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WEATHER DERIVATIVES IN INDIA -A PROPOSED MODEL

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Abstract **:** Most of the industries in the world are directly or indirectly exposed to adverse weather conditions. Weather has become quite unpredictable due to increase in global warming and the burning of fossil fuels. As a result, farmers are affected and the agricultural output becomes very irregular and this increases losses not only to the farming sector but also to the related industries. Although the weather is uncertain and cannot be controlled, there exists a new solution to the adverse financial effect that it can have on the incomes of economic liaisons of developed and emerging economies. There are number of instruments and tools available for management of weather risk such as weather risk insurance but it is not a full proof solution to hedge weather risks. Weather Risk Management market is the most dynamic sector of the financial arena and is drawing the interest of the companies that are seeking to protect against the financial impact of non-catastrophic weather. So, for hedging risk of weather, weather derivatives have been developed. Weather derivatives could provide a solution towards effectively hedging against the adverse weather conditions. Therefore, this paper is developed to overview the concept of weather derivatives market and efforts are also made to propose a hedging model with Heating Degree Day (HDD) Index and Cooling Degree Day (CDD) Index technique in the Indian derivative market.

Key Words- Weather, Weather Risk, Weather Futures, Weather Derivatives, Weather Insurance, DD, HDD, CDD, Index, Hedging

INTRODUCTION

In the current era of digital trading one can trade stocks, currencies and commodities. Physical commodities are bought and sold directly in the real market whereas commodity futures are a bit different and fall into the category of online trading. Online trading of commodity futures gives the traders a new platform to stabilize prices and give producers and buyers of commodities to hedge their price risk. With the advent of time and introduction of futures market the prices have become more volatile and unstable which gives the investors an opportunity for easy entry and exit. The prices of these commodity futures are determined by market forces, supply and demand. Commodity futures market play a very vital role in any economy as the futures contracts perform important function of price discovery. A new kind of derivative called Weather Derivatives was introduced in the year 1997 by Aquila Energy as a weather option embedded in a power contract. Weather derivatives are financial instruments that can be employed by businesses or individuals as part of a risk management strategy to mitigate the risk of poor or unexpected weather. It is unlike other derivatives in the way that the underlying asset (rain/ temperature/ snow) has no direct value to price.

Farmers can use weather derivatives to hedge against poor harvests caused any uncertain event; the parks may want to insure against rainy weekends during extreme summer seasons; and gas and power companies may use heating degree days (HDD) or cooling degree days (CDD) contracts for even earnings. Moreover, companies are exposed to many different weather risks besides just temperature and precipitation. The creation of new weather derivatives to address these other risks will become increasingly important in the future. However, the knowledge of derivatives in itself is very limited to certain segments of the society, cut shoot the weather derivatives. In spite of many challenges, it's high time the government should take steps and speed up the process of introducing weather derivatives in India too. But, unlike other financial markets, Weather Derivatives market do not have any standard pricing models. Many market players have developed their own models which they use only for their purposes and rarely share with others.

So, considering weather derivatives as an important tool for hedging risk of adverse weather conditions, a hedging model is proposed with HDD and CDD Index technique in the Indian derivative market.

LITERATURE REVIEW

Sandy fe (2011) in her article "Commodity Trading" mentioned the evolution of technology in trading commodities and explained how a trader should start dealing in commodity derivatives and also mentioned the pros and cons of technology in commodity trading.

Schofield N (2007) provides a detailed and accessible resource for anyone working in or researching commodity markets and its associated derivatives in his book "Commodity Derivatives: Markets and Applications." Each chapter aims on how the products could be used along with the physical supply chain and seeks to identify the main market risks and how they can be hedged. The book then brings into view how the structuring banks can hedge their own resultant exposure and analyses the attraction of OTC investment structures for the wholesale market.

Dr. Behera C (2015) conducted a study on "Price Discovery and Market Efficiency in Indian Futures Market" to examine the efficiency of Indian futures market in discovering price in the spot market with respect to metal and energy commodity futures. The data is collected from official website of MCX, Mumbai. The study period is from September 1, 2005 to December 30, 2011 for gold, silver, copper, and crude oil and November 1, 2006 to December 30, 2011 for natural gas futures. Granger Causality test shows that the price discovery takes place in the futures market of the respective commodities. Standard deviation test reveals that except for gold, future prices of all other commodities are more efficient in transferring information to spot market. Thus, the study was concluded as futures market being more informationally efficient in all commodities except in gold market.

Lokare S M (2007) in his paper "Commodity Derivatives and Price Risk Management: An Empirical Anecdote from India", has done a study on the commodity markets. Efforts are made to test the efficacy and performance of commodity derivatives in steering the price risk management. The hedging proves to be effective in few products traded with a considerable amount of risk, whereas a large number of speculators also find a level playing in the field. He has noticed that the commodity markets in India are progressing at a slower pace.

Singh I (2015) in his article titled, "Impact of Derivatives on Spot Market Volatility: A Case of Indian Agriculture Commodity" studied to understand the impact of future derivative contracts on the spot returns & volume of agriculture commodities and its trend, as well as to understand the relationship between spot and future market of agriculture commodities. Data of daily spot prices (returns), future trading volume and open interest of the selected agricultural commodities i.e., Chana, Pepper, Jeera, Chilli, Soya Bean, Mustard Seed are taken. There exists of autocorrelation in the series. The results indicate that there is high cointegration among spot returns, volume and open interest of all the commodities studied. Thus, there is a strong relationship between the series and hence the study leads to a significant price discovery and risk management.

Mahalik M K, Acharya D and Babu M S (2014) in their study titled "Price discovery and volatility spillovers in futures and spot commodity markets: Some Indian evidence" tried to examine the effectiveness of futures market in serving the price discovery function and volatility spillovers in Indian spot-futures commodity markets. Data of four indices-MCXCOMDEX, MCXAGRI, MCXENERGY and MCXMETAL are used obtained from MCX, Mumbai. It is found that Future price index of LAGRIFP, LENERGYFP and LCOMDEXFP effectively serve the price discovery function in the spot market. There is no cointegrating relationship between metal future and spot price index. EGARCH model shows that volatility spillover exists from future to spot in any future market but the reverse exists in the case of LAGRI index. Hence, the futures market plays a vital role especially in the case of effective price discovery.

Paul J (2013) in her article "A Study on the Feasibility of Weather Derivatives in India" conceptually studied the feasibility of weather derivatives in the agricultural sector in India and concluded that Weather Derivatives in India has a long way to go but few issues are there in implementing it, which need to be tackled.

Choksi A (2012) studied the emergence of weather derivatives as an alternative hedging tool in her article titled "Emergence of Weather Derivatives-Feasibility in Indian Context". She also focused on various issues related to risk management in agriculture like failure of crop insurance in India, as well as Feasibility of Weather derivative contracts.

Ray P (2016) took ahead the study "Weather Derivatives – A Need for Indian Farmers?" by comparing and contrasting the concepts of weather insurance and weather derivatives. He has also put some light on ways that might lead to the success and widespread acceptance of weather derivatives in India. It is concluded from the literature that there exists basis risk which need to be solved through various technological improvements.

Pandey V K and Kaur H (2013) conducted a study on "Weather derivative: A New Market Innovation" analyzed the growth of weather derivative market from energy to non-energy sectors like agriculture, entertainment, retail etc. This research indicated that Weather derivatives can become very useful to risk managers who understand options and the risk profile associated with buying and selling weather options relative to their business. It also suggested that farmers can use this product for hedging against the risk relating to weather fluctuation.

Francis G. (2019) in his article "A study on Emerging Trends in Indian Derivative Market" he analysed the derivative market and its recent developments in the Indian commodity markets where he concluded that there is a significant contribution of derivatives to financial system and Indian economy.

Datta B S (2018) in his research article titled "Feasibility and Deterrents of Weather Derivatives- A Review in the Indian Context" studied in the Indian context where he overviewed the concept of weather derivatives and also discussed its prospects and the factors deterrent for its usage. He concluded that if the limitations are worked upon and subsequently removed, weather derivative should find a good market in India and should also be able to address the concerns of the farmers alike.

Dutton (2002), conducted a study on "Opportunities and Priorities in a New Era for Weather and Climate Services" which relates the sensitivity of weather to the various economic sectors. According to the paper published by him approximately a little more than 30% of the United States economy is some way or the other related to the vagaries of weather. Though popular in the weather trading universe his work was more qualitative rather than quantitative.

Larson (2006) took ahead the study done by Dutton and tried to quantitatively define the effect of weather. In his report "An evaluation of the Sensitivity of US economic Sectors to Weather" he tries to prove qualitatively by using econometrics that different economic sectors are affected by weather risks. He used Monte Carlo Simulations study, transcendental logarithmic functions (TRANSLOG) study to suggest the dependency of different economic sectors on weather. He also studied the effect of weather in different regions and came to the conclusion that the effect of weather was different for different economies in different regions.

Štulec I (2017) in his article "Effectiveness of Weather Derivatives as a Risk Management Tool in Food Retail: The Case of Croatia" reviewed available weather risk management solutions in retail, present weather derivatives as non-catastrophic weather risk management tools, empirically demonstrated the process of designing weather derivatives and assessed their effectiveness as risk mitigating tools in retail. Empirical analysis is performed on beverage sales in 60 large food stores in Croatia, and performance of monthly temperature put options during the summer season is examined. For weather sensitivity analysis of sales, the method of panel regression was employed by the author. Results indicate that weather has a statistically significant effect on beverage sales and hence weather derivatives prove to be effective in reducing the uncertainty in beverage sales. Their effectiveness differs between periods and cities taken.

Prabhakaran S and Singh J P (2017) in their article "Modeling and Pricing of Weather Derivative Market" studied the modelling and Pricing of Weather Derivative Market using a stochastic process. They constructed the temperature model under Ornstein – Uhlenbeck process that is driven by a Levy process rather than a standard Brownian motion is investigated. They also discussed how weather forecasting and seasonal forecasting could potentially improve our valuation of weather derivative contracts. It is concluded that Weather risk has some specificities compared to other sources of economic risk: in particular, it is a local geographical risk, which cannot be controlled. Moreover, weather risk is often referred to as a volumetric risk, its potential impacts being mainly on the volume and not on the price.

Andrea S M, Antonia M and Rodon T (2020), examined the rightness of suggesting the Gamma distribution to price rainfall contracts by applying the Index Value Simulation technique and the viability of using a unique distribution to model the rainfall risk of regions located nearby in their article titled, "Approaching rainfall-based weather derivatives pricing and operational challenges". The results suggests that the most convenient choice depends on the period and location considered, although the mixed exponential appears as a reasonable option in most cases. It also concluded that given the insufficient degree of correlation between nearby locations, rainfall risk hedging measures may rely on compound derivatives referred to several neighbor stations.

Sergio C, Jesus S, Carlos V and Rafael B (2020), in their article titled "Pricing rainfall derivatives in the equatorial Pacific", tried to develop a complete framework suitable for valuing rainfall derivatives in the equatorial Pacific using vector generalized linear models (VGLM). Esscher transform is also employed to price rainfall derivatives. The results prove more accurate than those of Markovian gamma models based on purely statistical descriptions of the daily rainfall probabilities.

From the above literature review, it is observed that there is enormous amount of literature on derivatives trading considering the commodity market in India. However, there is research gap related to weather derivatives especially in Indian context. It is also observed that there is no universal technique of pricing the weather derivatives globally.

RELEVANCE OF THE STUDY

Weather derivative which is a popular concept in the western side of the globe and is gradually gaining momentum can possibly be of help to the Indian farmers and many other industries which are affected by weather. Weather events can be categorized as catastrophic and non-catastrophic. The purpose of weather derivative is to insure the companies and individuals against such non calamitous events which occur repeatedly. It is the most dynamic sector of the financial arena and is drawing the interest of the entities that are seeking to protect against the financial impact of non-catastrophic weather. So, for hedging weather risk, weather derivatives have been developed. Thus, weather derivative can be considered as an effective tool to minimise risk created by unanticipated weather and avoiding negative impact of weather variability on the profitability of the businesses.

Considering the importance of weather derivatives, this study aims to overview the concept of weather derivatives. In the Indian context, weather futures would prove to be immensely beneficial in eliminating the loss arised due to adverse weather conditions. Therefore, it will discuss about the usefulness of weather derivatives in Indian context and suggest a hedging model with HDD and CDD technique in the Indian derivative market.

OBJECTIVES OF THE STUDY

The Indian commodity market is gaining its significance day by day. Previously main focus was on the commodity market, but with advent of time and increasing globalization, many sectors felt the need of commodity futures market. However, in spite of India being one of the leaders in commodity futures market, still there exist concern regarding the application of Weather derivatives. Application of weather derivatives in Indian commodity market is necessary for the investors, traders and many other organizations to diversify and hedge their weather-related risk exposures. Considering the importance of weather derivatives in Indian derivative market, the objectives of the paper are:

1. To overview the concept of weather derivatives.
2. To examine the concept of HDD and CDD with its calculation process.
3. To suggest a hedging model with HDD and CDD technique in the Indian derivative market.

SCOPE OF THE STUDY

The scope of the study will be limited to Weather Derivatives as a hedging instrument in India. The study will be undertaken to overview the concept weather derivatives in Indian commodity market using this instrument for hedging weather risk. Also, to understand the HDD and CDD techniques and to suggest these techniques as a prospective weather hedging model in Indian commodity market.

LIMITATIONS OF THE STUDY

- This study will be conducted to suggest a hedging model with HDD and CDD technique in the Indian derivative market.
- As Weather derivatives is not yet implemented in India, so the study is basically suggesting a model for implementation with respect to HDD and CDD techniques.
- The figures taken to analyze the suggested model using HDD and CDD technique are imaginary figures.
- The data collected for the study is bounded to 2 months (62 daily day weather observations) only.

RESEARCH METHODOLOGY

Research Design

The study is descriptive and analytical in nature. It is based on secondary data collected from websites Delhi Weather Station. The reliability and validity of the study depends upon the methods used.

Data Source and Sample Design

The study is based on secondary data. The source of data includes raw weather data (minimum and maximum temperature) obtained from Safdarjung, New Delhi weather station to analyze the HDD and CDD technique as a suggested model in Indian commodity market.

Some imaginary contract values have been taken to give a proper explanation to the suggested model.

Data Period

The time period considered for undertaking the study is 62 days (2 months i.e., January 2021 and May 2021). Degree Day is calculated taking the minimum and maximum temperature of 62 days, to examine the CDD (May 2021) and HDD (January 2021) index techniques for hedging weather risk in Indian context.

Tools for Analysis

Degree day Indices is used to form the underlying asset for pricing the weather derivatives. In this model maximum and minimum temperatures of a day are taken to calculate the average temperature. The difference between the temperature of a given day and a temperature threshold is calculated to calculate the value of HDD and CDD. The market for weather derivatives is a typical example of an incomplete market, because temperature itself cannot be traded, and so one cannot form a parallel between temperate and equities. Therefore, the market price of risk is to be considered, in order to obtain unique prices for such contracts. Because there isn't yet an actual market from which to collect prices, we'll assume that the risk market price is constant for the sake of simplicity. Furthermore, it is assumed that a risk-free asset is given with constant interest rate r and a contract that for each degree Celsius pays one unit of currency.

WEATHER RISK

The climate change such as Rain, Snow, Heat, etc is creating big losses to those corporate, whose production and Revenue depends a lot on the unexpected shift of such climatic changes. Companies involved in agriculture, energy, aviation, construction, mining, event management, tourism etc. face revenue risk due to adverse weather events.
Weather risk does not only emerge from catastrophic events like earthquake, tornados or flood. Weather risks also emerge from ordinary variations in climatic conditions which are non-catastrophic in nature such as temperature, rainfall, humidity, snowfall etc. In a 1998 testimony to Congress, former commerce secretary William Daley stated, "Weather is not just an environmental issue; it is a major economic factor."

- Beer sales in India drops significantly if summer is mild.
- Hydroelectricity companies generate lower revenue if rainfall is low
- Mining companies halt mining operation when there is heavy rainfall
- Construction projects are subject to cost overruns because of weather induced delays.

WEATHER DERRIVATIVES- A Weather Risk Hedging Instrument

The unexpected change in the weather has created a great threat to the profitability of the industrial houses whose revenue depends on the weather to the great extent and at the same time it has created the opportunity for the investor who wants to trade on these weather fluctuations. Weather derivatives are used to hedge weather risks that are non-catastrophic in nature. It helps companies to mitigate volumetric risk – risk associated with decline in sales volume.
Until recent times insurance was considered to be the main tool for protection against unexpected weather conditions. But it was only the protection for the catastrophic damage. It failed to protect the loss against the reduced demand that business experience as a result of weather that is unexpected. Considering the loss due to routine weather fluctuations, the concept of weather derivative was developed. This is a fascinating innovation in the financial market making pre-specified pay-outs if pre-specified weather events occur. Futures are legally binding agreements to buy or sell an asset at a certain date in the future.
The value of the contract depends upon the weather conditions like rainfall, temperature snow etc. The underlying asset for weather derivatives is weather measure which depends upon the nature of individual contracts. (Paul Jayeeta, 2013) differentiated it from other derivatives on the basis that the underlying assets in weather derivatives does not have a direct value to price. Weather derivatives include those listed on Chicago Mercantile Exchange (CME) and those available as over-the-counter contracts. Three market makers for over-the-counter weather products are Koch, Aquila and Southern Company. The CME listings are based on temperature. OTC contracts can be structured on temperature, wind, rain, etc.
Generally, the weather derivatives depend upon:

- Heating degree days: HDD days is the measurement premeditated to reflect the requisite of energy to heat a building which is directly proportional to the quantity of HDD in that location.
- Cooling degree days: CDD days is the measurement premeditated to reflect the requisite of energy to cool a building.
- Precipitation or snowfall over a given period of time

HDD AND CDD AS A DERIVATIVE MODEL FOR HEDGING WEATHER RISK

The CME offers Heating Degree Day (HDD) and Cooling Degree Day (CDD) futures contracts and options on futures for monthly and seasonal temperature related events. HDD futures and options are traded on the Autumn and winter months of October through April, while CDD futures and options are traded on the spring and summer months of April through October.

Base temperature is given in the futures contract specification Actual temperature is measured by independent agency and the same is applied by independent agency to the exchange. The contract will also mention in exact location within a city where temperature will be recorded to calculate the actual temperature Degree Day (DD)- It measures a day's average temperature on a midnight-to-midnight basis.

Heating Degree Day (HDD)- It measures the coldness of the daily temperature compared to 65 deg. F

Cooling Degree Day (CDD)- It measures the warmth of the daily temperature compared to 65 deg. F.

Daily HDD= Max (0, 65-DD), Daily CDD= Max (0, DD-65)

Where, DD= $\frac{Maximum\ Temperature+Minimum\ Temperarture}{2}$

HDD Index- It is the sum of daily heating degree days over a month.

CDD Index- It is the sum of daily cooling degree day over a month.

Contract Value- The notional value of HDD/CDD futures is Rs.100 times the HDD or CDD index. The contracts are quoted in HDD/ CDD index points.

Therefore, HDD Index Contract value= HDD Index x Rs.100.

The minimum change in contract value is one HDD or CDD index point, each valued at Rs.100.

EXAMPLE OF HEDGING WITH FUTURES

HDD Futures

Table – 1.1- Calculation of HDD with base Temperature 65 Degree F

January	Max	Min	DD	Daily HDD
1	65	37	51	14
2	62	0	31	34
3	60	51	55.5	9.5
4	72	56	64	1
5	68	58	63	2
6	69	59	64	1
7	68	52	60	5
8	62	53	57.5	7.5
9	67	53	60	5
10	61	48	54.5	10.5
11	62	49	55.5	9.5
12	54	48	51	14
13	62	34	48	17
14	66	40	53	12
15	68	45	56.5	8.5
16	65	45	55	10
17	58	46	52	13
18	67	51	59	6
19	68	47	57.5	7.5
20	63	49	56	9
21	72	47	59.5	5.5
22	63	42	52.5	12.5
23	67	50	58.5	6.5
24	58	47	52.5	12.5
25	63	47	55	10
26	68	43	55.5	9.5
27	69	45	57	8
28	66	42	54	11
29	69	42	55.5	9.5
30	70	44	57	8
31	75	41	58	7
January CDD Index				296

(Source- https://www.wunderground.com/)

In the Table 1.1 the average temperature i.e., the degree day for the month of January 2021 has been calculated and thereafter Daily HDD is calculated taking the base temperature as 65 deg. F. The table 1.1 shows that the HDD index for the month of January is 296. HDD index for the month of January is the sum of daily HDD of the month.

Table 1.2- HDD Payoffs {Max(0, base-Ti)}

	HDD Settlement Value	Actual Climatic Condition	Cash Settlement	Payment/ Receipt
A farmer takes Long Futures (50 contracts) at 296 for the month of January 2021	330	Colder Winter	Receives Cash	Rs.100 x (330-296) x 50 contracts= Rs.1,70,000
	265	Warmer Winter	Pays Cash	Rs.100 x (296-265) x 50 contracts= Rs.1,55,000

(Source- Authors' estimations)

A wheat farmer knows that a warmer winter is good for wheat production. The farmer is happy if there is less number of days requiring heating i.e, less HDDs in the month of January 2021.The farmer will incur loss if higher HDDs. To offset the probable loss, for example the farmer takes long futures in HDD. Table 1.2 shows the payoff structure of HDD if the farmer takes long futures of 50 contracts at 296 (Refer Table 1.1) for the month of January 2021. As per the analysis if the contract settles the following month at 330 (i.e., colder winter) then the farmer would show a gain of 34 HDD index points time Rs.100 per tick or Rs.1,70,000 on 50 contracts of January month. However, if the contract settles at 265 (i.e., warmer winter) then the famer would a incur loss of 31 index points and pay Rs.1,55,000 for 50 contracts purchased of January HDD index. At the same due to favorable weather condition the farmer can earn more profits from adequate wheat production in the spot market. This is how a farmer and other companies affected by colder winter can hedge their risk using the hedging instrument known as weather derivatives.

CDD Futures

Table 2.1- Calculation of CDD with base Temperature 65 Degree F

May	Max	Min	DD	Daily CDD
1	105	84	94.5	29.5
2	103	79	91	26
3	101	78	89.5	24.5
4	105	79	92	27
5	103	80	91.5	26.5
6	103	73	88	23
7	95	74	84.5	19.5
8	101	76	88.5	23.5
9	102	78	90	25
10	98	79	88.5	23.5
11	103	78	90.5	25.5
12	98	76	87	22
13	94	74	84	19
14	99	76	87.5	22.5
15	101	77	89	24
16	103	74	88.5	23.5
17	99	78	88.5	23.5
18	86	75	80.5	15.5
19	74	0	37	-28
20	88	70	79	14
21	90	70	80	15
22	95	67	81	16
23	92	75	83.5	18.5
24	96	73	84.5	19.5
25	101	77	89	24
26	103	75	89	24

27	105	0	52.5	-12.5
28	101	80	90.5	25.5
29	98	82	90	25
30	98	80	89	24
31	102	79	90.5	25.5
May CDD Index				614

(Source- https://www.wunderground.com/)

In the Table 2.1 the average temperature i.e., the degree day for the month of May 2021 has been calculated and thereafter Daily CDD is calculated taking the base temperature as 65 deg. F. The table 2.1 shows that the CDD index for the month of May is 614. CDD index for the month of May is the sum of daily CDD of the month.

Table 2.2- CDD Payoff Max{0, Ti-base}

	HDD Settlement Value	**Actual Climatic Condition**	**Cash Settlement**	**Payment/ Receipt**
A construction company takes Long Futures (50 contracts) at 614 for the month of May 2021	656	Hotter Summer	Receives Cash	Rs.100 x (656-614) x 50 contracts= Rs.2,10,000
	587	Colder Summer	Pays Cash	Rs.100 x (614-587) x 50 contracts= Rs.1,35,000

(Source- Authors' estimations)

A tea making company fears a hotter summer in the month of May. It knows that a hotter summer day may decrease his sales volume. The company is happy if there is less number of days requiring cooling i.e, less CDDs in the month of May 2021. The company will incur loss if higher CDDs. To offset the probable loss, for example the tea making company takes long futures in CDD. Table 1.2 shows the payoff structure of CDD if the company takes long futures of 50 contracts at 614 (Refer Table 2.1) for the month of May 2021. As per the analysis if the contract settles the following month at 656 (i.e., hotter summer) then the company would show a gain of 42 CDD index points time Rs.100 per tick or Rs.2,10,000 on 50 contracts of May month. However, if the contract settles at 587 (i.e., colder summer) then the tea company would a incur loss of 27 index points and pay Rs. 1,35,000 for purchasing 50 contracts of May HDD index. At the same due to favorable weather condition the company can earn more profits from increased sales volume in the spot market. This is how a company affected by hotter summer can hedge their risk using the hedging instrument known as weather derivatives.

CONCLUSION

There are many challenges to the effective use and management of weather futures. Most importantly pricing models for weather derivatives exist at many levels of sophistication and implementing this instrument in India is a big question. In this paper we tried to propose a simple model which can give a rough idea of what weather futures is all about and a technique that can be used to hedge weather risk should cost. Weather derivatives can be very useful to risk managers who understand the risk profile associated with buying and selling weather futures relative to their business

While the CME is listing only CDDs and HDDs, Aquila can design OTC contracts on rain, snowfall, wind, etc. From the analysis of the proposed technique of HDD and CDD it can be concluded that if an instrument like weather derivatives is introduced in Indian commodity market with proper planning and execution regarding tools, methods for calculation and its pricing, it will improve the weather risk management market of the country. Weather derivatives will be helpful not only for farmers but all other companies who are exposed to adverse weather conditions due to which their sales volume, revenue and costs are affected.

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