Forecasting of Frequency Containment Reserve Prices using Econometric and Artificial Intelligence Approaches

(5) Energiemärkte

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Motivation and Objective

TSOs procure reserve power meeting different quality requirements through tenders. This leads to market segments for primary (Frequency Containment Reserve, FCR), secondary and tertiary control reserve power in the market for ancillary services.
Potential suppliers face several opportunities besides FCR to market their flexible generation capacity. Therefore forecasting is crucial for market participants, for both taking the trading decision and placing optimal bids.
The objective of this study is to firstly elaborate different approaches for modelling the price for FCR in order to identify fundamental price drivers and explain price variations. Secondly, these models are used to forecast FCR prices.

Methodology

This study focuses on the largest European FCR market, consisting of Austria, Switzerland, France, Belgium, the Netherlands, Luxemburg and Germany. Currently, TSOs procure FCR capacities on a weekly basis. The modeling and forecasting of prices on ancillary services markets has been comparatively rare in the literature. We therefore explore methods to forecast FCR prices, precisely the weighted average price of each tender.
Following Weron [1], the majority of short-term price forecasting models originates from two different groups: approaches based on time series analysis and artificial intelligence or machine learning approaches. We thus apply seasonal auto-regressive integrated moving average (SARIMA) as well as regression models to FCR price forecasting. With these models, predictions are obtained as linear combinations of past observations and other exogenous variables. Intuitively, external factors influencing the FCR price level can be related to the opportunity cost of reserving capacity on the one hand and the activation probability of the reserved capacity on the other hand.
However, the presence of intermittent spikes and nonlinearities makes the prediction very challenging. Therefore, we secondly use an artificial neural network approach. We then compare the forecast quality of linear SARIMA and non-linear ANN models with and without additional external predictors.

Results and Conclusions

All autoregressive models lead to comparatively good forecasts and outperform the naive method of using the last observation as a forecast. The quality of forecasts from the models combining autoregressive terms with external predictors is high. Especially the neural network model with external predictors (NNETARX) performs significantly better on the test data than the linear models, supporting both hypotheses of nonlinearities in the data as well as interactions between the FCR market and the considered predictors.
The most important exogenous factors, which are used for forecasting, contain the price range of all accepted FCR bids of the previous tender, the future price for electricity in France as well as in Germany (respectively Germany and Austria), the expected load in France and Germany (respectively Germany and Austria) and the planned unavailable capacity in Germany.
Most importantly, we achieve the aim of providing a qualified prediction of the FCR price level by applying different methodological approaches. Figure 1 provides a summary of the prediction results for Q1 to Q3 2018.

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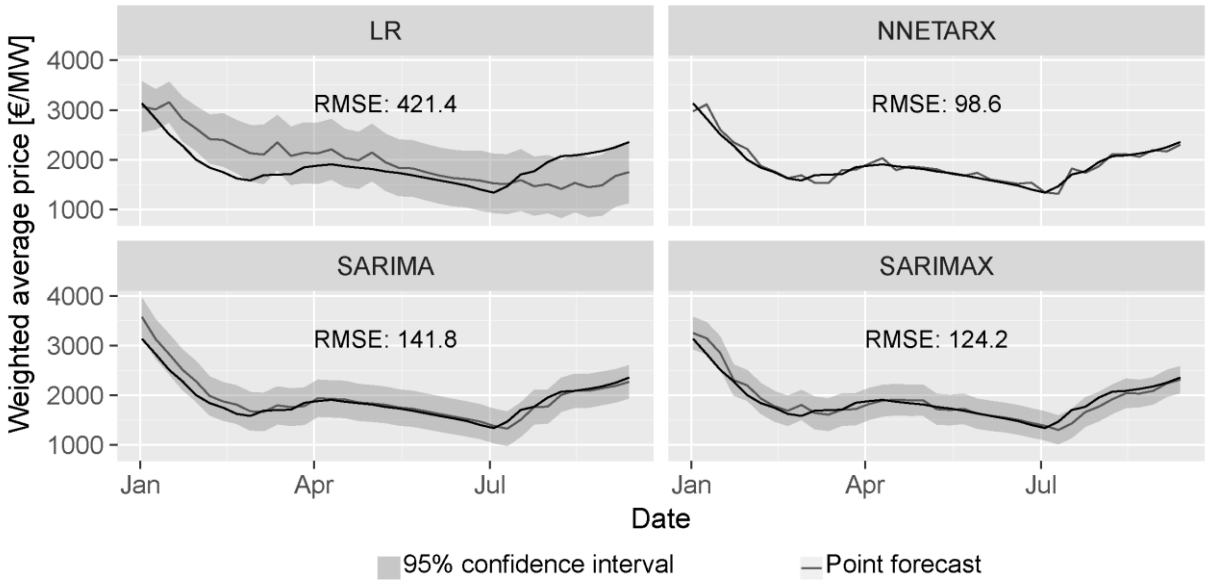

Figure 1: Time series of FCR price forecasts 2018 (Q1-Q3, grey lines) using linear regression (LR), neural network with exogenous factors (NNETARX), SARIMA and SARIMAX (own illustration, validation data (black lines) from [2]).

Literatur

[1] Weron, Rafał (2014): Electricity price forecasting. A review of the state-of-the-art with a look into the future. In: International Journal of Forecasting 30 (4), S. 1030–1081. DOI: 10.1016/j.ijforecast.2014.08.008.

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