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Real-time price elasticity of electricity demand in wholesale markets

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Overview

At all times, system security in electricity markets relies crucially on interactions between demand and supply. While researchers have devoted much attention to dynamics on the supply side - most often under inelastic demand assumptions - the analysis of price effects on consumer demand still needs to be widened. In the past consumers were exposed to retail prices and wholesale prices were simply not observable. With the establishment of energy exchanges as trading platforms and the growing participation of utilities and industries in auctions the dependency on retail prices might have changed. In this debate, real time pricing could provide incentives for customers to reduce demand in hours where prices peak and, vice versa, shift demand to off peak hours when market demand is low. In theory, we expect a demand smoothing effect on prices in peak hours that increases social welfare. However, it still remains unclear how and to what extend the level of demand responds to changes in prices. We are thus interested in the real-time price elasticity of electricity demand and its evolvement in the past years. Besides being an important information for participants in the market for electricity, the level of price elasticity is especially important for policy makers which are concerned about system security.

Method

We empirically estimate the real-time price elasticity of demand for electricity in the wholesale markets. We follow the attempts of Patrick and Wolak (2001) who estimated the level of price elasticity by industrial and commercial customers. Later Lijesen (2007) analyzed the market in the Netherlands using hourly data on prices and demand. We extend this approach by using a two-stage least squares regression technique with feed-in data from renewable energies as instrumental variable. Our approach accounts for recent changes in the electricity sector by incorporating increased feed-in of fluctuating renewable energy that influence the supply side but not necessarily the level of demand for electricity. We start with an estimation on price elasticity of demand for different hours during the day. Then, we extend the analysis by applying this method to multiple markets in Europe.

Results

Our results indicate that the price elasticity of demand is low but nevertheless significantly higher than in previous studies. The price elasticity varies throughout the day. Especially during peak hours consumers respond to an increase in prices by reducing their load. In off-peak times, when prices are usually observed to be lower, price elasticity is low. By making use of the recent changes on the supply side in energy markets and implementing the fluctuating feed-in of renewable energies in our model, we are able to create much more robust results compared to a use of lagged price variables as instruments. We are thus confident that our results contribute to a better understanding of the demand side and their response to market prices.

Conclusions

Identifying key elements for policies that help to restructure electricity markets is a crucial task for all market participants and policy makers. One of these elements is to better understand the real-time market for electricity and the dynamic interactions between supply and demand. So far discussions about system security in electricity markets are mainly concerned with the supply side. Our paper helps to quantify the possible real time behavior of the demand side on changes in electricity prices. By estimating the price elasticity of demand we are able to contribute to the discussion and measure the impact of demand reductions when prices increase during peak times. The results show that the demand is not necessarily completely inelastic to price changes and may thus be able to contribute to the system security through reduced demand during peak-hours. Furthermore, our results indicate that the risk of market power abuse in peak-hours may not be as prominent as suspected.

References

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