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Annual End of Year Issue Special Reprint

Exotic Weather Derivatives

Beyond the Heat and Beyond the Humidity

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The recession has made companies painfully aware of factors that make their earnings more volatile – and in recent months – much lower than in the 1990s boom economy. Earnings volatility can also hamper corporate recoveries when the economy rebounds. Specifically, companies with volatile earnings are more prone to layoffs and hence, may not have the necessary employees on board to seize new opportunities when economic times improve. Creative thinking is needed in the derivatives field to develop new financial products that minimize earnings volatility.

For many industries, weather makes earnings volatile. Specifically, weather influences the price and sales volume of a commodity bought or sold by a company. An obvious example is a natural gas supplier for residential or commercial heating. An unusually warm winter would reduce both the sales volume (demand) and price, driving down the supplier's earnings. Weather derivatives can offset these risks.

Weather derivatives based on temperature (e.g., heating or cooling degree days) are commonly used by energy companies to offset financial risks arising from unusual temperature patterns. Derivatives contracts based on rainfall indices are beginning to find a market as well. Here, we explore other, more exotic, weather-related derivatives that could insulate companies from adverse weather events. While these derivatives may not attain the popularity of say, Eurodollar futures, they could underlie an overall hedging strategy in some industries. Exotic weather derivative products should be on everybody's radar screen as we mover into 2002.

Hydrology (River/Lake Levels)

The recent power crisis in the Pacific Northwest arose because hydropower production fell with decreased precipitation. Power companies that relied on cheap hydropower had to purchase power in the open market at high prices and then sell that power at much lower regulated rates. For example, one utility was buying power in the open market at about $300/MWh but was only allowed to sell the power at about $30-$40/MWh. Effective use of hydrological derivatives might have enabled such a utility to reduce its exposure to this volatile market.

The energy a hydropower plant can generate is a function of the height the water falls before entering the plant's turbines and the flow of water passing through the turbines. This height is known as the "head" and is a proxy for the amount of power that can be generated. More head means the water moves faster and imparts more energy to the turbines. Obviously, a larger flow also means more power. (The water level of major lakes and rivers is tracked by government agencies such as the United States Geological Survey.) Low head causes problems for generating companies because the water will not generate as much power (kW) and there will a smaller supply of water (fuel) to convert into energy (kWh). Because the relationship between head and electric power can be easily calculated based on knowledge of the dam and turbine's characteristics, one could create a "head derivative," i.e., a index futures contract based on water level above a turbine.

As an example of the possible use of a head derivative, consider a dam with one turbine designed for 200 feet of head. The generating company has a commitment to sell 1000/MWh/month at a price of $1,000/MWh. (These numbers are used simply for ease of calculation and are not intended to be representative of actual power prices.) The turbine can produce 1,000/MWh/month when there is 200 feet of head. With the design of the system, each one foot drop of head reduces the energy that can be produced in a month by 5 MWh. Because a one foot drop in head reduces the energy generated by the turbine by 5 MWh/month, this energy must be purchased on the open market. If the market price is $2,000/MWh, it will cost the generating company $10,000 to replace the lost 5 MWh/month it has previously committed to sell for $1,000/MWh. In summary, the one foot drop in the head has caused the company to incur a loss of $5,000. But what if there was an actively traded market in head futures that would pay the generating company $1,000 times the number of feet the head was below 200 feet? Shorting five contracts would neutralize the loss suffered on the loss of water.

Wind

For years, there has been a great deal of discussion suggesting that solar- and wind-generated power will soon become major power sources. Environmentalists keep pushing these technologies and seek subsidies to make them work. Unless these technologies can actually make it in the marketplace, however, they are destined to remain marginal players. It is now time for proponents of "green power" to start thinking about market tools that can help promote these technologies if they wish to be taken seriously.

One factor that limits the development of wind and solar power is the variability of the source. This is especially true with respect to wind power. While there are many places

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on earth where it is known to be typically windy at certain times of the day, there are, of course, no guarantees. Specifically, there are no guarantees that there will be sufficient wind to generate the necessary power during times of peak demand. Moreover, studies suggest wind power generation may not be financially feasible, unless there is sufficient wind during daily peak pricing periods. The presence of wind during nonpeak periods is not a significant factor. At the moment, the only way of reducing wind variability is to have multiple windfarms to increase the likelihood of wind being present at some generating facility or to have an arrangement to supply backup power – either approach being a significant cost to the wind power generating company. But another alternative could be the development of a wind power futures contract that could provide a virtual financial wind to offset the risks of windspeed variability.

Here is how it could work. Similar to what is done with heating and cooling degree day weather derivatives, some reliable measurement of windspeed at a particular location could serve as the basis of a wind index futures contract. For example, the value of the contract could be $1,000 multiplied by some index that reflects how much the actual peak-period windspeed at the location, measured over some period of days or months, was less than some benchmark (average) peak-period windspeed at that location. A holder of such a contract would thus be protected against unusual stillness during daily periods of peak demand and profitability.

Solar Flux

In theory, solar power could meet all our energy needs, but as of yet, we have not harnessed its full potential. One problem is that the sun does not always shine. The variability of the solar flux reaching the earth's surface (measured in Watts/m^2) is highly dependent on geography. For example, it is relatively constant from day to day in places that are almost always sunny or almost always cloudy. But in most other places, the solar flux is highly variable. Of course, averages have been computed for many locations. But how many utilities have suffered financially from planning for that average summer only to have a season of high temperatures create an incredible energy demand and strain the capabilities of their systems? (Recall what a few days of high temperatures did to power prices in the Midwest in 1998!)

What if a solar power generating company could, in effect, buy the number of sunny days it needs to satisfy its demands? This would allow the generating company to plan its operations in advance and obtain some level of comfort about its cash flows in the future. The ideal way to do this would be to set up an indexed derivative based on the solar flux received at the specified location during a given time period. This is similar to what was discussed earlier for wind index derivatives. Such solar flux derivatives could help protect solar power generators from the cloudy day "blues."

V. Atmospheric Disturbances and Conditions

Recently the airline business has been hard hit financially. Although derivatives cannot get passengers back on planes, proper use of weather derivatives can ease the financial costs of weather-related delays. These delays are costly to the industry because they keep the industry from using the fleet more efficiently and increase fuel costs. These costs could be offset, however, through the use of various weather derivatives.

Two of the most common dealys caused by weather are thunderstorms and low visibility conditions. What if derivatives could be developed based on the incidence of thunderstorms along major flight routes and around key hub airports? By using such a thunderstorm index derivative, airlines could reduce their financial risk due to flight delays caused by thunderstorms. Excessive thunderstorms that cause the index to exceed a certain agreed upon level would entitle the airline to a payout.

The same approach could be applied to visibility. The visibility at major hub airports is constantly monitored and reported to pilots for use in their flight planning. An airline could purchase a visibility index derivative, for example, $100,000 multiplied by the average miles of visibility in a week or month. If the visibility index falls below an agreed upon level, the airline would receive a payout. If not, the company would lose money on the derivatives contract but profit from better capacity utilization.

Space Weather

Earlier this year in separate issues of *The Desk* and The *Risk Desk*, we wrote about the effects of solar storms on satellites. This has been a pretty busy year for solar flares and solar storms. It has also been a problematic year for some satellite companies that have suffered from advanced degradation of their solar arrays. This degradation leads to a reduced power supply and a shortened life for the satellite. Some have speculated that solar storms may have led to this advanced aging. In reality, no one can tell for sure, because the satellites are up there and we are down here. However, one thing is clear: If the satellite owners had purchased a call option on a solar storm index, they would have received a financial payout without having to prove that solar storms actually caused the satellite problems. This is in contrast to satellite insurance where the insured would have to prove loss due to a covered contingency. This illustrates an important advantage to using derivatives instead of insurance to manage risk.

Conclusion

Weather risk is an inherent part of many businesses. Although the physical hazards created by weather events cannot be eliminated, the financial risks can be reduced through effective use of weather derivatives. Moreover, companies are exposed to many different weather risks besides just temperature and precipitation. We think the creation of new weather derivatives to address these other risks will become increasingly important in the future.

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