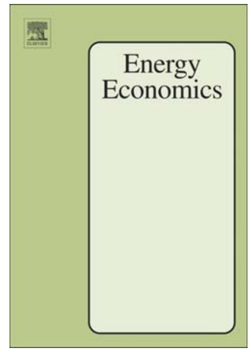

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Modeling Positive Electricity Prices with Arithmetic Jump-Diffusions

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Abstract: We propose a mean-reverting electricity spot price model of arithmetic jump-diffusion type yielding positive prices. Based on this approach, we derive the corresponding forward and futures price representations. We further discuss different choices for the stochastic mean level process and investigate the long-term behavior of the spot price. In the second part, we take future information available to the traders into account. The latter is modeled by initially enlarged filtrations with respect to (a) the mean level of the spot, (b) the driving diffusion component and (c) the jump term. We also derive forward and futures price representations under these enlarged filtrations. Finally, we consider the evaluation of options in the proposed models.

Keywords and phrases: stochastic calculus, positivity of solution to stochastic differential equation, Ornstein-Uhlenbeck process, enlargement of filtration, future information, insider trading, arithmetic jump-diffusion model, long-term behavior, electricity spot/forward/futures price, option pricing

MSC (2010) codes: primary: 60G44, 60G51, 60G57, 60H30; secondary: 60H05, 60H10, 91B44

JEL classification: D52, G13, G14

1 Introduction

In this paper, we propose an electricity spot price model of *arithmetic* jump-diffusion type yielding *positive* prices. In a first step, we give a brief overview on existing spot models in the literature which can be divided into geometric and arithmetic approaches. For instance, in [20] the authors compare the arithmetic electricity spot price model $S_t = f(t) + X_t$ with the corresponding geometric one reading $S_t = \exp\{f(t) + X_t\}$ where $f(t)$ is a deterministic seasonality function and X_t is a continuous Ornstein-Uhlenbeck (OU) process. The latter approach is extended in [13] by considering the model $S_t = \exp\{f(t) + X_t + Y_t\}$ where Y_t is another OU component yet driven by a pure jump process accounting for the empirically observed electricity spot prices spikes. In [12] electricity prices are modeled with a geometric one-factor Markov jump-diffusion where both the jump direction and intensity is level-dependent, the latter modeling different market regimes. Moreover, in [3] the authors present an electricity spot price model wherein the low-frequency dynamics is generated by a non-stationary independent increment process while the large fluctuations are modeled by a non-Gaussian stable CARMA process. This model is also calibrated to empirical data. In [25] the electricity spot price is modeled by a Lévy semi-stationary process (i.e. a two-sided Lévy process defined on the entire real line) in connection with a stochastic volatility specification. In this framework, the authors compare geometric with arithmetic approaches and investigate the empirical behavior of risk premia in electricity markets. Further, in [1] the author interprets price formation in electricity markets as a resulting balance of supply and demand. That is, the stochastic demand process is required to match with a deterministic supply function. Remarkably, the presented structural/equilibrium model is able to generate price spikes although it is based on a pure diffusion approach. Moreover, Section 3.2 in [5] is dedicated to electricity spot price modeling with OU processes. In Section 3.2.1 in [5] a geometric multi-factor spot model of the form