# Re-evaluating the success of the EPA's 33/50 program: evidence from facility participation

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# Re-evaluating the Success of the EPA's 33/50 Program: Evidence from Facility Participation

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**Abstract**

Using previously unavailable data, we examine facility participation in the 33/50 Program and its effect on aggregate and toxicity weighted emissions between1991 and 1995 for a sample of facilities whose parent firms committed to the Program. By focusing on individual facilities we avoid the biases created by aggregating emissions across facilities. We find that while more polluting facilities within a firm were more likely to participate, even when we account for the toxicity of emissions, across firms there is no evidence of greater participation by facilities with higher emissions. Although emissions of the 33/50 chemicals fell over the years, we find that participation in the Program did not lead to the decline in the 33/50 releases generated by these facilities.

**Keywords**: Toxic Release Inventory; program participation; program evaluation, GMM, dynamic panel

**JEL classification codes**: Q53, Q58, L60

## 1. Introduction

In the early 1990s the United States Environmental Protection Agency (EPA) initiated a series of voluntary agreements under which firms pledge to reduce their emissions of pollutants otherwise not regulated directly. The 33/50 Program was the first of these voluntary initiatives. Inaugurated in 1991, its goal was to reduce the releases and transfers of 17 high priority chemicals by 33% by 1992, and by 50% by 1995, compared to their 1988 levels [7]. Under this Program, the EPA sent letters to eligible company Chief Executive Officers eliciting their participation in the Program. Roughly 1,300 companies responded with a clear commitment to participate. These firms accounted for over 60% of the 1988 emissions of the 33/50 chemicals [7]. Emissions data reported to the EPA's Toxic Release Inventory (TRI) show that over the life of the Program, 1991-1995, releases and transfers of the 17 targeted chemicals fell by 47%, and according to the EPA, the ultimate goal of the Program, 50% reduction in emissions relative to 1988 levels, was achieved in 1994, a year ahead of schedule [7].

Several studies evaluate the success of the Program and the results of this literature are not conclusive. Those studies that argue that the Program was successful analyze only the chemical sector [13], use a small subset of firms that also adopted Total Quality Environmental Management which is another voluntary activity [17], or find that participation in the Program led to a reduction in firm emissions only in the first year of the Program, 1991 [12]. Gamper-Rabindran [8] and Vidovic and Khanna [20] analyze firms from all industry sectors and find participation in the Program had no effect on the emissions of the targeted chemicals. Vidovic and Khanna [20] conclude that the reduction in the emissions observed by the EPA was the result of an independent trend rather than a direct consequence of the Program.

In contrast to the above studies, we use previously unavailable data on facility

commitment and examine the impact of participation in the 33/50 Program on facility emissions using a sample of facilities whose parent companies committed to the Program. According to the Program design, a parent company was recognized as a participant even if only one of its production facilities participated in the Program. This allowed facilities to free ride on reductions achieved by a subset of production plants, thus potentially diluting the impact of Program participation at the firm level. For example, the abatement effort of a single facility might decrease overall firm emissions despite the fact that no other facility belonging to the parent firm reduced emissions. Conversely, it is possible that the pollution abatement efforts of some facilities are outweighed by the increase in emissions of other facilities owned by the same firm so that overall firm emissions increase. Yet, such firms would be counted as participants in the 33/50 Program. Thus, a firm level analysis has potential biases that work against an accurate evaluation of the Program, and it is not surprising that the results of the firm level analyses that dominate the literature are mixed. By using facility level information regarding commitment to the Program we are able to rule out such possible free riding across facilities owned by the same firm. Therefore, we are better able to assess the impact of participation in the Program using our facility level data, even though the Program was operational at the firm level.

Only three other studies explicitly consider facility participation. Due to lack of data, Khanna and Vidovic [14] and Gamper-Rabindran [8] incorrectly assume that all facilities belonging to a parent firm that committed to the Program participated. Bi and Khanna [5] use the newly available data on facility participation but include all facilities in their analysis, regardless of their parent firm's participation status. Using a sample of 2,034 facilities that belong to 197 publicly owned parent firms that participated in the Program, we analyze the impact of the 33/50 Program on the releases of the 17 targeted chemicals between 1991 and 1995

using a panel data Generalized Method of Moments (GMM) framework to account for dynamic adjustment in facility emissions. We find that while more polluting facilities within a firm were more likely to make commitments to reduce the releases and transfers of the targeted chemicals, participation in the Program by itself is not associated with a significant decline in emissions. This result is consistent with our earlier analysis of firm level data [20] but contrary to the results of Khanna and Damon [13], among others.

## 2. Incentives for participation in the 33/50 Program and hypothesis tested

### *2.1. Incentives for participation*

The EPA emphasized that the 33/50 Program was appealing to firms because participants received public recognition through the media and certificates of recognition from the EPA. The literature on voluntary abatement programs suggests four mechanisms that motivate firms to participate: green marketing [3, 4, 13, 20], regulatory pressure [12, 13, 15, 18, 19, 20], interest group pressure [12, 17], and firm specific characteristics such as its size [3, 19, 20], financial and asset position [3, 12, 17], emissions profile [3, 12, 13, 20] and proclivity to participate in other voluntary abatement programs [3, 13]. Table I summarizes the literature on firm participation in terms of the main hypotheses, variables used to test each hypothesis, expected sign on variable coefficients and the actual sign and the statistical significance of the coefficients obtained.

The incentives for facility participation, explored by Khanna and Vidovic [14], Gamper-Rabindran [8] and Bi and Khanna [5], are very similar to those for firm participation. However, because individual facilities do not typically interact directly with the final consumer, the incentives created by green marketing opportunities ([4]) are unlikely to operate at the facility level. On the other hand, the participation incentive created by mandatory regulation [15, 18]

may be even greater for facilities. For example, facilities located in counties classified as being out of attainment with the National Ambient Air Quality Standards (NAAQS) may be more likely to participate in order to improve their environmental performance and avoid more stringent mandatory regulation in the future [9]. Indeed Bi and Khanna [5] find facilities located in non-attainment counties are more likely to participate. All three facility level studies examine the participation incentives created by the National Emission Standards for Hazardous Air Pollutants but only Khanna and Vidovic [14] find that facilities with higher ratios of the HAPs to 33/50 emissions are more likely to participate. Bi and Khanna [5] and Gamper-Rabindran [8] find that plants that were inspected more frequently for compliance or penalized for non-compliance with Clean Air Act (CAA) regulations were more likely to join the 33/50 Program.

Pressure from local communities and non-governmental organizations may create additional incentives for participation. Plants may participate in voluntary programs in order to deter environmentally conscious consumers and environmental interest groups from lobbying for increased regulation [11, 15, 12]. This threat of tighter regulation is more likely to be a motive for facility participation in states with higher membership in environmental interest groups such as the Sierra Club, or in states with Congressional representatives that have a track record of voting in favor of environmental initiatives [10, 15, 12]. Bi and Khanna [5] test the association between the probability of facility participation and the home state's representatives' environmental rating as published by the League of Conservation Voters (LCV) as well as the state per capita membership rate in the Sierra Club, but find that facilities located in states with higher membership rates in the Sierra Club are less likely to participate. In addition, facilities located in neighborhoods with a higher willingness to pay for environmental amenities and with a greater propensity to engage in the political process may experience more pressure to join

voluntary agreements. Khanna and Vidovic [14] and Bi and Khanna [5] find facilities located in counties with a higher median income are more likely to join the Program. On the other hand there is no evidence that voter participation rates or the socio-economic and demographic composition of a county have an effect on a facility's participation decision [14, 8].

Based on the current literature, we anticipate that larger, more polluting facilities, as well as facilities that emitted a larger share of their parent firm's 33/50 emissions and whose parent firms were invited in the first wave of invitations are more likely join the Program. Facilities emitting a larger absolute quantity of 33/50 releases or a larger share of their parent company's 33/50 emissions may be been more likely to join the Program since they face a greater potential for emission reduction. Similarly, facilities whose parent companies were invited in the first wave may be more likely to participate either because they had higher 33/50 emissions or because they received greater outreach by the EPA.[1]

To the extent that facilities may wish to mitigate the cost and stringency of current and or future mandatory regulation, we anticipate that facilities with higher total TRI emissions, a larger number of government inspections and enforcement actions under the CAA, and facilities that emit a larger share of 189 HAPs among all TRI chemicals may be more likely to join the 33/50 Program. We also expect to find that facilities located in regions with tougher air pollution policies and greater community environmentalism will have a higher probability of participation. For that reason, we presume facilities located in states with a larger per capita membership in Sierra Club and facilities located in counties with a greater propensity for collective action may be more likely to participate. Similarly, facilities located in counties designated to be out of attainment with NAAQS and facilities located in states with higher LCV scores may fear tougher

[1] The EPA invited firms in five stages. In March 1991 it invited the "top 600" firms with the highest releases and transfers of the 33/50 chemicals. It invited 5,000 additional firms in summer 1991 and another 2,500 over the next three years [7]. The largest number of commitments came from the first invitation group.

regulation in the future and be more likely to self-regulate to reduce regulatory pressure.

### *2.2. Hypothesis tested*

Our main hypothesis is that facilities that committed to the Program lowered their emissions of the 17 targeted chemicals as a result of joining the Program. We presume that a facility's emissions of the 33/50 chemicals are determined by its participation in the Program and many of the same factors that shape its participation decision such as the percentage of HAPs in total TRI emissions, number of inspections and enforcement actions, LCV score and per capita membership in Sierra Club in the facility's home state, number of air pollutants the facility's home county is in non-attainment with the CAA, and voter participation rates in the facility's home county. Additional controls include socio-economic and demographic characteristics of a facility's home county. We anticipate that facilities that expect larger potential liabilities under mandatory regulation and facilities that experience greater pressure from constituents and non-governmental environmental groups will have lower 33/50 emissions.

The Program goals were formulated in terms of aggregate emissions. This gave firms an incentive to focus their efforts on the chemicals with the lowest marginal abatement costs rather than the most toxic chemicals. From a public health perspective, however, the relative toxicity of the chemicals is important. Even if the aggregate emissions of the targeted chemicals declined as a result of the Program, the overall toxicity of the emissions need not have declined in tandem, especially because firms could reduce emissions of only a subset of the Program chemicals and could potentially substitute more toxic chemicals for less toxic ones. Therefore, in addition to analyzing aggregate emissions, we also analyze the impact of Program participation on toxicity weighted releases.

## 3. Methodology

We examine the incentives for participation in the 33/50 Program and the impact of the Program on emissions of the targeted chemicals for a sample of facilities whose parent firms committed to the Program. The EPA sent letters of invitation to the Chief Executive Officers of parent companies and not to individual facilities [7], and we assume that the decision to participate was first made by the parent firms and then extended to their facilities.

Our approach is motivated by the data made available to us by Hampshire Research. As Table II shows, our data include parent companies that committed to the Program and some but not all of their facilities also committed, and parent companies that committed but none of their facilities committed.[2] If none of the facilities committed but the parent company did commit, the decision to participate could not have been driven by the decision at the facility level and was probably made by the parent company. Assuming that all commitments were credible and made with the intention of meeting their stated goals, a company that joined the Program would have to reduce its emissions, even if none of its facilities specifically joined the Program. This would imply that when a parent firm committed to the Program, it automatically *jointly* committed all of its facilities to the Program. In this sense, all nine facilities belonging to Firm 2 in Table II are participants in the 33/50 Program, even though no individual facility made a specific commitment to join the Program. Thus, in the case where the parent company committed and none of the facilities committed, it does not make sense to model these facilities as non-participants while ignoring the firm decision. We prefer to consider these nine facilities as not having made any specific commitment over and above the firm's decision to participate in the Program. This distinguishes these facilities from Facility 2 and Facility 5 of Firm 1, both of which made a specific commitment to the EPA. Note that the EPA regarded both Firms 1 and 2

[2] There are no instances where a facility committed to the Program and a parent firm did not.

as participants and did not distinguish between them.

For this reason we assume that the decision to participate in the Program was made at the company level, and conditional on the parent firm's participation decision, individual facilities made additional commitments to reduce their emissions and participate in the Program. Therefore, our estimation strategy is threefold: we first model the firm's participation decision, and using data only on facilities that belong to firms that participated in the Program, we model the facility's participation decision. Finally, we evaluate the facility's emissions conditional on its participation decision. To test the sensitivity of our results we follow Bi and Khanna [5] and also model the facility participation decision independently of the firm's decision using the entire universe of facilities eligible to participate in the Program. In this case, the nine facilities belonging to Firm 1 in Table II are no different from facilities belonging to a parent firm that did not participate in the Program.

## 4. Empirical model

A facility's expected net benefit from participation in the Program, $Z_{1it}^{*}$, is given by

$$Z_{1it}^{*} = X_{1it}\beta_1 + \varepsilon_{1it,} \quad i = 1, \dots, I; \;\; t = 1, \dots, T \qquad (1)$$

where $X_{1it}$ is a vector of covariates, $\beta_1$ is a vector of coefficients, and $\varepsilon_{1it} \sim N(0,1)$. We do not observe $Z_{1it}^{*}$, only whether the facility participated or not. That is, we observe $Z_{1it}$, a dichotomous variable equal to 1 if the expected net benefit is positive and 0 otherwise. Furthermore, $Z_{1it}$ is only observed for a subset of facilities whose parent firms participated in the Program. That is $Z_{1it}$ is observed if and only if $Z_{2it}$ is equal to 1, where $Z_{2it}$ is a dichotomous variable equal to 1 if the parent firm's expected net benefit from participation is positive and 0 otherwise. The parent firm's expected net benefit, $Z_{2it}^{*}$, is given by

$$Z^*_{2it} = X_{2it}\beta_2 + \varepsilon_{2it,} \quad i = 1, \ldots, I; \;\; t = 1, \ldots, T \qquad (2)$$

where $X_{2it}$ is a vector of covariates, $\beta_2$ is a vector of coefficients, and $\varepsilon_{2it} \sim N(0,1)$. This leads to a bivariate probit model with sample selection.

We estimate $\beta_1$ and $\beta_2$ in Eqs. (1) and (2) simultaneously using maximum likelihood methods and assuming that $\varepsilon_{1it}$ and $\varepsilon_{2it}$ are distributed bivariate normal with means and standard deviations as specified above, and that $corr(\varepsilon_{1it}, \varepsilon_{2it}) = \rho$. If $\rho = 0$, the facilities are randomly selected to the sample and consistent estimates of $\beta_1$can be obtained by estimating model (1) with an ordinary probit regression. After estimation, a simple likelihood ratio test (or Wald test) can be used to test the null hypothesis that $\rho = 0$.

For the model to be identified there should be at least one right hand side variable that appears in the selection equation (Eq. 2) but does not appear in the outcome equation (Eq. 1). In our case the selection equation includes firm level variables. These are a final good dummy, change in aggregate 33/50 emissions prior to the start of the Program, ratio of HAPs to TRI emissions, ratio of 33/50 emissions to TRI emissions, number of Superfund sites for which a firm is a Potentially Responsible Party (PRP), number of inspections and enforcement actions against a parent firm's facilities, Sierra Club membership and the LCV score averaged across a firm's facilities, and firm specific factors such as age of assets and R&D expenditure. The first invitation group dummy is the only variable common to both equations.

Given that we have data on a panel of *I* facilities and firms over *T* years, we would like to use panel data methods to estimate Eq. (1). However, the corresponding panel data estimator is not available and we use a pooled cross section estimator but adjust standard errors for intra-panel correlation.[3]

[3] We estimated the model using the heckprob procedure in Stata 10 and adjusted the standard errors by clustering on

Facility emissions at time *t*, $Y_{it}$, are determined by a set of facility specific factors, $X_{3it}$, and the facility's participation decision, $P_{it}$, as

$$Y_{it} = X_{3it}\beta_3 + P_{it}\delta + \mu_i + v_{it} \quad (3)$$

where $\beta_3$ is a vector of coefficients, $\delta$ is a scalar coefficient, $\mu_i$ is a fixed effect and $v_{it} \sim N(0, \sigma^2)$. $X_3$ includes facility specific factors that determine its emissions in any year, such as its level of output, operational decisions and the organizational culture. Such detailed facility level information is not available in the public domain. Furthermore, changes in the level of output and adoption of new technology occur slowly over time and are generally unobserved. To account for such effects and the lack of detailed facility information we include the lagged values of facility emissions on the right hand side of equation (3). This leads to a dynamic specification for $Y_{it}$, as

$$Y_{it} = Y_{i,t-1}\alpha + X_{4it}\beta_4 + P_{it}\delta + \mu_i + v_{it} \quad (4)$$

where $X_4$ includes facility and parent firm specific factors for which information is available.

As facility emissions are determined by many of the same factors that affect facility participation in the Program, $P_{it}$ is endogenous in Eq. (4). We use the predicted probability of participation for each facility for each year from Eq. (1), $F(X_{it}\hat{\beta}_{1it})$, which is a cumulative distribution function, as an instrument for the facility's participation decision in Eq. (4).

Again, we would like to exploit the panel structure of the data. Applying the fixed effects estimator to Eq. (4) will result in a dynamic panel data bias as $Y_{it-1}$ is correlated with the error term. Arellano and Bond [1] suggest transforming the model by taking first differences to eliminate the fixed effects, and then estimating it using instrumental variable techniques where the second and higher lags of the endogenous variables in levels are used as instruments.

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parent firms. We thank Gustavo Sanchez of Stata Corp. for this suggestion.

However, lagged levels are often poor instruments for first differences. Arellano and Bover [2] and Blundell and Bond [6] show that this problem can be alleviated by estimating a system of equations which includes the original equation in levels and uses lagged differences as instruments. A secondary advantage of this system GMM estimator is that it can also accommodate models with time invariant regressors.

We apply system GMM to Eq. (4). The estimator rests on the strong assumption that lagged values of the dependent variable and changes in the error term are uncorrelated. Although first order autocorrelation is expected, we examine the validity of this assumption by testing for the presence of second order autocorrelation. We estimate robust standard errors using the two-step version of the system GMM estimator with a finite-sample correction [21].[4]

The rank and order conditions for identification of the parameters in Eq. (4) require that we have some variables in Eq. (1) that are hypothesized to influence facility participation but are otherwise uncorrelated with the facility emissions. We include three variables in Eq. (1) that are not in Eq. (4): first invitation group dummy, change in facility 33/50 emissions between 1988 and 1990, and the percentage of the parent firm's 33/50 releases emitted by a facility.

## 5. Data description

We draw upon several data sources. Hampshire Research provided us with the list of firms invited to participate in the 33/50 Program, their participation status, and information about when the firm was contacted by the EPA. For the firms that participated in the Program, they also provided us with a list of facilities and their participation status. We obtained data on emissions of the 33/50 chemicals, total TRI releases, HAP releases, names and Dun and

[4] We estimate equation (4) using xtabond2 in Stata 10 with twostep and robust options. For a discussion of xtabond2 see Roodman [16].

Bradstreet numbers of parent firms, and facility SIC codes and locations from the TRI (www.rtknet.org/new/tri). Information on the number of inspections and enforcement actions under the CAA is from the Integrated Data for Enforcement Analysis database (www.epa-echo.gov/echo/index.html); county nonattainment status with the CAA is from the EPA's Green Book (www.epa.gov/oar/oaqps/greenbk). LCV scores are from various National Environmental Scorecards published annually by the League of Conservative Voters (www.lcv.org). The Sierra Club provided us with the data on its state per capita membership while Election Data Services provided county level voter participation rates. Firm level financial data are from the Standard and Poor's Compustat database and the information on Superfund Site responsibility is from the CERCLIS database (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). County socio-economic data is from the 1990 Census.

We define facility emissions of the 33/50, HAP and TRI chemicals as annual releases to air, surface water, land, and underground injection plus offsite transfers to treatment, storage and disposal. Toxicity weighted 33/50 emissions are pounds of emissions multiplied by the toxicity weights used in the EPA's Risk Screening Environmental Indicators (http://www.epa.gov/oppt/rsei/). We weight the air releases of each of the 17 chemicals by their inhalation toxicities and the emissions to other media by oral toxicities. Firm emissions are the sum of the emissions for all facilities reporting to each parent company in each year. We define the change in the pre-Program 33/50 releases as the emissions in 1990 minus the emissions in 1988. We use total facility TRI emissions to capture facility size.

The state LCV score is an average of the rating assigned to the elected officials in the Senate and the House of Representatives by the LCV based on their voting record on environmental bills for each session of the Congress. A score of 100 indicates the strongest

commitment to environmental protection, while a score of 0 shows a consistent voting pattern against conservation and environmental health and safety protection. The county non-attainment status is the count of pollutants for which a whole or a part of the county has been designated by the EPA to be out of attainment with the NAAQS. The EPA will designate the county to be in nonattainment whenever air pollution levels persistently exceed the NAAQS for six pollutants: ozone, lead, carbon monoxide, sulfur dioxide, nitrogen dioxide and particulate matter. We define the firm level LCV score, per capita membership in Sierra Club, number of enforcements and inspections as the average across all plants owned by a parent firm.

We represent the propensity for collective action by the fraction of the voting age population registered to vote in the 1992 Presidential elections in a facility's home county.[5] Socio-economic and demographic characteristics of the county in which a facility is located include the fraction of African-American population, the percentage of population with at least a bachelor's degree, median household income, the percentage of population below poverty, and the percentage of children up to 5 years of age. Additional control variables include population per square mile and dummy variables for the facility 2 digit primary SIC codes.

To construct our sample we first searched the TRI to identify facilities that emitted a positive amount of 33/50 chemicals in 1988, 1989 or 1990. This resulted in 16,550 facilities in the continental United States. We successfully matched 13,734 facilities to their parent companies by either parent firm name or Dun and Bradstreet number.[6] Since we model facility participation conditional on the parent firm's decision, we use an unbalanced panel of 368 publicly owned firms represented in the Standard and Poor's Compustat database of which 197

[5] North Dakota and Wisconsin do not report voter registration. For these two states, we use the ratio of voter turnout to voting age population.

[6] According to the EPA 1294 parent companies participated in the 33/50 Program by 1994. We were able to identify 1224 participating parent firms. We were unable to find the remaining 70 firms in the 2008 version of TRI database.

firms participated in the Program and 171 did not participate over the period 1991 – 1995.[7] To evaluate facility emissions and participation in the Program, we use a subset of 2,034 facilities that belong to these 197 participating firms. Out of the 2,034 facilities, 126 participated and 1,908 did not participate in the Program. Most facilities in our sample reported to the TRI for at least three years between 1991 and 1995.

Tables III and IV summarize our data for 1990. On average, participating firms have higher aggregate and weighted 33/50 emissions as well as release intensity per unit of sales relative to non-participants. They have a larger number of facilities, face a larger number of inspections and enforcement actions and are a PRP for a greater number of Superfund sites. Compared to non-participants they also reduced emissions of the Program chemicals by a larger amount between 1988 and 1990 and a larger fraction was included in the first invitation group.

At the facility level, participating facilities have lower aggregate and toxicity weighted 33/50 emissions compared to non-participating facilities. Compared to non-participants, participants have higher total TRI emissions, face a larger number of inspections and enforcement actions and a larger number of them are located in counties that are in nonattainment with a greater number of pollutants, as well as counties characterized by higher median household income and lower percentage of African American population. 85% of the facilities in our sample are owned by firms invited to participate first; however, a larger percentage of these facilities are non-participants.

Comparing emissions in 1991 to 1995, we find that the 197 participating firms in our sample reduced their emissions of the 33/50 chemicals by 42.4% relative to 1991 compared to 43.6% by the non-participating firms. If we consider the entire universe of firms for which the EPA provided us with information (i.e., including non-publicly traded firms contacted by the

[7] Our sample starts in 1988 to allow for lags and differencing.

EPA, and firms located in Hawai'i, Alaska and Puerto Rico) the 1287 participating firms decreased their 33/50 releases by 41.8% compared to 30.4% by the 6143 non-participating firms. At the facility level we find that the 126 participating facilities in our sample that belonged to participating firms decreased their 33/50 releases by 46.3% compared to the 42.8% decline achieved by the 1908 non-participating facilities. This compares to the 52.3% reduction achieved by 1060 participating facilities and 39.5% reduction by 5751 non-participating facilities in the entire EPA dataset of participating firms. Given these statistics, it is possible that the sample of publicly owned firms and their facilities that we use in our benchmark analysis is not representative. For this reason, we also use a secondary and much larger sample of facilities for which the summary statistics on emissions reductions are much closer to the universe of firms and facilities for which the EPA provided us with information (see section 6.4 for details).

## 6. Results and discussion

### *6.1. Facility participation in the Program*

We first examine the incentives for facility participation in the 33/50 Program. We have a non-random sample of 2,034 facilities whose parent firms committed to the Program leading to 9,701 facility-year observations. The facility participation results obtained from simultaneously estimating Eqs. (1) and (2) by maximum likelihood are presented in Table V. We include on the right hand side aggregate 33/50 emissions in Model 1 and the toxicity weighted 33/50 emissions in Model 1W. All time varying variables are lagged by one year relative to the year in which a facility participation decision is measured.[8] We control for eight most representative industry groups based on two-digit SIC codes. Table A1 in the Appendix presents the results of the

[8] We assume that firms committed to the Program in the same year that they were invited.

selection equation on firm participation in the Program.[9]

In both models in Table V we find that facilities that account for a larger proportion of a parent firm's aggregate and toxicity weighted 33/50 emissions were more likely to participate. On the other hand, facilities with greater 33/50 emissions were less likely to participate while the level of toxicity weighted emissions does not seem to have a statistically significant impact on a facility's participation decision. The coefficient on the variable measuring the change in aggregate facility emissions between 1988 and 1990 is not statistically significant indicating that facility participation was not driven by reductions in emissions achieved prior to the start of the Program. In addition, we find weak evidence that larger facilities as measured by the aggregate TRI emissions were more likely to join the Program.

In terms of regulatory pressure, the coefficient on county nonattainment status is statistically significant and positive indicating that the Program attracted facilities located in counties in which a larger number of the regulated pollutants that were out of attainment with NAAQS. Surprisingly, the coefficient on Sierra Club membership is negative and statistically significant at the 10% level indicating that facilities located in states with greater membership rates in an environmental interest group were less likely to participate. Although there is evidence that facilities located in counties with young children and a lower fraction of African Americans were more likely to participate, community characteristics are generally not good predictors of facility participation in the Program.

While the largest, most polluting firms invited in the first wave of invitations were more likely to participate in the Program (Table A1), confirming the results of earlier studies of firm

[9] We have an unbalanced panel of 368 firms of which 197 participated and 171 did not participate in the Program. We find that a firm's participation probability is positively correlated with its R&D expenditures per unit of sales and with the age of its assets. Also, firms included in the EPA's first invitation group and firms in the chemical sector had a higher participation probability.

participation, [3, 13, 20], we find that facilities belonging to these companies were less likely to make additional commitments. The coefficients on the first invitation group dummy are negative and statistically significant in both models.

For both models in Table V, the null hypothesis that the error terms in the outcome and the selection equations are not correlated cannot be rejected at the 10% level of significance, although in model 1W the p-value is less than 13%. This lack of evidence against the null hypothesis at traditional levels of significance raises the question of whether we should model facility participation conditional on the parent firm's participation decision. Given the structure of our data, and as discussed earlier in the context of Table 2, we feel that it is inappropriate to model a facility's participation decision ignoring the parent firm's decision. Nonetheless, in section 6.3 we test the sensitivity of our results by examining the association between facility participation and facility emissions regardless of the parent firm's participation decision.

### *6.2. Facility 33/50 emissions*

To evaluate whether facility participation is associated with a decline in emissions we analyze facility emissions over the life of the Program (1991-1995). We take the natural logarithm of facility 33/50 emissions, toxicity weighted emissions and the TRI emissions. We lag the number of inspections and enforcement actions by one year relative to the year in which the dependent variable is measured. All other time varying variables are measured in the same year as the dependent variable. The results of system GMM estimates are presented in Table VI. In the Models 1-3 in Table VI, the dependent variable is the aggregate 33/50 emissions, while in the Models 1W-3W, the dependent variable is the toxicity weighted 33/50 emissions. In all models the Hansen's J and Sargan's statistics that test for overidentifying restrictions are not

statistically significant indicating that our instruments are valid from the perspective of these tests. We found the fifth and the sixth lags to be a valid set of instrument for the lagged 33/50 emissions. We use the predicted probability of participation from the models in Table V as an instrument for facility participation in the Program. All other variables act as their own instruments.[10] We include time dummies in all models.

In models 1 and 1W we presume that the number of enforcement actions or the number of inspections affect the emissions of the 33/50 chemicals only indirectly through Program participation and we do not include them on the right hand side. In models 2, 3, 2W and 3W, we relax this assumption and account for the possibility that facilities with a poor environmental record may reduce their emissions of the 33/50 chemicals to signal their environmental efforts.

The coefficient of most interest in Table VI is the coefficient on the Program participation variable. In all models, this coefficient is negative and statistically significant indicating that Program participation led to a decrease in both aggregate and toxicity weighted emissions for facilities that have made additional commitments beyond their parent firm's commitments. This is in contrast to Gamper-Rabindran [8] but similar to Bi and Khanna [5].

While all the models shown in Table VI pass the Hansen's J and Sargan tests, the crucial test for the second order autocorrelation cannot be rejected even at the 10% level of significance for the three models where the dependent variable is aggregate 33/50 emissions. This questions the validity of the results for the first three models in Table VI. To account for this, we add the second lag of the dependent variable to our original model. While the test for second order autocorrelation is not statistically significant when the dependent variable is toxicity weighted emissions, for consistency we add the second lag of the dependent variable to all models in Table

[10] Facility TRI releases and the ratio of HAPs-TRI could be correlated with the firm fixed effects in the error term, thus making them potentially endogenous. However, the GMM estimator we use is designed to address such correlation and we do not need any additional instruments for these variables.

VI. The results are presented in Tables VII and VIII. In models 1-3 in Table VII, the left hand side variable is aggregate 33/50 emissions while in models 1W-3W it is toxicity weighted 33/50 emissions. We treat the specification in Model 1 of Table VII as our benchmark model.

In all models in Table VII, the coefficient on the Program participation variable is not statistically significant indicating that participation in the Program did not have a strong effect on either the aggregate or toxicity weighted 33/50 emissions. Recall that in Table VI, the models for weighted 33/50 releases pass all the tests for instrument validity and the coefficient on Program participation is statistically significant in these models. Comparing the results for weighted releases in Tables VI and VII shows that coefficient on Program participation is sensitive to model specification and that the results should be interpreted with caution.

In Table VII, as in Table VI, we assume that a facility's TRI releases and the HAP to TRI release ratio are exogenously determined. However, HAPs were subject to regulation by the late 1990s and facilities that initiated reductions in HAPs would also reduce the 33/50 emissions even in the absence of the Program. So, in Table VIII we treat these two variables as being simultaneously determined with facility 33/50 emissions and therefore endogenous. We instrument for these two variables using their own second and higher lags. Similar to the results for our benchmark specification (model 1 in Table VII), the coefficient on Program participation though negative is not statistically significant in any models in Table VIII, not even when the dependent variable is toxicity weighted emissions (models 4W-6W). However, in all models in Table VIII, the coefficients on the year dummies are negative and statistically significant indicating that facilities reduced the emissions of the Program chemicals between 1991 and 1995 for reasons independent of the 33/50 Program and not directly accounted for in our model.

With respect to other variables (Tables VII and VIII), we find that larger facilities as

measured by the total TRI releases had higher aggregate and toxicity weighted 33/50 emissions. Positive and statistically significant coefficients on the county nonattainment status and HAP-TRI ratio indicate that facilities located in counties that were out of attainment with the CAA and facilities that emitted a larger percentage of HAPs among all TRI chemicals had higher 33/50 emissions. Facilities located in counties with higher median household income had lower aggregate and toxicity weighted emissions of the Program chemicals (Table VIII). On the other hand, the coefficients on the number of enforcements and the number of inspections are not statistically significant indicating that the anticipation of more stringent mandatory regulation did not have an effect on emissions of the 33/50 Program chemicals.

### *6.3. Sensitivity analysis*

Unlike our analysis that focuses on facilities that specifically committed to reduce emissions in addition to the goals stated by their parent firms, Bi and Khanna [5] study participation in the Program and its impact on the releases of Program chemicals for all facilities eligible to participate, regardless of their parent firms' decision. By assuming that the decision to participate in the Program was made at the facility level, they are able to utilize a much larger sample of facilities, including facilities owned by firms that are not publicly traded as well as facilities that belonged to firms that did not commit to the Program.

To examine the sensitivity of our results, we explore the possibility that the participation decision was made by facilities independently of parent firms. We use an unbalanced panel of 8,583 facilities eligible to participate in the Program over the period 1991 – 1995. Among these facilities there are 792 participants and 7,791 non-participants. For this sample, participating facilities reduced their emissions by 50.9% between 1991 and 1995 compared to 38.6% by the non-participating facilities. We estimate the same models from Tables VI, VII and VIII by

system GMM using this larger sample of facilities, and ignoring the firm's participation decision.

We estimate facility participation in the Program using a random effect probit model with firms as cross sections. The results, shown in Table IX, are very similar to our benchmark results reported in Table V. The main differences are that we now find some evidence to suggest that facilities whose parent firms were invited first may have been more likely to participate (model 1) and the facilities that reduced 33/50 emissions in pre-Program years were more likely to join the Program. Facilities located in states with higher LCV scores, facilities located in counties that were out of attainment with CAA, and facilities located in counties with lower median income as well as lower percentage of population below poverty were also more likely to participate. We also find that facilities located in more densely populated counties, with a more educated population and higher voter participation rates were more likely to join the Program.

Tables X and XI show the results for aggregate and toxicity weighted facility emissions of the 33/50 chemicals, respectively. All models include the second lag of the dependent variable on the right hand side to account for the second order autocorrelation. We find that the coefficient on facility participation in the Program is not statistically significant in any of the models in Tables X and XI.

To assess how our results compare with Bi and Khanna [5], we follow their approach and estimate the model of facility participation in the Program using a pooled probit and facility emissions using a two step feasible GMM estimator.[11] Regardless of how they instrument for participation decision, Bi and Khanna find that the coefficient on Program participation is negative and statistically significant. However, for our data, the coefficient on Program participation is positive and statistically significant at the 10% level indicating that facilities that

[11] To be consistent with Bi and Khanna we include only one lag of facility emissions on the right hand side of the emission equation. Also, we follow their estimation procedure and use ivreg2 in Stata 10.

participated in the Program may have increased rather than decreased emissions. For all other variable coefficients we obtain qualitatively identical signs and significance. The only exceptions are the coefficients on time dummies for which, unlike Bi and Khanna [5], we obtain statistically significant and negative coefficients. These results are not shown here but are available from the authors upon request.

Finally, we also estimate the models in Tables V, VI, VII and VIII using firms invited in the first two invitation waves in 1991. The first invitation wave included the 'top 600' most polluting firms and the second invitation wave included all firms that reported positive emissions of any of the 17 targeted chemicals in 1988, 1989 or 1990. Innes and Sam [12] have argued that for this set of firms, participation in the 33/50 Program was associated with a statistically significant decline in emissions. The overwhelming majority of the firms in our benchmark sample were invited in 1991: we lose only 37 facilities when we restrict ourselves to this smaller sample of participating firms. Therefore, it is not surprising that our qualitative results are the same as those reported in Tables V-VIII. These results are also available from the authors.

## 7. Conclusion

We examine the incentives for facility participation in the 33/50 Program and analyze the impact of participation on facility level aggregate and toxicity weighted emissions over the Program years, 1991-1995. Unlike others, we study the success of the Program at the facility level using a sample of facilities that made commitments in addition to the overall commitments made by their parent firms. These facilities communicated their participation decisions to the EPA and thus identified themselves as the source of the potential emissions reduction to be achieved by their parent firms under the Program. Therefore, these facilities had an even greater

incentive to meet their stated goals and could not free ride on the efforts of other facilities belonging to the same parent firm. So, if the 33/50 Program was successful in decreasing the emissions of the 17 targeted chemicals, we are likely to find evidence for this in our sample.

Our analysis shows that most polluting facilities within a firm but not the most polluting among all facilities across firms were more likely to join the Program. Unlike the literature on firm participation, we do not find that a facility's decision to participate was driven by the incentive to preempt special interest groups from lobbying for tighter environmental regulation and enforcement or to avoid later and more expensive penalties under mandatory regulation. Thus, it seems that firms and facilities have different motives for joining voluntary programs.

More importantly, we find that participation in the Program did not have a direct effect on facility emissions between 1991 and 1995, and that facilities may have reduced the emissions of the Program chemicals for other reasons not directly accounted for in our model.

The currently published literature on the 33/50 Program, including our own earlier work, analyzes the success of this voluntary pollution abatement program using firm level data on participation and emissions. Two factors complicate a firm level analysis and lead to possible aggregation biases. First, the EPA considered a parent firm as a participant even if only one of its facilities participated in the Program. Second, while the emissions abatement under the Program was executed by individual facilities, the EPA credited the decline in emissions to the parent firm. The facilities that we classify as participants are facilities that made commitments to the EPA and presumably were confident that they could bring about the necessary changes in production to meet their environmental goals. That our results suggest that the observed reduction in facility emissions was not correlated with facility participation unambiguously questions the success of the 33/50 Program.

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**Table I: Review of published studies: Firm participation in the 33/50 Program**

| Hypotheses tested and expected sign on coefficients | Arora & Cason (1996) | Khanna & Damon (1999) | Videras & Alberini (2000) | Vidovic & Khanna (2007) | Innes & Sam (2008) | Sam *et al.* (2009) |
|---|---|---|---|---|---|---|
| ***Green marketing*** | | | | | | |
| Final good (+) | | (+)** | (-) | (+) | (+) | (+) |
| Advertising expenditure (+) | (+)*** | | | (+)*** | | |
| ***Regulatory pressure*** | | | | | | |
| Number of Superfund sites (+) | | (+)* | (+)** | (+)*** | (+)* | |
| HAP-33/50 ratio (+) | | (+)* | | (-) | | |
| RCRA corrective action (+) | | | (+)*** | | | |
| Enforcements (+) | | | | | (+)* | (+)** |
| Inspections (+) | | | | | (+)** | (+)** |
| Strict liability statute (+) | | | | | (-) | (-) |
| ***Interest group pressure*** | | | | | | |
| Sierra Club (+) | | | | | (+) | (+)*** |
| Boycott deterrence (+) | | | | | (+)* | |
| ***Firm specific factors*** | | | | | | |
| Number of facilities (+) | (-) | (+) | | (+)*** | | (+)* |
| Employment (+) | (+)*** | | (+)** | | (+)* | |
| Age of assets (-) | | (-)* | | (-)*** | | (-) |
| R&D expenditure (+) | (+)*** | (-) | (-)* | (-)* | (+)* | (+)** |
| Herfindahl index | (-) | | | | (+) | (+) |
| CMA (+) | | (+)*** | | | | |
| Green Lights (+) | (+)*** | | | | | |
| 33/50 releases (+) | (+) | (+)* | | (+)* | (+)* | (+) |
| 33/50 releases/sales (+/-) | (+) | (+)* | | (-) | | |
| 33/50-TRI release ratio (-) | | (-)* | | (-)** | | |
| Change in 33/50 releases, 1990-88 (+) | (-) | (+) | | (-)*** | (+)* | (+) |
| First invitation group (+) | (+)*** | (+)*** | | (+)*** | | |
| Period under study | 1991-94 | 1991-93 | 1993-95 | 1991-95 | 1991-95 | 1991-95 |
| Number of firms | 6,265 | 246 | 218 | 365 | 319 | 107 |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Arora and Cason (1999) include public and private firms while all other studies include only public firms also represented in the Compustat database. They also use industry level information to capture the influence of firm specific factors. Khanna and Damon (1999) include firms in the chemical sector only. The table shows variables associated with the main hypotheses tested in the surveyed studies. For a complete list of variables refer to each study.

**Table II: An example of firm and facility commitment to the Program**

| Facility Name | Facility Status | Parent Firm Name | Parent firm Status |
|---|---|---|---|
| Facility 1 | | Firm 1 | Committed |
| Facility 2 | Committed | Firm 1 | Committed |
| Facility 3 | | Firm 1 | Committed |
| Facility 4 | | Firm 1 | Committed |
| Facility 5 | Committed | Firm 1 | Committed |
| Facility 6 | | Firm 1 | Committed |
| Facility 7 | | Firm 1 | Committed |
| Facility 8 | | Firm 1 | Committed |
| Facility 1 | | Firm 2 | Committed |
| Facility 2 | | Firm 2 | Committed |
| Facility 3 | | Firm 2 | Committed |
| Facility 4 | | Firm 2 | Committed |
| Facility 5 | | Firm 2 | Committed |
| Facility 6 | | Firm 2 | Committed |
| Facility 7 | | Firm 2 | Committed |
| Facility 8 | | Firm 2 | Committed |
| Facility 9 | | Firm 2 | Committed |

*Source*: This example is based on the data provided by Hampshire Research.

**Table III: Descriptive statistics (1990): Firm level means and standard deviations (in parentheses)**

| Variable | All firms | Participants | Non-participants |
|---|---|---|---|
| Final good [a] | 32.07 | 30.96 | 33.33 |
| R&D/sales | 0.02 (0.03) | 0.03 (0.03) | 0.02 (0.043) |
| Newness of assets | 0.77 (0.97) | 0.76 (0.10) | 0.79 (0.88) |
| 33/50 releases/sales (lbs/million $) | 734.7 (15935.7) | 810.3 (18725.0) | 650.0 (1209.1) |
| Weighted 33/50 releases/sales | 291854.9 (1739433) | 319762.9 (1917629) | 260644.1 (1520699) |
| 33/50 releases (millions lbs) | 1.28 (3.69) | 2.13 (4.87) | 0.29 (0.63) |
| Weighted 33/50 releases (millions) | 410.39 (1538.29) | 698.46 (2032.71) | 78.53 (379.98) |
| Prior change in 33/50 releases (millions lbs) | -0.37 (1.168) | -0.66 (1.50) | -0.04 (0.29) |
| 33/50 -TRI release ratio | 0.51 (0.36) | 0.48 (0.38) | 0.55 (0.34) |
| HAP-TRI release ratio | 0.62 (0.28) | 0.61 (0.26) | 0.64 (0.31) |
| Number of facilities | 11.36 (15.26) | 15.52 (18.15) | 6.44 (8.79) |
| Number of Superfund sites | 4.03 (7.76) | 6.67 (9.72) | 0.99 (1.92) |
| Number of inspections | 3.16 (6.49) | 4.80 (7.99) | 1.27 (3.26) |
| Number of enforcement actions | 2.82 (6.25) | 4.30 (7.63) | 1.13 (3.43) |
| State per capita Sierra club membership | 0.23 (0.12) | 0.22 (0.09) | 0.24 (0.14) |
| State LCV score | 59.26 (10.17) | 58.81 (9.24) | 59.78 (11.16) |
| First invitation group [a] | 41.30 | 65.98 | 12.87 |
| SIC 26: Paper [a] | 3.26 | 4.06 | 2.34 |
| SIC 28: Chemical [a] | 18.21 | 25.88 | 9.36 |
| SIC 29: Petroleum and coal [a] | 3.53 | 6.09 | 0.58 |
| SIC 30: Rubber [a] | 2.44 | 3.55 | 1.17 |
| SIC 33: Primary metal [a] | 6.52 | 7.61 | 5.26 |
| SIC 34: Fabricated metal [a] | 7.07 | 4.57 | 9.94 |
| SIC 35: Machinery and computer [a] | 14.40 | 11.67 | 17.54 |
| SIC 36: Electronics [a] | 13.32 | 14.21 | 12.28 |
| SIC 37: Transportation [a] | 8.97 | 8.63 | 9.36 |
| SIC 38: Instruments [a] | 8.15 | 5.07 | 11.69 |
| All other SIC codes [a] | 14.13 | 8.66 | 20.48 |
| Number of firms | 368 | 197 | 171 |

*Note:* [a] This is a dummy variable for which the percentage of firms in each category is reported.

**Table IV: Descriptive statistics (1990): Facility level means and standard deviations (in parentheses)**

| Variable | All facilities | Participants | Non-participants |
|---|---|---|---|
| 33/50 releases (millions lbs) | 0.19 (0.67) | 0.17 (0.35) | 0.19 (0.69) |
| Weighted 33/50 releases (millions) | 0.58 (0.04) | 0.01 (0.04) | 0.53 (0.04) |
| TRI releases (millions lbs) | 0.73 (4.51) | 0.99 (5.38) | 0.71 (4.44) |
| Ratio of facility to firm 33/50 releases | 8.98 (18.86) | 33.77 (39.28) | 7.34 (15.32) |
| Ratio of facility to firm weighted 33/50 releases | 0.09 (0.21) | 0.32 (0.39) | 0.07 (0.19) |
| HAP-TRI release ratio | 62.20 (35.22) | 64.54 (33.24) | 62.05 (35.35) |
| Number of inspections | 0.38 (0.99) | 0.41 (1.10) | 0.38 (0.98) |
| Number of enforcement actions | 0.34 (0.98) | 0.39 (1.13) | 0.34 (0.97) |
| State LCV score | 49.22 (17.09) | 51. 52 (16.44) | 49.12(17.15) |
| County non-attainment status | 1.13 (1.21) | 1.44 (1.34) | 1.11 (1.19) |
| State per capita Sierra club membership | 0.19 (0.14) | 0.21(0.15) | 0.19 (0.14) |
| Median household income (1990$) | 30167.11 (6950.99) | 31400.63 (6557.21) | 30085.65 (6970.16) |
| % bachelor degree or higher | 12.24 (4.60) | 12.85 (4.36) | 12.20 (4.62) |
| % age less than 5 | 8.77 (0.93) | 8.80 (0.92) | 8.77 (0.93) |
| % African American | 11.66 (12.19) | 8.53 (9.17) | 11.87 (12.35) |
| % below poverty | 12.62 (5.15) | 11.24 (4.04) | 12.71 (5.20) |
| Population per square mile | 956.58 (1637.63) | 993.56(1252.41) | 954.15 (1660.16) |
| County voter participation rate | 0.74 (0.11) | 0.73(0.11) | 0.74 (0.11) |
| First invitation group [a] | 85.44 | 51.58 | 87.68 |
| SIC 26: Paper [a] | 3.49 | 1.58 | 3.61 |
| SIC 28: Chemical [a] | 25.96 | 24.60 | 26.05 |
| SIC 30: Rubber [a] | 6.44 | 4.76 | 6.55 |
| SIC 33: Primary metal [a] | 7.12 | 19.84 | 6.29 |
| SIC 34: Fabricated metal [a] | 8.85 | 13.49 | 8.54 |
| SIC 35: Machinery and computer [a] | 9.88 | 7.93 | 10.01 |
| SIC 36: Electronics [a] | 12.09 | 12.69 | 12.05 |
| SIC 37: Transportation [a] | 12.39 | 7.14 | 12.74 |
| All other SIC codes [a] | 13.78 | 7.97 | 14.16 |
| Number of facilities | 2,034 | 126 | 1,908 |

*Note:* [a] This is a dummy variable for which the percentage of facilities in each category is reported.

**Table V: Determinants of facility participation in the Program, 1991-1995**

| Variable | Model 1 | Model 1W |
|---|---|---|
| First invitation group | -0.647* | -0.710** |
| | (0.333) | (0. 153) |
| Facility 33/50 emissions | -5.2E-07*** | - |
| | (1.4E-07) | - |
| Weighted facility 33/50 emissions | - | -7.1E-11 |
| | - | (2.0E-10) |
| Ratio of facility to parent firm 33/50 releases | 0.018*** | - |
| | (0.003) | - |
| Ratio of weighted facility to parent firm 33/50 releases | - | 1.029*** |
| | - | (0.240) |
| Pre-Program change in 33/50 releases | 4.7E-08 | -7.1E-08 |
| | (1.3E-07) | (9.0E-08) |
| TRI releases | 0.040* | 0.035* |
| | (0.022) | (0.021) |
| HAP-TRI ratio | 0.001 | 0.001 |
| | (0.001) | (0.001) |
| Number of inspections | -0.016 | -0.002 |
| | (0.040) | (0.038) |
| Number of enforcement actions | 1.5E-04 | -0.015 |
| | (0.041) | (0.041) |
| State LCV score | 0.001 | 0.002 |
| | (0.003) | (0.003) |
| County non-attainment status | 0.159*** | 0.156*** |
| | (0.057) | (0.054) |
| Sierra Club membership | -0.836* | -0.777* |
| | (0.489) | (0.456) |
| Median household income | -1.3E-05 | -1.2E-05 |
| | (1.9E-05) | (1.9E-05) |
| % bachelor degree or higher | 0.009 | 0.008 |
| | (0.020) | (0.019) |
| % age less than 5 | 0.113** | 0.096** |
| | (0.046) | (0.047) |
| % African American | -0.015* | -0.014* |
| | (0.009) | (0.008) |
| % below poverty | -0.021 | -0.021 |
| | (0.027) | (0.026) |
| Population per square mile | 2.0E-05 | 1.5E-05 |
| | (3.0E-05) | (2.6E-05) |
| Voter participation rate | -1.055 | -0.916 |
| | (0.654) | (0.645) |

| | | |
|---|---|---|
| SIC 26: Paper | 0.360 | 0.245 |
| | (0.451) | (0.419) |
| SIC 28: Chemical | 0.513 | 0.420 |
| | (0.316) | (0.303) |
| SIC 30: Rubber | 0.438 | 0.305 |
| | (0.273) | (0.253) |
| SIC 33: Primary metal | 1.279*** | 1.147*** |
| | (0.383) | (0.378) |
| SIC 34: Fabricated metal | 0.676** | 0.606** |
| | (0.285) | (0.278) |
| SIC 35: Machinery and computer | 0.406 | 0.359 |
| | (0.276) | (0.268) |
| SIC 36: Electronics | 0.475* | 0.463* |
| | (0.281) | (0.263) |
| SIC 37: Transportation | 0.579** | 0.425 |
| | (0.293) | (0.288) |
| Constant | -1.973** | -1.792** |
| | (0.954) | (0.889) |
| | | |
| Wald statistic (H0: $\rho$=0) | 0.98 | 2.32 |
| Wald test p – value | 0.322 | 0.128 |
| Number of observations | 12,462 | 12,462 |
| Censored observations | 2,761 | 2,761 |
| Uncensored observations | 9,701 | 9,701 |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard errors clustered on firms are in parentheses.

**Table VI: Determinants of facility 33/50 emissions, 1991 – 1995**

| Variable | Model 1 | Model 2 | Model 3 | Model 1W | Model 2W | Model 3W |
|---|---|---|---|---|---|---|
| 33/50 releases$_{(t-1)}$ | 0.758*** | 0.755*** | 0.758*** | - | - | - |
| | (0.107) | (0.107) | (0.107) | - | - | - |
| Weighted 33/50 releases$_{(t-1)}$ | - | - | - | 0.889*** | 0.885*** | 0.887*** |
| | - | - | - | (0.079) | (0.078) | (0.078) |
| TRI releases | 0.408*** | 0.414*** | 0.412*** | 0.376*** | 0.383*** | 0.382*** |
| | (0.065) | (0.064) | (0.064) | (0.052) | (0.051) | (0.051) |
| HAP-TRI ratio | 0.011*** | 0.011*** | 0.011*** | 0.007*** | 0.007*** | 0.007*** |
| | (0.002) | (0.002) | (0.002) | (0.001) | (0.001) | (0.001) |
| Number of enforcements | - | -0.060** | - | - | -0.074** | - |
| | - | (0.024) | - | - | (0.037) | - |
| Number of inspections | - | - | -0.054** | - | - | -0.070** |
| | - | - | (0.022) | - | - | (0.032 |
| Program participation | -1.066*** | -1.055*** | -1.056*** | -2.520*** | -2.498*** | -2.498*** |
| | (0.361) | (0.359) | (0.359) | (0.727) | (0.723) | (0.723) |
| State LCV score | 0.002 | 0.002 | 0.002 | 0.005** | 0.005** | 0.005** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| County nonattainment status | 0.104*** | 0.111*** | 0.109*** | 0.164*** | 0.174*** | 0.171*** |
| | (0.028) | (0.028) | (0.028) | (0.046) | (0.046) | (0.046) |
| Sierra Club membership | -0.603* | -0.634** | -0.639** | -1.148** | -1.188** | -1.196** |
| | (0.319) | (0.318) | (0.318) | (0.472) | (0.471) | (0.472) |
| Median household income | -2.2E-05** | -2.1E-05** | -2.1E-05** | -2.3E-05 | -2.3E-05 | -2.2E-05 |
| | (1.1E-05) | (1.1E-05) | (1.1E-05) | (1.4E-05) | (1.4E-05) | (1.4E-05) |
| % bachelor degree or higher | 0.003 | 0.002 | 0.001 | -0.004 | -0.006 | -0.006 |
| | (0.011) | (0.011) | (0.011) | (0.013) | (0.013) | (0.013) |
| % age less than 5 | 0.035 | 0.037 | 0.037 | 0.041 | 0.043 | 0.043 |
| | (0.030) | (0.030) | (0.030) | (0.046) | (0.046) | (0.046) |
| % African American | -0.008* | -0.008* | -0.007* | -0.010** | -0.009** | -0.009** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| % below poverty | -0.016 | -0.016 | -0.015 | -0.015 | -0.016 | -0.015 |
| | (0.011) | (0.011) | (0.011) | (0.014) | (0.014) | (0.014) |
| Population per square mile | 1.2E-05 | 1.1E-05 | 1.0E-05 | 3.3E-06 | 1.7E-06 | 1.4E-06 |
| | (2.1E-05) | (2.1E-05) | (2.1E-05) | (2.9E-05) | (2.9E-05) | (2.9E-05) |
| Voter participation rate | -0.169 | -0.120 | -0.134 | -0.446 | -0.387 | -0.397 |
| | (0.297) | (0.295) | (0.293) | (0.377) | (0.376) | (0.374) |
| Year 1991 | -0.315*** | -0.317*** | -0.318*** | -0.431*** | -0.435*** | -0.437*** |
| | (0.101) | (0.101) | (0.101) | (0.154) | (0.154) | (0.154) |
| Year 1992 | -0.206* | -0.205* | -0.205* | -0.067 | -0.066 | -0.068 |
| | (0.106) | (0.106) | (0.106) | (0.155) | (0.155) | (0.155) |
| Year 1993 | -0.267** | -0.266** | -0.265** | -0.077 | -0.077 | -0.077 |
| | (0.119) | (0.119) | (0.119) | (0.171) | (0.171) | (0.171) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Year 1994 | -0.213 | -0.210 | -0.209 | 0.030 | 0.034 | 0.032 |
| | (0.174) | (0.174) | (0.174) | (0.193) | (0.193) | (0.192) |
| Year 1995 | -0.230 | -0.225 | -0.223 | -0.023 | -0.016 | -0.016 |
| | (0.184) | (0.184) | (0.185) | (0.206) | (0.207) | (0.207) |
| SIC 26: Paper | -0.987*** | -0.939*** | -0.947*** | -1.267*** | -1.209*** | -1.215*** |
| | (0.295) | (0.296) | (0.294) | (0.345) | (0.354) | (0.351) |
| SIC 28: Chemical | -0.373*** | -0.391*** | -0.385*** | -0.452** | -0.476** | -0.469** |
| | (0.141) | (0.140) | (0.140) | (0.193) | (0.191) | (0.191) |
| SIC 30: Rubber | -0.192 | -0.213 | -0.208 | -0.386 | -0.420 | -0.412 |
| | (0.220) | (0.220) | (0.219) | (0.321) | (0.318) | (0.317) |
| SIC 33: Primary metal | 0.099 | 0.099 | 0.101 | 0.502* | 0.508* | 0.509* |
| | (0.169) | (0.170) | (0.170) | (0.303) | (0.305) | (0.304) |
| SIC 34: Fabricated metal | 0.005 | -0.014 | -0.011 | 0.267 | 0.242 | 0.243 |
| | (0.284) | (0.286) | (0.284) | (0.321) | (0.321) | (0.320) |
| SIC 35: Machinery and | 0.224* | 0.213* | 0.213* | 0.367** | 0.353** | 0.352** |
| computer | (0.128) | (0.129) | (0.129) | (0.164) | (0.164) | (0.164) |
| SIC 36: Electronics | -0.074 | -0.090 | -0.088 | -0.039 | -0.063 | -0.061 |
| | (0.130) | (0.131) | (0.131) | (0.198) | (0.198) | (0.198) |
| SIC 37: Transportation | 0.171 | 0.164 | 0.161 | 0.114 | 0.103 | 0.100 |
| | (0.146) | (0.147) | (0.147) | (0.219) | (0.219) | (0.219) |
| Constant | -2.356*** | -2.399*** | -2.405*** | -2.460** | -2.491** | -2.500** |
| | (0.601) | (0.603) | (0.603) | (1.043) | (1.045) | (1.046) |
| Observations | 11,336 | 11,336 | 11,336 | 11,336 | 11,336 | 11,336 |
| AR(1) - p value | 0.000*** | 0.000*** | 0.000*** | 0.000*** | 0.000*** | 0.000*** |
| AR(2) - p value | 0.075* | 0.076* | 0.076* | 0.314 | 0.321 | 0.318 |
| Sargan test – p value | 0.747 | 0.758 | 0.762 | 0.320 | 0.332 | 0.329 |
| Hansen J test – p value | 0.786 | 0.793 | 0.796 | 0.402 | 0.413 | 0.411 |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard error clustered on firms with Windemeijer's finite sample correction are in parentheses. In Models 1-3, the dependent variable is aggregate 33/50 emissions. In Models 1W-3W, the dependent variable is toxicity weighted 33/50 emissions.

**Table VII: Determinants of facility 33/50 emissions, 1991 – 1995**

| Variable | Model 1 | Model 2 | Model 3 | Model 1W | Model 2W | Model 3W |
|---|---|---|---|---|---|---|
| 33/50 releases$_{(t-1)}$ | 0.118 | 0.133 | 0.148 | - | - | - |
| | (1.256) | (1.279) | (1.321) | - | - | - |
| 33/50 releases$_{(t-2)}$ | 0.449 | 0.436 | 0.426 | - | - | - |
| | (0.891) | (0.909) | (0.938) | - | - | - |
| Weighted 33/50 releases$_{(t-1)}$ | - | - | - | -0.872 | -0.855 | -0.857 |
| | - | - | - | (2.145) | (2.137) | (2.142) |
| Weighted releases$_{(t-2)}$ | - | - | - | 1.479 | 1.464 | 1.466 |
| | - | - | - | (1.858 | (1.852) | (1.856) |
| TRI releases | 0.522** | 0.523** | 0.519** | 0.560*** | 0.562*** | 0.561*** |
| | (0.221) | (0.222) | (0.229) | (0.196) | (0.192) | (0.193) |
| HAP-TRI ratio | 0.014*** | 0.014** | 0.013** | 0.009*** | 0.009*** | 0.009*** |
| | (0.005) | (0.005) | (0.005) | (0.003) | (0.003) | (0.003) |
| Number of enforcements | - | -0.041 | - | - | -0.043 | - |
| | - | (0.043) | - | - | (0.049) | - |
| Number of inspections | - | - | -0.034 | - | - | -0.039 |
| | - | - | (0.048 | - | - | (0.046) |
| Program participation | -0.585 | -0.590 | -0.599 | 0.715 | 0.698 | 0.704 |
| | (0.995) | (1.005) | (1.031 | (3.834) | (3.809) | (3.814) |
| State LCV score | 0.001 | 0.001 | 0.001 | -0.002 | -0.002 | -0.002 |
| | (0.003) | (0.003) | (0.003 | (0.009) | (0.009) | (0.009) |
| County nonattainment status | 0.104*** | 0.109*** | 0.107*** | 0.176*** | 0.181** | 0.179** |
| | (0.034) | (0.034) | (0.034) | (0.081) | (0.081) | (0.080) |
| Sierra Club membership | -0.913 | -0.927 | -0.920 | -2.095 | -2.108 | -2.112 |
| | (0.743) | (0.734) | (0.743) | (1.557) | (1.534) | (1.536) |
| Median household income | -2.8E-05 | -2.8E-05 | -2.8E-05 | -3.3E-05 | -3.2E-05 | -3.2E-05 |
| | (1.8E-05) | (1.8E-05) | (1.9E-05) | (2.7E-05) | (2.7E-05) | (2.7E-05) |
| % bachelor degree or higher | 0.002 | 0.001 | 0.001 | -0.034 | -0.035 | -0.035 |
| | (0.013) | (0.013) | (0.013) | (0.040) | (0.040) | (0.040) |
| % age less than 5 | 0.048 | 0.049 | 0.048 | 0.038 | 0.039 | 0.039 |
| | (0.052) | (0.052) | (0.052) | (0.082) | (0.081) | (0.081) |
| % African American | -0.009 | -0.009 | -0.008 | -0.011 | -0.010 | -0.010 |
| | (0.006) | (0.006) | (0.006) | (0.009) | (0.009) | (0.009) |
| % below poverty | -0.021 | -0.021 | -0.021 | -0.017 | -0.017 | -0.017 |
| | (0.018) | (0.019) | (0.019) | (0.028) | (0.028) | (0.028) |
| Population per square mile | 2.1E-05 | 2.0E-05 | 1.9E-05 | 4.6E-05 | 4.4E-05 | 4.4E-05 |
| | (3.4E-05) | (3.5E-05) | (3.6E-05) | (8.3E-05) | (8.3E-05) | (8.4E-05) |
| Voter participation rate | -0.044 | -0.016 | -0.031 | 0.057 | 0.087 | 0.080 |
| | (0.552) | (0.529) | (0.534) | (0.874) | (0.856) | (0.861) |
| Year 1991 | -0.542 | -0.538 | -0.533 | -1.702 | -1.691 | -1.693 |
| | (0.433) | (0.441) | (0.454) | (1.570) | (1.563) | (1.566) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Year 1992 | -0.706 | -0.692 | -0.682 | -2.484 | -2.458 | -2.463 |
| | (0.980) | (0.999) | (1.031) | (3.004) | (2.995) | (3.001) |
| Year 1993 | -0.731 | -0.719 | -0.709 | -2.022 | -2.003 | -2.006 |
| | (0.871) | (0.888) | (0.918) | (2.329) | (2.320) | (2.325) |
| Year 1994 | -0.816 | -0.799 | -0.786 | -2.081 | -2.058 | -2.062 |
| | (1.157) | (1.181) | (1.219) | (2.525) | (2.518) | (2.523) |
| Year 1995 | -0.818 | -0.800 | -0.787 | -2.079 | -2.054 | -2.058 |
| | (1.101) | (1.124) | (1.162) | (2.448) | (2.442) | (2.447) |
| SIC 26: Paper | -1.100** | -1.062** | -1.068** | -2.103* | -2.057* | -2.063* |
| | (0.459) | (0.472) | (0.475) | (1.141) | (1.165) | (1.163) |
| SIC 28: Chemical | -0.511 | -0.520 | -0.511 | -1.019 | -1.027 | -1.023 |
| | (0.338) | (0.333) | (0.342) | (0.737) | (0.725) | (0.730) |
| SIC 30: Rubber | -0.477 | -0.484 | -0.474 | -1.640 | -1.646 | -1.642 |
| | (0.595) | (0.590) | (0.601) | (1.424) | (1.405) | (1.412) |
| SIC 33: Primary metal | 0.046 | 0.047 | 0.050 | 0.736 | 0.738 | 0.737 |
| | (0.229) | (0.230) | (0.231) | (0.539) | (0.537) | (0.537) |
| SIC 34: Fabricated metal | -0.243 | -0.249 | -0.240 | -0.198 | -0.206 | -0.205 |
| | (0.596) | (0.594) | (0.602) | (0.952) | (0.941) | (0.943) |
| SIC 35: Machinery and | 0.170 | 0.164 | 0.166 | 0.489 | 0.479 | 0.479 |
| computer | (0.199) | (0.197) | (0.197) | (0.338) | (0.341) | (0.340) |
| SIC 36: Electronics | -0.231 | -0.238 | -0.231 | -0.640 | -0.646 | -0.644 |
| | (0.394) | (0.391) | (0.399) | (0.949) | (0.937) | (0.940) |
| SIC 37: Transportation | 0.338 | 0.330 | 0.326 | 0.405 | 0.397 | 0.396 |
| | (0.365) | (0.373) | (0.384) | (0.531) | (0.531) | (0.533) |
| Constant | -1.539 | -1.588 | -1.603 | 0.916 | 0.860 | 0.860 |
| | (1.520) | (1.567) | (1.617) | (4.086) | (4.088) | (4.102) |
| Observations | 11,233 | 11,233 | 11,233 | 11,233 | 11,233 | 11,233 |
| AR(1) - p value | 0.907 | 0.906 | 0.907 | 0.028** | 0.021** | 0.022** |
| AR(2) - p value | 0.700 | 0.714 | 0.730 | 0.496 | 0.499 | 0.499 |
| Sargan test – p value | 0.746 | 0.747 | 0.743 | 0.799 | 0.794 | 0.790 |
| Hansen J test – p value | 0.851 | 0.847 | 0.844 | 0.848 | 0.844 | 0.842 |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard errors clustered on firms with Windemeijer's finite sample correction are in parentheses. In models 1-3 the dependent variable is aggregate 33/50 emissions, while in models 1W-3W the dependent variable is toxicity weighted 33/50 emissions. We regard Model 1 in this Table as our benchmark model.

**Table VIII: Determinants of facility 33/50 emissions, 1991 – 1995**

| Variable | Model 4 | Model 5 | Model 6 | Model 4W | Model 5W | Model 6W |
|---|---|---|---|---|---|---|
| 33/50 releases$_{(t-1)}$ | 0.663*** | 0.663*** | 0.663*** | - | - | - |
| | (0.140) | (0.140) | (0.140) | - | - | - |
| 33/50 releases$_{(t-2)}$ | 0.060 | 0.060 | 0.059 | - | - | - |
| | (0.057) | (0.057) | (0.057) | - | - | - |
| Weighted 33/50 releases$_{(t-1)}$ | - | - | - | 0.698*** | 0.697*** | 0.697*** |
| | - | - | - | (0.090) | (0.090) | (0.090) |
| Weighted releases$_{(t-2)}$ | - | - | - | 0.137** | 0.137** | 0.137** |
| | - | - | - | (0.062) | (0.063) | (0.062) |
| TRI releases | 0.302** | 0.302** | 0.303** | 0.240*** | 0.242*** | 0.242*** |
| | (0.119) | (0.119) | (0.119) | (0.092) | (0.092) | (0.092) |
| HAP-TRI ratio | 0.007* | 0.007* | 0.007* | 0.002 | 0.002 | 0.002 |
| | (0.004) | (0.004) | (0.004) | (0.005) | (0.005) | (0.005) |
| Number of enforcements | - | -0.014 | - | - | -0.026 | - |
| | - | (0.025) | - | - | (0.042) | - |
| Number of inspections | - | - | -0.007 | - | - | -0.017 |
| | - | - | (0.024) | - | - | (0.039) |
| Program participation | -0.299 | -0.296 | -0.300 | -1.024 | -1.012 | -1.017 |
| | (0.355) | (0.352) | (0.350) | (0.670) | (0.665) | (0.661) |
| State LCV score | 0.001 | 0.001 | 0.001 | 0.003 | 0.003 | 0.003 |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.003) | (0.003) |
| County nonattainment status | 0.058* | 0.060* | 0.058* | 0.116** | 0.120** | 0.118** |
| | (0.032) | (0.033) | (0.032) | (0.047) | (0.049) | (0.048) |
| Sierra Club membership | -0.302 | -0.312 | -0.307 | -0.747 | -0.763 | -0.758 |
| | (0.352) | (0.351) | (0.351) | (0.481) | (0.481) | (0.480) |
| Median household income | -2.8E-05** | -2.8E-05** | -2.8E-05** | -2.7E-05* | -2.7E-05* | -2.7E-05* |
| | (1.2E-05) | (1.2E-05) | (1.2E-05) | (1.4E-05) | (1.4E-05) | (1.4E-05) |
| % bachelor degree or higher | 0.003 | 0.003 | 0.003 | -0.008 | -0.009 | -0.008 |
| | (0.011) | (0.011) | (0.011) | (0.014) | (0.014) | (0.014) |
| % age less than 5 | 0.053 | 0.053 | 0.053 | 0.023 | 0.024 | 0.024 |
| | (0.039) | (0.039) | (0.039) | (0.050) | (0.050) | (0.049) |
| % African American | -0.004 | -0.004 | -0.004 | -0.005 | -0.004 | -0.004 |
| | (0.004) | (0.004) | (0.004) | (0.005) | (0.005) | (0.005) |
| % below poverty | -0.025* | -0.025* | -0.025* | -0.022 | -0.022 | -0.022 |
| | (0.015) | (0.015) | (0.015) | (0.016) | (0.016) | (0.016) |
| Population per square mile | -9.6E-06 | -1.0E-05 | -9.9E-06 | -2.1E-05 | -2.1E-05 | -2.1E-05 |
| | (2.3E-05) | (2.2E-05) | (2.3E-05) | (3.1E-05) | (3.1E-05) | (3.1E-05) |
| Voter participation rate | 0.194 | 0.205 | 0.196 | -0.075 | -0.054 | -0.061 |
| | (0.383) | (0.380) | (0.376) | (0.421) | (0.418) | (0.416) |
| Year 1991 | -0.390*** | -0.391*** | -0.389*** | -0.609*** | -0.611*** | -0.610*** |
| | (0.125) | (0.124) | (0.124) | (0.180) | (0.180) | (0.179) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Year 1992 | -0.358*** | -0.358*** | -0.356*** | -0.386** | -0.385** | -0.385** |
| | (0.136) | (0.136) | (0.135) | (0.185) | (0.185) | (0.185) |
| Year 1993 | -0.472*** | -0.472*** | -0.471*** | -0.497** | -0.497** | -0.496** |
| | (0.149) | (0.149) | (0.148) | (0.213) | (0.213) | (0.212) |
| Year 1994 | -0.455*** | -0.454*** | -0.453*** | -0.368* | -0.366* | -0.366* |
| | (0.175) | (0.175) | (0.174) | (0.211) | (0.211) | (0.210) |
| Year 1995 | -0.534*** | -0.533*** | -0.532*** | -0.511** | -0.507** | -0.507** |
| | (0.177) | (0.177) | (0.176) | (0.218) | (0.219) | (0.218) |
| SIC 26: Paper | -0.611 | -0.597 | -0.606 | -0.781 | -0.757 | -0.766 |
| | (0.485) | (0.481) | (0.483) | (0.469) | (0.469) | (0.469) |
| SIC 28: Chemical | -0.250* | -0.255* | -0.252* | -0.328** | -0.336** | -0.332** |
| | (0.144) | (0.146) | (0.145) | (0.149) | (0.151) | (0.151) |
| SIC 30: Rubber | -0.294 | -0.301 | -0.296 | -0.531* | -0.542* | -0.537* |
| | (0.294) | (0.293) | (0.293) | (0.314) | (0.312) | (0.312) |
| SIC 33: Primary metal | 0.062 | 0.060 | 0.061 | 0.534 | 0.534 | 0.535 |
| | (0.205) | (0.205) | (0.205) | (0.355) | (0.355) | (0.354) |
| SIC 34: Fabricated metal | -0.068 | -0.075 | -0.070 | -0.036 | -0.047 | -0.041 |
| | (0.393) | (0.392) | (0.392) | (0.370) | (0.368) | (0.368) |
| SIC 35: Machinery and | -0.006 | -0.011 | -0.007 | 0.076 | 0.070 | 0.074 |
| computer | (0.175) | (0.174) | (0.174) | (0.192) | (0.190) | (0.189) |
| SIC 36: Electronics | -0.182 | -0.187 | -0.184 | -0.222 | -0.231 | -0.226 |
| | (0.155) | (0.154) | (0.154) | (0.239) | (0.238) | (0.237) |
| SIC 37: Transportation | 0.303** | 0.301** | 0.300** | 0.297 | 0.293 | 0.295 |
| | (0.149) | (0.150) | (0.150) | (0.191) | (0.192) | (0.192) |
| Constant | -0.634 | -0.633 | -0.643 | 0.284 | 0.278 | 0.266 |
| | (0.812) | (0.813) | (0.810) | (1.083) | (1.079) | (1.075) |
| | | | | | | |
| Observations | 11,233 | 11,233 | 11,233 | 11,233 | 11,233 | 11,233 |
| AR(1) - p value | 0.000*** | 0.000*** | 0.000*** | 0.000*** | 0.000*** | 0.000*** |
| AR(2) - p value | 0.972 | 0.972 | 0.968 | 0.231 | 0.232 | 0.233 |
| Sargan test – p value | 0.079* | 0.078* | 0.079* | 0.009*** | 0.009*** | 0.009*** |
| Hansen J test – p value | 0.125 | 0.126 | 0.126 | 0.163 | 0.164 | 0.164 |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard errors clustered on firms with Windemeijer's finite sample correction are in parentheses. In models 4-6 the dependent variable is aggregate 33/50 emissions, while in models 4W-6W the dependent variable is toxicity weighted 33/50 emissions. TRI and HAP-TRI ratio are treated as endogenous.

**Table IX: Determinants of facility participation: Ignoring firm participation**

| Variable | Model 1 | Model 2 |
|---|---|---|
| First invitation group | 1.325*** | -0.095 |
| | (0.198) | (0.197) |
| Facility 33/50 emissions | -1.1E-07 | - |
| | (7.8E-08) | - |
| Weighted facility 33/50 emissions | - | -4.2E-11 |
| | - | (4.1E-11) |
| Ratio of facility to parent firm 33/50 releases | 0.016*** | - |
| | (0.001) | - |
| Ratio of facility to parent firm weighted | - | 0.757*** |
| 33/50 releases | - | (0.082) |
| Pre-Program change in facility 33/50 releases | -2.8E-07** | -6.6E-07*** |
| | (1.1E-07) | (1.1E-07) |
| TRI releases | 0.072*** | 0.104*** |
| | (0.011) | (0.011) |
| HAP-TRI ratio | -0.001 | 0.000 |
| | (0.001) | (0.001) |
| Number of inspections | -0.026 | 0.001 |
| | (0.041) | (0.041) |
| Number of enforcement actions | 0.045 | 0.036 |
| | (0.039) | (0.039) |
| State LCV score | 0.005*** | 0.006*** |
| | (0.002) | (0.002) |
| County non-attainment status | 0.147*** | 0.145*** |
| | (0.031) | (0.031) |
| Sierra Club membership | -0.032 | 0.045 |
| | (0.278) | (0.279) |
| Median household income | -4.0E-05*** | -4.0E-05*** |
| | (8.7E-06) | (8.9E-06) |
| % bachelor degree or higher | 0.052*** | 0.056*** |
| | (0.009) | (0.009) |
| % age less than 5 | 0.092 | 0.077 |
| | (0.030) | (0.029) |
| % African American | -0.004 | -0.004 |
| | (0.003) | (0.003) |
| % below poverty | -0.059*** | -0.058*** |
| | (0.011) | (0.011) |
| Population per square mile | 7.5E-05*** | 7.7E-05*** |
| | (1.9E-05) | (1.8E-05) |
| Voter participation rate | 0.440* | 0.521** |
| | (0.263) | (0.265) |
| SIC 24: Lumber and wood | 0.374 | 0.455* |

| | | |
|---|---|---|
| | (0.246) | (0.263) |
| SIC 25: Furniture and fixtures | -0.362 | -0.444 |
| | (0.313) | (0.381) |
| SIC 26: Paper | 1.727*** | 2.018*** |
| | (0.214) | (0.232) |
| SIC 28: Chemical | 0.885*** | 0.913*** |
| | (0.147) | (0.153) |
| SIC 30: Rubber | -0.277 | -0.157 |
| | (0.191) | (0.192) |
| SIC 33: Primary metal | 0.879*** | 0.907*** |
| | (0.151) | (0.153) |
| SIC 34: Fabricated metal | 0.408*** | 0.423*** |
| | (0.143) | (0.147) |
| SIC 35: Machinery and computer | 0.563*** | 0.527*** |
| | (0.167) | (0.172) |
| SIC 36: Electronics | 0.834*** | 0.909*** |
| | (0.166) | (0.168) |
| SIC 37: Transportation | 0.400** | 0.418** |
| | (0.175) | (0.179) |
| SIC 38: Instruments | 0.918*** | 1.083*** |
| | (0.223) | (0.224) |
| Constant | -12.780*** | -12.105*** |
| | (0.470) | (0.474) |
| | | |
| Log likelihood | -4409.75 | -4469.16 |
| Observations | 41,662 | 41,662 |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard errors are in parentheses. The models are estimated using a random effects probit model with firms as cross sections.

**Table X: Determinants of aggregate facility 33/50 emissions: Ignoring firm participation**

| Variable | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|---|---|---|---|---|---|---|
| 33/50 releases$_{(t-1)}$ | -0.208 | -0.177 | -0.151 | 0.352*** | 0.354*** | 0.353*** |
| | (0.656) | (0.641) | (0.630) | (0.100) | (0.100) | (0.100) |
| 33/50 releases$_{(t-2)}$ | 0.843 | 0.816 | 0.795 | -0.017 | -0.017 | -0.017 |
| | (0.531) | (0.519) | (0.509) | (0.026) | (0.026) | (0.026) |
| TRI releases | 0.510*** | 0.511*** | 0.509*** | 0.583*** | 0.582*** | 0.585*** |
| | (0.070) | (0.069) | (0.068) | (0.094) | (0.094) | (0.094) |
| HAP-TRI ratio | 0.016*** | 0.016*** | 0.016*** | 0.019*** | 0.019*** | 0.019*** |
| | (0.003) | (0.003) | (0.003) | (0.002) | (0.002) | (0.002) |
| Number of enforcements | - | -0.082*** | - | - | -0.027 | - |
| | - | (0.018) | - | - | (0.019) | - |
| Number of inspections | - | - | -0.085*** | - | - | -0.017 |
| | - | - | (0.017) | - | - | (0.021) |
| Program participation | 0.506 | 0.494 | 0.485 | -0.153 | -0.118 | -0.132 |
| | (0.693) | (0.677) | (0.667) | (0.967) | (0.957) | (0.959) |
| State LCV score | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| County nonattainment status | 0.046* | 0.050** | 0.050** | 0.066** | 0.067** | 0.066** |
| | (0.026) | (0.026) | (0.025) | (0.029) | (0.029) | (0.029) |
| Sierra Club membership | -0.594* | -0.610** | -0.608** | -0.350 | -0.360* | -0.357 |
| | (0.316) | (0.308) | (0.303) | (0.218) | (0.218) | (0.218) |
| Median household income | -8.5E-06 | -8.1E-06 | -7.9E-06 | -7.8E-06 | -7.6E-06 | -7.6E-06 |
| | (7.1E-06) | (7.0E-06) | (6.9E-06) | (8.2E-06) | (8.1E-06) | (8.2E-06) |
| % bachelor degree or higher | 0.004 | 0.003 | 0.002 | 0.001 | 7.7E-05 | 1.8E-04 |
| | (0.007) | (0.007) | (0.007) | (0.008) | (0.008) | (0.008) |
| % age less than 5 | -0.012 | -0.010 | -0.011 | -0.009 | -0.008 | -0.009 |
| | (0.024) | (0.023) | (0.023) | (0.024) | (0.024) | (0.024) |
| % African American | -0.009** | -0.008** | -0.008** | -0.007*** | -0.007*** | -0.007*** |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| % below poverty | -0.001 | -0.001 | -0.001 | -0.011 | -0.011 | -0.011 |
| | (0.008) | (0.008) | (0.008) | (0.010) | (0.010) | (0.010) |
| Population per square mile | 2.0E-05* | 1.9E-05* | 1.9E-05* | 1.5E-05 | 1.4E-05 | 1.4E-05 |
| | (1.1E-05) | (1.1E-05) | (1.1E-05) | (1.2E-05) | (1.2E-05) | (1.2E-05) |
| Voter participation rate | 0.016 | 0.060 | 0.041 | 0.086 | 0.101 | 0.091 |
| | (0.231) | (0.224) | (0.222) | (0.240) | (0.239) | (0.239) |
| Year 1991 | -0.861*** | -0.848*** | -0.841*** | -0.365*** | -0.369*** | -0.367*** |
| | (0.262) | (0.256) | (0.251) | (0.109) | (0.108) | (0.108) |
| Year 1992 | -1.332** | -1.300** | -1.278** | -0.445*** | -0.448*** | -0.446*** |
| | (0.599) | (0.586) | (0.576) | (0.113) | (0.112) | (0.112) |
| Year 1993 | -1.248** | -1.218** | -1.197** | -0.508*** | -0.510*** | -0.508*** |
| | (0.563) | (0.550) | (0.541) | (0.113) | (0.112) | (0.112) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Year 1994 | -1.346** | -1.311** | -1.286** | -0.651*** | -0.654*** | -0.652*** |
| | (0.652) | (0.638) | (0.627) | (0.115) | (0.115) | (0.115) |
| Year 1995 | -1.278** | -1.241** | -1.218** | -0.765*** | -0.765*** | -0.764*** |
| | (0.597) | (0.585) | (0.575) | (0.113) | (0.113) | (0.113) |
| SIC 24: Lumber and wood | 0.833*** | 0.812*** | 0.811*** | 0.401*** | 0.393*** | 0.401*** |
| | (0.152) | (0.151) | (0.149) | (0.150) | (0.148) | (0.148) |
| SIC 25: Furniture and fixtures | 0.316 | 0.283 | 0.277 | 0.483*** | 0.476*** | 0.478*** |
| | (0.276) | (0.273) | (0.268) | (0.132) | (0.133) | (0.133) |
| SIC 26: Paper | -0.941*** | -0.878*** | -0.870*** | -0.350 | -0.330 | -0.338 |
| | (0.220) | (0.216) | (0.213) | (0.268) | (0.266) | (0.266) |
| SIC 28: Chemical | -0.392** | -0.402*** | -0.392*** | -0.392*** | -0.397*** | -0.394*** |
| | (0.154) | (0.150) | (0.149) | (0.115) | (0.115) | (0.116) |
| SIC 30: Rubber | -0.153 | -0.175 | -0.174 | -0.166 | -0.173 | -0.170 |
| | (0.131) | (0.128) | (0.127) | (0.130) | (0.130) | (0.130) |
| SIC 33: Primary metal | 0.256** | 0.250** | 0.252** | 0.183 | 0.180 | 0.181 |
| | (0.100) | (0.098) | (0.097) | (0.112) | (0.112) | (0.112) |
| SIC 34: Fabricated metal | 0.197 | 0.175 | 0.178 | 0.107 | 0.098 | 0.104 |
| | (0.138) | (0.135) | (0.134) | (0.141) | (0.140) | (0.140) |
| SIC 35: Machinery and | 0.315*** | 0.294*** | 0.295*** | 0.333*** | 0.325*** | 0.331*** |
| computer | (0.112) | (0.111) | (0.110) | (0.122) | (0.121) | (0.121) |
| SIC 36: Electronics | -0.483** | -0.492** | -0.483** | -0.305** | -0.313** | -0.308** |
| | (0.244) | (0.238) | (0.234) | (0.132) | (0.132) | (0.132) |
| SIC 37: Transportation | 0.146 | 0.128 | 0.125 | 0.414*** | 0.408*** | 0.411*** |
| | (0.153) | (0.151) | (0.150) | (0.136) | (0.136) | (0.137) |
| SIC 38: Instruments | -0.358* | -0.376* | -0.368* | -0.215 | -0.223 | -0.219 |
| | (0.207) | (0.203) | (0.201) | (0.197) | (0.197) | (0.198) |
| Constant | -1.893** | -1.979*** | -1.987*** | -0.722 | -0.730 | -0.743 |
| | (0.761) | (0.751) | (0.737) | (0.545) | (0.548) | (0.550) |
| Observations | 48,070 | 48,070 | 48,070 | 48,070 | 48,070 | 48,070 |
| AR(1) - p value | 0.277 | 0.369 | 0.442 | 0.000*** | 0.000*** | 0.000*** |
| AR(2) – p value | 0.164 | 0.169 | 0.173 | 0.470 | 0.467 | 0.465 |
| Sargan test – p value | 0.997 | 0.998 | 0.999 | 0.000*** | 0.000*** | 0.000*** |
| Hansen J test – p value | 0.998 | 0.998 | 0.998 | 0.000*** | 0.000*** | 0.000*** |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard errors (clustered on firms) with Windemeijer's finite sample correction are in parentheses. Dependent variable is aggregate 33/50 emissions. In models 1-3 TRI and HAP-TRI ratio are treated as exogenous. In models 4-6 TRI and HAP-TRI ratio are treated as endogenous.

**Table XI: Determinants of facility toxicity weighted 33/50 emissions: Ignoring firm participation**

| Variable | Model 1W | Model 2W | Model 3W | Model 4W | Model 5W | Model 6W |
|---|---|---|---|---|---|---|
| Weighted 33/50 releases$_{(t-1)}$ | 1.3751** | 1.3971** | 1.4173** | 0.6614*** | 0.6607*** | 0.6612*** |
| | (0.6330) | (0.6413) | (0.6476) | (0.0740) | (0.0740) | (0.0740) |
| Weighted releases$_{(t-2)}$ | -0.3449 | -0.3664 | -0.3853 | -0.0672** | -0.0672** | -0.0677** |
| | (0.5667) | (0.5744) | (0.5802) | (0.0262) | (0.0261) | (0.0262) |
| TRI releases | 0.3840*** | 0.3895*** | 0.3898*** | 0.3455*** | 0.3455*** | 0.3477*** |
| | (0.0407) | (0.0404) | (0.0408) | (0.0865) | (0.0863) | (0.0865) |
| HAP-TRI ratio | 0.0105*** | 0.0104*** | 0.0104*** | 0.0126*** | 0.0126*** | 0.0125*** |
| | (0.0014) | (0.0014) | (0.0014) | (0.0032) | (0.0032) | (0.0032) |
| Number of enforcements | - | -0.1360*** | - | - | 0.0098 | - |
| | - | (0.0279) | - | - | (0.0263) | - |
| Number of inspections | - | - | -0.1368*** | - | - | 0.0298 |
| | - | - | (0.0269) | - | - | (0.0287) |
| Program participation | -1.0604 | -1.0156 | -1.0496 | 1.0562 | 1.0321 | 1.0143 |
| | (0.9557) | (0.9453) | (0.9576) | (1.1643) | (1.1326) | (1.1432) |
| State LCV score | 0.0030 | 0.0032 | 0.0032 | -2.88E-04 | -2.91E-04 | -2.66E-04 |
| | (0.0020) | (0.0020) | (0.0021) | (1.69E-03) | (1.68E-03) | (1.68E-03) |
| County nonattainment status | 0.0610** | 0.0672** | 0.0659** | 0.0722* | 0.0720* | 0.0713* |
| | (0.0274) | (0.0272) | (0.0274) | (0.0414) | (0.0410) | (0.0411) |
| Sierra Club membership | -0.1158 | -0.1503 | -0.1507 | -1.0359*** | -1.0329*** | -1.0230*** |
| | (0.4238) | (0.4243) | (0.4286) | (0.3017) | (0.3012) | (0.3012) |
| Median household income | -7.43E-06 | -6.65E-06 | -6.40E-06 | -3.68E-06 | -3.70E-06 | -3.84E-06 |
| | (6.43E-06) | (6.46E-06) | (6.48E-06) | (1.02E-05) | (1.02E-05) | (1.02E-05) |
| % bachelor degree or higher | 0.0099 | 0.0077 | 0.0071 | -0.0119 | -0.0118 | -0.0112 |
| | (0.0065) | (0.0064) | (0.0064) | (0.0101) | (0.0100) | (0.0101) |
| % age less than 5 | -0.0222 | -0.0174 | -0.0190 | -0.0362 | -0.0364 | -0.0371 |
| | (0.0187) | (0.0186) | (0.0186) | (0.0313) | (0.0313) | (0.0312) |
| % African American | -0.0047 | -0.0044 | -0.0040 | -0.0112*** | -0.0111*** | -0.0112*** |
| | (0.0029) | (0.0029) | (0.0030) | (0.0035) | (0.0035) | (0.0035) |
| % below poverty | -0.0028 | -0.0026 | -0.0024 | 0.0153 | 0.0153 | 0.0151 |
| | (0.0065) | (0.0065) | (0.0065) | (0.0119) | (0.0118) | (0.0118) |
| Population per square mile | 1.53E-05 | 1.43E-05 | 1.39E-05 | -2.22E-05 | -2.22E-05 | -2.17E-05 |
| | (1.21E-05) | (1.21E-05) | (1.21E-05) | (1.39E-05) | (1.38E-05) | (1.37E-05) |
| Voter participation rate | -0.2929 | -0.2183 | -0.2482 | 0.1561 | 0.1598 | 0.1550 |
| | (0.2098) | (0.2048) | (0.2081) | (0.2987) | (0.2972) | (0.2972) |
| Year 1991 | -0.4632 | -0.4508 | -0.4377 | -0.6772*** | -0.6735*** | -0.6700*** |
| | (0.4581) | (0.4633) | (0.4677) | (0.1527) | (0.1502) | (0.1510) |
| Year 1992 | 0.1304 | 0.1654 | 0.1959 | -0.6067*** | -0.6035*** | -0.5999*** |
| | (0.9537) | (0.9661) | (0.9754) | (0.1602) | (0.1576) | (0.1583) |
| Year 1993 | 0.2179 | 0.2471 | 0.2754 | -0.6307*** | -0.6279*** | -0.6243*** |
| | (0.8275) | (0.8380) | (0.8460) | (0.1555) | (0.1530) | (0.1536) |
| Year 1994 | 0.2534 | 0.2845 | 0.3111 | -0.6874*** | -0.6848*** | -0.6808*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.8148) | (0.8252) | (0.8329) | (0.1649) | (0.1623) | (0.1629) |
| Year 1995 | 0.0745 | 0.1129 | 0.1393 | -0.9193*** | -0.9175*** | -0.9146*** |
| | (0.7887) | (0.7994) | (0.8066) | (0.1627) | (0.1607) | (0.1612) |
| SIC 24: Lumber and wood | 0.6046** | 0.5715** | 0.5717** | 0.8325*** | 0.8359*** | 0.8449*** |
| | (0.2513) | (0.2555) | (0.2561) | (0.2406) | (0.2388) | (0.2386) |
| SIC 25: Furniture and fixtures | -0.4112*** | -0.4516*** | -0.4497*** | -0.1875 | -0.1851 | -0.1834 |
| | (0.1274) | (0.1303) | (0.1298) | (0.1534) | (0.1536) | (0.1532) |
| SIC 26: Paper | -1.0294*** | -0.9266*** | -0.9141*** | -0.6845*** | -0.6866 | -0.7035 |
| | (0.2307) | (0.2395) | (0.2378) | (0.2369) | (0.2355) | (0.2340) |
| SIC 28: Chemical | -0.1105 | -0.1337 | -0.1198 | -0.2156* | -0.2129 | -0.2112 |
| | (0.1343) | (0.1335) | (0.1354) | (0.1284) | (0.1281) | (0.1279) |
| SIC 30: Rubber | -0.1242 | -0.1591 | -0.1552 | -0.5849*** | -0.5826 | -0.5782 |
| | (0.1499) | (0.1482) | (0.1501) | (0.1756) | (0.1755) | (0.1758) |
| SIC 33: Primary metal | 0.2836 | 0.2684 | 0.2642 | 1.4572*** | 1.4601 | 1.4593 |
| | (0.3309) | (0.3339) | (0.3362) | (0.2557) | (0.2553) | (0.2549) |
| SIC 34: Fabricated metal | 0.3973*** | 0.3576*** | 0.3603*** | 0.2169 | 0.2209 | 0.2272 |
| | (0.0899) | (0.0906) | (0.0901) | (0.1679) | (0.1667) | (0.1669) |
| SIC 35: Machinery and computer | 0.2949 | 0.2592 | 0.2584 | 0.4866*** | 0.4902 | 0.4958 |
| | (0.1829) | (0.1867) | (0.1868) | (0.1776) | (0.1768) | (0.1764) |
| SIC 36: Electronics | 0.0675 | 0.0402 | 0.0493 | -0.2924 | -0.2875 | -0.2813 |
| | (0.2029) | (0.2029) | (0.2056) | (0.2163) | (0.2156) | (0.2153) |
| SIC 37: Transportation | -0.1550 | -0.1789 | -0.1802 | 0.1455 | 0.1529 | 0.1572 |
| | (0.1532) | (0.1526) | (0.1524) | (0.2028) | (0.2025) | (0.2020) |
| SIC 38: Instruments | -0.0265 | -0.0581 | -0.0444 | -0.5173** | -0.5152** | -0.5127** |
| | (0.2351) | (0.2337) | (0.2367) | (0.2520) | (0.2515) | (0.2518) |
| Constant | -4.6750*** | -4.7984*** | -4.7987*** | 0.8384 | 0.8402 | 0.8178 |
| | (1.1686) | (1.1889) | (1.1933) | (0.7364) | (0.7370) | (0.7345) |
| Observations | 48,070 | 48,070 | 48,070 | 48,070 | 48,070 | 48,070 |
| AR(1) – p value | 0.212 | 0.207 | 0.201 | 0.000*** | 0.000*** | 0.000*** |
| AR(2) – p value | 0.498 | 0.482 | 0.467 | 0.003*** | 0.003*** | 0.003*** |
| Sargan test – p value | 0.873 | 0.882 | 0.886 | 0.000*** | 0.000*** | 0.000*** |
| Hansen J test – p value | 0.852 | 0.861 | 0.866 | 0.000*** | 0.000*** | 0.000*** |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard errors (clustered on firms) with Windemeijer's finite sample correction are in parentheses. Dependent variable is toxicity weighted 33/50 emissions. In models 1-3 TRI and HAP-TRI ratio are treated as exogenous. In models 4-6 TRI and HAP-TRI ratio are treated as endogenous.

**Table A1: Determinants of firm participation in the 33/50 Program, 1991-1995**

| Variable | Model 1 | Model 1W |
|---|---|---|
| Final good | -0.420 | -0.395 |
| | (0.308) | (0. 302) |
| R&D/sales | 20.227*** | 19.434*** |
| | (5.231) | (5.127) |
| Newness of assets | -3.251** | -3.483** |
| | (1.363) | (1.611) |
| 33/50 releases/sales | -17.093 | - |
| | (39.495) | - |
| Weighted 33/50 releases/sales | - | -1.6E-07 |
| | - | (1.2E-07) |
| 33/50 releases | 0.037 | - |
| | (0.031) | - |
| Weighted 33/50 releases | - | 5.0E-05 |
| | - | (8.1E-05) |
| Prior change in 33/50 releases | 0.281 | 0.267 |
| | (0.191) | (0.189) |
| 33/50 -TRI release ratio | -0.382 | -0.343 |
| | (0.309) | (0.287) |
| HAP-TRI release ratio | -0.002 | -0.048 |
| | (0.383) | (0.362) |
| Number of facilities | -0.010 | -0.009 |
| | (0.010) | (0.009) |
| Number of Superfund sites | 0.108 | 0.107 |
| | (0.071) | (0.070) |
| Number of Superfund sites squared | 0.002 | 0.002 |
| | (0.004) | (0.004) |
| Number of enforcement actions | 0.080 | 0.085 |
| | (0. 055) | (0.053) |
| Number of inspections | -0.030 | -0.032 |
| | (0.054) | (0.052) |
| Sierra club membership | 0.281 | 0.414 |
| | (1.152) | (1.123) |
| State LCV score | -0.006 | -0.007 |
| | (0.007) | (0.007) |
| First invitation group | 1.502*** | 1.524*** |
| | (0.302) | (0.306) |
| SIC 26: Paper | 0.829* | 0.821* |
| | (0.478) | (0.471) |
| SIC 28: Chemical | 1.178** | 1.233*** |
| | (0.474) | (0.445) |
| SIC 29: Petroleum and coal | 0.827 | 0.763 |

| | | |
|---|---|---|
| | (0.688) | (0.668) |
| SIC 30: Rubber | 2.114*** | 2.195*** |
| | (0.715) | (0.720) |
| SIC 33: Primary metal | 0.493 | 0.614 |
| | (0.498) | (0.494) |
| SIC 34: Fabricated metal | 0.849* | 0.863* |
| | (0.458) | (0.454) |
| SIC 35: Machinery and computer | 0.238 | 0.255 |
| | (0.450) | (0.444) |
| SIC 36: Electronics | 0.983** | 1.013** |
| | (0.454) | (0.454) |
| SIC 37: Transportation | 0.034 | 0.067 |
| | (0.433) | (0.416) |
| SIC 38: Instruments | 0.044 | 0.061 |
| | (0.456) | (0.439) |
| Constant | 1.498 | 1.648 |
| | (1.234) | (1.205) |
| Number of observations | 12, 462 | 12, 462 |

*Note:* *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level. Robust standard (clustered on firms) errors are in parentheses. Coefficients are from the selection equation from the bivariate probit model. Number of observations is the facility-year observations for the outcome equation in the bivariate probit model.