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THE UP- AND DOWNSIDE OF HIDING INFORMATION – ZONAL VS NODAL PRICING IN ELECTRICITY MARKETS

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Overview

Liberalization in electricity markets has led to unbundling of vertically integrated utilities during the last decades. Consequently, generating electricity and operating the grid are tasks performed by separate entities. Crucial for system stability, generator schedules and grid operation must circumvent any imbalance caused by congestion and therefore require explicit coordination. Different solutions have been proposed and implemented, e.g. nodal pricing (PJM) or zonal pricing with administrative congestion management (Germany). Although, assuming complete information, all mechanisms should in theory result in the same efficient dispatch, the literature (e.g. Harvey and Hogan 2000, Bjørndal and Jørnsten 2001) concludes that due to implementation difficulties and hidden scarcities, zonal pricing is likely to cause an inefficient market outcome. However, the literature lacks economically well-founded arguments why zonal pricing should be preferred in any case. Noticeably, the majority of publications on congestion management focused on environments with complete information. If in addition uncertainty and limited information of transmission system operators (TSO) and generation companies (GenCo) are considered, the picture may look different. In environments with incomplete information wirth respect to uncertainty about future states, missing information and hidden scarcities do not necessarily have to be negative. In fact, hidden scarcities may reduce uncertainty for both, the TSO and the GenCos, and hence - given their respective strategies - lead to an increase of overall welfare. Hence, the inefficiencies of zonal pricing may be counter-balanced by the benefits of hidden information.

Method

We set up an analytical model to compare the two congestion management mechanisms nodal pricing with financial transmission rights and zonal pricing with administrative redispatch (which is neutral with respect to generator profits) in terms of overall welfare. The objectives of the TSO and the *n* GenCos for the two mechanisms differ in their functional form with respect to available information (e.g., GenCos do not consider the location of a power plant to be relevant in the zonal pricing setting). Completeness of information is modeled as knowledge of the players about nature draws determining future states of demand and grid expansion. Specifically, the nature draw is implemented for the absolute level of demand and grid expansion including different locational realizations. For example, higher demand at a location in combination with insufficient grid expansion leads to major congestion and therefore different optimization outcomes. The analysis considers different levels of information completeness, i.e., the range of uncertainty.

Results

The results of comparing zonal pricing with administrative redispatch and nodal pricing under complete information are straight forward and imply that nodal pricing is superior to zonal pricing. This is due to the fact that zonal pricing misses incentives for generators to locate their power plants on sites beneficial to the grid infrastructure. With incomplete information, i.e., uncertainty about future demand and congestion (level and location) however, the superiority of either nodal or zonal pricing is ambiguous and depends on the trade-off between inefficiencies due to hidden information and the benefits of reduced uncertainty. As the analysis shows, this trade-off is mainly influenced by the relative importance of uncertainty about future demand and congestion, i.e., the decision of where to build power plants and how to expand the grid. The greater the uncertainty about the future states becomes, the less valuable the information about the level and location of congestion (demand) is for the GenCo (TSO). Hence, in a state of great uncertainty, zonal pricing can be preferable to a nodal pricing regime. In the further analysis, the impact of strategic behavior, i.e., the degree of possible market power, is ought to complete the analysis.

Conclusions

The right choice of instruments for handling explicit coordination between unbundled electricity generation and grid operation depends crucially on the existing electricity system as well as the range of uncertainty about the level and the location of future demand and congestion. Although nodal pricing allows efficient coordination under complete information, a zonal pricing approach may be more suitable with consideration of uncertainty. We conclude that careful evaluation of the trade-off of hiding information is necessary. Furthermore, shortfalls in efficiency of zonal pricing due to poorly located power plants (with regard to the grid infrastructure) may be compensated by implementing a locational grid tariff.

References

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