Stochastic modeling of day-ahead electricity prices in the Turkish market

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In the past two decades, electricity industries in many countries which were initially designed as vertically integrated national or state dominated monopolies have been experiencing a deregulation process. Throughout this process, generation, transmission, distribution and marketing activities have been separated and opened to competition wherever it is possible and profitable. The rise in the number of market players together with the competition and development of relatively more liberal electricity markets caused spot prices to be determined by supply and demand. This development increased the importance of accurate electricity price forecasting and therefore electricity price modeling. As a commodity, electricity has different characteristics than other commodities as well as financial assets due to its non-storability, its demand inelasticity and significant seasonality of its consumption and production. Electricity consumption is mainly influenced by industrial production, business activities and weather conditions, therefore electricity prices show intra daily, weekly and annual seasonal behaviour. Electricity prices are also mean reverting processes with high volatility and sharp price spikes. Non-storability of electrical energy and necessity of continuous supply and demand balance in the transmission mechanism cause direct reflection of supply and demand shocks on electricity prices. As soon as these extreme conditions disappear, their effects on price levels also fade away. Additional to bilateral electricity trade contracts, whose conditions are predetermined, a significant amount of electricity trade takes place in the spot markets. In this paper, we model daily equally weighted average of system marginal prices of each days balancing intervals (hour / half hour) formed in the day ahead market.

Due to mean reversion property of electricity prices, modeling with Ornstein Uhlenbeck type processes are very common in the literature, like
Schwartz’s (1997) model, which is an extension of geometric Brownian motion allowing mean reversion. In their two factor model Lucia et al. (2002) also introduce a deterministic seasonality component, while Cartea et al. (2005) introduce a Poisson jump process to the Ornstein Uhlenbeck type process in order to capture the price spikes. Deng (2000), Villaplana (2004) and Benth et al. (2008) model power prices as a summation of non-observable factors composed of Brownian motions and jump processes with different term effects on prices. The need for a better fit of model forecasts with observations leads to more complicated models with hidden variables and multiple regimes. However with an increasing number of parameters, the estimation process also gets complicated. Filtering techniques are one of the widely used methods in parameter estimation of the jump processes. Pirino et al. (2010) use an iterative threshold filtering in identification of spikes in their univariate jump model and use the separated processes for parameter estimation.

In our model, three jump processes without predetermined jump size distributions and a Brownian motion are combined with a deterministic seasonality term where two of the jump processes are mean reverting. While the Brownian motion captures the daily regular price movements, pure jump process models price shocks which have long term effect and two Ornstein Uhlenbeck type processes with different mean reversion speeds capture price shocks that have short term effects. One of the mean reverting processes is assumed to model price shocks that revert back in the next observation (price spikes) and the other is assumed to model price shocks that take a few days to fade away (semi-spikes). An iterative threshold derived by using estimated volatility with GARCH(1,1) is used to filter the price jumps. Although in Mancini (2009) using a threshold in order to separate jumps form Brownian motion is proposed and in Mancini et al. (2010) GARCH(1,1) volatility estimation is suggested to be used in calculation of threshold, none of the models investigated in these researches include as much factor as our model. On the other hand, instead of Pirino et al. (2010) which use a kernel based estimator for threshold, we use GARCH(1,1). In this paper we construct an algorithm for step by step parameter estimation of a multifactor price model.

In this research after description and model validation of our multi-factor stochastic spot electricity price model, step by step parameter estimation method using GARCH threshold is applied and tested.