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Title: From Fuel to Power: A Bid Stack Approach to Modeling Energy Markets

Abstract:

Today's energy markets reveal high volatility, unusual features, and complex interdependencies, suggesting the need to model prices through a single interconnected framework. We develop an intuitive structural approach to modelling spot electricity prices, by analysing the underlying supply and demand factors, and the relationship between them. We propose a stochastic model for fuel prices, power demand and generation capacity availability, as well as a parametric form for the bid stack function which maps these price drivers to the spot power price. We fit the model to the PJM and New England markets and discuss its performance, in terms of capturing key properties of spot and forward prices, including relationships with natural gas and coal prices. We then discuss option pricing techniques in this framework, providing closed-form solutions where available, as well as approximation and simulation based methods. Finally, we suggest an extension to incorporate the recently-developed CO₂ emissions markets, and discuss their key role in determining the new dependence structure of energy markets.