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A Lattice-Based Method for Pricing Electricity Derivatives Under the Threshold Model

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Abstract

Of the several models introduced for the modelling of electricity prices, the one proposed by Geman and Roncoroni, that we will refer to as the ‘threshold model’, has exhibited significant success in both its statistical properties and ability to accurately replicate trajectories of electricity prices. This article presents a lattice-based method for the discretization of the threshold model that allows for the pricing of derivatives, including swing options. The methodology builds on an idea presented by Bally et al. for discretizing density functions, and constructs an approximating process that is shown to be a good proxy of the original process, producing a grid that incorporates both mean reversion and jumps.

Keywords:

Electricity spot prices threshold model lattice-based jump representation

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Notes

1. Details of the calibration procedure of the model can be found in Roncoroni (2002).

2. It is important to keep in mind that, in commodity markets, Futures and Forward contracts are by far the most liquid instruments. In the case of crude oil, the number of maturities for liquid Futures contracts is quite large.

3. For instance, in the case of equity markets, Carr–Geman–Madan–Yor (Carr et al., 2002), assumed that the mathematical structure of the pure jump Lévy process, denoted CGMY, was the same under P and Q , with two different quadruplets for the parameters. Moreover, we believe that the extension to electricity of the 'Fundamental Theorems of Asset Pricing' is, because of the non-storability issue, a very complex problem that is beyond the scope of this paper.

4. This is supported, moreover, by the properties of on-peak and off-peak prices, observed for electricity at different times in the day.

5. If no such value of ρ is found, then β is too small for the current value of Π. Notice that the bounds m_u (i, j) and m_d (i, j) are still well defined in such a situation, from Definition 4.1; however, it is better to avoid it and increase β or decrease Π, until suitable values of ρ become available.

6. It is possible to construct the grid using a time-varying vertical step, $\Delta E(i)$, $0 \leqslant i \leqslant n$. A candidate, β, for the vertical step, $\Delta E(i+1)$, is tested by computation of the relevant quantization errors, for all nodes (i, j) of time-step i, and reduced accordingly if needed.