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"Deregulation and Resource Reconfiguration In The Electric Utility Industry"

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DEREGULATION AND RESOURCE RECONFIGURATION

IN THE ELECTRIC UTILITY INDUSTRY

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DEREGULATION AND RESOURCE RECONFIGURATION

IN THE ELECTRIC UTILITY INDUSTRY

ABSTRACT

This paper analyzes how economic deregulation impacts resource reconfiguration in the electric utility industry. We argue that to understand strategic change in this industry, we need to understand how development and deployment of a firm's resources reflects path dependencies that nonmarket actors impose on firms. We find evidence that the deregulation introduced to this historically staid industry has stimulated environmental differentiation strategies for incumbent firms. Consistent with theories that suggest differentiation is most likely to appear where its point of uniqueness is valued by customers, utilities engaged in differentiation if they served states whose populace exhibited a higher level of environmental sensitivity. The tendency for firms to differentiate is lessened if they are relatively more dependent on coal-fired generation or relatively more efficient. In both of these cases, the variables are associated with lower operating costs, in turn demonstrating that firms sort themselves into either differentiation or low cost strategies as their environments reflect more market-like segmentation in a deregulated world. This paper contributes to the resource based view of the firm by highlighting the importance of the nonmarket context in which resources are developed and leveraged.

Key words: deregulation, nonmarket environment, environmental performance,

environmental differentiation, renewable energy, resource based view, electric utility.

Deregulation and Resource Reconfiguration

In the Electric Utility Industry

Introduction

The resource-based view of the firm focuses on resources as the key competitive dimension (Barney, 1991; Peteraf, 1993; Kogut and Zander, 1993; Conner and Prahalad, 1996; Grant 1996; Spender, 1996; Wernerfelt, 1984). Considerable research has now aggregated around the core concept of this theory—that organizations consist of bundles of resources that are unique to themselves and that organizations succeed by acquiring or creating resources that are valuable, rare, inimitable, and non-substitutable (Mahoney and Pandian, 1992).

Critics of this theory have argued that the role of external factors has been downplayed in favor of the theory's focus on variables that are internal to the firm. Even when they explicitly integrate such external factors into their theories, researchers working in the resource-based theory rely almost exclusively on product market and competitive variables, ignoring important nonmarket influences. This omission has been noted repeatedly by researchers. Russo and Fouts (1997:540) discuss political acumen as a potentially potent organizational resource that "has received little previous attention in resource-based theory development." More recently, Klepper and Simons (2000) identified the role of what they term "extra market institutions" in the development of capabilities as an area worthy of study. Finally, Barney, Wright, and Ketchen (2001) place the study of how the institutional environment influences strategy among topics worthy of further research in a recent comprehensive survey on the resource-based view of the firm. Despite these occasional calls, the study of how nonmarket factors influence resources has yet to capture the imagination of researchers.

In this paper, we ask where and how the introduction of nonmarket initiatives will motivate firms to change their resource bases. Specifically, we study how deregulation in the electric utility industry triggered strategic changes to the resource bases of some firms, creating environmental differentiation. We find evidence that as deregulation in this industry was introduced, firms reconfigured their productive assets to increase their generation of "green" power. This differentiation was accentuated in states with greater levels of environmental sensitivity—illustrating how the principles of effective differentiation have been applied in the industry. We also find evidence that differentiation is less pronounced the more efficient is the utility's generation base, and that the more of a utility's generation assets that are devoted to coal-fired power plants the less differentiation activity that takes place. These last two results are consistent with the emergence of a Porterian dichotomy, where firms sort themselves into two strategic archetypes: differentiation or low-cost.

We begin by surveying the strategies of firms under deregulation, trying to learn from researchers that have studied strategic change under nonmarket forces. In particular, those working more closely within the sociology and economic domains have produced a rich and diverse literature that explores how economic regulation and deregulation has impacted the behavior of firms. A common theme has been that government and other public agencies elicit profound organizational change by redrawing industry boundaries, shifting the scope of permissible activities for incumbents and entrants, and otherwise changing incentives for behavior (e.g., Bonardi, 2004; Fuentelsaz, Gomez, and Polo, 2002; Haveman, 1993; Haveman, Russo, and Meyer, 2001; Miller and Chen, 1994; Smith and Grimm, 1987). But as we show, this work generally does not explore resource reconfiguration.

Prior Research on Strategic Responses to Deregulation

Our focus is on deregulation, and it is important at the outset to note that deregulation can take many forms. To name just a few, deregulation can permit new competitors to enter a field previously closed to them (e.g., airlines), it can allow incumbents to compete in fields previously closed to them (e.g., savings and loans), and it can remove restrictions on pricing (e.g., long distance telecommunications). Frequently, deregulation combines some or all of these. The competitive implications of deregulatory regimes can vary greatly, one reason they have elicited very different reactions in affected industries.

Deregulation has consistently stimulated a diversity of strategic responses. Smith and Grimm (1987) identified profound shifts in the strategies of railroads following deregulation. Haveman (1993) found that once able to diversify, savings and loans expanded aggressively into new domains. Bonardi (1999) showed how customer segmentation followed regulatory relaxation in British telecommunications, with some firms targeting specific customer segments and others competing aggressively on price. Cho (2001) established that deregulation shifted managerial perspectives to a more entrepreneurial mindset. Russo (2001) and Walker, Madsen, and Carini (2002) found that new technological and competitive forms appeared in the utility and airline industries following institutional change that facilitated entry.

The well-established archetypes of differentiation and low-cost strategies have consistently occurred in deregulated industries. An example comes from the airline industry. Here, the rise of the hub and spoke system meant that flyers were much more conveniently served by airlines that had the city nearest to them as a hub, because that airline could offer so many non-stop routes. Airlines with a given city for a hub thus were differentiated from airlines that would need to have passengers change planes in their own hubs en route to their destination. On the other hand, Southwest Airlines, JetBlue, and other upstart airlines proved that a strategy stressing low operating costs and fares could win in the new environment.

Several studies have taken the next step to demonstrate that particular strategies can pay off under deregulation. Smith and Grimm (1987), in their study of post-deregulation railroads, found that the differentiators outperformed others. Corsi, Grimm, Smith, and Smith (1991) replicated the result in their study of the less-than-truckload trucking industry following deregulation. Haveman (1992) found that diversification by savings and loans after their deregulation generally augmented profits, although the greatest gains were captured by firms that leveraged their existing competency base.

This review suggests several takeaways. First, we need to know more about the intersection of nonmarket initiatives and resource configurations. The studies done to date, even taken cumulatively, still say little of direct relevance to the resource-based view of the firm. Haveman (1993) measured investment in new domains by savings and loans, but focused primarily on size as a driving force. Haveman, Russo, and Meyer (2001) tied deregulation of hospitals and savings & loans to diversification in a similar manner. They also showed that turnover in one organizational resource, CEOs, increased after deregulation of both industries. But in both cases, the authors do not connect resource reconfigurations to external conditions except that of deregulation, because they do not consider variables in the nonmarket environment. On the other hand, those studies that do reference external market conditions (e.g., Smith and Grimm, 1987) tend to simply measure shifts in strategy—not resource configurations. A study that can provide insight into how market and nonmarket conditions intertwine to elicit resource configurations would inform this vital literature

Second, with the exception of Russo's (2001) study of new energy forms, in no case is there variation across the institutional context—that is, deregulation occurs at once and applies to all organizations simultaneously. A study that focused on changing resource configurations within a heterogeneous institutional context would deliver scholarly value-added by isolating the effects of institutional shifts and avoiding potential confounding effects. Hypothetically, if there was a discontinuous shift in interest rates when savings and loans were deregulated, researchers could not conclude that their new resource configurations were solely due to deregulation. And if a breakthrough in telecommunications technology took place simultaneously with deregulation, the same confounding influence could be present. For our situation, if deregulation that applied to all firms took place at the same time that fossil fuel prices changed drastically, then utilities that changed their mix of resources could be responding to fuel price changes rather than deregulation.

Finally, work to date has not expanded our knowledge about the ability of deregulation to affect the provision of public goods. Previous work has shown how private benefits accrue to customers and firms via deregulation-induced differentiation.

This research largely has been restricted to dimensions that are familiar to competition: markets served, products offered, prices charged, and so on. What has not been explored is whether or not benefits of a more public nature—like a cleaner environment—might also emerge following deregulation.

Thus, there is much to learn by analyzing how and where resource reconfigurations occur in response to nonmarket events. Before developing theoretical arguments, it is instructive to begin with a brief historical sketch of resource reconfigurations that are beginning to materialize within the electric utility industry. As we hope to show, the response of firms in this industry to deregulation is a fortuitous platform for testing our theories.

Deregulation in the Electric Power Industry

Until relatively recently, the $300 billion U.S. electric power industry consisted mainly of vertically integrated utilities serving various “service areas” under exclusive franchise agreements. This arrangement has metamorphosed under retail deregulation plans in California, New York, Illinois, Texas, Michigan, Arizona, New Mexico, and several states in the New England and Mid-Atlantic regions. Prior to retail deregulation, electricity rates were set on a cost recovery basis. Investments in physical assets were granted a rate of return, while fuels costs were passed through to customers directly. Such an arrangement had its pitfalls, most notably a built-in incentive to over-invest in physical assets (Averch and Johnson, 1962), but did result in a reliable, well-understood mode of operation.

The roots of modern deregulation were in the Public Utility Regulatory Policies Act of 1978 (Russo, 2001). By forcing utilities to purchase electricity from private generators, policy-makers began to see that vertical integration in the industry was not essential to its operation. The law set in motion the processes that have challenged the concept of the utility monopoly and led to significant deregulatory initiatives. It is important to note that most of the initiatives for electric utility deregulation have taken place at the state level. This activity reflects a diffusion process has taken place across time, as states adopt deregulation at different points in time.

Consistent with other industries, as deregulation has unfolded in the electric generation industry, so has a range of strategic responses. Some firms, such as American Electric Power Company, stress low-cost power and focus on minimizing generation costs and hence, prices to consumers. Differentiation also is possible, although it is difficult in this industry because there are few products as quintessentially commoditized as a kilowatt-hour. For this reason, differentiation must take place in other ways, which permits an important point of connection between deregulation and environmental quality.

The theories that we now develop spotlight a particular type of differentiation—environmental differentiation—and show how attempts of electric companies to lessen their environmental impact and broaden their use of more environmentally-sensitive generating technologies can be seen partially as responding to marketplace effects that have followed from the early stages of deregulation.

NONMARKET INITIATIVES AND RESOURCE RECONFIGURATION

In our theory development we address three questions. First, under deregulation, what external conditions will cause utilities to reconfigure their productive resources?

Second, how might this reconfiguration manifest itself? Third, how might the exiting resource mix constrain the reconfiguration?

The critical element of the story is that utilities will segment the marketplace. Under economic regulation, and with monopoly provision of electrical service, there essentially were three segments: industrial, commercial, and residential. (It was not quite this simple, since there were differences among the industrial customers in terms of time of use pricing, interruptible service, and so on, but a customer still only had one provider). For utilities serving under a monopoly franchise, there was little incentive to segment further. Under deregulation, however, much greater segmentation can be expected. It is important to note that economic deregulation can potentially lead to marketplace effects that could reward firms choosing to go beyond compliance and embrace cleaner generation. If markets are rewarding companies that are environmental leaders (Russo and Fouts, 1997), then it may be in the economic interest of utilities to create and serve segments by marketing so-called "green power," electricity produced by sources which neither produce emissions nor are associated with nuclear generation. Thus, when utilities reconfigure their resources to produce and sell green power, they can differentiate themselves by pursuing a relatively new strategy in the industry.

Where might such environmental differentiation strategies emerge first? To address this question, it is instructive to look at differentiation strategies in conceptual terms. The concept of differentiation is simple and well-known, and was given its most rigorous treatment in Michael Porter's 1985 treatise, *Competitive Advantage* (Porter, 1985). Essentially, differentiation is based on the perception of the customer that a product is distinct from those of competitors. There are many points of differentiation, including brand image, quality, features, and service. In general, differentiation inflates the cost of a product or service, so that the firm employing the differentiation strategy will succeed only if the customer sees value in the point of differentiation such that he or she is willing to pay a premium for the product. The differentiator will succeed if this premium is greater than the additional costs incurred by differentiating (e.g., image-related advertising or additional service representatives), and sales volume is sufficient.

As noted, in the electricity industry, one straightforward way to differentiate is by offering green power. Given that there is some evidence of willingness to pay for green power (Byrnes, Jones, and Goodman, 1999) this can be a viable source of differentiation. Evidence suggests that in fact, green power marketing is enjoying a significant growth spurt in the United States (Bird and Swezey, 2003). On the other hand, at least in the short run, green power has tended to be more expensive than other sources (Burtraw, Palmer, and Heintzelman, 2000), creating the classic differentiation-cost tradeoff. A primer on its rise appears in Appendix A.

Of great importance is whether or not the point of differentiation is valued by customers, for if they are not willing to pay the premium associated with that differentiation, the strategy will fail (Reinhardt, 1998). Almost any type of differentiation will be valued by some customers; the key is to appeal to a greater number of customers. This is why we believe that the relationship between deregulation and differentiation strategy will be moderated by contextual variables that allow us to capture this valuation. Specifically, we believe that the environmental sensitivity of the population will moderate the relationship, such that the greater that sensitivity the more likely is deregulation to lead to environmental differentiation.

Environmentally sensitive consumers, who are generally better educated and enjoy higher incomes (Ottman, 1998), can be expected to have an effect on the electric utilities performance and behavior—but only where deregulation has been set in motion. Where deregulation is underway and competition can be expected, we believe that environmental differentiation will take place. Customers that value green power will see the chance to purchase it and be more likely to do so.

Given that particular customer classes value green power, how can a company's resource mix (its portfolio of generating plants) change to reflect this interest? Unlike in highly stylized economic models, in the resource-based view heterogeneity of assets indicates that such a change is costly and requires new resources (Barney, 1991). This in turn necessitates that new investments be made. If the firm follows this agenda, it will have to create or purchase the specific assets necessary to respond to the demands of customers. By thus reconfiguring its resources it is in a better position to create value by successfully differentiating.

In this sample, where a firm's market reflects environmental sensitivity, we would expect companies to make greater investments to augment their renewable generating assets. In summary, we hypothesize that environmental differentiation in the electric utility sector will appear under two conditions. First, retail deregulation needs to be in place to allow for differentiation strategies to emerge. Second, demand for environmental quality should be present in the state. We argue that when these two conditions are present, firms will have the incentive to reconfigure resources in order to pursue environmental differentiation strategies. They will do this by increase their investments in renewable energy generating resources. Hence:

Hypothesis 1. Under conditions of deregulation, the greater the level of environmental sensitivity among a generation company's customers, the higher the increase in firm resources relying on renewable generation.

Resource reconfiguration must reflect the demands of the marketplace, but it also must respect the realities of the organization undergoing change. The existing resource base can be the result of an initial resource endowment, technological trajectories, luck, and any number of other historical factors. When a new potential opportunity arises in a marketplace, firms will see that opportunity in a heterogeneous fashion. For some, few changes to the resource mix will be required to pursue them, and by leveraging on strengths they can pursue the opportunity. For others, developing these resources will threaten existing competencies and competitive advantages, and be less likely to be undertaken.

In the research setting here, investments in renewable energy technologies represent a very significant shift from coal generating technologies for two reasons, and together, these will suggest a negative relationship between resources devoted to coal generation and investments in renewables. The first reason has to do with strategy. Even without deregulation, a number of utilities focused on low-cost energy and so invested heavily in coal generation, which is a low-cost source of electricity (United States Energy Information Administration, 1998). For these firms, moving into the relatively higher-cost world of renewables could obscure their strategic intent.

The second reason for a negative coal-renewables relationship is due to the issue of reputation, since the greater the level of coal generation, the more difficult will it be for a utility to capture some of the reputational benefits of creating a green electricity presence. Coal-fired electricity generation is known to create a number of health and environmental problems including respiratory problems and acid rain (Sawin, 2003). To the extent that a firm is heavily invested in coal, it will be more likely to have a poor reputation. Without some degree of esteem on the part of customers, green offerings may be viewed with some suspicion and therefore draw few new customers. For example, Southern Company, one of the nation's most prolific burners of coal, was challenged by the U.S. Public Interest Research group when it tried to polish its green credentials (Odell, 2001).

Hypothesis 2. The greater the level of firm resources devoted to coal generation, the lower the increase in firm resources relying on renewable generation.

The third hypothesis suggests that the greater the level of productive efficiency of the firm, the lower its investments in renewable technologies. Productive efficiency refers to how, in relation to its peers, a firm can efficiently convert inputs into outputs. To the extent that a firm is more efficient, it can face a significant cost penalty for reconfiguring resources. Put differently, firms that have a resource base that is well-matched to the current conditions should be the least likely to initiate or capitalize on changes that require changes to that resource base.

By the same token, for firms saddled with inefficient mixes of resources, deregulation can offer some promise, because it offers a potential method for creating higher margins needed to offset the higher costs due to their inefficiency. Under regulation, the penalties for this inefficiency were not terribly severe for firms, since they still enjoyed monopoly status. However, with the competition induced by deregulation threatening high-cost players, other sources of margins must be found. In this way, we could expect another reason for efficiency and renewable investments to move in opposite directions, because low efficiency can induce resource reconfigurations that can boost margins. Hence:

Hypothesis 3. The greater the level of firm productive efficiency, the lower the increase in firm resources relying on renewable generation.

METHODOLOGY

To create our sample, we began with all 176 privately-owned electric utilities, representing 83% of the total US electricity production by privately- and publicly-owned utilities from 1998-2000. These utilities are incumbent firms that were present before and after deregulation. Non-utility generators were not included because they do not generally sell to end consumers. Because we employed a lagged variable approach for these tests to account for prior causality, we lost the year 1998 from the analysis. Due to missing data for one or more variables, we had 106 utilities that had complete data records for the two years, resulting in a final sample of 212 observations.

We used a combination of several databases, mainly the Federal Energy Regulatory Commission Form Number 1 (United States Department of Energy, 1998-2000) and the Emissions & Generation Resource Integrated Database (United States Environmental Protection Agency, 2002), from 1998 to 2000. The FERC Form 1, the Annual Report for Major Electric Utilities, is filed by privately-owned electric utilities. The report for each utility, which averages 140 pages, contains general corporate information, financial statements and supporting schedules, and a wealth of engineering statistics. The Emissions & Generation Resource Integrated Database (EGRID) contains emissions and resource mix data for all U.S. electricity generating plants that produce electricity and report data to the United States government. It contains information from three federal agencies: U.S. Environmental Protection Agency (EPA), the Energy Information Administration (EIA) and the Federal Energy Regulatory Commission (FERC). EGRID aggregates the data from the plant level to the utility company level, providing a detailed emissions profile, as well as the generation resource mix and capacity, ownership, corporate affiliation and location information, and other pertinent variables.

To test our hypotheses, we estimate changes in the generation mix that reflect shifts in the extent of resources that relay on renewable generation. These changes result from investment decisions that utilities make to respond to independent variables.

Dependent Variable

Change in Percentage of Generation from Renewables. This variable represents the yearly changes in percentages of total renewables generation as a percentage of the total generated by a utility. Using EGRID, we calculate the difference between the percentages in two consecutive years as the percentage of renewable resources that firm uses for generated electricity in a given year minus the percentage of renewables used in the previous year.

Independent Variables

Deregulation. To pick up the effect of deregulation, we created a variable to represent whether or not retail deregulation policy had been enacted in a given state, using information from the U.S. Department of Energy (2000a). Although the particulars of the policies varied across jurisdictions, the formal adoption of retail deregulation is an important threshold that is tractable and consistent across states.[1] The creation of this variable for a given utility is complicated, however, because 14% of our utilities operate in both regulated and deregulated states. To address this issue, following Delmas and Tokat (2005), we first created a variable that takes the value of 1 if retail deregulation had been enacted or a regulatory order had been issued, and 0 otherwise. This variable then is weighted based on the percentage of electricity sold by each utility within the state to create the variable deregulation used in the regression.

There are other types of deregulation that were adopted in some states, sometimes in concert with retail deregulation. Two such policies were to require utilities to divest their generating assets and to allow the recovery of stranded costs (costs associated with plants approved and built in the monopoly era that were too expensive to be viable in a competitive context). To explore the sensitivity of our results to other types of deregulation, we created three additional variables that represent whether i) there was retail deregulation and the recovery of stranded costs was allowed, ii) there was retail deregulation and divestiture of generating assets was required, and iii) there was retail deregulation but there was no requirement that assets be divested nor the possibility of recovery of stranded costs (see Delmas and Tokat, 2005). The results of the regressions with these variables are not significantly different from the ones that are presented in this paper.

Insert Table 1 about here

Environmental Sensitivity. The environmental sensitivity of the population of the state in which the firm operates plays a pivotal role in our story. Several prior researchers have used the scores of the League of Conservation Voters (LCV) as a measure of the environmental sentiment of the people of a state (Gray, 1997; Terry and Yadle, 1997).[2] Each year, the LCV selects environmental issues that constitute the environmental agenda with a panel comprising the main U.S. environmental groups. The organization then creates an index by counting the number of times that each representative or senator in Congress votes favorably for the "environmental agenda" (e.g., against logging in national forests or for proper mining waste disposal). The index ranges from 0 to 100, with 100 representing a record of voting with the environmental agenda in all cases. Following Kahn (2002) and Levison (1999), the raw variable is calculated as the average of the environmental scores of members of the United States House of Representatives and Senate. We then weighted this average by the total number of Congressional representatives in each state and by the percentage of generation of each firm in each state. Our source was the League of Conservation Voters (1998, 1999).

Percentage of Generation from Coal. To measure this variable, we used the percentages of coal used to generate electricity from EGRID.

Productive Efficiency. We estimate productive efficiency using Data Envelopment Analysis (DEA) (Charnes, Cooper and Rhodes, 1978; Banker, Charnes and Cooper, 1984). The DEA technique uses linear programming to convert multiple input and output measures into a single measure of relative efficiency for each observation. Further details on DEA and how we used it appear in Appendix B.

Control Variables

Market Concentration Ratio. The level of concentration of the competitive environment may impact differentiation strategies. This variable captures market concentration based on the 4 largest firms in each state. It represents the percentage of utility retail sales by the four largest utilities in the state and it is weighted by the percentage of generation in the state at the firm level. Data for this variable was constructed from the U.S. Department of Energy (2000b).

Renewables Portfolio Standard in Place. This variable captures the effect of operating in a state with an established renewable portfolio standard (RPS). These standards mandate that utilities generate a specified proportion of their energy from renewable sources. We first created a variable that takes the value 1 if the state has an RPS in place and 0 otherwise using the National Database of State Incentives for Renewable Energy (Interstate Renewable Energy Council, 2004). For multi-state utilities, this variable is weighted then based on the percentage of electricity sold within each state by the utility.

Number of Nonattainment Areas. This variable represents the level of pollution in the state as compared to national ambient air quality standards set within the Clean Air Act. Nonattainment areas are counties in the United States where air pollution levels persistently exceed the national ambient air quality standards. This variable represents the ratio of the total number of the nonattainment areas in all the counties that belong to a particular state divided by the number of counties of the state. The information comes from the U.S. Environmental Protection Administration (1998, 1999). Our nonattainment variable is calculated by using the number of times that a given county in a state exceeds the limits of the 6 pollutants identified in the Clean Air Act. If 1 pollutant exceeds its limit in a year, then the county's score is set equal to 1. If the same county fails with respect to another pollutant in the same year, then the number of nonattainment is equal to 2. We sum the number of nonattainments for all counties for a particular state and then normalize this figure by dividing by the total number of counties in a state. For example, if a state has 3 counties and the first county has 2 pollutants that exceed their limits during the year, the second county has 4 such pollutants, and the third county 1 such pollutant, then the value of this nonattainment variable for this state is (2+4+1)/3 = 2.33. We aggregate this ratio at firm level using the percentages of generation in each state.

Residential Proportion of Customers. This variable is included to pick up the effect of differences in the types of customers served by the utility. If residential customers are more receptive to renewable generation, then the coefficient on this variable will be positive. The source of data for this variable was FERC Form 1 reports.

Annual Net Generation. To proxy the size of the firm we use the annual net generation of the firm in megawatt hours given in EGRID database. A logarithmic transformation was used to reduce skewness.

Average Plant Age. The age of the generators could influence the ability to reconfigure resources. The older the average plant age, the easier it might be to justify investments in new technologies, like renewables. Using EGRID, we compute the average of the number of years since installation of each generating unit. The aggregation at the utility level is based on ownership and is weighted by the percentage of generation.

Research and Development. This variable represents the research and development expenses divided by the total operational expenses that the utility reports to the FERC. Firms that invest in R&D may have a higher probability of investing in renewables than those that do not invest in R&D.

Merger Process with Gas or Electricity Utilities. We also controlled for the effects of merger activity. From 1995 to 2000, 36 mergers or acquisitions were completed between investor-owned electric utilities or between investor-owned electric utilities and independent power producers (United States Department of Energy, 2000a).[3] We measure whether an electric utility is merging with other electric utilities or non-utility power producers, or with gas producers. A merger with an electricity company is considered as a related merger whether a merger with a gas company correspond to a diversification strategy. When a firm goes through a merger, there is uncertainty about whether the merger will be accepted and how to merge the assets of the different companies. In addition, during the merger process, there can be changes in the structure of the firm. For example, firms may decide to downsize their labor force or adopt similar technologies in the merged facilities or retire some of their facilities. During this adjustment period, it is possible that a firm will slow down other strategic moves such as adopting an environmental differentiation strategy. If the utility itself or its holding company goes through a merger process, then the indicator is 1 the year before until the year after the merger is completed (i.e. if the merger took place in year 1999, the indicator would be 1 for the years 1998 and 1999).

Interconnected Network Membership. We control for location in a specific interconnected network to which the electric utility belongs. An interconnected network (or power grid) consists of extra-high-voltage connections between utilities designed to distribute the electrical energy from one part of the network to another. Transfers between networks are nearly impossible because there are few lines that connect them. Following Energy Information Administration, we use the following three major networks: (1) the Eastern Interconnected System, consisting of the eastern two-thirds of the United States; (2) the Western Interconnected System, consisting primarily of the Southwest and areas west of the Rocky Mountains; and (3) the Texas Interconnected System, consisting mainly of Texas. Each firm in our sample belongs to one of three of these networks, so we omitted the Eastern network to avoid overdetermination.

Year Effects. We include a dummy variable for the year 1999 to pick up any effects specific to the years in the analysis.

Estimation Method

The distribution of the dependent variable changes in renewables is censored at its lower limit.[4] When the dependent variable is censored, conventional regression methods fail to account for the qualitative difference between limit observations and non-limit (continuous) observations. The Tobit technique we employ instead uses all observations, both those at the limit and those above it, to estimate a regression line, and is preferred over alternative techniques that estimate a line only with the observations above the limit (McDonald and Moffitt, 1980).

To test Hypothesis 1, we needed to interact variables measuring deregulation and environmental sensitivity in a state. To avoid multicollinearity, we first de-meaned these two variables, and then computed the interaction term as the product of both.

RESULTS

Table 2 displays the descriptive statistics and Table 3 the correlations of the variables used in the analysis. The regression results are presented in Tables 4 and 5.

Insert Tables 2 and 3 about here

In Table 4, Model A presents the result of the regression with the baseline variables. In Model B we include the variables that represent whether or not deregulation has been enacted and the environmental sensitivity of the population. In Model C, we incorporate the interaction effect between deregulation and the environmental sensitivity of the population in the state, to test Hypothesis 1. As the Log Likelihood tests show, each addition of new variables significantly improves the fit of the model.[5]

Insert Table 4 about here

The coefficients on variables representing deregulation and the environmental sensitivity of the population in the state are positive and significant in Model B although deregulation is significant only at the 10 percent level. In Model C, the interaction term between deregulation and the environmental sensitivity of the population in the state is also positive and significant. Firms located in deregulated states with a higher environmental sensitivity increase the share of renewables in their production mix more than firms that operate only in deregulated states or in states with a high environmental sensitivity. Thus, Hypothesis 1 is confirmed.

The coefficient on the percentage of coal used in the production mix is negative and significant. In our sample, the higher the percentage of coal generation, the lower the increase in investments in renewable generating capacity. This finding is consistent with Hypothesis 2.

The coefficient on the firm's productive efficiency is negative and significant at the 1 percent level in Models A and C, and at the 5 percent level in Model B. This indicates that firms enjoying higher levels of productive efficiency are less likely to increase their investments in the generation from renewables, and vice-versa. The effect supports Hypothesis 3.

Turning to the control variables, we find that the size of utilities is positively and significantly associated with the dependent variable. The coefficients on the variable representing the research and development effort is significant and positive showing that firms that invest in R&D invest in renewables. And the coefficients on the variables representing merger activities with either gas or electric utility companies are negative and significant in Models B and C showing that companies that are engaged in merger processes invest less in renewables. Finally, the coefficient on the year 1999 dummy is weakly positive, suggesting greater changes in investments in renewables in 1999 as compared to 2000.

The coefficients on the variables representing market concentration ratio, presence of a renewables portfolio standard, number of nonattainment areas in the state, and the residential proportion of customers are not significant. Of the interconnection variables, the Western interchange is significant once, suggesting that any effect of these variables is spurious.

Some of our variables have relative high correlations, including market concentration ratio, presence of a renewables portfolio standard, number of nonattainment areas, and productive efficiency. We remove each of these variables individually in Models D to G in Table 5. The results are not sensitive to the inclusion or exclusion of these variables.

Insert Table 5 about here

DISCUSSION AND CONCLUSION

Deregulation, Segmentation, and Resource Reconfiguration

We find that firms are more likely to reconfigure their resources to support an environmental differentiation strategy following deregulation in states where there is a high environmental sensitivity. However, incumbent firms that relied heavily on coal or sustained high levels of productive efficiency were less likely to adopt such strategies in that context. These results allow us to conclude that deregulation can energize the latent potential for segmentation in markets, and firms can use this segmentation to guide the reconfiguration of their resources.

In this way, nonmarket initiatives like deregulation influence resource configurations in a unique way. In retrospect, regulation acts as a shaper and delimiter of resource development, in essence by mandating path dependencies. This is typically manifested in statutory limits on domains of activity, such as when savings and loans could not develop competencies outside of residential lending or when AT&T was barred from developing resources to serve telecommunications markets overseas from 1934 until 1984. What we discovered here was that the external environment faced by utilities also is strongly shaped by regulation in ways that lead to resource development following particular paths. It was not that utilities were prevented from developing green power resources (and of course, several of them did do so). Rather, it was that the nature of utility regulation itself blocked incentives for market segmentation, in turn biasing downward opportunities for reconfiguring resources to promote renewable generation. In this way, resource reconfiguration under deregulation is distinct from resource reconfiguration under the types of contextual change that resource-based theory researchers usually study.

If the application of the resource-based theory to deregulation and perhaps other types of nonmarket initiatives is not a straightforward replication of its theories, then a number of researchable topics can be identified. It would be particularly instructive to study other elements of the nonmarket environment (e.g, patent laws, trade agreements, professional licensing, etc) to see how well resource-based theory fits them. The key point is that the nonmarket environment often change creates significant discontinuities that are less likely to occur in competitive markets (Haveman, Russo, and Meyer, 2001).

These conditions can create unpredictable change, winners and losers, and a competitive landscape that features rapid emergence of heterogeneity.

Environmental Differentiation in Action

Our results indicate that the environmental sensitivity of the populace served by a utility was reflected in its managerial actions. In other industries, the idea that companies would act in accordance with the preferences of their customers is hardly a subject for lively debate. But it is news in this industry, as market-like behavior replaces the more paternalistic approach under regulation. Historically, regulatory commissions were expected to articulate the desires and protect the interests of the populace, in theory creating efficient and socially optimum outcomes. However, even when commissions acted in the public interest (as opposed to being dominated by the companies they regulated), their mission generally was conceived narrowly. Although occasionally playing different roles in promoting alternative technologies (Russo, 2001), mandating a particular structure for pricing (Shepherd, 1985) and so on, most commissions focused their energy on scrutinizing the cost structure of utilities. Their collective attention was directed to review of rates charged to customers and two associated areas, fuel and construction costs. The job of regulatory commissions was never to replicate marketplace outcomes.

Deregulation has changed this. In the world of utilities, as deregulation unfolds the power to influence their activities and policies is slowly migrating from regulatory commissions expected to represent customers to the customers themselves. And that change has potentially profound ramifications. Under traditional utility regulation, a clearly defined institutional apparatus developed to bond utilities and commissions.

Across nearly a century of use, this apparatus became standardized and the regulatory agenda became defined and constrained (Gormley, 1983). As with the prototypical institutional process, the idea of vertically-integrated monopoly achieved taken-for-granted status. This was only challenged with the passage of PURPA, which unexpectedly created the conditions for competition in this world (Joskow, 1997).

For the foreseeable future, the electric generation industry will retain a strong institutional character. However, our results indicate the beginnings of behavior consistent with more market-like tendencies. Environmental differentiation by firms, especially when the populace they serve is most likely to value that differentiation, was very much in evidence in our sample. Essentially, this differentiation acts in ways that Porter (1985) and others would expect: it creates value by segmenting a product market and serving a well-defined constituency. The success of green power depends on taking a quintessential commodity, a kilowatt-hour, and segmenting it by how it is created.

Differentiation, Private Benefits, and the Common Good

Our study also has implications for the literature on environmental differentiation in consumer markets. Environmental product differentiation consists of offering products that provide greater environmental benefits, or that impose smaller environmental costs, than similar products. These products may be costlier than traditional products but they allow the firm to command a price premium in the marketplace or to capture additional market share. The environmental differentiation literature argues that one way of creating willingness to pay for public goods is to bundle them with private goods (Reinhardt, 1998). For example, many consumers are willing to pay a premium for organic food products that benefit directly their health and may taste better than nonorganic products. Speaking of Toyota's entry in the hybrid automobile market, an industry observer opined that "if you want to wear your green credentials on your sleeve, the Prius is the way to go." (Ulrich, 2004). Thus, the Prius produces a private benefit to the wearer as others see his or her pro-environmental behavior. Green electricity does not offer private benefits—other than the warm glow of altruism—because green and brown electricity are identical once they reach the consumer, and because the product's use is within the household of the consumer.

How can such a lack of private benefits be overcome? One way is to use the public policy process to create the benefit. Consider first how this is playing out in the case of sustainably harvested lumber. Like electricity, lumber represents a case where it is difficult to bundle private and public goods: green lumber does not have physical characteristics that differ from brown lumber. It is therefore hard to imagine that mainstream customers will be willing to buy green lumber certified by the Forest Sustainable Council at a 20% premium. At this point, policy-driven government purchases of green building materials still constitute most of the demand for FSC certified lumber. But as sales volumes rise and the supply chain for FSC lumber matures, it is likely that the price of FSC lumber will become competitive with non-FSC lumber, delivering private benefits.

A similar mechanism could occur in the electricity market. Green consumers still represent the minority of consumers, and change may come from recent public policies calling for requirements of minimums of green energy consumption by state-owned facilities. If these purchases bring the costs of green power to competitive levels, demand for green power will broaden and private benefits will appear. But this process is quite circuitous, compared to the more straightforward provision of private benefits seen in organic produce and other consumer product markets.

We have extended knowledge in the area of environmental differentiation with our analysis. Environmental differentiation plays out in ways that blend together traditional differentiation strategies with an element of conscious contribution to the common good that is not generally seen in the more familiar product differentiation that consumers face. But the study of this phenomenon is broader than the environmental context. For example, many social issues create platforms for differentiation in analogous ways, as when consumers take into account labor practices of companies when making purchasing decisions. Our knowledge of these points of "social differentiation"—strategies used to create and exploit them, and the relative longevity of advantages they may create—is minimal. With information about the companies that make their products increasing available and relevant to consumers, social differentiation also may become an important marketplace trend. Though researchers face a gap in the literature on this topic, that gap translates into a sizeable opportunity to study a phenomenon powered by growing momentum.

ENDNOTES

1. Retail deregulation did not confer complete freedom on competitors, as in every case the state placed a cap on prices when it adopted retail deregulation.

2. To verify that LCV ratings do reflect the environmental sentiment of the state's population generally, we attempted to validate them by comparing them to percentage of the state's residents that are members of the Sierra Club. We had membership data only for 2004, so it could not be used in the analysis. But the correlation between the 2004 LCV average rating for a state and the percentage of its residents that were Sierra Club members in 2004 was 0.45. This suggests that the LCV ratings are a reasonable measure of the strength of statewide environmental sensitivity.

3. We obtained additional information on the mergers from the FERC website: http://www.ferc.gov/industries/electric/gen-info/mergers/merger-apps.asp.

4. Electric utilities all started with a small percentage of their production mix so there is no negative change in percentage below -9.

5. The coefficients and significances of deregulation and the LCV rating do not change if we incorporate each of these variables independently or together in the model. And in the case of adding either one alone to Model (A), a significant improvement to the model fit is obtained.

Appendix A
Notes on Green Power Marketing

From the initial offerings of green power by several utilities in 1993, the movement has grown to the point where more than 500 investor-owned utilities, municipal utilities, and cooperatives—serving roughly half of America's population—offer green power options for customers (United States Department of Energy, 2004). Green power is actively marketed by utilities (United States Department of Energy, 2001). According to Bird, Swezey, and Aabakken (2004), the number of customers participating in utility green pricing programs increased four-fold between 1999 and 2002. Although still relatively small in total number, a continuation at anything like this three-year rate will create very sizeable aggregate demand in the next decade. Wiser, Bolinger, Holt, and Swezey (2001) projected total demand for green power from 2000 through 2010. Actual experience through 2002 suggests that if the current trends continue, demand for green power will quadruple between 2002 and 2010.

There are several options available to customers to pay for this power, including monthly surcharges, kilowatt-hour premiums, and voluntary contributions. In 2002 per kilowatt-hour premiums ranged from 0.7 ¢/kWh to 17.6 ¢/kWh, with a median of 2.5 ¢/kWh (Bird, Swezey, and Aabakken, 2004). The higher prices charged for green power are attributable to the higher costs faced by providers in securing sources of this power. A myriad of generation options are represented, including power derived from biomass, wind and solar, geothermal, landfill gas, and other options.

APPENDIX B

The Data Envelopment Analysis Technique

The DEA technique uses linear programming to convert multiple input and output measures into a single measure of relative efficiency for each observation. A piecewise linear industry best practice frontier is constructed using the observations in the sample. If a firm is on this frontier, it is considered efficient. If it is not on the frontier, its radial distance from the best practice frontier is a measure of the firm's *in*efficiency. Majumdar (1998) presents a good overview of the DEA technique while Coelli, Rao, and Battese (1998) provide a more detailed description. DEA is emerging as a powerful tool of data analysis for the electric utility sector as corroborated by the study of Majumdar and Marcus who used DEA in their paper on the impact of flexible environmental regulations on productivity in the electric utility sector (Majumdar and Marcus, 2001).

Our construction of the measure of productive efficiency is derived from the work of Delmas and Tokat (2005), who analyzed the productivity consequences of deregulation regulations in the electric utility sector. Data came from FERC Form 1 reports. The productive efficiency of a firm in a specific year is computed by comparing it to all other firms in the same year, using a program written by Coelli (1996). We use an input-oriented productive efficiency measure, which seeks to reduce the input quantities without changing the output quantities. Our DEA calculations also recognize that all firms may not be operating at optimal scale. Therefore, we allow different firms to have different returns to scale and the productive efficiency measure is devoid of the scale effects (Coelli, 1996). The inputs and outputs of the variable that represents efficiency are described below.

*Inputs***.** We use the following items as inputs: labor cost, plant value, production expenses, transmission expenses, distribution expenses, sales, administrative and general expenses, and electricity purchased from other sources in Mwh. Our choice of inputs is consistent with the literature. Roberts (1986) suggests using electricity purchased from others, capital used in transmission and distribution in addition to generation inputs. Similarly, Majumdar and Marcus (2001) include production expenses, transmission expenses, distribution expenses, administrative and general expenses, number of employees as inputs to electric utilities, and electricity purchased from other sources.

Outputs. We consider the following outputs: quantities of low-voltage sales (residential and commercial), high-voltage sales (industrial, interchanges out, and wheeling delivered), and sales for resale to other utilities in megawatt hours. A firm's cost of supplying power to final consumers is affected by the type of customer it serves (Roberts, 1986; Thompson, 1997). High voltage sales incur less transmission costs than low voltage sales due to reduced operating and maintenance costs. Furthermore, wholesale sales are less costly than both low and high voltage sales since they typically occur on less costly off-peak hours and entail larger quantities per transaction (Berry and Mixon, 1999). We consider these three types of outputs separately because of their differing costs.

REFERENCES

Averch, H., and Johnson, L. 1962. Behavior of the firm under regulatory constraint. *American Economic Review*, **52**: 1052-1069.

Banker R, Charnes A., and Cooper W.W. 1984. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis. *Management Science* **30**(9): 1078–1092.

Barney, J. 1991. Firm Resources and Sustained Competitive Advantage. *Journal of Management*, **17**: 99-120.

Barney, J. Wright, M., and Ketchen, D. J. 2001. The resource-based view of the firm: Ten years after 1991. *Journal of Management*, **27**: 625-641.

Berry D.M., Mixon F. G. Jr. 1999. Multiproduct Outputs and Scale Economies in Electric Power Production: Some New Estimates. *Review of Industrial Organization* **15**: 65-76.

Bird, L., and Swezey, B. 2003. *Green Power Marketing in the United States* (6th ed.). Golden, CO: National Renewable Energy Laboratory.

Bird, L., Swezey, B., and Aabakken, J. 2004. *Utility Green Pricing Programs: Design, Implementation, and Consumer Response.* Golden, CO: National Renewable Energy Laboratory.

Bonardi, J. P. 1999. Market and Nonmarket Strategies of a Former Monopoly During Deregulation: the British Telecom Case. *Business and Politics*, **1**(2): 203-232.

Bonardi, J. P. 2004. Global and Political Strategies in Deregulated Industries: The Asymmetric Behaviors of Former Monopolies. *Strategic Management Journal*, **25**(2):101-120.

Burtraw, D., Palmer, K., and Heintzelman, M. 2000. *Electric Restructuring: Consequences and Opportunities for the Environment*. Discussion Paper, Resources for the Future, Washington, DC.

Byrnes, B., Jones, C., and Goodman, S. 1999. Contingent valuation and real economic commitments: Evidence from electric utility green pricing programmes. *Journal of Environmental Planning and Management*, **42**(2): 149-157.

Charnes A, W.W. Cooper, WW and Rhodes. E. 1978. Measuring the Efficiency of Decision Making Units. *European Journal of Operational Research* **2**(6): 429-444.

Cho, T. 2001. The effects of top executive team composition, pay structure, and attention on strategic change: The case of the airline industry. In D. Nagao (Ed.), *Academy of Management Best Papers Proceedings.* Washington, DC: Academy of Management.

Coelli T. 1996. *A Guide to DEAP Version 2.1: A Data Envelopment Analysis Computer Program*. Department of Econometrics. University of New England, Australia.

Coelli. T.D., Rao S.P. and Battese, G. E. 1998. *An introduction to Efficiency and Productivity Analysis*. Boston. Kluwer Academic Publisher.

Conner, K. R. and Prahalad, C. K. 1996. A resource-based theory of the firm: Knowledge versus opportunism. *Organization Science*, **7**(5): 477-501.

Corsi, T. M., Grimm, C. M., Smith, K. G., and Smith, R. D. 1991. Deregulation, Strategic Change, and Firm Performance Among LTL Motor Carriers. *Transportation Journal*, **31**(1): 4-14.

Delmas, M., and Tokat, Y. 2005. Deregulation, Efficiency and Governance Structures: The U.S. Electric Utility Sector. *Strategic Management Journal*, forthcoming.

Fuentelsaz, L., Gomez, J. and Polo, Y. 2002. Followers' Entry Timing: Evidence from the Spanish Banking Sector After Deregulation. *Strategic Management Journal*, **23**(3): 245-264. DOI: 10.1002/smj.222.

Gormley, E. T. J. 1983. *The Politics of Public Utility Regulation*. Pittsburgh: University of Pittsburgh Press.

Grant, R. M. 1996. Toward a knowledge-based theory of the firm. *Strategic Management Journal*, **17**(Winter Special Issue): 109-102.

Gray, W. B. 1997. Manufacturing Plant Location: Does State Pollution Regulation Matter: Working Paper 5880, National Bureau of Economic Research.

Haveman, H. A. 1992. Between a rock and a hard place: Organizational change and performance under conditions of fundamental environmental transformation. *Administrative Science Quarterly*, **37**(1): 48-75.

Haveman, H. A. 1993. Organizational size and change: Diversification in the savings and loan industry after deregulation. *Administrative Science Quarterly*, **38**(1): 20-51.

Haveman, H. A., Russo, M. V., and Meyer, A. D. 2001. Organizational environments in flux: The impact of regulatory punctuations on organizational domains, CEO succession, and performance. *Organization Science*, **12**(3): 253-273.

Interstate Renewable Energy Council (IREC). 2004. *US National Database of State Incentives for Renewable Energy (DSIRE)*. Interstate Renewable Energy Council. http://www.dsireusa.org/

Joskow, P. L. 1997. Restructuring, competition and regulatory reform in the U.S. electricity sector. *The Journal of Economic Perspectives*, **11**(3): 119-139.

Joskow, P. L. 1998. Electricity Sectors in Transition. *The Energy Journal*, **19**(2): 25-52.

Kahn, M. E. 2002. Demographic change and the demand for environmental regulation. *Journal of Policy Analysis and Management*, **21**(1): 45-62.

Klepper S., and Simons K.L. 2000. Dominance by birthright: Entry of prior radio producers and competitive ramifications in the U.S. television receiver industry. *Strategic Management Journal* **21**(10/11): 997-1016.

Kogut, B. and Zander, U. 1993. Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation. *Journal of International Business Studies*, **24**(4): 625-645.

League of Conservation Voters. 1998-1999. *National Environmental Scorecard*, Washington, DC: League of Conservation Voters. http://www.lcv.org

Levinson, A. 1999. *An Industry-Adjust Index of State Environmental Compliance Cost.* Working Paper 7297, National Bureau of Economics Research.

Mahoney, J. T. and Pandian, R. J. 1992. The Resource-Based View Within the Conversation of Strategic Management. *Strategic Management Journal*, **13**(5 June): 363-380.

Majumdar S. 1998. On the Utilization of Resources: Perspectives from the US Telecommunications Industry. *Strategic Management Journal* **19**(9): 809-831.

Majumdar S. K., Marcus A. A. 2001. Rules versus Discretion: The Productivity Consequences of Flexible Regulations. *Academy of Management Journal* **44**(1): 170-179.

McDonald, J. F., and Moffitt, R. A. 1980. The Uses of Tobit Analysis. *The Review of Economics and Statistics*, **62**(2): 318-321.

Miller, D., and Chen, M. J. 1994. Sources and consequences of competitive inertia: A study of the U.S. Airline Industry. *Administrative Science Quarterly*, **39**(1): 1-23.

Odell, A. M. 2001. "Watchdog Challenges Southern Company," posted July 6 on SocialFunds.com website. http://www.socialfunds.com/news/print.cgi?sfArticleId=620.

Ottman, J. A. 1998. *Green Marketing: Opportunity for Innovation*. New York: NTC-McGraw-Hill.

Peteraf, M. 1993. The Cornerstones of Competitive Advantage: A resource-Based View. *Strategic Management Journal*, **14**(3): 179-193.

Porter, M. 1985. *Competitive Advantage: creating and sustaining superior performance*. New York: Free Press.

Reinhardt, F. L. 1998. Environmental product differentiation: Implications for corporate strategy. *California Management Review*, **40**(4): 43-73.

Roberts M. J. 1986. Economies of Density and Size in the Production and Delivery of Electric Power. *Land Economics* **62**(4): 378-387.

Russo, M. V. 2001. Institutions, exchange relations, and the emergence of new fields: Regulatory policies and independent power producing in America, 1978-1992. *Administrative Science Quarterly*, **46**(1): 57-86.

Russo, M. V., and Fouts, P. A. 1997. A resource-based perspective on corporate environmental performance and profitability. *Academy of Management Journal*, **40**(3): 534-559.

Sawin, J. 2003. Charting a New Energy Future. In L. Starke (Ed.), *In State of the World 2003*: 85-109. New York: Norton.

Shepherd, W. G. 1985. *Public Policies Toward Business* (7^{th} ed.). Homewood, IL: Irwin.

Smith, G. K., and Grimm, C. M. 1987. Environmental Variation, Strategic Change and Firm Performance: A study of Railroad Deregulation. *Strategic Management Journal*, **8**(4): 363-376.

Spender, J. C. 1996. Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal, Winter*, **17**(winter special issue): 1745-1762.

Terry, J. C., and Yandle, B. 1997. EPA'S Toxic Release Inventory: Stimulus and Response. *Managerial and Decision Economics*, **18**(6): 433-411.

Thompson H. G. Jr. 1997. Cost efficiency in Power Procurement and Delivery Service in the Electric Utility Industry. *Land Economics* **73**(3): 287-296.

Ulrich, L. 2004. Interview on National Public Radio Morning Edition, July 15, 2004.

United States Department of Energy. 1998-2000. *FERC 1 Survey*. Washington, DC: Federal Energy Regulatory Commission. http://www.ferc.gov/docs-filing/eforms/form-1/elec-subm-soft.asp.

United States Department of Energy. 2000a. *The changing structure of the Electric Power Industry*: *An Update*. Washington, DC.

United States Department of Energy. 2000b. State Electricity Profiles. DOE/EIA/0629 http://www.eia.doe.gov/cneaf/electricity/st_profiles/toc.html

United States Department of Energy. 2001. *Status of State Electric Industry Restructuring Activity*. http://www.eia.doe.gov/cneaf/electricity/chg_str/restructure.pdf

United States Department of Energy. 2004. *Green Power Network: Buying Green Power*. http://www.eere.energy.gov/greenpower/buying/index.shtml.

United States Energy Information Administration. 1998 *Challenges of Electric Power Industry Restructuring for Fuel Suppliers*. Washington, DC: EIA, September.

United States Environmental Protection Agency. 1998-1999. Green Book: Nonattainment Areas for Criteria Pollutants. Washington, DC: Environmental Protection Agency. http://www.epa.gov/oar/oaqps/greenbk/index.html

United State Environmental Protection Agency. 2002. *EGRID2002*, Version 2.01. Washington, DC: Environmental Protection Agency. http://www.epa.gov/cleanenergy/egrid/index.html.

Walker, G., Madsen, T. L., and Carini, G. 2002. How Does Institutional Change Affect Heterogeneity Among Firms? *Strategic Management Journal*, **23**(2): 89-104. DOI: 10.1002/smj.216.

Wernerfelt B. 1984. A Resource-Based View of the Firm. Strategic Management Journal **5**(2): 171-180.

Wiser, R., Bolinger, M., Holt, E., and Swezey, B. 2001. *Forecasting the Growth of Green Power Markets in the United States*. Golden, CO: National Renewable Energy Laboratory.

TABLE 1
Retail Deregulation by State

State	Year of Deregulation
Arizona	1998
Arkansas	1999
California	1998
Connecticut	1998
Delaware	1999
District of Columbia	2000
Illinois	1998
Maine	1998
Maryland	1998
Massachusetts	1998
Michigan	1998
Montana	1998
Nevada	1998
New Hampshire	1998
New Jersey	1998
New Mexico	1999
New York	1998
Ohio	1999
Oklahoma	1998
Oregon	1999
Pennsylvania	1998
Rhode Island	1998
Texas	1999
Virginia	1998
Vermont	1998
West Virginia	2000

TABLE 2
Descriptive Statistics

VARIABLE	N	MEAN	S.D.	MIN	MAX
Change in percentage of generation by renewables	236	1.95	12.98	-9.20	100.00
Deregulation	303	0.50	0.49	0.00	1.00
League of Conservation Voters (LCV) rating	305	46.61	23.42	2.00	96.67
Deregulation X LCV rating	303	5.28	10.13	-20.26	24.53
Percentage of generation from coal	259	50.47	40.28	0.00	99.97
Productive efficiency	305	88.00	15.12	33.20	100.00
Market concentration ratio	303	76.76	12.06	40.70	100.00
Renewables portfolio standard in place	303	0.17	0.37	0.00	1.00
Number of nonattainment areas	305	0.34	0.42	0.00	2.00
Residential proportion of customers	305	0.28	0.14	0.00	0.60
Annual net generation (log scale)	256	15.15	2.47	5.90	18.40
Average plant age	279	27.32	9.15	2.00	67.09
Research and development	305	2.24	4.13	0.00	36.01
Merger process with gas utility	305	0.07	0.25	0.00	1.00
Merger process with electric utility	305	0.25	0.43	0.00	1.00
Eastern interconnected system	305	0.81	0.39	0.00	1.00
Western interconnected system	305	0.11	0.32	0.00	1.00
Texas interconnected system	305	0.05	0.21	0.00	1.00

TABLE 3
Correlations of Variables Used in Analysis

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Change in percentage of generation by renewables	1.00														
2. Deregulation	0.19	1.00													
3. League of Conservation Voters (LCV) rating	0.24	0.41	1.00												
4. Deregulation X LCV rating	0.12	-0.19	0.03	1.00											
5. Percentage of generation from coal	-0.20	-0.29	-0.31	-0.17	1.00										
6. Productive efficiency	-0.28	-0.38	-0.42	0.02	0.25	1.00									
7. Market concentration ratio	0.09	0.44	0.43	-0.10	-0.22	-0.38	1.00								
8. Renewables portfolio standard in place	0.02	0.11	0.43	-0.02	-0.09	-0.02	0.12	1.00							
9. Number of nonattainment areas	0.12	0.55	0.46	0.12	-0.35	-0.36	0.39	0.35	1.00						
10. Residential proportion of customers	0.00	0.05	-0.02	-0.07	-0.03	-0.07	0.25	-0.06	0.05	1.00					
11. Annual net generation (log scale)	-0.07	-0.29	-0.48	-0.24	0.42	0.32	-0.14	-0.23	-0.38	0.21	1.00				
12. Average plant age	-0.14	-0.01	0.04	-0.10	0.04	0.04	-0.01	-0.03	-0.13	-0.08	0.10	1.00			
13. Research and development	0.22	0.08	0.18	0.00	-0.16	-0.24	0.06	-0.01	0.03	0.18	0.03	0.04	1.00		
14. Merger process with gas utility	-0.06	0.05	0.04	-0.02	-0.14	0.01	0.03	-0.05	0.11	0.16	0.13	-0.02	0.21	1.00	
15. Merger process with electric utility	-0.10	0.16	0.19	0.01	0.06	-0.08	0.07	0.28	0.16	0.07	-0.03	-0.01	-0.04	-0.04	1.00

TABLE 4
Tobit Regression Results
Dependent Variable: Change in Percentage of Generation from Renewables [a]

	(A)	(B)	(C)
Deregulation		4.136 (2.218)+	**6.019** **(2.321)***
League of Conservation Voters (LCV) rating		0.113 (0.057)*	**0.118** **(0.056)***
Deregulation X LCV rating			**0.223** **(0.092)***
Percentage of generation from coal	-0.060 (0.026)*	-0.054 (0.025)*	**-0.046** **(0.025)+**
Productive efficiency	-0.219 (0.071)**	-0.175 (0.071)*	**-0.187** **(0.070)****
Market concentration ratio	-0.013 (0.078)	-0.108 (0.083)	**-0.104** **(0.082)**
Renewables portfolio standard in place	0.412+ (3.126)	-0.514 (3.310)	**0.917** **(3.317)**
Number of nonattainment areas	2.735 (2.817)	-0.530 (3.071)	**-2.609** **(3.147)**
Residential proportion of customers	-6.285 (6.912)	-4.450 (6.808)	**-3.916** **(6.717)**
Annual net generation (log scale)	0.959 (0.519)+	1.298 (0.533)*	**1.547** **(0.535)****
Average plant age	-0.243 (0.095)*	-0.255 (0.094)**	**-0.234** **(0.093)***
Research and development	0.394 (0.191)*	0.340 (0.188)+	**0.328** **(0.186)+**
Merger process with gas utility	-4.716 (3.498)	-6.039 (3.479)+	**-6.260** **(3.433)+**
Merger process with electric utility	-2.886 (1.938)	-3.771 (1.926)+	**-4.232** **(1.909)***
Western interconnected system	-5.848 (2.760)*	-3.595 (2.823)	**-2.338** **(2.832)**
Texas interconnected system	-3.373 (4.706)	-1.568 (4.711)	**-1.145** **(4.649)**
Year 1999	2.554 (1.655)	2.832 (1.701)+	**2.872** **(1.678)+**
Constant	18.663 (11.190)+	17.918 (11.079)	**13.070** **(11.108)**
Observations	212	212	**212**
Log Likelihood	-816.54	-812.57	**-809.66**
Likelihood Ratio Test		8.14*	**5.81***

[a] Standard errors in parentheses + significant at 10%;* significant at 5%; ** significant at 1%

TABLE 5
Tobit Regression Results
Dependent Variable: Change in Percentage of Generation from Renewables [a]

	(D)	(E)	(F)	(G)	**(C)**
Deregulation	5.383	5.853	5.117	6.414	**6.019**
	(2.276)*	(2.243)**	(2.054)*	(2.355)**	**(2.321)***
League of Conservation Voters (LCV) rating	0.097	0.123	0.114	0.146	**0.118**
	(0.054)+	(0.053)*	(0.056)*	(0.056)*	**(0.056)***
Deregulation X LCV rating	0.225	0.218	0.202	0.207	**0.223**
	(0.092)*	(0.090)*	(0.089)*	(0.093)*	**(0.092)***
Percentage of generation from coal	-0.044	-0.045	-0.044	-0.047	**-0.046**
	(0.025)+	(0.025)+	(0.025)+	(0.025)+	**(0.025)+**
Productive efficiency	-0.173	-0.183	-0.180		**-0.187**
	(0.070)*	(0.069)**	(0.070)*		**(0.070)****
Market concentration ratio		-0.104	-0.106	-0.070	**-0.104**
		(0.082)	(0.082)	(0.083)	**(0.082)**
Renewables portfolio standard in place	0.858		-0.102	-0.831	**0.917**
	(3.331)		(3.086)	(3.305)	**(3.317)**
Number of nonattainment areas	-2.744	-2.287		-1.685	**-2.609**
	(3.159)	(2.924)		(3.180)	**(3.147)**
Residential proportion of customers	-6.100	-4.024	-4.290	-3.859	**-3.916**
	(6.520)	(6.707)	(6.714)	(6.828)	**(6.717)**
Annual net generation (log scale)	1.460	1.542	1.590	1.350	**1.547**
	(0.533)**	(0.535)**	(0.534)**	(0.539)*	**(0.535)****
Average plant age	-0.239	-0.237	-0.237	-0.240	**-0.234**
	(0.093)*	(0.092)*	(0.093)*	(0.094)*	**(0.093)***
Research and development	0.353	0.329	0.338	0.437	**0.328**
	(0.186)+	(0.186)+	(0.186)+	(0.184)*	**(0.186)+**
Merger process with gas utility	-5.859	-6.303	-6.331	-7.137	**-6.260**
	(3.435)+	(3.430)+	(3.438)+	(3.473)*	**(3.433)+**
Merger process with electric utility	-4.046	-4.123	-4.210	-3.974	**-4.232**
	(1.911)*	(1.868)*	(1.912)*	(1.938)*	**(1.909)***
Western interconnected system	-2.915	-2.497	-3.281	-2.022	**-2.338**
	(2.807)	(2.773)	(2.598)	(2.876)	**(2.832)**
Texas interconnected system	-1.028	-0.942	-1.295	-1.061	**-1.145**
	(4.667)	(4.592)	(4.653)	(4.726)	**(4.649)**
Year 1999	2.786	2.790	2.627	2.876	**2.872**
	(1.683)+	(1.652)+	(1.654)	(1.706)+	**(1.678)+**
Constant	5.913	12.933	11.708	-3.149	**13.070**
	(9.602)	(11.099)	(11.005)	(9.429)	**(11.108)**
Observations	212	212	212	212	**212**
Log Likelihood	-810.46	-809.70	-810.00	-813.12	
Likelihood Ratio Test (Model C is full model)	1.26	0.08	0.69	6.92**	

[a] Standard errors in parentheses + significant at 10%;* significant at 5%; ** significant at 1%