FORECASTING THE EU ELECTRICITY WHOLESALE PRICES: DO MULTIPLE TIME SERIES MODELS PERFORM BETTER?

Marta Trabucchi, Università degli Studi di Bergamo, Phone: +39 3471882626, e-mail: marta.trabucchi@unibg.it
Michele Dalena, REF-E Economics Engineering Energy Environment, Phone: +39 3931446858, e-mail: michele.dalena@ref-e.com

Overview

Since the mid-1990s, the EU institutions have been promoting an extensive reform process aimed at liberalizing and restructuring the Member States national electricity markets, with the ultimate goal of their integration into a single EU electricity market. Within this process, power exchanges have taken a key role as shown by the growing volumes of energy traded on their different segments. Power exchanges prices forecasting and especially day ahead price forecasting has therefore become essential for electricity market players, not only for long-term capital budgeting but also for short-term bidding optimization.

Focusing on short-term forecasting of day ahead electricity prices, the recent empirical literature usually suggests using ARIMA models or possibly regime switching and mean reverting jump diffusion models in cases of higher price volatility. However, many contributions address day ahead electricity prices forecasting without including in the proposed models the possibility of co-movements between different interconnected markets. In recent years, a large body of empirical literature has also investigated whether or not EU wholesale electricity markets are cointegrated, and despite there is no conclusive evidence at the EU level the presence of partial cointegration seems to emerge between day ahead electricity prices of Central-West European countries.

This paper aims to compare the forecasting performance obtained by single time series models, considering each country and hour of delivery separately, generally used in previous contributions, with the ones coming from multiple time series models, that allows to capture the presence of complex price interdependencies and possible cointegration between European electricity markets.

Methods

In this paper each hour of the day is modeled separately, in order to capture the day ahead electricity markets microstructure. Indeed, in day ahead negotiation, electricity products are traded on hourly base, with separate bids and different prices for each hour in the day.

Augmented Dickey-Fuller and Phillips-Perron unit root tests, on the one hand, and Kwiatkowsky-Phillips-Schmidt-Shin stationarity test, on the other hand, show contradictory evidence about the integration properties of the 24 daily day ahead electricity price time series. Given these unclear results, we proceed estimating AR ARX VAR and VARX models assuming that all price series are jointly I(0) and ARI, ARIX, VEC, VECX models assuming the presence of unit root for all the series.

In all the models six dummy variables are included, one for each day of the week, in order to capture the weekly deterministic seasonality.

Moreover when an exogenous variable is included we introduce the hourly load given the close correlation between load and prices.

Each model has been used to make one step ahead forecast in a four weeks out of sample interval. Finally, we propose a comparison of the forecasting performance of all estimated models using MAPE, SMAPE and RMSE loss functions.

Results

The empirical analysis has been carried out using a dataset of the day ahead electricity prices listed on Power Exchange, EXAA (for Austria), APX (for the Netherlands), BELPEX (for Belgium), EPEX SPOT (for France, Germany and Switzerland), IPEX (for Italy) and BSP (for Slovenia) and hourly load values published in the ENTSO-E Country Packages for the period October, 1st 2010- July, 29 2013. Due to the possible presence of negative day ahead prices in some markets, the variables have not been pre-treated with logarithmic transformations.

The dataset has been split into an in sample period running from October, 1st 2010 to June, 30 2013 and an out of sample period from July, 1st to July, 29 2013.

MAPE SMAPE and RMSE loss functions show that single time series models and multiple ones lead to comparable forecasting performance: no model outperforms the other ones for all the hours and the countries analyzed.

Generally speaking the inclusion of the exogenous variable in the models allows for better forecasting performance.

Conclusion

At present we are not able to state that estimating multiple time series models, and especially including potential cointegration relationship between day ahead electricity prices, greatly improve their forecasting performance compared to estimating single time series models. The more general literature on macroeconomic forecasting is already familiar with this result, even if macroeconomic time series and day ahead electricity prices have quite different characteristics.

Within this literature, indeed, Elliott (2006) notes that the inclusion of cointegrating relationship does not necessarily improve the forecasting performance of VAR models, as this depends on "almost all the parameters in the design, including the covariance matrix of the errors". After all, another explanation for this result may be precisely the presence of heteroskedasticity in all or part of the time series analyzed, that is not captured in the models estimated in the present paper.

Accordingly, future developments include heteroskedasticity modeling, through estimating ARCH/GARCH components in the proposed framework. Moreover, the future research may include a new evaluation of the forecasting performance of all estimated models after applying some prefiltering procedure to all day ahead electricity prices, in order to remove at least their more pronounced spikes, as well as the implementation of both simple and multiple time series models allowing for fractional integration.

Finally, further analyses are needed in order to verify whether or not the results of the present paper are robust to not only different in sample and out of sample periods but also to the inclusion of different countries in the estimated models.

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