Marking to model – or to market?

Should weather risk managers continue to value weather portfolios in line with their pricing models? Or does growing trading activity mean they can be valued against market prices? **Paul VanderMarck** weighs up the arguments

Consider a risk manager responsible for overseeing a growing weather derivatives portfolio. In late September he notices that a November–March Heating Degree Day (HDD) swap referenced to temperatures at New York LaGuardia is trading at 3,850 HDDs. Several months earlier, he had agreed with the head weather trader to establish a pre-season valuation of 3,750 for this contract, on the basis of modelling of historical weather data.

When he asks the trader about the discrepancy, she tells him the market has been bid up from earlier levels close to 3,750, because of a couple of rumoured large end-user deals and because of forecasts of a cold winter. She tells the risk manager not to worry and that the 3,750 valuation is still appropriate: such seasonal forecasts often don't have any bearing on what kind of weather will actually occur.

Admittedly, the start of the November–March winter season is still over a month away, and nothing has changed in the historical data that was used in the modelling. But this isn't just a theoretical exercise – the portfolio has an HDD delta of –$10,000 at LaGuardia, which means its value would be reduced by approximately $1 million if valued at 3,850. In all other markets the risk manager tracks, a contract that traded yesterday at 3,850 would be marked to market at 3,850 without a second thought. So, should the same concepts be applied here, or should he take the trader's advice and leave the mark at 3,750?

Such is the dilemma that confronts weather market participants as the market matures. In its early days, there was intermittent trading on many different locations. Liquidity at individual locations was low, and everyone in the market tracked positions on the basis of a model. These models produced static valuations before the start of a season which then moved around during the season as actual temperature measurements came in and as short-term forecasts were adjusted.

Over the past two years, trading has consolidated at key locations such as Chicago O'Hare, New York LaGuardia and London Heathrow. This shift, and the continuing growth of the market, have resulted in a significant increase in liquidity, introducing the possibility of valuing positions based on current market price levels.

This would fit with trends in other markets. Risk managers, particularly within financial institutions, are increasingly demanding that positions be marked to market, partly to ensure a more accurate reflection of a portfolio's value should it need to be liquidated.

The debate around whether to conduct weather portfolio risk management on a mark-to-model or mark-to-market basis centres on three main issues.

The first is a theoretical one: are the standard mark-to-market concepts used for other commodities relevant for weather derivatives, or is weather somehow different in a way that makes mark-to-model more appropriate?

The crux of this issue is the argument that supply/demand dynamics can potentially distort the valuation of a weather contract away from the best 'fair value' estimate of where that contract will settle at maturity. In other commodity markets, supply/demand dynamics are an intrinsic aspect of what a position will be worth at its expiration. Current market forward curves provide the best indication of future settlement value in those markets, and a mark-to-market approach is therefore the most appropriate way to estimate the expected settlement value of a position.

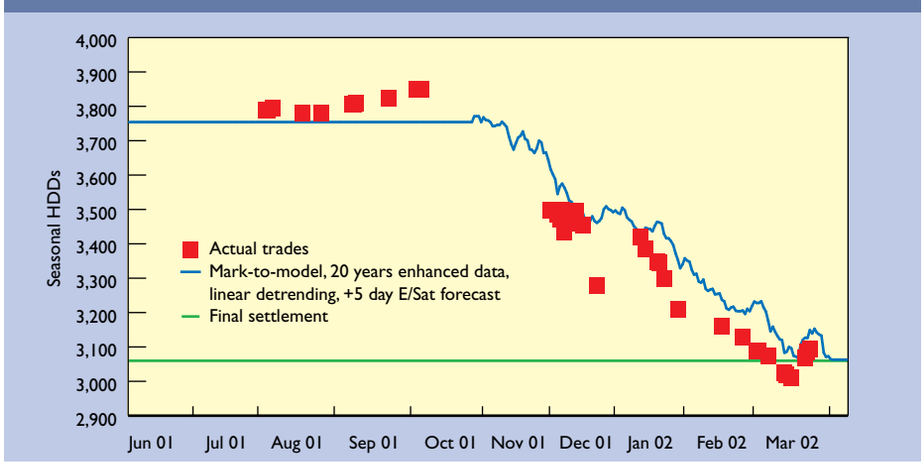
In contrast, weather derivatives settle on a meteorological index that cannot be influenced by any amount of buying or selling. And so, the argument goes, mark-to-model is more accurate than mark-to-market.

Although theoretically convincing, the practical problem with this is that it is difficult to isolate the supply/demand component of market prices. As shown in Figure 1, market prices can vary significantly from mark-to-model valuations, both before and during a season. However, it is not clear how much of the difference at any point in time is caused by supply/demand factors and how much is caused by the market having a different view of value than what the model indicates.

If the weather market is at least moderately balanced and liquid, market valuation at any point in time should reflect a composite of all the modelling approaches and forecast data being used in the market, and any excessive deviations from this 'fair value' due to pure supply/demand effects would be corrected by speculators. Still, a trader or risk manager concerned about market dynamics having undue influence on portfolio valuation can decide to use a mark-to-model approach. In doing so, however, they run the risk of erroneously assuming that their internal model is more accurate than the market-implied valuation.

Also, in a company where mark-to-model is preferred, it is important to recognise the relevance of mark-to-market for tracking liquidation value. This has been highlighted by recent credit downgrades or defaults among

1. A mark-to-model valuation of New York LaGuardia HDDs through the 2001/02 winter season, with actual swap transactions overlaid



trading counterparties which have caused premature termination of some positions.

The second issue is one of timing: at what point is liquidity sufficient to justify a switch from mark-to-model to mark-to-market? This is an issue that must be addressed in most over-the-counter derivatives markets, since liquidity varies across products and tenors.

One guideline is provided by the Committee of Chief Risk Officers (CCRO), a coalition of energy companies, which has recently published best practices for calculating the value and risk exposure of energy-related commodity positions (see www.ccro.org). It recommends that mark-to-market be used "when there is a liquid market in which the underlying commodities or instruments are being actively traded" and goes on to suggest that this level of liquidity has been reached "when the market is sufficiently deep to accommodate exchange of the positions being evaluated".

Other possible criteria for evaluating liquidity at a specific location include general trading volume statistics, or the existence of a regularly posted two-way market, either via brokers or on an exchange such as the Chicago Mercantile Exchange. Ultimately, each dealer must decide for itself when it believes trading activity at a certain location has reached the critical juncture to support mark-to-market.

At present, most active traders in the market consider five to 10 locations in the US and up to five in Europe as being sufficiently liquid to support mark-to-market.

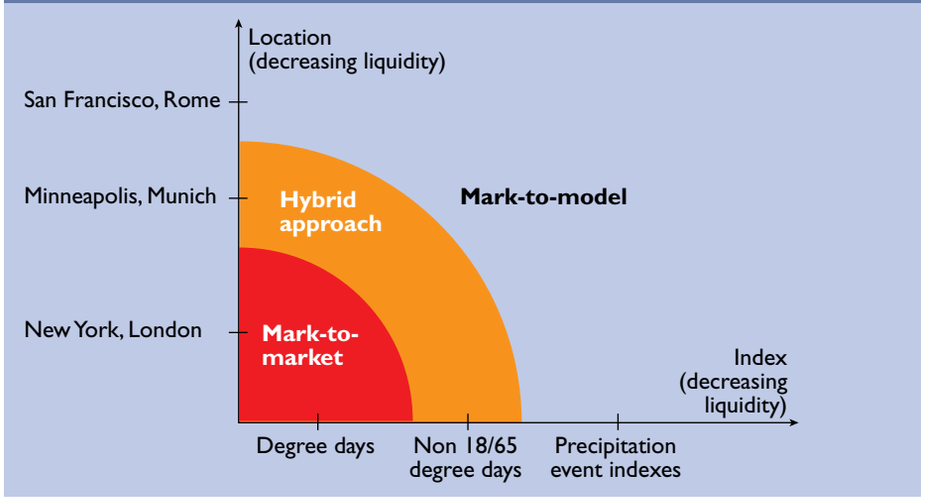
Another area addressed by the CCRO is the possibility of extending mark-to-market concepts to less liquid positions. In the weather market, this is relevant for locations that may trade only infrequently and therefore cannot be directly marked to market but which are highly correlated with liquid locations. For example, a Hartford, Connecticut, trade could very reasonably be marked to market by inferring a market valuation from nearby New York LaGuardia, which is highly correlated to Hartford and much more liquid. With such techniques, many of the positions in a typical portfolio can be marked to market in some form once sufficient liquidity exists at a few regional anchor locations.

Figure 2 indicates how liquidity can be considered in deciding whether a particular position should be marked to market, marked to model or valued using a hybrid approach as discussed below.

The third issue in the debate is the practical challenge of how to implement mark-to-market concepts for weather derivatives. This initially seems to be a difficult task: since market data on its own is rarely sufficient for valuing all positions in a portfolio, it is necessary to combine market data and modelling to develop accurate portfolio valuations and risk metrics. With a sufficiently robust portfolio risk management framework, however, this should be a straightforward process.

Such a framework starts with an analysis of the indexes underlying each contract in a portfolio. Each type of index at each location needs to be characterised with a probability distribution that accurately represents the range of possible outcomes at expiry. Because of the caps on most weather swaps, accounting for the full distribution is relevant for valuing swaps as well as options.

2. Index and location liquidity must be considered in establishing a valuation method



When there is active trading of both swaps and options on an index, such as Heathrow HDDs, its entire distribution can be derived from market price data. Conversely, when there is no liquidity on a particular index – as is common for customised end-user solutions – and when that index has minimal correlation with a liquid index or location, modelling of historical data is necessary to characterise the full distribution.

For all other cases, an index distribution may be best defined with a hybrid approach that combines market and historical data. One common example is found at locations with a liquid swap market but only occasional option trading. In such cases, the index mean can be set to the market swap level while the remainder of the distribution can be derived from historical data.

Hybrid approaches are also feasible for valuing indexes at illiquid locations that are at least moderately correlated with liquid locations.

As noted above, a mean index value for a location like Hartford can sometimes be inferred directly from swap prices at a more liquid location like New York. However, this is only possible when the two locations are highly correlated. When correlations are weaker, one approach used by some market participants is to set the mean index at a value that is a weighted combination of the market-implied swap level and a mean derived from historical data, with the weight on the market data reflecting the degree of correlation. Although somewhat arbitrary, this sort of approach provides a rational way of combining market and historical data. Similar hybrid approaches can also be applied to non-standard indexes.

Once each of the underlying indexes has been characterised, portfolio valuation and risk is calculated by simulating the combined behaviour of all contracts in the portfolio. Monte Carlo simulation can generate thousands of realistic scenarios across all positions in a portfolio, while maintaining the correlations that have been observed historically between indexes. In addition to portfolio valuation, the simulation output quantifies the full range of possible portfolio outcomes and the associated probabilities. Key portfolio risk measures such as standard deviation, expiry value at risk (VAR), and mean losses in excess of VAR are calculated from this information.

With such a framework, the effects of changing market prices, actual weather measurements, and revised short-term weather forecasts can all be quickly reflected in updated portfolio analyses. Changing views of liquidity can also be easily incorporated by adjusting the mix of market data and modelling used to value individual positions.

Increasingly widespread use of mark-to-market concepts in the weather market is a result of continuing growth as well as the entry into the market of banks and other financial institutions. These companies are insisting on implementing mark-to-market risk management approaches similar to those used on their other trading desks.

At the same time, there is still a legitimate role for models of historical weather data in quantifying portfolio value and risk. Modelling is important for supplementing market data and is necessary to be able to value illiquid positions.

Ultimately, each market participant must consider their unique portfolio and business mix in establishing an appropriate combination of mark-to-market and mark-to-model approaches within their overall portfolio analysis framework. EF

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