

Energy Market Design, Performance Measurement and Monitoring

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Description: In spite of the California electricity crisis, three years of unusually high prices in the US natural gas industry, two electricity crises in the New Zealand electricity market in three years, and several other episodes of aberrant market outcomes in energy industries in other countries, the process of worldwide energy industry restructuring continues. One lesson that has emerged from these events is that the unique features of the structure of production and regulatory oversight in electricity and natural gas industries make them susceptible to the exercise of unilateral market power. This fact makes successful restructuring in electricity and natural gas industries extremely challenging. The only thing regulators can be sure of is that the initial market design will contain flaws that must be corrected, and if they are not corrected significant consumer harm can occur in a very short time. Consequently, particularly for these two industries, there is a need for consistent measures of market performance that can be compared across regions and over time to detect market design flaws and determine the appropriate regulatory intervention or market rule change.

This research devises and implement techniques for measuring market performance in electricity, natural gas and petroleum industries. This research has four lines of inquiry measuring performance in wholesale electricity markets. I plan to apply the methodologies for measuring market performance in the electricity supply industry presented in Borenstein, Bushnell and Wolak (2002) and Wolak (2003b) to provide a comprehensive diagnosis of the causes and solution to the California electricity crisis. The second project will adapt these two methodologies for measuring market-wide and firm-level market power (or market inefficiencies) to wholesale electricity markets that use locational marginal pricing (LMP) procedures to price electricity. The third topic is how to value the net benefits of transmission network upgrades in a wholesale market regime. Transmission network expansions have the potential to increase the competitiveness of a wholesale electricity market because they can increase the number of independent suppliers able to compete with each local supplier, a source of benefits to transmission upgrades that did not exist in the former vertically-integrated regime. The power outage in the eastern U.S. on August 14 and 15, 2003, suggests that an internally consistent methodology for valuing transmission upgrades in a wholesale market regime is far overdue. The fourth line of inquiry will study the extent integration of financial markets for electricity with the real-time market for electrical energy. In all U.S. wholesale markets, electricity is traded in a number of financial markets in advance of delivery. There are a number of arbitrage relationships that should hold between these markets if energy traders are risk-neutral, and a different set of relationships that should hold if energy traders are risk-averse. This research will derive these relationships and examine their empirical relevance.

In all countries around the world, the natural gas industry is increasingly integrated with the electricity supply industry because combined cycle-natural gas-fired facilities are the least cost way to meet an increase in electricity demand in virtually countries with a natural gas delivery infrastructure that do not have significant unexploited hydroelectric resources. Most all of the more than 100,000 MW of new generation capacity constructed in the U.S. over the past four years is natural gas-fired. This enormous increase in the demand for natural gas has put substantial stress

on the North American natural infrastructure. Prices in the U.S. natural gas industry for the past three years have averaged almost double their average values during the decade of the 1990s. To understand this sequence of events, my proposed research will construct a measure of natural gas market performance similar to the measures of electricity market performance described above and apply it to the U.S. natural gas industry using data collected by the Federal Energy Regulatory Commission (FERC).

The final project analyzes the performance of the California gasoline market. For the past year, retail gasoline prices in California have averaged close to two dollars per gallon, and slightly higher in large metropolitan areas. More important, these prices are 30 cents per gallon higher than average retail prices in the rest of the United States. Two major factors blamed for higher gasoline prices in California are: (1) higher production costs to meet California's stringent environmental standards, and (2) a less competitive refining and retailing sector which leads to higher margins above the variable cost of production earned by both gasoline refiners and wholesalers. This research will quantify the relative contribution of each of these and other possible explanations for higher gasoline prices in California.

Status: This work continues research previously funded by the National Science Foundation and the Energy Foundation.

Publications (available at <http://www.stanford.edu/~wolak>):

Borenstein, Severin, Bushnell, James and Wolak, Frank A. (2002) "Measuring Market Inefficiencies in California's Restructured Wholesale Electricity Market," *American Economic Review*, December, 1367-1405.

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Wolak, Frank A. (2000) "An Empirical Analysis of the Impact of Hedge Contracts on Bidding Behavior in a Competitive Electricity Market," *International Economic Journal*, Summer, 1-40.

Wolak, Frank A. (2003a) "Identification and Estimation of Cost Functions Using Observed Bid Data: An Application to Electricity," *Advances in Econometrics: Theory and Applications, Eighth World Congress, Volume II*, Mathias Detwatiripont, Lars Peter Hansen, and Stephen J. Turnovsky (editors), Cambridge University Press, 133-169.

Wolak, Frank A. (2003b) "Measuring Unilateral Market Power in Wholesale Electricity Markets: The California Market 1998 to 2000," *American Economic Review*, May 2003, 425-430.

Wolak, Frank A. (2003c) "Diagnosing the California Electricity Crisis," *The Electricity Journal*, August/September, 11-37.

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