Weather Derivatives: Modelling & Pricing

Abstract
Weather derivatives is an emerging financial tool, which is gaining momentum through its ability to provide risk management to businesses who may be affected by deviations in the weather.

Time series forecasting of the temperature and the pricing of temperature based weather derivatives, based on models that are flexible, simple and easily implementable is explored.

1. Daily Temperature Models
Temperature forecasting of the daily mean temperature for Sydney is systematically broken down into the three components of trend (overall movements), seasonal (annual periodic patterns) and cyclical (remaining series after trend and seasonal components have been remove), using linear regression, Fourier series analysis and autoregressive modelling.

2. Model Selection
The number of model parameters is determined using the Akaike and Schwarz Information Criteria, which provide an operational way of trading off the complexity of an estimated model against how well the model fits the data.

The best model is a partial Fourier series with 3 cosine and sine terms, plus an order 6 autoregressive model.

Temperature Model
= Trend + Seasonal + Cycle + Error

3. Temperature Forecasting
The temperature model is used to create density forecasts of the temperature. Gaussian white noise is injected into the model, creating a realisation of the future. Many realisations are created, converted to a HDD indices, and then into accumulated HDD indices. This produces a distribution, which is the density forecast.

4. Price Modelling
Price models are drawn up using the economics approach of marginal values. Accumulated HDDs and commodity prices are taken to be adhering to geometric Brownian motion, which gives explicit an pricing formula based on the Black-Scholes pricing formula.

The parameters of the forecasted accumulated HDD distributions are fed into the explicit pricing formula, to determine the price of put and call options.

Conclusion
As is argued, time series modelling shows promise in long horizon density forecasting, which is fundamental in the pricing of weather derivatives. Fundamental assumptions for the explicit price model proved hard to substantiate, and require further analysis.

Further Work
Temperature models to take into account for the conditional heteroskedasticity, maybe exploring autoregressive conditional heteroskedasticity models. Extending the explicit price model to provide better distinction between the correlations of the price and temperature processes.