Commodity Derivatives and Risk Management
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Week-10
Lecture 49
Weather Derivatives (Rainfall & Hurricane)

Welcome to the 49th lecture on Commodity Derivatives and Risk Management. And today we are going to discuss more on weather derivatives related to rainfall and the hurricane derivatives and today's session is going to be the last session on different aspects related to the weather derivatives. Now let us understand how rainfall derivatives work. So, the rainfall index is the underlying for the rainfall futures contract or rainfall option contract. So, one has to calculate what is the rainfall index. Now let us understand how the rainfall index is calculated in the Indian context. Please note that in the previous two or three sessions related to weather parameters, I have extensively discussed weather contracts related to American market and European market because in India we do not have any weather derivatives trading as of now. However, at National Commodity Derivative Exchange, NCDEX is now preparing and reporting the India rainfall index. So, we will be understanding how this rainfall index is calculated and how futures contract on this rainfall index can be developed. Let me also share here with all of you that as of now there is no derivative exchange traded derivative contract on rainfall in India for that matter any other weather related parameters, but going forward I feel that these exchanges are going to very soon introduce contracts on weather parameters like the way different kind of contracts futures and option contracts on cooling degree days, heating degree days etcetera are traded in USA exchange. So, now let us understand how National Commodity Derivative Exchange calculates and reports India rainfall index. Please note that to calculate the India rainfall index, NCDEX calculates what is going to be the rainfall value for a given day. So, what is the rainfall value for a given day? That is the actual value of rainfall on that day minus the normal value for that day. So, how exactly the normal value will be calculated for a given day? Let us take an example let us say 24 June 2023, the normal value of rainfall for this particular date is going to be the average of actual rainfall on the same date during1992 to 2022.Please note that we are finding out what is going to be the normal value for the year24 or for the date 24 June 2023 and we will be using the value actual rainfall value for the last 30 years ranging from 1992 to 2022 for the same date. So, the normal value is going to be calculated as the average sum total of the actual rainfall over the last 30 years divided by 30. So, that is going to be the normal rainfall value. Now what is going to be the daily rainfall value? So, daily rainfall value for a given day that is going to be the let us say 24 June 2023is going to be actual rainfall on 24 June 2023 minus the normal value. So, as weas the

formula indicates, this index for a given day can be positive or negative. So, the daily value for a given day is going to be actual rainfall minus the normal rainfall for that day. Let us assume that on 24 June 2023 the normal rainfall based on the last 30 years average is 25 millimeter actual rainfall suppose on 24 June is 38 millimeter then the daily value is going to be 13 that is 13 and if the actual rainfall is 10 millimeter the daily value is going to be negative 15.So, this is how the daily value for the for daily rainfall value for a different days will be calculated by national commodity derivative exchange. Now coming to the rain index daily value is not the index the rain index values for a given day is the sum of the daily rainfall value from the beginning of month up to the date. So, let me give an example let us say we want to find out what is going to be the index value Indian rain index value on January 1. So, January 1 rain index value is going to be daily value is 4 Indian rain index value is going to be 4. Let us say January 2 daily value is going to be minus 3. So, the rain index is going to be 1. So, as you can see let us say January 6 the daily value is positive value of 6, but the Indian rain index is negative value. So, this particular panel is the actual data which I have downloaded from the NCDEX website, and this blue line indicates the daily value in the month of January 2023.So, month of January I think month of January 2020. So, this 2020 data value daily values are given as you can see someday you have a positive value negative value, and the orange line indicates the indicates the day index value Indian rain index value. So, again please note that this index value is set to 0 at the end of the month. So, this is again the plot of the rain index for the year 2020 to 2023 for 4 years that is 2020 to 2023 for the month of January. So, as you can see the rain index for the month of January almost is negative that means, compared to other 3 years in the month of January India has experienced the lesser rain. Similarly, the for the month of February the in the index starts at a 0 and the index values for a different month of February is calculated again this particular table shows this particular panel shows the movement of the India rain index for the month of February. This data which I have downloaded from the national commodity derivative exchange this is freely available for any one of you is interested to understand more on this Indian rain index and the calculation of it is also available in a PDF file over there. Now this is just a precursor to the calculation of the rain index the exchange is yet to introduce any futures and option contract on this rain index, but I feel it is very in very soon this exchange is going to introduce futures and option contract on this rain index and if the exchange introduces long futures position and short futures position will be parties will be entering into long and short futures position. So, depending on if somebody is fearing that high rainfall is going to be harmful or low rainfall is going to be harmful for them, they will be able to enter into long or short futures contracts. These contracts will be working much like our other contracts on temperature and snowfall frost etcetera we discussed in the previous lecture session. So, now let us discuss very interesting aspects on derivative contracts on hurricanes and whenever I have discussed this particular concept in the class students get really excited

to understand or know how exactly somebody can enter into futures contract on hurricanes. So, this starts with measuring the severity associated with hurricanes, please note that the severity of hurricanes is measured by a scale which is known as your Saffir Simpson hurricane scale or SSH scale developed in the year 1969.This scale measures the sustained wind speed for a given hurricane and based on this scale the National Hurricane Center of USA categorizes the hurricane on a scale of 1 to 5.And as you can see if a particular hurricane has a wind speed of more than 119 kilometer and less than 153 kilometer per hour it will be categorized as a category 1 hurricane. Similarly, a hurricane will be, or hurricane or a cyclone will be categorized as a category 5 hurricane if it is expected to approach more than 252 kilometer per hour as a wind speed. So, based on this wind speed, the National Hurricane Center used to categorize the hurricanes into category 1 and category 1 to category 5. Subsequently a new index called Carville Hurricane Index or CHI index was used to measure the impact of hurricane. So, this particular index calculates or uses two parameters, that is your maximum sustained wind speed for a particular hurricane that is the value of v, and this v is compared with the base sustained wind speed of 74 miles per hour. In addition to the sustained wind speed this particular measure also considers the radius of force wind and that is denominated as r and this r is also compared with a base value of 60 miles. So, these four values v, v 0, r and r 0 is used and the formula is given here thus you know Carville Hurricane Index this formula is mentioned here.Honestly speaking I do not know exactly how this3 by 2 to the square all this is arrived, but if you are more interested to understand about this Carvill Hurricane Index you can go and browse the internet to know exactly the logic or the rationale behind this particular formula. So, the index is calculated for a named hurricane. Please note that all hurricanes are nowadays, or all cyclones are nowadays named. In this context, please note that the naming of the cyclones is done by the world meteorological organization and this particular organization has started the process of naming hurricanes or cyclones. Please note that all oceanic disturbances are not assigned with a name. There are many hundreds and thousands of oceanic disturbances happening all over the world regularly in different oceans. So, all disturbances are not assigned within name. Please note that an oceanic disturbance will be known as depression if it has a maximum wind speed less than 63 kilometers. Some depression will graduate to a storm and when the maximum wind speed becomes more than 63 kilometers per hour and at that point in time the name will be given to a particular storm or cyclone before that there will be no name. Now who gives this name please note that the names are always crowd sourced from different countries. For example, the names of cyclones originating from Indian Ocean has been crowd sourced from the countries which may be affected by that particular hurricane or cyclone each country basically gives 10 names. As you can see this particular lower panel, I have taken from the world meteorological organization website. So, this list or this table shows the cyclones which will be emanating from Arabian Sea and the Bay of Bengal. So, the contributory nations the names have come from

Bangladesh, India, Iran and Yemen. So, these are some 10-11 countries which have contributed 10 names each and as you can see the names which have been contributed by Bangladesh is Nisarg, Biparjay, Arnab and Uppakul. In fact, there are other 6 names and I have not collected I mean I have not I am not showing those detail because this is not relevant at this point in time. And as you as we are recording this particular video, or this particular session people are discussing Biparjay. So, this is how the world meteorological organization gives a name to a particular cyclonic storm. And more detail about this naming convention naming details is available in the weblink given here. And please note that naming cyclones also helps in quick identification of the names as names are easier to remember. And media reporting about cyclones makes it easier with the name because it helps for a better preparedness by the government. So, earlier maybe some 8-10 years ago cyclonic storms and hurricanes did not have a name, but now all storms or all hurricanes are given a name. And once a name is given it becomes easier for the government to talk about it, it becomes easier for media persons to report the intensity of this particular storm. So, it is it gets an easier visibility a particular storm gets a easier visibility with a name and of course, leads to better preparedness by the government. And ok I just gave the example of the names which are emanating from I gave the example of the names for those hurricanes which are emanating from Arabian Sea and Bay of Bengal. So, world meteorological organization collects names for each of this category and for each category there will be about 10 to 12 countries who will be contributing names for cyclones emanating from let us say central north pacific names will be given by some countries for that matter or western north pacific and south China sea names will be contributed by some set of countries. Now coming to the interesting aspect of the futures contract on hurricane, Chicago Mercantile Exchange offers futures and option contract on hurricane the block which I have taken this is again a directly I have taken a snapshot from the CME website. As you can see from the index future the index future has 1000 times respective CHI basically 0.1 CHI index point is equivalent to 1000 dollars. And futures trading for a named storm starts when it becomes category 2, please note that before that the there will be no futures contract available for trading CME will not be basically listing a contract on a hurricane or a cyclone unless it becomes a category2.And this particular contract this futures contract on the named hurricane will terminate after 2 calendar days following the exit of storm from the designated area. So, unlike standard futures contracts or option contracts where you have a fixed maturity these futures contracts do not have any fixed maturity period. And an independent organization called EQECAT of USA uses the data provided by the national hurricane center to calculate the CHI values for a given named hurricane. And the actual CHI value if somebody has taken into long futures position or a short futures position that particular point is compared with the actual CHI value to decide whether a long futures position holder is going to get money or pay money from the counterparty. As mentioned, every 0.1 point of CHI value is equivalent to your 1000 US dollars. Now one may ask who

would take long or short futures position on a hurricane index futures and options. Let us say for other weather parameters such as temperature there will be companies who will be interested to enter into long or short future positions because their business is getting affected because of the temperature. For example, let us say higher cooling degree days let us say somebody is fearing that cooling degree days are going to be higher. Let us say higher cooling degree days hot summer happens some companies would benefit, and some company companies would lose. For example, companies will be happy if the summer becomes very hot which needs a higher cooling degree day. So, AC, cooler, fan manufacturing companies power generation companies' beer and sub drink manufacturing company they will be very happy if summer becomes very hot. Who will be the unhappy ones: movie hall companies, restaurants, tours and travels these companies are going to lose business. So, depending on their expectation regarding whether the summer months are going to be hotter or milder this company will be entering into a long position in CDD or short futures position in CDD contracts. Now in this context one may ask who would lose and who can gain from a higher value of hurricanes. Please note that to enter into to ensure that the derivative contracts are traded there should be somebody who would be benefiting from something and somebody who would be benefiting from the underlying asset price movement. So, as you can see nobody benefits from the higher hurricane. In fact, many would lose if the hurricane value were much higher. There will be lot of devastation power companies will be losing there I mean the I mean many companies will be losing business if hurricane values are significantly higher. So, there are going to be many people who would be interested to take long futures position or a long call option on hurricanes. As no one benefits from the hurricanes there will be nobody who would be interested in taking a short futures position or a short call or other derivative positions. So, trading in hurricane futures and options is feasible only when some speculator is willing to take a counterparty position. Unless speculator is there there will be no trading in the hurricane futures or option contracts. Now coming to this another aspect of these weather contracts please note that the weather contracts are predominantly trade in OTC market. There is an exchange called weather exchange. Please note that this is not a commodity derivative exchange, this is just a company name which is known as a weather exchange. This particular exchange creates many weather-related indexes, and these indexes form the basis for the weather contracts. More about this particular company and the interesting indexes this particular company creates is available in this web link. I have just chosen two interesting indexes which are used by companies to mitigate the weather-related risk. For example, wind gust index and critical low wind average index. So, what is this wind gust index does? This index derives its value from the daily maximum wind gust speed over a threshold level. If the maximum wind speed is greater than the threshold level the index value increases. Many cranes operating companies are using this index to mitigate the risk. Please note that if the wind gust speed is higher crane companies crane operating companies will not be able

to do their business, they will lose their business. So, they will be the ones who would be interested into to enter into OTC derivative contracts when the underlying is wind gust index. Similarly, critical low wind average index. This is again as you can see this index derives its value from the actual wind speed below the threshold level. And major normally this particular index is major near a specific location of wind farm and many wind farms are major user of this particular index. As you can understand, these wind farms will be incurring business loss if there is not enough wind, they will not be able to generate electricity. Now coming to the last interesting or important aspect of pricing of futures and option on weather parameters. In the last three sessions I have just explained the nuts and bolts associated with the trading of weather parameters, but how one would go about pricing these contracts I have not discussed. The logic behind not discussing is as follows. Please note that weather parameters which are underlying the futures and options are different from standard commodities underlying such as crude oil, natural gas, gold, silver etcetera. And the cost of carry models is used for pricing future contracts and the black 76 model for option valuations are also we have discussed extensively cost of carry model and black76 model for valuing futures and options. Please note that these two models are not applicable to weather contracts, we cannot use these pricing models to value the futures contract or option contracts. The logic for not being able to use these standard models is because weather parameters are neither tradable nor physically deliverable. There is no spot market or spot price. Hence there is no supply or demand function to arrive at the spot price and none of these underlying parameters weather parameters can be stored. Hence the cost of carry model or black 76 model or black Scholes option pricing model which requires basically the underlying asset return to follow a normal distribution. The cost of carry model requires that the underlying commodity can be stored. So, these basic assumptions will not hold true for weather parameters. Hence, we cannot use this standard model to price futures and options. So, what people do is that they basically generate thousands of scenarios they undertake simulation exercises, and they generate thousands of scenarios to arrive at the expected value of the weather parameter and that expected value they take into consideration for putting a price for trading this futures and option contracts. So, with this we will end our discussion related to futures and option contracts related to weather parameters. We discussed temperature contracts, we discussed rainfall, snowfall, frost contracts, we also discussed hurricane contracts. So, with this we will be ending our discussion related to weather parameters and derivative contracts related to weather parameters. In the next session we will be discussing more on electricity as a commodity and derivative contracts and spot trading of electricity. With this I end today's session and I am eagerly looking forward to interacting with all of you in the next session. Thanking all of you.