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Determinants of voluntary electricity demand management program participation

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ABSTRACT

This paper examines the voluntary electricity demand management decisions of commercial and industrial customers (at the firm and facility level) of an electric utility serving a United States Mid-western metropolitan area. Using standard probit analysis, we find that electricity costs are a major determinant of a firm's decision to voluntarily engage in demand management programs. Specifically, an additional $100,000 in electricity costs raises the probability of participation in an electricity demand management program by 0.3 percent. We also find that companies with multiple sites are 3.7 percent more likely to participate. In terms of demand management program participation, these results indicate a difference between organization and size that warrants further examination.

1. Introduction

A substantial body of research devoted to the study of Corporate Social Responsibility (CSR) has developed in recent years. Publications by Vogel (2005), and Hey et al. (2005) synthesize and extend this research, largely through case study analysis and empirical investigation, and serve as examples of the current prominence of CSR social science and policy analysis. This focus has, in large measure, been driven both by an increasing number of instances whereby firms appear to be voluntarily choosing to behave in a type of "self-regulatory" fashion, as well as by a proliferation of private and government-sponsored certification programs which seek to induce firms to act in a socially responsible manner.

CSR can come in many forms, from limiting effluent releases of unregulated pollutants beyond what is required by law, to voluntarily investing in, and implementing, worker safety devices and practices, to voluntarily participating in government-sponsored regulatory compliance programs (e.g., Vogel, 2005; 131–132). Several theories have been advanced to explain why firms may choose to engage in such behavior, much of which has come from the environmental economics literature.[1] Such theories include consumer demand and wealth effects, pre-empting future and potentially tougher regulations, influencing stockholder demand, creating entry barriers, and enhancing productivity.

Empirical work has primarily focused on ascertaining the characteristics of firms choosing to self-regulate or participate in voluntary programs. These characteristics include not only firm-specific characteristics (size, profitability, etc.) but also industry, regional, and community-level attributes that might be linked to a firm. Prakash and Potoski (2006), for instance, undertake an in-depth analysis of firm decisions to seek ISO 14001 certification. Khanna and Damon (1999), Arora and Cason (1996), and Videras and Alberini (2000) address characteristics of firms who elected to participate in the US EPA's 33/50 program in the early 1990s.

Khanna and Anton (2002a, 2002b) and Anton et al. (2004) model the adoption by firms of environmental management systems. In these papers, a number of additional measures are added to account for possible regulatory and liability pressures that could explain the environmental goods provision by firms.[2] Collins and Harris (2002) study whether foreign (non-U.K.) firms spend more than domestic U.K. firms on plant pollution controls. They conclude that non-E.U. foreign-owned plants spend more on controls than U.K.-owned plants. This result indicates that the country where the firm is headquartered may affect the environmental behavior of that firm's facilities.

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[1] For a review of this literature, see Lyon and Maxwell (2002). See also Alcott and Mullainathan (2010).

[2] It should be noted that this potential liability may be tied to the size of the firm, since larger firms may be seen by potential litigants as having deeper pockets. Thus, liability could be related to the degree of entrepreneurship of the firm through size.

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Peters and Turner (2004) study the participation of small- and medium-sized enterprises (SMEs) in voluntary environmental initiatives and find that SMEs need better demonstration of potential benefits from participation in order to participate in these programs. In some respects, this need would indicate the opposite result – entrepreneurs are less likely to behave in an environmentally positive manner than more established firms. The relationship between firm size and voluntary environmental behavior remains unsettled.

While the economics literature is replete with research focusing on pollution control, very little work has focused on voluntary programs geared toward energy conservation. Moreover, no study accounts for facility-specific differences or for differences in interaction between firms and their facilities as potential determinants of voluntary behavior with respect to electricity demand or energy conservation.

We examine commercial and industrial customers' (at the firm and facility level) willingness to voluntarily participate in various demand management programs offered by an electric utility serving a Midwestern metropolitan area in the United States. Electricity demand management will continue to be an important consideration of electric utilities for two reasons: the pressure to reduce carbon emissions and increasing demand on aging power generation facilities. Demand-side management programs (DSM programs) have been a component of this utility's efforts to assist firms in reducing their electricity use. DSM programs are typically voluntary programs that use a variety of incentives to encourage energy conservation by both residential and commercial utility customers. Notable examples of DSM programs include the U.S. EPA's Green Lights and Energy Star programs, which provide utilities with incentives to encourage customers to reduce electricity use through improved lighting or to adopt other energy efficient technologies. In many instances, DSM programs are also delivered directly through electric utilities. For example, Florida Power and Light offers a "Solar Rebate Program" to both residential and commercial customers who install photovoltaic (PV) and solar water heating systems in an effort to reduce electricity demand from the utility. We examine data on electricity usage, firm and community characteristics, and DSM program attributes to determine the components of business participation in these programs.

Research on these programs for the energy industry has been as varied as the economics research on pollution control. However, this research has focused on the results of individual programs rather than on the effects of particular characteristics (e.g., Sullivan, 2009a & 2009b). Our research differs from industry-level research because it examines the marginal effects of particular firm characteristics on program participation.

Examining the marginal effects of specific firm characteristics improves understanding of participation across programs, as opposed to explaining participation of a particular program, and improves electric utilities' effectiveness at targeting DSM programs to specific characteristics of firms and the overall design of DSM programs. This type of research has been advocated in the utilities research by Farnsworth (2007), but has yet to be seen in academic research.

The paper is organized as follows. In Section 2, we develop a conceptual framework to support our empirical specifications. In Section 3, we discuss the data used in this study. In Section 4, we discuss the results and in Section 5, we conclude.

2. Conceptual framework and model specification

The electric utility offers several demand reduction programs to commercial customers. We assume customers decide whether or not to participate in an electricity DSM program if the (perceived) gains from program participation exceed the costs of participation. Gains from DSM programs include at minimum reduced electricity use – and therefore lower electricity bills – but certainly could include other environmentally-related benefits to the commercial electric customer as well.

Costs of program participation depend on the design of the DSM program in question. A program replacing lighting types from T12 to T5 potentially could require the business to close for a short time, resulting in loss of revenue, even if the electric utility is paying the costs of the lighting upgrade. Benchmarking electric use, such as is required for participation in the Energy Star Challenge, comes with some monitoring costs. These costs may be minimal, but increase with the number of electric meters for which the firm is responsible.

Commercial electricity customers are profit-maximizing firms each with the profit function:

$$\Pi_i = P_i Q_i(\mathbf{x}, s(\mathbf{e}, \eta; \mathbf{a}); \mathbf{z}) - C(\mathbf{x}, s(\mathbf{e}, \eta; \mathbf{a}); \mathbf{z}) \tag{1}$$

where $\mathbf{x}$ is a $K \times 1$ vector of inputs (excluding electricity), s is the electricity demand function, and $\mathbf{z}$ is a matrix of non-selected production conditions (e.g., weather). The electricity demand $s(\mathbf{e}, \eta; \mathbf{a})$ is partially state-dependent based on participation in a DSM program with attributes $\mathbf{a}$ and where $\mathbf{e}$ is a $K \times 1$ vector of electricity use by the inputs in $\mathbf{x}$ and η is a $K \times 1$ vector of efficiency parameters for the inputs in $\mathbf{x}$.

Participation in an electricity DSM program will be chosen if

$$\begin{aligned} &P_i Q_i(\mathbf{x}, s(\mathbf{e}, \eta; \mathbf{a}); \mathbf{z}) - C(\mathbf{x}, s(\mathbf{e}, \eta; \mathbf{a}); \mathbf{z}) \\ &\quad > P_i Q_i(\mathbf{x}, s(\mathbf{e}, \eta; 0); \mathbf{z}) - C(\mathbf{x}, s(\mathbf{e}, \eta; 0); \mathbf{z}) \end{aligned} \tag{2}$$

where $s(\mathbf{e}, \eta; 0)$ denotes non-participation in any DSM program. The vector $\mathbf{a}$ remains in the participation profit function since programs differ in attributes and in resulting electricity demand.

Two potentially competing issues define both the programs and customer participation in them. First, Wirl (1997, p. 43) notes a paradox for energy conservation: improved efficiency in energy use can lead to increased demand for energy, a phenomenon known as the rebound effect. The basis for the rebound effect is the relationship between increasing efficiency and electricity demand from the production function $y = f(\mathbf{x}, s; z)$. Wirl (1997, p. 18) assumes the electricity demand is $s = e'\eta$. Obviously, not all of the inputs use electricity so some elements of $\mathbf{e}$ equal zero. The rebound effect occurs because an increase in efficiency of any single input reduces the relative cost of electricity for all inputs. Firms operated by rational managers will reduce their firms' use of other inputs in favor of increasing demand for relatively cheaper electricity, *ceteris paribus*.

Second, most electricity DSM programs – and, in particular, the programs examined here – are offered by electric utilities. Depending on the relationship between the utility and its commercial customers, the customers may view the offer of demand management assistance to be tied to rate or other electric cost increases that may occur in the future. If commercial customers perceive the utility's program only as a means for the utility to increase the utility's profits, then the commercial customer will discount program benefits when determining whether to participate.

3. The empirical model and data

Since according to Eq. (2) a firm will only participate in a DSM program if it is profitable to do so, and since, as evidenced by our data below, not all firms choose to participate, the empirical question is: What are the characteristics of firms that consider DSM programs profitable? Following convention, we model a firm's