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A space-time random field model for electricity forward prices

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Abstract

Stochastic models for forward electricity prices are of great relevance nowadays, given the major structural changes in the market due to the increase of renewable energy in the production mix. In this study, we derive a spatio-temporal dynamical model based on the Heath-Jarrow-Morton (HJM) approach under the Musiela parametrization, which ensures an arbitrage-free model for electricity forward prices. The model is fitted to a unique data set of historical price forward curves. As a particular feature of the model, we disentangle the temporal from spatial (maturity) effects on the dynamics of forward prices, and shed light on the statistical properties of risk premia, of the noise volatility term structure and of the spatio-temporal noise correlation structures. We find that the short-term risk premia oscillates around zero, but becomes negative in the long run. We identify the Samuelson effect in the volatility term structure and volatility bumps, explained by market fundamentals. Furthermore we find evidence for coloured noise and correlated residuals, which we model by a Hilbert space-valued normal inverse Gaussian Lévy process with a suitable covariance functional.

JEL Classification: C02, C13, C23
Keywords: spatio-temporal models, price forward curves, term structure volatility, risk premia, electricity markets

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