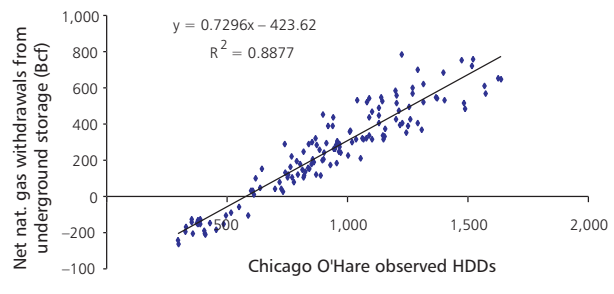
Using weather futures as weather forecasts

Vishu Kulkarni examines the role of weather futures in the shifting energy markets and in attracting new market participants

The nascent weather derivatives market continues to grow. As evidenced by the PricewaterhouseCoopers 2003 survey released in June, the weather derivatives industry is thriving in the midst of significant reorganisation in the over-the-counter (OTC) energy-trading world. For some, the weather markets proved to be a valuable tool in navigating the recent turbulence in the energy markets. Moreover, the fastest growth in the industry was observed in the CME weather futures market where volumes and liquidity increased more than twenty fold over the previous survey year. This trend benefits any trader or hedger with an exposure to weather: energy firms, agricultural firms and insurance firms.

In addition, increasing interest in weather derivatives from end users in the retail, construction and beverage industries is attracting newer participants to the market. By observing the traded levels of CME weather futures, all players have valuable and quick access to the best available forward-looking weather information. This information, which was once available only to large OTC weather trading entities, is now revealed and observable in the CME weather futures prices. In addition, the increased liquidity of the contract has drawn transactional participation from those having proprietary weather forecasting. As a broad range of speculators and hedgers enter the market, those with the newest and best technologies in the atmospheric sciences will find incentive to act on (and thereby reveal) such information in weather futures pricing. In essence, CME weather futures are a very good reflection of the overall weather outlook of numerous businesses with substantial weather exposure.

1 Scatter plot of national net monthly gas withdrawal (national) vs. Chicago O'Hare HDDs



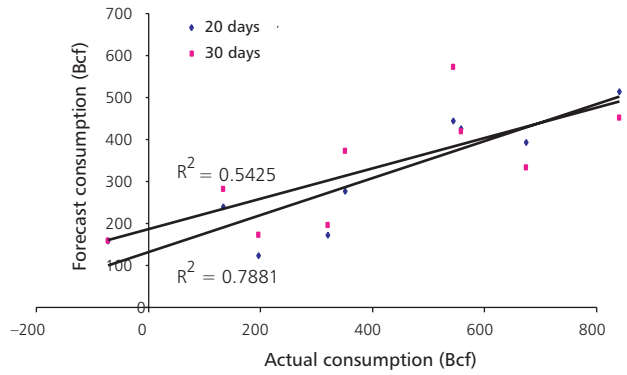
Utilising weather futures information

A basic question for commodity traders who do not currently trade weather futures might be: 'what can one infer and exploit from the implicit weather forecasts embedded within weather futures?' In this article, we help lay the groundwork to answer this question, by providing an illustrative example in the natural gas market. The approach provides a logical and straightforward framework that can be applied by hedgers and speculators alike. Examples include hedgers such as natural gas marketing companies who have volumetric exposure to consumption and speculative traders who need to estimate gas storage levels to anticipate possible price moves. The general approach is simple and consists of two steps: 1) develop a quantitative estimate of the weather dependency in question, and 2) utilise weather futures trading levels as weather forecasts, by using futures prices within the quantitative models.

The analysis presented in this example has been kept simple. In practice, more involved and complex models can be developed and this is discussed in the concluding section. An advantage of the simplicity of the model presented below is that it directly provides a useful forecast. Should readers choose to implement the model below, they could do so with no further pre- or post-processing of weather forecasts.

Chicago Mercantile Exchange

2 Monthly nat. gas withdrawal forecast based on HDD futures



Monthly injection/withdrawal and its relation to EIA weekly storage numbers

The US natural gas market eagerly anticipates and reacts to the Energy Information Administration's [EIA] release of the weekly estimated natural gas storage figures, especially during the winter heating season. The level of natural gas consumption related to heating demand can mean the difference between relative scarcity or availability of the commodity. The weekly natural gas report is, in fact, backward looking information – the figures for a given week are released the following week.

During the winter months the weekly injection/withdrawal figures are very closely tied to the weather in the eastern US. In fact, several weather forecast vendors provide EIA forecasts based on weather forecasts. Here, we develop a model for forecasting the overall national injection/withdrawal on a monthly basis based on CME weather futures. This approach is similar to forecasting the weekly figures based on a weekly weather forecast, except that the weather 'forecast' is actually the weather futures level and resulting consumption forecast is for an entire calendar month. The resulting monthly consumption forecast certainly looks beyond the traditional two-week forecast horizon. Moreover, the total consumption in the winter months is more important in determining the likelihood of scarcity than any single week's consumption alone. The data used in this study are the national monthly consumption figures (provided by the EIA on a historical basis), and historical weather futures data (provided by Chicago Mercantile Exchange).

The first step in the study was to develop a simple model for the relationship between monthly consumption and weather, using data from Jan 1979–March 2001. In the second step, national consumption for a different time period (Nov 2001–March 2003) is forecast. We used national consumption figures for the months of October through March and the accompanying Chicago O'Hare heating degree days (HDDs), for years 1979–2001.[1] While a better model-fit might be achieved through utilising additional weather data from a north-eastern city such as Philadelphia or NY LaGuardia, figure 1 shows that the fit using O'Hare alone is considerable (with an adjusted R^2 of 0.8877).

In the second part of the analysis we forecast the monthly net withdrawal figures using actual weather futures data from the 2001–2002 Nov–March, and the 2002–2003 Nov–March heating season.[2] The forecasts were created at two different time horizons. The first time chosen was the last trading day prior to the beginning of the contract month and the second, the traded futures level 10 days into the traded month. These time

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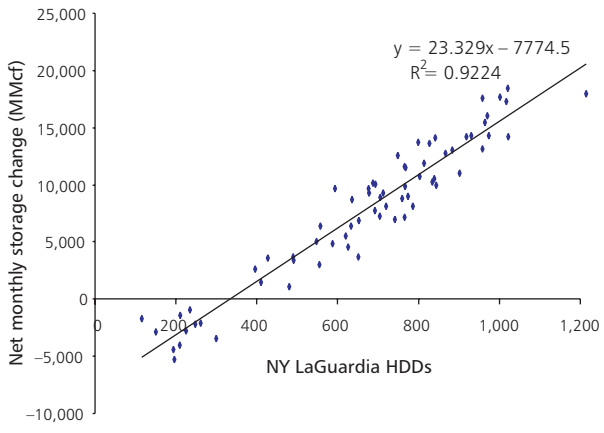
frames correspond to 30 and 20-day ahead forecasts respectively. Note that the last forecast is really only a forecast of the past 20 days of any given month since the first 10 days of the month's temperatures have already been realised. As can be seen from figure 2, even when using the crude model developed above, the weather futures market provides valuable fore-

3 NY state natural gas storage change vs. monthly LaGuardia HDDs



[1] For definitions of heating degree days (HDDs) and cooling degree days please refer to the CME website, www.cme.com. For the sake of this example, the definitions are omitted, as winter weather futures are traded on an index of HDDs.

[2] At the time of writing, February 2002 futures data was not available and was therefore omitted from the analysis.

cast information relevant to predicting winter natural gas consumption. As expected, the predictive value of that forecast increases greatly when the time horizon of the forecast decreases to 20 days (with an adjusted R^2 of 0.7881) versus the 30-day forecast (with adjusted R^2 of 0.543).

In practice, of course, one would re-forecast every day given that each day should provide better information than the previous. The improvement in predictive value of monthly injection/withdrawal estimate is dramatic; somewhere between 30 and 15 days prior to the realisation of any given calendar month. This horizon is far ahead of the one week backward looking EIA weekly storage figure release. As a consequence, any entity with natural gas exposure should reasonably expect to incorporate information from the weather futures market into their own trading and planning operations as a supplement to their internal weather forecasting processes and information.

A regional example

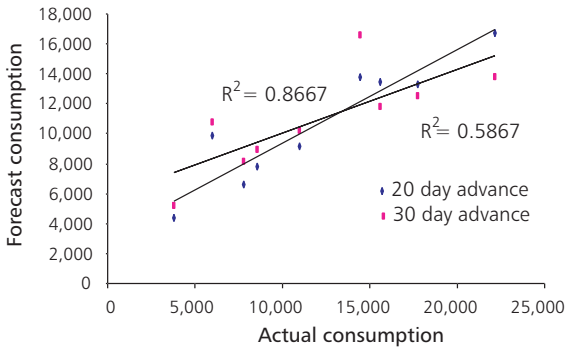
In the following example, we examine the applicability of the above analysis on a regional level. Given that many hedgers and traders are as concerned about the local effect of weather on natural gas consumption as the national effect, the regional applicability is equally important. Figure 3 depicts the relationship between New York State wintertime (monthly) net natural-gas storage changes and monthly HDDs as measured at NY LaGuardia. The relationship is strong (adjusted R^2 of 0.922).

Given the valuable information revealed in the weather derivatives market and the growth in trading volume of the CME weather futures contracts, traders and hedgers alike should be monitoring this new market

Figure 3 was developed using October through March data from January 1990 to March 2001. Using futures trading data from the winters of 2001–2002 and 2002–2003, consumption forecasts were developed using the above regression model at 30 and 20-day horizons. As in the previous national model, the forecast test period data set was kept separately from the time period the model was developed on. The results are shown in figure 4.

As before, we see that 30-day forecasts are valuable, explaining more than 50% of the variance (adjusted R^2 of 0.5867) in the state-wide consumption figures. As expected, the forecast accuracy improves dramatically as the forecast horizon decreases, with 87% of variability in storage changes (adjusted R2 of 0.8667), predictable 20 days before the forecast month realisation.

4 Comparison of 20- and 30-day advance forecasts of NY state natural gas consumption



Conclusions

We have presented a simple but useful example of using the weather futures market to help forecast weather. In addition to forecasting, the models developed above can be used to find trading opportunities. If a trader believed their proprietary forecasts were sufficiently different from the weather futures levels observed in the market, they could examine the discrepancy for a potential cross-commodity trading opportunity. In addition, one could develop improvements to the above models by developing the regressions with multiple weather indexes (locations) as independent variables. Similarly, one might develop different models for some of the individual monthly injection and withdrawal figures. Given the valuable information revealed in the weather derivatives market and the growth in trading volume of the CME weather futures contracts, traders and hedgers alike should be monitoring this new market, as opportunities to act on such information are becoming increasingly common. ■

Vishu Kulkarni has worked as a trader on Mirant''s cross commodity and weather desk, and has also served as a market-maker on the floor of the Chicago Board Options Exchange. The views and opinions contained in the article are those of the author and not representative of any company.

Contact

Vishu Kulkarni
3131, Kings Arms Ct NE
Atlanta, GA 30345

Tel: +1 770 330 0726
Email: vishuk@comcast.netWeb: