What Drives Participation in State Voluntary Cleanup Programs? Evidence from Oregon

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ABSTRACT. *Virtually all U.S. states have now created voluntary cleanup programs (VCPs), offering liability relief and other incentives for responsible parties to remediate contaminated sites. We use a multinomial probit model to analyze participation in Oregon's two VCPs. In contrast to previous VCP research, we find that these programs attract sites with significant contamination, not just clean ones. Furthermore, we find that regulatory pressure—in particular, the public listing of contaminated sites—drives participation. These findings imply Oregon has been able to spur voluntary remediation via public disclosure, a result that comports with themes in the literature on voluntary environmental regulation.* (JEL Q53, Q58)

I. INTRODUCTION

More than a quarter-century after the passage of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, or Superfund), hundreds of thousands of properties contaminated with hazardous substances have yet to be remediated (Simons 1998; Heberle and Wernstedt 2006). Part of the reason for this backlog is CERCLA itself, which by making liability for cleanup retroactive, strict, joint, and several, created incentives for property managers and developers to shun contaminated properties for fear of being saddled with the cost of cleanup. State "minisuperfund" laws with similar liability features may have compounded the problem. In addition, federal and state regulators typically have resources to oversee cleanup of only a relatively small number of severely contaminated sites (USGAO 1997; Dana 2005).

To address those concerns, since the late 1980s, virtually all states have created programs that offer a basket of incentives for responsible parties and others to voluntarily remediate contaminated sites.[1] These incentives typically include relief from liability for future cleanup, variable (versus uniform) cleanup standards that link the level of required cleanup to the future use of the site, flexible enforcement of environmental regulations, expedited permitting, and financial support for remediation through such mechanisms as grants, loans, subsidies, and tax incentives (USEPA 2005). By 2004, roughly 20,000 contaminated sites had participated in, or were participating in, state voluntary cleanup programs (VCPs) (USEPA 2005).

Despite the prominent role that state VCPs now play in contaminated site policy, we know relatively little about the factors that drive participation in these programs—information that is needed to enhance their efficiency and effectiveness. This gap in the empirical literature is partly due to the difficulty of collecting the necessary infor-

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[1] Federal legislation also has attempted to address these problems. The Small Business Liability Relief and Brownfields Revitalization Act of 2002 provided firmer statutory footing for expanded liability protection and authorized up to $200 million annually for site assessment and remediation and up to $50 million annually in assistance to state and tribal response programs.

mation. Econometric analysis of participation requires data on contaminated sites that are not participating in the VCP (a control group) as well as those that are (a treatment group). But data on nonparticipating sites are scarce because contaminated properties may be "mothballed" to avoid detection and because state regulatory agencies lack the resources to identify them.

To our knowledge, only one econometric analysis of VCP participation has appeared. Alberini (2007) examines VCP participation in Colorado, which, like most states, does not maintain a database of contaminated properties that are not participating in cleanup programs. To construct a sample of nonparticipating sites, Alberini uses the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), a national registry of sites in need of investigation or cleanup that is maintained by the U.S. Environmental Protection Agency (EPA). CERCLIS focuses on sites with relatively severe (confirmed or suspected) contamination that are candidates for the federal Superfund program. Alberini finds that Colorado's VCP mainly attracts sites with minimal contamination and high development potential not listed in CERCLIS. She concludes,

> These findings raise questions as to whether participation in VCPs may—depending on program features—be sought primarily as a way to improve the market attractiveness of the parcels with minimal or no environmental remediation. Were this possibility confirmed by similar findings for other states' programs, this would cast doubts about the incentives created by VCPs and about these programs' effectiveness in encouraging cleanups by reversing some of Superfund's unintended consequences. (p. 416)

The present paper analyses VCP participation in Oregon, one of a small number of states that maintains a database of contaminated sites, including those with minimal contamination. We use these data to construct a control sample.[2] In contrast to Alberini's findings for Colorado, we conclude that Oregon's VCP does attract sites with significant contamination. Furthermore, we find that regulatory pressure—in particular, Oregon's practice of formally compiling a public list of sites with confirmed contamination—drives VCP participation. Together, these findings imply that Oregon has been able to spur voluntary remediation by publicly disclosing information on contamination, a relatively inexpensive and, hence, efficient approach. Our results comport with key themes in the literature on voluntary environmental programs: the threat of mandatory regulation spurs participation in such programs, and public disclosure of environmental performance is an efficient policy tool for promoting abatement and remediation.

II. LITERATURE

This section briefly reviews relevant literature on three topics: voluntary environmental programs administered by regulatory agencies, site managers' decisions to remediate contaminated properties, and policies and programs that publicly disclose firms' environmental performance.

Voluntary Programs

Empirical research on public voluntary environmental programs suggests that pressures applied by regulators, markets, and civil society drive participation, as does variation in transaction costs associated with joining these programs.[3]

Regulators. A leading hypothesis in the literature on voluntary environmental regulation is that private parties participate in order to preempt more stringent mandatory regulation or to soften enforcement of existing regulation (Segerson and Miceli 1998; Maxwell, Lyon, and Hackett 2000).

[2] We sought to identify a state that both operates a VCP with a sufficiently large number of sites and maintains a database of nonparticipating sites. Toward that end, we contacted regulatory authorities in 16 states (CA, CO, CT, IL, IN, KS, MA, MI, MO, NC, NC, NJ, OR, PA, TX, and WA) that according to USEPA (2005) had VCPs with more than 100 participating sites.

[3] For reviews, see Lyon and Maxwell (2002), Alberini and Segerson (2002), and Khanna (2001).

Research on this "background threat" hypothesis as it relates to public voluntary programs has focused mostly on whether firms under pressure from regulatory authorities were more likely to join the EPA's 33/50 program.[4] For example, Khanna and Damon (1999), Videras and Alberini (2000), Sam and Innes (2008), and Vidovic and Khanna (2007) all find that firms named as potentially responsible parties at a higher than average number of Superfund sites were more likely to join. Closely related to the hypothesis that regulatory pressure drives firms into voluntary programs is the notion that firms join in order to obtain preferential treatment from regulators. For example, Cothran (1993) and Decker (2003) find that firms obtain permits for new facilities more quickly if they have engaged in voluntary abatement.

Markets and civil society. Pressure brought to bear by consumers may also motivate participation in public voluntary programs. Theory suggests that firms may voluntarily improve their environmental performance to attract "green" consumers (Arora and Gangopadhayay 1995), and some empirical evidence suggests that this logic applies to participation in voluntary programs. For example, Arora and Cason (1996) and Vidovic and Khanna (2007) show that firms with a higher ratio of advertising expenditures to sales were more likely to participate in EPA's 33/50 program. Pressures generated by communities and nongovernmental organizations may also create incentives for firms to join voluntary programs. Such pressures are the focus of the literature on so-called informal regulation, which mostly consists of cross-sectional, plant-level econometric analyses of environmental performance in developing countries (see Blackman, in press, for a review).

Transaction costs. The transaction costs associated with joining voluntary regulatory programs inevitably vary across firms (because of differences in human capital, among other things) and may help explain participation (Delmas and Marcus 2004). For example, Blackman and Mazurek (2001) find that in a sample of 11 firms, transaction costs associated with participating in EPA's Project XL averaged more than $450,000 per firm, varied considerably across firms, and deterred some firms from participating.

Drivers of Remediation

Although to our knowledge Alberini's (2007) is the only published econometric analysis of VCP participation, researchers using other methods have examined a closely related topic: the drivers of site managers' and developers' decisions to remediate contaminated properties, whether they are in a VCP or not. For example, Wernstedt, Meyer, and Alberini (2006) examine the effect of various public policies on remediation decisions and find that developers place a relatively high value on liability relief. Sherman (2003) analyzes public policies that provide financial incentives for remediation and concludes that although developers find tax abatements most attractive, these policies usually do not change their decisions about whether to remediate a property. Finally, Schoenbaum (2002) examines the relationship between severity of contamination and property redevelopment in inner-city Baltimore and fails to find a correlation between the two factors.

Public Disclosure

Initiatives that collect and disseminate data about private parties' environmental performance have grown increasingly popular over the past 20 years (Tietenberg 1998; Kerret and Gray 2007; Dasgupta, Wheeler, and Wang 2007). Research suggests that public disclosure creates incentives for pollution control and remediation by leveraging many of the same pressures discussed in the literature on voluntary programs, including those generated by regulators, markets, and civil society (Bennear and Olmstead 2008; Dasgupta et al. 2006).

[4] Launched in 1991, the 33/50 program required participants to pledge to cut their emissions of 17 high-priority toxic chemicals by 33% by 1992 and by 50% by 1995.

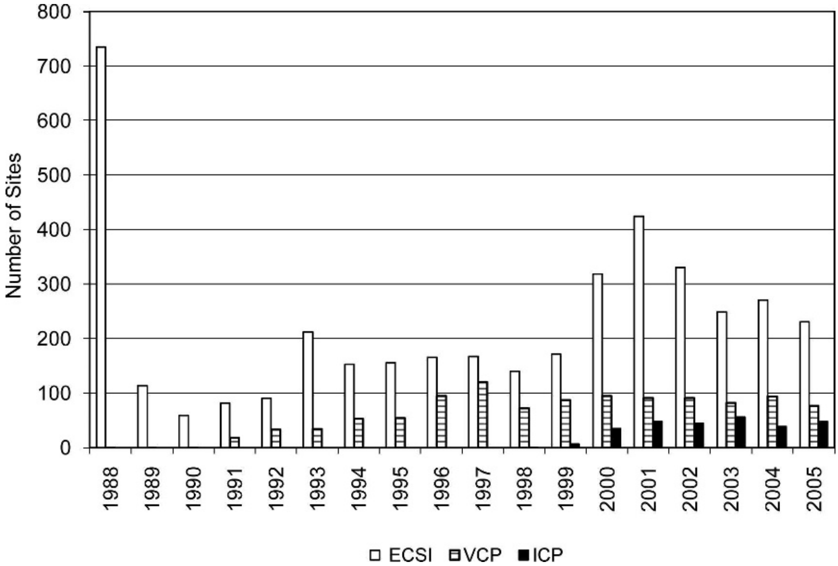

FIGURE 1
ENTRY INTO OREGON'S ENVIRONMENTAL CLEANUP SITE INFORMATION (ECSI) REGISTRY AND PARTICIPATION IN ITS VOLUNTARY CLEANUP PROGRAM (VCP) AND INDEPENDENT CLEANUP PATHWAY (ICP) 1988–2005, BY YEAR

Although evidence about the U.S. Toxic Release Inventory, arguably the best-known public disclosure program, is mixed (Bui 2005; Greenstone 2003; Koehler and Spengler 2007), studies of other programs have generated compelling evidence that this policy can drive emissions reductions (García, Sterner, and Afsah 2007; Powers et al. 2008; Bennear and Olmstead 2008; Delmas, Montes-Sancho, and Shimshack 2007).

III. OREGON'S CLEANUP PROGRAMS

This section discusses Oregon's contaminated property cleanup programs.

Environmental Cleanup Site Information Database

In 1988, Oregon's Department of Environmental Quality (DEQ) established the Environmental Cleanup Site Information (ECSI) registry of contaminated and formerly contaminated sites. In July 2006, when we downloaded the registry, it contained information on 4,223 sites.[5] Figure 1 shows the number of sites that entered ECSI each year between 1988 and 2005, the last full year of our data.[6] Seven hundred thirty-five sites entered ECSI in its first year. Subsequently, an average of 196 sites were added each year. Sites in ECSI have come to the attention of DEQ in a variety of ways, including corroborated citizens' complaints and referrals from other regulatory programs such as DEQ's hazardous waste program. The criterion for inclusion in ECSI is simply that a site is known or suspected to be contaminated. ECSI contains a variety of data about sites including their location, prior uses, ownership, and any remedial actions that have been performed. It also contains information on all DEQ actions and decisions regarding each site.

[5] The number includes 377 "candidate" and "historical" sites that are not considered fully fledged entries. ECSI is not comprehensive; it does not include a significant number of sites about which DEQ has no information. ECSI also excludes sites with petroleum releases from underground storage tanks.

[6] The figure and the discussion that follows omit 65 sites for which the date of entry is not available.

DEQ maintains two subsets of the database: the Confirmed Release List and the Inventory of Hazardous Substance Sites. The Confirmed Release List consists of sites where contamination has been confirmed (by qualified observation, operator admission, or laboratory data), has been deemed "significant" by virtue of its quantity or hazard, has not been regulated under another program, and has not been adequately cleaned up or officially deemed to require no further action. Managers of sites on the Confirmed Release List are subjected to enhanced pressures from both regulatory and nonregulatory actors. They can be required to participate in DEQ's mandatory cleanup program and may have difficulty transacting their properties. Hence, "listing" is a serious regulatory action. Prior to listing, DEQ notifies site managers of its intent to do so and gives them an opportunity to comment and provide additional information. In addition, DEQ provides a public comment period prior to delisting a site that has completed the requisite cleanup. The Inventory of Hazardous Substance Sites is a subset of the Confirmed Release List. It comprises sites where contamination is considered a threat to human health or the environment and must be cleaned up.

Oregon's Mandatory and Voluntary Cleanup Programs

In principle, DEQ classifies ECSI sites as high, medium, or low priority for further regulatory action, and this classification determines each site's eligibility for the state's three cleanup programs: the Site Response Program, the Voluntary Cleanup Program (VCP) and the Independent Cleanup Pathway (ICP). Actually, however, DEQ reliably assigns classifications only to high-priority sites; most medium- and low-priority classifications are missing in ECSI. The Site Response Program is DEQ's mandatory program, reserved for high-priority sites (although not all such sites are required to participate). For sites in this program, DEQ provides oversight throughout the investigation and cleanup and selects the remedial action. Of the 4,223 sites in ECSI, 416 (10%) are participating in, or have participated in, the Site Response Program.

Established in 1991 and 1999, VCP and ICP are DEQ's voluntary cleanup programs. They are targeted at medium- and low-priority sites. However, high-priority sites are allowed to participate in VCP (but not ICP). ICP, and to a lesser extent VCP, entails lower levels of DEQ oversight than the mandatory Site Response Program. Of the 4,223 sites in ECSI, 1,138 (27%) had joined VCP and 301 (7%) had joined ICP. Figure 1 shows the number of sites that joined each year between 1991 and 2005. Participation in VCP has accelerated from an average of 39 sites joining each year from 1991 and 1995 to more than 70 sites joining each year after 1995. On average, 40 sites per year have joined ICP since its inauguration.

The mechanics of participation in VCP are as follows. Site managers submit an "intent to participate" form and deposit $5,000 in an account that DEQ may draw upon to cover administrative expenses. Next, DEQ reviews written documentation on the site, visits the site, and works with the site manager to develop a cleanup plan. DEQ holds a public comment period and then decides whether to approve, disapprove, or modify the cleanup plan. If the plan is approved, the site manager implements it. When implementation is complete, DEQ invites public comment again and, barring serious objections, issues either a "no further action" (NFA) determination, which provides some assurance that DEQ will not require further remediation, or a conditional NFA, which provides this assurance contingent upon the site manager's undertaking certain actions, such as land-use control.

DEQ promotional materials list the benefits and risks of participating in VCP (Oregon DEQ undated a). The benefits include DEQ guidance and oversight, possible exemptions from permits for on-site work, and DEQ permission to redevelop

TABLE 1
SITES IN OREGON'S ENVIRONMENTAL CLEANUP SITE INFORMATION THAT COMPLETED REMEDIATION AS OF JULY 2006, BY PARTICIPATION IN VOLUNTARY CLEANUP PROGRAM AND INDEPENDENT CLEANUP PATHWAY

	Not Complete	Complete	Total
Nonparticipants	2,342 (81%)	563 (19%)	2,905 (100%)
Participants	645 (49%)	673 (51%)	1,318 (100%)
Total	2,987 (71%)	1,236 (29%)	4,223 (100%)

part of the site while other parts are being cleaned up. Among the risks are automatically being added to ECSI and being forced to join the mandatory Site Response Program if the site falls behind in implementing the cleanup plan.

ICP entails less DEQ oversight than does VCP. Essentially, site managers who pass an initial screening are allowed to complete an investigation and cleanup independently and then request final approval from DEQ. Alternatively, participants can have DEQ oversight if they want it and are willing to pay for it. According to ICP promotional materials, the risks of participation include not winning DEQ approval of an independently planned and implemented cleanup. Also, DEQ does not provide permit waivers to ICP participants (Oregon DEQ undated b).

DEQ recruits VCP and ICP participants by sending invitation letters to the managers of ECSI sites where it has determined that further action is needed. The vast majority of such letters simply describe the programs. Some letters, however, sent to high-priority sites only, essentially give site managers an ultimatum: either join VCP or be forced to participate in the mandatory Site Response Program. Of the 1,318 sites in the ECSI database that are participating or have participated in VCP or ICP, 1,142 (87%) joined after being included in the ECSI database and receiving an invitation letter. The remaining sites were unknown to DEQ before they submitted an application to join.

Not surprisingly, successful remediation—designated in almost all cases by the award of an NFA letter—is more common among VCP and ICP participants than among nonparticipants. Of the 4,223 sites in ECSI as of July 2006, DEQ had officially recognized 1,236 (29%) as having completed remediation (Table 1). Fifty-one percent of participants in VCP or ICP completed their cleanup, compared with only 19% of nonparticipants.

IV. EMPIRICAL ANALYSIS

This section presents our analysis of participation in VCP and ICP. Specifically, it discusses our data, econometric model, explanatory variables, and results.

Data and Regression Sample

Our regression data are drawn from the 2006 ECSI database described above, and 2000 block-group census data for Oregon. We merged the ECSI and census data using geographic information system software. Starting with the 4,223 sites in ECSI, we constructed our regression sample by dropping five sets of sites. First, when merging the data, we were forced to drop 458 sites either because locational information (latitude and longitude) was missing from the ECSI data or because block-group information was missing from the census data. Second, we dropped 344 sites that were ineligible to participate in VCP or ICP because they had been drafted into the mandatory Site Response Program (319 sites), listed on the National Priorities List (11 sites), or declared "orphans," without any identifiable responsible party (4 sites). Third, we dropped 244 sites for which participation in VCP or ICP was unlikely to have been fully voluntary either because they had received an "ultimatum" letter from DEQ warning them that if they did not join VCP they would be forced to join the mandatory Site Response Program (120 sites), or because they had been classified as "high priority" for further action (124 sites). Fourth, we dropped 1,506 sites because ECSI data on the site's prior use were missing. Finally, to determine whether being on the Confirmed Release List or the CERCLIS registry drove participation, we dropped 147 sites that were on one or both lists and that participated in the voluntary program before being listed. We discuss the reason for dropping these sites in Section IV below. After these exclusions, our regression sample comprised 1,534 sites, of which 500 (33%) participated in VCP, 125 (8%) participated in ICP, and 909 (59%) participated in neither.

Econometric Model

This section develops a multinomial probit model of site managers' decision to participate in a voluntary remediation program. We assume that site managers, indexed by i = (1, 2, ... N), choose among the following three alternatives, indexed by j:

1 = do not join either DEQ voluntary remediation program
2 = join ICP
3 = join VCP

They select the one alternative that generates the greatest expected profit, an unobserved latent variable given by

$$\Pi_{ij} = \mathbf{X}_i \boldsymbol{\beta}_j + \varepsilon_{ij} \qquad j = (1, 2, 3), \tag{1}$$

where Π_{ij} is expected profit, $\mathbf{X}_i$ is a row vector of observed site characteristics that determine profit, $\boldsymbol{\beta}_j$ is a column vector of parameters, and ε_{ij} are error terms that capture unobserved site-level determinants of profit. Let $\upsilon_{i21} = \varepsilon_{i2} - \varepsilon_{i1}$; $\upsilon_{i31} = \varepsilon_{i3} - \varepsilon_{i1}$; $\boldsymbol{\gamma}_{12} = \boldsymbol{\beta}_1 - \boldsymbol{\beta}_2$; $\boldsymbol{\gamma}_{13} = \boldsymbol{\beta}_1 - \boldsymbol{\beta}_3$; and $f(\upsilon_{i21}, \upsilon_{i31})$ be the joint probability density function of υ_{i21} and υ_{i31}. Then probability, P_{i1}, that a site manager chooses alternative 1 is

$$\mathrm{P}_{i1} = \Pr(\Pi_{i1} \geq \Pi_{i2} \text{ and } \Pi_{i1} \geq \Pi_{i3}) \tag{2}$$

$$= \Pr(\varepsilon_{i2} - \varepsilon_{i1} \leq \mathbf{X}_i\boldsymbol{\beta}_1 - \mathbf{X}_i\boldsymbol{\beta}_2 \text{ and. } \varepsilon_{i3} - \varepsilon_{i1} \leq \mathbf{X}_i\boldsymbol{\beta}_1 - \mathbf{X}_i\boldsymbol{\beta}_3) \tag{3}$$

$$= \Pr(\upsilon_{i21} \leq \mathbf{X}_i\boldsymbol{\gamma}_{12} \text{ and } \upsilon_{i31} \leq \mathbf{X}_i\boldsymbol{\gamma}_{13}) \tag{4}$$

$$= \int_{-\infty}^{X_i\gamma_{12}} \int_{-\infty}^{X_i\gamma_{13}} f(\upsilon_{i21}, \upsilon_{i31}) d\upsilon_{i21} d\upsilon_{i31}. \tag{5}$$

Expressions for P_{i2} and P_{i3} are derived in a similar manner. Let y_i be the site manager's choice variable and define λ_{ij} = {1 if $y_i = j$ and 0 otherwise}. Then the likelihood function is given by

$$L = \prod_{i=1}^{N} \prod_{j=1}^{3} P_{ij}^{\lambda_{ij}}. \tag{6}$$

We assume that the errors, υ_i, are distributed multivariate-normally and estimate the model as a multinomial probit using maximum likelihood (Hausman and Wise 1978).

In theory, $\mathbf{X}_i$ could include the following observable components of expected profit, which would vary across sites: (1) expected cleanup costs (which for nonparticipants include the expected cost of being forced by DEQ to participate in the Site Response Program or being subjected to a civil lawsuit compelling cleanup, or both); (2) expected appreciation in property values from any remediation carried out under VCP or ICP; (3) expected costs imposed by neighbors, community groups, environmental nongovernmental organizations, and other stakeholders concerned about contamination; (4) pecuniary transaction costs of participating in VCP or ICP, such as DEQ administrative fees; (5) pecuniary and nonpecuniary transaction costs involved in learning about VCP or ICP and navigating the DEQ bureaucracy; and (6) for sites that are unknown to DEQ and participate in VCP or ICP, the costs of informing the agency about potential contamination and being added to ECSI. In practice, we do not directly observe these components of profit. As discussed in the next section, we use data from ECSI and the 2000 census (at the block-group level) as proxies.

TABLE 2
VARIABLES IN ECONOMETRIC ANALYSIS: DEFINITION AND SAMPLE MEANS

Variable	Description	All (n = 1,534)	VCP (n = 500)	ICP (n = 125)	Nonparticipants (n = 909)
Dependent					
VCP	Participant in Voluntary Cleanup Program?[a]	0.326	1.000	0.000	0.000
ICP	Participant in Independent Cleanup Pathway?[a]	0.081	0.000	1.000	0.000
Independent					
Regulatory activity					
CRL	On Confirmed Release List?[a]	0.167	0.194	0.120	0.158
CERCLIS	In CERCLIS?[a]	0.153	0.068	0.064	0.211
PERMIT	Has DEQ permit?[a]	0.147	0.144	0.120	0.153
E_REGION	In DEQ eastern region?[a]	0.243	0.298	0.136	0.227
W_REGION	In DEQ western region?[a]	0.389	0.258	0.336	0.469
NW_REGION	In DEQ northwestern region?[a]	0.368	0.444	0.528	0.305
Neighborhood characteristics					
HOUSEVAL	Median house value in census block group ($10,000)	0.143	0.144	0.164	0.139
TR_TIME	Avgerage travel time to work in census block group (hours)	0.401	0.394	0.393	0.407
Prior use					
SIC1	SIC div. A: agriculture, forestry, farming[a]	0.049	0.032	0.048	0.058
SIC2	SIC div. B: mining[a]	0.057	0.016	0.032	0.084
SIC3	SIC div. C: construction[a]	0.005	0.004	0.008	0.004
SIC4	SIC div. D, major group 24: manufacturing: wood products except furniture[a]	0.092	0.098	0.096	0.088
SIC5	SIC div. D, major group 28: manufacturing: chemicals	0.026	0.006	0.016	0.036
SIC6	SIC div. D, major groups 33, 34: primary metals except machinery and transportation[a]	0.032	0.032	0.016	0.034
SIC7	SIC div. D, other major groups: manufacturing: all other products[a]	0.073	0.068	0.048	0.079
SIC8	SIC div. E: transportation, communications, electric, gas, sanitary[a]	0.181	0.224	0.144	0.162
SIC9	SIC div. F: wholesale trade (includes bulk oil, salvage)[a]	0.091	0.102	0.120	0.081
SIC10	SIC div. G: retail trade[a]	0.113	0.114	0.120	0.111
SIC11	SIC div. H: finance, insurance, real estate[a]	0.000	0.000	0.000	0.000
SIC12	SIC div. I: services (includes dry-cleaning, auto repair)[a]	0.179	0.182	0.240	0.168
SIC13	SIC div. J: public administration (includes military)[a]	0.044	0.052	0.072	0.035
SIC14	Not classifiable[a]	0.059	0.070	0.040	0.056

[a] Dichotomous dummy variables (0/1).

Variables

Table 2 lists the variables used in the econometric analysis and presents means for the entire sample of 1,534 sites and for the subsamples of sites that participated in VCP, those that participated in ICP, and those that participated in neither. We use three types of variables to explain site managers' choice of one of these three options: (1)

dichotomous dummy variables that concern DEQ regulatory activity; (2) continuous variables that capture the characteristics of the neighborhood in which the site is located; and (3) dichotomous dummy variables that control for the type of industrial or commercial activity found on each site. The regulatory and prior-use variables are drawn from our July 2006 ECSI data, and the neighborhood characteristic variables are drawn from 2000 block-group census data.

Regulatory activity variables. Among the regulatory activity variables, *CRL* is a dummy variable that indicates whether DEQ placed the site on the Confirmed Release List. As Table 2 shows, DEQ "listed" roughly a sixth of the sites in our sample. We expect *CRL* to be positively correlated with participation because, as discussed above, listed sites are subjected to enhanced pressures to clean up from regulators and other actors such as mortgage lenders. For example, listed sites face a higher probability of being forced into the mandatory Site Response Program and being denied bank credit. Thus, all other things equal, we expect the net benefits of participation to be higher for such sites.

CERCLIS is a dummy variable that indicates whether the federal government includes the site in CERCLIS, the database EPA uses to track activities conducted under its CERCLA authority. Screening criteria for CERCLIS specify that the program target sites not covered by state regulatory programs, including voluntary programs (USEPA 1999, 2). Not surprisingly then, very few CECRLIS sites have participated in state programs (Probst et al. 2001). For example, in her analysis of participation in Colorado's VCP, Alberini (2007) finds that only 6 of 159 participants were listed in CERCLIS. Hence, we expect *CERCLIS* to be negatively correlated with participation.

As noted in Section IV, we have controlled for potential endogeneity of *CRL* and *CERCLIS* by restricting our sample. We are interested in determining whether being added to the Confirmed Release List or CERCLIS ("listing") has a causal effect on joining VCP or ICP ("joining"). But in theory, joining could also cause listing if it informs DEQ about contamination. Fortunately, ECSI notes the date on which sites were listed and joined. Therefore, to avoid conflating the effect of listing on joining with the effect of joining on listing, we dropped all 147 observations where listing (on either the Confirmed Release List or CERCLIS) came after joining (either VCP or ICP).

PERMIT is a dummy variable that indicates DEQ has issued a permit to the site manager, whether for air emissions, liquid effluents, or hazardous waste. About a sixth of the sites in our two regression samples received permits from DEQ. *PERMIT* may be positively correlated with participation because DEQ presumably has more comprehensive and accurate information about permitted sites, and vice versa. As a result, one of the costs to site managers of participation—revealing information about potential contamination to DEQ—is lower for permitted sites. Also, their transaction costs of participation are lower.[7]

We include two dummies that indicate which of the three DEQ regional offices (east, west, and northwest) is responsible for administering the site: W_REGION and NW_REGION (the east region is the reference category). The west and northwest regions have 39% and 37% of the sites in our samples, respectively, and the east region has 24%. These dummies aim to control for any differences in program administration that might affect the net benefits of participation. We have no strong expectations about the signs of these dummies.

Finally, note that we are not able to use ECSI data on DEQ's high-, medium-, and low-priority status designations to control for the severity of contamination on our sample sites. As noted in Sections II and IV, priority status data are reasonably complete and reliable only for high-priority sites, and we drop all 124 such sites from our regression sample because their decision to join VCP

[7] Unfortunately, ECSI does not contain information on the timing of permitting. Therefore, we are not able to control for potential endogeneity by dropping observations where permitting comes after joining. However, as discussed in Section IV, endogeneity is unlikely to be an issue, since *PERMIT* turns out not to be correlated with joining.

may not be completely voluntary (of these sites, 73, or 59%, joined VCP). Data on medium- and low-priority status are missing for 65% of the sites in our sample and likely of poor quality for the remainder. Having dropped the high-priority sites, we rely on our prior-use variables, described below, to control for the remaining variation in the severity of contamination in our sample.

Community characteristics variables. We include two variables drawn from 2000 block-group census data that measure potentially relevant characteristics of the communities in which the site is located. *HOUSEVAL*, the median housing value in the relevant census block group, aims to capture the market value of the site as well as the expected appreciation in property values from any remediation carried out under VCP or ICP.[8] To the extent *HOUSEVAL* is a reasonable proxy for market value, we expect it to be positively correlated with participation for two reasons. First, site managers and developers may have stronger financial incentives to remediate more valuable properties. Second, contamination on particularly valuable sites may attract more attention from regulators, neighbors, and others.

TR_TIME is the average travel time to work in hours in the relevant census block group. It is included to control for locational factors that might influence a site manager's decision to participate, including the market value of the site and external pressure to remediate. We expect this variable to be negatively correlated with participation (as is distance to central business district in Alberini 2007) because sites located farther from business districts may be less valuable and may attract less attention from regulators, neighbors, and others.

Prior-use variables. Finally, we include 12 dummy variables drawn from our ECSI data, *SIC2–SIC12* and *SIC14*, that indicate the two-digit standard industrial classification (SIC) code most closely associated with the site's prior commercial or industrial use (*SIC1* is the reference category, and *SIC13* is omitted because none of the sites in our sample fall in this category). These variables are intended to control for site characteristics such as the nature and severity of the contamination, site size, and site complexity. In our regression samples, the categories with the greatest proportion of sites are SIC 8 (transportation, communications, electricity, gas, and sanitary), with roughly 18%; SIC 12 (services, including dry-cleaning and auto repair), with roughly 18%; SIC 10 (retail trade), with 11%; and SIC 4 (manufacture of wood products), with 9%. Although ECSI contains more direct information on site characteristics, including size and current operational status, these data are too incomplete to be used in our analysis.

Results

Table 3 presents our regression results. Estimated multinomial probit coefficients are difficult to interpret: for example, they need not have the same sign as marginal effects (Greene 2003). Hence, the table presents marginal effects. For dichotomous explanatory variables, they are the change in probability of choosing a particular alternative when the explanatory variable switches from zero to one, and for continuous explanatory variables, they are the change in probability of choosing the alternative due to a one-unit change in the explanatory variable.[9]

[8] We also collected data on commercial property values compiled at the county level for tax assessment purposes. However, we were unable to use these data in our regression analysis because most Oregon countries do not collect the data needed to locate the properties in the appropriate census block group or to control for property size.

[9] A potential concern is that managers of sites that "emerged from the woodwork"—in other words, that DEQ did not know about until they volunteered to join VCP or ICP—made their choices differently than managers whom DEQ invited to join these programs because officials knew about their sites. Of the 1,534 sites in our regression sample, 207 (13%) emerged from the woodwork. We tested to see whether these sites merited separate treatment by dropping them from the regression sample and rerunning the multinomial probit model. The important qualitative results discussed in Section IV do not change: *VCP* is still positively correlated with *CRL* at the 1% level, negatively correlated with *CERCLIS* at the 1% level, and correlated with five of the prior-use dummy variables; ICP is still negatively correlated with *CERCLIS* and *TR_TIME* at the 5% level. We are grateful to an anonymous reviewer for raising this issue.

TABLE 3

MULTINOMIAL PROBIT REGRESSION RESULTS: MARGINAL EFFECTS (SE)

Variable	Choice = VCP, pr(VCP) = 0.3095	Choice = ICP, pr(ICP) = 0.0739
Regulatory activity		
CRL[a]	0.0966*** (0.0357)	−0.0275* (0.0153)
CERCLIS[a]	−0.2160*** (0.0277)	−0.0528*** (0.0134)
PERMIT[a]	0.0130 (0.0376)	−0.0097 (0.0188)
W_REGION[a]	−0.1939*** (0.0309)	0.0352* (0.0212)
NW_REGION[a]	−0.0176 (0.0386)	0.0828*** (0.0276)
Neighborhood characteristics		
HOUSEVAL	0.0010 (0.0021)	0.0024** (0.0011)
TR_TIME	−0.1682 (0.1222)	−0.1459** (0.0620)
Prior use		
SIC2[a]	−0.1543** (0.0662)	−0.0091 (0.0405)
SIC3[a]	0.0177 (0.1855)	0.0024 (0.0867)
SIC4[a]	0.1935** (0.0819)	0.0143 (0.0413)
SIC5[a]	−0.1687** (0.0836)	−0.0081 (0.0554)
SIC6[a]	0.1782* (0.1060)	−0.0442 (0.0292)
SIC7[a]	0.1265 (0.0851)	−0.0341 (0.0287)
SIC8[a]	0.2032*** (0.0736)	−0.0245 (0.0288)
SIC9[a]	0.1174 (0.0806)	0.0313 (0.0463)
SIC10[a]	0.0975 (0.0762)	−0.0122 (0.0326)
SIC12[a]	0.1111 (0.0728)	0.0041 (0.0348)
SIC13[a]	0.2284** (0.0948)	0.0317 (0.0522)
SIC14[a]	0.1680** (0.0861)	−0.0362 (0.0276)
Number of observations	1,534	
Log pseudo-likelihood	−1,232.6858	

[a] Dichotomous dummy variable: *dy/dx* = change in pr(participation) due to change in dummy from 0 to 1.
* Significant at 10% level; ** significant at 5% level; *** significant at 1% level.

Voluntary Cleanup Program. Three regulatory explanatory variables—*CRL*, *CERCLIS*, and *W_REGION*—are significantly correlated with choosing to participate in VCP, all at the 1% level. As expected, *CRL* is positively correlated with VCP participation. The magnitude of this effect is substantial: adding a site to DEQ's Confirmed Release List increases the probability that it participates in VCP (versus participates in neither VCP or ICP) by 10 percentage points. Also as expected, *CERCLIS* is negatively correlated with participation. Adding a site to CERCLIS reduce the probability that it participates in VCP by 22 percentage points. Finally, *W_REGION* is negatively correlated with VCP participation. Location of a site in the western DEQ region increases the probability of participation by 19 percentage points.

Neither of the two neighborhood characteristic explanatory variables is correlated with VCP participation. Assuming that these variables are reasonable proxies for market value, the fact that they are not significant suggests that sites entering the VCP are less motivated by expected appreciation in property values than other factors, such as expected costs imposed by regulators and other stakeholders.

Seven of the 12 prior-use explanatory variables—*SIC2*, *SIC4*, *SIC5*, *SIC6*, *SIC8*, *SIC13*, and *SIC14*—are significant. Of these, the largest marginal effects are for *SIC13* (public administration sector, including military), *SIC8* (transportation, communication, electricity, gas, and sanitary sectors), and *SIC4* (wood products manufacturing sector), all of which are positive and significant at the 1% or 5% level. Current or past economic activity in one of these economic sectors increases the probability that a site participates in VCP by at least 20 percentage points.

Independent Cleanup Pathway. Four of the regulatory explanatory variables—*CRL*, *CERCLIS*, *W_REGION*, and *NW_REGION*—are significantly correlated with choosing to participate in ICP. In contrast to our results for VCP, *CRL* is negatively correlated with ICP participation, at the 10% level. Adding a site to the Confirmed Release List decreases the probability that it participates in ICP by 3 percentage points. The explanation likely has to do with how listing affects the benefits and costs of participating in ICP versus VCP. As discussed in Section III, according to DEQ, the main risk of ICP participation is not winning DEQ approval of an independently planned and implemented cleanup. Presumably, listing increases this risk, so that managers of listed sites prefer the higher level of DEQ involvement in remediation that comes with joining VCP, despite the higher transaction costs. Hence, while listing increases the probability of VCP participation, it decreases the probability of ICP participation.

As in the case of VCP, *CERCLIS* is negatively correlated with participation in ICP, although the magnitude of the effect is smaller: adding a site to CERCLIS reduces the probability that it participates in ICP by 5 percentage points. Finally, both *W_REGION* and *NW_REGION* are positively correlated with ICP participation: location in the west DEQ region increases the probability that it participates in ICP by 4 percentage points, while location in the northwest DEQ region increases the probability that it participates by 8 percentage points.

Both of the neighborhood characteristic explanatory variables—*HOUSEVAL* and *TR_TIME*—are significant at the 1% or 5% level. *TR_TIME* is negatively correlated with ICP participation, suggesting that sites in neighborhoods with shorter average travel times to work are more likely to participate. A one-hour reduction in average travel time increases the probability of participation by 15 percentage points. *HOUSEVAL* is positively correlated with ICP participation. The magnitude of the effect is quite modest: a $10,000 increase in median housing value raises the probability of participating in ICP by one-fifth of 1 percentage point. In any case, the significance of the neighborhood characteristic explanatory variables suggests that site managers joining ICP are at least partly motivated by expected appreciation in property values.

Finally, in contrast to the case of VCP, none of the prior-use variables are significantly correlated with ICP participation. As discussed in Section IV, these variables are intended to proxy for site characteristics such as nature and severity of contamination. The fact that they do not help explain ICP participation comports with the hypothesis that site managers joining this program—like those in Colorado studied by Alberini (2007)—are motivated less by pressure to clean up significant contamination than by a desire to remove a perception of possible contamination so that the property can be developed and transacted.

Discussion. Several of the results from the empirical analysis are particularly noteworthy from a policy perspective. First, both of Oregon's voluntary cleanup programs are attracting sites with significant contamination. This is evident from the simple summary statistics in Table 2, which indicate that 19% of the 500 sites in our sample that participated in VCP and 12% of the 125 sites that participated in ICP were on the Confirmed Release List (i.e., their contamination has been confirmed and deemed significant by virtue of its quantity or hazard). These percentages would be significantly higher had we counted sites dropped from the regression sample for various reasons. In the full sample of 1,138 sites that participated in VCP, 39% were on the Confirmed Release List, and in the full sample of 301 sites that participated in ICP, 20% were on the Confirmed Release List. This finding contrasts sharply with the situation in Colorado, where according to Alberini (2007), the state voluntary cleanup program overwhelmingly attracts sites with minimal contamination and high development potential.

Second, our regression results imply that sites on the Confirmed Release List are more likely to join VCP, all other things equal. As noted above, for the average site, inclusion in the Confirmed Release List increases the probability of participation by 10 percentage points.

Those two findings—that the Oregon VCP is attracting sites with significant contamination and that listed sites are more likely to join—are potentially important for policy makers. Together, they imply that DEQ has been able to spur voluntary remediation of some contaminated sites by adding them to the Confirmed Release List.

Finally, our results suggest that Oregon has been successful in developing separate voluntary cleanup programs that cater to the two types of sites likely to join such programs: (1) those with significant contamination under pressure (from regulators and other stakeholders) to remediate, and (2) those with minimal contamination and high development potential. Presumably, this dual structure promotes higher levels of participation by each type—a seemingly desirable outcome, since removing contamination or the stigma of possible contamination from each type of site generates social benefits, be they environmental or economic.

V. CONCLUSION

We have presented an econometric analysis of participation in a state VCP. We have overcome the problem of assembling a control group of nonparticipating sites by focusing on VCPs in a state that maintains a registry of known contaminated sites. The regressors in our econometric analysis are site characteristics that aim to capture the benefits and costs of participation, including the expected savings that arise from avoiding the mandatory Site Response Program, and expected appreciation in property values from obtaining a "no further action" letter. We have used a multinomial probit model to account for Oregon site managers' choice between joining two different DEQ voluntary programs.

Our results suggest that (1) Oregon's voluntary programs are attracting sites with significant contamination, and (2) all other things equal, sites that state regulators have formally added to a public list of sites with confirmed significant contamination are more likely to subsequently join one of the state's voluntary programs. Together, these findings imply that state regulators can spur voluntary remediation of contaminated sites by collecting, verifying, and publicly disclosing information on contamination. This is a mechanism for encouraging VCP participation that, to our knowledge, has not yet received any attention in the literature. Compared with some other policy tools frequently used to encourage participation in VCPs, it would appear to be relatively inexpensive. Our findings comport with a growing body of evidence suggesting that public disclosure of environmental performance is an efficient policy tool for promoting abatement and remediation.

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