THE EFFECT OF FUEL COST UNCERTAINTY ON CAPACITY INVESTMENT: DUAL FUEL CAPABILITY AND TECHNOLOGY MIX

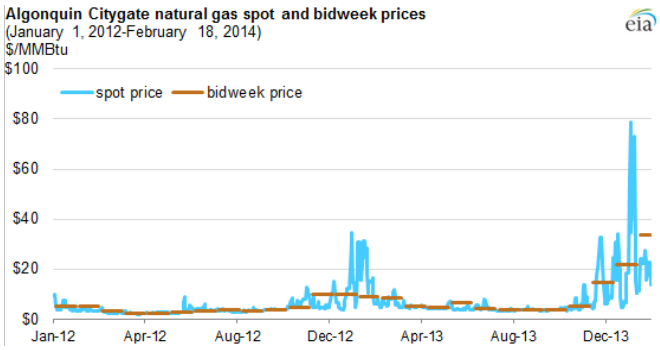
Nurit Gal, Public Utility Authority - Electricity, Jerusalem, Israel, nuritgal@pua.gov.il
Irena Milstein, Holon Institute of Technology, Holon, Israel, irenam@hit.ac.il
Asher Tishler, College of Management, Rishon LeZion, and Faculty of Management, Tel Aviv University, Tel Aviv, Israel, ashert@tauex.tau.ac.il.
C.K. Woo, Hong Kong Baptist University, Hong Kong, ck@ethree.com

Overview

Firms in competitive markets are exposed to risks previously borne by end-users, thus affecting their expected profits and their investment decisions.

IPPs owning natural-gas-fired generation are exposed, among other risks, to large fuel cost risks because natural gas price volatility is higher than the price volatilities of other fuels. Natural gas price volatility is mainly caused by transportation constraints and storage limitations (Eydeland and Wolyniec, 2003); Thus, atural gas prices surge when natural gas production is disrupted or when demand spikes, (Alterman, 2012).

Figure 1 - Natural Gas price spikes
(source: EIA –Today in Energy, February 21, 2014)



Dual fuel capability and the use of technology mix enhance the firm's risk management strategy by mitigating the risk of gas supply interruptions and by capping the potential fuel cost.

This paper studies the effect of natural gas cost uncertainty on investment in dual fuel plants and in capacity mix. The first part of the model provides the conditions under which dual fuel capability improves social welfare. The second part determines optimal capacity mix as a function of fuel cost uncertainty, natural-gas cost and the known cost of alternative fuels (i.e. coal or oil).

Methods

Following Pilipovic (1997) and Geman (2005), we assume that natural gas prices follow a log normal distribution, thus higer volatility increases the probability of low natural gas prices.

Building on Tishler et al. (2008) and Gal et al. (2016), we use a two-stage decision process as follows. In the first stage, N identical independent power producers (IPPs) build their optimal capacities, conditional on their perceived uncertainties in natural-gas cost and the known cost of alternative fuels (i.e. coal or oil). Equilibrium prices and quantities are determined in the second stage in which the IPPs are engaged in a Cournot competition, given capacity constraints and actual fuel prices. The model is solved recursively.

Results

An increase in natural gas price volatility in a dual fuel market icreases optimal capacity, expected operating profits and expected consumer surplus. However, when natural gas price volatility is high, the presence of dual fuel plants leads to a smaller capacity investment and smaller producers' profits relative to those in a single fuel market. However, if volatility is low, the presence of dual fuel plant can lead to higher capacity investment and, as a result, both consumer surplus and producers' profits increase.

In a two-technologies market (natural gas and coal, say), when natural gas price volatility is sufficiently high, the share of gas plants in the capacity mix would increase, even if the initial generation cost of the coal technology is significantly cheaper.

Conclusions

Intervention intended to reduce the volatility of a well-functioning competitive natural-gas spot price market can have the unintended consequence of discouraging generation investment, raising electricity prices, and reducing consumer welfare. In fact, policy makers can encourage a shift from coal to natural gas by liberalizing natural gas markets and allowing for natural gas price uncertainty.
The value of dual fuel capability declines with higher volatility of natural gas prices. Moreover, if volatility of natural gas price is sufficiently high, investment in dual fuel capability can reduce welfare.

References

Alterman, S., 2012. Natural Gas Volatility in the U.K. and North America. The Oxford Institute for Energy Studies, University of Oxford.

Eydeland, A., Wolyniec, K., 2003. Energy and Power Risk Management: New Developments in Modeling, Pricing, and Hedging (Vol. 206), Wiley and Sons.

Gal, A., Milstein, I., Tishler,A., Woo, C.K., 2016. The Effect of Natural Gas Price Uncertainty on Capacity Investment and Electricity Prices in a Competitive Electricity Market, Faculty of Management, Tel Aviv University.

Geman, H., 2005. Commodities and Commodity Derivatives, Wiley and Sons.

Pilipovic, D., 1997. Energy Risk: Valuing and Managing Energy Derivatives. McGraw-Hill.

Tishler, A., Milstein, I., Woo, C.K., 2008. Capacity Commitment and Price Volatility in a Competitive Electricity Market. Energy Economics 30 (4), 1625-1647.