An Empirical Analysis of Private Energy Provider Residential Market Share in Electricity Market in USA

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Abstract

In this paper we examine the determinants of residential electricity provider market share. The paper focuses on deregulation in terms of the energy providers entering the market, and consumer's actual action in selecting residential energy providers. Our investigation of private provider participation confirms the hypothesis of profit motivation on their part. This motivation which drives private participation runs at cross purposes with the public regulators' intent of driving down prices via competition. It also explains, in part, the motivation for recent roll-back in utility deregulation. Our findings indicate that the higher the population density, the higher the average residential price per kilo-watt-hour. Similarly, the size of the residential market share of private energy providers in the state is positively related to the size of commercial and industrial market.

I. Introduction

The purpose of this paper is to examine the determinants of residential electricity provider market share. We attempt to answer the question of why some states have larger energy provider market shares than others. In other words, what are the economic and demographic factors that encourage residential electricity deregulation in a state? And why have some states moved faster than others to deregulate the residential sector? What factors attract energy providers to some residential electric markets rather than others, beyond such things as politically motivated incentives? In essence, this paper focuses on deregulation in terms of the consumer's actual action in selecting residential energy providers. Our a priori conjectures are that such factors as population density, higher than average residential prices, a presence of energy providers in the commercial and industrial sectors, and other demographic and economic variables should be the major driving forces behind residential electricity deregulation. Though political factors do indeed play an important role, we surmise that their role is driven by market forces, and market characteristics.

The remainder of the paper is organized as follows: In section II we provide a discussion of the motivation for our work and undertake a literature review in section III. Section IV is a discussion of our method and we discuss the data in section V. Section IV is a discussion of the results of our empirical analysis following which we make some concluding remarks.

II. Motivation

Residential electricity deregulation has moved at vastly different rates across the U.S. States vary substantially in the progress that they have made in this area. Some made very little progress, others moved slowly, while some other states are moved fairly rapidly. This paper examines the determinants of the residential or residential market share that is comprised by energy providers or electricity marketers[1]. It attempts to answer the question of why some states

[1] In this paper we use the term energy provider, and energy marketer synonymously, to mean new privately owned entrants that simply provide electricity sales, as opposed to those that provide fuller services, such as transportation, and distribution. We distinguish these suppliers from the traditional suppliers that may be fully vertically integrated,

have made more progress in residential electricity deregulation than others. This provides an indirect indication of the characteristics of consumer perception to electricity deregulation.

Certainly, one important determinant of the energy provider market share is whether or not a state allows competition in residential electricity. Researchers have examined the characteristics that allow for a state to be more politically amenable to competition. However, these studies have been mostly of a subjective nature[2]. In our paper we seek to determine the key underlying characteristics or factors, which must drive the political decisions. Fundamentally, we assume the major driving forces determine both the economic, as well as political decision-making process. While political factors are important we assume that for this decision they are driven by the underlying economic and demographic characteristics of the market.

Thus, we seek to examine those factors that seem to be most significant in determining the residential market share of energy providers. In our study, we examined a number of variables that we felt might be major driving forces towards the use of energy providers. The fact that energy providers are allowed to serve residential customers in a state may not, of and by, itself encourage energy providers to enter, or enter with vigor. Energy provider's decision to enter certain states or to market more strongly in some states rather than others has to do with their expectation of the profitability associated with entering. Certainly, the level of competition as measured by the proportion of public ownership and the market share of dominant utilities will have a role. The size of the potential market is also a major factor; as well as the density of the market. Indeed, we hypothesize that population density is a major determinant. In a market of greater density more customers can be served, and economies of both scale and scope may be exploited. The scale economies are quite obvious in the serving of residential electric markets. The scope issues may come in when an energy provider is able to serve commercial, industrial, and residential customers, over a densely populated area. Here we define scope as providing multi-product service that is selling to residential, industrial, and commercial customers. Therefore, economies of scope occur when:

$$TC(Q_r, Q_i, Q_c) < TC(Q_r) + TC(Q_i) + TC(Q_c)$$

Where: Q is output, and r, i, and c, denote residential, industrial and commercial consumers respectively.

In addition to competition, and market size and density, the current price level existing in the market for residential consumers must also be considered. Higher prices relative to energy provider or new entrant costs surely would be a major attractor of energy providers and a major force in customer switching to the new provider[3].

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or provide either transmission and distribution services or both. In addition, we distinguish a third category of supplier, publicly owned utilities, which include Federal, Municipal, and Cooperative suppliers of electricity.

[2] See, "Electricity Retail Energy Deregulation Index 2003," 4th Edition, April 2003 (www.caem.org)

[3] We also examined a number of other variables such as family size, average income, and proportion of the dependency population-those younger than sixteen, and older than sixty-five. We also created a dummy variable to measure political climate in the state to determine if party control of the state legislature had any impact on deregulation; this variable was never found to be statistically significant. Some states also have had incentive programs which encouraged switching, however, we were unable to quantify this in a uniform manner across states.

Therefore, it is imperative to examine the impact of all of the above factors on the entrance of energy providers in a states residential electricity market.

III. Literature Review

Since Christensen and Greene (1976) numerous articles have been written on the efficacy of the deregulation of electric power. Joskow and Schmalense (1983) have provided a significant review of the literature arguing for deregulation. While others have warned more caution in this area, e.g., Both Kaserman and Mayo (1990) and Lee (1995) has shown that vertical disintegration of electricity entails technology loss. Joskow (1997) has provided a more recent and succinct overview of the progress and problems of reform in the electric power sector. While there is a significant and controversial literature on deregulation of electric power, to our knowledge few studies have examined the determinants of the competitive entrance. A few surveys have looked at switching at the mico-level or individual consumer choice level (Watson, A, 2000, et. al.). But most have assumed markets, once opened up, will automatically attract new residential energy providers. Many studies have argued for more consumer choice, and market solutions to the residential electricity markets. White (1996) suggests a clear connection between the magnitude of the price-cost gap and a states deregulatory activity, and uses this to explain and forecast wide heterogeneity between states deregulatory progress. Moreover, Joskow (1996) argues that in states such as California, and Northeastern states, the price-cost differential between retail, and wholesale markets is the largest; and therefore, these are the regions which have the largest potential benefits to deregulation. In our paper we examine this price gap, as well as a number of other important determinants. While these previous researchers have suggested hypotheses, few have empirically examined them. In this paper we will attempt to look at a number of the determinants by addressing these issues based upon a cross-sectional state-by-state study.

IV. Method

In analyzing this problem of market share determinants we chose to use the method of Seemingly Unrelated Regression Equations, or SURE. SURE was chosen in order to take care of the contemporaneous cross-equation error correlations. Viewing only the ordinary least square regression results, the equations might seem unrelated. In fact, they may be related through the cross-correlations in the errors. It would be unrealistic to expect that the errors in the ordinary least squares regression equations are uncorrelated. The fact that the market share of one type of provider certainly impacts the market share of the other providers may cause this problem, and lead to non-robust standard errors. Clearly, market share data which sums to one when all competitors are included is susceptible to this problem. The fact that shares do sum to one causes problem, therefore, we use SURE and drop one set of market shares from the model. What we have done is run two SURE models. One in which we exclude the Investor Owned Utility (IOU) or traditional suppliers, and use simply the publicly owned supplier residential market share, and the Energy provider residential market share. In the second model we include the IOU market share, and drop instead the publicly owned market share (Green, 2003).

In addition to SURE, we create two instrumental variables in order to eliminate the possible endogeneity effect of price. We handle this by creating the instrumental variables of delta in the first model, where delta is the residual variable of the OLS regression of price on publicly owned market share, thus delta represented price cleaned of its causation between itself and the publicly

owned market share effect. The variable Gamma was similarly used in the second model to take care of the same problem between price and traditional supplies market share.

V. Data

The paper represents a cross-sectional study of the determinants of residential energy in the U.S. Our analysis included data from the 50 U.S. states and the District of Columbia. The study represented a cross-sectional analysis for the year 2001, the most recent year for which the market share data was calibrated. Various reports of the Energy Information Administration were the source of all electric utility information (see www.eia.gov). All the state demographic and economic characteristics of states were obtained from the U.S. Census Bureau (www.census.gov). Table I provides a summary of the final variables used in the analysis.

Description of variables
FMCRMS - represents the residential electricity market share in a state of Federal, Cooperative, and Municipal suppliers.
Popdensity - the population density of the state.
Popdenssq - the square of the population density of the state.
Delta: Instrumental used for price. We first regressed price against FMCRMS and delta is the residual of that regression
Avghhsize - represents the average size of households in the state.
EPRMS - represents the percentage residential market share in a state held by energy providers.
EPNRMS – represents the non-residential market share (Commercial and Industrial) of energy providers.
Price: Average residential price per kwhr in nominal values.
TSRMS - represents the residential electric market share of traditional full service providers, or Investor Owned Utilities.
Gamma - Instrumental used for price. We first regressed price against TSRMS and delta is the residual of that regression

Table 1: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
FMCRMS	51	42.072	31.923	0	100
Popdensity	51	361.092	1302.833	1.1	9316.4
Popdensq	51	1794478	12100000	1.21	86800000
Delta	51	0	1.973	-3.67	6.67
Avghhsize	51	2.554	0.146	2.16	3.13
EPRMS	51	0.891	5.009	0	35.51
EPNRMS	51	0.029	0.066	0	0.29
Price	51	8.366	2.332	5.13	16.41
TSRMS	51	57.037	31.329	0	100
Gamma	51	0	2.021	-3.67	6.706

This data is based on the years 2000-2001. Many of the demographic variables are based on the Census 2000.

The U.S. average of the overall market share held by energy providers is approximately 4.3%, with Maine, and California, having the largest percent 66.33%, and 28.7% respectively, of residential, commercial, and industrial electricity supplied by energy providers in 2001. Roughly

thirty states had no residential electricity supplied by energy providers. The picture for the residential sector alone is much dimmer. As seen in table 1 the U.S. average residential percentage market share was .89%, while it ranged from zero in many states, to 35.51% in Maine. A question that we attempt to investigate in this paper is why there is such a disparity among the states.

Population density is a measure of the size of the market in a state. The District of Columbia had the highest population density with 9316 people per sq. mile, and New Jersey was second with 1134 people per sq. mile.

Our expectation regarding population density was that this variable would be positively associated with the residential market share of energy suppliers. The denser the population the more the likelihood that privatized residential electricity supply would be feasible from a marketing and efficiency standpoint, and the more likely a customer switching and bandwagon effect.

Regarding the average revenue per kilowatt-hour variable, our a priori expectations were that the higher this variable the higher the market share of revenues for energy providers. That is energy providers would be attracted to markets with high price-cost margins. Thus, we are using average price per kwhr as a proxy for the price-cost margin. This would reflect the idea that consumers paying more per kwhr basis would be more amenable to the selection of an alternative supplier. Indeed, this variable represented a proxy for residential price.

In terms of the percentage of residential electricity sales provided by public power facilities, Nebraska led all states with 100%. On the other hand, traditional investor owner utility market share range from zero in Nebraska, to 100% in the District of Columbia, with New Jersey at 98% and Connecticut with 95%.

VI. Results

In Table 3 we present the results of the SURE regression using the market shares of public ownership and energy providers as dependent variables, and dropping the equation of the investor-owned utility market share. From these results we see that there does exist a scale effect for population density. For both equations population density and population density squared are statistically significant, and have negative and positive signs respectively. This indicates that there are scales economies associated with density of markets.

Average household size, while having the same sign in both equations, was statistically significant only in the energy provider equation. The negative sign indicates that larger households in a state are less like to attract energy providers. Viewing Table 2, we see that average household size is negatively and statistically significantly related to both population density, and population density square. This indicates that average household size is larger in less densely populated rural areas. This provides a further confirmation of the importance of population density as a measure of market potential. The price variables delta in the publicly owned model, and the variable Price in the energy provider model both had a positive sign indicating that higher price attracted both public ownership and energy provider entrance, however the delta was not statistically significant; indicating that price had little influence on

publicly owned enterprise market share. Finally, we find that the variable EPNRMS was statistically significant and positively related to energy provider residential market share indicates that an already existing presence of energy providers in other segments of the market attracts energy providers; this provides evidence of economies of scope in these dense markets.

Table 2: Correlation Table

	FMCRMS	Popdensity	Popdensq	Delta	Avghhsize	EPRMS	EPNRMS	Price	TSRMS	Gamma
FMCRMS	1									
Popdensity	-0.276	1								
Popdensq	-0.196	0.985*	1							
Delta	0	-0.109	-0.14	1						
Avghhsize	0.039	-0.376*	-0.385*	0.274	1					
EPRMS	-0.196	-0.036	-0.026	0.209	-0.167	1				
EPNRMS	-0.366*	0.097	0.073	0.151	-0.068	0.594*	1			
Price	-0.533*	0.055	-0.014	0.846*	0.211	0.281*	0.322*	1		
TSRMS	-0.988*	0.286*	0.204	-0.033	-0.013	0.04	0.277*	0.498*	1	
Gamma	-0.047	-0.101	-0.134	0.995*	0.251	0.301*	0.213	0.867*	0	1

* indicates statistical significance at 5 percent level

Table 3: Seemingly unrelated regression

Equation	RMSE	R-sq	chi2	N
Dependent Variables				
FMCRMS	26.91762	0.2748	19.33	51
EPRMS	3.679542	0.4497	41.74	51
	Coef.	Std. Err.	z	P>z
FMCRMS				
Popdensity	-0.07	0.017	-4.06	0
Popdensq	0	0	3.69	0
Delta	1.114	2.039	0.55	0.585
Avghhsize	-10.643	29.148	-0.37	0.715
Constant	82.284	74.877	1.1	0.272
EPRMS				
EPNRMS	41.075	8.37	4.91	0
Popdensity	-0.005	0.003	-2.05	0.04
Popdensq	0	0	1.8	0.073
Price	0.531	0.264	2.01	0.044
Avghhsize	-8.102	4.008	-2.02	0.043
Constant	16.978	9.966	1.7	0.088

Table 4 contains the results of our second set of seemingly unrelated regression models. The results in this table are quite similar in all respects except for slightly higher R-squares, and Z values. While in the first model we found market share of energy providers to be positive related to price, and publicly owned not significant; in this second set of models we find price to be similarly statistically significantly related to market share and otherwise for the investor-owned utility. Again, this is to be expected. High prices in a market should draw private energy providers with the potential to attract more customers, and therefore increase their market share. The fact that the results were almost identical confirms the notion that it does not matter which of the equations we drop from the model[4].

Table 4: Investor owned and energy provider market shares

Equation	RMSE	"R-sq"	chi2	N
TSRMS	25.94	0.3	21.89	51
EPRMS	3.69	0.45	46.95	51
	Coef.	Std. Err.	z	P>|z|
TSRMS				
Popdensity	0.072	0.017	4.3	0
Popdensq	0	0	-3.89	0
Gamma	-1.222	1.903	-0.64	0.521
Avghhsize	17.786	27.937	0.64	0.524
Constant	-1.747	71.76	-0.02	0.981
EPRMS				
EPNRMS	41.967	8.291	5.06	0
Popdensity	-0.006	0.003	-2.23	0.025
Popdensq	0	0	1.97	0.049
Avghhsize	-8.466	4.007	-2.11	0.035
Price	0.635	0.263	2.41	0.016
Constant	17.097	9.966	1.72	0.086

VII. Concluding Remarks

In this paper we investigated the factors that determine the residential share of energy provider. Our results indicate that energy provider market share is positively related to price of electricity in the state. That is, higher electricity prices in a state attract energy providers. Somehow, electricity prices are treated as indicators of inefficient cost and pricing structures of the dominant existing utility company. Second, major attractor is existence of economies scale reflected by higher population densities. We found that energy provider residential market share is positively related to population density. Thirdly, we find that the presence of energy providers in the commercial and industrial sector in the state also positively impacts the market share for

[4] For purpose of comparison we provide the OLS results in the Appendix section of this paper.. Note that the OLS coefficients are almost identical to those obtained by using SURE.

energy providers in the residential sector. This last factor may be interpreted as a proxy of the existence of economies of scope.

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Appendix

Table 5: OLS Regression Results				
Dependent Variable: TSRMS	Coefficients	Standard Error	T	P>|t|
Popdensity	0.072	0.018	4.08	0
Popdensq	0	0	-3.7	0.001
Gamma	-1.253	2.008	-0.62	0.536
Avghhsize	17.887	29.419	0.61	0.546
Constant	-2.013	75.567	-0.03	0.979
N	51			
R-squared	0.3005			
Adj R-squared	0.2397			
Dependent Variable: EPRMS	Coefficients	Standard Error	T	P>|t|
EPNRMS	41.056	8.910228	4.61	0
Popdensity	-0.005	0.00272	-1.92	0.061
Popdensq	0	2.91E-07	1.68	0.099
Price	0.53	0.280833	1.89	0.066
Avghhsize	-8.098	4.267141	-1.9	0.064
Constant	16.978	10.60983	1.6	0.117
N	51			
R-squared	0.45			
Adj R-squared	0.389			
Dependent Variable: FMCRMS	Coefficients	Standard Error	T	P>|t|
Popdensity	-0.07	0.018	-3.86	0
Popdensq	0	0	3.51	0.001
delta	1.114	2.147	0.52	0.606
Avghhsize	-10.643	30.692	-0.35	0.73
Constant	82.284	78.841	1.04	0.302
N				
R-squared	0.275			
Adj R-squared	0.212			

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