

MODELLING GERMAN ELECTRICITY WHOLESALE SPOT PRICES WITH A PARSIMONIOUS FUNDAMENTAL MODEL – VALIDATION & APPLICATION

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Overview

German electricity spot market prices declined by 38% between 2011 and 2015. Various reasons have been identified in literature, namely a drop in CO₂ certificate prices, expansion of renewable energies or cheap fuel prices. During the same period, German government decided to shut down nuclear power plants after the Fukushima disaster which rather by itself would have led to an increase in prices.

In this paper, we use a parsimonious fundamental electricity market model for determining German day-ahead power market prices and production volumes. We find that this simplified model can reproduce the hourly historical prices with a MAE of 5.99 €/MWh and also replicates the observed price drop. We also validate production volumes by technology classes. The model appropriately reproduces the production volumes despite some inaccuracies with regards to biomass and gas-fired power plants.

In a case study, we apply the model for a counterfactual scenario without accelerated nuclear phase-out in Germany after the Fukushima disaster in 2011. Results indicate that without the nuclear phase-out, German day-ahead power prices would have declined on average by 3.93 €/MWh. The results also indicate that the output of coal- and gas-fired power plants would have dropped, but that German overall production would have risen and German net power exports would have increased drastically.

We conclude that the parsimonious model is a simple modelling approach for describing fundamental coherences for prices and production volumes and that it is suitable for several applications.

The paper is structured as follows: Section one is a short introduction with a brief overview about the German electricity spot market and the German decision to phase out nuclear power production. In section two, we introduce the fundamental parsimonious market model. The third section is a model backtesting with respect to prices and production volumes. In section four, we apply the model on a case study without the German nuclear phase-out. In the final section, we conclude and name applications for the model setup.

Methods

Parsimonious fundamental electricity market model

We model prices as the result of a market mechanism that intercepts aggregated supply and demand functions. Our methodology approximates the supply curve by a piecewise linear function with consideration of fundamental information, e.g., power plant capacities and availabilities, fuel prices, must-run production and cross-border exchange.

Results

First, a parsimonious fundamental electricity market model is introduced.

Second, we show that German day-ahead prices can be reproduced with an overall MAE of 5.99 €/MWh. The production volumes for technology classes can be determined appropriately.

Third, we apply the model to a counterfactual case-study clocking back German nuclear phase-out. We find that day-ahead prices drop by 3.93 €/MWh on average and that production from coal- and gas-fired power plants rises. The overall electricity production increases and Germany's net exports of electricity rise to an even higher level.

Conclusions

Fundamental price movements and (with reservations) production volumes can be modelled by the means of a parsimonious fundamental electricity market model. Avoiding the nuclear phase-out, German electricity prices would have been 3.93 €/MWh lower on average. Associated therewith, German overall production would have risen and Germany would have exported even more electricity to its neighbouring countries. As a result, German CO₂ emissions would have declined, but due to additional production for its neighbours, the decline is lower than expected.

References

Kallabis, T.; Pape, C.; Weber, C. (2016): The plunge in German electricity futures prices – Analysis using a parsimonious fundamental model. In: *Energy Policy* 95, S. 280-290.

Pape, C.; Hagemann, S.; Weber, C. (2016): Are fundamentals enough? Explaining price variations in the German day-ahead and intraday power market. In: *Energy Economics* 54, S. 376-387.

Weron, R. (2014): Electricity price forecasting: A review of the state-of-the-art with a look into the future. In: *International Journal of Forecasting* 30, S. 1030-1081.