Commodity Derivatives and Risk Management
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Lecture 33
Weather Derivatives (Part 1)

Hi all, welcome to this session on Commodity Derivatives and Risk Management and today we are going to start discussing on different aspect of Weather derivatives exchange traded Weather derivatives. And before we go to today's session, I would like to highlight that this exchange traded derivative contracts are not used to mitigate catastrophic weather related events. So, catastrophic weather related events like loss arising out of earthquake or tsunami or excessive rainfall and maybe excessive snowfall, so those are the risk which gets mitigated by insurance contract. However, many companies enter into this exchange traded derivative contracts which are used to mitigate revenue related loss because of minor variation in weather parameters.

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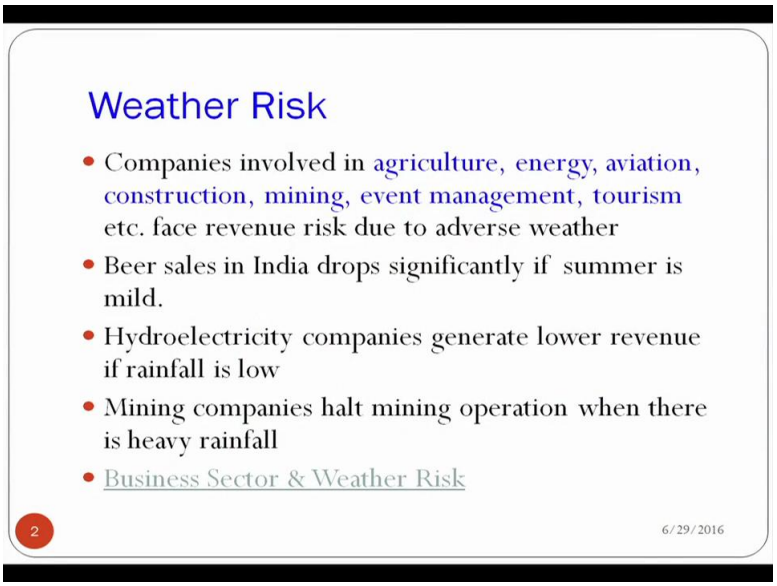

Let us take the examples of some of the minor variation of weather parameters and how it can affect the revenue of some of the businesses. And all of you all of us we know that whenever there is variation in temperature the agricultural quantum of agricultural output may go down or even if quantum does not go down maybe the quality of the agricultural output may take a hit may take the quality of output may not be so good. Similarly, you have aviation industry which gets severely affected at times because of the fog and all of us in India we know there are many flights get cancelled because of the fog during the winter months.

Similarly construction activities, many construction companies are not able to proceed with their construction activities during the rainy season and even management companies, tourism companies are also affected by variation in weather parameter. One example of weather risk which is not catastrophic in nature is the beer sales beer sales in India drops significantly in summer months if the summer is has been mild. So it is not a catastrophic loss event decline in summer temperature is not cannot be treated as a catastrophic weather parameter however, this affect the revenue of beer manufacturing companies.

Similarly if the rainfall has been low you have electricity companies generate lesser electricity and generate lesser revenue, similarly mining companies at tie halt mining operation if there has been excess rainfall and I am not using the word excessive rainfall even if at times there has been little more rainfall and mining companies there maybe flooding and mining companies are not able to continue with their mining operation.

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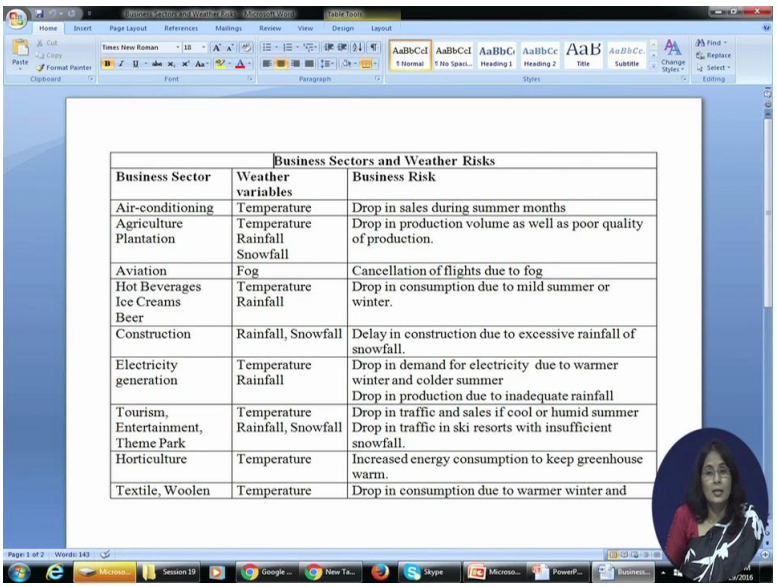

Business Sectors and Weather Risks

Business Sector	Weather variables	Business Risk
Air-conditioning	Temperature	Drop in sales during summer months
Agriculture Plantation	Temperature Rainfall Snowfall	Drop in production volume as well as poor quality of production.
Aviation	Fog	Cancellation of flights due to fog
Hot Beverages Ice Creams Beer	Temperature Rainfall	Drop in consumption due to mild summer or winter.
Construction	Rainfall, Snowfall	Delay in construction due to excessive rainfall of snowfall.
Electricity generation	Temperature Rainfall	Drop in demand for electricity due to warmer winter and colder summer Drop in production due to inadequate rainfall
Tourism, Entertainment, Theme Park	Temperature Rainfall, Snowfall	Drop in traffic and sales if cool or humid summer Drop in traffic in ski resorts with insufficient snowfall.
Horticulture	Temperature	Increased energy consumption to keep greenhouse warm.
Textile, Woolen	Temperature	Drop in consumption due to warmer winter and

So many businesses face revenue risk when weather parameters change, so this particular document shows some of this weather change in the weather variable and the business risk air conditioning companies do not sell enough number of AC's if the summer has been mild and let us say hot coffee and ice cream manufacturing companies sell less number of units if the summer is winter is not cold enough or summer is not enough. Similarly electricity generation companies there is a demand for electricity due to warmer winter or colder summer specifically if the summer is not very hot, many people do not switch on the AC and the total demand for electricity also goes down and in turn revenue of this electricity companies.

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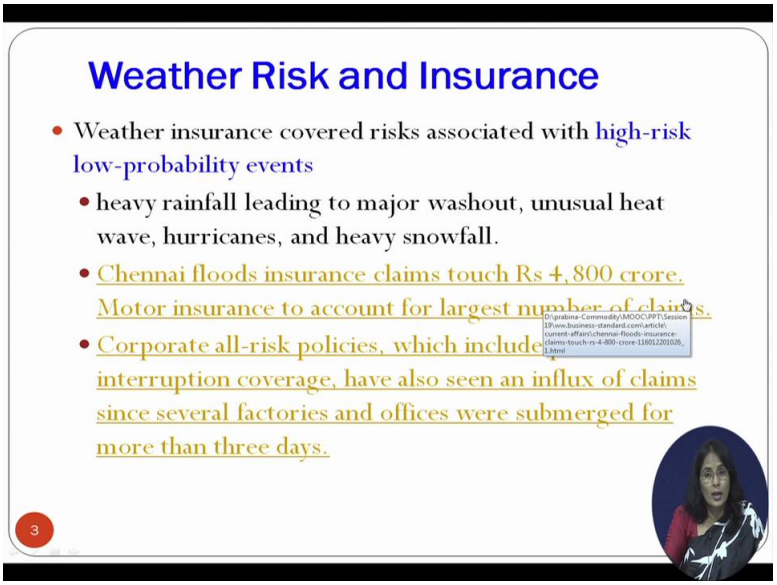

Similarly many other companies like let us say this woollen garments manufacture also its revenue also gets affected if the winter is not cold enough. So to summarise whether insurance covers the risk associated with high risk and low probability events or catastrophic events. These catastrophic events are very, their magnitude of loss is substantially higher but the probability of this happening is very low. However, what we are going to talk or what we are going to discuss in this session are those weather related risk which are high probability but of low magnitude. That is temperature in a given summer month maybe very maybe high and another summer month maybe low and this variation in temperature can may affect the sales of a particular company, so this company can utilise derivative contracts weather derivative contracts to mitigate the revenue risk.

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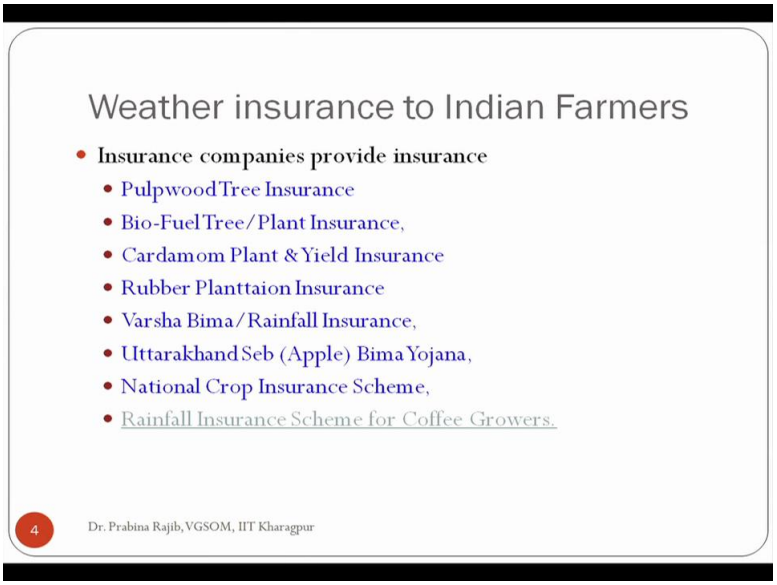

And in India you have much different insurance which are available to Indian farmers, so all these insurance companies normally provide insurance some assured whatever the amount of insurance cover a particular farmer has taken only when there has been a loss. If there is no loss then the insurance company does not pay anything, but except last one all other insurance are of same nature that is only when there has there is a loss the insurance company pays money to the farmers. Let us spend couple minutes understanding what this rainfall insurance is came for coffee growers.

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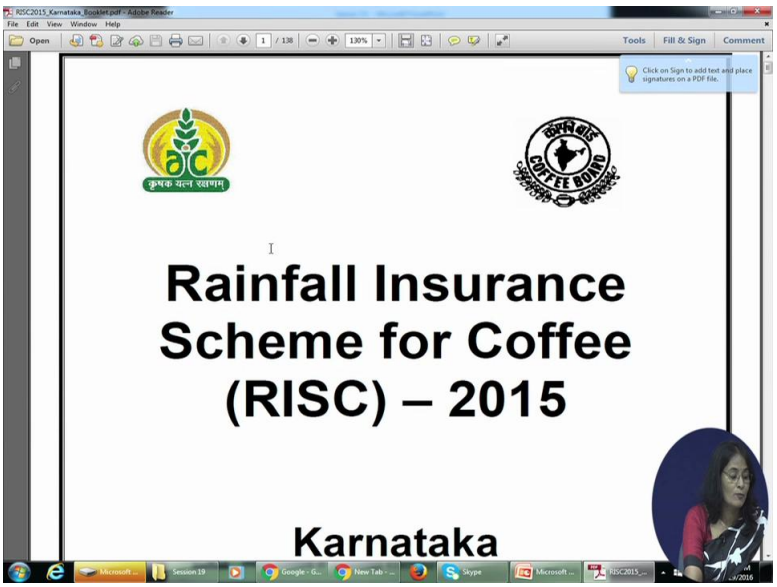

This is particular document which has been prepared by the Karnataka rainfall insurance came for coffee so this is all details are here, I am not going into this detail because this quite

a big document running into 138 page, so let us spend little more time only focusing on some important aspect, so who are the people who can buy this insurance this is the coffee producers from coffee planters from Chikmagalur, Kodagu and Hassan district of Karnataka and both Robusta and Arabica variety of coffees are covered and what is the duration of the insurance?

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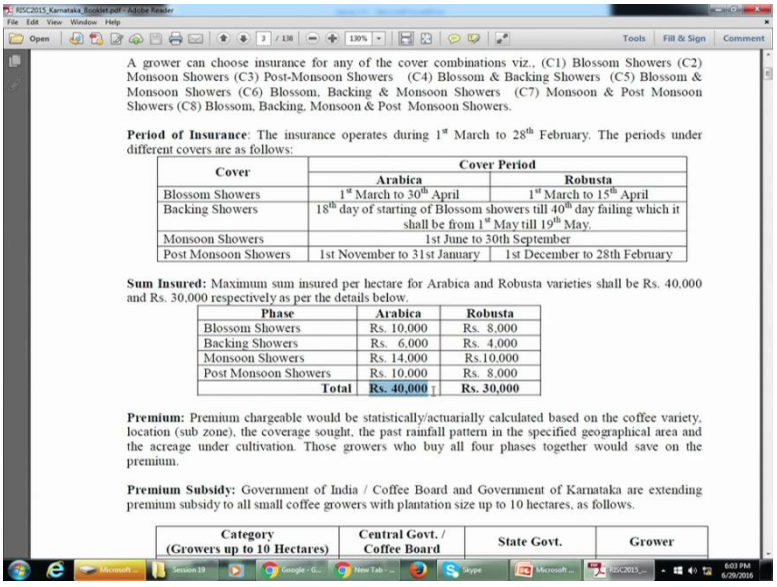

A grower can choose insurance for any of the cover combinations viz., (C1) Blossom Showers (C2) Monsoon Showers (C3) Post-Monsoon Showers (C4) Blossom & Backing Showers (C5) Blossom & Monsoon Showers (C6) Blossom, Backing & Monsoon Showers (C7) Monsoon & Post Monsoon Showers (C8) Blossom, Backing, Monsoon & Post Monsoon Showers.

Period of Insurance: The insurance operates during 1st March to 28th February. The periods under different covers are as follows:

Cover	Cover Period	
	Arabica	Robusta
Blossom Showers	1st March to 30th April	1st March to 15th April
Backing Showers	18th day of starting of Blossom showers till 40th day failing which it shall be from 1st May till 19th May.	
Monsoon Showers	1st June to 30th September	
Post Monsoon Showers	1st November to 31st January	1st December to 28th February

Sum Insured: Maximum sum insured per hectare for Arabica and Robusta varieties shall be Rs. 40,000 and Rs. 30,000 respectively as per the details below.

Phase	Arabica	Robusta
Blossom Showers	Rs. 10,000	Rs. 8,000
Backing Showers	Rs. 6,000	Rs. 4,000
Monsoon Showers	Rs. 14,000	Rs.10,000
Post Monsoon Showers	Rs. 10,000	Rs. 8,000
Total	Rs. 40,000	Rs. 30,000

Premium: Premium chargeable would be statistically/actuarially calculated based on the coffee variety, location (sub zone), the coverage sought, the past rainfall pattern in the specified geographical area and the acreage under cultivation. Those growers who buy all four phases together would save on the premium.

Premium Subsidy: Government of India / Coffee Board and Government of Karnataka are extending premium subsidy to all small coffee growers with plantation size up to 10 hectares, as follows.

Category (Growers up to 10 Hectares)	Central Govt. / Coffee Board	State Govt.	Grower

Duration of the insurance is very clearly mentioned this blossom shower period, which starts from 1st March to 30th April for Arabica and 1st March to 15th April for Robusta coffee, you have similarly backing showers, you have monsoon shower period and post monsoon shower period. And this particular table shows what is the insurance premium which these planters have to pay if they want to take coverage for all 4 periods or a any specific period. So if all 4 periods they have you are interested to take they have to pay for Arabica 40000 rupees per hector, this is the maximum some insured per hector. So they are going to get back, they are going to receive 40000 rupees per hector of coffee which is being planted by these planters.

Now and when the payment is going to happen the payment is going to happen only when there is a difference in the rainfall, so if the rainfall is beyond certain limit so this is the pay outs shall come in if the rainfall is below 25 mm for Arabica and 20 mm for Robusta during the specified period in 5 consecutive days and full pay-out is given if the rainfall is below 5mm. So if the pay-out shall commence, so commence means if the actual rainfall is less than 25 mm for Arabica coffee planters, so the insurance company is going to pay to the coffee planters some graded amount of graded amount of insurance. Only when the total rainfall is

less than 5 mm the coffee planters are going to get the full sum assured of 40000 per hector if the farmer has gone for an insurance cover for all 4 seasons.

So this is one example of a insurance contract. where the insurance company is going to make payment irrespective of whether the company, whether the planters have incurred loss or not, so just with respect to the rainfall, if rainfall is less than a given range the insurance company will start making payment to the coffee planters. However, most of the other insurance products are with respect to catastrophe related losses and even if they are do not cover catastrophic related losses they this companies insurance companies make payment only when actual loss has happened.

Now let us go to this particular slide as mentioned in this slide this weather risk does not emanate from catastrophic events like earthquake, tornado or flood, weather risk can emanate from ordinary variation in climatic conditions, so this is the highlight of the discussion that is weather risk emanate from ordinary variation in climatic condition, so temperature can vary and with the variation in temperature a company sales may go up or go down. So weather derivatives exchange traded weather derivatives are used to hedge these kind of a risk. So which are these risks are non-catastrophic in nature.

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Now let us go to two of the popular contracts which is traded at Chicago Mercantile Exchange, these 2 contracts are known as heating degree days and cooling degree days. So what exactly is a heating degree day contract or let us first understand, what is a heating degree day, which day can be categorised as a heating degree day? A day can be categorised

as a heating degree day if it is cool enough for people to start their heating appliances, let me repeat if it is cold enough for people to start their heating appliances then only it will be treated as a heating degree day. Similarly which day will be treated as a cooling degree day, a day will be treated as a cooling degree day only when it is hot enough for people to start their air conditioning, so that is your cooling degree day. So the contracts weather contracts traded at CME is based on these 2 concepts that is heating degree day concept and a cooling degree day concept.

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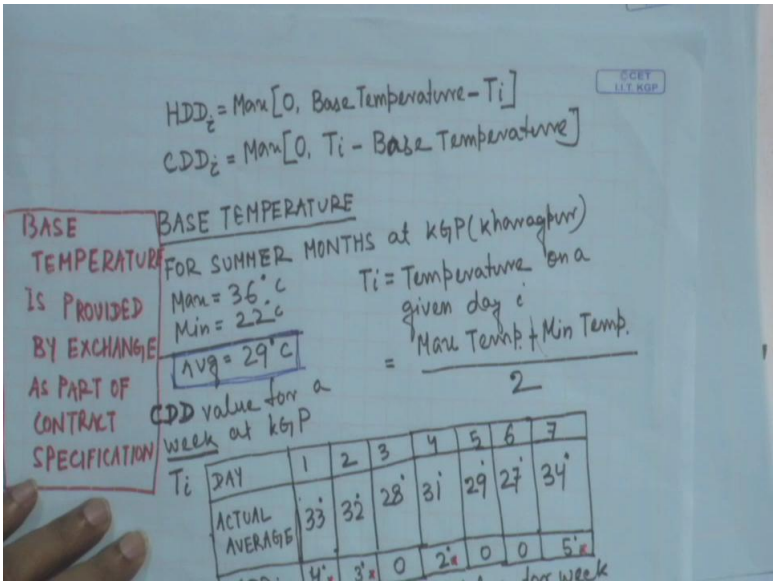

Now let us go and understand what little more about these 2 contracts. Now let us so as we mentioned a day will be treated as a heating degree day when the temperature is low enough for people to start their heating appliances. So how do we calculate what is the HDD value for a particular day, so please see this one this HDD heating degree day value for I, I is your for a given day which max of 0 comma base temperature - TI, TI is the temperature average temperature for a given day. So how do we calculate TI, TI is temperature on a given day I, so maximum temperature for + minimum temperature divided by 2. So if this TI temperature for a given day is who is low enough for people to start their air conditioning than only it will be treated as a heating degree days.

So how it will be what will be the value of HDD, so it will be max - max of 0 comma base temperature - TI. So how do we find out let us say the this base temperature is for Kharagpur, suppose we are calculating which day is HDD for Kharagpur, let us say base temperature we are going to take, let us say 37 degree. Base temperature if you take 37 degree centigrade, so if we are taking 37 degree centigrade and let us say this what is the TI value on a given day

suppose we find out given day it is average of high and low is 22 degree, so will it be treated as a heating degree day? So max of 0 comma base temperature - TI, 37 degree - 22 degree is 15 degree so will it be treated as a heating degree day, yes, so it will be treated as a heating degree day and the total value of HDDI will be 15 degrees centigrade.

Of course this we in Kharagpur probably we do not start we never require heating we never start any heating appliance because Kharagpur temperature does not go below so much that we require heating and specifically these contracts are for USA, so when there is excess snow and all and the temperature goes down the this base temperature and people start their heating appliances and it is categorised as a heating degree day. Now let us take this example, so let us say cooling degree day, so how do we say whether a day is cooling degree day or not, it will be max of temperature on a given day - base temperature. So if temperature on a given day average temperature of in a given day is higher than the base temperature than we treat it as a cooling degree day.

Now let us take an example of let us take an example, let us calculate CDD value for a week at KGP. So which day we will be calling as a within a week which days will be called as a cooling degree days. Suppose we take the base temperature as 29 degree centigrade, so somewhere let us say we are able to measure the temperature of prevailing at a Kharagpur, so there has to be a independent party who will be measuring a the temperature prevailing at Kharagpur, so highest temperature and lowest temperature recorded in a given day will be used to calculate the average temperature for that day and that will be denominated as TI.

So what is our base temperature, base temperature let us say we have taken 29 degree, so on a given day let us say the TI is 33 degree, so whether this one will be treated as a cooling degree day or not? Yes, it will be treated as a cooling degree day because it is more than 29 degree, so 33 degree - 29 degree which is your base temperature, so that is your 4 degree, so the value of CDD for day one is 4 degree. Similarly we have day 2 the average temperature is 32 this is more than 29, so we will have 3 degree as the CDD value for day 2. Day 3 what is a value, day 3 is your 28 degree, so it is the value of CDD is max of, let us focus on max of 0, TI - base temperature. So what is our TI, TI is 28 degree and T base temperature is 29 degree, so this side is - 1 degree so we will be only taking 0, we will not be taking max of 0 and - 1 is 0, so we will be taking 0 as your CDD value.

Similarly other days similarly it will be calculated and CDD value for Kharagpur for the week is 14 degree that is sum total of these seven days CDD values. So similarly from for

any place we will be able to calculate what is the CDD or HDD value, and this CDD or HDD value forms the basis of futures contract which gets traded at CME.

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Now please focus on this and if you see heating degree days futures contract will be traded only when only during winter months because if months are colder enough or cool enough for people to start their heating appliance than only it will be treated as a heating degree day. So HDD futures contract at CME has contract months for November, December, January, February, March, April and October ok there is a repetition, it should be January, February, March, April and October, November and December. Similarly CDD futures contract at CME will have has May, June, July, August, September.

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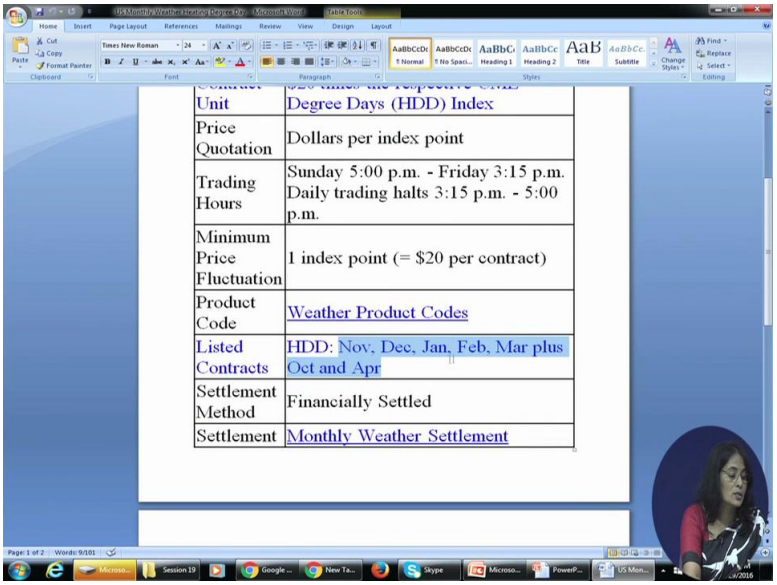

Unit	Degree Days (HDD) Index
Price Quotation	Dollars per index point
Trading Hours	Sunday 5:00 p.m. - Friday 3:15 p.m. Daily trading halts 3:15 p.m. - 5:00 p.m.
Minimum Price Fluctuation	1 index point (= $20 per contract)
Product Code	Weather Product Codes
Listed Contracts	HDD: Nov, Dec, Jan, Feb, Mar plus Oct and Apr
Settlement Method	Financially Settled
Settlement	Monthly Weather Settlement

And one interesting point about this temperature contracts are there these are the location specific. So summer months in USA will be will be winter months probably it will be winter in Australia, so if the CDD contracts will have the other months in Australia then which is being traded at at CME for US locations. So this is a day US monthly weather heating degree day contract specification I have downloaded, so what is a if you see which are the listed months, listed months are November, December, January, February, March and October, April, so October, November, December, January, February, March and April. And these are financially settled and what is how much settlement value or what is a contract unit dollar 20 times the respective CME degree day index.

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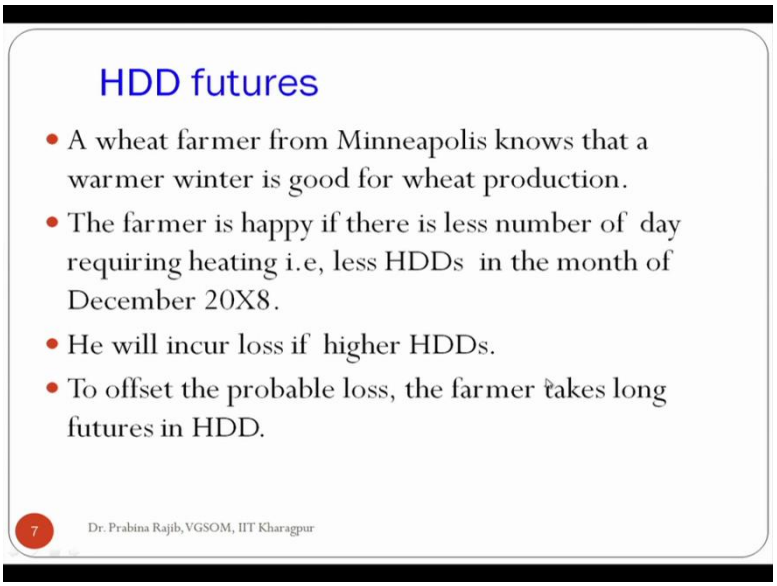

Now let us go to a real life example, so that we understand a little more on how these contracts are traded. Now let us say, HDD contract, how HDD contract is utilised by a wheat farmer. Let us say wheat farmer for Minneapolis knows that the warmer winter is good for wheat production, so if winter is relatively warmer than its quality as well as a quantity of wheat which is going to be produced is going to be good, so better quality and better quantity higher quantity wheat it will be able to produce.

Now the farmer is happy if there is less number of days requiring heating, so the months are or days are not cold enough for requiring heating, so if there are more number of heating degree days, this farmer is going to incur loss, let me repeat, if there are more number of heating degree days that means the days temperature is cold enough for people to start their heating appliances that means cooler days. So if days are cooler it is the farmer is going to incur loss, so how the farmer will be able to mitigate this risk by using the HDD contract. So

he will incur loss if HDDs are higher value, so the farmer will take long futures on HDD contract, if fear is true and there more number of days requiring heating, so he will be gaining from the futures contract.

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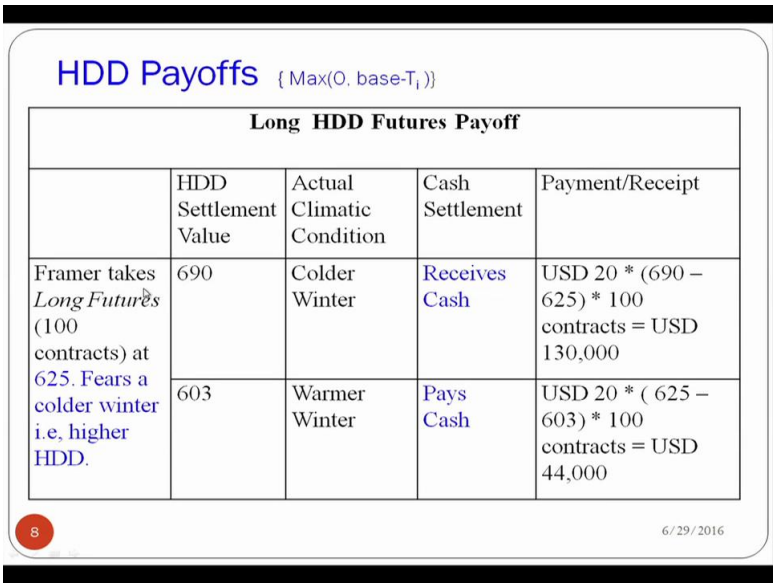

So please see this pay off, so the as you can see the long the farmer takes a long futures position on 100 contracts at 625 so HDD value is at 625 and the farmer fears that a colder winter is going to happen and he is going to be incurring loss in terms of the quality of wheat it is going to produce and maybe the quantity of wheat the farmer is going to produce, so the farmer took long futures at 625. Let us say the farmer fear came to be true and the HDD contract settled at 690, so when he has the farmer has taken a long futures contract somebody must have taken the short futures contract, so if the contract settles at that is HDD contracts value settles at 690, the farmer will receive cash from the counter party so how much cash he is going to receive, he is going to receive 20 dollar into the difference into 100 contracts.

So it took long futures at 625 and the futures value has gone up to now 690 and the farmer is going to benefit and the benefit amount is going to be coming to 130000 US dollar. Now let us say suppose the farmers fear has not been right and the farmer entered has entered into the farmer entered into the long futures contract and the contract closed at 603. Not many days require heating so you have this is warmer winter and you have the farmer will be paying cash, so how much cash the farmer will pay, farmer will pay 20 dollar into the difference that is 625 - 603 into 100 contracts, so that is coming to your 44000 dollar.

So this with this let me summarise what we discussed, we discussed about catastrophic weather related events which are managed by or this kind of risk gets mitigated by insurance contract, so change in weather parameter and leading to loss of revenue for some companies can be mitigated by exchange traded weather contracts and we started discussing what is a HDD contract and what is a CDD contract. And HDD contracts are those or a day can be treated as a HDD day if it requires heating, so if the actual temperature is less than the base temperature then only it will be treated as a heating degree day. And similarly in case of a cooling degree day if the temperature is high enough and more than the base temperature requiring a air conditions conditioners to be started then only it will be treated as a cooling degree days.

Ok, I maybe saying air condition need to be started but it need not be as long as the actual temperature is more than the base temperature; it is it will be treated as a heating degree day. So with this we come to an end of this session, we will continue with the next session with the remaining part of the weather derivative contracts and thanking all of you.