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THE INFLUENCE OF UNCERTAINTY UPON GENERATION ADEQUACY

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Overview

In response to concerns about insufficient investment in generating capacity in liberalized electricity markets, a number of capacity mechanisms have been proposed which are intended to stabilize the volume of generating capacity. (For an overview, see De Vries, 2004). While most of these capacity mechanisms work well in an ideal environment, they differ with respect to their resilience against market imperfections such as risk-averse behavior by investors or insufficient information about the rate and stochastic distribution of demand growth. One of the risks is that an investment cycle develops (cf. Ford, 2001; Visudhiphan, 2001). A system dynamics model is built to test the performance of different capacity mechanisms and a market without a capacity mechanism (an energy-only market) in the face of uncertainty about the demand growth rate.

Methods

This model is an extension of the deterministic system dynamics model that was presented by De Vries (2005). In order to make the model more sophisticated, it is re-built in the programming language Maple. This environment allows greater flexibility; among others, it makes it easier to use stochastic variables. The basic structure of the model is still given by De Vries (2005).

An important improvement is that the growth rate of demand can be varied stochastically. Because uncertainty regarding the demand for electricity is a key issue in investment planning, this feature makes it possible to model investment behavior more realistically. Secondly, investment behavior is modelled more realistically, by letting the investment decision depend upon a forecast of the profitability of the generation portfolio including the new generating capacity. The stability of electricity markets will be tested in different market designs, such as an energy-only market, a capacity market and a market with operating reserves pricing.

Demand growth will be modeled in three ways: with a fixed growth rate, with a randomly varying growth rate (for instance around an average growth rate, or a random walk), and with a historic series of annual growth rates. Using randomly generated growth rates makes it possible to determine the effects of the average growth rate and the stochastic distribution upon the stability of different market designs. The use of historical data is interesting because may be more realistic. Moreover, the model can be validated by using recent historical data and comparing it to actual investment.

Results

The model results consist of overviews of the performance of different market designs (energy-only market, a market with a strategic reserve or operating reserves pricing, a market with capacity obligations) in combination with different demand conditions. The stability of the market – the ability to respond with sufficient investment, in time, to changing conditions – will be tested with a fixed growth rate of demand, stochastically distributed demand growth, and with a time series of historic demand growth patterns.

In addition to modelling the different capacity mechanisms, an energy-only market is modelled with the assumption that generating companies are able to exercise sufficient market power to raise revenues by 10%. If they reinvest these revenues in generating capacity, this would largely stabilize the market. Reasons for incumbent generating companies to pursue this strategy is that it would deter new market entrants and ward off the kind of government involvement that would likely follow a period of shortages.

Conclusions

Capacity mechanisms that perform similarly in a static analysis may perform very differently dynamically. In particular, price-based mechanisms appear more sensitive to uncertainty with respect to load-growth and prices than capacity mechanisms that regulate the total volume of generating capacity, like PJM's system of ICAP. On the other hand, a modest degree of market power may provide sufficient revenues to incumbent generating companies to provide a sufficient reserve margin. They may have an interest in doing so, as it would deter new market entrants and reduce the risk of (for them undesirable) government intervention. This may explain the relative stability of existing power markets without capacity mechanisms.

References

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