Risk-aversion in Capacity Mechanisms – Computing Stochastic Market Equilibria using ADMM

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Uncertainty about demand levels and revenues on electricity markets introduces a risk for investors in generation technologies. These investments are coined by high fixed cost and face an increased dependency on scarce, or even uncertain high prices. Risk-averse behavior of investors might lead to suboptimal decision making and undermines generation adequacy. The interaction of market design and risk aversion is rarely treated in electricity market models. Capacity mechanisms are only poorly, or even not considered in modeling approaches focusing on risk aversion. Our contribution addresses two problems.
First, we propose a methodology to assess risk-aversion and capacity mechanisms in a stochastic market equilibrium model. The equilibrium model comprises investment decisions and hourly dispatch. Generators, each investing in a grouped technology, are represented as risk-averse agents. The Conditional Value-at-Risk (cVaR) is used to represent risk aversion. An additional agent represents the aggregated consumers.
Second, we propose an algorithm inspired by the Alternating Direction Method of Multipliers (ADMM) to compute a Nash Equilibrium (NE) by iteratively adapting prices and the agents' decisions. We benchmark our approach with a state-of-the-art solver relying on the Mixed Complementarity Problem (MCP) reformulation.
Our case study shows that for models with increasing numbers of scenarios and time steps integrating risk-averse conventional generators and renewable resources, our proposed approach is preferable. The algorithm converges in all cases while the conventional solvers fail to find an equilibrium for larger models. The results suggest that the proposed methodology is applicable on a wide range of equilibrium models overcoming the problem of integrating risk-averse behavior.

References

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