Information Disclosure Policies: Evidence from the Electricity Industry

Magali Delmas
UC Santa Barbara

Maria Montes-Sancho
Carlos III University

Jay Shimshack[*][⊥]
Tufts University

May 2007

Information Disclosure Policies: Evidence from the Electricity Industry

May 2007

ABSTRACT

A "third wave" of environmental policy has recently emerged that emphasizes information provision as an integral part of the risk mitigation strategy. While theory suggests that information programs may correct market failures and improve welfare, the empirical effectiveness of these programs remains largely undetermined. We show that mandatory information disclosure programs in the electricity industry achieve stated policy goals. We find that the average proportion of fossil fuels decreases and the average proportion of clean fuels increases in response to disclosure programs. However, the programs also produce unintended consequences. Customer composition and pre-existing fuel mix significantly affect program response, suggesting that effective information disclosure policies may not be efficient.

Keywords: disclosure, information, fuel mix, electric utilities

1. Introduction

Developed nations' environmental policies have evolved substantially in the last several decades. Early pollution control programs involved command and control approaches. Policies then frequently included pollution charges, tradable permits, and other market based instruments. Most recently, a "third wave" of environmental policy has emerged that emphasizes information provision as an integral part of the risk mitigation strategy. Here, (further) government regulation is replaced or augmented by publicly provided information presumed to assist more cost effective private market and legal forces. Common examples include the toxics release inventory, lead paint disclosures, drinking water quality notices, and eco-labels. The empirical effectiveness of such programs, however, remains largely undetermined. This paper examines the impact of a prominent mandatory disclosure program on the fuel mix percentages of large electric utility corporations.

The prominence of mandatory information policies is not restricted to environmental arenas. For example, OECD countries' equity markets generally require firm-level financial information provision. In many countries, agricultural goods require country of origin and other health labels. Restaurants are increasingly required to display hygiene grade cards. Domestic colleges and universities are required by law to inform current and prospective students of crime statistics, equity data, and performance metrics. Even significant medical errors must now be disclosed to the community.

There are several potential advantages of information provision policies, and theory suggests that disclosure programs may effectively achieve their goals. Healy and Palepu (2001) provided a survey of the evidence in capital markets. Brouhle and Khanna (2007) demonstrated that information provision can improve product quality. In the environmental area, Kennedy et

al. (1994), Arora and Gangopadhyay (1999), Maxwell et al. (2000), Kirchoff (2000), and Khanna (2001) showed that the provision of information about pollution may correct a market failure, improve performance, and be welfare improving.

Despite the literature's theoretical findings, the empirical effects of disclosure programs remain inconclusive. Early studies of securities regulation found mixed results. See Stigler (1964), Robbins and Werner (1964), and Benston (1973). A more recent literature suggested that disclosure programs in financial markets can achieve their desired effects; La Porta et al. (2006) and Greenstone et al. (2006) found that both market size and market returns were positively influenced by mandatory disclosure programs. In product quality settings, Chipty and Witte (1998) established that resource and referral agencies significantly influenced child care prices, but had no impact on the quality of care. In contrast, Jin and Leslie (2003) found that mandatory hygiene grade cards positively affected restaurant quality and health outcomes. Broadly, Weil *et al.* (2006) performed eight case studies of regulatory disclosure programs and concluded that transparency policies can be effective, but results are highly sensitive to context.

Studies of environmental performance yielded similarly mixed results. Desvousges, Smith, and Rink (1992) found that information-based programs influenced attitudes favorable to radon testing, but testing itself only increased when mass media dissemination was coupled with community-based implementation programs. Konar and Cohen (1997) and Khanna et al. (1998) found that stock movements associated with Toxic Release Inventory (TRI) announcements led to increased abatement and reduced emissions. However, Bui (2005) found that the declines in emissions after TRI reporting events may have been attributable to regulation rather than investor pressure. Bennear and Olmstead (2006) found that drinking water quality notices lowered violations for some systems, but not others.

This paper is the first empirical economic study of the effectiveness of information provision in the electric utility industry. Environmental disclosure programs in electricity markets are a promising area of exploration for the efficacy of information policies for several reasons. First, electricity is a homogeneous commodity. From a consumption point of view, there are no differences in the characteristics of green or brown electricity. Therefore, this setting allows us to directly attribute program-induced changes to agent preferences. This is not true in much of the broader literature. For example, if eco- or organic- labeled products gain market share, it is difficult to establish whether consumers are expressing preferences for environmental improvement or whether consumers perceive other differences in product quality (like health, safety, and taste). Second, electric utilities are among the leading polluters in the United States. For example, about 40 percent of domestic CO_2 and 67 percent of SO_2 emissions are attributable to electricity generation.[1] Utilities are also the largest source of anthropogenic mercury emissions. Third, electric disclosure programs exhibit a number of features desirable for econometric identification. For example, the programs were adopted at the state-level and progressively introduced over time, so all firms were not impacted uniformly.

To what extent did mandatory disclosure laws affect the environmental performance of the electric utility industry? We address the question by examining monthly firm-level fuel mix and program data from 145 of the largest investor-owned electric utility companies for the period 1995-2003. We first analyze how firms' fuel mix percentages respond to mandatory disclosure programs. Panel data techniques allow us to identify disclosure program effects separately from the effects of other state and local programs like Renewable Portfolio Standards. We also correct for the potential statistical endogeneity of the program variable using fixed effects and

---

[1] U.S. Environmental Protection Agency, 1999 National Emissions Inventory.

instrumental variables. We then explore the detected response in more detail. We use OLS and IV interaction models to explore the effect of customer composition on disclosure responses and standard and IV conditional quantile regressions to examine how the entire fuel mix distribution shifts.

We find three main results. First, *mandatory disclosure programs can affect fuel-mix outcomes*. We find that the average proportion of fuel usage attributable to fossil fuels substantially decreases and the average proportion of fuel usage attributable to clean fuels significantly increases in response to disclosure programs in the electric utility industry. Second, *customer composition significantly impacts disclosure response.* We find that firms' clean fuel program responses become considerably stronger (more positive) as the firm proportionately serves more residential customers. Firms' fossil fuel program responses become weaker (less negative) as they proportionately serve more residential customers. In other words, as firms proportionately serve more residential consumers, any nuclear program responses become weaker (less positive). Third, *pre-existing fuel mix significantly impacts disclosure program response.* Our results suggest that firms that already use substantial amounts of clean fuels most significantly increase clean fuel percentages in response to disclosure programs. Similarly, firms that already use relatively small amounts of fossil fuels most significantly decrease fossil fuel usage in response to disclosure programs.

The paper proceeds as follows. Section 2 provides background information on the electric utility industry and its disclosure programs. Section 3 discusses economic theories explaining why information disclosure programs may alter environmental performance. Section 4 describes our Energy Information Administration and Interstate Renewable Energy Council data. Section 5 presents an empirical foundation. In Section 6, we first analyze how firm-level fuel mix

percentages respond to mandatory disclosure programs. We then explore the detected response in more detail. Section 7 provides a concluding discussion.

2.   Background

2.1   Fuel Mix in the Electric Utility Industry

In 2004, domestic electricity generation totaled 3,953,407 gigawatt hours. Of total generation, 50 percent was attributable to coal, 18 percent was attributable to gas, and 3 percent was attributable to oil. Nuclear sources generated nearly 20 percent of electricity. Cleaner energy sources, like hydropower, biomass, geothermal, solar and wind, generated approximately 9 percent (Edison Electric Institute 2005).

Renewable fuel use has trended upward since the fuels' widespread debut in 1993. More than 600 electric utilities currently offer green power options to their customers, and Lamarre (1997) and Delmas et al. (2007) found a distinct market niche for renewable energy even at a price premium. Renewable capacity is quite variable across both space and time. For example, in 2003, many states, including CA, NY, ME, and VT, had green energy generation proportions in excess of 20 percent (USDOE (2003)). In 2004, although it remained a small portion of total electricity generation, wind power usage increased 27 percent.

2.2   Mandatory Information Disclosure Programs in the Electric Utility Industry
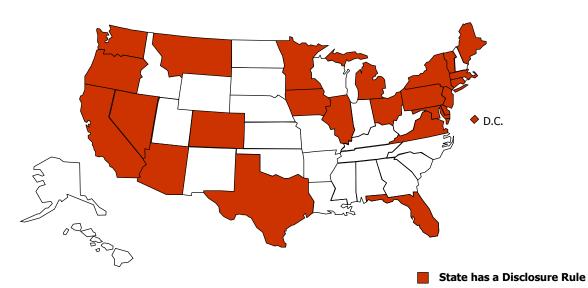
In the U.S. electricity industry, information disclosure refers to the mandatory provision of fuel mix percentages and pollution discharge statistics to utility consumers. For example, Minnesota's Public Utilities Commission decreed:

"The Commission recognizes that there is a need for the consumer to be informed

and educated on environmental issues and that all Minnesota utilities' customers

... should have similar access to information." (Minnesota PUC, 2002)

The state issued an order requiring regulated utilities to disclose information on fuel mix and air emissions to customers. Twice annually, utilities must include a bill insert that contains a pie chart depicting the mix of fuel sources, a bar chart of air pollutant emissions, a chart of costs associated with different generating sources, and a discussion of energy efficiency measures. Further, the utility must list a phone number and web address on all bills so that consumers can access environmental information. Other states' disclosure programs are similarly motivated and implemented, although specific details may vary. For example, several states' disclosure programs require quarterly (rather than biannual) inserts.

Figure 1 indicates which states had disclosure programs in 2005. By that year, 25 states had adopted generation disclosure rules, and these states represented over 65 percent of the United States population. Since consumer preferences may factor into disclosure effectiveness, programs may be particularly meaningful in deregulated states. Indeed, 23 of the 25 state-level disclosure programs were enacted in deregulated states, including NY, IL, TX, MI, AZ, NM, and much of the mid-Atlantic and northeastern regions. Additionally, Colorado and Florida instituted mandatory disclosure programs despite failing to deregulate their industries.

Figure 1. State Generation Disclosure Rules – September 2005

Source: Database of State Incentives for Renewable Energy (DSIRE).
Accessible online at http://www.dsireusa.org/.

2.3   Other Information Programs in the Electric Utility Industry

In addition to the mandatory state-level disclosure programs that are the focus of this study, many electric utilities must comply with other information requirements. Most notably, "major" firms are required to file Federal Energy Regulatory Commission Form Number 1, the Annual Report for Major Electric Utilities, each and every year.[2] These reports average 140 pages and contain general corporate information, financial statements, supporting schedules, and information on environmental investments. In addition, electric utilities are required to provide information about their environmental performance to the U.S. Environmental Protection Agency (EPA) and the Energy Information Administration (EIA). Although all of the aforementioned data is publicly accessible through government databases, users typically must have environmental and database expertise to interpret the information. In marked contrast,

---

[2] Major electric utilities are classified as those with annual sales or transmission service that exceeds one of the following: (1) one million megawatt hours of total annual sales, (2) 100 megawatt hours of annual sales for resale, (3) 500 megawatt hours of gross interchange out, or (4) 500 megawatt hours of wheeling for others (deliveries plus losses).

disclosure programs are designed explicitly to produce easily accessible and readily interpretable environmental information.

3.   Theories Linking Disclosure and Environmental Performance

We will present evidence that information disclosure programs alter fuel mix outcomes in the electricity industry. Indeed, altering fuel mix and reducing air pollution emissions was the ky declared intention of the state agencies that issued the policies. Several theories allow for a link between mandatory information disclosure programs and environmental performance.[3]

Perhaps the simplest theoretical explanations entail increased community coercion or investor or employee pressure. In the presence of information on the relative environmental performance of a given firms, community activists may lobby for future regulation or attempt to harm the firm's reputation with the consuming public (indirectly reducing demand). Employee turnover and dissatisfaction may result from disclosed poor environmental performance (Tietenberg (1998)). Investors may express environmental preferences or concerns over future environmental regulation by decreasing demand for shares (Khanna *et al.* (1998)). However, the information provided by disclosure programs in the electricity industry is typically already available to highly motivated and trained experts like lawyers, investors, and community activists.

A more compelling theory, then, for the link between information and environmental performance in the electricity industry might involve the threat of future regulation or legal action. In a dynamic political economy context, disclosure programs may simply signal the state's willingness to impose future regulations on the industry unless firms self-regulate.

---

[3] See Khanna (2001) for an excellent overview of the literature on non-mandatory environmental policies, including information disclosure programs.

Similarly, disclosure programs may increase a reporting firm's susceptibility to liability under legal statutes. Segerson and Miceli (1998) and Maxwell, Lyon, and Hackett (2000) explore firms' incentives to preempt future regulation or legal liability.

Perhaps the most persuasive theory for the link between disclosure and environmental performance is a direct demand effect. In the presence of simple, easily interpretable, and directly provided information, consumers may increase demand for fuels perceived as environmentally favorable and decrease demand for fuels perceived as environmentally unfavorable. Of course, this mechanism requires: (1) that information affects consumer awareness, (2) that consumer awareness can translate to changes in demand, and (3) current or future consumer choice among electricity products. However, the mechanism does not require choice among electricity providers.

An emerging literature suggests that consumer awareness changes in response to environmental information and that shifts in awareness can translate in behavioral changes. Desvousges, Smith, and Rink (1992), Blamey et al. (2000), Loureiro (2003), Loureiro and Lotade (2005), and Leire and Thidell (2005) all demonstrate shifts in consumer awareness after exposure to environmental information or eco-labels. In our context, disclosed information may remind consumers of the consequences of their own actions, notify customers that alternative fuels exist and are widely used, and demonstrate the variability in utilities' fuel mix percentages and emissions. Teisl, Roe, and Hicks (2002) and Shimshack, Ward, and Beatty (2006) establish that changes in environmental awareness can be translated into new consumption patterns. More broadly, Stigler and Becker (1977) provide a general framework for information to enter a consumer demand framework. Here, information is viewed as an input in the household production function of Lancaster (66) and Michael & Becker (73).

Consumers increasingly have the option to purchase greener energy at a price premium, and therefore increasingly have choice among consumer products. Thiry-six states and over 600 utilities currently offer green power pricing programs where consumers can support cleaner energy usage in exchange for an electricity price increase.[4] Further, there are dozens of certificate programs (many at the national level) that allow consumers to purchase green certificates or green tags that require the replacement of traditional types of energy with greener alternatives. These certificates are available whether or not the consumer has direct access to green power options from their own provider. Note also that the direct demand mechanism does not require customer choice across electricity providers, i.e. if information provision shifts consumers' relative marginal willingness to pay curve for different energy products, firms' marginal revenue calculations change and a new equilibrium will result. In fact, many utilities were very interested in disclosure programs when they were being considered since such policies allowed firms to "distinguish their price structure, fuel mix, or environmental profile in the eyes of the consumer and found mandatory standard labels to be a credible way to do that." (NCCEI 2002) In other words, disclosure programs were perceived as an effective and particularly convincing way to price discriminate.

Of course, all theories linking disclosure programs and fuel mix percentages in the electric utility industry require that supply of a given fuel type category is not completely inelastic. In other words, firms must be able to realistically alter their fuel mix portfolios in the short- to medium- run. On the margin, at least, they can. While purchasing or building new facilities may be required to dramatically alter fuel mix portfolios, relatively small portfolio

---

[4] U.S. Department of Energy, Energy Efficiency and Renewable Energy pages. Retrieved October 2006 from http://www.eere.energy.gov/greenpower/markets/.

shifts are easily obtainable. First, utilities can alter their capacity utilization. Second, major electric utilities can buy and sell power generation in response to changing market conditions.[5]

Thus, several theories can explain the link between information disclosure and environmental performance. Empirically, we will follow the broader information literature and estimate the general impact of mandatory information programs. Regressions of quantity on information variables (and other covariates) are identified under any of the mechanisms discussed above, and an identified response represents the impact of disclosure programs on the equilibrium quantity of electricity generated from the specifically analyzed fuel source.

4.   Data

4.1   Data sources and content

Our research assesses the impact of environmental disclosure programs on the fuel mix percentages of major electric utility firms. We focus on fuel mix indicators from the electric power industry for three reasons. First, utilities are among the nation's leading sources of pollution. Second, fuel mix is the most readily identifiable and interpretable measure of environmental performance on disclosure program bill inserts and web postings. Third, information disclosure programs are heterogeneous, yet all require generation mix provision.

We analyze data from the Energy Information Administrations (EIA)'s Annual Electric Power Industry Database and the Interstate Renewable Energy Council (IREC)'s Database of

---

[5] While expanded production on the margin is more transparent for traditional fuel sources, nuclear facilities also regularly increase generation on the margin. First, net unit capability is altered by reducing unplanned outages and decreasing planned outage time through improved maintenance. In the mid-1990s, average nuclear unit capability was approximately 82 percent. By the early 2000s, capability increased to approximately 90 percent. Second, nuclear power output is frequently increased via the use of more productive inputs, more efficient use of feedwater flow, and equipment modifications.

State Incentives for Renewable Energy. Fuel mix data come from forms EIA-906 (and its predecessor EIA-759), the monthly utility electric power plant reports. We focus on production-based fuel mix rather than sales-based fuel mix to identify actual changes in environmental quality. Firm characteristics are obtained from forms EIA-861, the annual electric power industry reports. Disclosure program information comes directly from IREC's Database. Since it is possible that other state-level programs like Renewable Portfolio Standards and Green Power initiatives may impact utilities' fuel mix percentages, we also analyze other program data from the IREC database.

4.2   The Sample

Our final sample includes monthly information from the 145 major investor-owned electric utility companies with relatively complete data in EIA databases. We focus on large investor-owned firms because these companies represent the majority of industry electricity and pollution generation. Further, EIA data (EIA-906 and EIA-759) is imputed for smaller companies based upon information from these larger firms. All firms with at least one plant with a capacity of 50 megawatts or more (25 megawatts or more prior to 1999), all firms with nuclear generation, and all firms with significant renewable capacity file reports with the EIA for each and every month of operation. Since our data represent the big incumbents in the electric utility industry, the results of our analysis should be extrapolated to smaller firms with a degree of caution. We focus on the firm level (as opposed to the plant-level) since management decisions are centralized and disclosure program requirements operate at the company-level.

We observe fuel mix percentages and program variables for our 145 firms for the 108 months spanning 1995-2003. Our sample begins in 1995 in order to obtain pre-program

information for all impacted states; the first disclosure program was enacted in mid-1997. The sample concludes in 2003 because we were unable to obtain reliable data for 2004.

4.3   Summary Statistics

Conditional on positive generation, aggregate fossil fuels (coal, oil, and gas) represent approximately 74 percent of generation over our entire sample. Aggregate clean fuels (renewables, hydroelectric) represent approximately 9 percent and nuclear represents approximately 17 percent.[6] Our sample numbers closely correspond to total national generation proportions for the sample period.

Additional summary statistics, broken down by disclosure status for those firms with complete fuel mix data for all periods, are presented in Table 1. Standard errors appear in parentheses. Table 1 indicates that the percentage of generation attributable to clean fuels decreases for those firms never subject to mandatory disclosure but increases for those firms subject to disclosure at some point during our sample period. Similarly, Table 1 indicates that the percentage of generation attributable to fossil fuels increases for those firms never subject to mandatory disclosure but decreases for those firms subject to disclosure at some point during our sample period.

---

[6] Here and throughout the paper, we refer to fuels as "clean" if they generate low levels of common air pollutants relative to fossil fuels and are not nuclear. This definition is debatable, but consistent with issuing agencies' goals that emphasize air quality over other environmental or social objectives.

Table 1. Mean Fuel Mix Percentage Statistics

Group	First Period (Month1)	Last Period (Month 108)	Difference
Clean Fuels			
Firms Never Subject to Disclosure	.121	.113	-.008
	(.049)	(.050)	(.004)
Firms Subject to Disclosure During the Sample Period	.104	.109	+.005
	(.029)	(.031)	(.022)
Fossil Fuels			
Firms Never Subject to Disclosure	.754	.774	+.020
	(.052)	(.053)	(.018)
Firms Subject to Disclosure During the Sample Period	.701	.698	-.003
	(.035)	(.042)	(.034)

Results in Table 1 are highly suggestive of disclosure program effects on fuel mix outcomes, but the differences are not typically statistically significant. Additionally, these simple summary statistics do not control for numerous cross-firm and other differences that may impact changes in fuel mix outcomes over time. Consequently, we must conduct a more careful analysis in order to understand the impact of information disclosure programs on the environmental performance of the electric utility sector.

5. Primary Methods

Our overall empirical strategy is to use panel data techniques to exploit within-firm temporal variation in program status to analyze the effect of mandatory disclosure programs on fuel mix percentages. First, using ordinary least squares and instrumental variables regression methods, we demonstrate that disclosure programs significantly reduce the proportion of fossil fuel usage and significantly increase the percentage of clean fuel usage. Second, we examine the disclosure response in more detail. We use OLS and IV regressions with interactions to demonstrate that the impact of information programs on the proportion of clean fuel usage is significantly greater when firms have proportionately greater sales to residential customers. We

then use standard and IV conditional quantile regressions to explore the impact of disclosure programs on the entire range of the fuel mix distribution. We establish that firms that use relatively small amounts of fossil fuels most significantly decrease fossil fuel percentages in response to mandatory programs.

5.1 Primary Variables

Our key dependent variables represent fuel mix percentages. For example, the continuous dependent variable may signify the percentage of the firm's generation in a given month attributable to fossil fuels, including coal, oil, and natural gas. The dependent variable may also frequently denote the percentage of the firm's generation in a given month attributable to the clean fuels, including hydroelectricity and renewable fuels like wind, solar, and biomass. In other cases, the dependent variable represents the percentage of the firm's electricity generation attributable to nuclear power.

Our key explanatory measure is a continuous variable representing the proportion of the firm's sales that are subject to an operational or effective mandatory disclosure program. If all of a firm's sales are subject to disclosure requirements in a given month, this explanatory variable takes a value of 1. If only 80 percent of a firm's electricity sales are subject to disclosure in a given month (such that 20 percent of company sales go to states without operational disclosure programs), this variable takes a value of 0.80.

Analyses also include several other explanatory variables. Fixed effects allow us to capture systematic firm differences due to factors such as size, age, community characteristics, management profiles, average regulatory stringency, and ownership type. Fixed effects also capture differences in input and output prices due to factors like distance to fossil fuel markets

and state-level variation in taxation. Plant production varies seasonally, so we include quarterly dummy variables. Finally, we include flexible annual dummies to account for broad trends in prices, technological change, and other factors.

5.2 Basic Regression Model

The basic regression model is $y_{it} = D_{it}\delta + \mathbf{X_{it}}\boldsymbol{\beta} + \alpha_i + \varepsilon_{it}$, where i indexes the unit of observation (a firm) and t indexes time (months). y_{it} represents the percentage of firm i's generation in period t attributable to the fuel source being analyzed. D_{it} represents the proportion of firm i's sales that are subject to an effective disclosure program in period t. The elements of the vector $\mathbf{X_{it}}$ include all of the non-program explanatory variables discussed above. α_i is an unobserved time invariant individual effect and ε_{it} is the usual time variant idiosyncratic shock.

5.3 Consistency Considerations

A potential concern with our key program D_{it} variable is that it may be statistically endogenous. For example, consider the possibility that the likelihood of program adoption is a function of the average environmental performance of the large electric utilities operating within the state. In terms of the basic regression model, the concern is that the time invariant individual effect α_i is correlated with the program variable D_{it}. However, fixed effects prevent bias from this type of correlation. In our context, the inclusion of fixed effects prohibits the possibility of bias introduced when program adoption is a function of the *temporal average* fuel mix of the firm.

It is also possible that the program variable D_{it} is correlated with the time variant error term ε_{it}. For example, consider the possibility that states choose to adopt disclosure programs in periods in which large electric utilities operating within that state are utilizing more fossil fuels

than usual. A standard correction for this type of statistical endogeneity is instrumental variables. Our chosen instrument is the weighted average of program status in states near those states in which the particular firm operates. Two assumptions are required for the validity of this instrument. First, states base policy choices in part on decisions of other nearby states. Second, states do not base policy choices on the contemporaneous environmental performance of firms in other states. To be conservative, we eliminate states directly upwind and directly downwind from the states in which the particular firm operates.[7]

6.   Empirical Analysis

6.1   Ordinary Least Squares and Instrumental Variables Regressions

Do disclosure programs affect fuel mix percentages on average? Our goal here is to investigate the relationship between disclosure programs and firm's fossil fuel and clean fuel usage. Thus, we regressed fuel mix proportion measures on the percent of a firm's sales subject to disclosure requirements and other covariates. Simultaneous estimation of the multiple fuel mix equations through a SUR regression would yield no efficiency gain, since the covariates in each equation are identical. For each equation, we ran both fixed effects linear regressions and fixed effects instrumental variables regressions. Results are presented in Table 2. All computed standard errors are heteroskedastic-consistent. T-statistics appear in parentheses.[8]

---

[7] Upwind and downwind states are determined by following prevailing westerly, southwesterly, and southerly winds. Pollution transport follows these winds fairly closely. See, for example, the Ozone Transport Assessment Group (OTAG)'s Map of Ozone Pollution Transport, available online as the Air Quality Analysis Workgroup Results Summary at http://capita.wustl.edu/OTAG/ .

[8] Later quantile regressions suggest that slope parameters are sensitive the distribution of the dependent variables, suggesting the presence of heteroskedasticity.

Table 2. Firm-Level Regression Results: Aggregate

Variable Description	Dependent Variable: Percentage of Fuel Mix <u>Attributable to Fossil Fuels</u>		Dependent Variable: Percentage of Fuel Mix <u>Attributable to Clean Fuels</u>	
	Linear Regression	Instrumental Variables Regression	Linear Regression	Instrumental Variables Regression
Disclosure Program	-.050***	-.127***	.020***	.148***
	(-8.39)	(-2.59)	(4.59)	(3.83)
Season 2 Dummy	.004	.005	.002	-.001
	(1.25)	(1.49)	(0.48)	(-0.03)
Season3 Dummy	.017***	.018***	-.013***	-.016***
	(4.68)	(4.93)	(-4.16)	(-4.72)
Season4 Dummy	-.001	.003	-.003	-.007*
	(-0.04)	(0.62)	(-0.79)	(-1.94)
Year2 Dummy	-.009*	-.009*	-.037***	-.038***
	(-1.77)	(-1.73)	(-7.26)	(-7.27)
Year3 Dummy	.007	.007	-.036***	-.036***
	(1.39)	(1.42)	(-7.04)	(-7.04)
Year4 Dummy	.017***	.024***	-.051***	-.063***
	(3.32)	(3.52)	(-10.17)	(-9.84)
Year5 Dummy	-.030***	-.012	-.064***	-.094***
	(-5.31)	(-0.95)	(-12.02)	(-8.55)
Year6 Dummy	-.048***	-.024	-.065***	-.104***
	(-8.56)	(-1.63)	(-11.54)	(-7.61)
Year7 Dummy	-.022***	.011	-.023***	-.079***
	(-3.68)	(0.52)	(-4.38)	(-4.39)
Year8 Dummy	-.002	.041	.004	-.067***
	(-0.33)	(1.48)	(0.64)	(-2.91)
Year9 Dummy	.012*	.053*	-.007	-.077***
	(1.92)	(1.99)	(-1.20)	(-3.46)
Fixed Effects	144Firm-Level Fes	144Firm-Level FEs	144Firm-Level Fes	144Firm-Level Fes

[a] The dependent variables are the percentage of fuel mix attributable to the source indicated in the column heading. The key independent variable, the disclosure program variable, ranges from 0 to 1. It indicates the percentage of firm sales subject to operational disclosure programs.

[b] Superscripts *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.

[c] All analyses consist of 14,168 observations from 145 firms over the 108 sample months.

Results in Table 2 indicate that the estimated impact of an operational disclosure program is negative and significant at the 1 percent level for fossil fuel production. The results are also economically significant. As the proportion of the average firm's sales subject to disclosure increases 1 percent, the average proportion of generation attributable to fossil fuels drops

between 0.05 percentage points (OLS point estimate) and 0.13 percentage points (IV point estimate).

Similarly, results in Table 2 indicate that the estimated impact of an operational disclosure program is positive and significant at the 1 percent level for clean sources like hydroelectric and renewables. As the proportion of the average firm's sales subject to disclosure increases 1 percent, the average proportion of generation attributable to clean fuels increases between 0.02 percentage points (OLS point estimate) and 0.15 percentage points (IV point estimate).[9]

Results in Table 2 also demonstrate the potential statistical endogeneity of the program variable. In the ordinary least squares regressions, clean fuel coefficients were negatively biased and fossil fuel coefficients were positively biased. Results suggest the presence of time variant correlation between the program variable and the error term. Specifically, disclosure program adoption may have been most likely when fossil fuel usage was particularly high and clean fuel usage was particularly low.

As expected, seasonality appears to play a role in fuel mix percentages. The proportion of fossil fuel usage is higher and the proportion of clean fuel usage is lower in the late summer and fall months. We also find that fuel mix decisions appear to trend over time, although non-linearly. Systematic differences across firms also exist, as firm specific intercepts differ substantially.

---

[9] Disaggregated results for specific fuel sources mimic these aggregate results. There is a statistically significant negative relationship between disclosure programs and the proportional use of the fossil fuels coal and gas. There is a statistically significant positive relationship between disclosure programs and the proportional use of renewable and hydroelectric generation. Results also suggest a modest positive relationship between disclosure programs and the proportional use of nuclear electricity generation (categorized as neither fossil fuel nor clean fuel and therefore omitted from Table 2), but the relationship is not statistically significant. Disaggregated results are available upon request from the authors.

6.2   Sensitivity Analysis

The obvious concern with the preceding results is omitted variables. Perhaps other factors and government programs impacting fuel mix outcomes in the electric utility industry are driving the results in Table 2. However, omitted variables will not bias our results unless they are systematically correlated with disclosure program introductions. Disclosure programs exhibit considerable heterogeneity across both space and time. Therefore, significant bias requires that other government programs impacting fuel mix are passed at approximately the same time as disclosure in each state. Other concerns with the preceding results may include variable definitions, model structure, and the precise nature of the 'event.' Below, we provide evidence that the results in Table 2 are robust to a number of sensitivity considerations.

Deregulation

Joskow (1998) noted that restructuring of electricity supply has the potential to significantly impact industry fuel mix outcomes. As noted in the background section, the vast majority of disclosure programs were enacted in deregulated states at some point after restructuring. Only two states, CO and FL, instituted mandatory disclosure programs without restructuring their electricity industries. Consequently, it is possible that omitting deregulation may bias our results. Table 3 reports results from robust instrumental variable regressions augmented with the percent of firm's sales in deregulated states.

Table 3. Instrumental Variable Regressions: Deregulation

	Percent Fossil Fuels	Percent Clean Fuels	Percent Nuclear
		Dependent variables	
Disclosure Program	-.227**	.268***	.118
	(-2.45)	(3.43)	(1.46)
Deregulation	.078**	-.094***	-.045
	(2.33)	(-3.21)	(-1.53)
Season Dummies		3 Season Dummies	
Year Dummies		8 Year Dummies	
Fixed Effects		144 Firm-Level Fixed Effects	

[a] The dependent variables are the percentage of fuel mix attributable to the source indicated in the column heading. The key independent variable, the disclosure program variable, ranges from 0 to 1. It indicates the percentage of firm sales subject to operational disclosure programs.
[b] Superscripts *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.
[c] All analyses consist of 14,168 observations from 145 firms over the 108 sample months.

Results in Table 3 indicate that disclosure programs impacts are similar in sign and significance, and larger in magnitude, when deregulation variables are added to the analysis.[10] As the proportion of the average firm's sales subject to disclosure increases 1 percent, the average proportion of generation attributable to fossil fuels decreases approximately 0.23 percentage points and the average proportion of generation attributable to clean fuels increases 0.27 percentage points. The average proportion of generation attributable to nuclear seems to increase, but changes are not statistically significant.

Renewable Portfolio Standards and Other Programs

Other state and local regulations and financial incentives may also impact firms' fuel mix percentages. Examples include Renewable Portfolio Standards, Mandatory Green Power Initiatives, and tax incentives. However, the adoption of these programs does not generally closely coincide with the adoption of disclosure across time. As a sensitivity analysis, however,

---

[10] Ideally, one might also interact disclosure program variables with deregulation indicators to see if program responses become stronger in restructured markets. However, since only 2 states implemented disclosure without restructuring, such results are quite sensitive to model specification.

we tested whether other prominent state-level programs targeting utilities' fuel mixes impacted our key results.

Renewable Portfolio Standards (RPS) typically mandate tradeable credit programs with fixed quotas for renewable generation. We examined whether the inclusion of a variable for the introduction of RPS changed our disclosure results, suggesting the presence of omitted variable bias. Instrumental variable coefficients for the disclosure program variable were extremely similar (signs, significance, and point estimates) to the results presented in Tables 2 and 3. For example, when variables indicating the percent of the firm's sales subject to RPS are included, the disclosure program coefficient for the clean fuel response is 0.159 (t-statistic 3.96) and the coefficient for the fossil fuel response is -0.128 (t-statistic -2.51).

Mandatory green power policies require utilities operating in the state to offer and publicize green power options to consumers. When variables indicating the percent of the firm's sales subject to mandatory green power initiatives are included in the analysis, results were once again very similar (signs, significance, and point estimates) to the results presented in Tables 2 and 3. The disclosure program coefficient for the clean fuel response is 0.145 (t-statistic 3.78) and the coefficient for the fossil fuel response is -0.129 (t-statistic -2.64).

State and local sales and corporate tax credits and exemptions for green energy generation are becoming increasingly prominent. Again, the adoption of these programs does not generally closely coincide with the adoption of disclosure across time. When variables indicating the percent of the firm's sales subject to state corporate or sales taxes for green power are included in the analysis, results were once again very similar (signs, significance, and point estimates) to the results presented in Tables 2 and 3. When sales tax incentives for green power are included, the disclosure program coefficient for the clean fuel response is 0.123 (t-statistic

3.86) and the coefficient for the fossil fuel response is -0.103 (t-statistic -2.42). When corporate tax incentives for green power are included, the disclosure program coefficient for the clean fuel response is 0.170 (t-statistic 4.63) and the coefficient for the fossil fuel response is -0.127 (t-statistic -2.75).

Not surprisingly, when all other program variables (RPS, Mandatory Green Power, Sales Tax Exemptions, and Corporate Tax Incentives) are included in the analysis, results remain very similar (signs, significance, and point estimates) to the results presented in Table 2. The disclosure program coefficient for the clean fuel response is 0.155 (t-statistic 4.93) and the coefficient for the fossil fuel response is -0.101 (t-statistic -2.44).

Sensitivity to Other Assumptions

In addition to omitted variable concerns, one possible worry is the robustness of our results to the chosen instrument. Consequently, we experimented with an instrument that contains program information from all states adjacent to those in which the firm operates (not just states that are neither upwind nor downwind). We further experimented with instruments that contained program information from nearby, yet non-upwind, states and nearby, yet non-downwind, states. For all regression analyses, these more general instrument generated results similar in sign and significance to those reported in Tables 2 and 3. Coefficients, however, were typically larger in magnitude.

Another possible concern is the sharpness of our study's program variables. Perhaps utilities were broadly aware of the disclosure programs prior to their effective date and changed their behavior ahead of time. Of course, if utilities had already completely responded to disclosure programs before the effective dates, it would be difficult to reconcile the observed responses in our analyses. However, as a sensitivity test, we repeated all analyses with program

24

variables that reflect the dates the programs were enacted. In general, we find qualitatively similar results (in signs and significance) to those reported here, but magnitudes are frequently smaller.

Our key program variable is constructed by weighting each firm's state-level disclosure program status by the percentage of sales that occur in each state. A possible apprehension is that the percentage of a firm's sales attributable to each state may change in response to the program itself. This would introduce bias. However, if we replace our program variable with a 0/1 dummy indicating whether *any* of a firm's sales are subject to disclosure, we find qualitatively similar results.

Finally, in our analysis we control for the possibility of persistence with fixed effects and the possibility of systematic changes in technology with time dummies. However, as a sensitivity check, we include an auto-regressive term lagged one year to help control for unobserved technology shifts. Including this lagged discharge variable did not substantively change the results; signs, significance, and approximate magnitude are similar to those reported.

6.3   The Impacts of Disclosure: Further Exploratory Analysis

The regressions in Tables 2 and 3 demonstrate that disclosure programs reduce fossil fuel usage and increase clean fuel usage on average. However, it may be informative to explore these effects in more detail. Consequently, in this section, we first use regressions with interactions to explore whether the impact of information programs on fuel mix depends upon customer composition. We then explore the impact of disclosure policies beyond the mean; we utilize conditional quantile regressions to investigate program effects on the entire range of the fuel mix distribution.

Regression Models with Interactions

Are disclosure program impacts conditional on customer composition? Our goal here is to examine whether the effect of disclosure programs depends upon a firm's proportion of sales to residential consumers. Consequently, we regress fuel mix proportion measures on the percent of the firm's sales subject to disclosure, the proportion of the firm's sales to residential consumers, an interaction of the policy variable with the residential variable, fixed effects, and other covariates. More formally, we consider the basic regression model $y_{it} = D_{it}\delta + R_{it}\gamma + D_{it}R_{it}\eta + \mathbf{X_{it}\beta} + \alpha_i + \varepsilon_{it}$. D_{it} still represents the proportion of firm i's sales that are subject to an effective disclosure program in period t, R_{it} represents the proportion of firm i's sales going to residential customers, and the elements of the row vector $\mathbf{X_{it}}$ include all of the non-program explanatory variables.

Since both the program variable D_{it} and its interaction $D_{it}R_{it}$ may be statistically endogenous, we again employ instrumental variables regressions. One instrument remains the same. Our second instrument is the interaction of the first with the residential variable. Since this interaction in not a linear combination of the first instrument, it is as valid as the primary instrument itself. Results for aggregate categories are presented in Table 4. Computed standard errors are heteroskedastic-consistent. T-statistics appear in parentheses.

Table 4. Disclosure & Customer Composition Instrumental Variable Regression Results

	Dependent variables		
	Percent Fossil Fuels	Percent Clean Fuels	Percent Nuclear
Percent of Sales to Residential	-.146	-.649***	.562***
	(-1.03)	(-3.82)	(3.88)
Disclosure Program	-.502***	-.333**	.632***
	(-3.96)	(-2.09)	(4.70)
Disclosure/Residential Interaction	.889***	1.27***	-1.42***
	(3.75)	(3.24)	(-5.26)
Season Dummies	3 Season Dummies		
Year Dummies	8 Year Dummies		
Fixed Effects	144 Firm-Level Fixed Effects		

[a] The dependent variables are the percentage of fuel mix attributable to the source indicated in the column heading. The key independent variable, the disclosure program variable, ranges from 0 to 1. It indicates the percentage of firm sales subject to operational disclosure programs.
[b] Superscripts *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level.
[c] Analyses use 13,957 observations from 143 firms over the 108 sample months. 2 firms are missing residential data.

Table 4 coefficients on the un-interacted residential variable indicate that, in the absence of any disclosure program, an increase in sales to residential customers increases the proportion of fuel mix attributable to nuclear energy and decreases the proportion attributable to clean fuels. Coefficients on the un-interacted disclosure program variable indicate that, when firms sell to no residential customers, programs reduce the proportion of usage attributable to fossil fuels, reduce the proportion of usage attributable to clean fuels, and increase the proportion of usage attributable to nuclear energy. As always, however, some care should be exercised interpreting coefficients conditioned on zeroed variables. There are relatively few observations in which firms sell to no residential customers.

The interaction results in Table 4 indicate that the impact of disclosure programs on both clean fuel usage and fossil fuel usage becomes more positive as the percentage of residential customers rises. In other words, as firms proportionately serve more residential customers, clean fuel program responses become stronger (more positive). Alternatively, as firms proportionately serve more residential customers, fossil fuel program responses become weaker (less negative).

These results are not inconsistent. Examining the last column of Table 4, we see that the interaction coefficient for nuclear energy is negative and statistically significant. As firms proportionately serve more residential customers, any nuclear program responses become weaker (less positive). In other words, disclosure programs induce considerably smaller increases in nuclear fuel usage when firms' residential customer proportions are high (relative to the average program response).

Marginal disclosure program impacts clarify the interpretation of the results in Table 4. At the first quartile of the residential customer variable, the marginal impact of disclosure on clean fuel usage is +0.024.[11] At the median of this variable, the marginal impact of disclosure is +0.086, at the third quartile, the marginal impact of disclosure is +0.142, and at the 90th percentile, the marginal impact of disclosure is +0.213. Thus, clean fuel program response becomes stronger (more positive) as firms proportionately serve more residential customers. The marginal impact of disclosure on fossil fuel usage is -0.252 at the first quartile of the residential variable, -0.209 at the median, -0.170 at the third quartile, and -0.120 at the 90th percentile. Therefore, fossil fuel program response becomes weaker (less negative) as firms proportionately serve more residential customers. Finally, the marginal impact of disclosure on nuclear fuel usage is +0.223 at the first quartile of the residential variable, +0.163 at the median, +0.101 at the third quartile, and +0.021 at the 90th percentile. Any nuclear fuel program response becomes weaker (less positive) as firms proportionately serve more residential customers.

---

[11] For the percent of firm's sales subject to residential consumers, Q25=0.281, Q50=.330, Q75=.374, and Q90=.430.

Conditional Quantile Regressions

Do disclosure program impacts vary across the fuel-mix distribution? Our goal here is to examine whether the effect of disclosure programs depends upon firms' pre-existing fuel mix portfolios. For example, do disclosure programs impact dirty firms the same way they impact cleaner firms? Therefore, we use Koenker and Bassett (1978)'s conditional quantile regressions. In our context, quantile regressions decompose the mean response revealed by the linear regression results in Table 2 into changes across the entire probability distribution of fuel mix levels. In particular, conditional quantile regressions allow us to estimate different slope coefficients for different fuel mix quantiles. For example, a regression on the 50th percentile estimates the effect of disclosure on the sample median of the dependent variable in question.

An additional advantage of conditional quantile regressions in our context relates to censoring. In our data, some observations have proportional clean fuel usage at or near 0 and proportional fossil fuel usage at or near 1. Less commonly, some observations have proportional clean fuel usage at or near 1 and proportional fossil fuel usage at or near 0. Such censoring may bias least squares regressions, but the weighted least absolute deviation estimation underlying the quantile regression method minimizes or eliminates the impact of censoring on the uncensored quantiles.

More formally, we consider the linear model for the conditional quantile function, $Q_{y_{it}}(\tau \mid D_{it}, \mathbf{X}_{it}) = \alpha(\tau) + D_{it}\delta(\tau) + \mathbf{X}_{it}\boldsymbol{\beta}(\tau)$ for τ between 0 and 1. D_{it} still represents the proportion of firm i's sales that are subject to an effective disclosure program in period t and the elements of the row vector $\mathbf{X_{it}}$ include all of the non-program explanatory variables. Note that we omit firm-level fixed effects. Including firm-level fixed effects in quantile regressions would yield coefficients that indicate an average firm's program responses across the distribution of

departures from that individual firm's typical fuel mix levels. So, a 75th percentile coefficient would be the disclosure response when firms are using a particularly large proportion of fuel from source Y, relative to their own typical levels of fuel Y. In contrast, our purpose is to investigate what happens to the overall emissions distribution. In other words, we wish to examine if the fuel mix distribution shifts more strongly for firms that typically use high proportions of fuel Y.

Of course, it is still possible that the program variable D_{it} is statistically endogenous. Therefore, in addition to standard conditional quantile regressions, we perform instrumental variable quantile regression. For basic quantile regressions, estimation and inference follows Koenker and Bassett (1982) and Rogers (1993). For instrumental variable quantile regression, we use the implementation by Chernozhukov and Hansen (2004) for estimation and inference.

Table 5 presents quantile regression results for the impact of disclosure programs on proportional fossil fuel usage. Here, we conduct quantile regressions at the 20th, 30th, 40th, 50th, and 60th percentiles because these represent the relevant range for this distribution. There is little variation below the 20th percentile, as 15 percent of observations reflect proportional fossil fuel usage at or near 0. Similarly, there is little variation above the 60th percentile, as nearly 40 percent of observations reflect fossil fuel usage at or near 1 (100%).

Table 5. Conditional Quantile Regressions: Fossil Fuels

	Std. Quantile Regression					Instrumental Var. Quantile Regression				
	Q20	Q30	Q40	Q50	Q60	Q20	Q30	Q40	Q50	Q60
Disclosure Program	-.323*	-.294*	-.201*	-.149*	-.017*	-.525*	-.985	-.467*	-.326*	.094
	(-19.9)	(-19.2)	(-13.5)	(-21.1)	(-19.2)	(-9.18)	(-0.04)	(-9.34)	(-4.35)	(0.24)
Season2 Dummy	-.001	.024	.023	.015	.001	.003	.001	.018	.002	-.001
	(-0.02)	(1.60)	(1.61)	(2.16)	(0.01)	(0.18)	(0.01)	(1.64)	(0.20)	(-0.02)
Season3 Dummy	.056*	.049*	.041*	.019*	.001	.040	.025	.033*	.002	.001
	(3.51)	(3.33)	(2.89)	(2.79)	(0.01)	(2.40)	(0.30)	(3.22)	(0.21)	(0.02)
Season4 Dummy	.001	-.001	.012	-.010	.001	.026	.003	.017	.002	-.001
	(0.04)	(-0.01)	(0.86)	(-1.47)	(0.01)	(1.58)	(0.03)	(1.60)	(0.20)	(-0.02)
Year Dummies			8 Year Dummies					8 Year Dummies		

[a] The dependent variables are the percentage of fuel mix attributable to the source indicated in the column heading. The key independent variable, the disclosure program variable, ranges from 0 to 1. It indicates the percentage of firm sales subject to operational disclosure programs.
[b] A superscript * indicates statistical significance at the 1% level.
[c] All analyses consist of 14,168 observations from 145 firms over the 108 sample months.

Results in table 5 demonstrate that the disclosure program point estimates tend to decrease as one moves up the distribution of fossil fuel emissions. These differences are frequently both statistically and economically significant. For example, all matched pair differences except (Q20, Q30) are statistically significant for the standard quantile regressions. Further, the fossil fuel program response it the 20th percentile is 1.6 (IV QREG point estimates) to 2.2 (standard QREG point estimates) times greater than the response at the 50th percentile. Results in Table 2 indicated that disclosure programs induce reductions in fossil fuel usage on average. The quantile regression results in table 5 suggest that it is firms that already use relatively limited amounts of fossil fuels that reduce fossil fuels the most in response to disclosure programs.

Results for clean fuel responses to disclosure programs largely mirror the results in Table 5. Point estimates generally increase as one moves up the distribution of clean fuel usage, suggesting that disclosure programs induce firms that already use substantial amounts of clean fuel to increase clean fuel usage the most. For both fossil fuel and clean fuel responses, care

should be taken interpreting these results. Technically, the quantile regressions compare differences in the absent-disclosure and present-disclosure *distributions*. Rank preservation is not guaranteed. While it is practically quite likely that firms that are at high quantiles of the absent-disclosure distribution also appear at similarly high quantiles of the corresponding present-disclosure distribution, this is not required. Thus, quantile regression results merely suggest that firms that already use substantial amounts of fossil fuels reduce fossil fuel usage the most in response to disclosure programs.

7.   Discussion and conclusion

On the margin, we find a statistically and economically significant impact of information disclosure programs in the electricity industry. We find that mandatory disclosure programs decrease firms' percentage of generation attributable to fossil fuels and increase firms' percentage of generation attributable to clean fuels like hydroelectric and renewables. As the proportion of the average firm's sales subject to disclosure requirements increases 10 percent, the average proportion of generation attributable to fossil fuels drops approximately 1.3 percentage points. Further, as the proportion of the average firm's sales subject to disclosure increases 10 percent, the average proportion of generation attributable to clean fuels rises approximately 1.5 percentage points.

We also find that disclosure program responses are sensitive to customer composition and pre-exiting fuel mix levels. Firms' clean fuel program responses become considerably stronger (more positive) as the firm sells to more residential consumers. Fossil fuel program responses become considerably weaker (less negative) as the proportion of sales to residential consumers increases. Further, disclosure program responses differ across the fuel mix distribution. Results

suggest that firms that already use relatively low levels of fossil fuels decrease their fossil fuel percentages the most in response to information disclosure policies. For example, the program-induced decrease in fossil fuel usage is approximately 2 times greater for firms generating approximately 38 percent of their energy from fossil fuels than for firms generating approximately 83 percent of their energy usage from fossil fuels.

The key implication arising from our results is that information disclosure programs that regularly provide easily interpretable information can be an effective and low cost means of achieving policy goals. This result holds even when the provided information already exists in the public domain. Further, the result holds when the program targets an impure public good with private consumption attributes that are not correlated with public benefits. We find a significant impact of mandatory information policies for electricity, and green electricity is equivalent to brown electricity as a final consumption product. Information policies like eco- and organic- labels frequently target impure environmental public goods, but it is very difficult to disentangle disclosure responses attributable to environmental preferences from disclosure responses attributable to perceived changes in product quality (like health, safety, and taste).

Other significant policy implications follow from our results. Most notably, information policies may generate significant unintended consequences. For example, particular attention must be paid to customer composition when introducing disclosure programs in the electricity industry. When utilities serve high proportions of residential consumers, mandatory information programs may spur particularly significant increases in clean fuel usage. However, in these circumstances, these increases come at the relative expense of nuclear fuel usage and not fossil fuel usage. This may be consistent with stakeholder preferences, but it is unlikely to be consistent with air pollution-oriented policy goals. Second, the pre-existing fuel mix results

33

suggest that disclosure programs make "clean" firms cleaner while leaving "dirty" firms relatively unchanged. If the marginal benefits of pollution abatement are larger at dirty firms than at clean firms, disclosure programs may induce inefficient abatement allocations.

This paper suggests promising avenues for future research that are beyond the present scope. First, our results indicate that mandatory information disclosure programs affect the economic incentives and the behavior of utilities. However, assessing the full welfare effects of information-based policies requires a differentiation between new generation and ownership changes. Second, our results and anecdotal evidence suggest direct demand and political economic theories provide a credible link between mandatory information disclosure programs and fuel mix outcomes. However, a full understanding of the implications of these information-based policies requires precise identification of the underlying mechanism or mechanisms. Third, we demonstrate that information programs affect fuel mix outcomes. While fuel mix is correlated with emissions, gauging the social value of the policies involves an empirical evaluation of program-induced impacts on environmental quality. Finally, our results are suggestive for other settings. However, mandatory provision programs are becoming increasingly common in other countries and the extent of policy induced changes may be sensitive to cross-country institutions.

References

Arora, Seema, and Shubhashis Gangopadhyay. 1995. "Toward a Theoretical Model of Voluntary Overcompliance," *J. of Economic Behavior and Organization*, 28: 289-309.

Bennear, Lori, and Sheila Olmstead. 2006. "The Impacts of the "Right to Know": Information Disclosure and the Violation of Drinking Water Standards." *Mimeo*, Duke University.

Benston, George. 1973. "Required disclosure and the Stock Market: An Evaluation of the Securities Market Act of 1934." *American Economic Review* 63: 132-155.

Blamey, RK., Bennett, JW., Louviere,JJ., Morrison, MD, and Rolfe, J. 2000. A test of policy labels in environmental choice modelling studies *Ecological Economics*, Volume 32, Issue 2, February, Pages 269-286

Brouhle, K. and M. Khanna. 2007. "Information and the provision of quality differentiated products." *Economic Inquiry*, 45:2, 377-394.

Bui, Linda. 2005. "Public Disclosure of Private Information As a Tool for Regulating Emissions: Firm-level Responses by Petroleum Refineries to the Toxics Release Inventory." *Mimeo*, Brandeis University.

Chernozhukov, V. and C. Hansen. 2004a. "Instrumental Variable Quantile Regression." *Mimeo*, Massachusetts Institute of Technology.

Chipty, Tasneem and Ann Dryden Witte. 1998. "Effects of Information Provision in a Vertically Differentiated Market," NBER Working Paper, #6493.

Delmas, M., Russo, M., and Montes, M. 2007. "Deregulation and Environmental Differentiation in the Electric Utility Industry." *Strategic Management Journal*, 28(2), 189-209.

Desvousges, W.H., Smith, V.K., and H.H. Rink. 1992. "Communicating Radon Risks Effectively: The Maryland Experience." *J. of Public Policy and Marketing,* 11(2), 68-78.

Edison Electric Institute. *EEI's Statistical Yearbook of the Electric Power Industry*, August 2005.

Greenstone, Michael, Paul Oyer, and Annette Vissing-Jorensen. 2006. "Mandated Disclosure, Stock Returns, and the 1964 Securities Act." *Quarterly J. of Economics*, forthcoming.

Jin, Ginger and Phillip Leslie. 2003. "The Effect of Information on Product Quality: Evidence from Restaurant Hygiene Grade Cards," *Quarterly J. of Economics*, 118(2), 409-51.

Joskow, P. 1998. "Electricity Sectors in Transition." *Energy Journal*, 19:2, 25-52.

Healy, P. and K. Palepu, 2001. "Information Asymmetry, Corporate disclosure, and the capital markets: A review of the empirical disclosure literature." *J. of Accounting and Economics* 31: 405-440.

Kennedy, P., B. Laplante, and J. Maxwell, 1994. "Pollution Policy: the Role for Publicly Provided Information," *J. Environmental Economics and Management*, 26: 31-43.

Khanna, M. 2001. "Non-Mandatory Approaches to Environmental Protection." *J. Economic Surveys,* 15(3): 291-324.

Khanna, M., W. Quimio, and D. Bojilova, 1998. "Toxic Release Information: a policy tool for environmental information." *J Environmental Economics and Management*, 36: 243-266.

Kirchhoff, S. 2000. "Green Business and Blue Angels." *Environ. Resource Econ* 15: 403-420.

Koenker, Roger and Gilbert Bassett. 1978. "Regression Quantiles," *Econometrica* 46: 33-50.

Koenker, Roger and Gilbert Basett. 1982. "Robust Tests for Heteroskedasticity based on Regression Quantiles," *Econometrica* 50: 43-61.

Konar, S. and M. Cohen, 1996. "Information as Regulation: The Effect of Community Right to Know Laws on Toxic Emissions" *J. Environmental Economics and Management*, 32: 109-124.

Kotchen, Matthew. 2006. "Green Markets and Private Provision of Public Goods." *J. of Political Economy* 114(4): 816-834.

Lamarre (1997). L. Utility customers go for the green. *EPRI Journal* 22 2 (1997), pp. 6–15.

La Porta, Rafael, Florencio Lopez-de-Silanes. 2006. "What works in securities laws?" *J. of Finance* 61: 1-33.

Leire, C and Thidell, A .2005. Product-related environmental information to guide consumer purchases – a review and analysis of research on perceptions, understanding and use among Nordic consumers. *J. of Cleaner Production*, Volume 13, Issues 10-11, August-September, Pages 1061-1070.

Loureiro. ML. 2003. Rethinking new wines: implications of local and environmentally friendly labels. *Food Policy*, Volume 28, Issues 5-6, October-December, Pages 547-560.

Loureiro, M.L and Lotade, J. 2005 Do fair trade and eco-labels in coffee wake up the consumer conscience? *Ecological Economics*, Volume 53, Issue 1, 1 April, Pages 129-138.

Maxwell, J., T. Lyon and S. Hackett, "Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism," *J. of Law and Economics* October 2000, 43: 583-618.

Minnesota Public Utilities Commission, "Order Clarifying Disclosure Requirements and Setting Procedural Schedule," Docket No. E,G-999/CI-00-1343, September 2002.

National Council on Competition and the Electric Industry. "Electric Product Disclosure: A Status Report" Consumer Information Series, July 2002.

Robbins, Sidney, and Walter Werner. 1964. "Professor Stigler Revisited." *J. of Business* 37: 406-413.

Rogers, WH.1993. "Calculation of Quantile Regression Standard Errors." Stata Technical Bulletin 13:18-19.

Segerson, K. and T.J. Miceli. "Voluntary Environmental Agreements: Good or Bad News for Environmental Protection?" *J. of Environmental Economics and Management*, 36: 109-130.

Shimshack, J.P., M.B. Ward, and T.K.M. Beatty. 2006. "Mercury Advisories: Information, Education, and Fish Consumption," forthcoming, *J. of Environmental Economics and Management.*

Stigler, George. 1964. "Public Regulation of the Securities Market." *J. of Business* 37: 117-142.

Teisl, Mario F., Brian Roe and Robert Hicks. "Can Eco-Labels Tune a Market? Evidence from Dolphin-Safe Labeling of Canned Tuna," *Journal of Environmental Economics and Management*, 43 (May 2002): 339 – 59.

Tietenberg, T. 1998. "Disclosure Strategies for Pollution Control." *Environment and Resource Economics*, 11: 587-602.

US Department of Energy, Energy Information Administration, "Power Plant Report," 2003.

Weil, D., A. Fung, M. Graham, and E. Fagotto. 2006. "The Effectiveness of Regulatory Disclosure Policies." *J. of Policy Analysis and Management*, 25(1): 155-181.