THE IMPACT OF TRANSPARENT WHOLESALE ELECTRICITY MARKETS ON MARKET PARTICIPATION IN THE U.S. ELECTRICITY INDUSTRY

THEODORE J. KURY

I. Introduction

On December 20, 1999, the Federal Energy Regulatory Commission ("FERC" or "the Commission") issued Order No. 2000 in Docket No. RM99-2-000, a docket opened to explore the role of Regional Transmission Organizations ("RTO") in the restructured electricity marketplace. The FERC noted that since Order 888 was issued in 1996, trade in the bulk electricity markets had increased significantly. FERC also noted that during the Notice of Proposed Rulemaking process for the instant docket, the Commission had "reviewed evidence that traditional management of the transmission grid by vertically integrated electric utilities was inadequate to support the efficient and reliable operation that is needed for the continued development of competitive electricity markets, and that continued discrimination in the provision of transmission services by vertically integrated utilities may also be impeding fully competitive electricity markets." FERC further enjoined utilities, state officials, and affected interest groups to voluntarily develop RTOs. Despite the urging of FERC, there remain substantial portions of the United States electricity grid that are not administered by RTOs or Independent System Operators ("ISOs").

One way that ISOs and RTOs can aid in the development of electricity markets is by providing a transparent wholesale electricity market. Consider the case of an electric utility, Alpha, operating essentially as an island, isolated from the electricity grid around it. The utility dispatches its generating units to supply electricity to its customers, and attempts to do so in a manner that optimizes performance, typically measured in terms of cost or reliability. If electricity demand and the criteria under which the utility optimizes its portfolio, (e.g. least cost) are taken as exogenous, then the utility's only decisions involve which of its generating units are dispatched at any given time. Alpha assesses the hourly marginal costs of its generating units, considers any constraints related to the units' availability or operating characteristics, determines how much electricity it must supply, and dispatches units sufficient to meet that demand at the least possible cost.

Now consider the existence of a second electric utility, Beta, physically interconnected to Alpha in a neighboring area. Operating as an island, Beta faces the same decision as Alpha. However, if both utilities seek to minimize costs, and there is difference between the utilities' marginal costs of generation that is greater than the cost of transmission from Beta to Alpha, then the opportunity for Pareto improvement exists. If Alpha has a higher marginal cost of generation than Beta in a given hour, then Beta can generate that marginal kWh and sell it to Alpha at a price somewhere between their respective marginal costs, and both utilities have lowered their effective average costs of generation. Alpha by buying the marginal kWh at less than it would cost to generate it with its own units and Beta by realizing sales revenue greater than the cost to generate the marginal kWh.

But the costs that must be incurred in order to achieve this benefit are not limited to the cost of any transmission and the transaction itself. Each utility must also expend costs to gather information about the electricity system around it. First, each must gather information about the existence or number of potential trading partners. Second, each needs information regarding the costs and availability of electricity in any given hour, for every one of those potential trading partners, to determine whether an opportunity to trade exists. Third, each needs to know how to make the arrangements necessary to have that electricity delivered to the purchasing utility system in the event that a transaction is agreed upon. Before the advent of RTOs and ISOs, the first and third tasks were performed by regional balancing authorities, organizations registered by the North American Electric Reliability Council (NERC) to integrate future resource plans, maintain the balance between load, interchange, and generation, and support real time interconnection frequency for a given area. The second function was accomplished primarily through bi-lateral contact between utilities, though confederations of utilities also existed. For example, the Florida Municipal Power Pool was formed in 1988 between the Orlando Utilities Commission, the City of Lakeland, and the Florida Municipal Power Agency to centrally commit and dispatch all of the pool members' generating resources to meet the pool's load obligations in the most economical manner, before ISOs and RTOs existed.

By establishing a transparent wholesale market place, however, the RTO can fulfill the second task for the utility, either by maintaining a centralized databank of hourly prices, or by collecting hourly bids and offers from utilities interested in participating in the market. While the RTO can lower the costs required to gather this information, (e.g. by making it available on a website Bakos Communications of the ACM paper) the costs to participate in this market have still not been eliminated. Utilities must still incur costs in order to conform to the rules and procedures of this wholesale market, and the ability to trade with utilities that are members of other RTOs may be constrained (see PJM/MISO seams changes debate at FERC). Therefore, we have confounding factors that may influence the utility's willingness to participate in this wholesale market. Our hypothesis, then, is to test whether the existence of a transparent wholesale marketplace increases the degree to which an electric utility participates in the wholesale market.

The remainder of the paper is organized as follows: Section II provides a review of the existing literature, Section III describes the data utilized, Section IV describes the model and estimation methodology, Section V the results of the estimation, and Section VI some concluding remarks.

II. Existing Literature

This work follows earlier work (Kury 2011) that examined the retail price effects of RTOs and ISOs in the United States Electricity market. That work concluded that ISOs and RTOs did not have a statistically significant effect on retail prices, once the confounding effects of electric restructuring were removed from the data. However, that work also acknowledges that lower prices are not the only benefit of establishing these organizations. Another possible benefit is that of greater access to wholesale markets for electricity generators and electricity providers.

III. Data

The primary data source for the model is the Form 861 database compiled by the U.S. Department of Energy's Energy Information Administration. The reporting of information collected on the Form 861 is an annual requirement for all privately and publically owned electric utilities. Data collected includes the amount of wholesale and retail purchases and sales, revenues, customer counts, peak load, as well as demand-side management programs, green pricing and net metering programs, and distributed generation capacity. The utilities also report their control area operator on the form, which allows us to identify the time periods during which the utility is a part of an RTO that has established a transparent wholesale market. The data used on the study form includes the annual generation for each utility, net of the plant's own use (reported as net generation), and purchases from the wholesale market (reported as purchases). Together, these accounts are aggregated as total electricity sources for the utility. The total sources of electricity in a given year must always equal the total disposition of electricity, which is disaggregated into sales to ultimate consumers (retail sales), sales for resale (wholesale sales), and electricity losses (losses due to the transmission or distribution of electricity).

The data set consists of over 64,000 data points, each representing the response of one electric utility for one year from 1990 through 2009. The number of utilities responding in any given year ranges from 3090 to 4020. However, these utilities enter and exit the sample in a non-random fashion, and the inclusion of all utilities in the sample can lead to selection bias (Heckman 1979 reference). Therefore, we have elected to use only those utilities for whom the full 20 years of data exists

For our initial purchase sample, we have chosen utilities with positive sales to ultimate consumers, that is, utilities who serve electric load. We have then eliminated from our sample all those utilities that do not themselves generate any electricity in any year of the sample. These utilities are likely 'all requirements customers' of another utility, and therefore lack the means to serve their electric load, except by purchasing electricity on the wholesale market. These utilities would therefore be unaffected by the presence of a transparent wholesale market. The dependent variable is the fraction of the total sources of energy that comes from the wholesale market.

Similarly for our initial sales sample, we have included all utilities with positive net electricity generation in a given year, but then excluded any utility that sold all of that generation in the wholesale market over the entire time period in our study. Again, these utilities are likely wholesale generators, and the presence of a transparent wholesale market will have no effect on their behavior. The dependent variable in this case is the fraction of total disposition of energy that is sold on the wholesale market.

There is another way to derive our samples, however. Recall that our initial purchase sample consisted of any utility that did not generate electricity in any year during the sample period. However, a transparent wholesale marketplace might afford utilities that do not generate electricity the opportunity to purchase electricity in the wholesale market, and then resell it to another retail provider. Utilities that choose this opportunity in the wholesale market will be excluded from our initial sample. Therefore, for our second sample, we have included any utility in the initial sample, as well as utilities that reported sales for resale during the sample period. This sample is much larger, and allows us the opportunity to use the majority of our data points. Similarly, we have constructed a second sales sample that encompasses generating utilities that serve ultimate consumers during some period during the sample. This does not lead to a large increase in the sample, size, however.

IV. Model

The model to be estimated is our dependent variable (*DV*), which is either the fraction of the total sources of energy that comes from the wholesale market (for the Purchased regression), or the fraction of total disposition of energy that is sold on the wholesale market (for the Sold regression).

$$DV_{it} = \alpha_i + \beta_0 MktUtils + \beta_1 Time + \beta_2 ISO\_Whl + \beta_3 SumPk + \beta_4 Federal + \beta_5 Muni + \beta_6 IOU + \beta_7 SumPkxISO + \beta_8 MunixISO + \beta_9 IOUxISO + \varepsilon_{it}$$

Changes in the dependent variable are explained by a utility-specific fixed effect, the number of utilities that exist in the 48 contiguous United States in the given year (*MktUtils*), a linear time trend (*Time*), an indicator variable equal to 1 if the utility is a member of an RTO that operates a transparent wholesale market in that year (*ISO_Whl*), the size of the utility measured by its summer peak demand (*SumPk*), and indicator variables equal to 1 depending on the ownership of the utility (*Federal* if it is a federal power project, *Muni* if a municipally-owned utility, and *IOU* if a privately-owned utility). Our variables of interest include the *ISO_Whl* variable, as well as the interaction between this variable and the size and ownership variables.

The utility specific fixed effect accounts for the fact that utilities serve their load obligations with different combinations of owned generation and purchased power. Due to the long-lived nature of generating assets we would expect that this fixed effect will simply reflect the average purchases and sales of the utility over time, and will be relatively stable. We expect that market utilities variable will be positive, as the liquidity of the market should increase as more utilities are participating in it. The remaining variables are our variables of interest, although we would expect that effects of the constraints imposed by the transparent wholesale markets would be less than the effects of the cost reduction of the information regarding electricity availability and price, and that the coefficients on these variables will be positive.

V. Results

The results of the estimation with the initial sample are given below in Table 1.

Table 1: Parameter Estimates for Initial Sample

Variable	**% Purchased**	**% Sold**
Average Fixed Effect	0.7054*** (0.0591)	0.0987*** (0.0231)
MktUtils	1.51e-05*** (3.75e-06)	2.98e-05*** (6.98e-06)
Time	0.0033*** (0.0004)	0.0017*** (0.0004)
ISO_Whl	-0.0185 (0.0193)	-0.0294** (0.0146)
SumPk	-4.93e-07 (1.93e-06)	-1.17e-06*** 3.82e-07
Federal	-0.3979*** (0.0039)	
Muni	0.0538 (0.0785)	0.0162 (0.0279)
IOU	0.0303*** (0.0039)	0.0155*** (0.0034)
SumPk x ISO_Whl	1.1e-05** (5.31e-06)	-2.76e-06 (2.26e-06)
Muni x ISO_Whl	-0.0116 (0.0120)	0.0199 (0.0157)
IOU x ISO_Whl	0.2046*** (0.0421)	0.0751** (0.0323)
N	19405	9819
Number of clusters (utilities)	980	524
R-squared	0.8705	0.9532

(Robust standard errors clustered by utility in parentheses)
* Statistically significant at the 90% level
** Statistically significant at the 95% level
*** Statistically significant at the 99% level

The average fixed effect represents the average purchases or sales of the utilities in the wholesale market, and is, as expected, positive and significant. The number of utilities in the market also has a positive and significant effect on the fraction of wholesale purchases and sales for the utilities. It appears, from the time trend, that utilities have been purchasing about 0.3% more and selling about 0.2% more electricity in the wholesale market every year, perhaps due to technological increases in the economy as a whole. The presence of a wholesale market has a negative effect on sales, and its effect on purchases is insignificant. This may indicate that the barriers imposed by these markets may make it more difficult to sell electricity. The coefficient on the size of the utility indicates that larger utilities have a tendency to sell less electricity. However, the magnitude of this effect on sales is very small. For a utility with a peak demand of 1000 MW, slightly smaller than Knoxville, Tennessee, the effect on sales would be 0.1%. The ownership indicators are only significant for the federally-owned and privately-owned utilities, indicating that the federal utilities purchase much less than other utilities, on average, and that privately-owned utilities both purchase and sell more. More insight can be gleaned from the interaction terms, however. They indicate that municipally-owned utilities do not significantly change their participation in the wholesale market when the market becomes more transparent, while privately-owned utilities participate in the markets to a much greater degree, increasing purchases, all else equal, by 20%, and their sales by 7.5%. Further, larger utilities also seem to purchase more in the presence of a transparent whole market, and in this case, the magnitude of the coefficient is larger. Our hypothetical Knoxville utility above would purchase 1% more of their electricity in the presence of a transparent wholesale market. These results are similar to the results of Rose and Joskow (1990) where larger firms and privately owned firms tended to adopt new gas-fired generating technologies sooner than smaller and municipally-owned ones. In this instance, the creation of a transparent wholesale electricity market can be seen as the innovation.

When we estimate the regression for the expanded sample, the coefficients change, but our basic results remain the same. The principal difference is the much larger sample of utilities in the purchase equation. Recall that this expended sample includes utilities that may not own generation themselves, but purchase electricity in excess of the needs of their customers to resell on the wholesale market. Therefore, the average fixed effect increases by approximately 20%, as we are now allowing utilities that don't generate electricity themselves, but resell wholesale purchases into the sample. Now, the effect of the wholesale market variable is negative and statistically significant for both purchases and sales. Again, larger utilities increase participation in the wholesale markets, with the purchases for a 1000 MW utility increasing about 1.4%. Municipal utilities again see no significant change in their purchases and sales as a result of the wholesale market, and privately-owned utilities increase purchases by about 17% and sales by almost 7%.

Table 2: Parameter Estimates for Expanded Sample

Variable	**% Purchased**	**% Sold**
Average Fixed Effect	0.9028*** (0.0370)	0.1292*** (0.0215)
MktUtils	5.17e-06*** (1.34e-06)	2.77e-05*** (6.67e-06)

Time	0.0011*** (0.0001)	0.0006 (0.0006)
Log(Time)		0.0076** (0.0032)
ISO_Whl	-0.0112*** (0.0024)	-0.0257** (0.0126)
SumPk	9.74e-09 (1.05e-07)	-1.19e-06*** 3.81e-07
Federal	-0.3754*** (0.0014)	
Muni	0.0196 (0.0557)	0.0118 (0.0209)
IOU	-0.0501 (0.0543)	0.0168*** (0.0033)
SumPk x ISO_Whl	1.41e-05** (5.50e-06)	-2.53e-06 (2.11e-06)
Muni x ISO_Whl	0.0008 (0.0032)	0.0184 (0.0140)
IOU x ISO_Whl	0.1719*** (0.0320)	0.0695** (0.0303)
N	55484	10165
Number of clusters (utilities)	2802	544
R-squared	0.8839	0.9578
(Robust standard errors clustered by utility in parentheses) * Statistically significant at the 90% level ** Statistically significant at the 95% level *** Statistically significant at the 99% level		

VI. Conclusions

RTOs and ISOs can provide opportunities in the electricity market that might not otherwise exist. One such opportunity is the transparent wholesale electricity market. Transparent wholesale markets can reduce the information costs that limit the participation of certain types of utilities in the marketplace, and the opportunities that might arise with that participation. Through our analysis, we have shown that the presence of a transparent wholesale marketplace has the effect of increasing participation in the wholesale market, but that this participation is not increased symmetrically across all types of electric utilities. Greater participation is induced in privately-owned and larger utilities, mirroring the results of Rose and Joskow who found that privately-owned and larger electric utilities are more willing to adopt technological innovations in the industry.