NATURAL GAS DEMAND FOR POWER GENERATION IN THE US: COINTEGRATION AND FUEL SWITCHING

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Overview

This paper examines natural gas consumption in the US electricity sector by region. It considers the relative prices of natural gas and its primary fossil fuel competitors – petroleum products and coal – as well as other exogenous factors that change the demand for natural gas for electricity generation. We use results from previous research that estimate the long run relationships between the competing fuels and examine how fuel switching is impacted by deviations in this estimated price relationship. In addition to grid-level switching within a NERC region, we consider micro-level switching by estimating fuel switching at plants with dual-fuel capabilities. The combination of the grid and plant-level analysis allows us to draw conclusions regarding the total amount of flexibility in the electricity sector.

Methods

Consistent with past studies, we use the translog functional form to represent the cost-minimizing agent and to examine the grid-level switching that occurs within each NERC region and some of the larger sub-regions. We modify these studies, however, by estimating the cointegrating relationship between the prices of natural gas and petroleum products used in electricity generation, specifically distillate and residual fuel oil. This accounts for the co-movement of natural gas and crude oil product prices while allowing for improvements in the thermal efficiency of burning natural gas for electricity generation. By using a stationary representation of departures from a long run equilibrium between crude oil and natural gas prices, we obtain estimators that have more desirable statistical properties. We use our estimated relationship to examine the effect on fuel shares of relative price movements, controlling for technology. In order to estimate plant-level switching responses we use a panel data approach. We estimate the sensitivity of plants with on-site switching capabilities to deviations in long run price relationships to determine how plant operators respond to price deviations.

Results

Preliminary results indicate that those regions with the highest switching capability, indicated by significant gas and fuel-oil fired electricity generation, are also the most sensitive to deviations in the long run equilibrium price relationship. Conversely, regions in which there is little oil-fired generation show very little sensitivity to deviations from the long run price relationship.

Conclusions

This paper shows that deviations in the long run price relationship between fuel oil and natural gas can impact the fuel mix in generation through two mechanisms. First, the movement of plants within a region's supply stack can alter dispatch order, representative of grid-level switching. Alternatively, plants with duel-fired capabilities can choose to switch on-site to profit maximize using the lowest-cost generation technique.