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STRATEGIC BEHAVIOR OF ENERGY SUPPLIERS IN BALANCING MARKETS UNDER INCREASED RENEWABLE SUPPLY

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Overview

Increasing levels of renewable installations in Germany lead to major challenges for reserve and balancing markets for electricity. On the market for balancing energy, suppliers of reserve (or control) energy as suppliers of last resort guarantee to deliver in the case of short term imbalances. Retail suppliers demand balancing energy in order to provide sufficient supply of electricity to satisfy load in real time. For a certain zone, one single retail supplier has the responsibility not only to balance supply and demand on the retail level, but also to forecast residual load. This forecast includes all relevant stochastic components including renewable forecasts.

We investigate the decision of responsible retail suppliers (rrs) for respective balancing zones to buy on either spot (day ahead, intraday) or reserve markets as well as possible abuse to use their forecasts for renewables. Renewable feed-in complicates forecasts because of its asymmetric and level dependent forecast error distributions. We separate between spot and balancing market arbitrage, which would be economically beneficial from a welfare point of view, and abuse of the skewness, i.e. asymmetry, in forecast errors to take advantage of spot/reserve market imbalances and possibly lower prices on reserve markets. rrs would then ignore the skewness of the forecast errors ex ante in order to strategically over- or undersupply their balancing zone and then buy relatively cheap electricity on the reserve market.

This may, first, increase electricity system stress, which is already challenged by exploding renewable capacity and German nuclear phase out. Second, this may increase the need for (expensive) reserve electricity.

Method

We first develop an analytical oligopoly setup modeling the rrss' choice of sourcing electricity on either spot or reserve markets. The forecast of stochastic renewable feed-in is integrated in the rrss' decisions convoluting (approximate) demand and renewable forecast error characteristics (extending Just and Weber (2014)). The demand (and thereby forecasting) strategy between spot and reserve markets is then derived. It is shown to depend on the convolution of stochastic feed-in characteristics as well as expected spot and reserve market imbalances.

In an empirical application based on German data (Eurowind), we first demonstrate the stochastic characteristics of renewable forecast errors on the basis of unique forecasting data of renewable feed-in. This knowledge is then used to set up an econometric model parameterizing the analytically derived decision model. We relate the control zone imbalance to differences of spot (intraday) and reserve market prices as well as renewable and load forecast errors. Further typical control variables are included (weather, calendar variables). Due to the endogenous nature of sourcing decisions between the markets and the resulting equilibria we estimate market equilibria in a two-step model instrumenting spot prices (by input prices and renewable feed-in).

Results

rrss are shown analytically to make their sourcing decision dependent on expected arbitrage opportunities and renewable feed-in characteristics. Empirically, we find a strong positive relation between control zone imbalances and very short-term spot- (intraday price at gate closure) and reserve-market price imbalances indicating arbitrage between the two markets. A positive relation is found for control zone imbalances and renewable forecast errors as well. Furthermore, evidence is found that temperature still has a strong influence on control zone imbalances in extreme situations.

Conclusions

Strong empirical evidence of high substitutability between the spot price at gate closure and control zone imbalances indicates working arbitrage between spot and reserve markets. In contrast to the current German regulation of imposing upper and lower bounds to the reserve market prices by day ahead market prices, this rather suggests relating reserve prices to the last intraday price (gate closure).

The evidence found related to the correlation of forecast errors, i.e. their positive skewness, and positive control zone imbalances, suggests rrss to use of forecasts to strategically purchase cheaper electricity on the reserve markets. This may either be explained by poor forecasts—which could easily be improved by means of simple modern forecasting methods—or intentional forecasting behavior.

Furthermore, load profiles used for forecasting seem to show potential. Extreme weather conditions explain a significant share of the control zone imbalances' variance.

References

Just, S. and Weber C. (2014) "Strategic Behavior in the German Balancing Energy Mechanism: Incentives, Evidence, Costs and Solutions ", forthcoming *Journal of Regulatory Economics*.