OPTIMAL PRICE ZONES FOR THE GERMAN ELECTRICITY MARKET

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Overview

With a growing share of renewables, regional price signals become more important as a possible remedy for dealing with network congestion. While some countries such as the United States use a nodal pricing approach in order to account for restrictions given by the physical transmission network (see, e.g., Holmberg and Lazarczyk, 2012), the European market is split into a limited number of zones with uniform prices where in most cases price zones coincide with country borders. However, additional bidding zones within the countries could enable better signalling of scarcities induced by the transmission network and are therefore under discussion. Still, it is not clear how many bidding zones would be beneficial and how exactly a market should be split in order to maximize overall welfare. This paper addresses the problem of determining the welfare-optimal bidding zone configuration for the German electricity market. We use a computable equilibrium model to calculate optimal prize zones and analyse their impact on investment incentives in conventional as well as in renewable electricity generators.

The paper is structured as follows. After the introduction, in Section 2 we will present the computable equilibrium model which is used for the specification of price zones and generation investment in electricity markets. Section 3 contains a detailed case study for the German electricity market where results for different regulatory frameworks will be quantified. The paper closes with some concluding remarks and policy as well as research implications in Section 4.

Methods

In order to gain insight into the best possible zoning of an electricity market and its impact on investment incentives, we use a multilevel optimization model based on Grimm et al. (2017), which incorporates the optimal configuration of price zones, generation capacity investment of conventional and renewable energy sources and redispatch. With an exogenously given number of price zones, the model is able to determine the optimal zoning of the market. Furthermore, the optimal capacities of inter-zonal lines within the country are determined endogenously. The model is implemented in Python and solved to global optimality, using a decomposition approach that is specifically tailored for the effective solution of the resulting optimization problems.

Results

First computational results reveal that the right choice of price zones can lead to a more efficient locational choice for investment in generation capacity and therefore increase welfare. Furthermore, it can be beneficial to restrict inter-zonal transmission capacity for spot market trade in order to intensify price signals, which leads to more efficiency in electricity trade with respect to transmission capacity.

Conclusions

The paper at hand analyses the welfare-optimal configuration of price zones for the German electricity market and its effects on investment incentives in generation capacity. We developed a multilevel equilibrium model incorporating the optimal configuration of price zones, generation capacity investment and redispatch, including endogenous decisions about investment in conventional and renewable electricity sources as well as hourly production and load curtailment.

In the future, different branches of research may be followed. First, one could also consider endogenously determined investment in transmission line expansion, as there might be a tremendous welfare effect due to a decreased need for transmission line expansion when introducing zonal pricing. Second, we assumed deterministic input parameters in our calculations. However, amongst others, the political framework as well as the future development of electricity demand is uncertain. Therefore, an interesting next step would be a sensitivity analysis in order to check whether the optimal configuration is stable under changing input parameters.

References

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