NEGATIVE PRICE IN THE ELECTRICITY MARKET: PATTERN, VOLATILITY AND IMPACT TO PEAK LOAD DEMAND

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Overview

With the development of restructured wholesale electricity markets and sophisticated auction mechanisms, preriods with extreme prices have frequently emerged during recent years. Numerous prior studies consider negative pricing as the trigger of price volatility. In this study, we investigate which type of phenomenon dominates the hourly wholesale electricity price volatility. As two significant phenomena, both peak load and negative prices are often observed in wholesale electricity markets as the constituents of extreme values. However, their indications differ oppositely by the economic theory. Negative price is a signal of over-supply, whereas peak load prices means over-demand. Therefore, in a competitive electricity market, it is critical to make clear under which circumstance high price volatility is incurred at a larger probability.

The paper is organised as follows: the second section gives a brief overview about our research methodology. The third section provides the descriptive outcomes of the recent years locational marginal prices in the PJM electricity markets and depicts the price swings. In the fourth section, we examine how negative prices and peak load prices account for the cross-sectionl price volatility for each pnode. The fifth section concludes.

Methods

Principal Component Analysis (PCA)
Principal Component Regression (PCR)
Panel Data Analysis

Results

To compare the effects on price volatility from negative prices and peak load prices, we construct a Principal Component Analysis (PCA) model. We find that the position and dispersion of peak load prices have the largest explanatory power to the variation of data. By contrast, components dominated by negative pricing have much smaller explanatory power to the variation of prices. Next, we run a Principal Component Regression (PCR) and examine how these principal components affect the price volatility. Our results show that the performance and distribution of peak load prices account for more price volatility than those of negative prices. As an implication, fulfillment of over-demand issues should be the resolution to reduce price swings.

Conclusions

In summary, our results from PCA and PCR both suggest that the performance and distribution of peak load prices account for more price volatility in the electricity RTOs with numerous transmission lines. We are aware that negative prices indicate over-supply while peak load prices indicate over-demand. Therefore, in order to improve the price forecast, issues about demand inflexibilities should be taken more into account. By comparison, the appearance of negative prices does not dominate in terms of both amount and impact on the overall price volatility.

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