Quantitative Investment Management
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Lecture 33
Derivatives, A Recapitulation

Welcome back so today we start a new segment of this course, so far we have been talking about fixed income securities, bonds and so on, today we start derivatives. I had given a brief introduction as to what derivatives are and what are the various types of derivatives right at the beginning of this course, we shall quickly recap the definitions and then we shall move on to the nuances of derivatives and the applications of various types of derivatives.

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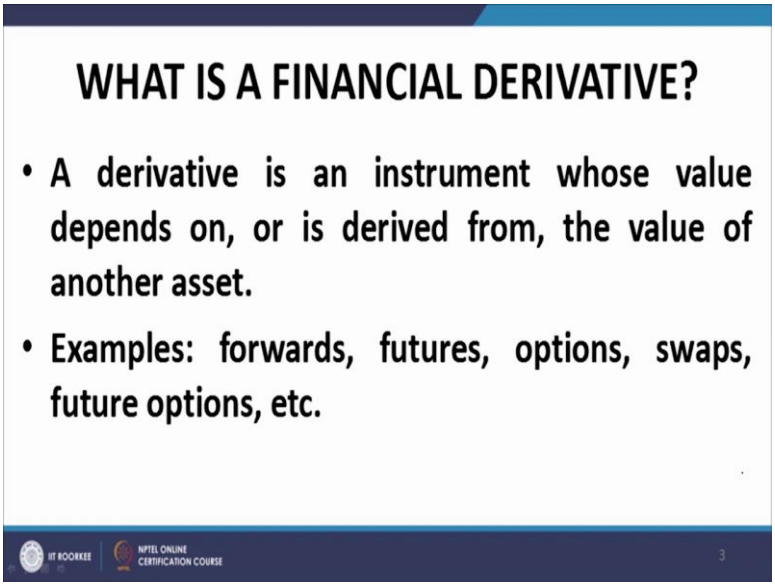

So let us start with defining a financial derivative, a financial derivative is an instrument whose value depends on or is derived from the value of another asset, for example we have forwards, we have futures, we have options, swaps, futures options and so on, so basically when we talk about the financial derivative we are talking about a financial instrument whose price process, in other words or whose value process depends on another asset the value or price of another asset which is called the underlying asset.

There is a functional relationship between the price or value of the underlying asset and the price or value of the derivative asset and that derivative as that is called the financial derivative.

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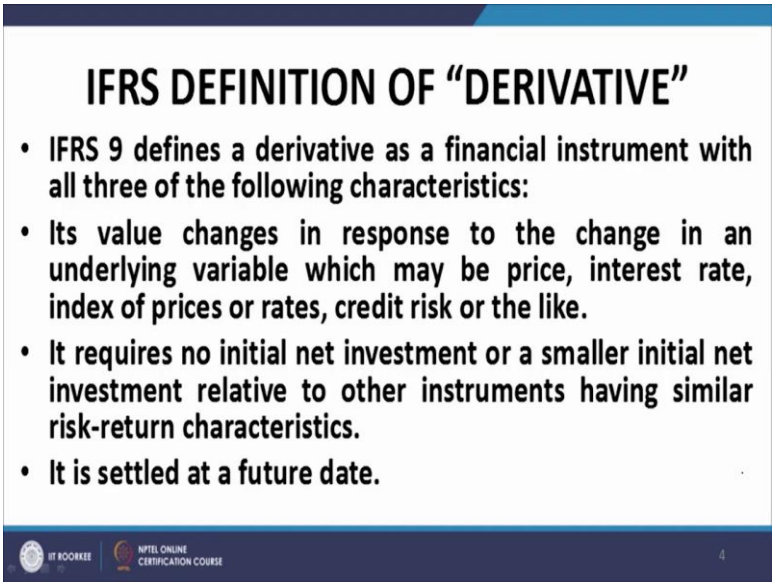

IFRS definition of derivative for the sake of completeness I have put it in this presentation so let us quickly read through it, IFRS 9 defines a derivative as a financial instrument with all three of the following characteristics, so all the three characteristics are mandatory, number 1 its value changes in response to the change in an underlying variable which may be price, which may be interest rates, which may be indices of prices or interest rates as well or credit risk or similar such parameters.

It requires no initial investment or a smaller initial investment relative to other instruments having similar risk return characteristics, it is settled at a future date, so these are the three fundamental prerequisites for a financial asset, for a financial instrument to be recognized as an IFRS financial derivative or as a financial derivative under the provisions of the international financial reporting standards.

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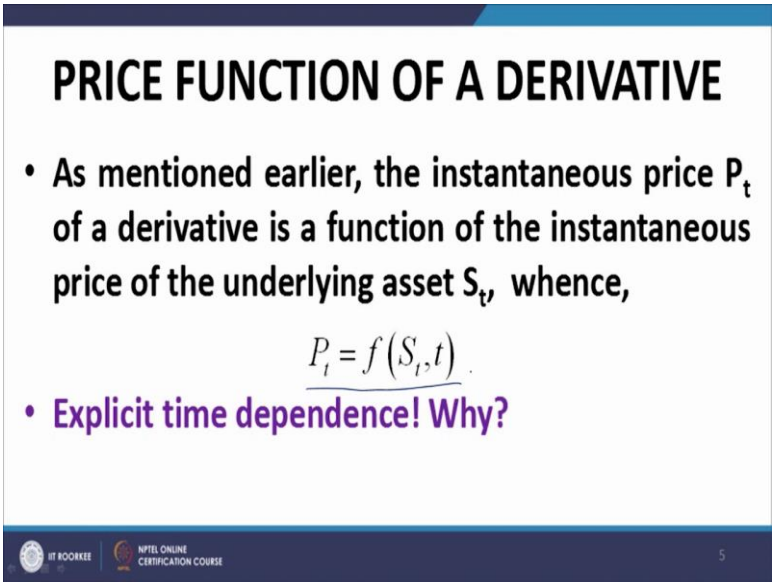

As I mentioned the price function of a derivative the very definition of a derivative is that this price function or its value function is a function of the price or value of another asset and therefore we can express the price function of a derivative in the form of this equation where P t is the price of the derivative at an arbitrary point in time t and it is a function of S t, S t is the value or price of the underlying asset at time t and it, the explicit dependence on time is also recognized the reason for that I will come to in a minute.

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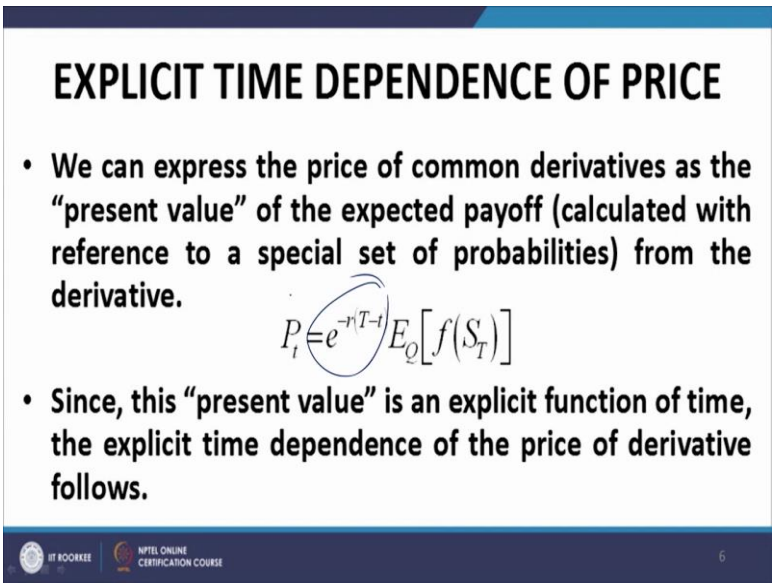

Explicit time dependency when we actually work out the value of a derivative or the price of a derivative we find that we can express the price just as in the case of the bonds that when

we worked out the intrinsic value we can also write down the price function or the price of a derivative in terms of the present value of future cash flows, what future cash flows the expected payoffs from the derivative with the expectation being calculated with respect to a special set of probabilities which are called risk neutral probabilities and the details of which we shall be discussing it in a later point in this segment when I talk about the evaluation and pricing of derivatives.

But basically the important thing at this point is that the derivatives, the pricing of derivatives or the price of derivatives entails the factor of present value and because it entails a factor of present value it incorporates a factor of present value the explicit time dependence is apparent.

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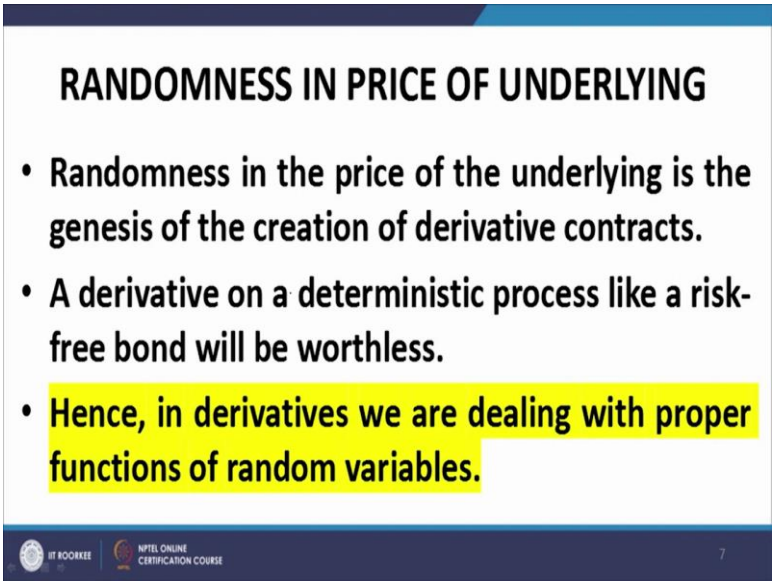

And then there is one more issue which I would like to clarify at the outset and that is in so far as the randomness on the price of the underlying, if the underlying has no randomness embedded in its price, in other words if the price evolution of an asset is deterministic that is at t equal to 0 at any arbit or at any arbitrary point in time we can precisely predict the path that the price process of the instrument is going to follow then there is no point in writing a derivative contract on such kind of instrument.

Because the derivative will have a functional relationship with a deterministic variable and that means because the function itself is also deterministic that means that value of the derivative or the price of the derivative will also follow a deterministic evolution and that makes us useless for the purpose for which it is envisaged.

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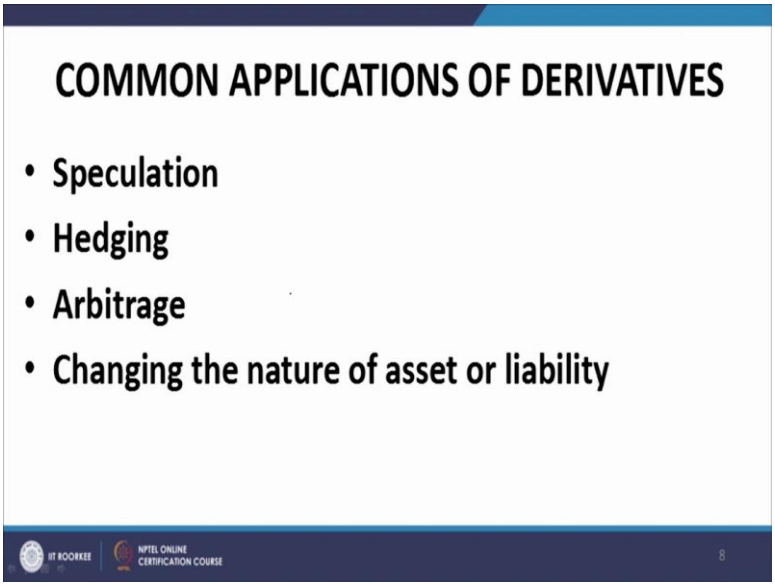

Common applications of derivatives we have speculation where we take an open position in derivatives and then try to project or predict forecast the price evolution of the derivative and if our evolution turns out to be correct contrary to what the market believes we tend to make profits or we tend to make significant profits that is if our estimation, if our expectation of the price at a future date turns out to be correct the markets expectation which is incorporated in the existing price turns out to be wrong then we tend to make or we are likely to make profits this struck, this attempt to make profits out of uncovered positions is called speculation.

Then we have hedging where we have an open position and we take a position in the derivatives to remove the element of risk in that open position so that when we have the combination of the open position and the hedge in other words we have the hedge structure that hedge structure becomes insulated from the impact of market fluctuations or from the impact of the stimuli that could cause price changes in the open position.

So you have an open position which is subject to price, which is subject to value changes corresponding to market stimuli you take a position in the derivative to protect yourself against the impact of that market stimuli on the open position and as a result of which your open position gets insulated in terms of the price and the combination of the hedge and the open position becomes protected from the market stimulus which in the absence of the hedge would have influenced the price or value of the open position and that is called hedging, I shall take concrete examples at later points in time I want to simply run through whatever has

been discussed earlier and then move into the nuances and the intricacies of the various aspects of derivatives.

Arbitrage we are very familiar with, we have been encountering the process of arbitrage throughout the almost the entire set of lectures that we have done so far basically it is the taking advantage, it is the siphoning of or the extraction of profits when an asset is priced differently in two different markets with identical risk profiles, changing the nature of asset or liabilities usually we use swaps to change the nature of an asset or liability for example the most popular type of swaps are interested swaps which are used for changing the, changing a fixed rate in, fixed interest rate liability to a floating interest rate liability or vice versa.

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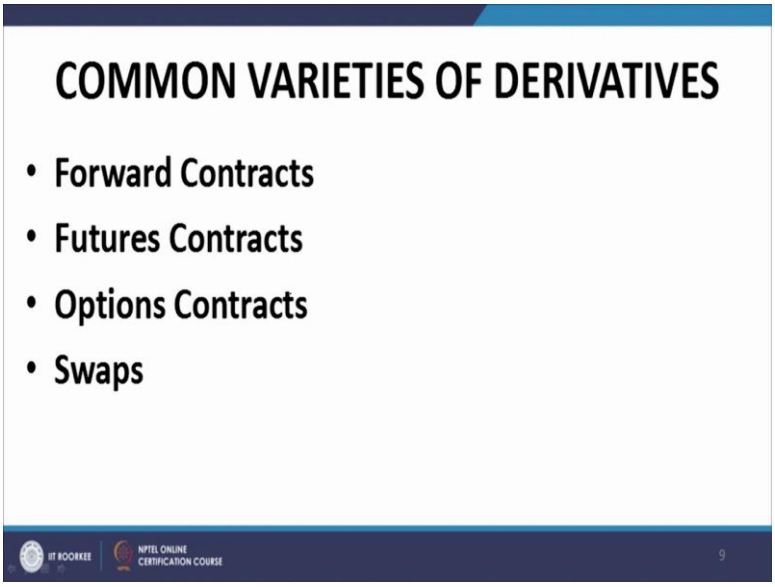

Then common varieties of derivatives we have forwards, futures, options and swaps and then we have combinations of derivatives like futures, options, forward contracts as I have been mentioning several times, a forward contract is a contract which is entered into, which is agreed upon, which is negotiated at t equal to 0 but the actual settlement of the contract occurs at a future date, the price of settlement, the price that settlement the item to be delivered against the settlement, the mode of delivery, the quality of the item, all the issues that relate to the unambiguous settlement of the contract are agreed upon at t equal to 0.

But the actual settlement is postponed to a future date at that future date is also agreed upon at t equal to 0 and that constitutes the maturity of the forward contract, so let me quickly read it out, forwards are customized contracts negotiated today that is t equal to 0 at today's agreed price and other terms of delivery, so everything that warrants consideration, that warrants agreement for an unambiguous settlement of the contract is done at t equal to 0 but the actual settlement occurs at a future date which is called the maturity of the forward contract and which is also agreed upon at t equal to 0.

However, the settlement of the contracts takes place on a specified future date t equal to capital T usually we denote the maturity of the instruments whether they be fixed instruments or derivatives by capital T so capital T represents maturity usually the settlement date is also agreed today so that is important, also the date is at a later date but the what date the settlement is to take place is agreed upon at t equal to 0.

Cash flow occurs in the future, no cash flow occurs at t equal to 0 except margins if mandated by either party and agreed upon by the other party you see please note this point that these are customized contract so because they are customized contracts the two parties negotiate the terms of the contract and if one party feels that in order to protect itself it needs to prescribe a certain amount of margins say 10 percent or 15 percent or whatever on the other party it can it is free to do so provided the other party agrees to it.

And if it is agreed the manner or fulfillment of this margin clause will also be agreed upon will also be negotiated and agreed upon at t equal to 0, usually it takes the form of either a cash deposit or of FDR pledged in favor of the second party by the first party, so since forwards are private contracts they are susceptible to default risks, so this is important forward contracts because there are contracts between two private parties there is the element of possibility of default, either party defaulting on its commitment into the forward contract.

And that means what, that means that the other party also has a choice to impose the necessary restrictions as for example I mentioned the case of margins so to minimize or to protect itself or to compensate itself in the event of default by the first party.

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Then we have futures contracts, futures are similar to forwards however they are tradable and at futures exchanges so that is the fundamental difference forward contracts are customized contracts they are not tradable freely they can be assigned from one party to another but to a third party but with the consent of the other party to the contract assignment without consent will not be allowed all the provisions of the contract act in relation to assignment need to be followed when a forward contract is assigned.

However in the case of a futures contract the situation is different what happens is that the futures contracts are freely tradable on exchanges which are instituted for this particular purpose, so futures are similar to forwards however they are traded on future exchanges since futures are exchange traded they need to, they need to be standardized and they need to be default free standardization is required in order that these contracts have adequate liquidity in the market.

And they need to be default free as well because if there is an element of risk embedded in for futures contracts the trading will be inhibited considerably the parties willing to wanting to take up positions will be reluctant to do so because of the subjectiveness of the risk content incorporated in the futures contract and as a result of which the trading is structured in such a way that the element of default risk is virtually eliminated.

In fact this is done by creating an intervening party between the two legs of the futures contract which happens to be the clearing house of the exchange so each futures contract is split up into two parts one part is between party a and the clearing house the other part is between party b and the clearing house and the clearing house guarantees the performance of the other party's leg of the contract and as a result of which a is guaranteed performance of b by the intervening clearing house and similarly b is guaranteed performance of a by the intervening clearing house.

So the cleaners guarantees the performance and that removes the aspect of default risk from the contract and enables and facilitates the uninhibited trading of such contracts on the exchange, so to enable trading the exchanges clearing house guarantees performance of both legs of these contracts and these contracts carry negligible default risk, the exchange protects itself by imposing margins and marking to market.

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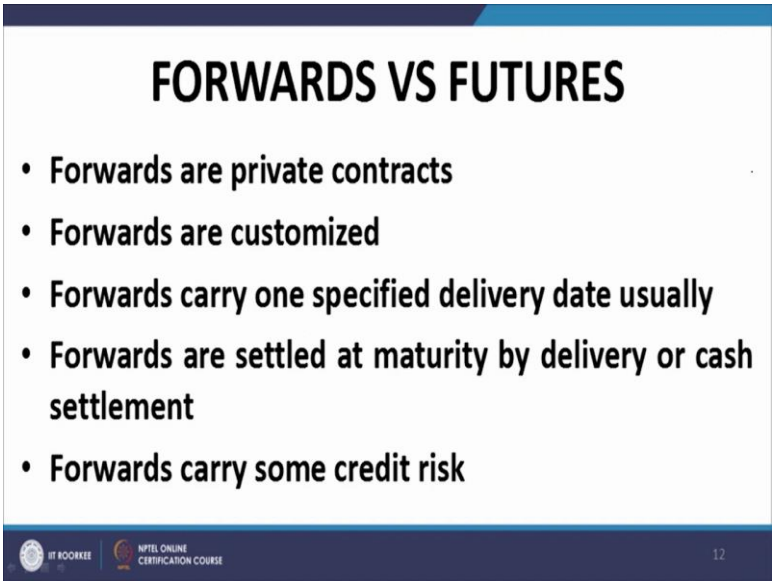

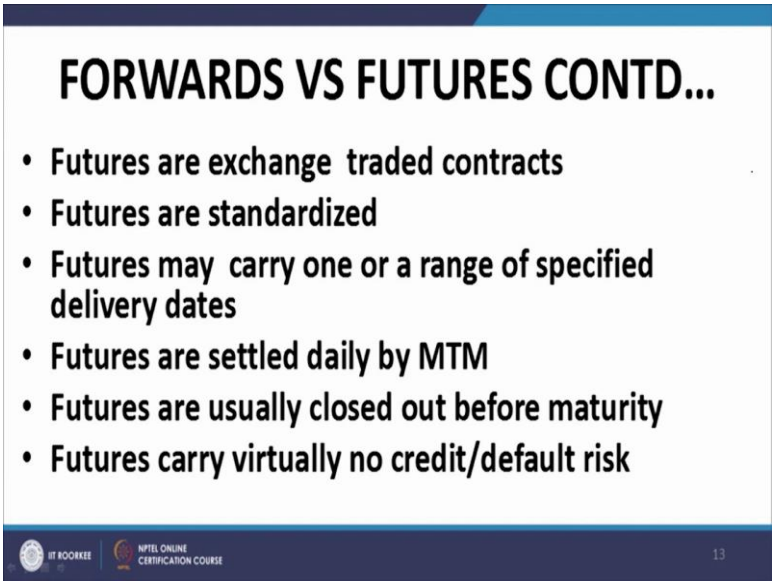

Forwards versus futures, basically both these contracts end with such delivery of an asset at a future date at a price which is agreed upon at t equal to 0 that future rate is called the maturity however forwards are customized futures are exchange traded and there are some other differences which we shall go through quickly, forwards are private contracts forwards are customized as I have mentioned just now, forwards usually carry one specified delivery date, forwards are settled at maturity by delivery or cash settlement forwards carry some defaulters this also I have mentioned.

In the context futures are exchange traded, futures are standardized, futures may carry one or a range of specified delivery dates, futures are settled daily by marking to market, I shall explain this process at a later section, futures are usually closed out before maturity, usually closed out not necessarily closed out, futures carry virtually no default risk.

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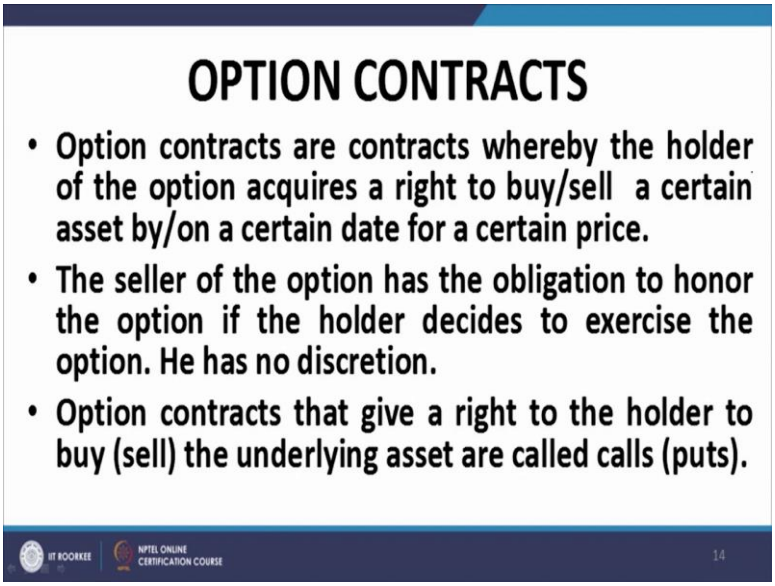

Then we talk about option contracts, option contracts are slightly different from forwards and futures, option by its very name means discretion means choice means prerogative means privilege, so again we have two parties to the option contract party a and party b however under the option contract both are not equally placed party a or one of the parties who buys the option has a right as a prerogative as a privilege party b has the obligation as the commitment arising out of the privilege or the prerogative to party a.

Let me repeat, we have two parties a and b, party a has a privilege, it has a prerogative, it has a discretion and on account of this discretion party b has an obligation, party b has a commitment, if party a decides to exercise that privilege, exercise that obligat, exercise that prerogative, party b is obliged to honor his leg of the contract, party b has no discretion, party b has no prerogative, it simply has the obligation the choice is party a's, if a decides to exercise the option, exercise the privilege, exercise the prerogative, party b must honor its leg of the commitment.

Now what could be the substratum of the contract, the substratum could be either the right to buy an asset at a predetermined price, at a price which is incorporated in the option contract or the right to sell an asset at a predetermined price which is again incorporated in the option contract, again I mentioned the all the important features like the quality of the asset, the mode of delivery, the price of the asset with the option can be accessed, other terms of delay, all the constituents and are required for an unambiguous settlement of the contract are mentioned in the option contract, you cannot have an ambiguous option contract, all the

issues that relate to the settlement of the option contract should the option holder decide to exercise the option all the things that are required for unambiguous settlement are incorporated in the option contract.

But the settlement occurs at a future date, today you agree upon the various terms of the option, the price at which the option will be exercised, the underlying, the quality of the underlying, the mode of delivery and everything you all these things we agree at t equal to 0 the maturity of the option which is the point at which the option will be exercise the nature of the option all these things are agreed upon and then on maturity as the case or up to maturity as the case maybe I will come back to this point, the actual settlement takes place if party a who is bought the option decides to access the option, party b must honor his leg.

And if party a decides not to exercise the option then party b goes scot free, so that is, this is the fundamental feature of the option, so let me now read it out, option contracts are contracts whereby the holder of the option acquires a right to buy oblique sell a certain asset by or on a certain date for a certain price.

Let me repeat this, option contracts are contracts whereby the holder of the option acquires the right to buy oblique sell a certain asset by or on a certain date for a certain price, so there are two issues here number one is buy, number two is sell, it can either be an option to buy an asset at a predetermined price or it can be an option to sell an asset at a predetermined price, in the first case it is called a call option, in the second case it is called a put option.

The second is by or on, if the option is exercisable on a particular date it is called a European option, if it it exercisable up to a particular date then it is called a American option, the seller of the option has the obligation to honor the option if the holder decides to exercise the option he has no discretion, that is the fundamental feature, the two parties to the option contract are not on the same pedestal a has a right, b has the obligation, so that is the fundamental difference.

In contrast to this forward contract or futures contracts can tell equal obligations on both the parties, both party a and party b must satisfy their obligation under the futures or the forward contract and that is not the case in the case of options, options one of them has a right and if a exercises that right b has the obligation if a does not access the right b goes scot free, so option contracts that give a right to the holder to buy the underlying asset is called a call

option, the where the option holder has the right to sell the underlying asset it is called a put option.

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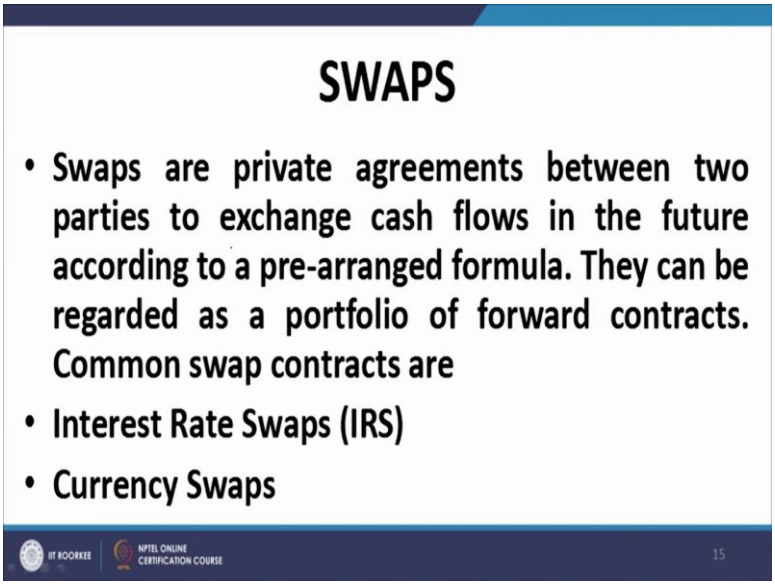

Then we have swaps, swaps are privatized agreements between two parties to exchange cash flows in the future according to a prearranged formula, they can be regarded as a portfolio of forward contracts, common swap contracts are interest rate swaps and currency swaps, so basically swaps are an exchange of cash flows the methodology of the computation of the cash flows that are to be exchanged between the parties who have entered into the swap contract is agreed upon in the swap contract and is also pre agreed, it is agreed at t equal to 0 it is agreed at the point then when they enter into the swap contract and thereafter at periodic intervals in terms of the issue document or the swap document both the parties exchange cash flows.

The typical example is the interest rate swap where one of the parties decides to pay, decides to receive say a floating rate interest stream and pay a fixed rate interest stream and the other party does the converse that is pay the floating rates stream and receive the fixed rate stream and that is a typical example as well, basically it involves exchange of cash flows, how those cash flows are computed is mentioned in the swap formula, is mentioned in the swap document and it is agreed at t equal to 0 and the cash flows are therefore thereafter exchange at periodical intervals in terms of the swap document.

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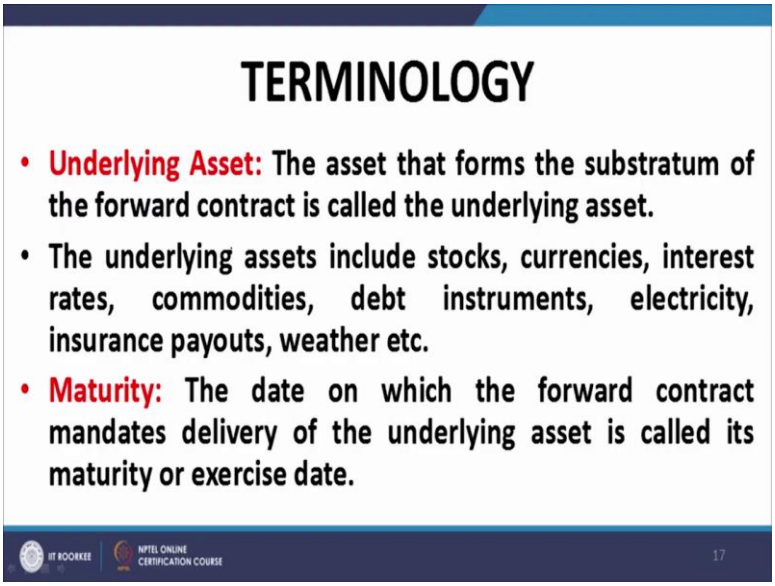

Now let us talk about forward contracts in detail, so quick terminology underlying asset, the asset which forms the substratum of the forward contract is called the underlying asset, in other words the asset that will be sold or bought under the forward contract is called the underlying asset, the underlying assets include stocks, it includes currencies, it includes interest rates, we have been talking about forward rates in a lot of detail in earlier lectures.

It can be commodities as well rice, maize, wheat and so on, debt securities, it can be electricity as well, insurance payouts whether these three are gradually assuming prominence in fact there are futures contracts on electricity on weather which are quite common in the United States, maturity, the date on which the forward contract mandates delivery of the underlying asset is called the maturity or the exercise date. So the date of settlement of the forward contract is the maturity date but please note this fundamental point the date of settlement is not ambiguous it is agreed upon at t equal to 0.

Long and short positions, underlying asset, now long and short positions can be described or can be related to the position of the instrument for example if you are talking about long in the underlying asset, you are talking about owning the underlying asset, you are talking about having the possession and the ownership of the underlying asset if you are talking about shorting the underlying asset you are talking about the borrowing of the underlying asset.

Long position in a forward contract, the party who buys the asset under the forward contract is said to be long in the forward contract, the party wish to deliver the asset under the forward contract is called the short party in the forward contract, similarly in the case of the option the

party who buys the right to exercise the option the who buys the option, who has the prerogative, who has the privilege is said to be long in the option, the party was given this prerogative, was given the right, who has the obligation, who does not have the right, who has transferred the right to the to the long party shared to be short in the option is also called the option writer.

The a part is called the option holder, b part is called the option writer, a part is said to be long in the option, b part is said to be short in the option so the a part is said to buy the option, b part is said to sell the option.

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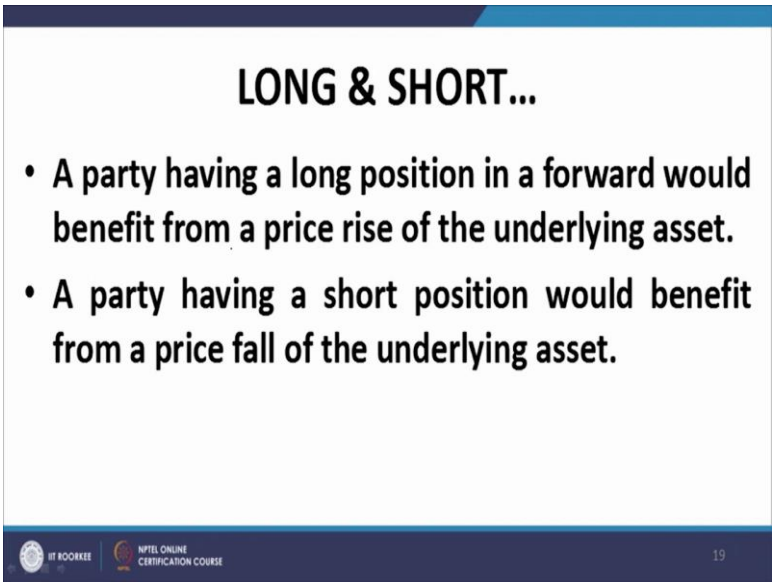

A party having a long position in a forward would benefit from a price as of the underlying asset, naturally if the price of the underlying asset rises the party was long in the forward contract with benefit, why would he benefit, well he would benefit because increase, he could buy the asset under the forward contract at the pre agreed price and if the price of the asset has gone above the pre agreed price he could sell the asset in the market and get the profit differential as the profit.

Let me take a concrete example, suppose you have a forward contract whereby you are buying 1000 US dollars at INR 70 at the end of one year say 31st December 2022 now if the price as on 31st December turns out to be 90 that means you could buy the 1000 dollars at 70 from the counter party to the forward contract and then you could sell it in the market at 90 thereby getting a profit of 20 per dollar.

Now as the price being 100 you would have made a higher profit at the price 1000 you would have made even a higher profit and so on, so higher the profit of the underlying asset in this case US dollars higher is the profit made under the forward contract, higher is the benefit to the long position and a party having a short position would obviously benefit from a price fall, you see it is basically a zero sum game, long position and short positions are zero sum game. So if one of the parties gets a profit under the long, under the say long position it must result in a loss to the short position and vice versa.

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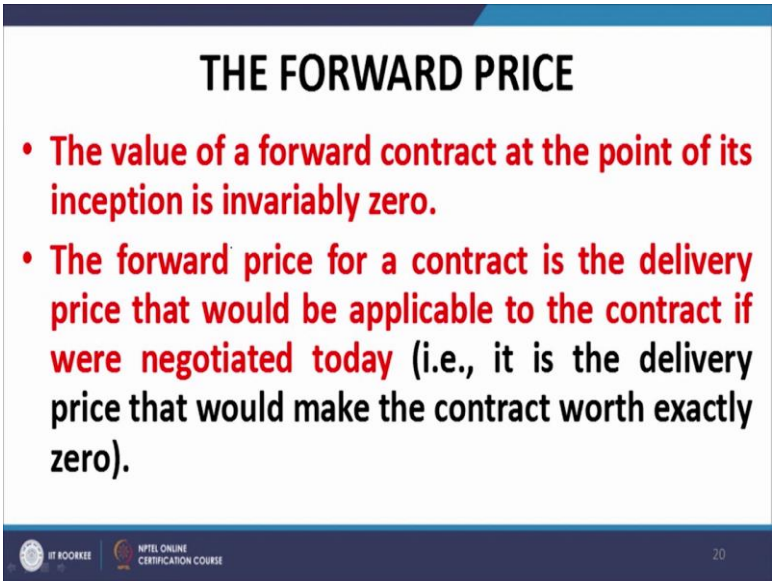

The forward price, the value of a forward contract at the point of its inception is invariably zero, now this is a fundamental principle and the learners need to keep track of it at the point at which the forward contract is agreed upon, not settled, its agreed upon, it is negotiated, the value of the forward contract is taken as 0 it is scale to 0 I repeat, at the point at which the forward contract is agreed upon it is negotiated, it is finalized, the value of the forward contract is 0.

And the price which is incorporated in the forward contract at which the underlying asset will be delivered on the date of maturity of the forward contract and the price will be paid on the maturity of the forward contract is called the forward price, let me repeat, at t equal to 0 you agree on a forward contract and the value of the contract is 0 the price that is the part of the contract at which the settlement is envisaged on the date of maturity of the futures contract by delivery of the underlying asset is called the forward price, so please note the difference between the value of the contract and the forward price.

The forward price is the price that is incorporated in the forward contract which will be paid on the date of settlement in receipt of the underlying asset, the value of the forward contract is the composite worth of the contract as a whole, this issue will be clarified in more detail as we talk about the valuation of a forward contract after inception but please note at the point of inception the value of a forward contract is 0.

The forward price for a contract is the delivery price that would be applicable to the contract if it was negotiated today so if you are the point at which you are negotiating the contract, the point at which you are agreeing the contract, the price that forms the part of the forward contract that is called the forward price that is the delivery price that would make the contract worth exactly 0.

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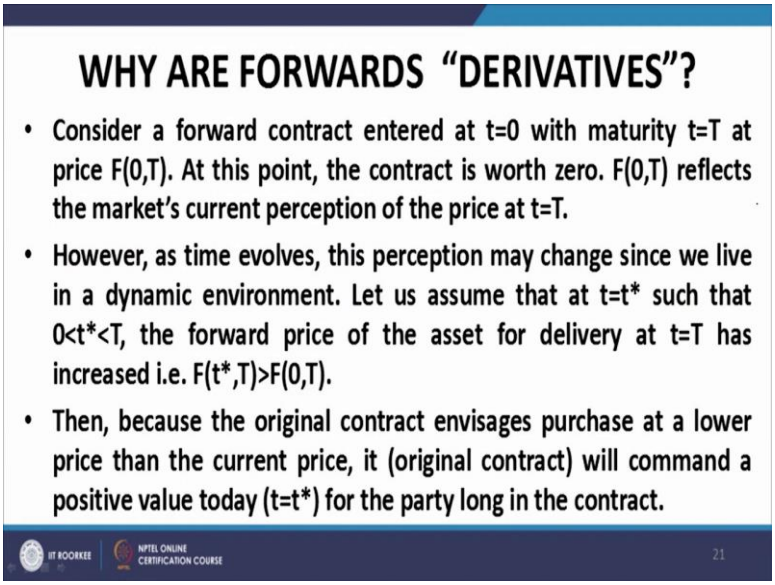

Why are forward derivative? Now this is a very interesting point, at the outset prima facie level you may feel that forward should not be derivatives because the value is known up front and how can we have a change in value when you know the forward price at t equal to 0, the price that you are going to pay for the US dollars and the number of US dollars you are going to receive if both of the things are agreed at t equal to 0 for maturity then where is the uncertainty, where is the issue of the derivative coming into play.

But the issue is a bit subtle, you see let us say at t equal to 0 you agree to buy 1 US dollars from, you are a and you agree with b that you will buy 1 US dollar at 31 12 2022 for rupees 75 you will pay INR 75 and you will buy 1 US dollars from a party b, now what happens is at

the point of inception of the contract the value of the contract is 0 that as I mentioned just now.

At the point where you agree that you will pay 75 rupees and a will give you 1 dollar on 31 12 2022 the value of the contract is 0 but as time passes, we live in a dynamic world, the price process of the US dollars will mandate that the prices change, they follow some sort of a stochastic process, a random process at every point in time the price of the US dollars in terms of INR will have a random component and as a result of it cannot be perfectly predicted.

Now let us assume that say 3 months down the line let us say at t equal to 1 4 2022 the price of US dollars for a forward contract which has maturity on 31 12 2022 is 90, remember the price of US dollars for maturity 31 12 22 as on January 1 was 75, now we have moved over to April 1 2022. Now what we find is the dollars have become dearer the perception of the market has changed, market fees that the value of dollar as in 31 12 2022 will not be 75, it will be 90.

Now because you as a holder of the forward contract will still get the US dollar on 31 12 2022 for INR 75 not INR 90 therefore as on 1 4 2022 you are holding or you are long position in the forward contract would carry a certain price or carry a certain premium because to any, to a person who enters into a forward contract on 1st April 2022 he has to pay 90 rupees for getting 1 US dollars on 31 12 2022 but you because you are entering the contract earlier by virtue of that contract you will get the same dollar at 75 on 31 12 2022.

So therefore your position has a premium compared to a party who is freshly entering into a forward contract and therefore that long position carries the value similarly that is the short position will carry a negative value, so as time flows because of the perception of the forward prices or future prices of the underlying asset what happens is that the contract acquires a non-zero value and may acquire a nonzero value.

It is not necessary that it will definitely acquire a nonzero value but there is certainly the chance that it may acquire a nonzero value and therefore if we say that it is a derivative, it is a function of the forward price of the underlying asset, that is the reason that we call forward contracts as derivative contracts. I will continue in next lecturer, thank you.