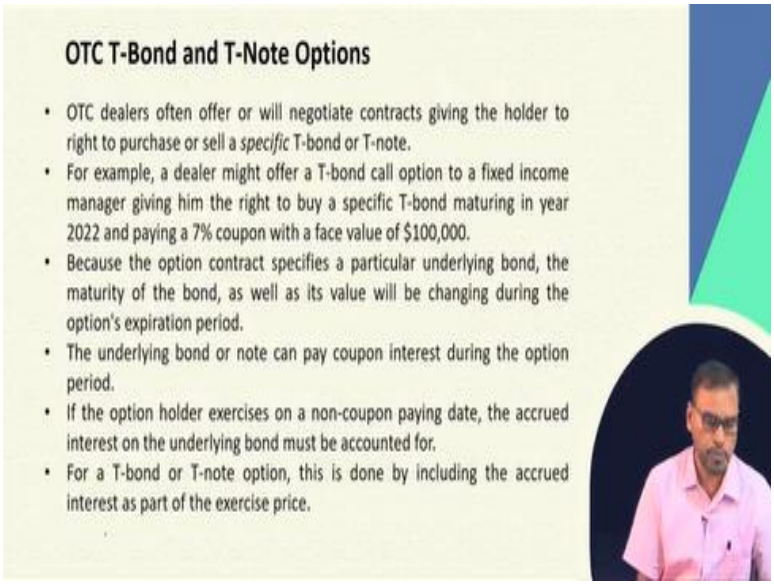

So, then OTC bond and T note options (over the counter market T bonds and T note options). The OTC dealers generally will negotiate contracts giving the holder the right to purchase or sell a specific T bond or the T note. For example, a dealer might offer a T bond call option to fixed income manager giving him the right to buy a specific T bond which is going to be matured in year 2022 and paying a 7% coupon with a face value of let $100000.

Because the option contracts specifies a particular underlying bond the maturity of the bond as well as its value will be changing during the options expiration period and the underlying bond

or note can pay the coupon interest during the option period. If the option holder exercises the non-coupon paying date, then the accrued interest on the underlying bond mostly accounted for. So, for a T bond or T note option this is done by including the accrued interest as a part of the exercise price.

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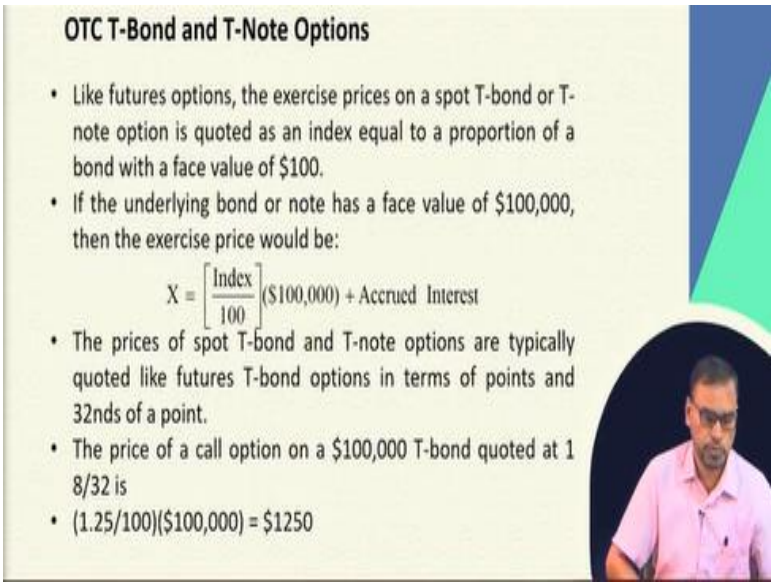

So, another thing here also like futures options the exercise prices on a spot T bond or T note option is quoted as an index equal to the proportion of the bond with a face value of 100 dollar. If the underlying bond or note has a face value of let 100,000 dollar then the exercise price would be your index by 100 into 100,000 plus the accrued interest. So, the price of the spot T bond and T note options are typically quoted like futures T bond options in terms of the points and the 32nds of the point.

$X = [\frac{Index}{100}]($100,000) + Accrued Interest.

So, the price of the call option which is 100000 T bond quoted as 1 8 by 32 will be nothing but 1.25 divided by 100 into 100,000 that will give you $1250.

$(1,25/100)$ ($100,000) = $1250

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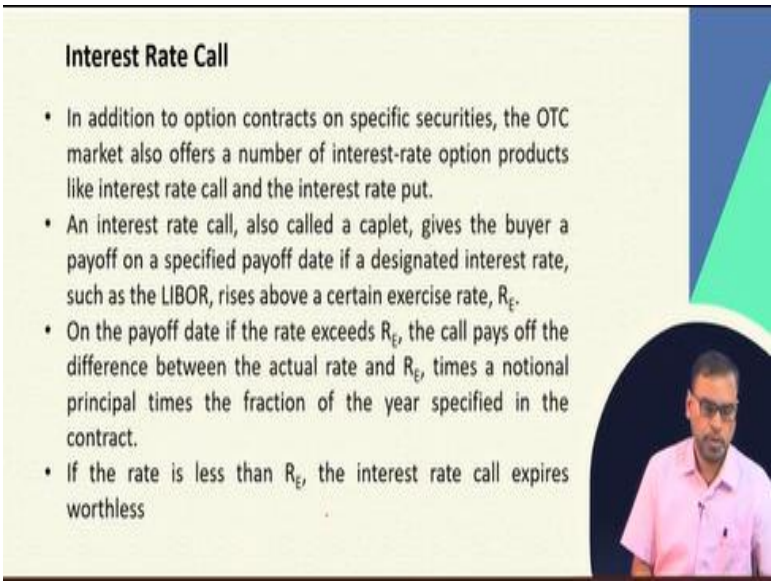

So, then another type of option also we see that is called the interest rate call. So, in addition to the option contracts on specific securities the OTC market also offer a number of interest rate option products like interest rate call and interest rate put. So, what do you mean by the interest rate call? The interest rate call also called the caplet, which gives the buyer a payoff on a specified payoff date if a designated interest rate such as LIBOR rises above a certain exercise rate that is exercise rate R_E.

So, on the payoff date if the rate exceeds this exercise rate that is R_E, then the call basically payoff the difference between the actual rate and R_E, times the notional principal times the fraction of the year specified in the contract. So, if the rate is less than R_E then the interest ratecall expires worthless. It is the same moneyness concept whatever just now we have discussed.

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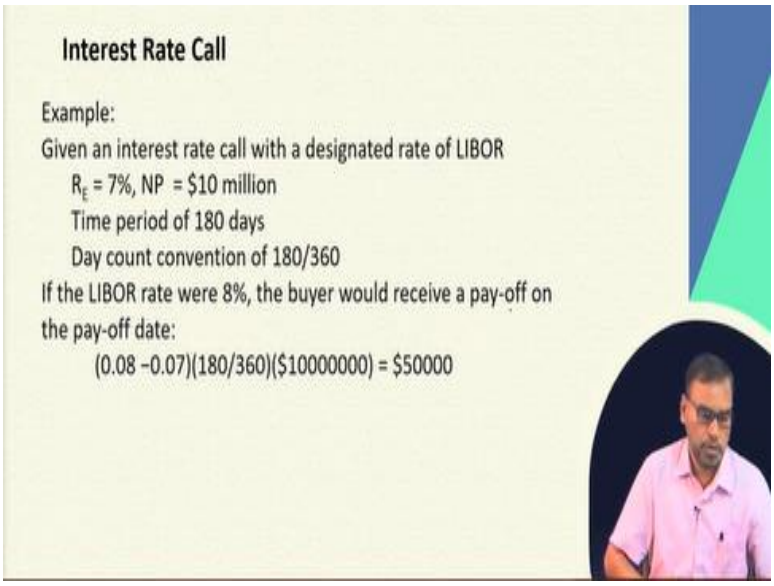

So, for example the interest rate call with a designated rate of LIBOR let R_E =7% notional principal is 10 million dollar. Why you would call it the notional? Because actual principal transaction is not taking place in this particular case. Let the time period is 180 days, day count convention is like 180 by 360. If the LIBOR rate were 8% then the buyer would receive the payoff on the payoff date and how much basically they will receive that is 50000.

How you got it? 0.08-0.07 into 180 by 360 into your 10 million dollar that will give you the $50000.

$(0.08\text{-}0.07)(180/360)(\$10000000) = \$5000.$

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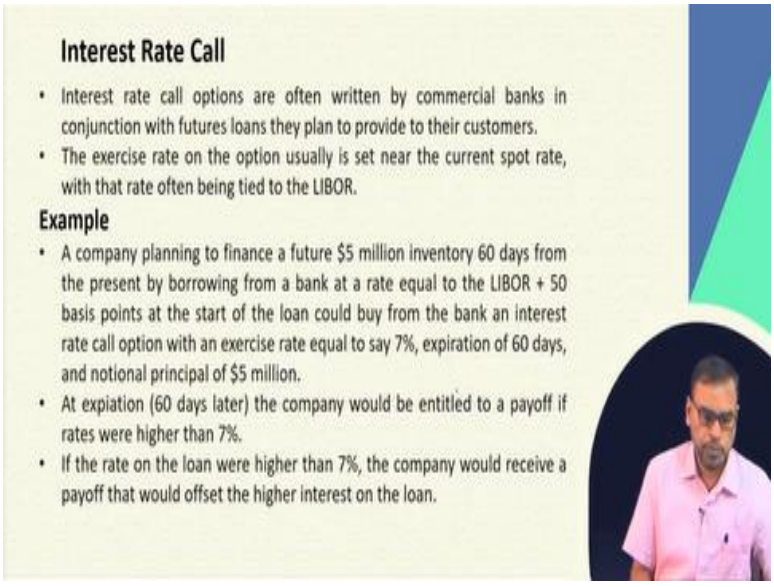

So, if the interest rate call options are often written by the commercial banks in conjunction with the future loans they plan to provide to their customers. The exercise rate on an option usually set near the current spot rate with that rate being tied with the LIBOR.

If you take example for example a company is planning to finance a future 5 million dollar inventory in 60 days from the present by borrowing from a bank at a rate which is equal to LIBOR+50 basis point at the start of the loan could buy from the bank and interest rate call option with an exercise rate let equal to 7% which is expiration of 60 days and the notional principal of the 5 million dollar. So, what expiration that when 60 days later the company would be entitled to a payoff if the rates were higher than 7%. If the rate on a loan were higher than 7% then the company would receive a payoff that would offset the higher interest rate on that particular loan that is basically the interest rate call.

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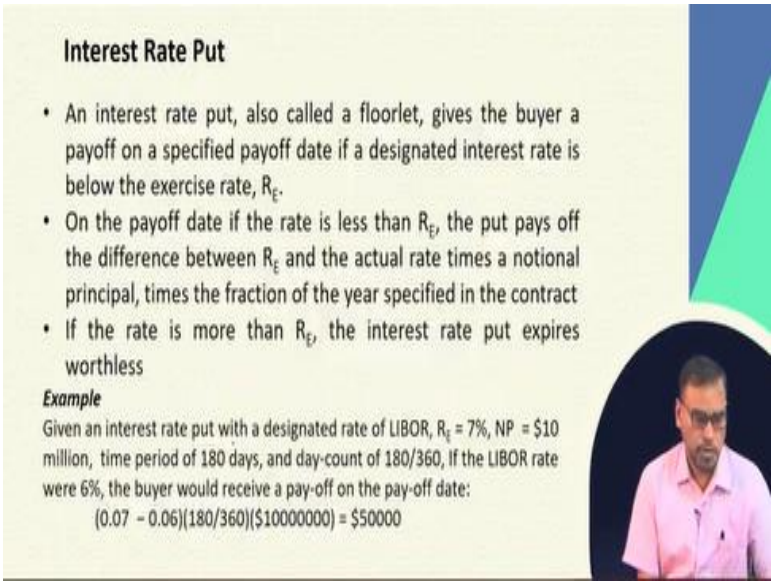

Then we have the interest rate put. So, interest rate put is basically called the floorlet. So, here it gives basically a buyer a payoff on a specified payoff date if designated interest rate is below the exercise rate it is just opposite. So, on the payoff date if the rate is less than R_E then the put payoff basically the difference between R_E and the actual rate times the notional principal times the fraction of the year specified in the contract.

So, if the rate is more than R_E then interest rate put options expires worthless that means option will not be exercised. So, if R_E for example 7% when NP is equal to notional principal is equal to

10 million, time period is 180 days and the day count convention is 180 by 360. If the LIBOR rate were 6% then the buyer would receive a payoff on the payoff date that will be your 50000 dollar. If this rate is more than that 7% then the particular put option will not be exercised.

The buyer would receive payoff:-

$$(0.07\text{-}0.06)(180/360)(\$10000000) = \$5000$$

So, the total option value will be zero in that particular case it will be worthless.

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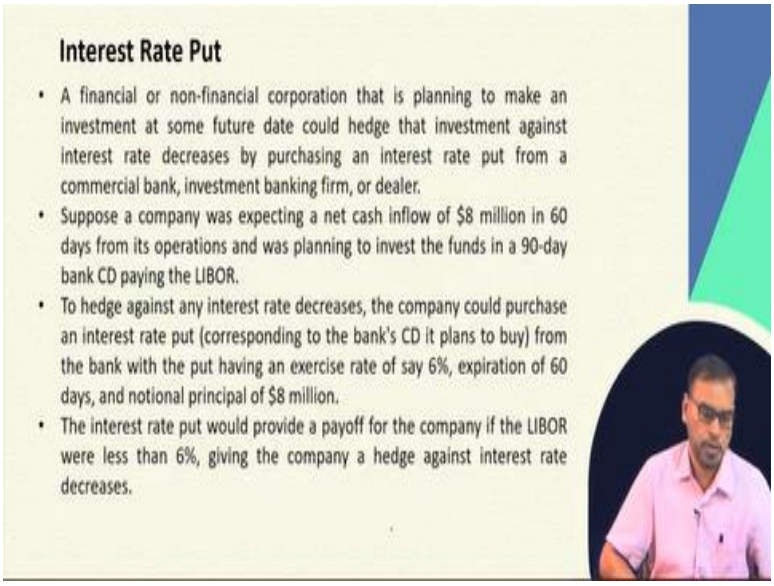

So, generally the financial and non-financial corporations who are planning to make an investment in some future date they can hedge that investment against their interest rate decrease by purchasing the interest rate put from a commercial bank or a dealer or from an investment banking firm. Suppose a company was expecting a net cash flow of 8 million dollar in 60 days from its operation and was planning to invest the fund in 90 day certificate of deposits paying the LIBOR.

Then to hedge the risk what they can do for to hedge against any interest rate decreases the company could purchase an interest rate put from the bank with the put having the exercise rate of 6% then expiration of 60 days for the notional principal of 8 million. If interest rate put were would provide a payoff of the company if the LIBOR rate was less than 6% then giving a

company hedge against the interest rate decreasing. So, that is what basically we call it the interest rate put.

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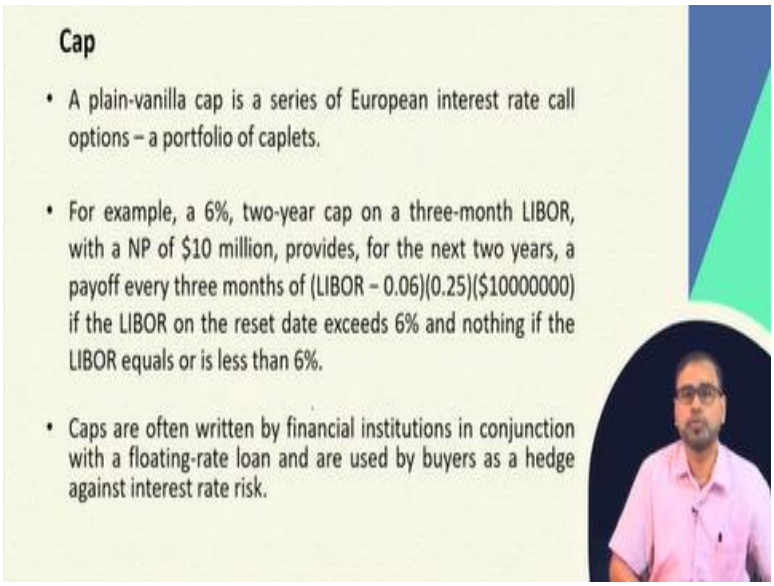

Then we have another kind of instrument always we look at that is called the cap. Cap is nothing but it is a series of European interest rate call options or a portfolio of the caplets. Just now we have discussed about the caplet and here the cap is nothing but a series of European interest rate call options.

For example, a 6%, 2 year cap on a 3 month LIBOR with a notional principal of 100 million provide for the next two years. Then a payoff of every 3 months of (LIBOR- 0.06) into 0.25 because it is quarterly then multiplied by the 10 million. If the LIBOR on the reset date exceed 6% and nothing if the LIBOR equals or less than this 6%.

Pay-off every three months= (LIBOR-0.06)(0.25)($10000000)

Caps are generally always written by the financial institutions with a floating rate loan and are used by buyers as a hedge against the interest rate risk. So, this is basically a series of the European interest rate call options.

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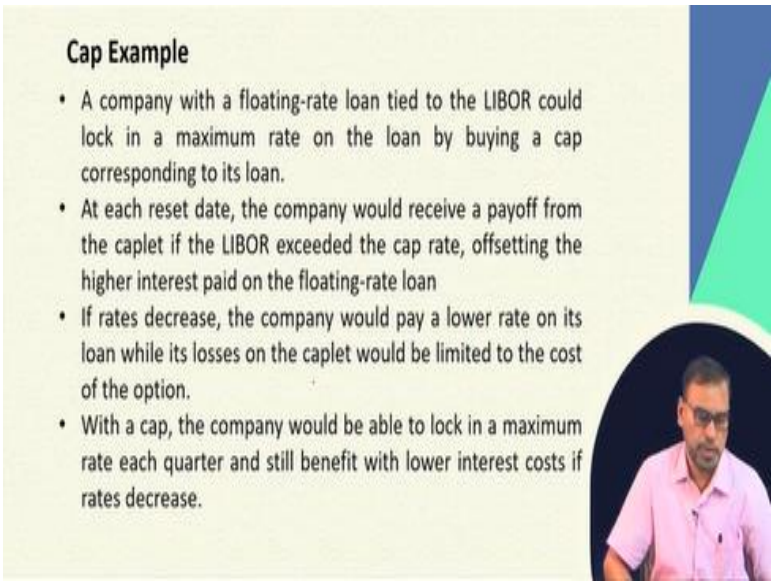

So, if a company with a floating rate loan let tied to a LIBOR could lock in a maximum rate on the loan by buying a cap corresponding to its loan. At each reset date, the company would receive a payoff from the caplet if the LIBOR exceeded the caplet offsetting the higher interest paid on the floating rate loan. If the rates decrease then the company would pay a lower rate on its loan and violate losses in the caplet and that would basically limit the cost of this particular option.

So, with a cap the company would be able to lock in a maximum rate each quarter and still benefit with lower interest cost if the rates are declining. So, that is the basic use of the cap.

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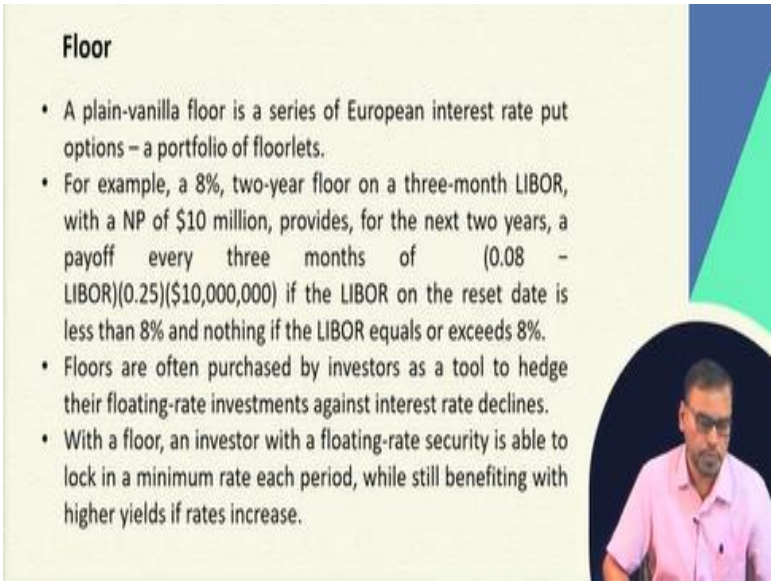

Then in the floor, the floor is nothing but as a European interest rate put options, it is a portfolio of the floorlets. And if you talk about let for example the eight percent two year floor on a three months LIBOR, with a notional principle of 10 million provides for the next 2 years then payoff every 3 months will be 0.08 - LIBOR into 0.25 into 10 million. If the LIBOR on the reset date is less than 8% and it will pay nothing if the LIBOR rate equal or exceeds 8%.
(0.08-LIBOR)(0.25)($10000000)

So, generally these floors are possessed by the investors as a tool to hedge their floating rate investment against this interest rate decline. So, with a floor the investor basically with a floating rate security is able to lock in a minimum rate each period while still benefiting with the higher else if the rates are increasing.

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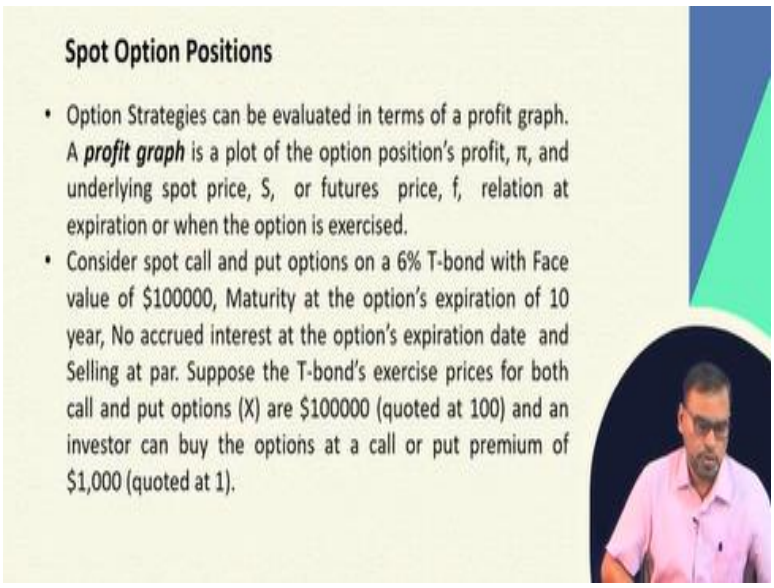

So, these particular option strategies or all kinds of things can be evaluated in terms of the profit graph. So, the profit graph is basically nothing but a plot of the option positions profit let we represent it at pi and underlying spot price let that is S and or the future price f. Generally, let you consider a spot call a put option at a 6% treasury bond with a face value of 100,000 dollar maturity at the options expiration for 10 year, no accrued interest at the options expiration date and selling at par.

Suppose the T bonds exercise price for both call and put options are 100,000 dollar quoted at 100 and that investor can buy the options at a call or a put premium of 1000 which is quoted at 1.

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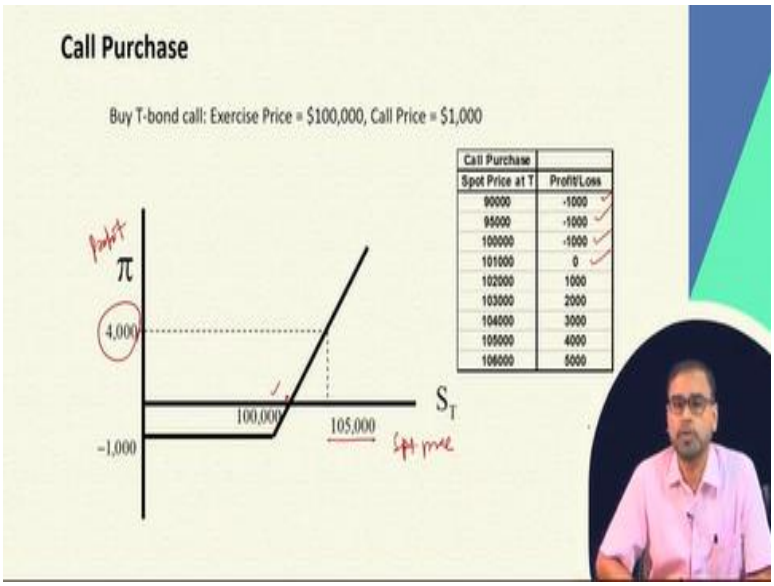

Then how the payoff diagrams basically look like. Let you are going for a purchasing a call. So, by the T bond call let with exercise price of 100,000 dollar then call price is 1000 dollar. Then this x axis basically represents your, this is your profit and this is basically your spot price. So, then if you see hundred this 1000 dollar you have paid at the premium that's why it is minus 1000 and this 1000 is basically your strike price.

So, depending upon the price change in the spot market the profit basically can be changed. So, let if you take the spot price is 105,000 then your total profit will be 5000, 105,000–100,000 that is 5000-1000 that will be 4000 is the profit. So, like that if you look at this particular table then depending upon the change in the spot prices the profit or loss of that particular contract or particular option is going to be changed.

So, if it is 101,000 there is no profit no loss that is zero so like that if you go on if it is exactly 1000 then already you have paid the premium that so it is minus 1000. So, everywhere it is minus 1000 the reason is that the option will not be exercised. If this scenario will arise but if the price is increasing then you will find that your profit is also increasing on the basis of the change in the spot prices of the market.

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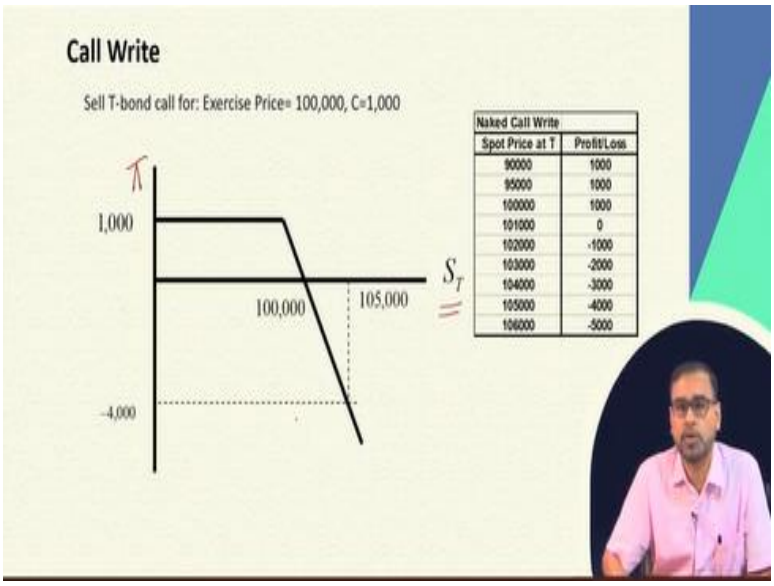

Like that if you go for a selling a call option then it is reverse that 1000 is the premium whatever basically you have received. Then depending upon that if you find that how the particular payoff or the profit can look like in that particular case. So, this is basically your pi, this is your spot price. Then accordingly your profit and loss of this particular kind of option like the selling the call option will basically look like.

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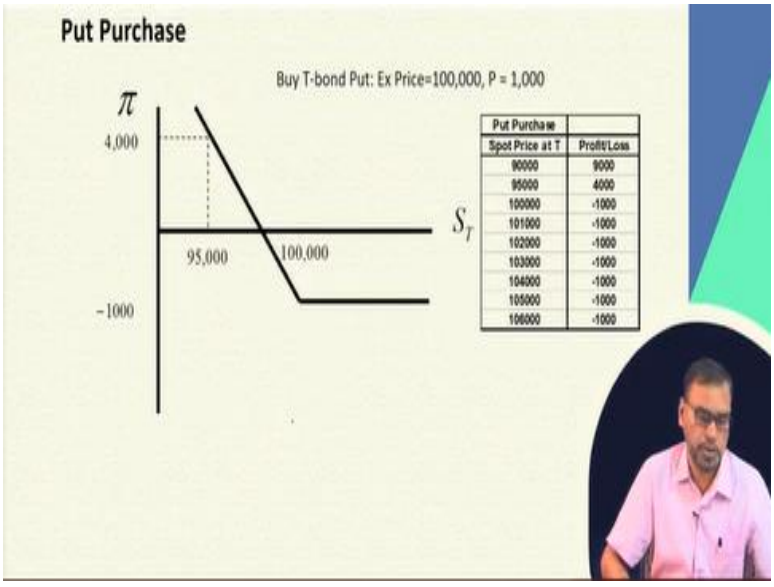

Like that you can go for the purchasing the put. So, if you go for a purchasing the put let buying the T bond put option exercise price is 100,000 and p =1000 mean that is the put price or the premium. Then you will find that depending upon the change in the spot price or the time T your

profit and loss is also going to be changed. So, this 1000 to the exercise price this is basically your current price.

If it is 95000 then already you are gaining total payoff basically 5000 and already 1000 is the premium what has been paid so your profit will be 4000. It is just reverse whatever way we have seen with respect to the buying the call option.

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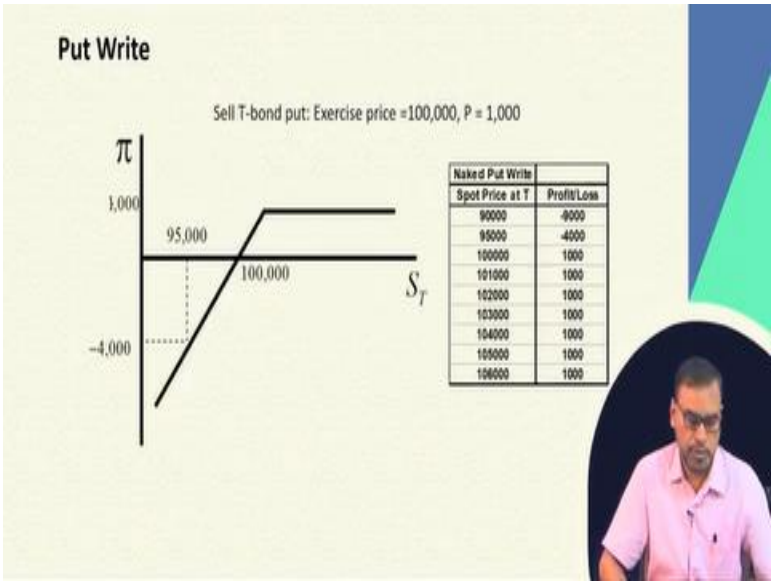

Then the same way you can also look at the payoff or the profit diagram of the selling a put option. You will find that the maximum profit you are gaining that is 1000 but the loss is basically changing on the basis of the change in the spot prices. So, this is basically the payoff diagram or payoff of the selling a put option.

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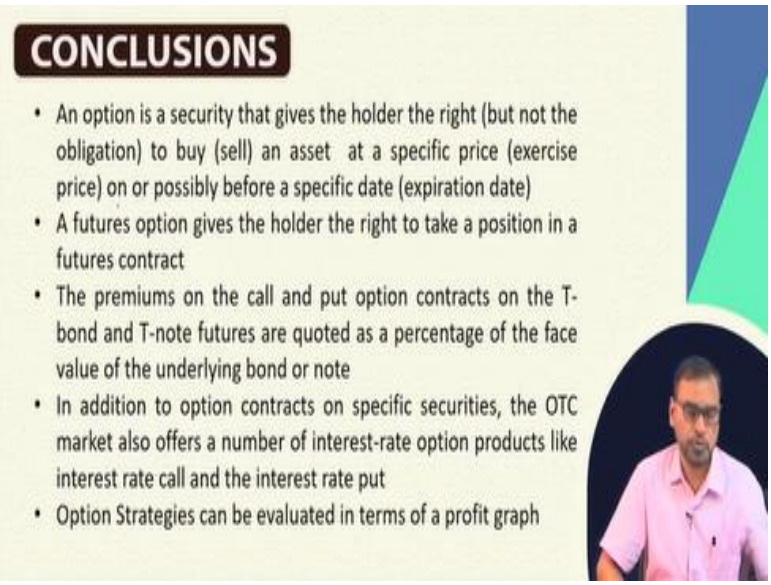

So, what basically we have discussed that, option generally is a security which gives the holder the right but not the obligation to buy or sell an asset at a specific price on or before a specific date which is called expiration date. Future options gives the holder the right to take a position in the future contract and the premiums of the call and put option contract on the T bond and T note futures are always quoted on a percentage of the face value of the underlying bond.

And the OTC market also offers a number of interest rate options like interest rate call and interest rate put and the option strategies can be evaluated in terms of the profit graph and depending upon the change in the spot prices your profit and loss basically will change.

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So, these are the references you can look at. Thank you.