RENEWABLE RISK AND ITS IMPACTS ON MARKET PRICES: THE GERMAN CASE

[Philip Schnaars, Universität Hamburg, +49 40428388024, philip.schnaars@uni-hamburg.de]

Overview

With an ever-increasing share of intermittent renewables in electricity across the globe, the price impact and subsequently price volatility is set to increase. I develop a theoretical framework that motivates firm behavior under renewable output risk. This behavior depends on the price impact of the renewable output risk and should lead to withholding capacity from the day-ahead market when firms are confronted with significant price risk. Depending on the constellation, individual output risk directly translates into price risk. This is the most relevant case and significant withholding effects are expected.

The model is motivated by the seminal work by Bessembinder & Lemmon (2002), who analyze electricity price formation under demand risk. Their general equilibrium model suggests that the convexity of the power production function and its impact on the skewness of prices are key elements in understanding electricity price premia. Unexpected changes in the intraday price, spot price and total revenue are found to increase the risk premium. This hypothesis was empirically confirmed by Longstaff & Wang (2004).
Kakhbod et al. (2021) show that renewable firms have an incentive to withhold capacity if they have private information. It is possible that firms have private information in this setting, as the gathering of information on forecast risk is relatively costly.

I test the derived hypotheses on a rich dataset from the German electricity market. As renewable subsidies granting a fixed tariff are fading out, an increasing share of renewable capacity in Germany is facing price risk. Empirical evidence on the German price premium is scarce. Obermüller (2017) finds that a minority of weather conditions are associated with a higher price premium in Germany, while Pietz (2009) does not find a systematic relationship between price risk and price formation. I extend on these studies by using a novel measure for renewable output risk, derived from a meteorological prediction model. Furthermore, I assess bidding behavior with detailed day-ahead auction data.

Methods

To measure the output and price risk, I gather information from a meterological ensemble weather prediction model. For every point in time and space, the model computes 20 different predictions. If these predictions are similar, renewable output risk at the day-ahead stage is considered to be low and vice versa. I construct a risk measure that also incorporates clustering of renewable capacity.

The difference between the day-ahead and the intraday price, the risk premium, should increase in response to higher renewable risk, if firms behave in accordance to the model. I estimate regressions controlling for a variety of factors, such as realized forecast errors of wind and solar.

Assessing the presence of renewable withholding requires investigating day-ahead bids. I use data on aggregated supply bids in the German day-ahead market. The data format does not reveal the source of the bids, as only aggregated price-quantity pairs are available. I overcome this challenge by fitting a cubic spline to each hours bids. This procedure yields a differentiable function, from which I compute the second derivative. This curvature of the supply curve should increase, ceteris paribus, with higher renewable risk.

Results

The results are obtained using data that consists of hourly observations at the German market from 2015 to 2018. Regressions using heteroscedasticity and autocorrelation-robust standard errors show that renewable risk does not explain the difference between day-ahead and intraday price. These results are robust to different specifications, incorporating spatial heterogeneity of installed renewable capacity. The main drivers of the premium are indeed the forecast errors of renewables and demand, as these have to be balanced on the intraday market.

To further test whether firms withhold renewable capacity from the day-ahead market, I estimate regression functions explaining the curvature of the supply curve. I do not find evidence of renewable withholding in response to output or price risk. The main factors explaining changes in renewable supply are the levels of wind and solar radiation.

Conclusions

I do not find evidence that renewable firms react systematically to changing levels of risk in their forecasts, based on the observed risk premium and day-ahead supply bids. This implies that renewable firms do not behave as expected, which has multiple possible implications. First, it is possible that firms do not have access to this information. Second, if they have access to this data, the firms do not consider risk as important information. The market outcome will hence be information inefficient, as not all relevant information reflects in the price. If renewable firms do not incorporate this information in their supply decision, it is possible that they face relatively low balancing costs on the intraday market, reducing the need to hedge their day-ahead positions.

References

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