Commodity Derivatives and Risk Management.
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Lecture-07.
Pricing and Valuation of Futures Contracts.

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Hi all, welcome to this session on commodity derivatives and risk management. And today we are going to discuss about the pricing and valuation of commodity forward and futures contract. And let me ask, start the session by asking a question to all of you. What is the difference between value and price? How many of you will be able to tell what is the difference between price and value? Okay, let me give an example to which will , clarify this very basic important understanding.

Let us say, you go and buy a company's share from the stock market at a price profiling let us say 180 rupees and your order got executed around 11 o'clock in the morning. So your, you bought the company shares by paying 180 rupees, so that is the price. Let us say there is no change in the price for let us say coming another half an hour, 45 minutes and in the meantime, the value of your investment has remained unchanged. So there is no value for you or the value of the investment is 0.

Let us say after half an hour, some positive news about the company comes and price increases to 220, so sometimes in the afternoon, when you sold the share, you sold the share at 220 rupees. So when you sold that one, or when the share is quoting a 220, the value of

your investment is now 40 rupees. So you bought the shares at 180 rupees and maybe an hour or 2 later, the price has increased and in that case, the value of your investment has, it is positive 40.

And let us say, some bad news about the economy happens or comes and the market reacts in a negative way and you share price goes down to let say 120 and of course, I am assuming that there is no circuit breaker for this company, with respect to circuit breaker, in a stock exchanges allow, what is the maximum amount of daily variation in share price can happen. Let us assume that this company does not have a stock circuit breaker associated with it and price falls to 120, in that case the value of the investment is negative 60.

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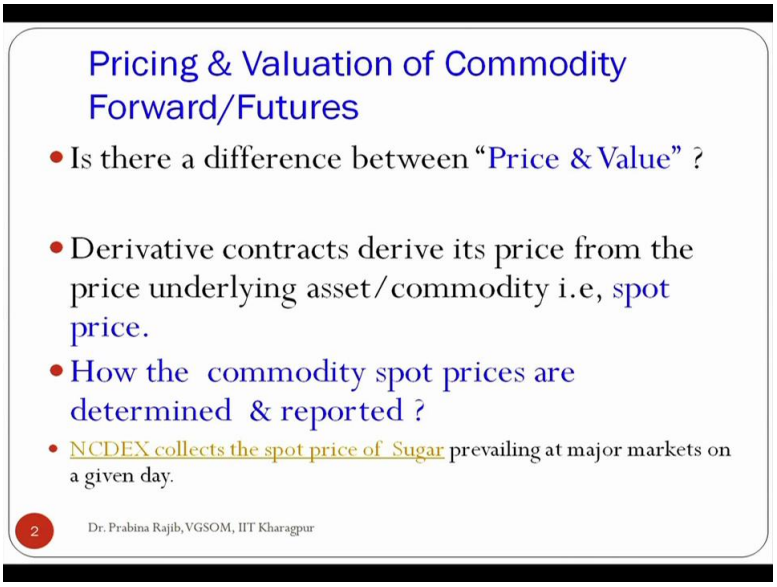

Now today, as I have mentioned that we will be discussing different aspects of pricing and valuation of commodity forwards and futures contract. Now all commodity derivative contracts or any derivative contract derives its price from the price of underlying assets, that is the, in this case, the commodity. So we must have a information related to spot price. So what is the spot price prevailing today, so that is going to be one of the important parameters or the most important parameters for pricing our derivative contract.

Now that commodities trade almost all places. So let me give an example, like if you go and ask, buy a packet of sugar, you go to your neighbourhood shop and each of you, whoever is seeing this video, if you go and start, if you ask the price, I am sure each of you will be getting a different price depending upon the, where are you, whether you are a rural town or

whether you are a big shopping mall or , depending upon which state you may end up paying a different price.

Now when we are talking about the spot price, so which price are we going to consider? Considering a spot price for a commodity can vary significantly from place to place. Now exchanges collate the spot price information pertaining to a particular commodity from the major trading centre for that particular commodity. And this major trading centre normally happens to be the basis Centre for delivery switches mentioned in the commodity contract specification.

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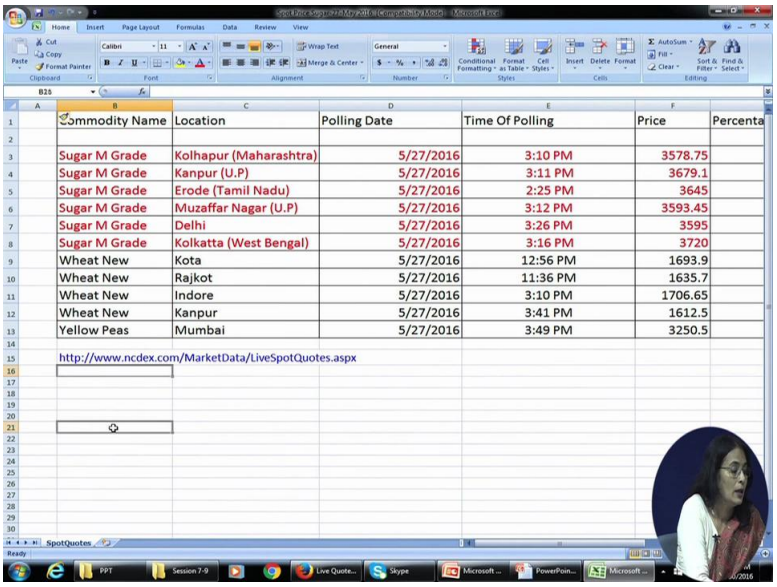

Now let me take you to the, this particular linked file, it is this the sugar M Grade, medium grade sugar, I hope you are able to see the left column. So this is your, yes, now the sugar M Grade price, the medium grade sugar price at Kolhapur on the polling which has been taken on 27 27th May at 10 p.m. So this is 3578.75 and also the, around same time in the afternoon, the National commodity derivative exchange has conducted a poll among major market participants to find out the price at which they are buying and selling sugar in the respective market.

So you have Kanpur, Erode, Muzaffar Nagar, Delhi, Kolkata, and if you can see as clearly visible, the price at Kolkata is 3720 rupees per quintal and at Kolhapur it is 3578.75. So the exchanges take the personality of collating this information and by conducting poll and informing this or letting this information made available in the exchange, commodity

exchange. So that derivative traders, futures traders, futures and options traders are able to use this information for pricing the derivative contracts.

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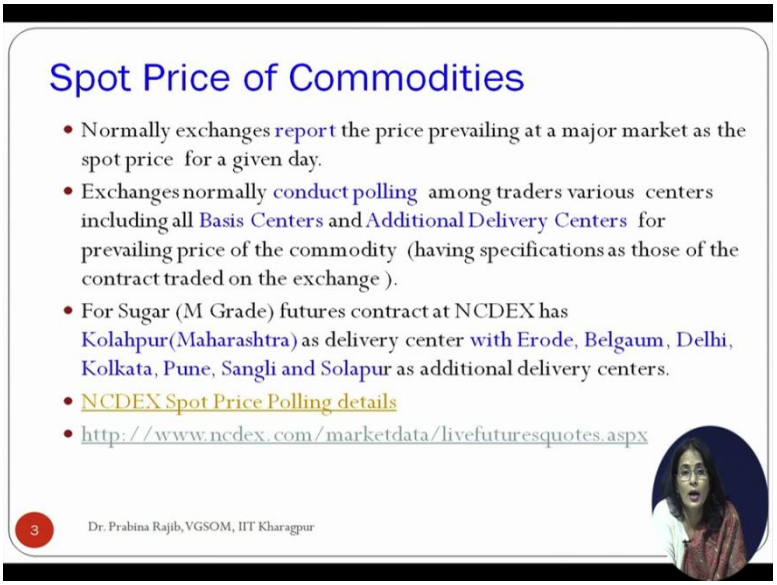

Now as I mentioned, this , the polling which is conducted by the commodity exchange is not only for the major , , market, spot market, they also do the polling for the additional delivery centres, the basis Centre and additional delivery Centre which is mentioned in the contracts specifications. So if you recall, in the sugar M Grade, futures contract at NCDEX has Kolhapur and, Kolhapur as the basis centre and Belgaum, Erode, Delhi, Kolkata, Pune, Sangli, etc. as the additional delivery Centre.

If you do not recall the contract specification for the sugar M Grade, I can, I will advise you to go to NCDEX website and download the contract specification for sugar M Grade. Now how exactly the polling is done, what is the mechanism followed by the commodity exchange to poll, who are the market participants, so all this information is very clearly elaborated or

made available by the exchange.

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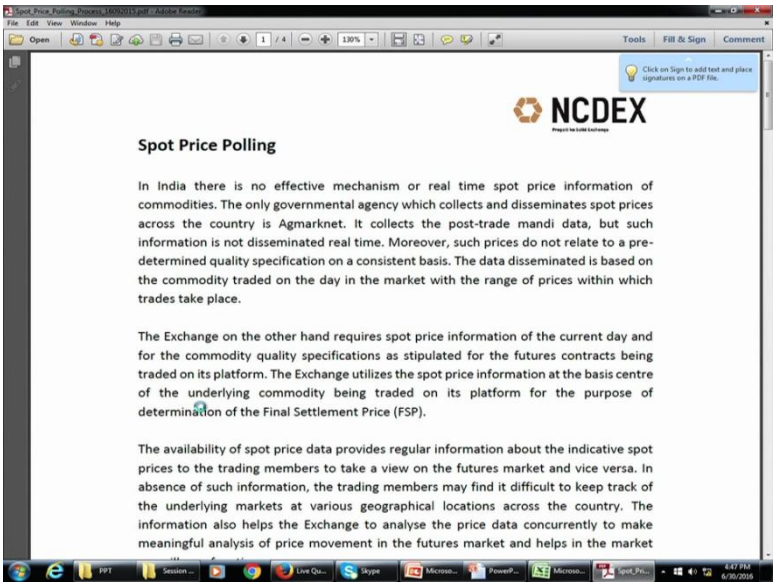

So this is the document which is NCDEX as spot polling mechanism, is the complete detail or spot polling, the polling mechanism is mentioned here. And this, this is an interesting document. So you do spend time to read this and how price tracking is done, and all interesting, important information pertaining to calculation of spot price, old spot price, I should not say spot price, calculation of old spot prices very very clearly mentioned. And this is a very important requirement because unless traders know what is the prevailing spot price, they will not be able to take, they will not be able to price the derivative contracts.

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Product Name	Exp DT	Open	High	Low	Close	LTP	Chg	(%)Chg	AV TP	Spot P.	Best B.	Best S.	OI
Barley	20 Jul 2016	1571	1578	1565.5	1574	1570	-4	-0.25	1570.4	1625.7	1565	1568.5	9540
Barley	19 Aug 2016	1601	1602	1593	1601	1598.5	-2.5	-0.16	1597.92	1625.7	1594	1597.5	5060
Barley	20 Sep 2016	1609	1632.5	1609	1637	1629	-8	-0.49	1617.19	1625.7	1620	1632.5	240
Barley	20 Oct 2016	1663.5	1664	1663.5	1671	1664	-7	-0.42	1664	1625.7	1652	1688	230
Chana	20 Jul 2016	7800	8100	7800	7790	8030	240	3.08	8000.55	8152.1	8020	8038	4120
Chana	19 Aug 2016	7968	8045	7968	7736	8045	309	3.99	8021.12	8152.1	8000	8045	2780
Chana	20 Sep 2016	7690	7690	7690	7490	7690	200	2.67	7690	8152.1	7700	0	420
Chana	20 Oct 2016	7462	7534	7462	7245	7462	217	3	7498	8152.1	0	0	390
Chana 2 MT	11 Jul 2016	8022	8070	8022	7790	8070	280	3.59	8032	8152.1	8040	8070	30
Coriander	20 Jul 2016	7260	7336	7241	7251	7278	27	0.37	7302.34	7458.85	7278	7289	12300
Coriander	19 Aug 2016	7325	7402	7309	7317	7330	13	0.18	7368.43	7458.85	7326	7348	7680
Cotton Seed Oilcake	20 Jul 2016	2575	2580	2543	2570	2550	-20	-0.78	2562.39	2622.5	2549	2550	68740
Cotton Seed Oilcake	19 Aug 2016	2616	2616	2589	2610	2595	-15	-0.57	2602.97	2622.5	2595	2597	36450
Cotton Seed Oilcake	20 Sep 2016	2665	2665	2640	2660	2647	-13	-0.49	2652.56	2622.5	2646	2650	16250

Now let us take, I will take you to the, so this is the, I hope you are able to see this screen. Let me increase the screen size. This is the live futures quotes at NCDEX, market is currently on right now, if you can see this, this is, this is the barley contract, , the contract which is maturing on 20th July 2016, barley 19th of August 2016, so this is the nearby contract, this is the , demand (())(10:16) contract. This is the contract maturing in September and October and if you see, this is the future price, open, high, low, close, etc. And you have a change compared to the previous day, percentage change, average trading price throughout the day, so throughout the day average price at which this barley contract has traded.

And please see this one, this is 1625.7, this is the spot, old spot price which has been collected by the National stock, national derivative, national commodity and derivatives exchange and has been made available to the traders. Similarly you have Chana, it is 8152.1 and different for all derivative contracts, they have, they are making available or NCDEX is making available the spot price. Okay, let us continue with our.

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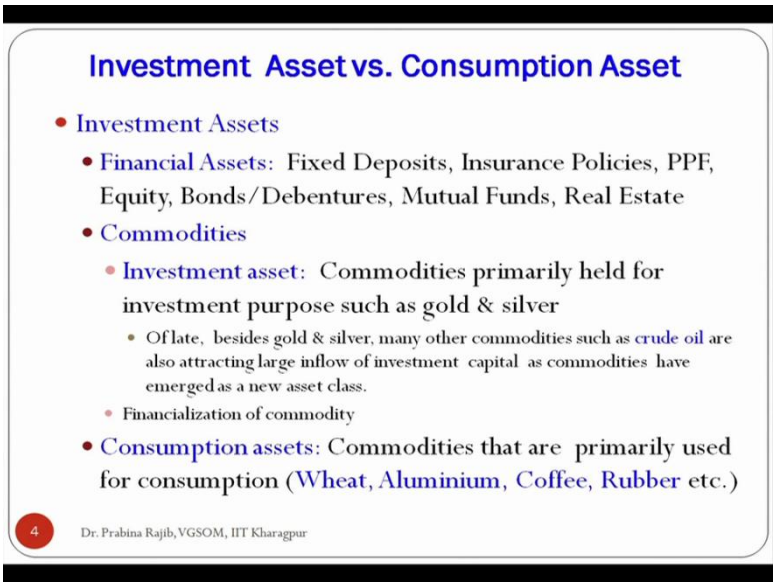

Now before we go to the discussion on how do we value forward contract or futures contract with respect to commodity and commodity underlying, let us focus our discussion little bit on what is the investment asset and what is a consumption asset. Okay, let me ask you a question, if I, , if I ask you to elaborate what are your financial assets, your or your family members financial assets, you will probably mention bank fixed deposits, some insurance policy, public provident fund, some equity investment, mutual funds, maybe some debentures and real estate.

So these are your investment assets which are financial investment assets and under the commodities, again, commodities can be categorised as investment asset and consumption asset. So which are investment assets? Commodities which are primarily held for investment purpose such as gold and silver. Of course in Indian context, maybe many people may not be holding silver as an investment commodity, however many, of late, many people have started investing in exchange traded funds of silver to just to make profit from the moment of the silver price.

So gold always has been our investment asset, most of the people hold gold either in jewellery form or bar or gold form for , getting some return out of it. And another, another commodity which is getting lot of attention of late, of course not in Indian context but in international context, as far as the , it, as far as it being considered as an investment asset is the crude oil. So now many hedge funds and exchange traded funds are investing in crude oil to make profit out of this crude oil.

So crude oil is also being considered as another investment asset in the in the Western market**,** context, not in Indian context, not many people hold warehouse receipts or crude oil and try to make profit out of the price movement of the crude oil. In this context of hedge fund money or exchange traded fund investment going to crude oil, a new term is being coined, that is called financialazation of commodities.

So when, a lot of, lot of investment money flows through a particular commodity, this commodity tend to exhibit significant amount of volatility and lot of research, a lot of debate also is going on whether, financialazation of this, it is leading to excess price volatility. Now let us go to our understanding of which is a consumption commodity. Consumption commodities are those commodities which are predominantly held for the consumption purpose like your wheat, aluminium, coffee, rubber, steel, all these are your consumption commodities.

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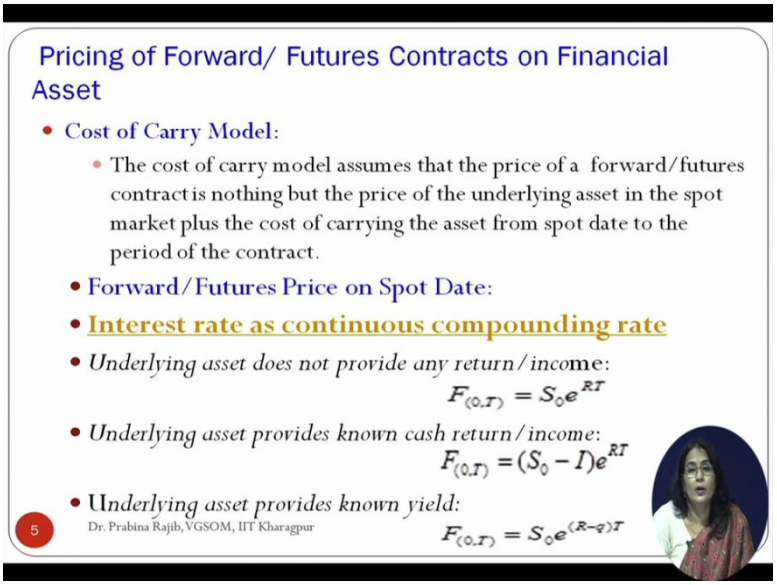

Now when we go and talk about pricing of forward in futures contract for financial asset, we use a , model called cost of carry model. So what exactly is a cost of carry model?

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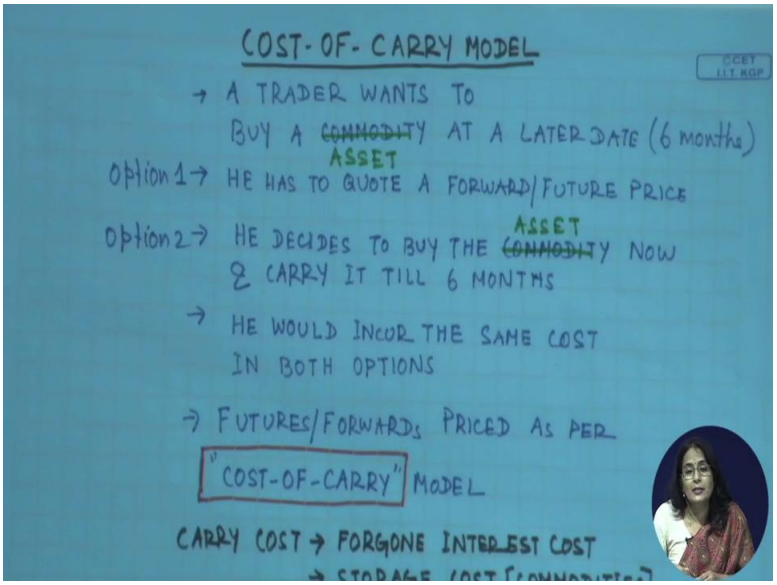

Let me, okay, let me let us focus on what is the, brief understanding of cost of carry model. Let us say a trader who is interested to buy a commodity over a financial asset. It could be any asset, let me put it instead of commodity, let me make it a any asset. A trader wants to buy asset at a later point of time, let us say after 6 months. So what are the options he has? He has 2 options in his hands hand. He can enter into a forward or futures contracts or he can buy the asset, let me again change this one to, he can buy the asset now and carry it till 6 months.

So here is 2 options, he can enter into a forward contract, that is long forward contract or long futures contract, so that he will have the underlying asset with him after 6 months or as part of our option 2, he can buy the asset today and carry a till 6 months. So he would incur any options he chooses, its cost is going to be the same in both options. So this cost of carry model proposes that a forward or futures contract is going to be, is going to be price based on the cost of carry model. So what is exactly, so forward or futures price, forward or futures contract, should be priced as per the cost of carry model.

What is the carrying cost? Carrying cost is the cost of buying the commodity and holding it till the maturity for the 6 months, 6 months in this case. So what is the total cost involved, what is going to be equal, that is going to be equal to the forward price or the future price that trader is going to quote. So in case of, regular financial assets, you have a foregone interest cost and also in case of a commodity, you have storage cost.

In case of financial asset, you do not have a storage cost associated with it but in case of your commodities, that is (())(17:50) is cost associated. Now let us take some numerical examples to understand how this cost of carry model is calculated using both financial underlying as well as commodity underlying. Okay. Now, so what is the, let us go to our understanding of this forward or futures price.

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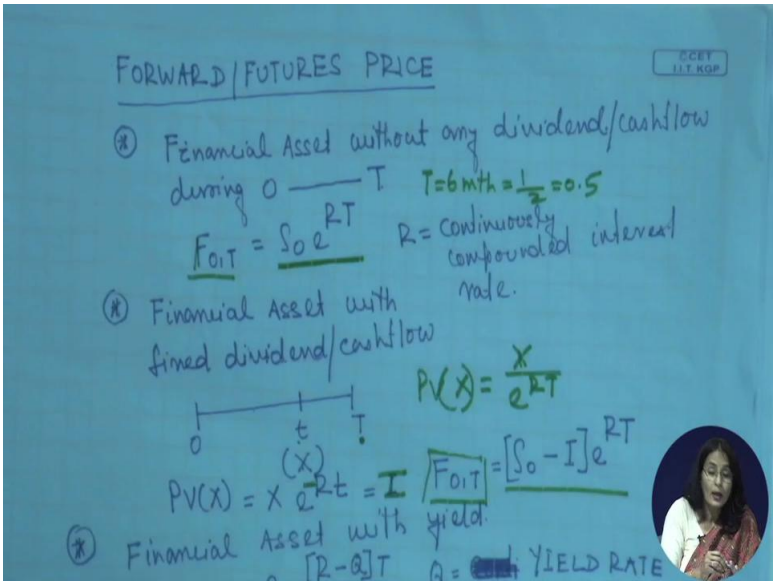

So let us start with our understanding of how forward or futures price can be calculated when the underlying is the financial asset and financial asset does not have any cash flow during the life of the contract. Let us say today you want to buy a financial asset, so, let us, let me

rephrase. Suppose we want to buy a financial asset 6 months from now and today we have to quote a price, so what should be the price? And during these 6 months, we are not expecting any cash flow out of this particular investment if we choose not to go for the futures contract but we, we go for, option 2, that is buying the underlying asset and holding it till the 6 months.

So the forward price is going to be nothing but your F 0 into, F forward price or future price F 0 T will be equal to S 0 into me to the power R T. And what is our R? R is your continuous compounded interest rate. And what is your T, T is your time period. So if T is 6 months, T value will be, 6 months will be equal to 1 by 2 which is 0.5. At this juncture, let us discuss little bit on continuous compounding. Okay, let me ask a question. If you go to a bank and make a fixed deposit, banks give you 2 options. One is, one is taking a bank, bank will give you 10 percent interest compounded annually and in option 2 bank will give you 10 percent interest compounded semi-annually, which one will you prefer?

It is a basic, very basic, finance concept and it is taught in the corporate finance time value of money. And we will quickly take some numerical examples to see how we can convert a interest rate fixed different compounding frequency to a continuous compounded rate.

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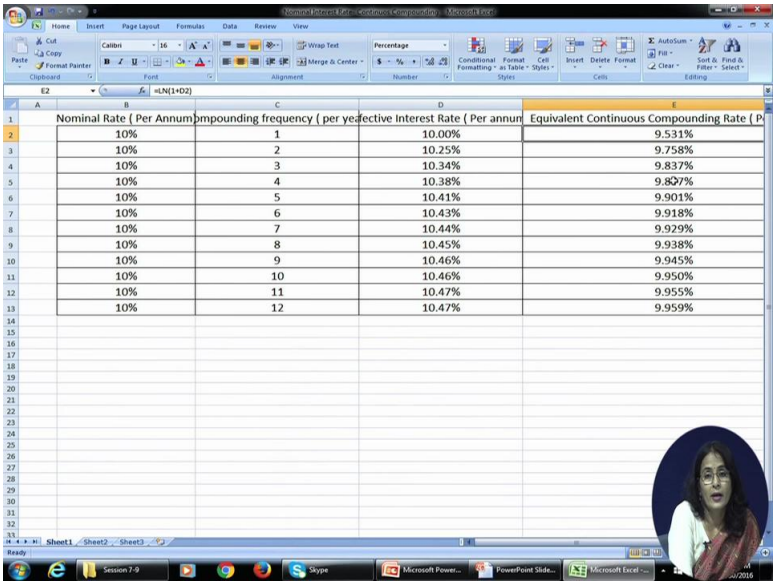

Since you see this particular slide, you have let say, the bank says, the bank is going to give you 10 percent nominal interest rate, so interest rate is nominal, nominal interest rate, compounding frequency is 1 percent, what is going to be the effective interest rate? Effective interstate is 10 percent and what is the equivalent compounding interest, continuous

compounding rate? That is coming to 9.531 percent. So if the bank says to you that I will give 10 percent annual compounding is equivalent to bank saying that we will give you 9.531 percent as continuous compounding.

Similarly you have a nominal interest rates of 10 percent, different compounding frequency and we have calculated the effective interest rate under corresponding continuous compounding rate. And for valuation of futures and forwards, we will be using a continuous compounding rate because it makes our life easier in terms of, we will be able to find out the forward or futures price to any number of dates. Need not necessarily for 6 months or one year, you can do it for 4 days, 5 days or 20 days, so on and so forth.

Now let us go to we started discussing about how do we go about pricing a forward or futures contract when underlying is the financial asset. Now let us go to the 2nd kind of a financial assets in which the, if a particular person buys the financial asset, he or she may get some dividend, he or she is going to get some dividend during the life of the contract. So how do we do it, how do we do about it?

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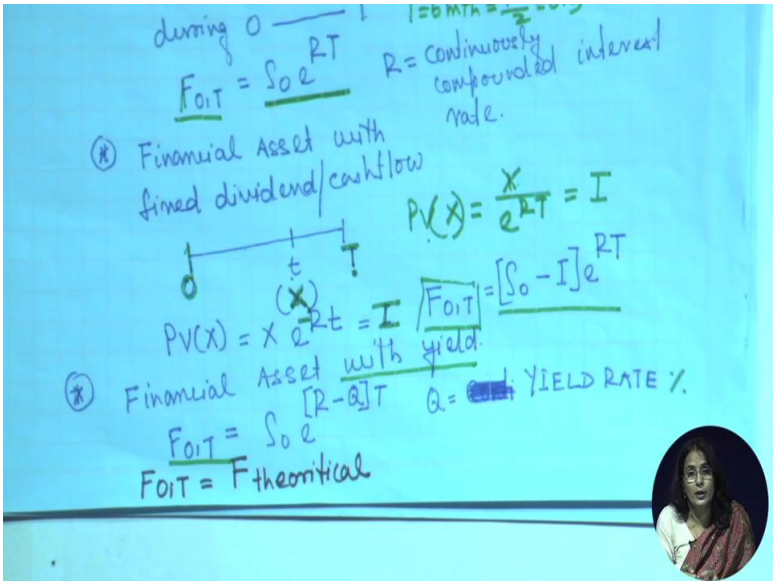

Let us see, this is the maturity. This is the spot date today, maturity date is the 20 and spewing the life of the contract that is small t, this company or equity share or, the, holder of the equity share is going to get X rupees as dividend. So in that case, what is going to be the value of the forward or futures contract? So what is going to be the present value of the X. So the present value of X will be X into E to the power - RT which is equal to your present value of X by E to the power RT.

Survey will be finding, we really finding out the present value of X and how do we adjust the forward price. So F0T is nothing but your S0 - I into E to the power RT. That is I is equal to your present value of the dividend. And this I, I is equal to this value. Now many a times, when the underlying asset is an index, specifically an equity index, we do not, when the underlying is the equity index, in that case we do not use the dividend amount, we calculate the dividend A. Let us take this example.

When the financial asset is, financial asset has a yield, than the forward price is equal to S0 into E to the power R - Q to the power T and what is this Q? Q is the yield rate in percentage stuff. So all these 3 forward prices or future price we are calculating, this is nothing but is called as F theoretical. So that should be the theoretical value of the forward contract. Now suppose in real life we are calculating the forward contract to be something but the , the same, contract is quoting at a different price in the market, so what is going to be our strategy?

And we know from the basic principle of finance that is the same asset is being mispriced, we can, it is quoting at a different price than the fundamental price, we will be able to undertake certain arbitrage benefit. So what is the basic principle of arbitrage, arbitrage means riskless profit and we undertake arbitrage by buying low and selling high. So what we calculated using these theoretical values that is your spot price + the carrying cost - the carrying return. So this theoretical spot, theoretical futures prices are going to be compared with the actual future price.

Now if there is a difference, we can undertake, if there is a difference, we can undertake cash-and-carry and reverse cash and, we can undertake certain arbitrage opportunity. Now what exactly is this arbitrage opportunity, let us quickly take some examples.

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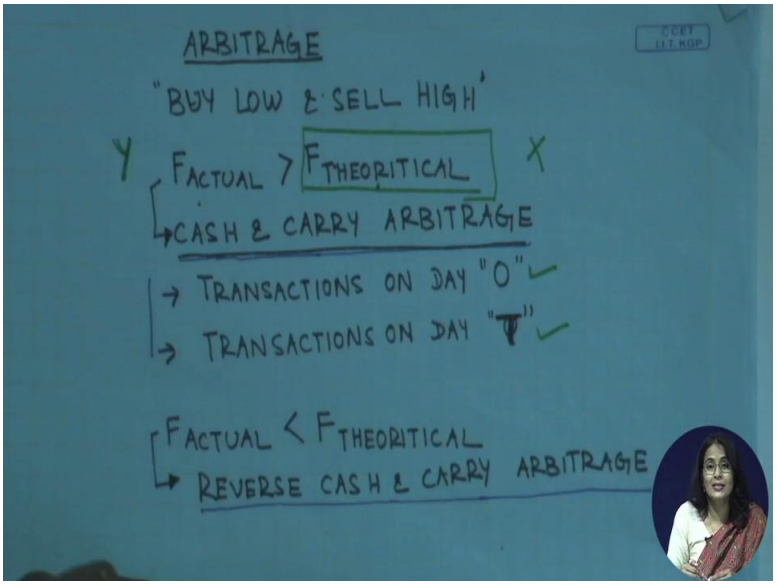

Let us say F Actual, we calculated F theoretical using our cost of carry model. In the market we are seeing another price. Suppose we are, this is the X, we calculated X and we are finding out this value to be Y, this is quoted in the market at Y value. So what is going to be our strategy? So if Y is greater than X, we will be undertaking cash-and-carry arbitrage. So what is the cash-and-carry arbitrage?

Basically it comes, it comes from this buying low and selling high. So where do we sell? This is the high price, we will be selling here and we will be buying here. So what is, so what we will be doing, we will be undertaking certain transactions on day 0 and certain transactions on Day T, that I will take example and elaborate. Now suppose the reverse happens, if F Actual, which is quoting in the market is less than F theoretical, we will have reverse cash-and-carry arbitrage.

So the reverse cash-and-carry arbitrage will be calculated again by, we will be able to undertake reverse cash-and-carry arbitrage by taking, doing certain transactions on day 0 as well as doing certain transactions on Day T. So what are those transactions we will be undertaking?

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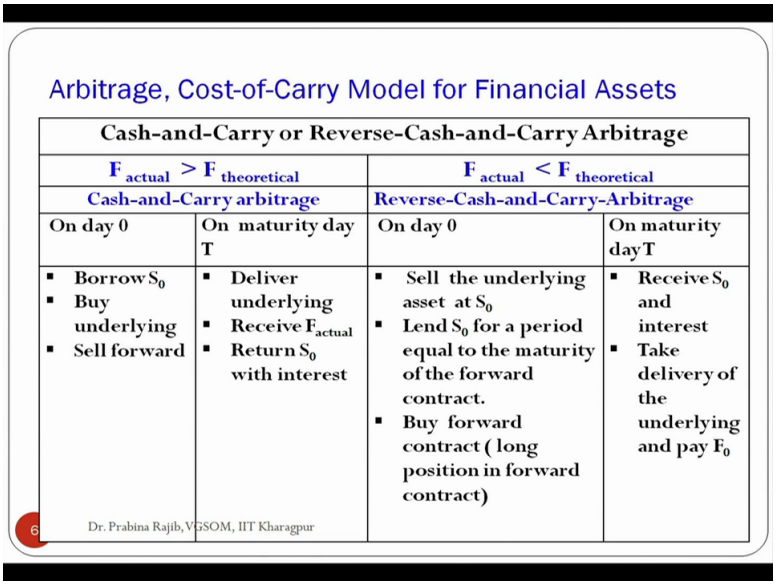

Let us go to the screen and, so if F Actual is greater than F theoretical, we will be using cash-and-carry arbitrage. So what is the meaning of cash-and-carry? Cash-and-carry means I borrow the spot price by the underlying and simultaneously enter into a short forward contract. And on Day T, what do I do? I deliver the underlying, I receive the F Actual and I return S0 with interest. Similarly if other way happens, that this F Actual, the price prevailing in the market is less than F theoretical, that is the price which we are calculating, we can undertake the reverse cash-and-carry.

So what is the reverse cash-and-carry? We will be selling the underlying at S0 and we will be lending the S0, the sales proceeds of the spot price at a rate for a period which is equal to the maturity period of the forward contract and simultaneously we will be entering into a long forward contract. F Actual is less, so we will be buying the forward contract. And on the maturity day T, we will receive S0 with interest, we will take delivery of the underlying from the forward contract and we will be paying F 0 for as part of the forward contract.

Now let me summarise what we discussed today. We started with, we started with our discussion on what is the difference between price and value. And we also discussed how forward price, how futures price for financial assets can be calculated and if the calculated price is different than the price which is prevailing at the market, at the market, it will give us an opportunity to undertake arbitrage. So if the actual price prevailing in the market is less than the price prevailing in the, if the actual price is less than the theoretical price, we will undertake reverse cash-and-carry.

And if the actual price is greater than the theoretical price, or the calculated price, we will undertake cash-and-carry arbitrage. So with this I will end of this session, we will continue with the remaining part of the session in the next class. Again looking forward to interacting with you all.