Modelling Electricity Swaps with Stochastic Forward Premium Models

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Executive summary

We present a new model for pricing electricity swaps. We posit swap electricity prices result from at least three driving forces. First, a stochastic factor acting as an anchor of the level of the forward curve. This is the average "consensus" price for the contracts within a maturity slot (yearly, quarterly, and monthly). Second, an element reflecting deterministic trend-seasonal components, because we assume market expects weather-related variations in demand. Third, a part accounting for (mean-reverting) stochastic deviations from the last two factors. These deviations depend on time to maturity and length of delivery period. By using a Multivariate Normal Inverse Gaussian (MNIG) distribution, our model embodies realistic probabilities of occurrence of extreme prices.

We test the model using EEX data for the German market. The model outperforms four competitors, both in in-sample valuation and in out-of-sample forecasting, and in fitting the term structure of volatilities by market segments. Competitor models depend on (i) diffusion spot prices, (ii) jump-diffusion spot prices with time dependent volatility, (iii) HJM approach and (iv) Lévy multifactor model based on the NIG distribution. The model presents noticeable ability in capturing extreme tail risk as suggested by results of VaR analysis. A practical implication is that capital charges to traders using EEX electricity contracts, based on risk-adjusted capital and on the normality assumption, are too low. We suggest increasing capital charges. Also, evaluators of traders' performance should adjust recommendations in line with this.

Keywords electricity swaps; stochastic forward premium; multivariate normal inverse gaussian distribution; Lévy processes.

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