Commodity Derivatives and Risk Management
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Week-10
Lecture 48
Weather Derivatives (Snowfall, Rainfall & Hurricane)

Welcome to the 48th lecture on Commodity Derivatives and Risk Management. And today we will continue with the discussion related to weather derivatives, but we will be focusing more on snowfall, rainfall and hurricane derivatives. Now let us little bit of we discuss what we have discussed in the last two sessions. Please recall that in the previous two sessions we focused on temperature contracts which are basically heating degree day and cooling degree day contracts. We discussed HDD and CDD monthly futures contract, HDD, CDD seasonal strip futures contract. We also discussed cumulative average temperature monthly as well as seasonal strip contracts. And we also discussed how companies' business volume gets affected because of the change in temperature. For example, some companies will be incurring less business if the summer is very cool, or summer is very hot. Similarly, many companies' business will be affected if the winter is milder, or the winter is severe. For example, beer sales companies will incur loss if the summer is very cool, or summer is milder summer. Similarly, golf course owners will be incurring loss in their business if the summer is very hot and very few people will be coming to their course to play golf. Now coming to the milder winter companies which are in the business of manufacturing woolen garments they will be incurring loss in their business if the winter is milder. Similarly, electricity distribution companies may incur losses when the winter is very severe because many a times the power lines snap because of the excessive cold or snow. So, in the previous two sessions we focused more on understanding these temperature contracts and how companies utilize derivative contracts on these weather parameters on temperature contracts to benefit from the risk they are facing. Now let us discuss other derivative contracts on weather parameters. But before we go into understanding more on snowfall, rainfall and hurricane futures contract, let us again revisit our discussion related to weather derivatives and weather insurance. In fact, at the cost of repeating this particular aspect I would like to again highlight the importance of weather derivatives and weather insurance. And let us take an example of what is the difference between weather derivatives and weather insurance. Please note that let us say a woolen garment manufacture does good business when the winter is very cold, and its fear is milder winter. Similarly, it fears a lower HDD value or heating degree day values. Now let us say in August 2023, the company is fearing that the month of December 2023 is going to be very milder it is not going to be very colder December month. Hence, it takes a short HDD futures contract in December 2023. Now let us say

the fear comes true and the winter is milder with lesser heating degree day values. It receives money from the counterparty as part of the futures contract. And it may so happen that the design of the woolen garments manufacture was so good that the company did good business. The winter was not severe, the company was fearing that it would lose business, but the designs of its garments were so good that the company still did good business. There is no loss from the actual business, but still it received payment from the counterparty as part of the HDD futures contract. Now let us come to the next situation or the other situation where the particular company's fear is not true. The winter was really cold with very high HDD values. So, it paid money to the counterparty as part of the futures contract. It may so happen that the designs were not good, and the company sales were not up to the mark. Winter was cold enough, but it was not able to do good business because its products were not demanded by the people in general. However, still this company had to pay money to the counterparty. So, the payment and receipt from the HDD futures contract will always be based on the temperature difference between the future contract and the actual temperature. So, if the actual temperature and the contracted temperature value with the future contract is different one party will pay the money to the other party. However, this is where the weather derivative contract differs from the weather insurance in the sense weather derivative contracts are easy to administer because any change in the temperature one party will pay the money to the other party and if it is an exchange traded contract the exchange will ensure that whatever payment is supposed to be made to each other party it will be done. In that sense the weather insurance contracts are also different, or this is where the weather insurance contract differs from the weather derivative contract. One receives payment from the insurance company only when there is an actual loss. Please note that in case of weather insurance if there is a loss then only one party will be getting money, but in case of a derivative contract if there is any difference in temperature one party will make the money payment to the other party. Even the party which is receiving money or paying the money has not incurred any loss or benefit. Now let us understand when a company decides to go for an HDD or CDD futures contract how many contracts it is going to buy or sell. So, that is a very important or most tricky part associated with any temperature contract. Now let us first understand how the price risk is managed through a normal commodity futures contract. Let us take an example of a let us say an ice cream parlour which has many ice cream parlours in the Las Vegas area of America. Let us say during April 2023 this particular company is expecting that the powder milk price is going to go up and the company's requirement is about 200,000 kgs of powder milk by May 2023. So, standing on April 2023 this company is fearing that the powder milk price is going to go up. Now to mitigate the risk let us say on 14th April 2023 the company will enter into a long futures contract on powder milk for the for 200,000 kgs as underlying. Let us say every futures contract has about 1000 kg as underlying. So, this company will enter into 200 contracts of long futures contract on powder milk. And of course, our assumption

related to the 200 contract comes from the understanding that the company is using a hedge ratio of 1. Suppose the company uses the hedge ratio of 0.75 then the company would enter into a long futures position for 15 contracts. So, as you can see the number of future contracts to be bought and sold is pretty straightforward to understand. Now, let us come to the central point what we are discussing at this point in time that is how many temperature contracts to be bought and sold by a company. Now let us say the same company, which is in the business of selling ice cream, the same company is fearing that the summer months are going to be cooler. Basically, the summer months are not going to be hot enough for people to demand or eat ice cream. So, it wants to take a short futures on CDD contract. Now the company has to decide how many CDD futures contract it must sell to mitigate the risk associated with cooler summer. Now the decision related to the number of CDD contract is not so straightforward like the risk associated with the milk powder price increase. Now the ice cream company has to first identify the relationship of its revenue with the temperature. Basically, it has to answer this question that is how much of its revenue is affected by the temperature that is how much of its revenue is affected if the summer is milder. And the answer to this question can come only by historical data analysis. So, the company has to do historical data analysis relating to the or modeling the relationship between temperature and the number of units of ice cream sold in the Las Vegas area. Now let us assume that the average daily temperature in the summer months in Las Vegas area is around 98-degree Fahrenheit. And based on the historical data analysis, the company finds that every 1-degree Fahrenheit decrease in the temperature from the average temperature leads to a 2 percent decline in revenue. So, this is what the analysis the company has to do from historical data, and this is going to be the beginning point on which the company will decide how many HDD or CDD futures contract it will take. Let me repeat here the company has to identify how many units of sales it is going to get with every decrease in temperature. So, for example, every 1-degree Fahrenheit decrease in the temperature the average revenue falls by 2 percent. Now let us say the company is expecting revenue of about 220,000 US dollars during the months of May and June 2023. So, now on 14th April 2023 the company feels that during May and June 2023 the average daily temperature is going to be around 94-degree Fahrenheit which is 4 percent or 4-degree Fahrenheit below the average 98-degree Fahrenheit. Hence the expected revenue loss for both months of May and June is going to be 35,200 and that has been calculated as 440,000 US dollars revenue into 4 degrees into 2 percent. And this 440,000 dollars revenue is coming for the both month with the assumption that that every month the company generates sales of about 220,000. Now please note that every 1-degree Fahrenheit per day is equivalent to 600 dollars for 1 CDD futures contract. Please recall that in the earlier sessions we have discussed that every 1 degree is equivalent to 20 dollars as part of the futures contract specification. So, if the company is going to make a loss of 35,200. So, the company would undertake about 58 futures contracts, or it would sell 58 futures contract and the

logic is very clearly explained that is 35,200 divided by 600. Now let us say on 14th April 2023 the May June strip CDD futures contract is trading at 1920 and the company took short futures contract at this value of 1920. Now on option 1 let us say what is going to be the actual temperature on 30th June 2023 when the contract expires. Now on 30th June 2023 on the contract expiry date let us say the underlying is at 1875. So, the ice cream company is going to get money or receive money from the counterparty to the tune of 52,200 dollars and the calculation is self-explanatory. Similarly, let us go to the other alternative where on the 30th of June 2023 the 2 months strip contract closes at 1950 in that case the ice cream company will be making payment to the other counterparty that is the long futures position by 34,800. Now let us come to another interesting contract on weather parameters which is futures contract on frost. This futures contract on frost is also a location specific contract and it is also offered only during winter months and the underlying to this particular futures contract is a frost index point. Now let us take an example of how Chicago Mercantile Exchange goes about calculating the frost index for a specific location. Now let us take the case of frost index for Amsterdam, Netherlands and a frost index point for CME frost index Amsterdam will be recorded whenever any one of the 3 or more than one condition is satisfied, and this condition related to the weather is mentioned here. The 3 weather conditions are the temperature at the morning 7 AM local time should be less than 3.5 degree centigrade less than below 3.5 degree centigrade. So, other 2 conditions are mentioned here. So, on a given day if any of the 3 conditions is satisfied then that is going to be considered as a frost index point and the temperature will always be measured at a specific location even in Amsterdam the location frost index point can vary from location to location. So, the contract specification also mentions at which specific location the frost index will be measured. So, as per the contract specification of CME it is at Schiphol airport in Amsterdam. So, if any one of the 3 conditions happens at Schiphol airport Amsterdam, then that particular day will be calculated as a frost index day. As I mentioned if any or more than one condition is met the index value increases by one for example, let us say for the month of November if 9 days out of 30 days satisfy one or more of this condition CME frost indices for November month is going to be 9. And every contract has a size of 10000-euro times the frost index. So, this particular frost index futures contract is for Amsterdam hence the contract specification is related to the euro. And if a number of frost days are higher than it negatively affects some companies and those company will enter into long futures contract for example, companies belonging to the aviation tourism and agriculture they will enter into long futures contract on frost. And if a smaller number of frost days negatively affects a company those companies will take short futures contract on frost days. Companies selling hot copy benefit from the colder days similarly gyms surge in clientele during the colder months. So, this kind of company will enter into a short futures contract. Now with this let us come to another derivative contract which is on snowfall please note there is a difference between the frost index and a snowfall index.

And snowfall in a location is measured using the water equivalent method and in this particular method snowfall is measured in a gauge containing antifreeze solution. And as soon as the snow falls in this particular gauge the snow melts and the amount of water in that gauge measures the snowfall. So, for measuring the snowfall index at a particular location it will be measured through the water equivalent method. And there are standard benchmarks to convert the water level in inches to the snowfall in inches. So, any location the company the Chicago Mercantile Exchange wants to offer a snowfall related futures contract it will install the snowfall gauge where the if any snowfall happens those snowfall will be collected in those gauges and from those gauges the snowfall index will be calculated. So, companies which are fearful of losing business due to higher snowfall will take long futures contract. Similarly, companies which lose business if snowfall is not enough will take short futures contract. For example, ski resorts and companies selling snow removal equipments and companies also selling salt used to remove snow in work paths and driveways. These companies will be incurring losses if there is not enough snow hence these particular companies will be entering into the short futures contract. With this let's understand how companies utilize different derivative contracts to mitigate their volumetric business risk. This is a case study with respect to a company called Bombardier Incorporation and the snowfall index option. Please note that in the previous slide we discussed the futures contract on snowfall and in this case this particular company the Bombardier Incorporation, use snowfall index option to mitigate the volumetric risk. In the year 1998 Bombardier Incorporation of Canada anticipated that there is going to be mild winter with less snowfall and this company Bombardier Incorporations sells snowmobiles. So, the image of the snowmobiles is given here. So, it was fearing that it is going to be mild winter with less snowfall and customers will not be buying snowmobiles. So, to motivate customers to purchase its snowmobiles so, it offered about 1000 dollars discount coupons. It assured customers that if it did not snow enough then the customers will get 1000 dollars cash back and this probable cash discount offer increase the actual sales by 38 percent. Now, the company had committed to customers that if there is not going to be enough snow it is going to return 1000 dollars cash back. So, to cover that expense this particular company that is Bombardier Incorporation, entered into a long-put option on snowfall index with a counterparty. As the option contract stated that if there is going to be less snowfall the counterparty is going to pay the Bombardier as if the actual snowfall is below the trigger label. In the year 1998 the snowfall was normal, and Bombardier Incorporation did not have to give cash back to its customers nor did it have to exercise the long-put option which it had bought. As mentioned, its revenue increased by 38 percent and more than the option premium it had paid to its counterparty. Let me repeat because of this particular long put option the company's sales increased by 38 percent and to buy the long-put option it had to pay a option premium and the increase in the revenue by 38 percent is much more than the option premium it had paid to the counterparty. So, this is an example of how index

option on snowfall was used by a company to mitigate the volumetric risk. Now, let us come to another interesting example similar to Bombardier Corporation where the proof garment company of USA entered into a CAT option that is your cumulative average temperature option contract. Please note that the weatherproof garment company was a newer braced manufacturer of sweaters jackets and coats. It supplies this item to major retail chains in the USA. And during 2006 December the winter was not very cold hence retailers returned merchandise to weatherproof as there was not enough customer to buy these sweaters jackets etcetera. Hence the revenue of this particular company weatherproof garment declined by 30 percent due to warmer winter. Now anticipating the similar warmer winter in the year 2007 December weatherproof bought call option on CAT contract for New York City. And as part of this option weatherproof would receive 10 million US dollars if the actual temperature is higher than the strike temperature value. Please note that the company was expecting that the winter is going to be milder, and the temperature actual temperature is going to be higher. So, that is a reason it entered into a call option on cumulative average temperature contract for New York City. Now during 2007 the there was a new contract was issued by the company called the New York not much of the summer was cooler sorry the winter was cooler and the weatherproof did its business as usual and it did not have to exercise the option. However, this particular option contract helped the company in many ways weatherproof use this option contract as a marketing tool. This is the innovative part of this particular case study. The company used the option contract as a marketing tool it promised the retail partners that in case the winter is warmer and weatherproof receives 10 million US dollars from the long call option it would share this particular payoff with actual with the retail partners. So, this made it easier for the retail partners to stop the weatherproof items compared to its competitors. So, this example related to weatherproof company and the bombardier company goes on to indicate that how companies are utilizing this derivative contract on various weather parameters to mitigate the risk associated with the volume of business they do. With this we will come to an end of today's session we will continue with the session related to hurricane and rainfall in the next session again I eagerly look forward to interacting with all of you in the next session.