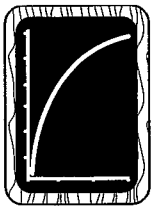


LEARNING CURVE®

Using Weather Derivatives To Mitigate Financial Risk

Although we get droughts, floods, fire, cyclones, snow and ice, economic adversity is not restricted to disaster conditions. A mild winter can ruin the earnings of ski resorts, dry weather can reduce crop yields, and rain can shut-down the entertainment and construction industries. Weather risk is one of the biggest uncertainties facing businesses.

Industry Impact

Consider the following report published in the financial pages of *The Australian* on 18 April: "Shares in **Harvey Norman** fell almost 4% yesterday as a cool summer and a warm start to winter cut into sales growth at the furniture and electrical retailer's outlet... Investors were expecting better and marked the shares down 3.8% to a low of USD3.55."

Agricultural Impact

Another illustrative report, published in *The Australian Financial Review* (AFR) on 8 May, that observes how "the Australian sugar industry is facing its fifth difficult year in a row." The article comments that a drought is "dashing hopes of an improved crop in Queensland, where 95% of Australia's sugar is grown." In an interesting acknowledgment of the complex manner in which weather affects agriculture, the AFR reports that, in Australia, whilst "dry weather during the May-December harvest period is ideal for cane, wet weather during this time causes the mature cane to produce more shoots and leaves, reducing its overall sugar content". Nevertheless, in recent years we have seen: wet weather damaging crops to such an extent that the cane was left in the fields in 1998, and continued wet weather causing damage in 1999.

In 2000, early rain in October associated with orange rust disease, and in 2001, continued adverse impact of the orange rust.

Mitigation

Weather forecasts may be used to manage risk associated with short-term activities, such as pouring concrete, and climate forecasts may be used to manage risk associated with long-term activities, such as sowing crops. As **Warren Buffett** said of the *Noah Rule*: "Predicting rain doesn't count, building arks does."

Now businesses can use weather derivatives to mitigate the risks. These businesses include energy and power, agriculture and agrochemicals, viticulture, brewing, clothing, construction, theme parks, retail food and drink, tourism, sporting, outdoor entertainment, water authorities, and irrigation.

Defining Weather Derivatives

Weather derivatives include futures, forwards, call options, put options, and swaps. The underlying variables are temperature, precipitation, wind, and the most common contracts are heating degree days (HDDs), and cooling degree days (CDDs).

This protection is achieved because a weather derivative contract, when applied as a hedge, sets limits on how far revenues can fall and expenses can increase. On the other side of such a contract may be a speculator, to whom the risk has been transferred in return for a reward.

Alternatively, on the other side of the contract may be another hedger, who wishes to protect against loss associated with the opposite scenario. So, like all derivatives, weather derivatives may be used to transfer risk from those who are involuntarily exposed to unwanted risk to those who have a traditional familiarity with risk.

The Growing Challenge

It is the energy sector, especially in the U.S., that has, so far taken advantage of the growing weather-risk market. But, the interest is spreading to other sectors of the economy.

For many years, the power industry in Australia has received detailed weather forecasts from the met office. The first Australian weather derivative was traded about two years ago. A number of businesses have now moved into the trading of weather risk products, almost all over the counter, and partnerships have been formed between merchant banks and weather forecasting companies.

Examples

Suppose that our cane grower has experienced an extended period of drought and that if rain does not fall next month, a substantial financial loss will be suffered.

One hedge, utilizing weather derivatives, could be to purchase a monthly rainfall put option. We shall assume that

Derivatives Week is now accepting submissions from industry professionals for Learning Curve®, the tutorial for new or potential users of derivatives. For details and guidelines on writing a Learning Curve®, please call **Jeremy Carter** in London at 44-20-7303-1753 or **Matthew Tremblay** in Hong Kong at 852-2912-8097.

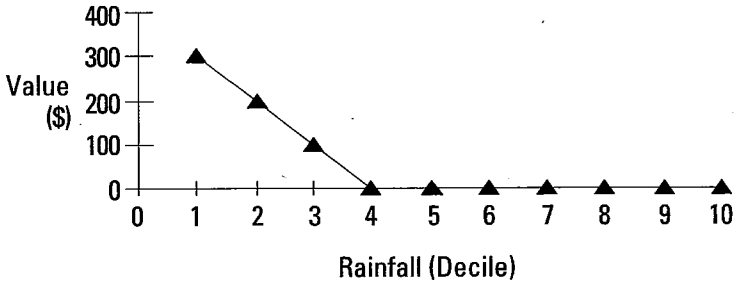
our cane grower decides only to take this action when there is already a risk of a dry month, that is, the current month's Southern Oscillation Index (SOI) is substantially negative. For the purpose of determining what might be the option's fair value, the example is applied only to the cases when the current month's SOI is in the lowest 5% of possible values, that is, below minus 16.4 mm.

Firstly, let us define our weather derivative contract thus:

- **Location:** Burdekin (on the central Queensland coast)
- **Type of asset:** Rainfall (Decile)
- **Strike:** Fourth decile
- **Expiry:** One month
- **Notional:** USD100 per decile below the fourth decile

If, at the expiration of the option contract, the actual rainfall is less than the strike price, the seller of the option pays the buyer USD100 for each decile that it is below the fourth declile. This is illustrated in the graph below.

Pay-Off Chart For A Monthly Rainfall Decile 4 Put Option.



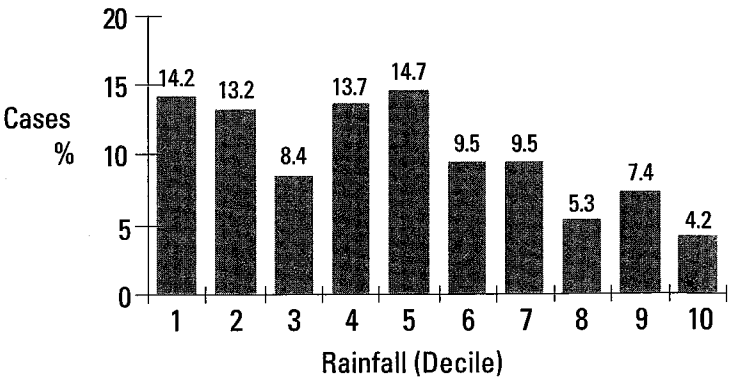
We now determine the price of our put option contract by employing historical simulation of the outcomes. We note that, since rainfall records began at Burdekin in December 1886, there are 1,385 months with rainfall records, of which 95 were preceded by months with an SOI below minus 16.4

The frequency distribution of historical outcomes for those 95 cases is presented in Figure 2, and illustrates the enhanced chance of dry weather associated with a strongly negative SOI (for example, a 14.2% chance of the first decile in contrast to a 4.2% chance of the tenth decile).

From the data presented in Figure 2, it may be seen that the contributions from the historical outcomes to the price of the fourth decile put option contract are

14.2%xDecile1=
USD(4-1)x.142x100=USD42.60
13.2%xDecile2=
USD(4-2)x.132x100=USD26.40
8.4%xDecile3=
USD(4-3)x.084x100=USD8.40
The price of this put option is USD77.40

Historical Outcomes For A Monthly Rainfall Decile 4 Put Option.



As a second illustrative example, we shall now suppose that our cane grower has experienced an extended period of wet weather and that if heavy rain continues during the next month, a substantial financial loss will be suffered.

A hedge, utilizing weather derivatives, could be to purchase a monthly rainfall call option. We shall assume that our cane grower decides only to take this action when there is already a risk of a wet month, that is, the current month's SOI is substantially positive. For the purpose of determining what might be the option's fair value, the example is applied only to the cases when the current month's SOI is in the highest 5% of possible values, that is, above 16.4.

Firstly, let us define our weather derivative contract thus:

- **Location:** Burdekin (on the central Queensland coast)
- **Type of asset:** Rainfall
- **Strike:** Decile 7
- **Expiry:** one Month
- **Notional:** USD100 per decile above the seventh.

If, at the expiration of the option contract, the actual rainfall is more than the strike price, the seller of the option pays the buyer USD100 for each decile that it is above.

Concluding Remark

The market for weather derivatives is growing. Thus far, contracts with a face value in excess of USD10 billion have been traded. As the market grows, a number of related data issues are gradually being addressed. These include quality control of data, international exchange of data, observational site security, impact of climate change, and legal liability.

*This week's Learning Curve was written by **Harvey Stern**, senior manager for climate and consultancy at the Bureau of Meteorology Victorian Regional Office Australia.*