GLOBAL APPLICATIONS OF WEATHER DERIVATIVES

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Abstract: *Recent innovations in capital markets suggest the possibility of addressing agricultural risk factors by issuing derivatives on weather elements. Such instruments appear particularly attractive, as asymmetric information and loss adjustment issues do not affect them. This article describes the concept, types and world experience in application of weather derivatives.*

Keywords: *Weather derivative, CDD, HDD, weather option/futures contract, weather risk management.*

Weather derivatives are financial contracts that can be utilized by businesses or individuals to mitigate the risk of poor or unexpected weather situations. These are also financial derivatives with a difference that the underlying asset, which could be rain, temperature, snow, wind or a combination of two or more, has no direct value to price the weather derivative, unlike other derivatives. The weather derivative contracts are tied to the weather indices and these weather indices are created by the help of the weather information provided by meteorological stations. This means that the meteorological stations' role is crucial and hence, the data manifested must be reliable to the best level possible.

The financial market related to weather, as per the Weather Risk Management Association (WRMA), has two main key aspects: managing the financial repercussions of harsh weather for those having direct exposure to weather, and commercial dealing in weather, both on its own and in concomitance with a wide range of commodities.

Like any other financial derivative contract, the weather derivative contracts can be in the form of Futures, Forwards, Options and Swaps. And, the indices on these contracts may be based on any of the following[1]:

Temperature- The most common types of temperature-based indices used heating degree days (HDD) and cooling degree days (CDD), where the base temperature is regarded as 18 degrees Celsius or 65-degree Fahrenheit, worldwide. Some may also be utilizing normal departure index (NORDIX) which denotes how "normal" or "strange" a given year or occurrence is whilst collating it to the long-term average for the region or area under examination. Apart from these, simply, maximum, minimum or average daily temperatures are made use of.

[1] Datta, B. S. (2018). Feasibility and Deterrents of Weather Derivatives-A Review in the Indian Context

Precipitation- An index based on precipitation is employed for the areas where rain or snow are prominent to the weather derivatives market participants who wish to hedge from weather related risks. Indices of such derivatives contracts are based on rainfall and snowfall levels.

Wind- Several weather derivatives contracts are also based on wind speed along a specific direction, wind farm output and variance, that is, variability is the wind.

The risks that industries confront differ, as do the sorts of indices that they use. For instance, the energy industry is exposed to temperature risk and so is the beverage industry, whereas agriculture businesses are, mostly, exposed to rainfall risk and so is the transportation business, ski resorts are exposed to snowfall risk and likewise. However, it is observed that maximum of the weather derivatives contracts is based on temperature-based weather indices, indicating the lion's share of 98%, while those based on rain, snow and wind merely account for 0.9%, 0.5% and 0.2%, respectively (Choudhary & Nair, 2017). And, the utmost used underlying is the Degree Days, specifically, Heating Degree Days (HDD) and Cooling Degree Days (CDD).

The HDD index employed during winter months and gauges the cold waves. A higher index indicates a colder day, showing higher demands for heating as a corollary and vice versa. Therefore, it can be computed as:

HDD= (0, Base temperature- Actual temperature), i.e.,

HDD= (0, 65° F- T)

This means that the payoff would be zero in case the actual day temperature is more than base temperature and in case the actual day temperature is lower than the base temperature, the payoff would be the difference between the two.

The CDD index, per contra, is made use of during the summer months and measures the heat. A higher index denotes a higher temperature, indicating more demand for cooling and vice versa. It can be computed as:

CDD= (0, Actual temperature- Base temperature), i.e.,

CDD= (0, T- 65° F)

This means that the payoff would be zero if the actual day temperature is less than the base temperature and it would be the difference between the two if the actual day temperature is more than the base temperature.

All weather derivative contracts delineate the following essentials:

- the location of the contract;
- the underlying;
- the strike price, that is, the predetermined price at which the derivative contract will be bought and sold at the time of execution of the contract;
- the expiration date, that is, the last day the derivative contract is valid;
- notional value, indicating the total amount of the underlying.

Many countries have introduced weather derivatives due to a growing

attention towards climate-related risks has fueled demand for financial products that safeguard against severe weather and climate-related effects.

The US is not only the first one to trade in weather related instruments but also witnesses the preponderance of weather derivatives transactions, both exchange traded and OTC traded. In 1997, Koch Energy and Enron signed the first official agreement on weather derivatives.[2] And, the first standardized future contracted was introduced in September, 1999 and was traded on the Chicago Mercantile Exchange.[3]

With temperature-based futures and options, the Chicago Mercantile Exchange Group provides centralized clearing and eliminates counter party risks along with price risk management, price transparency, liquidity, making it cost effective for the participants to deal in such products. Weather derivatives have been said to be the swiftly growing derivatives market, as per the CME (Chicago, 2006). Further adding that the major end users of weather derivatives have been utility companies; agricultural markets, on the other hand, have a lot more historical data than utilities. As a corollary, weather derivatives are increasingly being used to cover agricultural commodities and livestock. Weather futures contracts might be used to simply offset much of the risk in agricultural commodity volume, resulting in higher revenues for farmers and others in the agricultural industry.

In Canada, weather derivatives were started to be used by farmers as a way to manage weather related risk, especially in the higher crops like seed. Although weather derivatives were focused quite late by farmers, they were first developed in 1990 as a method for the energy sector to protect against temperature-based demand variations. Other businesses, including retail and tourism, such as ski resorts, soon adopted them as well. In 1998, a non-energy company, a Canadian snowmobile company, became one of the first to employ derivatives. Since then, energy industry participants have traded standardized weather contracts on established exchanges, and interest in non-standardized agreements addressing specific weather risks is expanding at a rapid pace.

Mexico had also launched weather derivatives witnessing the instrument's pros and had also used weather indexes to reinsure crop insurance in the past. The Mexican agricultural insurance programme (Agroasemex) used weather markets to reinsure a portion of its multiple crop insurance plans in 2001. By Using temperature and rainfall-based weather indices, considering several major production regions, a weather index that was in accordance with the experience pertaining to loss with crop insurance in Mexico was constructed. This reinsurance approach using weather instruments has proven to be effective in the country and the traditional reinsurance was found to be less efficient.

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[2] Cao, M., Li, A., & Wei, J. Z. (2003). Weather derivatives: A new class of financial instruments. Available at SSRN 1016123

Europe is also gaining speed in the growth of participants and contract types in the weather market. Most growth has been evident in France and the United Kingdom, followed by Scandinavia and Germany, as well as Sweden. Over time, there has been an improved availability of weather-related information provided by eight UK and three European sites. Howbeit, the majority of European trades are still over-the-counter (OTC) instead of exchange traded contracts. A report by Weather Risk Management Association (WRMA) in 2002 portrayed that while temperature-related hedge remained the most prominent; the share of contracts for rain, snow, and wind had climbed.

However, in Europe, weather derivatives have been less popular than insurance schemes. But they are regarded as efficacious for protecting against the risk associated with weather unpredictability, and they may become even more appealing in future climates featured by higher fickleness and frequency of harsh weather. Considering the stretched-out list of businesses that are exposed to risks associated to weather, Norway also incorporated weather derivative instruments in the financial markets. Various firms in the area of energy production and consumption, supermarkets, agriculture and leisure are making use of weather derivatives to protect themselves from revenue-draining weather. Although, weather data is provided by well-established meteorological stations, there are still discrepancies in weather related data,[4] therefore, the users cannot have complete reliability over such information. But it is suggested by numerous studies that the careful usage of weather derivatives would prove to be beneficial.

Weather derivatives have been successful to intrigue other parts of the world. Asia has experienced an upsurge in this field; however, weather derivatives in Asian countries are underdeveloped. The first agreement, in Asia, on wind speed was made for a wind power plant. Specifically, in Japan, the majority of transactions have come from non-energy sectors, with banks serving their role for

intermediation between end users and weather risk management companies. Weather risk management approaches, such as weather derivatives, appear to be in demand, according to several perspectives, in developing countries such as China.

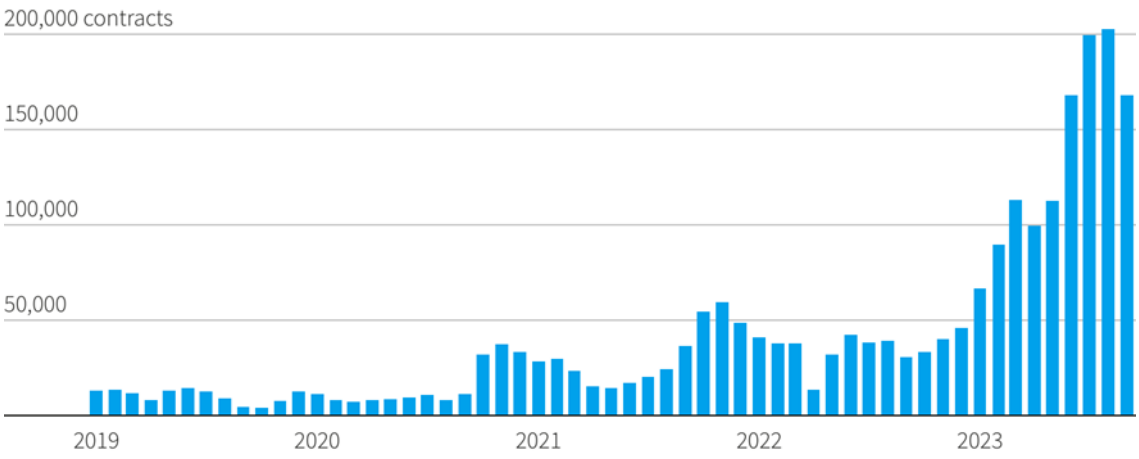
Numerous deals in Australia have engaged power retailers. Undoubtedly, the energy and power sectors have benefited the most from the weather derivatives. Weather derivatives have given cover against losses caused by excessive heat, in case electricity prices may skyrocket.

Not just the above-mentioned countries, but various others have commenced the use of weather derivative products at some levels or are

[4] Undli, H., & Schatvet, M. (2018). *Using Weather Derivatives to Hedge Precipitation Exposure for a Norwegian Hydropower Producer* (Master's thesis, NTNU).

planning to launch them considering uncertainties and losses to individuals and businesses that can be attributed to weather. Even though the market development internationally is laggard, the consideration and acclimatization of weather derivatives in different countries prove that the pavement of growth will continue to build up.

Exchange traded weather futures and options per month[5]



Source: CME Group | Reuters, Oct. 3 | By Harry Robertson

In October, 2023 average open interest in CME weather futures and options contracts in September was around 170,000 contracts, although market participants reckon 90% of the weather derivatives market is in over-the-counter deals.

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