FACILITY PARTICIPATION IN VOLUNTARY POLLUTION PREVENTION PROGRAMS AND THE ROLE OF COMMUNITY CHARACTERISTICS: EVIDENCE FROM THE 33/50 PROGRAM

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Abstract

The advent of voluntary pollution prevention programs has raised the question of their impact on the distribution of pollution. Do these programs enhance or alleviate the current inequity in the distribution of pollution in the US? This paper examines the evidence from the 33/50 Program. The participation decision of a facility is modeled as a probit function of various community characteristics such as income, race, educational status, housing tenure, and propensity for collective action. Several firm level variables identified in the currently published literature as having a statistically significant influence on the participation decision of the firm are included as control variables. Preliminary results suggest that a facility's decision to participate in the 33/50 Program is generally not influenced by these community characteristics. However, there is some tentative evidence to suggest that the probability of participation increases with median household income of the zip code in which the facility is located, and decreases with the percentage of the zip code population below the poverty line. It is unclear whether more polluting facilities are more likely to participate in the Program.

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1. Introduction and Overview of the 33/50 Program

In the past decade, there has been a fundamental shift in the approach to pollution control. More and more, there seems to be an emphasis on the use of voluntary pollution prevention programs rather than the traditional command and control approach, or even the use of market-based instruments such as taxes and tradable permits. The U.S. Environmental Protection Agency (EPA) lists at least twenty six voluntary initiatives at the federal level, with several additional programs at the state or regional levels. According to the EPA, the results of these programs have been impressive. The programs attracted participation from a wide variety of groups and reduced toxic emissions, solid wastes, greenhouse gas emissions, and pesticide risk (EPA, 1998).

The EPA's 33/50 Program derives its name from its goals. Under the Program, EPA identified 17 high priority toxic chemicals with a goal to reduce the releases and transfers of these chemicals by 33 percent by 1992 and 50 percent by 1995, compared to their 1988 levels. The pollutants were selected on the basis of their high volumes of industrial production as reported in the Toxic Release Inventory (TRI); high releases and off-site transfers of the chemical relative to total production; opportunity for pollution prevention by using substitutes or other preventive methods; as well as their toxicity and a potential to cause detrimental effects to human health and the environment. The 33/50 Program encouraged companies to set their own reduction goals and to develop the best way to meet these goals. The Program did not instruct companies how to reduce pollution, it did not monitor their progress, nor did it penalize them if they were unable to achieve their stated goals.

In March 1991, the EPA invited 600 firms identified to have the highest releases and transfers of the 33/50 chemicals to participate in the Program. By the summer of 1991, additional 5,000 firms were invited and another 2,500 more over the next three years (EPA, 1999). The initial invitation group targeted mainly large firms with facilities reporting the highest total releases of the 17 priority chemicals in 1988. The second group represented all other firms that reported releases of 33/50 chemicals in the 1988 TRI, while the third group firms and beyond did not report any 33/50 chemicals in 1988, but they did report 33/50 chemicals thereafter. All together, by March 1994, the EPA had invited over 8,000 firms to participate. Nearly 1,300 companies committed to the program accounting for 60 percent of targeted emissions (EPA 1999). Out of 1,294 companies that participated, 1,066 set measurable goals for reducing their releases and transfers of the 17 priority chemicals, measured against the 1988 baseline.

The TRI data for the reporting year 1991 indicated that the aggregate releases of the 17 chemicals for these companies declined by 40 percent between 1988 and 1991 surpassing the targeted 33 percent goal set for 1992. The ultimate goal of 50 percent reduction in releases and transfers of the chemicals was reached a year ahead of the schedule.

It is clear that the 33/50 Program achieved its stated goals of reducing emissions by the targeted amounts (see also Khanna and Damon, 1999). However, the success of this and other voluntary pollution prevention programs does not warrant complacency without further analysis. As Brooks and Sethi (1997) point out, nationally uniform standards (such as the National Ambient Air Quality Standards) are progressive insofar as they are likely to have the greatest impact in the poorest, most polluted areas. However, since programs such as 33/50 are not legally binding it is important to examine whether voluntary programs are contributing to inequality in the distribution of environmental quality faced by different socio-economic and demographic groups. This is particularly significant in the context of the Executive Order signed by President Clinton (White House, 1994) to address environmental justice issues in minority and low-income populations. Do firms in the poorest and minority communities tend to show a higher probability of participation in voluntary pollution prevention programs? This paper examines the evidence from the 33/50 Program. Not only does this provide further insight into the factors that provide an incentive to firms to exceed legally mandated reductions, it also determines whether such programs have a progressive or regressive impact on the distribution of pollution from a socio-economic perspective.

The paper is organized as follows. The first part of section 2 reviews the currently published literature examining firm participation in the 33/50 Program. This is followed by a brief overview of the literature on the distribution of toxic pollution. Section 3 describes the empirical model and the construction of some variables and section 4 describes the data used. Results are presented in section 5. Section 6 concludes.

2. Literature review

A. Voluntary Pollution Prevention

A firm's willingness to participate in voluntary programs suggests that participation has neutral or positive impacts on corporate performance. It is evident from the 33/50 Program that pollution has been reduced and that in some instances firms have achieved cost savings through the

Program implementation. Government assistance can help firms to overcome inefficiencies caused by management and take advantage of cost effective pollution controls. (Howarth et al., 2000)

Several studies have explored the potential reasons driving firms to participate. Arora and Cason (1995, 1996) and Khanna and Damon (1999) focus specifically on EPA's 33/50 Program, while DeCanio and Watkins (1996) explore participation in Green Lights. Videras and Alberini (2000) examine participation in three programs: 33/50, Green Lights and WasteWi$e. Although the EPA emphasizes public recognition as a direct benefit of the Program, and therefore a major incentive for firms to participate, the existing literature has proposed several other factors determining the differences in expected profit. These can be classified into three broad groups: (1) program features including the proximity to final consumers who are believed to desire green products, *ceteris paribus*, and technical assistance offered by the EPA with identifying and implementing new waste management practices; (2) seeking relief from mandatory environmental regulations; (3) firm specific characteristics such as firm size, level of R&D expenditure and the age of assets (Khanna and Damon 1999).

Arora and Cason (1995, 1996) and Khanna and Damon (1999) find that proximity to the final consumer is a statistically significant predictor of participation in the 33/50 Program.[1] On the other hand, Videras and Alberini (2000) find that firms that produce consumer goods may be less likely to be 33/50 participants. Khanna and Damon (1999) also argue that technical assistance offered to the participants by the EPA significantly benefits firms with great waste to output ratios rather than firms with lower waste to output ratios.

Theoretical models of self-regulation as a way of preempting government action indicate that an increased threat of government regulation can induce firms to voluntarily reduce pollution emissions (Maxwell *et al.*, 1998, Sergeson and Miceli, 1998). The empirical evidence that firms participate in voluntary programs in order to seek relief from the regulatory agency is mixed. Khanna and Damon (1999) find that mandatory regulations that provide credible threat of penalties and compliance costs can induce firms to voluntarily control pollution. Chemical firms listed as Potentially Responsible Parties (PRPs) for large number of Superfund Sites, as well as firms

[1] Arora and Cason (1995, 1996) and Videras and Alberini (2000) measure the proximity to final consumers by the ratio of industry advertising expenditure to sales. Khanna and Damon (1999) use a dummy variable to indicate firms selling final products.

emitting large volume of Hazardous Air Pollutants (HAPs) were more likely to participate in the 33/50 Program. Videras and Alberini (2000) also find that the number of PRP nominations positively affects participation. On the other hand, Arora and Cason (1996) do not find support for the interaction of voluntary and mandatory programs. More specifically, they found that the likelihood of participation in the 33/50 Program was not affected by the charges paid in the past for violating the Clean Air Act.

Firm specific characteristics such as R&D expenditure, firm size or the volume of toxic releases were also identified as important determinants of participation. Arora and Cason (1996) found that the level of R&D normalized by sales and firm size as represented by the level of employment have a positive and statistically significant impact on participation probability. It is plausible to expect that more innovative firms with larger R&D allocated toward lower cost methods of pollution prevention will be more likely to participate. Larger firms have a greater ability to influence environmental standards since they sell to a larger number of consumers. Participation increases the demand for their products through improvements in customer goodwill creating a larger benefit. Khanna and Damon (1999) also found that firms with older assets have a higher probability of participation since they face lower costs for replacing existing equipment.

The total releases of 33/50 chemicals as well as non-33/50 chemicals are expected to influence a firm's participation decision. Firms with greater emissions of the 17 toxic chemicals have the greatest aggregate reduction potential and may experience greater public pressure to reduce emissions, which could significantly increase the probability of participation. The empirical evidence shows that larger volumes of aggregate 33/50 releases, as well as non-33/50 releases, increase the probability of Program participation (Khanna and Damon, 1999). This clearly supports the hypothesis that the public disclosure of toxic releases and transfers through the TRI can compel the highest polluting firms to reduce their emissions and increase the probability for voluntary participation in the Program. Hamilton (1995) has shown that on the day the TRI data become available, firm's average abnormal return negatively affected the stock value of the firm.[2] The drop in the stock value was larger for the firms emitting greater quantities of chemicals. Hence, high levels of pollution may adversely affect firm's reputation and lead to loss of goodwill, as well as call for more stringent inspection by regulators and the community. In addition, firms

[2] Abnormal return is defined as difference between the normal return predicted by the market model for the firm and the firm's actual return as affected by the release of the TRI data.

with the highest emissions of the 17 priority chemicals were invited first to participate in the Program. Thus, it is reasonable to expect that firms invited in the first round are also more likely to participate.

On the other hand, firms that rely more heavily on 33/50 chemicals as inputs are expected to be less likely to participate given that they find it more difficult to substitute for other inputs. Khanna and Damon (1999) found that firms that could substitute other chemicals for 33/50 chemicals with greater ease (where the input substitutability is measured as the ratio of 33/50 releases to total TRI releases) were also more likely to participate. As mentioned earlier,

The 33/50 Program has been criticized by the Citizen Action consumer group for allowing companies to take credit for pollution reductions that have occurred before the inception of the Program, *i.e.* between 1988 and 1991 (Litvan, 1994). Both Arora and Cason (1996) and Khanna and Damon (1999) tested the free riding hypothesis that firms that have achieved large reductions in releases of 33/50 chemicals between 1988 and 1991 will free ride on their earlier reductions and be more likely to participate. They found no statistical evidence in support of this hypothesis.

Table A in the appendix summarizes the empirical literature on firm participation in the 33/50 Program.

B. Distribution of Pollution

None of the studies examining the firm's decision to voluntarily increase pollution abatement levels above and beyond mandatory requirements consider demographic, economic, and political attributes of the community in which the participating firms are located. Public disclosure of pollution data may lead to more stringent inspection by a community. Furthermore, some communities may be more effective in pressuring firms to abate. The empirical literature examining the relationship between race, income, and exposure to toxic emissions consistently found that most polluted areas in the U.S. are also the poorest areas with non white population (Arora and Cason, 1999, Brooks and Sethi, 1997). If firms located in these areas are less likely to participate, the Program would have a regressive impact on the distribution of pollution. (See Table B in the appendix for a summary of these studies.)

Arora and Cason (1999) and Brooks and Sethi (1997) examine the spatial distribution of toxic emissions reported in the TRI. Their analyses account for the socio-economic, political and demographic characteristics of communities relating to race, income, educational attainment, and

propensity for collective action over the period 1990-1993 and 1988-1992, respectively. Their results showed that neighborhood characteristics significantly affect the community exposure levels. Race and gender variables were found to have a statistically significant effect on releases. Neighborhoods with ethnic or racial minorities were the most highly exposed. Moreover, Arora and Cason (1999) found that larger proportions of non-white residents were associated with higher levels of releases especially in Southeastern states in primarily non-urban zip codes.

Economic variables were also found to be an important determinant of community exposure levels: highest exposure levels were found in communities characterized by low incomes, little education, and higher proportion of renter occupied housing units

Communities whose residents were more likely to act collectively to pressure firms to improve their environmental performance, consistently experienced less exposure to toxic releases. Brooks and Sethi (1997) found that communities with a greater propensity for collective action as measured by the voter turnout in presidential elections experienced lower exposure than communities with lower propensity for collective action. Arora and Cason (1999) do not use voter turnout as a proxy for collective action at a national level, but rather they use demographic variables such as education, age, number of households with children to express community's political preference since these variables seem to influence environmental outcomes primarily in non-urban areas. They do not find any evidence at a national level nor in the South and non-South samples that community political action affects releases.

This paper examines the role of community characteristics such as race, income, poverty status, housing tenure, and propensity for collective action in a facility's decision to participate in the 33/50 Program. Zip code level demographic and socio-economic variables are combined with county level voting data, facility level emissions data, and firm level control factors. The firm level control factors include firm size as measured by the level of employment, value of R&D expenditure per unit of sales, age of assets, as well as whether a firm is a Potentially Responsible Party (PRP) for Superfund sites. The choice of firm level control variables is based on the existing literature. Facility level pollution is measured by the sum of the releases and transfers of 33/50 chemicals. When necessary, the explanatory variables are lagged to avoid endogeneity. The analysis is carried out separately for each year over the life of the Program (1991-1995) to check for structural changes.

3. Empirical Model and Variable Construction

It is assumed that a firm participates in the Program if the expected net benefit from participating is positive. Firm *i*'s net benefit can be denoted as

$$Y_i^* = X_1'\beta_1 + X_2'\beta_2 + u \qquad (1)$$

where X_1 is a vector of community characteristics, X_2 is a vector of control factors including facility specific pollution level, and firm specific factors. β_1, and β_2 are vectors of coefficients and $u \sim N(0, \sigma^2)$. A firm's net benefit (Y^*) is unobserved in practice. Instead, we observe whether a firm participates in the Program. Thus, $Y=1$ if net benefits from participating are positive, and $Y=0$ otherwise. This leads to a probit model of participation. The likelihood and log likelihood function is given by

$$L = \prod_i [\Phi(x_i'\beta)]^{y_i}[1-\Phi(x_i'\beta)]^{1-y_i} \qquad (2)$$

$$\log L = \sum_i \{[y_i \ln \Phi(x_i'\beta) + (1-y_i)\ln[1-\Phi(x_i'\beta)]\} \qquad (3)$$

where $\Phi(\cdot)$ indicates the standard normal cumulative probability density function.

In order to test the influence of neighborhood characteristics, we define participation at a facility level. (The analyses in the existing literature are at the firm level). Since participation status is available at a firm level and not at a facility level, the dependent variable needs to be carefully defined. Firms included in the first and second invitation group were identified by the EPA as emitting at least one of the 17 chemicals in 1988. Firms included in the third invitation group and beyond were the firms that did not emit any of the 17 chemicals in 1988, but did thereafter. Hence, it makes sense to define a firm as eligible to participate if it emits at least one of the 17 chemicals in 1988 for examining participation in the first two years of the Program. For examining the third year of the Program and beyond, it is sensible to define a firm as eligible to participate if it emitted at least one of the 17 chemicals after1988 but not before. However, the TRI data set currently available includes revisions submitted to EPA between 1988 and 1998. Thus it is not possible to know whether the emissions reported to the TRI during the period 1988-1995 are the same as in our data set. Thus, for our analysis, we define a firm as eligible to participate if it has been included in one of the five invitation groups, and if its commitment status is known. Table 1 shows the invitation date and the number of firms contacted in each mail group.

Table 1. EPA Invitation Groups

	Group 1	Group 2	Group 3	Group 4	Group 5
Date contacted	March 1991	July 1991	July 1992	January 1993	January 1995
# of companies with 33/50 facilities	509	4,534	940	818	754
# of responses with commitments to the 33/50 Program	328	819	60	40	40
# of facilities in our sample	1,131	334	2	2	7

Note: RY = reporting year

Source: based on EPA, 1999 (Table 2, page 5)

Our analysis is carried out at the facility level, while participation information is available at the level of the firm (parent company). For a participating firm, there are two ways of defining participation by a facility. A simple way would be to assume that if a firm participates, all of its facilities participate. For firms with a small number of facilities this is a reasonable assumption. However, this would not be a good proxy for firms that have a large number of facilities (e.g., 40 or more), since the EPA classified a firm as participating even if only one of its facilities participated. It is possible that a firm may decrease emissions in some of its facilities and increase emissions in other. Thus, an alternative definition of participation at the facility level would be to assume that facility has participated in the Program if its releases and transfers have decreased over the life of the Program, relative to the year in which the parent company joined the Program. Moreover, we do not know when the firm decided to participate, only when it was invited to participate. Thus, we assume that firms commit to the Program in the year they were invited to participate. Once a firm has committed, we assume that it remained in the Program until the end.

Our analysis is based on a specified universe of manufacturing firms in the Standard & Poor 500 representing 246 companies and 1,228 unique zip codes. There were 1,132 facilities identified as belonging to companies invited to join in the first round of invitations (see Table 1). An additional 334 facilities in our sample belong to firms invited in the mailing group. The third group in our sample has only two facilities where one belonged to a firm that committed to the Program and one to a firm that did not. The Fourth invitation group has also two facilities, both of which belong to companies that did not commit, and the fifth group has seven facilities out of which six

were identified as belonging to participating firms and one to a non-participating firm.

Public disclosure of the TRI data can compel a facility to decrease its emissions. Furthermore, communities can put pressure on facilities to create environmental plans and improve the environmental quality of the surrounding area. Therefore, community characteristics may influence the firm's decision to decrease its emissions. Based on the literature of the distribution of toxic pollution, our analysis postulates that facilities will be less likely to participate in the 33/50 Program if they are located in the communities with higher proportion of non-white population, lower levels of incomes, less education and lower property values.

Facilities facing greater collective action by the residents in the neighborhood where they are located are expected to be more likely to participate. The propensity for collective action is measured by the ratio of voter turnout to number of registered voters in the 1992 Presidential elections. No voter registration data are reported for Wisconsin and North Dakota due to the lack of statewide reporting. For the counties that did not report the number of registered voters, a ratio of voter turnout to estimated voting age population was taken instead. However, some states do not report actual voter turnout. For such states an approximate measure of turnout was created by adding the total vote received by every Candidate for each individual office and selecting the office with the highest number of votes. Note that these data are available at the county level, and not for individual zip codes as our analysis would ideally require. Following Brooks and Sethi (1997) we assume that these data are uniformly distributed over all zip codes within a county.

Several control variables were included based on the existing literature on firm participation in the 33/50 Program. The complete list of variables included in our model is shown in Table 2. Here we discuss some particular issues associated with the firm level control variables. Participation in the Program may improve the public image of a firm since the EPA recognizes participating firms with outstanding achievements. Firms with higher releases of the 33/50 chemicals are expected to be more likely to participate because they are most likely to benefit from the Program in terms of improving customer goodwill, and because they may have experienced greater public scrutiny to reduce emissions. To capture this, we include facility level releases of the 33/50 chemicals. These releases are defined as sum of all annual on-site releases to air, surface water, land, underground injection, and all annual off-site transfers to treatment, storage and disposal as a measure of emissions.

Firm specific characteristics such as size, age of assets, expenditure on R&D, or closeness to the final consumer have all been identified in the previous literature as having a statistically significant influence on firm's participation decision. We include these as firm level control factors. (Ideally, we would prefer to use facility level data since we examine the participation decision at a facility level. However, these data are available at a firm level only.) Firm level R&D expenditure is normalized by the total firm sales. The number of employees (in thousands) captures the size of the firm. The age of assets is the ratio of total assets to gross assets.

Facilities belonging to a firm selling a final product are expected to have a higher probability of participation since public disclosure of environmental data helps consumers identify environmentally conscious firms. The previous literature has found that the proximity to the final consumer has a significantly positive influence on the probability of participation. However, at this point the variable capturing this effect (as measured by the advertising expenditure normalized by sales) is not included in our analysis, and therefore our results may be biased. We do not include this variable since advertising expenditure is not available for a large number of firms, and measuring it at the industry level (two-digit SIC code) may lead to aggregation bias.

Also included is a dummy variable for the chemical industry. Arora and Cason (1995) report that participation probabilities significantly differ across industries. Chemical firms (SIC 28) were most likely to participate, while rubber and plastics (SIC 30) least likely.

Several other control variables are included. The current literature is ambiguous about whether voluntary and mandatory programs can be considered as complementary. To capture the effect of compliance with mandatory laws as an incentive for participation in the Program, we use a dummy variable with a value 1 if the firm was issued either a general or a special notice for the Superfund sites for which a firm is a Potentially Responsible Party (PRP) prior to the year in which the firm was invited to participate.[3] A firm that has failed to comply with the mandatory laws may seek to avoid the penalties associated with the failure to comply or it may seek improve its reputation by participating in a voluntary program such as 33/50. On the other hand, a firm that is successfully complying with mandatory laws may join the voluntary programs since the associated costs may be small.

The study by Brooks and Sethi (1997) found that proximity to urban areas was associated

[3] The issuance of the general letter to the PRP informs the party of its potential liability inviting it to discuss involvement at the site. The issuance of a special notice letter to the PRP by the EPA starts a negotiation process for removal or remedial investigation.

with a disproportionate share of exposure to toxic chemicals. To capture any spatial differences, we use a dummy variable with a value 1 if more than 50 percent of residents in the zip code live in an urbanized area. Population density is included as an additional variable.

All the explanatory variables are lagged in order to avoid endogeneity. Socio-economic and demographic variables are set at the 1990 level. The facility level pollution variables and the firm level control factors are lagged by a year. Socio-economic and demographic data, are for the zip code in which the facility is located.

4. Description of the Data

Data were obtained from several different sources as shown in Table 2. The Toxic Release Inventory provided data on the volume of releases for each facility. Socio-economic and demographic factors relating to race, education and poverty status at the zip code level were obtained from the 1990 U.S. Census. Election Data Services provided the county level data on 1992 U.S. Presidential Elections. The Standard and Poor's Compustat database provided data on employment, sales, and R&D expenditures for the firms in our sample. The Compact D database was used to assign parent company Dun and Bradstreet number (D-U-N-S) to facilities that did not report it in the TRI. The EPA's Superfund Program Information Management System provided information on the Potentially Responsible Parties for Superfund Sites. The EPA also provided the data on firm participation.

Table 2. Variables Definitions and Data Sources

Variables	Definition	Source
pctfhs	• % female householder, no husband present	Census CD + Maps
pctnwh	• % of non white population	
medinc	• Median household income in 1989 (In $10,000)	
povpct	• % of population below poverty	
pctunpl	• Percent population that is unemployed	
pctrent	• % renter occupied housing units	
pctmfn	• % persons ages 16+ employed in manufacturing, mining, construction / total working population (all persons ages 16+)	
urban	• % residents in urban area (total persons inside urbanized area/population)	
popden	• Population density (1000 persons per square mile)	
pctcol	• % persons years 25 and over with a bachelor's degree	
political	• voter turnout /estimated voting age population (or number of registered voters)	Election Data Services
33/50 Releases	• Annual releases (air, surface water, land, underground injection) + annual offsite transfers (treatment, storage, & disposal) of the 17 chemicals by each facility (1000 lbs)	Toxic Release Inventory (TRI)
PRP	• Dummy variable = 1 when firm is a PRP for a Superfund site	CERCLIS
Invitation groups	• Dummy variable to indicate mail group in which parent company was invited to participate in the Program	EPA's list of participants
R&D expenditure	• R&D/annual sales (million $)	COMPUSTAT
Employment	• Number of employees (thousands)	COMPUSTAT
Age of Assets	• Total assets/ gross assets • Total assets = current assets + net property, plant and equipment + other non current assets (millions $) • Gross assets = total assets + accumulated depreciation on property, plant and equipment (millions $)	
First	• Dummy variable =1 if firm was invited in the first mailing group	

Table 3 provides summary statistics by participation groups for the explanatory variables, for the full sample and separately for participants and non-participants. The final data set used to determine Program participation has complete data for 1,131 facilities for the first year of the Program, 1,465 facilities for the second year, 1,467 facilities for the third year, 1,469 facilities for the fourth year, and 1,476 facilities for the last year of the Program. The Table 3 indicates that participants tend to emit greater quantities of 33/50 chemicals; have the largest representation from the chemical industry (SIC 28); and belong to the firms with more employees. The community characteristics generally do not show any perceptible differences between participants and non-participants. The only exception seems to be that participating facilities tend to be located in zip codes with slightly larger percentage of minorities, as well as in zip codes with a larger proportion of the population inside urbanized areas. Similar conclusions emerge when the data are examined separately for each invitation group, and when facility participation is defined using the alternative definition.[4]

[4] Alternately, a facility is assumed to have participated if it belonged to the company that committed to the Program, and if its releases have decreased between the year it joins and the final year of the Program (1995).

Table 3. Summary Statistics

	Non-Participants N=405		Participants N=1071		All firms N=1476	
	Mean	**Standard deviation**	**Mean**	**Standard devation**	**Mean**	**Standard Deviation**
% Non white	14.12	(18.55)	17.83	(21.53)	16.81	(20.81)
% Female headed house	2.28	(1.25)	2.53	(1.39)	2.46	(1.35)
% Below poverty	12.23	(8.79)	13.37	(9.44)	13.06	(9.28)
% Renter occupied	30.84	(12.96)	31.84	(13.08)	31.57	(13.05)
% Unemployed	5.98	(2.88)	6.79	(3.70)	6.57	(3.51)
Median Income	3.09	(1.09)	2.96	(1.07)	2.99	(1.08)
% College degree	7.57	(4.49)	6.89	(4.09)	7.07	(4.21)
% Manufacturing	18.96	(6.41)	18.21	(5.99)	18.42	(6.12)
Political	57.78	(8.75)	57.40	(8.23)	57.50	(8.38)
Pop density	1.58	(2.51)	1.67	(2.53)	1.64	(2.53)
Urban	0.55	(0.50)	0.60	(0.49)	0.58	(0.49)
33/50 Releases	90.05	(158.14)	203.12	(791.27)	172.10	(680.88)
R&D Expenditure	0.02	(0.02)	0.03	(0.02)	0.03	(0.02)
Employment	16.32	(18.73)	95.08	(155.30)	73.47	(137.22)
Age of assets	0.81	(0.09)	0.76	(0.09)	0.77	(0.10)
PRP	0.35	(0.48)	0.72	(0.45)	0.62	(0.49)
SIC 28	0.08	(0.27)	0.20	(0.40)	0.17	(0.37)
First Invitation Group	0.41	(0.49)	0.90	(0.30)	0.77	(0.42)

Note: Summary statistics based on all five invitation groups. A facility is assumed to participate in the Program if the parent company participates in the Program.

5. Results

As mentioned earlier, we have assumed that firms joined the 33/50 Program in the year that they were invited. Therefore, in evaluating the first year of the Program (1991) we include only firms invited in the first round of invitations. For the second year of the Program (1992), firms invited in both first and second invitation groups are included. In each of the subsequent years we increase the sample by adding an additional invitation group[5]. The results are shown in Table 4.

Many of the community variables have the expected signs. The coefficient on percent female-headed households is negative. The coefficients on percent population with college degree and the variable measuring the potential for collective action are positive. These signs are as expected, *a priori*. Surprisingly, we find the coefficient on the percent non-white population, percent renter occupied housing units, and percent unemployed to be opposite of what we expected.

Except for the first year of the Program, median household income is negative and statistically significant, and the corresponding squared term is positive and significant. This U-shape suggests that the probability of participation initially increases with decreases in income. This may suggest that at really low levels of income voluntary participation in the 33/50 Program has a progressive impact on the distribution of pollution. The poorest areas, which also tend to be the most polluted, see a greater chance of pollution reduction. However, beyond a certain threshold, richer communities see a greater probability of participation. This reversal may be a rational response by the firm to the potentially greater marginal clean up (damage) costs in communities with higher median household incomes.[6] It is worth noting that for the same years, zip codes with larger percent of population below poverty level have a lower probability of participation (the coefficient is significant at the 5% level).

For the first year of the Program, only find the coefficient on the percent non-white population is positive and significant out of the entire set of socio-economic variables.

The community variables are jointly insignificant based on the Wald test at 10% significance level for all years of the Program.

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[5] The third, fourth, and fifth invitation groups in our sample contain only 2,2, and 7 additional facilities, respectively. See Table 1.

[6] Not surprisingly, median household income and the median value of owner occupied houses are highly correlated in our data set. The correlation coefficient is 0.67.

Table 4: Probit Results

Variable	Year 1	Year 2	Year 3	Year 4	Year 5
Pctnwh	**0.0124****	**0.00582**	**0.00599**	**0.00595**	**0.00583**
	(0.00594)	(0.0406)	(0.00406)	(0.00406)	(0.00405)
Pctfhs	**-0.0378**	**-0.0254**	**-0.0292**	**-0.0294**	**-0.034**
	(0.0818)	(0.0603)	(0.0603)	(0.0603)	(0.0601)
Medinc	**-0.3141**	**-0.4439****	**-0.4455****	**-0.4441****	**-0.4459****
	(0.2585)	(0.1929)	(0.1931)	(0.1931)	(0.1924)
Medinc^2	**0.0186**	**0.0247***	**0.025***	**0.0249***	**0.0249***
	(0.0195)	(0.014)	(0.0141)	(0.0141)	(0.014)
Pctmfn	**0.00616**	**0.00650**	**0.00632**	**0.00618**	**0.00554**
	(0.0127)	(0.00945)	(0.00945)	(0.00944)	(0.00941)
Pctcol	**0.00424**	**0.0106**	**0.00952**	**0.00943**	**0.00845**
	(0.0307)	(0.0209)	(0.0209)	(0.0209)	(0.0208)
Pctrent	**0.00757**	**0.00259**	**0.00285**	**0.00287**	**0.00317**
	(0.00705)	(0.00546)	(0.00546)	(0.00546)	(0.00546)
Urban	**-0.2085**	**0.0558**	**0.0549**	**0.0563**	**0.0729**
	(0.1672)	(0.1309)	(0.1308)	(0.1308)	(0.1302)
Popden	**-0.00481**	**0.00936**	**-0.00868**	**-0.00901**	**-0.0111**
	(0.0344)	(0.0265)	(0.0266)	(0.0264)	(0.0264)
Povpct	**-0.0256**	**-0.0295****	**-0.0299****	**-0.0298****	**-0.0285****
	(0.0175)	(0.0132)	(0.0132)	(0.0132)	(0.0132)
Political	**0.00525**	**0.00504**	**0.00502**	**0.00507**	**0.00583**
	(0.00753)	(0.00596)	(0.00596)	(0.00596)	(0.00593)
Pctunpl	**-0.00593**	**0.0124**	**0.0129**	**0.013**	**0.0106**
	(0.0356)	(0.0271)	(0.0271)	(0.0271)	(0.027)
Rel 33/50	**-0.00005**	**-0.00005**	**-0.00004**	**-0.00004**	**-0.00004**
	(0.000197)	(0.00011)	(0.000121)	(0.000121)	(0.000118)
PRP	**0.6561*****	**0.6813*****	**0.6818*****	**0.6833*****	**0.6788*****
	(0.1277)	(0.0968)	(0.0967)	(0.0967)	(0.0963)
R&D exp	**1.7332**	**2.7034**	**2.7588**	**2.7886**	**3.465**
	(5.2894)	(2.677)	(2.6772)	(2.6673)	(2.6593)
Age of assets	**-7.9724*****	**-5.8199*****	**-5.8635*****	**-5.86*****	**-5.7567*****
	(0.8084)	(0.5798)	(0.5791)	(0.5789)	(0.5724)
Emp	**0.0267*****	**0.0177*****	**0.0178*****	**0.0178*****	**0.0175*****
	(0.00302)	(0.00201)	(0.00201)	(0.00201)	(0.002)
SIC 28	**5.8160**	**1.2198*****	**1.2067*****	**1.208*****	**1.1857*****
	(132.8)	(0.1685)	(0.1676)	(0.1677)	(0.1667)
First	**-**	**1.3138*****	**1.31*****	**1.3125*****	**1.3041*****
	-	(0.1685)	(0.1131)	(0.113)	(0.1124)
-2 Log L	554.37	931.158	932.749	933.125	940.623
N	1131	1465	1467	1469	1476
Participants	966	1069	1070	1070	1071

Note: Dependent Variable definition: if firm participates, all facilities participate
Standard Errors in Parenthesis.
* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level

Some economic and demographic variables are highly correlated which may explain why many of the socio-economic variables are statistically insignificant. The correlation coefficients between some key variables are shown in Table 5 below.

Table 5. Correlation Coefficients

	Medinc	Pctfhs	Pctnwh	Povpct
Pctcollege	0.69			
Pctunpl	-0.59	0.71	0.64	0.79
Pctfhs	-0.53		0.70	0.72
povpct	-0.72			

Our model validates the results of the previous literature (Arora and Cason 1995, 1996, and Khanna and Damon, 1999). Firm specific characteristics are important determinants of the participation decision of facilities. Facilities belonging to larger firms and firms with older assets are more likely to participate. The positive coefficient on the R&D expenditure indicates that facilities belonging to firms with greater R&D expenditure have a higher probability of participation, although the coefficient was insignificant. Except when evaluating the first year of the Program, the coefficient on the variable measuring whether the facility belongs to a firm in a chemical industry is positive and significant indicating that chemical firms do participate more. The coefficient on the PRP sites for which a firm was issued either a general or a special notice letter is positive and significant. It seems that compliance with mandatory regulations increases the probability of participation in the voluntary programs such as 33/50. When evaluating the second and later years of the Program, a dummy variable is included to control for the first invitation group. The coefficient on this variable is positive and significant. This indicates that firms invited first (the firms with greatest releases of the targeted chemicals) are more likely to participate.

Perhaps the most surprising result is that the coefficient on the releases of the 33/50 chemicals by facilities is insignificant and negative. Even though the decision to participate is made at a firm level, for reasons explained earlier in the paper, we would expect to see that larger releases of the targeted chemicals positively affect the facility's participation. However, our results

suggests that the pollution level at the does not in any way influence the decision of the *facility* to participate in the 33/50 Program. The existing literature indicates that more polluting firms tend to have a higher probability of participation. It seems that this result does not hold at the level of the facility.

These results are sensitive to the definition of the dependent variable. A separate regression was estimated where the dependent variable, was defined as follows: a facility participates if it belongs to a firm that has committed to the Program and if its releases have declined between the year it joins and the last year of the Program (1995). Table 6 shows the probit results. The effects of the firm specific variables are significant with expected signs. In this case the coefficient on the aggregate releases of the 33/50 chemicals by facilities are significant and positive indicating that the higher levels of releases positively affect facility's participation. The coefficient on percentage of renter occupied houses is positive and significant, which is the opposite of what we expected. Similarly, the coefficient on the dummy variable capturing spatial differences between urban and rural areas flips sign. It is now negative and significant. The coefficients on median household income also flip signs, though they are now statistically insignificant. Unexpected signs were also found on percent population living below poverty and percent population with a college degree. On the whole, the community variables remain jointly insignificant at 10% level of significance except when evaluating the first year of the Program where they are significant at 10% level.

Table 6. Probit Results (alternative definition of facility participation)

Variable	Year 1	Year 2	Year 3	Year 4	Year 5
Pctnwh	**0.00389**	**0.0027**	**0.00281**	**0.00283**	**0.00286**
	(0.00356)	(0.00308)	(0.00308)	(0.00308)	(0.003080)
Pctfhs	**-0.0342**	**-0.0397**	**-0.0425**	**-0.0425**	**-0.0409**
	(0.056)	(0.0479)	(0.0479)	(0.0479)	(0.0479)
Medinc	**0.1543**	**0.0138**	**0.0126**	**0.0134**	**0.0132**
	(0.1963)	(0.1602)	(0.1604)	(0.1605)	(0.161)
Medinc^2	**-0.00047**	**0.00423**	**0.00442**	**0.00438**	**0.004448**
	(0.0183)	(0.0136)	(0.0137)	(0.0137)	(0.0138)
Pctmfn	**-0.0136**	**-0.00839**	**-0.00849**	**-0.00842**	**-0.00832**
	(0.00875)	(0.00756)	(0.00756)	(0.00755)	(0.00755)
Pctcol	**-0.00136**	**0.00472**	**0.00385**	**0.004**	**0.00429**
	(0.0193)	(0.0159)	(0.0159)	(0.0159)	(0.0159)
Pctrent	**0.00896 ***	**0.00758 ***	**0.0078 ***	**0.00791 ***	**0.00794 ***
	(0.00483)	(0.00426)	(0.00426)	(0.00425)	(0.00425)
Urban	**-0.2711***	**-0.1739 ***	**-0.174 ***	**-0.1718 ***	**-0.1738 ***
	(0.1127)	(0.1001)	(0.1)	(0.1)	(0.0999)
Popden	**0.0153**	**0.0122**	**0.0127**	**0.011**	**0.0113**
	(0.0227)	(0.0201)	(0.0201)	(0.0197)	(0.0197)
Povpct	**0.0101**	**0.00251**	**0.00212**	**0.00219**	**0.00186**
	(0.012)	(0.0106)	(0.0106)	(0.0106)	(0.0106)
Political	**0.00799**	**0.00651**	**0.00649**	**0.00662**	**0.00659**
	(0.00573)	(0.00475)	(0.00474)	(0.005474)	(0.00473)
Pctunpl	**-0.0176**	**-0.00604**	**-0.00560**	**-0.0054**	**-0.00496**
	(0.0224)	(0.0199)	(0.0199)	(0.0199)	(0.0199)
Rel 33/50	**0.000434****	**0.000378****	**0.000402****	**0.000402****	**0.00402****
	(0.000169)	(0.000158)	(0.000160)	(0.00016)	(0.00016)
PRP	**0.3236*****	**0.4933*****	**0.4926*****	**0.4938*****	**0.4989*****
	(0.0.0874)	(0.0760)	(0.076)	(0.076)	(0.0759)
R&D exp	**6.3998****	**4.4194****	**4.4746****	**4.4987****	**4.4519****
	(2.689)	(2.0325)	(2.0334)	(2.0335)	(2.032)
Age of assets	**-1.6549*****	**-1.5145*****	**-1.5408*****	**-1.5411*****	**-1.5578*****
	(0.4322)	(0.3891)	(0.3887)	(0.3886)	(0.3884)
Emp	**0.000822****	**0.000849****	**0.000845****	**0.000844****	**0.000846****
	(0.000344)	(0.000334)	(0.000334)	(0.000334)	(0.000335)
SIC 28	**0.0894**	**0.2808*****	**0.2724****	**0.2739****	**0.2778****
	(0.1389)	(0.1084)	(0.1082)	(0.1081)	(0.1082)
First	**-**	**1.1145*****	**1.1081*****	**1.1115*****	**1.1216*****
	-	(0.0928)	(0.0924)	(0.0923)	(0.092)
-2 Log L	1265.73	1612.44	1614.44	1615.04	1617.04
N	1131	1465	1467	1469	1476
Participants	806	893	894	894	894

Note: Dependent Variable: facility participates if the firm participates, and if its releases have declined between the year it joins and 1995. Standard Errors in Parenthesis.
* Significant at 10% level; ** Significant at 5% level; *** Significant at 1% level

6. Conclusions

This paper examines the influence of socio-economic community characteristics (race, income, education, propensity to participate in the political process, etc) on a facility's decision to participate in the 33/50 Program. The larger objective is to examine whether participation in this program has a progressive or regressive impact on the distribution of pollution. The paper models a facility's participation decision as a probit function of several socio-economic characteristics of the zip code in which the facility is located. In addition, we add some firm level factors identified in the existing literature as control variables.

Preliminary results suggest that a facility's decision to participate in the 33/50 Program is generally not influenced by these community characteristics. There is some tentative evidence to suggest that the probability of participation increases with the median household income and decreases with the percentage of the population below the poverty line. However, while this may be indicative of a regressive impact, it may also just be a rational firm's response to the increasing marginal damage costs in richer communities. Further analysis is required before we can reach any unambiguous conclusion regarding this result.

The currently published literature on the 33/50 Program analyses the participation decision of the firm. The results clearly show that firms with larger emissions of the targeted chemicals are more likely to participate in the Program. Our analysis asks the same question from a slightly different perspective. What motivates each facility within a larger parent company to participate in the Program? In other words, once the parent company commits to participating in the Program, what factors determine which of its many facilities participate? Recall that the EPA classified a parent firm as participating in the 33/50 Program even if one of its subsidiary facilities participated. Our results do not provide any clear-cut answer. It is unclear whether the more polluting facilities are more likely to participate than less polluting facilities within the same company. Our results depend on the manner in which the dependent variable is defined. Again, further analysis is required. If, however, it is indeed correct that facility level emissions do not influence the decision to participate, and given that there is some evidence to suggest that richer communities tend to see a higher probability of participation, then there may be cause for concern. The most polluted areas in the U.S. are generally the poorest. In this case, pollution levels in these areas are unlikely to decrease, while wealthy communities are likely to witness a disproportionately higher reduction in pollution.

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Appendix

Description of Data Sources

A. Toxic Release Inventory

All manufacturing facilities with 10 or more full time employees that manufacture, import, process or use over 300 hazardous chemicals are required to report annually their releases of those chemicals into the environment. Along with the environmental data, facilities also provide some other useful information for identification purposes. Each facility reports its name, location (address and zip code), primary SIC code identifying type of business, name of parent company and parent company Dun and Bradstreet (D-U-N-S) number. The D-U-N-S number is a unique nine-digit number assigned to the business by Dun and Bradstreet financial services group to provide a universal identification system. This number was used to match the TRI data with the Compustat data. The zip code where each facility is located was used to match the TRI data with the Census data.

B. Compustat Database

The firm level data such as sales, R&D expenditure, employment, age of assets were obtained through the Standard and Poor's Compustat database. This database provides financial, statistical and market information on all publicly traded companies in the United States and Canada that file 10-K forms with the Securities and Exchange Commission. Since the Compustat data does not report the D-U-N-S number, Compact D disclosure database was used to assign the D-U-N-S number to the companies. Compact D database contains a wide range of identification, management and financial information on all public companies in the U.S. The D-U-N-S parent company number was used to merge the financial data with the environmental data. The Compustat database has data for 10,020 companies in each year. Compustat data was merged with the data on invited companies provided by the EPA by the parent company's Dun & Bradstreet number.

C. Socio-economic, demographic and political variables

The demographic and socio-economic data were obtained from the 1990 Census CD + Maps published by the Census Bureau. The Census provided information on race, gender, education, poverty status, income, housing by tenure as well as employment by industry. A

measure of political preference utilizes the data on the number of registered voters and the data on the estimated voting age population. The data for the most recent (1992 and 1996) primary, general and special elections was compiled by the Election Data Services. These data are available at the state and county level.

Census data was matched with the facility level emissions data by zip codes. Furthermore, voting data was merged with the facility level data by state and county fip codes.

D. Mandatory environmental regulation

Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) contains information on hazardous waste sites, site inspections, preliminary assessments and remediation of hazardous waste sites.

In 1980, Congress established the Superfund Program to locate, investigate and clean up the worst sites nationwide. The National Priority List (NPL) indicates the list of hazardous waste sites in the country that are being cleaned up under the Superfund Program. The EPA uses the Hazard Ranking System (HRS) to place the uncontrolled sites on the NPL. The HRS is based on preliminary assessment and investigation of the potential threat posed by the site to the human health or the environment. All companies placed on the NPL are PRPs for a number of Superfund sites.

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Table A. Factors Motivating Participation in the 33/50 Program

Arora & Cason (1995)	Arora & Cason (1996)	Khanna & Damon (1999)	Videras & Alberini (2000)
	Program Features		
•Advertising Expenditure/Sales	•Advertising Expenditure/Sales	•Final Good (+)*	•Consumer Good
•33/50 Releases/Sales	•33/50 Releases/Employment	•Release-Output Ratio (+)*	
	•Non-33/50 TRI Releases/Employment		
	Mandatory Regulations		
	•Clean Air Act Compliance (1992-1994)	•Number of Superfund Sites (+)* •Number of Superfund Sites^2 (-)*	•PRP notification (+)**
		•HAP-33/50 Release Ratio (+)* •HAP-33/50 Release Ratio^2 (-)*	•RCRA Corrective Action(+)**

(Table A, continued)

Arora & Cason (1995)	Arora & Cason (1996)	Khanna & Damon (1999)	Videras & Alberini (2000)
	Firm Specific Characteristics		
•R&D Expenditures/Sales	•R&D Expenditures/Sales (+)*	•R&D Expenditures/Sales	•R&D Expenditure/Emp
•Employment (+)* •Employment^2 (-)*	•Employment (+)* •Employment^2 (-)*		•Employment
•Herfindahl Index (-)*	•Herfindahl Index		•TRI releases/Emp (past period)
•Weighted 33/50 Releases (+)*	•Aggregate 33/50 Releases •Aggregate 33/50 Releases^2	•Aggregate 33/50 Releases (+)* •Aggregate 33/50 Releases^2 (-)*	
	•Non-33/50 TRI Releases (+)* •Non-33/50 TRI Releases^2 (-)*	•33/50-TRI Release Ratio (-)*	
	•% Reduction in 33/50 Releases	•% Reduction in 33/50 Releases	
•Number of Categories of 33/50 Chemicals (+)*	•Number of Facilities	•Number of Facilities	•Industry Increase in sales •Past Period Increase in Sales
	•Green Lights Participation (+)*		•Environmental Performance is a factor in manager compensation (+)**
	•1st Invitation Group (+)* •2nd Invitation Group (+)*	•1st Invitation Group (+)*	•Firm publishes an environmental report (+)**
	•Invitation Group Selection Bias		•Firm considers environmental risks to select partner, suppliers, customers
•Profit (+)* •Debt-Asset Ratio		•Age of Assets (-)* •CMA Membership (+)*	•Firm conducts environmental compliance auditing

Note:

Dependent Variable: *Participation in 33/50 Program*

* indicates variable is statistically significant at least 10% level

(+) indicates positive impact on participation probability

(-) indicates negative impact on participation probability

^{2} indicates a squared term

HAP = Hazardous Air Pollutants

CMA = Chemical Manufacturing Association

PRP = Potentially Responsible Party for Superfund Sites

RCRA = fines charged for violation of Resource Conservation and Recovery Act hazardous waste regulations

Table B. Community Characteristics and the Distribution of Pollution

Dependent Variable	*Aggregate TRI Releases in 1993*	*Index of Exposure to Emissions*
Exogenous Variables	**Arora & Cason (1999)**	**Brooks & Sethi (1997)**
Race/Gender Variables	•% female headed households •% female headed households^2 (-)*	
	•% foreign born residents	
	•% non-white residents (-)* •% non-white residents^2 (+)*	•% black residents (+)*
Economic Variables	•Median Household Income (+)* •Median Household Income^2 (-)* •Median Household Income^3 (+)*	•Median Household Income (+)* •Median Household Income^2 (-)*
	•% residents below poverty •% residents below poverty^2 (+)*	•% residents below poverty (-)* •% residents below poverty^2 (+)*
	•Median rent in renter occupied housing units (-)*	•Median value of owner occupied housing units (-)*
	•% housing units vacant (-)*	•% housing units renter occupied (+)*
	•Unemployment •Unemployment^2 (+)*	
		•% workers in manufacturing (+)* •% population 25 years & older with college degree (-)* •% population 25 years & older with high school degree only (-)*

(Table B, continued)

Exogenous Variables	Arora & Cason (1999)	Brooks & Sethi (1997)
Political/Collective Action Variables	•% workers in manufacturing •% population 25 years and older with college degree •% workers 16 years and older who carpool to work •% workers 16 years and older who carpool to work^2 •% household with children below 18 years •% household with children below 18 years^2 •Median age of residents	•Voter turnout rate in 1992 Presidential elections (-)*
Other Control Variables	•% residents in urban area •% residents in urban area^2	•Rural-urban dummy variable (+)*
	•Total population	•Population density (+)*

Note: * indicates variable is statistically significant at the 10% level or less
(+) indicates positive impact on participation probability
(-) indicates negative impact on participation probability
^{2} indicates a squared term
^{3} indicates a cubic term