International Journal of Innovative Computing, Information and Control
Volume **7**, Number **1**, January **2011**

ICIC International ©2011 ISSN 1349-4198
pp. 61–72

IDENTIFICATION OF ELECTRICITY SPOT MODELS BY USING CONVOLUTION PARTICLE FILTER

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Received March 2010; revised July 2010

Abstract. *We consider a slight perturbation of the Schwartz-Smith model for the electricity futures prices and the resulting modified spot model. Using the martingale property of the modified price under the risk neutral measure, we derive the arbitrage free model for the spot and futures prices. As the futures price formula is based on the arithmetic average of the unobservable spot prices, it is highly nonlinear. We use the particle filtering methodology for estimating the model parameters. The main advantage of the new model is that it avoids the inclusion of artificial noise to the observation equation for the implementation of the particle filter. The extra noise is built within the model in an arbitrage free setting.*

Keywords: Parameter estimation, Finance, Kalman filter, Maximum likelihood estimators, Particle filter, Electricity spot model

1. **Introduction.** Since the recent deregulation of power markets, large volumes of electricity contracts are frequently traded. Noting that electricity is a non-storable commodity, spot trading of electricity is not defined in the usual sense. Moreover, unlike other commodities such as oil or gas, electricity futures and forwards are based on the arithmetic average of the spot prices over a delivery period. During the delivery period the contract is settled in cash against the spot price. Hence, it resembles a swap contract, exchanging a floating spot price against a fixed price, see [1]. More specifically, a futures contract is a contract that obligates the seller of the contract to deliver and the buyer to receive a given quantity of electricity or gas over a fixed period $[T_0, T]$ at a price K specified in advance. The payoff of these futures are based on the arithmetic average of the spot price $\frac{1}{n}\sum_{t=T_0}^{T} S(t)$ and not one fixed spot price $S(T)$ as in most financial and commodity futures markets. Here n is the number of days during the delivery period $[T_0, T]$. This makes the problem highly nonlinear and we use particle filter for estimating model parameters. To the best of our knowledge, this has not been studied in detail before. Another important issue is related to the parameter estimation of the models representing the dynamics of both the spot and the futures. As a result of dealing with unobservable factors, a popular estimation method that has been proposed in the literature is the maximum likelihood estimation (MLE) method under the assumption that observations are corrupted with additive Gaussian noise. In this framework, the state