

Quantitative Finance
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Module – 03

Lecture – 18

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Chapter 2: Futures markets and its use for hedging

We will cover and discuss about

- Future contract trading
- Margin accounts and settlement
- Hedging using futures
- Optimal hedge ratio

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So, welcome back to the continuation of the discussion of forward futures and options which is the derivative products we are discussing. So, now will cover and discuss about future contract how they are traded, the margin accounts and the settlement how they are done, the hedging using futures and optimal hedge ratio. So, if you consider, we are only consider in the futures though. If you recall there was a settle difference between forwarded futures; in one case one was basically over the counter other was not; in other case the basically the prices of the other time to expiration was when it happen others it could be traded depending on before that something to do with the American option and the European option. So, we will continue the discussion with the futures because the future as a market where they are traded.

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Futures Contracts

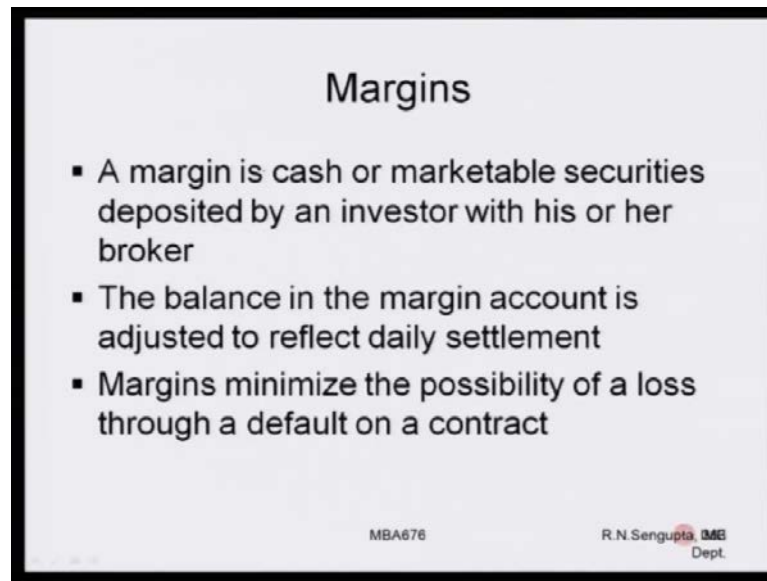
- Available on a wide range of underlying assets
- Exchange traded instruments: One party agrees to buy an asset at a future time for a certain price and the other party agrees to sell the asset at the same time for the same price
- Specifications need to be defined:
 - What can be delivered,
 - Where it can be delivered,
 - When it can be delivered
- Settled daily: Vast majority of the contracts do not lead to delivery as most traders close their positions prior to the delivery period specified in the contract

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So, future contracts are available on wide range of underlying assets exchange traded instruments are one party agrees to buy an asset at a future time for a certain price and the other party agrees to sell the asset the same time for the same price. Specifications need to be defined what can be delivered, what is the quantity, what can be delivered, where it can be delivered, what is the price, what is the quality of the goods and so on and so forth. They are settled on a daily basis vast majority of the contracts do not lead to the actual delivery of the product they are basically traded; that means, a position is open, a position is close depending on the need of the person without the actual delivery buying and selling of that actual product whether it is a ((Refer Time: 01:44)) instrument, whether is covariate actually taken place.

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
Now, in order to basically mitigate the risk, reduce the risk between buyer and seller long and a short position for a future, you need to have basically a account, because you have remember in the last slide, we said that the settlements are done on a daily base. So, depending on the price or depending on the demand and supply, you have price and quantity then one of person either a buyer or seller that is on a long or short position would make a profit and on the person would make a loss. Now, what is a little bit concern for the person who is making a profit is that the person is making loss may differ. So, in order to stop that then generally you have the margin account whether daily price fluctuation are reflected in a such a way, there in case the person defaults, the overall amount of money which is get in the margin account or some collateral account which is there can compensate the loss which is the person is making a profit can face in case the person who is making a loss defaults.

So, basically margin is cash or marketable security is deposited by investor with his or her broker in order to basically mitigate the risk and this is the type of collateral. The balance in the margin account is adjusted to reflect the daily prices how we will see that and margins minimize the possibility of a loss through default of a contract which may happen buy a particular person.

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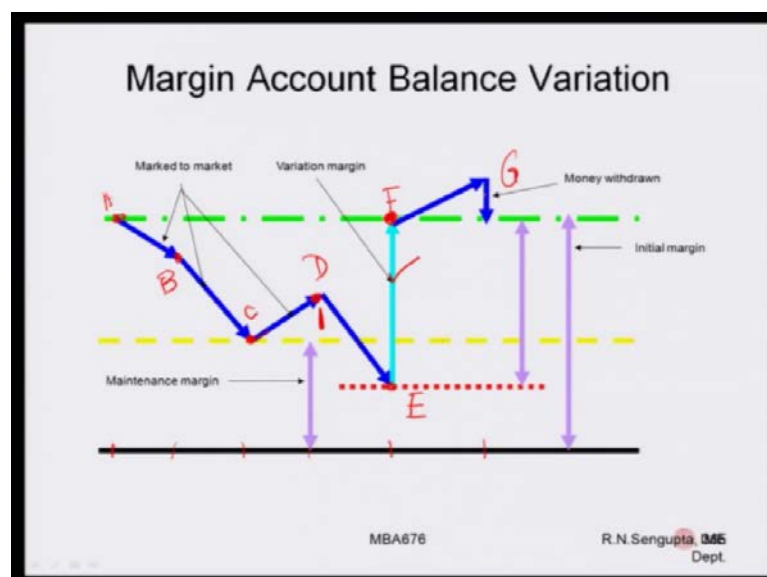
Margins

- Margin account
- Initial margin
- Marking to market: At the end of trading day the margin account is adjusted to reflect trader's gain or loss.
- Maintenance margin: Some percentage of the initial margin
- Variation margin

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So margins basically or margin accounts, they would be a initial margin, they would be a concept of marking to market and the end of trading day the margin account is adjusted to reflect the positive and negative price movement in the futures market such that all profit and losses are taken care in the account accordingly. Maintenance margin is that some percentage of the initial margin which is kept as a buffer such that in case the oral money that I can follow the below as the maintain model; obviously, this a margin call in order to bring up that money back to the initial margin and variation margin basically occurs due to the prices fluctuation of the futures depending on the demand and supply on a daily basis.

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So, this is a simple graph which I have drawn in order to make understand. So, consider the data black one is the zero value, so this is the amount. And the yellow line which you have, and the green line which you have is basically it means this is the maintenance margin; that means, any amount below this ((Refer Time: 04:18)) definitely not needed and not expected also. And the actual height are the value of the green one is the initial margin based on which is overall trading start. So, this I am drawing as a cumulative margin account also; obviously, it will depend the amount should depend on number of contract which are being bought and sold, number of items which you have there per contract what is the price, one unit price fluctuation; obviously, will have an effect on the contract because our contract need not have only one adding it can be a ((Refer Time: 04:49)) of such two hundred different type of items which is being bought and sold. Based on that your futures are a forward contract is made.

Now consider on a daily basis, the time frames are basically on the x axis. So, these are the time frames, I am drawing it for your convenience. So, from the first day, the prices goes down from point a to point b, so obviously, the overall amount on the money decreases and the person who is making a profit would obviously compensated by that particular delta amount in the price change in case the person who is facing a loss who things that prices will continue decreasing defaults. Day two also the price falls from b to c then also the person who is making a profit would be compensated by this amount. Day three consider the price increases goes to point d then obviously the flow of money would be in the reverse direction such that the person who was making a loss till now would gain by the delta amount depending on the price amount. So, this is the delta amount.

Now day four consider now the value of the whole contract goes down in such a way that it falls from d to e which means that e point has a value which is less in the margin account, margin is maintenance margin then immediately a call is made, call means not the call option the call is made by that person trading how and the person has to deposit a certain amount of money which is given by this variation margin such that the overall amount of money goes back to the initial account money which you have. So, it means that in case the portion had default and e then obviously the whole overall amount of money which is their in the account can compensate the loss which may happen for a default. Then again from e to f which we have moved is basically a vertical jump because you have deposit money then consider from f to g, the prices increases for this

persons such that overall amount of money in the maintenance margin has now increase.

So, in case I have just given a small example here that the amount of money which is the vertical drop the blue one is withdrawn by the person or if the money is not withdrawn if it is kept in the account then compensating interested definitely to leave it. So, in this way, the fluctuation occurs and when the position closes the persons - both the person basically decide what is the amount of money to exchange between these two players, it is exchange, but the margin account are both the players are kept in such a way that any negative price fluctuation for one is there in order to compensate the loss the person may face in case the person who is then other party defaults.

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Margin Account Balance Variation				
Future Price	Daily Gain/Loss	Cumulative Gain/Loss	Margin A/C Balance	Margin Call
400			4000	
397.00	-600(-3.00*200)	-600	3400	None
396.10	-180(-0.90*200)	-780	3220	None
398.20	+420(+2.10*200)	-360	3640	None
397.10	-220(-1.10*200)	-580	3420	None
396.70	-80(-0.40*200)	-660	3340	None
395.40	-260(-1.30*200)	-920	3080	None
393.30	-420(-2.10*200)	-1340	2660	340+1000=1340
393.60	+60(+0.30*200)	-1280	4060	60 could have been withdrawn
391.80	-360(-1.80*200)	-1640	3700	None
392.70	+180(+0.90*200)	-1460	3880	None
387.00	-1140(-5.70*200)	-2600	2740	260+1000=1260

NOTE: Total number of contracts is 200, initial margin 4000, Maintenance margin 3000

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So, consider the simple table which we have exactly as in the graph, but before you solve this problem note which is given as the below. Total number of contracts is 200, initial margin is 4000, and maintenance margin is 3000. So, now, the futures price is given in the first column, so it is changing from 400 to 397, 396.1, 398.20 and so on and so forth. The daily gain or loss are given as a second column. So, in a day zero the price was 400, day one the prices falling down into three ninety seven which means a fall of three rupees. So, now how many contracts you had, you have basically two hundred contracts. So, the overall price fluctuation for each contract is minus three these are total loss would be 203e which is minus 600 at noted now.

Next day, the price falls from 397 to 396 which means per contract minus one very or not minus 1 sorry 397 minus 396 point one zero is point nine point nine in a 200 is number

of contracts the overall fluctuation basically is minus 180. The next day prices increases from 396 point 10 to 398 point 20. So, now, this increase is happening of plus two point one zero. So, plus two point one zero multiplied by the number of contracts which is basically the total profit is happening. So, if you have the daily loss and gains and then try to find out, you have basically cumulative loss and gains as given by minus 600 then minus 600 minus one it is minus 78 then minus 780 plus 420 is minus 360 then minus 360 minus 220 is minus 580 and so on and so forth. So, you have basically cumulative loss and gain.

Now you want to find out, how is the fluctuation in the margin account happening. So, if you remember, the initial margin was 4000, so now it will be initially zero there was four thousand. Now cumulative loss is minus six hundred, so it falls down from 4000 to 3400. Next it falls down from 3400 to 3200. So, if you go in this way, these are all the falls which is happening, but note down one thing you have maintenance margin was three thousand. So, in the moment basically falls below three thousand, a margin call is given and the margin call is given in such a way that these three hundred will bring the value back to three thousand that is 2660 plus 340 would bring it back to 3000 plus 1000 would basically bring that amount back to the initial margin which you have. So, we are considering that this is a call would happen in this.

In the next case, due to increase in the prices which is here sixty, the overall value becomes 4060, which is 4060 is greater than 4000. So, in that case, the person could have withdrawn that is sixty rupees. So, we are mentioning here sixty which is pink shown could have been withdrawn by that particular person but we are not basically trying to show it here. So, based on that, with this table and the graph you can basically draw the margin account and really understand how the overall fluctuation of the prices happens which we basically is reflected in the margin account such that any person, who is making a loss or profit is compensated in such a way that if the other party defaults then the margin account of the other party is there to take care of any and toward incident which may happen.

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So, other definition that we will consider; day trading is happens, you will also consider spread transactions depending on demand and supply of the prices. You have the sell and buy prices. You will have exchange clearing houses which are basically a places where the exchange is takes place between all numbers of players such that it is basically market place in a rudimentary sense where the exchange is takes place between parties such that the demand and supply basically is reflected in that exchange places. You will have a clearing margin, you will have normal market with the future prices increases as the time to maturity increases, and we have the inverted market whether future price decreases as time to maturity increases.

So, why I would rather going to the actual definition and going with detail the discussion I will just give you the flavor of what you mean by that just a rudimentary example. And I will urge the students to basically study from the book which is ((Refer Time: 12:13)) in order to understand the concept in details. There are two points for that why I am doing that point number one the amount of coverage is huge, point number two is that before if I start going through the details then obviously we will very go slowly then people would not be encouraged or they would not finding very encouraging to read the books, so I would strongly urge, strongly request the students whatever to ready whatever I basically discuss such that give them in a better picture that what I am trying to discuss in the area options and futures.

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Future Markets

Settlement Price: Average of the prices at which the contract is traded immediately before the end of the trading for the day. This price is important as it is used for calculating the daily gains/losses and the margin requirements.

Open Interest: Total number of contracts outstanding. It is either the sum of all long positions or the sum of all short positions.

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Now, in the futures market, we have the settlement price, the settlement price the average of the price at which that contract is traded immediately before the end of the trading for the day. This price is important as it use for calculating the daily gain and loss. If you remember the margin account we have basically consider that price. And then open interest is the total number of contracts outstanding. So, depending on the position is somebody open the position and not closed it, or somebody bought and not sold it and sold not bought it depending on what we whichever situation you consider, the total number of contracts which still outstanding would be consider as the open interest. And it is each other some of all the long position or other all the sum of all short position cumulatively. So, person can going to different long positions, different short positions and finding on the cumulative of them would give you the open interest.

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Future Markets

When the delivery period is reached, the future prices equals - or is very close to - the spot price.

Why?
As arbitrage opportunities will rise if they are different.

How?

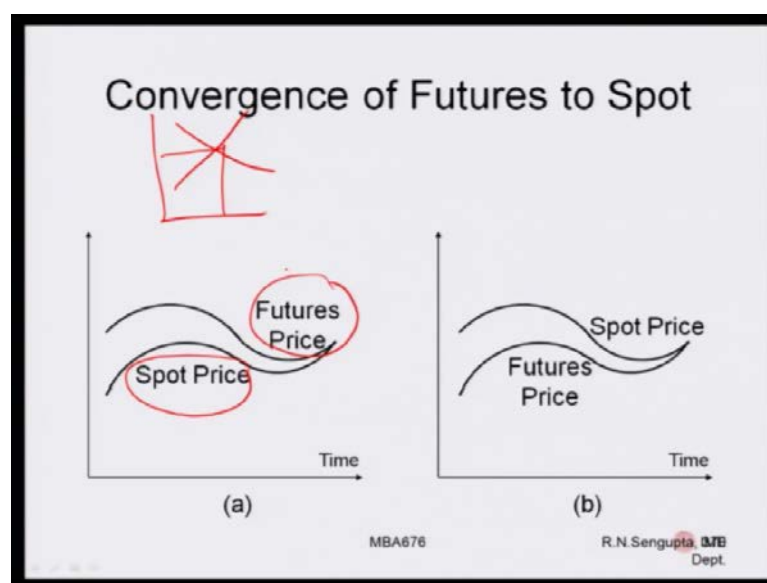
- Future price > Spot price: Short Future contracts.
- Future price < Spot price: Long Future contracts.

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Now, why the delivery period when the delivery period is reached, the future prices equal or very close to the spot price. The question is why and how it happens and if it does not happen what is the problem. So, why it happens and arbitrage opportunity will rise if they are different, because if they are different obviously, we will play in one market and buy and sell in the other market. So, the prices are increasing and I want to basically sell, or prices are decreasing and I want to buy I would basically pay in such a way that my overall profit is positive in the cumulative trading which is being done both in the spot which is room one as well in the forward of the future of the option which is in room two.

Now, how would basically the delivery period when it is reached, how the future prices if they are not equal what happens. If future price is greater than this spot price then obviously we will short futures contract, because spot price at time t zero, if it is less than the futures price then I will the sell product according to the price which is there in the contract which means I will buy it from the market at low price, sell it to higher price a make a profit. In case if future price is less than the spot price, what I will do, I will buy, why I will buy is that if the futures price is that less I will buy that contract and basically sell in the in the open market in order to make a profit. So, whichever position we see either for a futures being greater than spot or the futures pricing being less than spot we will basically taking the position or a short futures or long futures profit in order to make position in order to make profit.

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So, now we will consider the convergence of spot futures to the spot. Now if you remember discuss that whenever some demand and supplies happening there is a particular price at a quantitative. So, this is the price on the quantity which we have discussed. Now, what you are considering in forward futures in options is something different, the reason being that there are basically two different ways you are trying to handle. So, let me explain it in detail. In room one, which have been mentioning, you have the actual spot, the product the actual corn thing which you see either corn be it can be log, it can be some gold, silver, copper anything may we tries which you are buying and selling and it is a spot price. In room two, you have a particular financial product which is a derivative based on the actual product which you are buying and selling.

So now, the derivative whether is a forward futures or different types of options is being dictated in the price or two fronts, main two fronts; one is the demand and supply of that forward futures are options in room two, and number one is basically what is the relationship between the price fluctuation which is happening between the actual product and derive product. If you have that once I draw on the time scale you are basically drawing on the x-axis along the y-axis, you are basically denoting is the unit of money unit whatever is yen, dollars, rupees, dirham, Canadian dollar, UK pound that does not matter.

So, if you see this spot is the price in room one, future is the price in room two. So, in case, if they do not merge obviously persons who are there in the market and there in both the rooms room one and room two with their corresponding ((Refer Time: 17:19))

will sell and buy go long and short in any of the rooms in order to basically make an extraordinary profit. So, whether the price or the futures is below and slowly coming to the spot or whether the price of the futures is above slowly coming to the spot basically gives that the demand and supply match happens on the time expiry's as that nobody mix in extraordinary profit or a loss.

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Now, many hedging using futures you will use either a short hedge or a long hedge depending on whether company will sell an asset or buy an asset at a particular time. So, we are basically going for a short hedge or a long a hedge, you think the price are moving such a way that buy going for a short or for a long able to compensate any negative price movement of that actual product actual product means in room one.

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Long and Short Hedges

- A long futures hedge is appropriate when you know you will purchase an asset in the future and want to lock in the price
- A short futures hedge is appropriate when you know you will sell an asset in the future & want to lock in the price

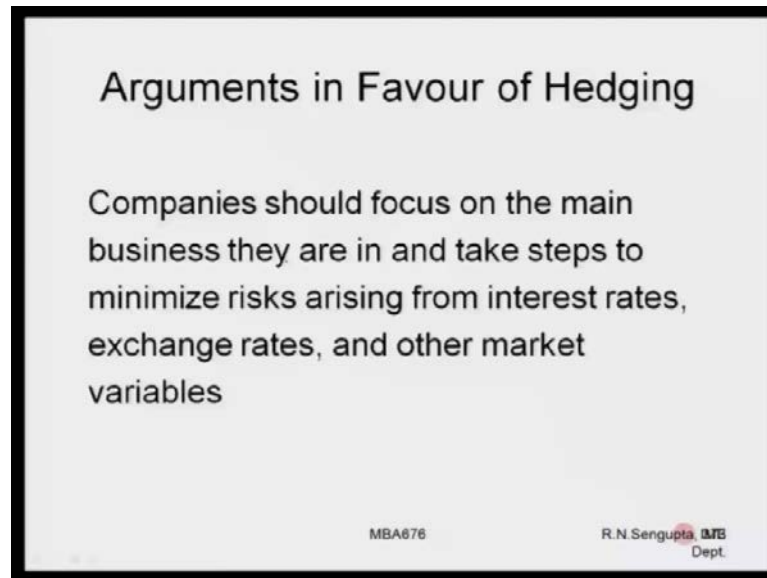
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A long future position is appropriate when you know you will purchase an asset in the future, I want to lock in the profit. Now one we want to basically long means I want to buy and short would basically I want to sell. So, when you know the you want to basically purchase an asset and if the prices are on an increasing trend or on a decreasing trend, if you think it is decreasing trend, you would never go for that forward and futures because you can buy it from the market at a lower price, but now considering the prices are increasing on going on upper trend, so basically you fix on a price and the movement basically the time to expression come utilize this price to basically buy that product or purchase that product because if we had not done that and you have gone to and you go to the open market the actual price you would have paid would be much higher.

Consider the short fund; I want to sell, so obviously, prices are much higher it is better for me. Consider the prices are on increasing trend, so if I go to sign a short contract, I would definitely not use that because the prices are always on upward trend, I would sell in the open market, and get a higher price. Now consider the other way the prices are falling. So, I am basically sign it on that short contract certain price, so whatever the prices availing spot is in the market if it is lower obviously, I utilize the short position in order to basically sell it in the higher price. So, it may can be say for example, you are on oil drilling rigging company and you know that you will basically drill oil at a certain point of time, you want to sell it to the market so obviously, you will go for certain type of contracts are derivative products such that it is agreed up between you and all producer and the other person who is a buyer such that you are able to sell that particular crude at

a certain price such that any negative price fluctuation does not effective because you have already gone to at your contract. So, if the price is an increasing you will sell in the open market; it is the pricing are decreasing it sell at the particular price based on which you have sign the contract.

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Arguments in Favour of Hedging

Companies should focus on the main business they are in and take steps to minimize risks arising from interest rates, exchange rates, and other market variables

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So arguments in favor of hedging; so companies should focus mainly on the business and takes steps in order to minimize the risk depending on type of contracts they are buy. So, their main concern is not the contract their main concern is the business and they use the concept of derivative in order to minimize the overall loss.

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Future Markets

But in general it is seen that hedging using future contracts is less than perfect, due to the following reasons:

- Asset whose price is being hedged may not be same as the price of the asset underlying the futures contract.
- Future contract is closed before expiration date.
- Uncertainty about the exact date when the asset will be bought or sold.

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But in general, it is seen that hedging using futures contract is less than perfect, due to the following reasons. Asset whose price is being not hedged may not be same as the price of the asset underlying the futures contracts, so this is what I will try to imply. In room one, we have the actual asset or actual finding shift products which you buy and sell, and it is count upon the derive product would be in room two. So, if I consider the price movement between room one and room two actual product and the futures of the forward product they do not match; obviously, this is mismatch. So, that would be basically have a different effect in the price movement such that you overall methodology are trying to basically minimize the loss or risk would may not be exactly true. Futures contract is close before the expiration date. So, this is what if you remember I have mentioned that the forward futures are for the duration of three months.

So, in case, if you need that actual product after say for example, three months exactly three months, so there is a mismatch of time does not occur to that maximum extend. But consider two case scenarios, scenario one - you need the actual product four months on the line, and scenario two - considering you need it six months there are down the line. So, in the first case, when is four months, it means you will definitely match the three month with the derivative, but the one month which you have you are not able to match hence they would be on a huge amount of fluctuation may happens such that the overall quantum or risk may be high. Second case is that for six months what you will technically do is the roll over the three month for two time periods first three months contract expires, second three months. So, as you are doing that the plus fluctuation slot ((Refer Time: 22:29)) increasing.

So, you will see later on that the concept of volatility or the change of the dispersion or the variance is such that is time dependent. So, the moment more you go down the line, hence the volatility will start increasing such a way that it will have an as adverse effort in the overall risk motivation based on which you are trying to basically minimize your risk. Uncertainty about the exact date when the asset will be bought and sold also not known as a mention in the example where it is four months and three months. Hence you will see for all this different cases, there is some mismatch which you have to basically understand and based on that you will try to formulate your simple problems in order to minimize your overall risk.

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Basis Risk

- Basis is the difference between spot & futures, i.e. (***spot price of asset to be hedged – future price of contract used for hedging***).
- Basis risk arises because of the uncertainty about the basis when the hedge is closed out

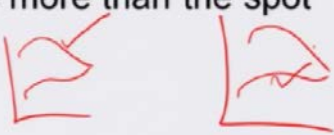
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Now, we will consider that all these risks are basically leads to the fact or the basis risk. So, basis is the difference between this spot and the futures which is S and capital F , which is the spot prices an asset to be hedged minus the future price of the contract which is being use for hedging. So, again room one, we have the spot which is s ; room two, we have the futures of the perfect which is F . Now basis this is basically difference in these prices; basis risk arises because of the uncertainty about the basis when the hedge is to be closed as I mention when you need this spot you do not know, the actual duration in the spot even if it is known may not match it the exact forward and futures duration because the durations are different in both the cases.

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Futures

- **Strengthening of the basis:**
Increase in the spot price is more than the future price.
- **Weakening of the basis:** Increase in future price is more than the spot price.



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So, you will consider two important aspect of the basis, one is the increase in this spot price when the increase happens is more than the future price, and weakening happens in the first case it was strength strengthening; in the second case is the weakening of the basis which is increase in the futures prices more than the spot price. So, if you go back to the slides, what we have understood later first one was basically, in this case the futures was above in this case the future is low. So, depending on which direction the futures prices are moving, the price fluctuation would be such that the basis would basically have this component of increase or decrease, and you have to basically make a distinction how will try to mitigate the loss whether you are on a short or long position. So, with this, we have a small note, I will close this lecture today, and next day will start of the considering in the concept of basis are the how the basis risk can be consider and how the role over basis can be consider as a very typical example and how what are the values we should basically consider and along with the variables of importance.

Thank you.