

On the valuation of historical nuclear production via option pricing: a stochastic equilibrium approach with risk aversion.

Ibrahim Abada, Grenoble Ecole de Management,
ibrahim.abada@grenoble-em.com
Mustapha Belkhouja, Grenoble Ecole de
Management
Andreas Ehrenmam, ENGIE Impact

Overview

Investments in nuclear production were historically financed by the state and operated by a historical monopoly. Today, nuclear production of historical assets is usually regulated to fulfill various objectives: limit the dominant position of the monopoly, enhance security of supply in the context of increasing renewable production, and share the benefits of a competitive power technology with consumers. To that end, countries adopted various regulation schemes but there is today no obvious first best option. Inspired by the French regulation of historical nuclear production and considering the market risk that now prevails in the sector, we propose an option-based regulation of nuclear production that fulfills the above-mentioned objectives. We consider a competitive, but financially incomplete market where the historical nuclear production is exchanged between the monopoly and competitors as a regulated call option. Agents do not have the same risk exposure and their attitude toward risk, which we model by coherent risk measures, might differ depending on the hedging contracts they acquire. The resulting model is a stochastic equilibrium model of option pricing in incomplete markets that we numerically calibrate and solve for the French market by simulating various scenarios of the spot market. We calculate the option value and quantify its impact on the system for various regimes of the spot market, including the current one of extreme and volatile prices. Based on our analysis, we also provide concrete recommendations on how to enhance the current French regulation of historical nuclear production.

Methods

We model a historical producer endowed with a substantial legacy nuclear capacity that is subject to regulation to prevent market abuse. We also model a set of alternative suppliers trading electricity in a market where the clearing price is random. These suppliers hence face some uncertainty that they need to hedge. We consider uncertainty of the demand and the spot market price, that we simulate using a time series analysis. Agents are averse to risk and do not have the same risk exposure as the historical producer. We consider the general situation where the market is incomplete, meaning that there is a limited set of contractual products allowing risk hedging or sharing between the agents. Inspired by the French nuclear regulation, we assess if an option-based regulated exchange of the historical nuclear production reduces the trading risk of the alternative suppliers while providing a fair remuneration to the historical producer allowing her to recover her production cost from the option plus the market revenues in a risk adjusted expectation.

Our model is formulated as a two-stage risk-averse equilibrium problem whose relevant outputs are the option volume contracted between the nuclear producer and the alternative suppliers, and the option price. We assess the extent to which the option mechanism reduces the risk of the alternative suppliers and we conduct a sensitivity analysis on the level of risk aversion of the market. Finally, we assess the implications of the recent French decision to increase the level of the exchange of the historical nuclear production on the price of the option.

Results

We use our time series analysis to generate scenarios of the spot market price in various market conditions, including the recent regime of high and volatile prices. Via a series of numerical simulations, we report on the evolution of the option price of the historical nuclear production with respect to the level of risk aversion and other market parameters. We focus in particular on the current the regime of high prices to test the limits of the option design and provide

recommendations on how to amend the current French regulation of the historical nuclear production to increase efficiency.

Conclusions

Future work can endogenize the formation of the market price to analyze its dependence on the option contracting strategies.

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