RISKY BUSINESS: MARGINAL SWITCHING AND PRICE VOLATILITY IN PJM

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Motivation

The debate about the merits of clean energy has two main factions: those in favour of clean energy because of its environmental benefits, and those opposed to clean energy, in part because it is more expensive. The tensions inherent in this debate have manifested most pronouncedly in electricity markets, with a motley parade of various policy directives.

Modern electricity sectors in the U.S. still rely largely on fixed price retail contracts, which makes the economic argument rather salient for load serving entities (LSEs). LSEs purchase power from generators on the wholesale market, where prices reflect the volatile cost of generation fuel, and resell this power on retail markets to end users at largely fixed prices. This exposes LSEs to wholesale price risk. Many states, through renewable portfolio standards, require LSEs to purchase a certain share of their total generation mix from clean power plants, including wind and solar farms. However, solar and wind generation is more expensive than traditional baseload sources like coal and nuclear power. The higher cost stemmes mostly from higher fixed costs of supporting the intermittency of wind and solar. Even though a part of this higher cost is passed on to end users, LSEs are still fully exposed to real time volatility of wholesale renewable prices.

One might argue that LSEs' preference for coal is economically rational, given coal's low and stable prices—exactly what is needed to offset some renewable price risk. However, a significant increase in natural gas generation capacity in the U.S. may be eroding the economic merits of coal, especially since gas prices fell to historic lows following the 2007 shale boom. With natural gas prices remaining at very low levels, natural gas power plants have become competitive as baseload generators. Fast ramping capabilities of natural gas plants also make them an attractive choice to support renewable intermittency. And their relatively benign carbon footprint makes them a viable alternative for coal plants.

Therefore, abstracting from the fact that all energy carries certain social costs (e.g., loss of coal jobs, environmental damages) that are very difficult to quantify, part of the economic argument in favour of dirtier energy may no longer be valid. Such a circumstance occurs for example if an increase in natural gas within the generation mix imparts benefits to LSEs (e.g, through a reduction in wholesale electricity price volatility).

In this study we evaluate the consequence of exogenous variation in the generation bid stack on price volatility in wholesale electricity markets using a natural experiment framework and data from PJM Interconnection.

Methodology

There is a lot of new natural gas generation capacity being built in U.S. power markets. As a consequence, power markets may become more dependent on natural gas generation, and this may impact wholesale electricity prices. Historically, natural gas prices have been more volatile than coal prices. Since the shale boom, however, gas prices fell significantly and have largely remained at very low levels. This has enabled natural gas power plants to become competitive as baseload generators. As natural gas plants supply a larger share of electricity generation, natural gas is likely to be on the margin more often, and the price of natural gas will begin to have a more pronounced impact on the wholesale price of electricity. It is not clear, however, whether the impact will be positive (e.g., lower price volatility) or negative (higher volatility).

This is not an easy question to answer because of a variety of confounding factors. First, both coal and natural gas have uses other than power generation (e.g. heating, transportation, metallurgical, and other industrial feedstock applications), and therefore their prices are affected not just by demand for electricity, but also by demand for other goods and services. In order to identify whether the volatility of wholesale electricity prices may change with a change in the marginal generation mix, we need to isolate only those price changes that are driven by demand for power.

Second, the reasons why we see more natural gas generation may vary. Sometimes we may see gas displacing coal, and other times we may see more gas generation being dispatched to support intermittent renewable generation. These two scenarios have very different implications for electricity price volatility. So we need an exogenous shock that is a) independent of the underlying cause for an increase in natural gas generation, and b) would affect which generation source is on the margin, but would not affect non-power demand for coal and natural gas.

In this study we identify one such exogenous shock—power plant outages—to help us answer our question. The natural experiment framework is as follows: all generators must at some point be taken offline (e.g., for maintenance), and a plant shutdown may provide the needed exogenous variation in marginal generation source. For example, if a marginal or inframarginal coal plant is taken offline, leading to a natural gas plant becoming the marginal generator. Prior to the plant's shutdown, coal is on the margin. Following the shutdown, gas is on the margin. The power sector's demand for coal would consequently decline, while its demand for natural gas would increase, but demand from non-power markets for both fuel types would be unaffected. Looking at wholesale price volatility before and after the coal plant outage would give us an idea of how an increase in marginal gas generation may impact electricity price volatility.

Data and results

Our empirical analysis is based on active plant-level outages within PJM Interconnection between July 2012 and December 2016. Preliminary results are forthcoming.