

February 2008 ■ RFF DP 08-04

# What Drives Participation in State Voluntary Cleanup Programs?

*Evidence from Oregon*

---

Allen Blackman, Thomas P. Lyon, Kris Wernstedt,  
and Sarah Darley

1616 P St. NW  
Washington, DC 20036  
202-328-5000 [www.rff.org](http://www.rff.org)



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

Allen Blackman, Thomas P. Lyon, Kris Wernstedt, and Sarah Darley

## **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 duration model to analyze participation in Oregon's program. In contrast to previous VCP research, we find that this program attracts sites with significant contamination, not just relatively 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 key themes in the literature on voluntary environmental regulation.

**Key Words:** environment, hazardous waste, brownfields, contaminated property, duration analysis, Oregon

**JEL Classification Numbers:** Q53, Q58, C41

© 2008 Resources for the Future. All rights reserved. No portion of this paper may be reproduced without permission of the authors.

Discussion papers are research materials circulated by their authors for purposes of information and discussion. They have not necessarily undergone formal peer review.

## **Contents**

<b>1. Introduction.....</b>	<b>1</b>
<b>2. Literature.....</b>	<b>3</b>
2.1 Public Programs .....	3
2.2 Drivers of remediation .....	5
2.3 Public disclosure .....	6
<b>3. Oregon’s Cleanup Programs .....</b>	<b>6</b>
3.1 The Environmental Cleanup Site Information database .....	7
3.2 Oregon’s mandatory and voluntary cleanup programs .....	7
<b>4. Analytical Framework, Data, and Variables.....</b>	<b>9</b>
4.1 Analytical Framework .....	9
4.2 Regression Samples .....	10
4.3 Variables .....	10
<b>5. Econometric Model.....</b>	<b>13</b>
<b>6. Results .....</b>	<b>15</b>
6.1 Voluntary Cleanup Program .....	15
6.2 Independent Cleanup Pathway.....	16
6.3 Discussion .....	16
<b>7. Conclusion .....</b>	<b>18</b>
<b>References.....</b>	<b>19</b>
<b>Tables .....</b>	<b>24</b>

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

Allen Blackman, Thomas P. Lyon, Kris Wernstedt, and Sarah Darley\*

## 1. 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 (U.S. GAO 1997; Dana 2005).

To address these 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.<sup>1</sup> 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 mechanisms such as grants, loans, subsidies, and tax

---

\* Allen Blackman (corresponding author), Senior Fellow, Resources for the Future, 1616 P St. NW, Washington, DC 20036, [blackman@rff.org](mailto:blackman@rff.org); Thomas P. Lyon, Dow Professor of Sustainable Science Technology, and Commerce, Stephen M. Ross School of Business, University of Michigan, 201 Tappan St., Ann Arbor, MI 48103-1234; Kris Wernstedt, Associate Professor, Virginia Tech. School of Urban Affairs and Planning, 1021 Prince St., Suite 200, Alexandria, VA 22314; Sarah Darley, Research Associate, Resources for the Future.

The U.S. Environmental Protection Agency STAR Program (Grant No. 83215401) provided funding for this research. We are grateful to Gil Wistar at the Oregon Department of Environmental Quality for careful explanations of Oregon’s contaminated site policy and data; to Mike Duthie, Brock Howell, and Francie Streich for excellent research assistance; and to Charlie Landman, Ann Levine, Larry Schnapf, and Tom Roick for helpful comments. Remaining errors are our own.

<sup>1</sup> Federal legislation has also 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.

incentives (U.S. EPA 2005). By 2004, roughly 20,000 contaminated sites had participated in, or were participating in, state voluntary cleanup programs (VCPs) (U.S. EPA 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 information. 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 Environmental Protection Agency (EPA) registry of sites in need of investigation or cleanup. 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 that

... these findings cast doubt on whether the VCP is truly attaining its original cleanup and environmental remediation goals and hints at the possibility that participation might be driven exclusively by the desire to rid the parcel of any stigma associated with the current or previous use of land (or to prevent such an effect with future buyers).

The present paper analyzes VCP participation in Oregon, one of a small number of states that maintain databases of contaminated sites, including those with minimal contamination. We

use these data to construct a control sample.<sup>2</sup> 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.

The remainder of the paper is organized as follows. The second section reviews the relevant literature. The third section provides background on Oregon's VCP. The fourth section discusses our data and variables. The fifth section presents our econometric model, and the sixth section discusses our results. The final section offers conclusions.

## **2. Literature**

A considerable literature has developed to explain participation in different types of voluntary environmental initiatives, including public programs administered by regulatory agencies, agreements negotiated between regulators and polluters, and unilateral private sector commitments.<sup>3</sup> This section reviews the literature on participation in public programs and VCPs in particular. It also briefly discusses a second relevant literature, that on public disclosure initiatives.

### **2.1 Public Programs**

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

---

<sup>2</sup> 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 have VCPs with more than 100 participating sites according to U.S. EPA (2005).

<sup>3</sup> For reviews, see Lyon and Maxwell (2002), Alberini and Segerson (2002), and Khanna (2001).

### 2.1.1 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). Research on this “background threat” hypothesis as it relates to voluntary programs (as distinct from other types of voluntary regulation) has mostly focused on whether firms under pressure from regulatory authorities were more likely to join the EPA’s 33/50 program.<sup>4</sup> Khanna and Damon (1999), Videras and Alberini (2000), Sam and Innes (2006), 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 participate. Similarly, Videras and Alberini (2000) and Sam and Innes (2006) find that firms that were out of compliance with the Resource, Conservation and Recovery Act or the Clean Air Act were more likely to join. The evidence about the impact of regulatory pressure on 33/50 participation is not one-sided, however. For example, Arora and Cason (1996) and Gamper-Rabindran (2006) find that firms that violated Clean Air Act requirements were not more likely to participate. As for research on other public voluntary programs, Videras and Alberini (2000) show that firms named as potentially responsible parties at a higher-than-average number of Superfund sites were more likely to participate in EPA’s Waste Wi\$e and Green Lights programs.

Closely related to the hypothesis that regulatory pressure drives firms into voluntary programs is the notion that firms participate in order to obtain preferential treatment from regulators. For example, anecdotal evidence about Project XL, EPA’s flagship voluntary program during the 1990s, suggests that firms obtained significant production cost advantages from participation, chiefly through relief from certain environmental regulations (Marcus, Geffen, and Sexton 2002). Similarly, Cothran (1993) and Decker (2003) find that firms obtain permits for new facilities more quickly if they have engaged in voluntary abatement.

### 2.1.2 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 Gangopadhyay 1995). Some empirical

---

<sup>4</sup> 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.

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, and Videras and Alberini (2000) show that firms selling directly to final consumers were more likely to participate in the Waste Wi\$e and Green Lights programs.

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 World Bank 1999 for a review). For example, Blackman and Bannister (1998) find that in the early 1990s, pressures applied by industry and neighborhood organizations spurred participation in a voluntary clean fuels initiative targeting small Mexican brick kilns.

### **2.1.3 Transaction costs**

The transaction costs associated with joining voluntary regulatory programs inevitably vary across firms due to, among other things, difference in human capital, 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 appear to have deterred some firms from participating.

## **2.2 Drivers of remediation**

Although to our knowledge Alberini (2007) is the only published econometric analysis of VCP participation, some authors using other methods have examined a closely related topic: site managers' and developers' incentives to remediate contaminated properties, whether via a VCP or not. Alberini et al. (2005) and Wernstedt, Meyer, and Alberini (2006) present results of conjoint choice experiments designed to identify the type of policies that create incentives for real estate developers to remediate contaminated properties. Alberini et al. (2005) find that European developers can be attracted to contaminated sites by subsidies, liability relief, and less stringent regulation. Wernstedt, Meyer, and Alberini (2006) find that U.S. developers place a relatively high value on liability relief—from both cleanup costs and claims by third parties—and a relatively low value on reimbursement of environmental assessment costs.

Researchers have also examined the impact of specific drivers of remediation, including financial incentives and the level of contamination. Sherman (2003) analyzes property tax



abatements, site assessment grants, development grants, and low-interest loans and concludes that of these financial incentives, property tax abatements are the most attractive to developers. However, he notes that financial incentives typically are not able to change developers' decisions about whether to remediate a contaminated property. Schoenbaum (2002) examines a sample of contaminated and uncontaminated properties in inner-city Baltimore and fails to find a systematic relationship between contamination and the probability that a property was developed, suggesting that other factors, such as access to transportation and crime rates, play a more important role in developers' decisionmaking. However, McGrath (2000) finds that sites in Chicago that may have been contaminated were less likely to be redeveloped.

### **2.3 Public disclosure**

Public disclosure initiatives collect and disseminate data about private parties' environmental performance both to inform the public about threats to human health and the environment and to strengthen private incentives for pollution control and remediation (Teitenberg 1998). Public disclosure has grown increasingly popular over the past 20 years, in part because it is viewed as a relatively inexpensive environmental management tool (Kerret and Gray 2007; Dasgupta, Wheeler, and Wang 2007). 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 public disclosure can drive emissions reductions. These programs include so-called performance evaluations and ratings initiatives in Indonesia and India (García et al. 2007; Powers et al. 2008); 1996 amendments to the U.S. Safe Drinking Water Act mandating that community drinking water systems publicly report regulatory violations (Bennear and Olmstead 2007); rules requiring U.S. electric utilities to publicly report the extent of their reliance on fossil fuels (Delmas, Montes-Sancho, and Shimshack 2007); and British Columbia's policy of publicizing the identity of plants that are noncompliant (Foulon, Lanoie, and Laplante 2002). Research suggests that public disclosure creates incentives for pollution control and remediation by leveraging many of the same pressures discussed in the literature on public voluntary programs, including those generated by regulators, markets, and civil society (Bennear and Olmstead 2007; Dasgupta et al. 2006).

## **3. Oregon's Cleanup Programs**

This section discusses the data that Oregon collects on contaminated properties and its mandatory and voluntary cleanup programs.

### ***3.1 The Environmental Cleanup Site Information database***

Oregon's Department of Environmental Quality (DEQ) maintains an Environmental Cleanup Site Information (ECSI) database, which in July 2006 contained information on 4,223 contaminated, potentially contaminated, and formerly contaminated sites.<sup>5</sup> The sites in the database came to the attention of DEQ in a variety of ways, including corroborated citizen complaints and referrals from other regulatory programs, such as DEQ's hazardous waste program and the federal CERCLIS. 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, former and present uses, ownership, and any remedial actions that have been performed. ECSI also contains information on all DEQ actions and decisions regarding each site.

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.

### ***3.2 Oregon's mandatory and voluntary cleanup programs***

DEQ classifies all contaminated 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

---

<sup>5</sup> 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.

Independent Cleanup Pathway (ICP). 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, 10% are participating in, or have participated in, the Site Response Program.

VCP and ICP are DEQ's voluntary cleanup programs, 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, 27% have participated in, or are participating in, VCP and 7% have participated in, or are participating in, ICP.

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 a set of 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 part of the site while cleanup is ongoing on other parts. 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 its implementation of the cleanup plan.

ICP entails less DEQ oversight than 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. That said, ICP 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 DEQ has determined that further action is needed. The vast majority of such letters simply describe the programs. The remainder, which are 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.

#### **4. Analytical Framework, Data, and Variables**

This section describes the analytical framework, data, and variables we use to analyze participation in VCP and ICP.

##### ***4.1 Analytical Framework***

We assume that a site manager will join VCP or ICP if the net benefits (benefits minus costs) of doing so are positive. The benefits include (i) the expected savings in transaction costs and cleanup costs that arise from avoiding the mandatory Site Response Program, under which the site manager would have less discretion in choosing how and how much to remediate, less regulatory flexibility (e.g., expedited and waived permits), and a higher level of DEQ oversight; (ii) the avoided future liability costs from obtaining an NFA; (iii) the expected appreciation in property value from remediation and obtaining an NFA over and above the savings in cleanup and liability costs; and (iv) the expected reduction in costs imposed by neighbors, community groups, environmental nongovernmental organizations, and other stakeholders concerned about contamination. The costs of participation include (i) pecuniary transaction costs, such as DEQ administrative fees; (ii) pecuniary and nonpecuniary transaction costs involved in learning about VCP and ICP and navigating the DEQ bureaucracy; (iii) costs of any actual cleanup; and (iv) for sites that are unknown to DEQ, the cost of informing DEQ about potential contamination, including costs associated with being added to ECSI.

We expect those benefits and costs of participation to vary across sites, such that net benefits of participation are positive for some sites and negative for others. We do not directly observe benefits and costs. Using ECSI along with data from block-group census data, however, we can observe site characteristics that proxy for these costs. We use these proxies as explanatory variables in our regression analysis.

## 4.2 Regression Samples

We cannot run a single regression to explain participation in VCP and ICP because the subsample of nonparticipating sites is different for each program: as noted above, high-priority sites are eligible to participate in VCP but not ICP. Therefore, we constructed two samples of ECSI sites, one to explain participation in VCP, and one to explain participation in ICP.

The first several steps of the database assembly were the same for both samples. First, we used geographic information system software to associate each ECSI site with a census block group and merged the site-level ECSI data with block-group census data. Of the 4,223 sites in ECSI, 458 had to be dropped either because locational information (latitude and longitude) was missing in the ECSI data or because block-group data were missing in the census data. Next, we dropped 340 sites that were ineligible to join VCP or ICP because they were participating in the mandatory Site Response Program (319 sites) or were listed on the federal National Priorities List (11 sites). We also dropped 120 ECSI sites that 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. We dropped these sites because their participation in VCP was not fully voluntary. In addition, we dropped four sites that DEQ had declared “orphans” because a responsible party could not be identified. Finally, we dropped 1,506 sites for which ECSI did not contain enough information to determine the prior industrial or other use of the site. The result was a data set containing 1,805 sites.

To create the sample used to analyze VCP—which we will call the “VCP sample”—we dropped an additional 125 sites for which VCP join data were inconsistent (because join date preceded the date the site was entered into ECSI), leaving a total of 1,680 sites, 613 (36%) of which participated in VCP.

To create the sample used to analyze ICP—the “ICP sample”—starting with the data set of 1,805 sites, we dropped 124 additional sites DEQ deemed to be high priority for further action, because such sites are not eligible to participate. In addition, we dropped 39 sites for which the ICP join date was inconsistent (again because join date preceded the date the site was entered into ECSI), leaving a total of 1,642 sites, 155 (9%) of which participated in ICP.

## 4.3 Variables

Table 1 lists the variables used in the econometric analysis and, for each sample, presents means for the entire sample and for the subsamples of participants and nonparticipants. We use four types of variables to explain participation in VCP and ICP: (i) dichotomous dummy

variables that have to do with DEQ regulatory activity; (ii) continuous variables that capture the characteristics of the neighborhood in which the site is located; (iii) variables that interact the regulatory activity and neighborhood characteristics variables; and (iv) dummy variables that control for the type of industrial or commercial activity found on each site. We are not able to include explanatory variables derived from the information in ECSI that ranks the severity of contamination (high, medium, low) because this information is missing or unreliable for the majority of the sample.

#### 4.3.1 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 1 shows, DEQ “listed” roughly a quarter of the sites in the VCP and ICP samples. 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. Table 1 provides a preliminary indication of a positive correlation between listing and participation in VCP. In the VCP sample, the percentage of sites that were listed was much higher among VCP participants (42%) than nonparticipants (16%). This seeming positive correlation between *VCP* and *CRL* does not prove that listing causes participation, however, because it may simply reflect an underlying correlation between *CRL* and another site characteristic. For example, it could reflect the fact that sites used for manufacturing (versus retail) tend to participate, and also tend to be listed. Alternatively, or in addition, the apparent correlation could reflect the effect of *VCP* on *CRL*—that is, perhaps sites that participate are subsequently listed. As discussed below, to control for site characteristics and potential endogeneity in *CRL* and other regulatory variables, we use a duration model that explicitly accounts for the timing of participation, listing, and other regulatory activities.

*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. We expect that *CERCLIS* is positively correlated with participation in VCP and ICP because inclusion in this federal list, like inclusion in ECSI, presumably enhances regulatory and nonregulatory pressures to clean up and thereby increases the net benefit of participation.

*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. We expect *PERMIT* to be positively correlated with participation for two reasons. First, all other things equal, DEQ likely has more comprehensive and more accurate information about potential contamination on permitted sites than on nonpermitted sites. As a result, one of the main costs to site managers of participation—revealing information about potential contamination to DEQ—is lower for permitted sites. Second, by virtue of their ongoing contacts with DEQ, permitted sites likely have more accurate and more comprehensive information about VCP and ICP than do nonpermitted sites (Wistar 2007). As a result, their costs of participation are lower.

Finally, we include 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 each have approximately 37% of the sites in our samples, and the east region has roughly 26%. These dummies aim to control for differences in program administration across the three regions that affect the net benefits of participation. We have no strong expectations about the signs of these dummies.

#### 4.3.2 Community characteristics variables

We include two variables 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.<sup>6</sup> To the extent *HOUSEVAL* is a good 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 median travel time to work in minutes 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 proximity to companies that provide remediation services. We expect this variable to be negatively correlated with participation (as is distance to central business district in Alberini 2007) because sites located

---

<sup>6</sup> 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 counties do not collect the data needed to locate the properties in the appropriate census block group or to control for property size.

farther from business districts may be less valuable and may attract less attention from regulators, neighbors, and others.

#### 4.3.3 Interaction terms

We include two interaction terms: *CRL\_HOUSEVAL*, which is *CRL* interacted with *HOUSEVAL*, and *CRL\_TR\_TIME*, which is *CRL* interacted with *TR\_TIME*. The aim of including these terms is to shed light on how listing affects the probability of participation.

#### 4.3.4 Prior use variables

Finally, we include 14 dummy variables, *SIC1–SIC14*, that indicate the two-digit SIC code most closely associated with the site's prior commercial or industrial use. These variables are intended to control for such site characteristics as size, complexity, and the nature of the contamination. In our regression samples, the categories with the greatest proportion of sites are SIC8 (transportation, communications, electricity, gas, and sanitary) with roughly 18%; SIC12 (services, including dry-cleaning and auto repair) with roughly 17%; SIC10 (retail trade) with 11%; and SIC4 (manufacture of wood products) with roughly 10%. Although ECSI contains more direct information on site characteristics, including the size and current operational status, these data are too incomplete to be used in our analysis.

### 5. Econometric Model

We use a duration model to analyze participation in VCP and ICP. Duration models are used to explain intertemporal phenomena, such as the length of time that patients with a life-threatening disease survive, and the length of time industrial facilities operate before adopting a new technology.<sup>7</sup> Duration models estimate a hazard rate,  $h$ , which may be interpreted as the conditional probability that a phenomenon occurs at time  $t$  given that it has not already occurred and given the characteristics of the unit of analysis (patient, plant) at time  $t$ . The hazard rate is defined as

$$h(t, \mathbf{X}_t, \beta) = f(t, \mathbf{X}_t, \beta) / (1 - F(t, \mathbf{X}_t, \beta)) \quad (1)$$

---

<sup>7</sup> For an introduction, see Keifer (1988).



where  $F(t, \mathbf{X}_t, \boldsymbol{\beta})$  is a cumulative distribution function that gives the probability that the phenomenon (death, adoption of a technology) has occurred prior to time  $t$ ,  $f(t, \mathbf{X}_t, \boldsymbol{\beta})$  is its density function,  $\mathbf{X}_t$  is a vector of explanatory variables related to the characteristics of the unit of analysis (which may change over time), and  $\boldsymbol{\beta}$  is a vector of parameters to be estimated. In our study, the hazard rate is the conditional probability that a site in our data set joins VCP or ICP at time  $t$ , given that it has not already joined and given the characteristics of the site at time  $t$ .

In duration models, the hazard rate is typically broken down into two components. The first is a baseline hazard,  $h_0(t)$ , which is a function solely of time (not of any explanatory variables) and is assumed to be constant across all plants. The baseline hazard captures any effects not captured by explanatory variables (such as the diffusion of knowledge about VCP and ICP or changes in macroeconomic conditions). The second component of the hazard rate is a function of the explanatory variables. Combining these two components, the hazard rate  $h(t)$  is written

$$h(t) = h_0(t)\exp(\mathbf{X}_t'\boldsymbol{\beta}). \quad (2)$$

The vector of parameters,  $\boldsymbol{\beta}$ , is estimated using maximum likelihood.

A duration framework is appropriate for analyzing participation in the program for two reasons. First, two of the regulatory activity variables—*CRL* and *CERCLIS*—may be simultaneously determined along with VCP and ICP; that is, they are potentially endogenous. In theory, participation could result in a site's being added to the Confirmed Release List or to CERCLIS. A duration model controls for this problem because it explicitly accounts for the intertemporal relationship of these explanatory variables and participation: once a site joins VCP or ICP, it drops out of the likelihood function, so the model takes into consideration only cases where listing precedes participation.<sup>8</sup>

A second reason for using a duration model is that it avoids the problem of “right censoring” that would arise in a simple cross-sectional dichotomous choice model because some of the plants that were not participating in July 2006, when our ECSI data were collected, could join subsequently. A duration model circumvents this problem by estimating the conditional probability of participation in each period.

---

<sup>8</sup> We are not able to account for the timing of *PERMIT* because the requisite data in ECSI are incomplete.

We use a Cox (1975) proportional hazard model. There are two broad approaches to specifying duration models. One is to make parametric assumptions about the time dependence of the probability density function,  $f(t, \mathbf{X}_t, \boldsymbol{\beta})$ . Common assumptions include exponential, Weibull, and log-logistic distributions. Each assumption implies a different shape for the baseline hazard function,  $h_0(t)$ .<sup>9</sup> A second general approach is to use a Cox (1975) proportional hazard model that does not require a parametric assumption about the density function. This feature accounts for the broad popularity of the Cox model among economists, and it is the reason we choose it. We use days as our temporal unit of analysis.

## 6. Results

Table 2 presents regression results for the Cox proportional hazard model. Model 1 and Model 2 focus on participation in VCP, and Model 3 focuses on participation in ICP. Because the hazard function given by equation (2) is nonlinear, the estimated coefficients do not have a simple interpretation (technically, they are the effect on the log hazard rate of a unit change in the explanatory variable at time  $t$ ). Exponentiated coefficients, however, can be interpreted as the hazard ratio—that is, the ratio of the hazard rate given an increase in an explanatory variable at time  $t$  (a unit increase in a continuous variable or a change from 0 to 1 of a dichotomous dummy variable) relative to the baseline hazard rate at time  $t$ . A hazard ratio greater than 1 indicates that an increase in the explanatory variable increases the hazard rate relative to the baseline. For example, a hazard ratio of 2 means that an increase in the explanatory variable doubles the hazard rate relative to the baseline.

### 6.1 Voluntary Cleanup Program

Of the regulatory variables in Model 1, *CRL*, *PERMIT*, and *NW\_REGION* are significant at the 5% level. As expected, both *CRL* and *PERMIT* are positively correlated with participation. The hazard ratios for these variables indicate that all other things equal, a site that has been placed on the Confirmed Release List is 28% more likely to join VCP than a site that has not been listed, and a site that has been permitted is 30% more likely to join VCP than a site that has not been permitted. The regression results also indicate that the DEQ administrative region

---

<sup>9</sup> For example, an exponential probability density function generates a flat hazard function,  $h_0(t)$ . The implication is that the probability of joining VCP and ICP (apart from the influences of regulatory activity and site characteristics) stays the same over time. A log-logistic probability density function, on the other hand, generates a hazard function that rises and then falls.

where the site is located affects the probability of participation: sites administered by the northwest DEQ region are 34% more likely to join than sites in the east region (the reference group). Evidently, listing a site in CERCLIS has no impact on the probability of participation.

Of the community characteristic variables, *TR\_TIME* is significant at the 10% level. However, the magnitude of the effect is quite small. Surprisingly, *HOUSEVAL* is not significant. Of the prior use variables, all are significant at the 5% or 10% level. The largest effects are for *SIC4* and *SIC13*.

Model 2 interacts CRL with *HOUSEVAL* and *TR\_TIME* to try to better identify the effect of CRL. Here, CRL is no longer significant, but results for the remaining variables in Model 1 are qualitatively identical. The interaction term *CRL\_HOUSEVAL* is significant at the 5% level, but *CRL\_TR\_TIME* is not significant. These results suggest that listing has a significant impact when the market value of the site is relatively high. Alternatively, they suggest that the market value of the site has an impact when the site is listed.

## 6.2 Independent Cleanup Pathway

Of the regulatory variables in Model 2, only *W\_REGION* and *NW\_REGION*, the two dummies that indicate which DEQ region administers the site, are significant, both at the 1% level. The hazard ratios indicate that sites in the west region are 3.24 times more likely to participate in ICP than sites in the east region, and sites in the northwest region are 2.57 times more likely to participate. Neither of the two community characteristics variables is significant. Finally, four of the prior use dummy variables are significant, all at the 5% level. The largest effects are for *SIC7* and *SIC9*.

## 6.3 Discussion

Several of the results from the empirical analysis are particularly noteworthy. First, both of Oregon's voluntary cleanup programs are attracting sites with significant contamination. This is evident from the simple summary statistics in Table 1 which indicate that 42% of the 613 sites in our sample that participated in VCP and 25% of the 155 sites that participated in ICP were included by DEQ on the Confirmed Release List (recall that sites are listed if contamination has been confirmed and deemed significant by virtue of its quantity or hazard). This finding contrasts sharply with the situation in Colorado, where according to Alberini (2007) the state voluntary cleanup program almost exclusively attracts sites with minimal contamination and high development potential.

Second, Models 1 and 2 imply that sites on the Confirmed Release List with relatively high market values are more likely to join VCP, all other things equal. The result for *CRL* in Model 1 indicates that for the average site, inclusion in the Confirmed Release List increases the probability of participation by 28%, all other things equal. The results for *CRL* and *CRL\_HOUSEVAL* in Model 2 suggest that inclusion on the Confirmed Release List mainly affects the probability of participation for sites with relatively high market values. Two complementary explanations for these findings are possible. One is that listing enhances regulatory and nonregulatory pressures for remediation, and these pressures are strongest in areas where property values are relatively high. For example, community groups in high-property-value areas may place more pressure to remediate on listed sites than do community groups in areas with low property values. The other is that managers of high-value listed sites may have stronger financial incentives to remediate than managers of low-value listed sites. For example, listing may not affect the manager's decision to transact the site when the market value is low; in such cases, the manager may have no intention of selling or developing the site. However, for valuable sites, listing may derail sales or development plans and may create incentives to join VCP to obtain an NFA letter.

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 from a policy perspective. Together, they imply that DEQ has been able to spur voluntary remediation of some contaminated sites by adding them to the Confirmed Release List.

A third finding is that listing does not drive participation in ICP. The reason may be that ICP, by virtue of the criteria and rules for participation, selects for sites where contamination is less severe and where remediation is relatively straightforward. Presumably, regulatory and nonregulatory pressures for remediating such sites are relatively low. If DEQ faces resource constraints that force it to focus on the most heavily contaminated sites, then managers of lightly contaminated sites know that their chances of being drafted into the mandatory Site Response Program are relatively low. Moreover, even if this does happen, mandatory cleanup is probably relatively inexpensive. Also, sites of the type that participate in ICP probably face relatively little pressure from nonregulatory actors.

A final noteworthy result is that sites with DEQ permits are more likely to participate in VCP. We hypothesized that sites that were permitted would be more likely to join, partly because they face lower costs of doing so since DEQ is more likely to already know about the potential contamination, and also because the managers are more likely to already be familiar with DEQ and its VCP. Without follow on research, we cannot be sure that this explanation is

valid. However, it also hints at the potential importance of informational issues in explaining VCP participation.

## 7. Conclusion

We have presented an econometric analysis of participation in a state voluntary cleanup program. 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 the cost of revealing to DEQ that a site is contaminated. We have used a duration model to account for the intertemporal relationship between our explanatory variables and participation, and to avoid right censoring.

Our results suggest that (i) Oregon's voluntary cleanup programs are attracting sites with significant contamination, and (ii) 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 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.

## References

- Alberini, A. 2007. "Determinants and Effect on Property Values of Participation in Voluntary Cleanup Programs: The Case of Colorado." *Contemporary Economic Policy* 253: 415-432.
- Alberini, A., and K. Segerson. 2002. "Assessing Voluntary Programs to Improve Environmental Quality." *Environmental and Resource Economics* 221-222: 157-84.
- Alberini, A., A. Longo, S. Tonin, F. Trombetta, and M. Turvani. 2005. "The Role of Liability, Regulation, and Economic Incentives in Brownfield Remediation and Redevelopment: Evidence from Surveys of Developers." *Regional Science and Urban Economics* 35: 327-351.
- Arora, S., and T. Cason. 1996. "Why Do Firms Volunteer to Exceed Environmental Regulation? Understanding Participation in EPA's 33/50 Program." *Land Economics* 72: 413-32.
- Arora, S., and S. Gangopadhyay. 1995. "Toward a Theoretical Model of Voluntary Overcompliance." *Journal of Economic Behavior and Organization* 28: 289-309.
- Bennear, L. and S. Olmstead. 2007. "The Impacts of the 'Right to Know': Information Disclosure and the Violation of Drinking Water Standards." Working Paper, Duke University.
- Blackman, A., and G. J. Bannister. 1998. "Community Pressure and Clean Technology in the Informal Sector: An Econometric Analysis of the Adoption of Propane by Traditional Mexican Brickmakers." *Journal of Environmental Economics and Management* 35: 1-21.
- Blackman, A., and J. Mazurek. 2001. "The Cost of Developing Site-Specific Environmental Regulations: Evidence from EPA's Project XL." *Environmental Management* 271: 109-21.
- Bui, L.. 2005. "Public Disclosure of Private Information as a Tool for Regulating Emissions: Firm-Level Responses by Petroleum Refineries to the Toxics Release Inventory." U.S. Census Bureau Working Papers 05-13.
- Cothran, M. C. 1993. "Pro-active Environmental Activity Eases Permitting Process." *Journal of Environmental Permitting* 2: 293-300.
- Cox, D. 1975. "Partial Likelihood." *Biometrika* 62: 269-76.

- Dana, D. 2005. "State Brownfields Programs as Laboratories of Democracy." *New York University Law Journal* 14: 86-107.
- Dasgupta, S., D. Wheeler, and H. Wang. 2007. "Disclosure Strategies for Pollution Control." In *International Yearbook of Environmental and Resource Economics 2006/2007: A Survey of Current Issues*, eds. T. Teitenberg and H. Folmer. Northhampton, Mass.: Edward Elgar, 93-119.
- Dasgupta, S., J. H. Hong, B. Laplante, and N. Mamingi. 2006. "Disclosure of Environmental Violations and Stock Market in the Republic of Korea." *Ecological Economics* 58: 759–777.
- Decker, C. S. 2003. "Corporate Environmentalism and Environmental Statutory Permitting." *Journal of Law and Economics* 46: 103-129.
- Delmas, M., and A. Marcus. 2004. "Firms' Choice of Regulatory Instruments to Reduce Pollution: A Transaction Cost Approach." *Business and Politics* 6(3): 1-20.
- Delmas, M., M. Montes-Sancho, and J. Shimshack. 2007. "Information Disclosure Policies: Evidence from the Electricity Industry." Tufts University Department of Economics Working Paper.
- Foulon, J., P. Lanoie, and B. Laplante. 2002. "Incentives for Pollution Control: Regulation or Information?" *Journal of Environmental Economics and Management* 44: 169–187.
- Gamper-Rabindran, S. 2006. "Did the EPA's Voluntary Industrial Toxics Program Reduce Emissions? A GIS Analysis of Distributional Impacts and by Media Analysis of Substitution." *Journal of Environmental Economics and Management* 52(1): 391–410.
- García, J., T. Sterner, and S. Afsah. 2007. "Public Disclosure of Industrial Pollution: The PROPER Approach for Indonesia?" *Environment and Development Economics* 12: 739–756.
- Greenstone, M., 2003. "Estimating Regulation-Induced Substitution: The Effect of the Clean Air Act on Water and Ground Pollution." *American Economic Review* 93(2), 442-448.
- Heberle, L., and K. Wernstedt. 2006. "Understanding Brownfields Regeneration in the U.S." *Local Environment* 11:479-497.
- Kerret, D., and G. M. Gray. 2007. "What Do We Learn from Emissions Reporting? Analytical Considerations and Comparison of Pollutant Release and Transfer Registers in the United States, Canada, England, and Australia." *Risk Analysis* 27(1): 203-223.

- Khanna, M. 2001. "Economic Analysis of Non-Mandatory Approaches to Environmental Protection." *Journal of Economic Surveys* 153: 291–324.
- Khanna, M., and L. Damon. 1999. "EPA's Voluntary 33/50 Program: Impact on Toxic Releases and Economic Performance of Firms." *Journal of Environmental Economics and Management* 37:1–25.
- Kiefer, N. 1988. "Economic Duration Data and Hazard Functions." *Journal of Economic Literature* 26: 646–79.
- Koehler, D., and J. Spengler. 2007. "The Toxic Release Inventory: Fact or Fiction? A Case Study of the Primary Aluminum Industry." *Journal of Environmental Management* 85(2): 296–307.
- Lyon, T., and J. Maxwell. 2002. "Voluntary Approaches to Environmental Regulation: A Survey." In *Economic Institutions and Environmental Policy*, eds. M. Frazini and A. Nicita. Aldershot and Hampshire: Ashgate Publishing.
- Marcus, A., D. Geffen, and K. Sexton. 2002. *Reinventing Environmental Regulation: Lessons from Project XL*. Washington, D.C.: Resources for the Future Press.
- Maxwell, J., T. Lyon, and S. Hackett. 2000. "Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism." *Journal of Law and Economics* 43(2): 583–618.
- McGrath, D. 2000. "Urban Industrial Land Redevelopment and Contaminated Risk." *Journal of Urban Economics* 47(3): 414–442.
- Oregon Department of Environmental Quality (DEQ). Undated(a). Fact Sheet: Voluntary Cleanup Program. Available at: <http://www.deq.state.or.us/lq/pubs/factsheets/cu/VoluntaryCleanupProgram.pdf> Accessed December 5, 2007.
- Oregon Department of Environmental Quality (DEQ). Undated(b). Voluntary Cleanup Program: Independent Cleanup Pathway. Available at: <http://www.deq.state.or.us/lq/pubs/factsheets/cu/VoluntaryCUProgramIndependentCUPathway.pdf> Accessed December 5, 2007.
- Powers, N., A. Blackman, U. Narain, and T. Lyon. 2008. "Does Public Disclosure Reduce Pollution? Evidence from India's Pulp and Paper Industry." Working Paper. University of Michigan, Ann Arbor.



- Sam, A., and R. Innes. 2006. "Voluntary Pollution Reductions and the Enforcement of Environmental Law: An Empirical Study of the 33/50 Program." Working Paper. Columbus: Ohio State University Department of Agricultural, Environmental, and Development Economics.
- Schoenbaum, M. 2002. "Environmental Contamination, Brownfields Policy, and Economic Redevelopment in an Industrial Area of Baltimore, Maryland." *Land Economics* 781, 60-71.
- Segerson, K., and T. Miceli. 1998. "Voluntary Environmental Agreements: Good or Bad News for Environmental Protection?" *Journal of Environmental Economics and Management* 36(2): 109-130.
- Sherman, S. 2003. "Government Tax and Financial Incentives in Brownfields Redevelopment: Inside the Developer's Pro Forma." New York University *Environmental Law Journal* 11(2): 317-371.
- Simons, R.A. 1998. "Turning Brownfields into Greenbacks." Washington, D.C.: Urban Land Institute.
- Tietenberg, T. 1998. "Disclosure Strategies for Pollution Control." *Environmental and Resource Economics* 11:587-602.
- U.S. Environmental Protection Agency (EPA). 2005. State of Brownfields and Voluntary Response Programs. No. EPA-560-R-05-001. Washington, D.C.
- U.S. General Accounting Office (GAO). 1997. Superfund State Voluntary Programs Provide Incentives to Encourage Cleanups. GAO/RCED-97-66. Washington, D.C. April.
- Videras, J., and A. Alberini. 2000. "The Appeal of Voluntary Environmental Programs: Which Firms Participate and Why?" *Contemporary Economic Policy* 184: 449-61.
- Vidovic, M., and N. Khanna. 2007. "Can Voluntary Pollution Control Programs Fulfill Their Promises? Further Evidence from EPA's 33/50 Program." *Journal of Environmental Economics and Management* 53: 180-95.
- Wernstedt, K., P. Meyer, and A. Alberini. 2006. "Attracting Private Investment to Contaminated Properties: The Value of Public Interventions." *Journal of Policy Analysis and Management* 252: 347-369.
- Wistar, Gil. Oregon Department of Environmental Quality. Personal communication. April 23.

World Bank. 1999. Greening Industry: New Roles for Communities, Markets, and Governments. New York: Oxford University Press.

## Tables

Table 1. Variables in econometric analysis: Definition and sample means

Variable	Description	VCP Sample			ICP Sample		
		All n=1,680	Parts. n=613	Nonparts. n=1,067	All n=1,642	Parts. n=155	Nonparts. n=1,487
<i>DEPENDENT</i>							
VCP	Participant in Voluntary Cleanup Program?*	0.365	1	0	0.398	0.477	0.389
ICP	Participant in Independent Cleanup Pathway?*	0.107	0.109	0.105	0.094	1	0
<i>INDEPENDENT</i>							
<i>Regulatory activity</i>							
CRL	On Confirmed Release List?*	0.255	0.423	0.159	0.242	0.245	0.242
CERCLIS	In CERCLIS?*	0.168	0.119	0.197	0.155	0.084	0.162
PERMIT	Has DEQ permit?*	0.168	0.194	0.150	0.151	0.110	0.155
E_REGION	In DEQ eastern region?*	0.263	0.321	0.229	0.257	0.181	0.265
W_REGION	In DEQ western region?*	0.371	0.238	0.448	0.378	0.361	0.380
NW_REGION	In DEQ northwestern region?*	0.366	0.440	0.323	0.365	0.458	0.355
<i>Neighborhood characteristics</i>							
HOUSEVAL	Median house value in census block group (\$)	142,237.1	145,068.4	140,610.5	142,564.6	158,785.8	140,873.7
TR_TIME	Med. travel time to work in census block group (min.)	12890.9	13,120.9	12,758.8	13042.9	14,051.8	12,937.7
<i>Prior use</i>							
SIC1	SIC div. A: agriculture, forestry, farming*	0.044	0.024	0.056	0.045	0.032	0.046
SIC2	SIC div. B: mining*	0.060	0.021	0.082	0.055	0.026	0.058
SIC3	SIC div. C: construction*	0.004	0.002	0.005	0.004	0.006	0.004
SIC4	SIC div. D, major group 24: manufacturing: wood products except furniture*	0.102	0.124	0.089	0.098	0.103	0.097
SIC5	SIC div. D, major group 28: manufacturing: chemicals	0.027	0.016	0.034	0.027	0.026	0.027
SIC6	SIC div. D, major groups 33, 34: primary metals except machinery and transportation*	0.039	0.046	0.035	0.034	0.032	0.034
SIC7	SIC div. D, other major groups: manufacturing: all other products*	0.076	0.078	0.074	0.072	0.077	0.071
SIC8	SIC div. E: transport, comm. electric, gas, and sanitary*	0.176	0.206	0.159	0.186	0.155	0.189
SIC9	SIC div. F: wholesale trade (includes bulk oil and salvage)*	0.100	0.124	0.086	0.094	0.110	0.093
SIC10	SIC div. G: retail trade*	0.107	0.093	0.115	0.110	0.097	0.111
SIC11	SIC div. H: finance, insurance, and real estate*	0	0	0	0	0	0
SIC12	SIC div. I: services (includes dry-cleaning, auto repair)*	0.174	0.171	0.175	0.173	0.265	0.163
SIC13	SIC div. J: public administration (includes military)*	0.043	0.051	0.039	0.046	0.045	0.046
SIC14	Not classifiable*	0.049	0.044	0.052	0.056	0.026	0.059

\*Dichotomous dummy variables (0/1)

Table 2. Duration regression results

Variable	Model 1 Dep. var. = VCP	Model 2 Dep. var. = VCP	Model 3 Dep. var. = ICP
<i>Regulatory activity</i>			
CRL	1.280** (0.125)	1.021 (0.212)	0.743 (0.167)
CERCLIS	1.024 (0.149)	1.026 (0.150)	1.455 (0.425)
PERMIT	1.303** (0.139)	1.310** (0.139)	0.956 (0.259)
W_REGION	1.122 (0.131)	1.126 (0.132)	3.240*** (0.815)
NW_REGION	1.342** (0.165)	1.327** (0.165)	2.577*** (0.737)
<i>Neighborhood characteristics</i>			
HOUSEVAL	1.000 (0.00000069)	1.000 (0.00000074)	1.000 (0.0000011)
TR_TIME	1.000* (0.000004)	1.000** (0.0000048)	1.000 (0.0000083)
<i>Interaction terms</i>			
CRL_HOUSEVAL	n/a	1.000** (0.0000012)	n/a
CRL_TR_TIME	n/a	1.000 (0.0000075)	n/a
<i>Prior use</i>			
SIC2	0.482* (0.191)	0.481* (0.191)	0.626 (0.449)
SIC4	3.379*** (1.040)	3.411*** (1.043)	2.545* (1.296)
SIC5	2.440** (0.965)	2.467** (0.974)	2.777 (1.750)
SIC6	2.537*** (0.892)	2.470** (0.869)	2.449 (1.663)
SIC7	2.577*** (0.804)	2.545*** (0.791)	3.022** (1.674)
SIC8	2.468*** (0.723)	2.477*** (0.723)	1.911 (0.973)
SIC9	2.010** (0.603)	2.018** (0.603)	3.191** (1.634)
SIC10	2.094** (0.647)	2.087** (0.642)	2.362 (1.239)
SIC12	2.016** (0.591)	2.001** (0.584)	2.879** (1.432)
SIC13	2.615*** (0.892)	2.598*** (0.887)	1.472 (0.855)
SIC14	2.156** (0.719)	2.194** (0.726)	1.130 (0.716)
Number of observations	1,680	1,680	1,642
Log pseudolikelihood	-3687.138	-3685.5098	-771.856

(standard errors in parentheses)

\* significant at 10% level

\*\* significant at 5% level

\*\*\* significant at 1% level