Financial Derivatives & Risk Management
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Module 1: Financial Derivatives & Risk Management
Lecture 1: Overview of Derivatives

I welcome you all to this course on Financial Derivatives and Risk Management. This course is conducted by IIT Roorkee under the NPTEL Program and I shall be talking in detail about various aspects of financial derivatives in this course. Financial derivatives are sometimes termed as the wild beast of finance. It is a very interesting nomenclature. The interesting part is that financial derivatives have been held responsible for a number of scandals that have rocked the financial markets. Several debacles have been attributed to the misuse or the use of financial derivatives.

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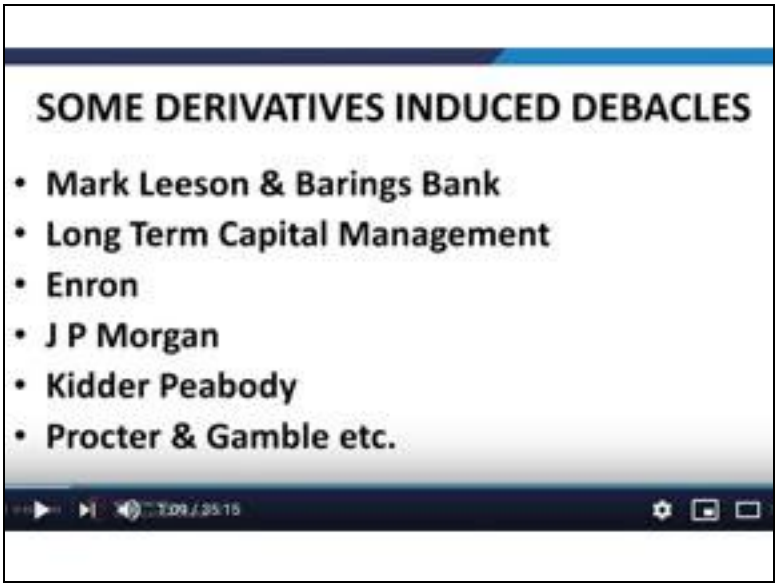

Some of the common ones are listed on the screen. The Barings Bank scam occurred in 1995 and literally took the financial markets by storm. We had the Long Term Capital Management scam. The Enron debacle is also partially attributed to the valuation of derivatives. JP Morgan, Kidder Peabody, Procter & Gamble are some other instances where financial derivatives have been responsible for catastrophic losses of the entities concerned.

But the more interesting part is, the intriguing part rather is, that despite all this, let us look at the growth in operations in financial derivatives, the growth in trading volumes in financial derivatives over the National Stock Exchange of India.

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These financial derivatives were first given the go ahead for trading on the NSE in June 2000 by SEBI and in a span of about seventeen years, the derivatives market has shown trading volumes far exceeding the cash market. Against a cash market volume of 72 lac crores or so in 2017-18, derivatives markets have been something around 17 crore crores.

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So what is it? On the one hand, these derivatives are held responsible. The debacles are attributed to these financial derivatives and on the other hand, notwithstanding this, the growth in trading volumes has been exponential, I think phenomenal. Derivatives enjoy a massive application spectrum. I shall be talking about this application spectrum as the course goes on.

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A brief touch on the milestones that have arisen in regard to the Indian markets. As I just mentioned, the derivatives started trading on the Indian markets in June 2000. Thereafter some of

the other salient or significant dates in relation to financial derivatives trading in India are listed. June 2001: trading of Equity Index Options started at NSE. July 2001: trading of stock options started and in 2002: Single Stock Futures started at BSE and Interest Rate Futures also started trading in 2003.

So we shall be exploring more about financial markets. I shall be talking more about financial derivatives. The proposed spectrum of this course is three-pronged. I shall be discussing the fundamentals of financial derivatives, following it up with the pricing and valuation of derivatives and finally touching upon the application of derivatives in various aspects, in relation to various entities that use financial derivatives.

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The utility of this course - well this course is immensely valuable. It is immensely useful for people who plan to enter or who are already working in the financial services industry. Be it banks, stock brokers, stock exchanges, commodity exchanges, portfolio managers. Corporate finance executives will also find it useful to broaden their spectrum of knowledge. Financial risk management is now becoming an integral part of corporate policy even for manufacturing companies. So people in finance need to be acquainted with the methods and mechanisms of managing risk. Academicians will also benefit because it will provide them with a gateway to work in related areas.

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The recommended text, well, Hull's book is probably a classic - John Hull, Options Futures and Other Derivatives. This is the global edition of Pearson Education. This forms the substratum of this course. It is a wonderful text. You can supplement it by Neftci's book on Financial Engineering. There's also a book by Cuthbertson that is also titled as Financial Engineering. These three books serve as a wonderful package when you want to know more about financial derivatives. Of course, the extent of literature available is gigantic.

But talking about literature, the literature in financial derivatives can broadly be segmented into two aspects, two packages rather. One of them is essentially oriented towards the mathematically literate audience. That is, people who have got a thorough grounding in mathematics. It deals in the mathematical underlyings of financial derivatives at a very sophisticated level using probabilities, stochastic processes, theory of probability measures and so on. It is far too deep for a management graduate, for example, to comprehend.

The other set of books is probably much too superficial. The focus is essentially on the trading aspects of derivatives, the underlying mathematics is given a go by and these two segments are by and large mutually exclusive and cater to their respective sets of audiences. That is where the USP of this particular course needs a mention.

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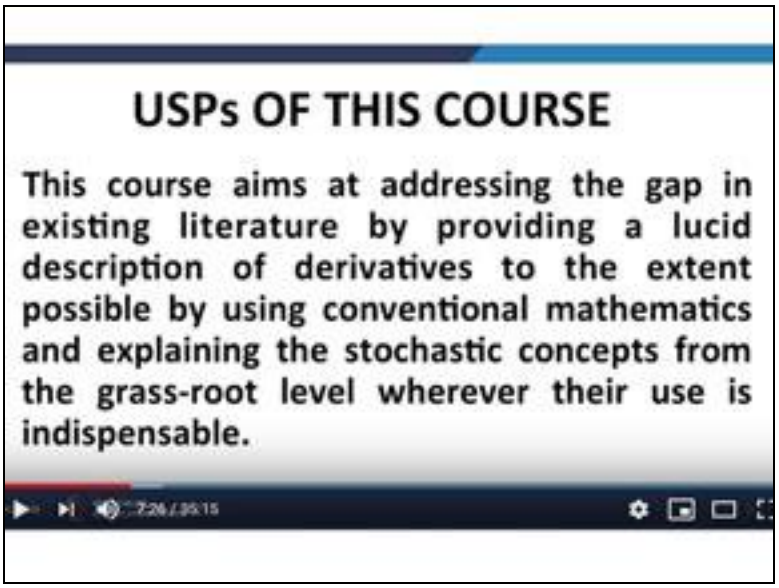

I do not propose to forego the mathematical content just because it is too technical. Mathematics will be used but at a level which is assimilable to a senior school student who has got an exposure of mathematics at that level.

Wherever advanced mathematics is indispensable, the concept will be started from the grassroots level. So a basic acquaintance with calculus, with probability distributions, normal distributions, concept of moments, mean and variance and so on are expected at least at the level of the senior school. The rest I'll build upon as the course requirement mandates.

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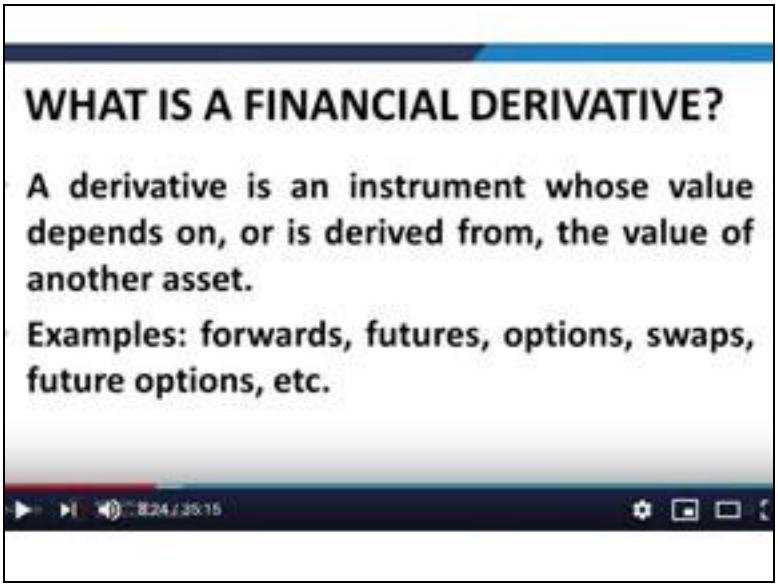

So let us start. Having talked about the pre-requisites and the literature and so on, let us get down to what exactly is a financial derivative. Financial derivative is a derivative and a derivative means its price or its price process is derived from the price process of something else. The price process is a function of something else. That means what? That means that there exists some independent variable and the price process of the derivative depends on that as a function of that particular independent variable. That independent variable can be a stock price, that can be commodity price, that can be an interest rate, that can be a price index; it can be anything.

$$P_t = f\left(S_t, t\right) \tag{1}$$

That independent variable is given a name. It is called the underlying. So the derivative is an instrument whose value depends on or is derived from the value of another asset which is called the underlying asset. Common forms of derivatives, well, we have forwards, we have got futures, options, swaps, futures on options, we have got many other types of derivatives, swaptions, variants of these. Options in themselves have a mass spectrum of variety. Futures also, we have got interest rate futures, commodity futures, we have got currency futures and so on. I shall be talking about the underlying principles that cover each of these instruments.

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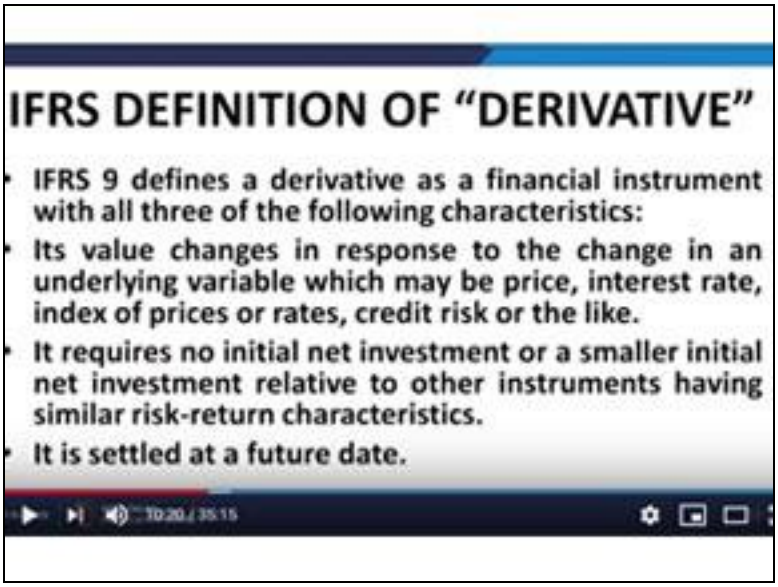

The accounting definition of derivative is more or less similar. It is contained in the International Financial Reporting Standards, Standard 9, IFRS 9. And it defines derivative in context of what I mentioned just now. The derivative is a financial instrument whose value changes in response to a change in the underlying variable. In addition, there are two more characteristics which are imposed by this particular definition. They are - the investment at the inception of the derivative contract is either nil or is very small in relation to the payoff envisaged by the derivative on maturity. And the final thing is that the derivative is usually settled at a future date. The derivative is negotiated as of today, it is settled at a future date.

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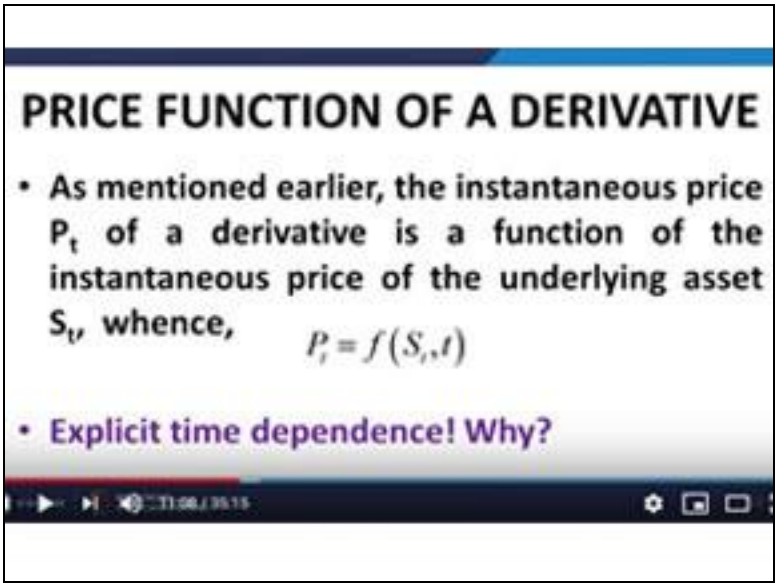

Now as mentioned the price function of a derivative is a function of the underlying, so we can write the price function as a function of the underlying, we shall normally use the stock as symptomatic of the underlying asset. So P_t is a function of the instantaneous spot price or stock price and the explicit dependence of time as well, which I have not mentioned so far.

$$P_t = f(S_t, t) \tag{1}$$

So the question is, from where does this explicit dependence on time come into play?

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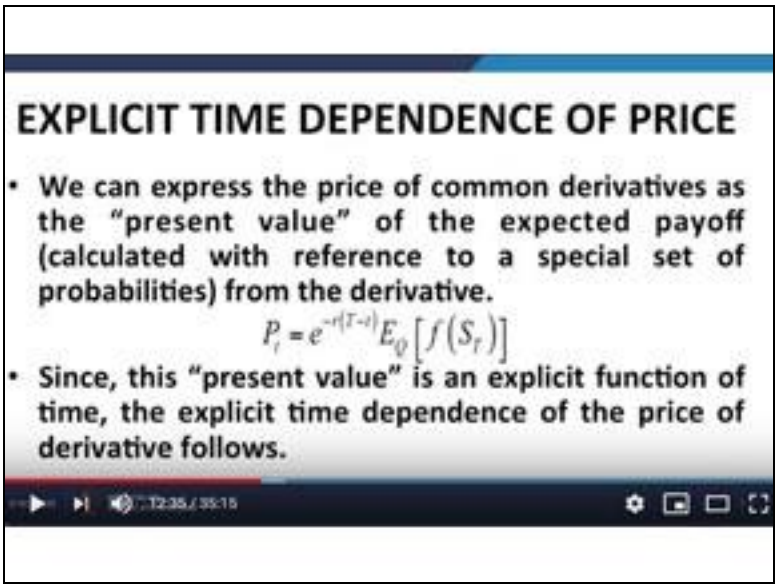

Well the answer is simple. Most of the financial instruments, when they are valued or priced, they contain an element of present value in them. Prices are the present value of future cash flows that are attributable to the particular instruments, rather, the present value of expected future cash flow:

$$P_t = e^{-r(T-t)} E_Q \left[f(S_T) \right] \quad (2)$$

The expectation may be calculated with reference to different probability measures, maybe not the conventional probability measures that we talk about in everyday life. But nevertheless it is a probability measure by which we calculate the expected value of the payoff.

But the more important and the more relevant thing here is that the price is the present value of that expected value. And when the present value comes into play, present value is obviously a function of time. As time passes, present value changes.

Therefore, the functionality of the explicit dependence of time is explained in the price equation. The implication of this explicit dependence on time is also that even if the price of the underlying asset remains unchanged, the value of the derivative will change in response to the passage of time. That is another implication of the explicit time dependence as I mentioned earlier.

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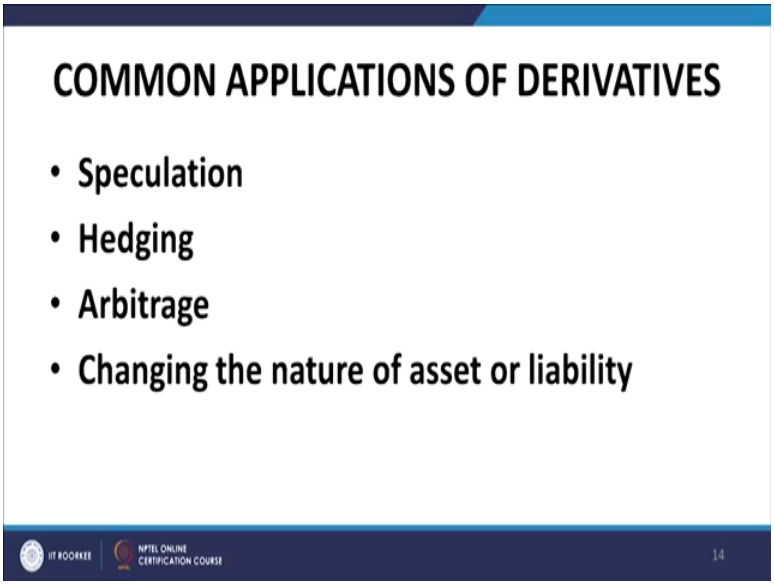

Now applications of derivatives, well, there are a host of applications of financial derivatives but they can be grouped under certain headings. Speculation - well, speculation, most of the viewers would be familiar with. You hold an asset with a perception different from the market. And as a result of which, if your perception materializes, you make a profit by holding the asset or by taking a short position in the asset which I shall explain later on.

But the basic thing is - you take a position in the asset with the perception that your forecast for the price of the asset is different from the market's forecast and if your forecast materializes, then you tend to make a profit or you benefit from your perception being realized in contrast to the market's perception.

Hedging - is probably the most important application of financial derivatives. Hedging is the concept of trying to reduce your financial risk. Suppose you are exposed to a certain stimulus, for example the market price. You have a portfolio and that is affected by the BSE Index for example, or you want to go abroad for study for which you need a certain amount of US dollars at the end of three months from now, you are influenced by the changes in exchange rates.

These kind of exposures you may be facing and you want to find a mechanism whereby you can protect yourself or you can reduce the influence of the stimulus, for example the exchange rate or the market price of stocks or BSE index in relation to your exposure. You want to be insulated,

you want to be immunized against fluctuations, the extraneous fluctuations over which you have no control. Derivatives help you in doing that.

Arbitrage - well, basically arbitrage is a concept that a commodity cannot enjoy two different prices at the same instant in identical situations. In other words, in the context of financial instruments or financial assets, a particular asset is a bundle of a risk return tradeoff. It is represented by a point in two dimensional space with the risk axis and the return axis. Let's ignore the measurement aspects but basically X-axis is usually (usually) taken to represent the risk and the Y-axis is usually taken to represent the return. And financial assets are represented by a point in this risk-return two dimensional space.

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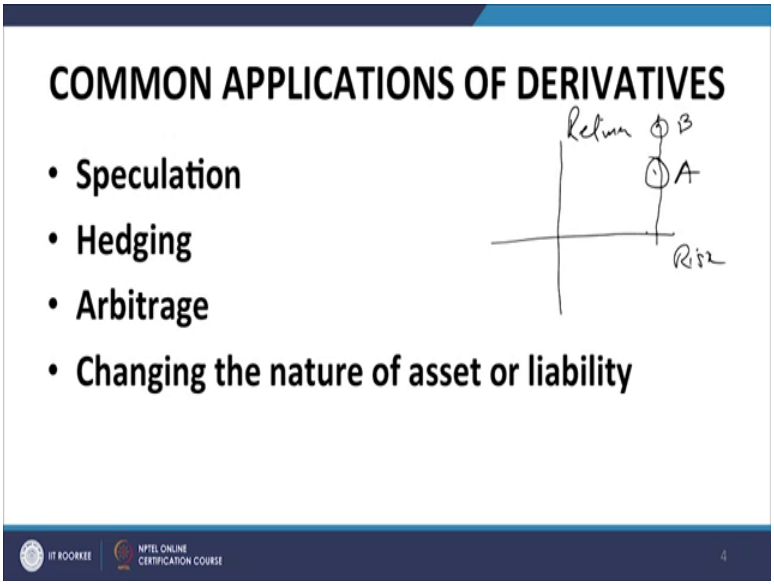

Now, if there are two assets that give you the same return, for example, in risk return space. Let any asset, let us say A, be represented by a point in the risk-return space. Now if you have another asset with the same level of risk - now this is very important, it has to have the same level of risk. The same level of risk but it gives you a higher return. Let us say that it is an asset B. So because it has the same level of risk, it lies in the same straight line. Now, then what will happen is because B is having a higher return than A, people will throng to buy the asset B and try to sell the asset A. This will increase the demand for the asset B and will reduce the demand for the asset A.

Assuming that the supply of these two assets remains unchanged, what will happen to the price? The price of B will increase and the price of A will decrease because B's demand is increasing. More people are going to buy asset B. And as a consequence of the increase in price of B and the reduction of price of A, the returns on B will fall and the returns on A will increase. And in equilibrium, what will happen is, these two points will move towards one another and will coincide. Of course, we are ignoring transaction costs and other market frictions in this explanation.

Then coming back to this, financial derivatives are also useful in adjusting or manipulating the nature of the asset or liability. For example, if you have a portfolio which is related to market index, for example the SENSEX or whatever, BSE index. You can modify that relationship. You can increase the relationship or you can reduce the relationship. You can also make your portfolio immunized from the market index by using suitable stock index derivatives, stock index futures.

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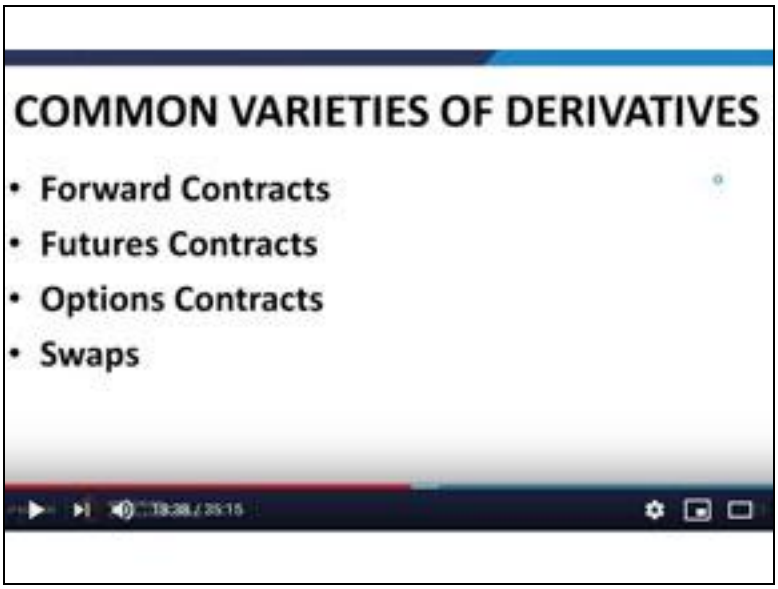

Common varieties of derivatives I've already mentioned. We've got forward contracts, we have got futures, we have got options and swaps. So, let us take these up one by one.

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Forward contracts are contracts that are negotiated today. Let us say today is t=0. So these contracts are negotiated at t=0. These contracts are agreed upon at t=0. The price and other terms of delivery are agreed upon at t=0. But the settlement of the contract, the delivery of the underlying asset and the payment of the price is scheduled to a future date, let us say t=T. This is called (t=T) the maturity of the forward contract. And the price embedded in the forward contract is called the forward price.

So t=0 is when the forward contract is conceptualized. It is negotiated, it is instituted, it is formalized at t=0. The settlement, the conclusion of the contract takes place at t=T. In between the interval 0 to T, there is no cash flow. And even at t=0, there is no cash flow unless the parties agree to a margin requirement. You may approach your banker for a forward purchase of US dollars which you want to send to the university in the United States. So for that purpose, the bank may say - okay deposit 15% margin money in Indian Rupees as a condition because we are not so convinced about your credit worthiness so we want a margin of 15%.

So that margin may be an outflow for you, it may be in the form of a fixed deposit or whatever the bank requires. But the basic thing is other than that, in relation to the forward contract there is no cash flow at t=0. There is no cash flow between 0 and T. You will make the payment in Indian Rupees at t=T and the bank will give you dollars at the same time t=T. Both the cash

flows are synchronized and they will occur at t=T. But the terms of the contract, particularly price and delivery conditions are agreed as of today.

Another important feature of forward contracts is they are customized. They are not traded on any exchange. They are customized, they are tailor made, you can approach your bank and you and your banker can enter into a forward contract. These contracts may be assigned with the consent of the party, the other party, but other than that, they cannot be freely traded. They are not freely traded. That is very important. That is a very important feature which distinguishes them from futures contract. I will come to that in more detail later. But for the moment for all practical purposes, they are not tradable in any form whatsoever.

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Futures contracts, as I made a passing reference just now, are very similar to forward contracts. But the futures contracts are traded. They are traded in exchanges setup for this purpose. There are futures exchanges like we have NSE. NSE has a futures & options wing. And futures contracts are traded on the NSE futures and options wing. They are regularly traded. Now, what does it imply? Because futures contracts are traded, we immediately have two fundamental requirements that they have to meet. First of all, they have to be liquid. Liquid means there should be sufficient numbers of buyers and sellers in this futures contracts at any point in time.

And that means what? That means that this contract must be standardized. If these contracts are not standardized, let us say we have a futures contract for 2,342 dollars, will you be able to find a

counter party who is willing to buy a contract having 2,342 dollars exposure? It is very unlikely. So we need to have a certain standardization inbuilt in futures contracts not only in terms of value but also in terms of the quality of the underlying asset to be delivered. We also need to have standardized delivery conditions, standardized in terms of the value of the underlying asset, the number of units of the underlying asset.

And by the way, there is one thing which is very important which I would like to emphasize at the beginning of this course because it will crop up again and again. See at the macro level, the price of a commodity, any instrument whether it is a derivative or whether it is an underlying instrument or any commodity, in fact, is determined by the forces of demand and supply. The pricing that we talk about in our financial literature is basically the value as determined by certain criteria, for example, the no-arbitrage condition which we will be talking more about. But at the overall level, at the macro level, it is the collective wisdom of all market players that determine the price of any asset.

Okay so futures are exchange traded. Futures are not customized. They are exchange traded and because they are exchange traded, they are standardized. They are standardized in terms of the number of units of the underlying asset, they are standardized in terms of the quality of the asset to be delivered, they are also standardized in terms of the delivery timings and so on.

There is another very important feature. Forward contract is a contract between two parties - you and your bank. So it is the two of you who have to assess the credit worthiness of each other and assess the possibility of default between yourselves. You have to worry about default by the banker in honoring his leg of the forward contract and the banker also has to worry about default on your part in honoring your leg of the contract. Because the banker also has to make commitments based on your forward commitments and you also have to do the same thing.

Anyway, so the important thing is, being a contract between two parties, it is these two parties who and who only are responsible for assessing the default risk of the contract, of the forward contract. However, when we look at futures, futures are readily tradable. Now futures can only be readily tradable if the element of default risk is eliminated from them, is removed from them, is siphoned off from them. Because if the default risk remains, it inhibits the trading of the futures. People would be reluctant to enter into futures market for trading.

So that is another important feature that the exchange has to ensure in order to enable free flow of trading of futures contracts. And how they do it, we will talk about it in detail but they do it. And the mechanism is called marking to market supported by a suitable margining system. Marking to market on a daily basis supported by a suitable margining system, these two together literally wipe out the possibility of default and as a result, for all practical purposes, futures contracts are deemed to be default free.

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So a brief recap. Forwards versus futures, forwards are private contracts, they are customized, they usually have one delivery date because they are customized and forwards are usually settled at maturity through cash settlement. Forwards, obviously, as I mentioned earlier may carry some credit risk. In fact, as far as the delivery is concerned, the parties among themselves, can decide whether to have cash settlement or physical settlement. Physical settlement means the underlying asset will be delivered on maturity of the contract. Cash settlement means what? Cash settlement means the difference between this spot price on the maturity date and the forward price will be given in cash and settlement will be concluded.

So in effect, it could come to the same but in case of commodities and other instances where delivery entails a certain amount of cost, they may not be equivalent. They may not be congruent. Also as far as forwards are concerned, the conditions can be tailor-made between the

two parties. They can decide on various things as per their own requirements and there is nobody to intervene.

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Futures on the other hand, as I mentioned, are standardized and they can have a range of delivery dates, they carry the process of marking to market, that is MTM, they also have a margining system in play. The two together are salient to futures contracts. Futures contract may be closed out before maturity. In other words, today I may buy a future, the maturity of the future may be four months, I may like to dispose it off or take a counter-position and cancel my original position at the end of three months when my exposure matures.

For example, if I have to pay US dollars at the end of three months, I may hedge it by longer-maturity futures and I may decide to lift the hedge at the end of three months notwithstanding the fact that the life of the futures may be more than three months. It may be four months, six months or so on. In other words, the futures need not be carried by an individual up to its maturity. Forward contracts by their very nature are carried by the parties up to maturity.

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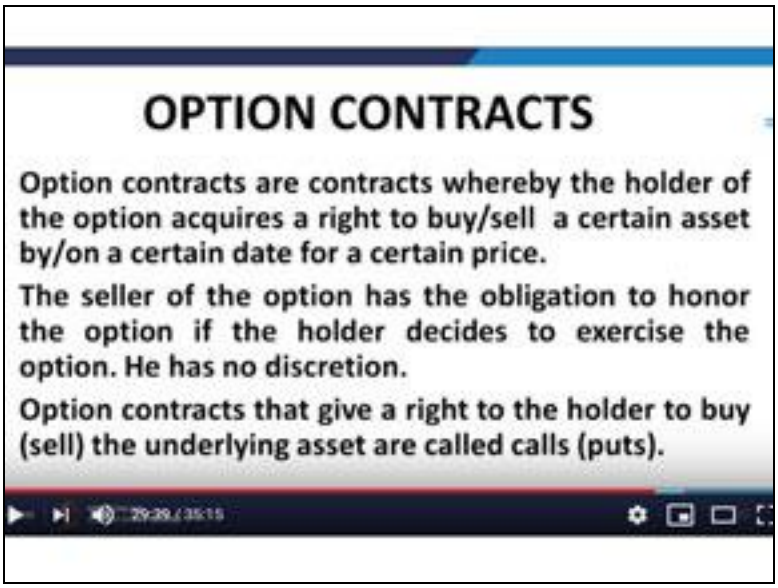

Options contract -Now this is another derivative contract. Option contracts are slightly different from forward and futures contract. What is an option? Option means choice. Option means discretion. So option contracts have an element of discretion in them, an element of choice in them. What is that choice? They give the holder of the option, the person who has bought the option contract, a right. The person who has bought the option contract has the right, right to what? Right to buy the underlying asset, the substratum of the contract, at a price which is specified in the option contract.

Or he may have a right to sell the underlying asset at a price which is specified in the contract, at a particular date or till a particular date. As I said in the beginning, there are a host of options, there is a multitude of varieties of options, variants of options but the basic options are options that give you a right to buy which is called a call option, an option which gives you a right to sell, called a put option.

Now, the important fundamental feature of an option contract is the option. It has the right, it does not have the obligation. In other words, the person who holds the option has the discretion as a choice whether he wants to exercise the option or whether he wants the option to lapse. He may do nothing and the option will lapse with passage of time. He can also allow that to happen. He may, on the other hand, decide that he wants to exercise the option and as a result of which buy the asset at a particular price which is embedded in the option contract.

But what about the other party to the option (the option contract involves two parties X and Y)? If X is the holder of the option, there must be some other party who is the counter party, who is called the writer of the option. X is the holder of the option, Y is the writer of the option. If X is the holder of the option, he has a right but that implies, that by its very nature implies, that Y has the obligation, he has the duty, that if X decides to exercise the option, Y must honor his commitment.

So Y has the obligation. Y does not have any right. Y cannot back out of the contract. Y must necessarily honor his leg of the contract. X may or may not, depending on his choice, exercise the contract or he may not exercise the contract. So that is the fundamental feature that separates forwards, futures from options. Options one party, forwards and futures both parties, have obligations. In options one party has the obligation and the other party has a right.

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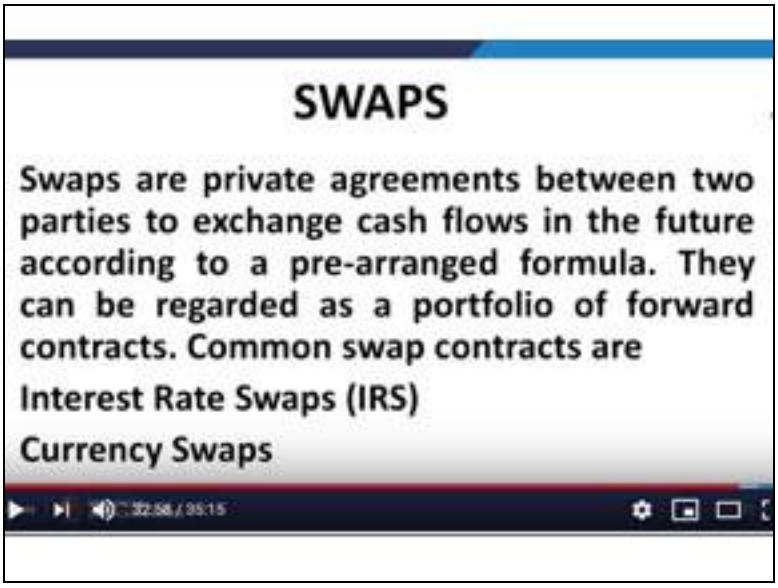

The other common type of derivatives are swaps. Swap means, exchange. So swaps are derivative contracts which entail exchange of cash flows between the contracting parties. The cash, the future cash flows, in relation to any underlying loan or underlying asset are exchanged between the two parties as embedded in the swap contract. The swap contract contains all the details of the exchange process, how the exchange cash flow streams shall be determined, whether they would be determined in relation to a currency rate, whether they would be

determined in relation to an interest rate or whatever - but essentially it is an exchange of future cash flow, stream of future cash flows.

The most common types of swaps are interest rate swaps where one party agrees to pay a fixed rate, interest rate, on a certain notional principal and the other party agrees to pay a floating rate that is a rolling over rate, a varying rate which changes from time to time in relation to certain market variables. The other is a currency swap where the currencies are exchanged. For example you may raise a loan in Indian rupees, your collaborator may raise a loan in US dollars and then you may decide to exchange the currencies so that they meet your basic requirements.

We will talk more about swaps when we take up this topic in detail. Thank you.