FUNDAMENTAL DRIVERS OF REGIME-SWITCHING: AN ANALYSIS OF GERMAN POWER PRICES

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Overview

On September 1, 2008, negative bids were allowed for the first time at the day-ahead market of the European Power Exchange (EPEX), the former European Energy Exchange (EEX). Since then, negative spot prices - sometimes quite large - have become a frequent phenomenon. For example, on October 4, 2009, the spot price plunged to -500 EUR per Megawatthour (MWh) in the trading hour between 2 and 3 a.m., a sizeable drop compared to the average electricity prices during that trading hour of about 38 EUR per MWh in 2009.

In addition to the typically low demand levels in the evenings, particularly on weekends, a key reason for this phenomenon is the rapid growth of electricity supply from renewable technologies in Germany. Between 2000, when Germany introduced the Renewable Energy Sources Act to support investments in renewable energy technologies, and 2012, the share of "green" electricity in Germany's electricity production almost quadrupled, increasing from almost 7 % to some 23 %.

It is a particularity of this support regime that, irrespective of the level of demand, utilities are obliged to preferentially accept the feed-in of renewable electricity into the grid, thereby paying technology-specific feed-in tariffs far above the utilities' production cost. In times of low demand, this regime is one of a confluence of factors, including the absence of sufficient storage possibilities for electricity as well as costly and long ramp-up times of base-load power plants, that impel producers to accept even negative prices, reflecting the high opportunity costs of a production stop in conventional plants.

Drawing on spot-market prices from the EPEX and using Markov regime-switching models to separate times of both negative and low prices from a normal price regime, this article econometrically investigates the effects of both Germany's substantial expansion of renewable energy technologies in electricity production and the nuclear moratorium of 2011 on the regime-switching behavior of spot prices. With this moratorium, which was issued by the German government on March 15, 2011, Germany reacted to the nuclear catastrophe in Japan's Fukushima, eventually leading to the permanent shut-down of 8 out of a total stock of 17 nuclear power plants and, hence, an immediate capacity reduction of 8,409 Megawatt (MW).

The paper is organized as follows: After the introduction, the dataset is described in the second section. The third section presents the econometric model, followed by the presentation of the estimation results and a model evaluation in the forth section. The fifth section summarizes and concludes.

Methods

Markov regime-switching model with time-varying switching probabilities.

The model extends Hamilton's Markov regime-switching model (Hamilton 1994) by adding time-varying switching probabilities. Such Markow regime-switching models with time-varying switching probabilities have been successfully applied to electricity spot prices by Mount et al. (2006) and Huisman (2008), for example. Whereas Mount et al. (2006) and Huisman (2008) model positive price spikes and employ data on capacity utilisation and temperature, respectively, in order to explain time-varying switching probabilities, this paper consideres negative price spikes during off-peak trading hours. Furthermore, it explains time-varying switching probabilities by data on load, the electricity production from renewable sources under fixed remuneration schemes and a dummy variable capturing the major impact of the nuclear moratorium on the electricity supply structure.

Results

First, an investigation into the low-price regime shows that this regime does not only capture extreme negative prices, but also low but positive prices. This finding suggests that a fuel switch, probably between hard coal and lignite, can explain the predominant non-linearity in off-peak spot price data from the EPEX.

Second, the model results imply that high levels of electricity production from renewables significantly increase the probability of these negative price spikes.

Third, we find that switching probabilities from the base to the low-price regime are reduced after the nuclear moratorium. This finding indicates that a nuclear phase-out leads to fewer negative price spikes.

Fourth, the model evaluation shows that the proposed two-regime models are capable of capturing the characteristics of spot prices at the EPEX for the majority of the off-peak trading hours.

Conclusions

These findings provide valuable insights with regard to the ambitious development plans for electricity generation from renewable sources and the planned nuclear phase-out in Germany by 2022. They imply that the nuclear phase-out in Germany might at least partly counteract the increase in negative price spike probabilities stemming from the increase in electricity infeed from renewable sources.

Moreover, the effect of the nuclear moratorium on fuel switches between lignite and hard coal is especially interesting for hard coal power plants. The results indicate that the nuclear moratorium decreased probabilities of a fuel switch between hard coal and lignite and therefore increased running times for hard coal power plants. Concerning the complete nuclear phase-out by 2022, similar effects are likely to prevail when additional nuclear power plants are shut down.

References

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