EPA s Voluntary 33/50 Program: Impact on Toxic Releases and Economic Performance of Firms

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This paper examines the motivations for participation in the voluntary 33/50 Program and the Program's impact on the toxic releases and economic performance of firms in the U.S. chemical industry. It demonstrates that the benefits due to public recognition and the potentially avoided costs of liabilities and compliance under mandatory environmental regulations provide strong incentives for participation. After controlling for sample selection bias and the impact of other firm-specific characteristics, this paper shows that Program participation led to a statistically significant decline in toxic releases over the period 1991-93. The Program also had a statistically significant negative impact on the current return on investment of firms, but its impact on the expected long run profitability of firms was positive and statistically significant.

1. INTRODUCTION

The existing prescriptive and inflexible command-and-control environmental regulations have contributed to rapidly rising costs of environmental protection in the U.S. The sixteen media-specific environmental laws make environmental regulations complicated and sometimes inconsistent as they shift pollution from one medium to another. A realization of the escalating cost of environmental protection has led to a re-engineering of environmental policy with a shift in emphasis towards self-regulated environmental management achieved through cooperative partnerships between firms and the EPA. This shift in paradigm led the EPA to initiate an array of partnership programs, such as the Common Sense Initiative, 33/50, and Green Lights[1], to promote proactive environmental management by firms. These programs encourage voluntary actions by firms to reduce pollution.

Voluntary approaches to pollution control offer certain advantages over mandatory regulations that impose technology restrictions or penalties on firms. They allow firms flexibility in their pollution control strategies. They also have the potential to reduce information costs and the administrative burden on environmental agencies. Several recent studies show theoretically that a firm's decision to voluntarily agree to reduce its pollution can be induced by a threat of mandatory environmental regulations (Segerson and Micelli, 1997), cost-sharing subsidies (Segerson, 1997), and a desire to improve public image (Arora and Gangopadhya, 1995). Other studies examine the potential for voluntary agreements negotiated between a regulator and firms to achieve social efficiency. They show that in the presence of asymmetric information and bargaining power between regulators and firms, these agreements may not achieve social efficiency or the optimal level of environmental quality (Hansen, 1997; Glachant, 1997).

Empirical research on the performance of voluntary programs for pollution control is limited to a few studies such as those by Arora and Cason (1995, 1996), which examine the factors that motivate firms to participate in the 33/50 Program. From an environmental policy perspective, it is also important to examine whether voluntary programs actually fulfill their promise as instruments of environmental policy and reduce pollution over and above the level that would have been achieved otherwise. It is necessary to explore the relative roles of mandatory regulations and voluntary programs in pollution control in practice. Are they complements or substitutes? It is also vital to examine the consequences of participation for a firm's economic performance. In the absence of the provision of any financial incentives by the government for participation in voluntary programs, the long term feasibility of such programs as instruments of environmental policy depends on their impact on a firm's profitability.

This paper analyzes these issues in the context of the EPA's 33/50 Program. It focuses in particular on the impact of the 33/50 Program on the toxic releases and economic performance of firms in the U.S chemical industry. The chemical industry generated the largest share of the toxic releases targeted by the 33/50 Program and had the largest number of participants in the Program among all manufacturing industries (EPA, 1995). This study examines the impact of the Program during its first three years, 1991-93. Section 2 presents background information about the 33/50 Program and motivations for this study. Section 3 discusses the conceptual framework and the empirical model. Section 4 describes the data used in this study. Sections 5 and 6 present the empirical results and assess the impact of the Program.

2. BACKGROUND

The 33/50 Program was launched by the EPA in 1991 to induce firms to voluntarily reduce their emissions of 17 high priority toxic chemicals. The goals of this Program were not media-specific, that is focused specifically on emissions to air, land or water. Rather, it aimed to reduce the aggregate releases of these chemicals by 33 percent by 1992 and by 50 percent by 1995 (GAO, 1994)[2]. Firms also had complete flexibility in the amount of reductions undertaken and the means used to achieve them. The EPA, however, encouraged firms to reduce pollution at source. Reductions were evaluated relative to the level of releases reported in the Toxic Release Inventory (TRI) for 1988[3]. Of the firms emitting one or more of these 17 chemicals in 1988, 14 percent had pledged their participation in the Program by 1993. The EPA (1995) reports that by the end of 1993, total releases of these chemicals had declined by 46 percent relative to the 1988 baseline, indicating that the Program's ultimate reduction goal of 50 percent was likely to be achieved a year ahead of schedule.

A closer look at the pattern of pollution reduction, however, casts doubts on the impact of the Program. Of the total reduction in the releases of these chemicals during 1988-93, 40 percent took place between 1988-90, before the Program was initiated. Between 1991-93, the releases by participants fell by 41 percent while those by non-participants fell by 18 percent. Davies and Mazurek (1996) and GAO (1994) in their assessment of the impact of the Program point out that it is inappropriate to attribute the entire reduction in releases that occurred since 1991 to the Program, because some of it was achieved by non-participants. While they conclude that the Program appears to be successful, they estimate its impact simply by the difference in percentage reductions in releases achieved by participants and non-participants.

Such a comparison is appropriate when participants and non-participants are identical in all respects other than their participation in the Program and there are no firm-specific characteristics and regulatory factors that could influence self-selection of firms into the Program and their subsequent toxic releases. This is typically not the case. We therefore specify a two-stage model that determines the outcome of program participation and the determinants of a firm's participation decision simultaneously, while controlling for sample selection bias and the effect of mandatory environmental regulations and other firm-specific factors on program outcome (Maddala, 1983).

Incentives to participate in voluntary programs depend critically on their impact on the economic performance of firms, particularly when the government does not provide any financial incentives for participation. Program participation may increase expenditures on labor and capital equipment in order to control pollution. But to the extent that participating firms benefit from technical assistance provided by the EPA and control their pollution generation at source by using their chemical inputs more efficiently (and increasing productivity of chemical inputs), they could reduce input costs. The reduction in current levels of pollution could also reduce environmental liabilities in the future and lower the (current and future) costs of compliance with mandatory regulations. A reduction in the pollution generated by firms could increase consumer goodwill, improve the public image of a firm and increase investor confidence. It may cause consumers to adjust their purchase decisions (Arora and Gangophadhaya, 1995) and investors to reevaluate a firm's expected future profits as demonstrated by Hamilton (1995) and Konar and Cohen (1997). Investors may perceive a firm that is committing to reducing its toxic pollution ahead of time by flexible methods as gaining a strategic advantage over its competitors. This together with reduced liabilities for Superfund sites and an expectation of lower costs of compliance with future environmental regulations could make a firm potentially more profitable in the long run than an identical firm that does not participate in the program. While many of the expenditures on pollution control, particularly on capital equipment, are likely to be incurred in the near term, most of the benefits may only be realized in the long run. The impact of the program participation on current and expected long run profitability of firms may therefore differ. In the next section we develop a conceptual framework to analyze these observed trends and to examine the extent to which they were influenced by the Program.

3. CONCEPTUAL FRAMEWORK

We assume that a rational firm chooses its levels of pollution generation at each point in time to maximize its discounted net benefits over a specified time horizon. The level of pollution to be generated at each point in time is then determined such that the marginal costs of generating pollution equal the marginal benefits of that pollution for the firm. The initiation of a voluntary program for pollution control could induce a firm to participate if the firm's expected discounted benefits from production with participation are greater than its expected discounted net benefits from production without participation in the program. While the program may not specify fixed goals for pollution reduction, it could induce a firm to reduce pollution below the level otherwise, if the discounted net benefits of doing so are positive.

We hypothesize that the *ith* ($i=1..I$) firm's pollution level at time t, Y_{it}, is determined by observed exogenous firm-specific variables, X_{1it} (such as a firm's production technology, level of output produced, input and output prices), and it's program participation decision, D_{it}. A firm's Program participation decision is typically observed as a discrete variable, equal to 1 if the firm participates and 0 otherwise. The program outcome model is specified as:

$$Y_{it}=X_{1it}\beta_1+\alpha D_{it}+\varepsilon_{1it} \qquad (1)$$

where ε_{1it} is a random error term. The model in (1) can also represent the reduced form equation to examine the impact of program participation on other endogenous variables such as a firm's profits. This participation decision, D_{it}, cannot however be treated as exogenous since the decision of a firm to voluntarily self-select into the program is likely to be influenced by the same observable and unobservable factors that determine Y_{it}. For example, a firm that undertakes larger investments in research and development (R&D) may be more likely to innovate lower cost methods of pollution control/waste reduction and may thus have greater incentives to self-select into the program than a firm that is not innovative. It is also possible that the former firm has lower emissions and higher profits even in the absence of the program. In order to correct for a bias due to self-selection, it is appropriate to model the participation decision of a firm as being an endogenous variable that is determined simultaneously with the outcome of the program.

The participation decision of a firm at time t depends on the discounted net benefits with and without participation at time t, that is on the net benefits from participation D_{it}^*. The *ith* firm's net benefit from participation is $D_{it}^*=X_{2it}\beta_2 + \varepsilon_{2it}$. The vector X_{2it} is a vector of exogenous variables for the *ith* firm and β_2 is a vector of parameters. We generally do not observe D_{it}^*. Instead what we observe is the firm's decision variable $D_{it}=1$ if $D_{it}^*\geq 0$; $D_i=0$ otherwise. With the assumption that ε_{2it} is independently and normally distributed, this relation can be represented using the probit model as follows:

$$D_{it}=F(X_{2it}\beta_2)+\mu_{it} \qquad (2)$$

where F is the cumulative distribution of the standard normal variate ε_{2it} (Maddala, 1983). Many of the variables included in the vector X_{2it} that are hypothesized to influence program participation are likely to be the same as those included in X_{1it} that influence the program outcome. The error terms ε_{1it} and ε_{2it} include measurement error and factors unobserved by the researcher, such as the 'green' preferences of the management that could affect both the decision to participate and the program outcome. These error terms are likely to be correlated.

In order to avoid self-selection bias in the estimation of equation (1) we use a two-stage least squares technique suggested by Lee and Trost (1978) and Barnow et al. (1981) and applied by Hartman (1988) to analyze the impact of voluntary programs on energy conservation. In the first stage, a probabilistic choice equation for the program participation decision (2) is estimated to obtain consistent estimates, $\hat{\beta}_2$. We then estimate the predicted probability, $\hat{D}_{it} = F(X_{2it}\hat{\beta}_2)$. We use this predicted probability as an explanatory variable in (1). Equation (1) can then be estimated using linear least squares regression to obtain consistent estimates of α and β_1.

In this study we have panel data for T years for the I firms. This provides multiple observations on each firm and allows us to take into account the impact of firm-specific effects on Y_{it} in (1) by estimating an error-components model after re-specifying the model in (1) as:

$$Y_{it} = \delta_i + X_{1it}\beta_1 + \alpha\hat{D}_{it} + \varepsilon_{1it}, \quad i=1,\ldots,I; \quad t=1,..T \tag{3}$$

where δ_i is a scalar constant representing the effects of omitted variables that are specific to the *ith* firm and constant over time (Hsiao, 1986). It is assumed that ε_{1it} is an independent and identically distributed random variable with mean zero and variance σ^2_ε. However, since the variance of the composite error term, $\delta_i+\varepsilon_{1it}$, is unknown a feasible generalized least squares (FGLS) method is used. When the firm-specific effects are correlated with the explanatory variables, X_{1it}, a fixed-effects model, which treats δ_i as a fixed constant, is appropriate. Alternately when δ_i is uncorrelated with X_{1it} a random-effects model is appropriate. The Lagrange Multiplier (LM) test is used to test the validity of using an error-components model and the Hausman test is used to select between a fixed and a random-effects model (Greene, 1993).

3.1. *Motivations for Participation in the 33/50 Program*

We now discuss the observable factors that may affect the *ith* firm's costs and benefits of participation and should be included in X_{2it}. Arora and Cason (1995) seek to explain a firm's motivation to participate by its size, financial characteristics, and desire for public recognition[4]. They find firm size to be significant but financial variables to be insignificant in explaining participation. Arora and Cason (1996) replace many of the financial variables by environmental performance variables, such as volume of toxic releases. They show that in addition to size, public recognition and volume of releases motivated participation. We build on these findings by hypothesizing that the incentives for participation arise from the following three sources.

A. Program Features

Participation in the Program provides certain direct benefits to firms. Their efforts to protect the environment are given public recognition through press releases, newsletters, and awards. This is expected to improve customer goodwill for participating firms. Firms that are in close contact with final consumers are expected to benefit more from this publicity. The Program also provides technical assistance to firms to help them identify and adopt innovative waste minimization practices, through nationally held workshops and computer bulletin boards. This lowers the costs of learning about waste-reducing practices. Such assistance is expected to benefit firms that have high waste-output ratios more than firms with low waste-output ratios.

B. Mandatory Environmental Regulations

The prescriptive nature of environmental regulations has typically been held responsible for inhibiting innovative and cost-effective strategies for pollution control. The threat of the imposition of penalties under mandatory environmental regulations may, however, motivate firms to participate in voluntary programs (Segerson and Miceli, 1997). Mandatory environmental regulations such as the Superfund Act of 1986 and the Clean Air Act (CAA) Amendments of 1990 make firms aware of the costs of their current toxic pollution to them, in the form of liabilities and compliance costs in the future.

Muoghalu et al. (1990) show that the greater the potential liabilities for environmental damages, the greater the deterrent effect of the Superfund Act on current pollution levels. Firms currently listed as potentially responsible parties (PRPs) for a larger number of Superfund sites are more likely to be aware of the liability costs of continuing to generate their past levels of toxic pollution. Such firms have greater incentives to reduce toxic pollution and are more likely to participate in the Program and showcase these efforts. We are not suggesting that participation would reduce their liabilities for environmental damages caused by pollution generated in the *past*. Instead, we are suggesting that participation may be motivated by a desire to reduce *current* levels of toxic pollution in order to reduce the likelihood of being held liable in the future.

The 17 chemicals targeted by the Program are among the 189 toxic chemicals covered by Title III of the 1990 CAA Amendments, which sets National Emission Standards for Hazardous Air Pollutants (NESHAP). Under NESHAP, emissions of these 189 toxic chemicals by air will be subject to the first major Maximum Available Control Technology (MACT) standards by the year 2000 (EPA, 1990). Awareness of the anticipated direction of environmental regulation may lead firms to seek to gain strategic advantage over their competitors by reducing their emissions of hazardous air pollutants ahead of time (Esty, 1997). Flexibility in the methods of reducing these pollutants are also expected to lower their costs of compliance with NESHAP in the future. Firms currently emitting a larger volume of hazardous air pollutants are expected to benefit more from their voluntary reduction.

C. Firm-Specific Characteristics

Firm-specific characteristics such as innovativeness, age of existing equipment, membership in industry trade association and volume of toxic releases are also expected to influence the costs and benefits of participation and thus the participation decision. Firms that are more innovative and undertake larger investments in R&D may have lower costs of participation in the Program, if their R&D is directed towards lower cost methods of pollution control. Firms with older assets may face lower costs of replacement than firms with newer assets. They may thus be more willing to undertake investments in new and more efficient equipment with a lower pollution intensity and to participate in the Program.

The Chemical Manufacturers Association (CMA) adopted Responsible Care in 1988, a voluntary initiative to continuously improve performance through responsible management of chemicals. All CMA-members are expected to make good faith efforts to implement the codes of management practices that form an integral part of Responsible Care. One of these codes is Pollution Prevention, which encourages ongoing reduction in waste. CMA-members are therefore more likely to participate in the Program because they may already be making efforts to reduce toxic pollution.

Firms emitting a larger volume of the 17 toxic chemicals may be more likely to participate because these chemicals were targeted by the Program and these firms may have experienced greater public pressure to reduce their emissions. These firms were also more likely to be invited by the EPA to participate in the 33/50 Program. Between 1991 and 1993, the EPA invited firms to participate in the Program in three phases. Firms with larger releases of 33/50 chemicals were included in the first group invited. However, despite EPA's invitation it was not mandatory for firms to participate. At the national level, while 60 percent of the 600 firms invited in the first group agreed to participate, the corresponding percentage for the second and third groups (which together included 7500 firms) was less than 15 percent. Thus firms in the first invitation group, in our sample, are expected to be more likely to participate than other firms.

The public disclosure of the TRI provides information to consumers, investors, and environmental groups about a firm's toxic releases. It also provides information to firms about their own toxic releases relative to those of their peers. This could have generated public and peer pressure and led firms to begin reducing their releases even prior to the announcement of the Program. *Toxics Watch* (1995) reports that 31 percent of the participants had achieved some reductions in releases prior to the 33/50 Program. Since reductions in the releases of 33/50 chemicals are measured relative to the 1988 baseline, firms that had already achieved large reductions in their releases between 1988 and 1990 would have greater incentives to participate since they have smaller additional costs of emissions reduction. Additionally, firms that are highly dependent on 33/50 chemicals as inputs in the production process are likely to find it more difficult to substitute other chemicals and would be less willing to participate. We therefore include the ratio of 33/50 releases to all TRI Releases by a firm as an explanatory variable. Finally, firms with a larger number of facilities have a greater likelihood of participation, since a firm was considered a participant if even one of its facilities volunteered to join[5].

3.2. *Impact of the 33/50 Program on a Firm s Environmental Performance*

We hypothesize that a firm's decision about the volume of releases of the 17 toxic chemicals to generate is influenced both by its Program participation and by other factors such as output levels, pressure from 'green' consumers, potential costs of compliance and liabilities under mandatory environmental regulations, and firm-specific characteristics. Many of these factors influence the Program participation decision and also have a direct effect on the level of toxic releases generated. These factors include pressure from consumers and from government regulations that have been found to be important factors in influencing companies to formulate environmental plans (Henriques and Sadorsky, 1996). Pressure from consumers is more likely to be felt by firms that are in closer contact with final consumers, that is, firms selling final goods. The threat of potential liabilities under the Superfund Act is likely to deter the generation of toxic pollution by firms. Firms anticipating an increased stringency in regulation of hazardous air pollutants are likely to make efforts to reduce them ahead of time by lower cost flexible methods rather than being subjected to high cost technology standards in the future. These incentives are expected to be stronger among firms currently emitting a larger volume of these pollutants.

Firm-specific characteristics that are expected to influence the volume of the releases of the targeted chemicals are: volume of sales, sales to asset ratio, rate of sales growth, age of assets, number of facilities, membership in the CMA, innovativeness of a firm and ease of input substitutability. Input and output prices could also influence the volume of toxic releases. Due to lack of data on firm-specific input and output prices and since we are focusing on firms in one industry, we make the simplifying assumption that they face similar prices and exclude prices as explanatory variables. Sales is used as a proxy for output. The recessionary trend in the U.S economy in the early 1990's led to a decline in sales for many firms. This could have directly led to a reduction in their emissions. However, the ability of a firm to undertake proactive measures for pollution control is also likely to be influenced by its financial health, which could be impaired during a recession. We control for these impacts by including sales per unit assets and rate of sales growth as explanatory variables. The sales-asset ratio is used as a measure of capacity utilization and financial health of a firm. We assume that firms take their sales and existing stock of assets as given at a point in time. Newer equipment is expected to be more efficient and environmentally friendly than older equipment and thus the volume of emissions is likely to be positively related to the age of assets. The number of facilities owned by a firm indicates the extent to which its operations are dispersed geographically. This could influence information flows within a firm and its costs of pollution control. Due to the CMA's emphasis on Responsible Care, CMA-membership could lead to lower pollution. A firm's innovativeness as indicated by its R&D expenditures per unit sales could also lead to lower pollution, if it is directed towards reducing the costs of pollution control. A firm's ability to reduce its releases is also expected to depend on the ease with which it can substitute other inputs for the 33/50 chemicals. Firms having a high proportion of 33/50 chemicals among the toxic chemicals employed by them, as well as those with a high ratio of 33/50 chemicals to total output are more dependent on these chemicals and are expected to find it more difficult to substitute other inputs for 33/50 chemicals. We therefore expect such firms to have larger 33/50 Releases.

3.3. *Impact of the 33/50 Program on a Firm s Economic Performance*

Participation in the Program is expected to have different impacts on the current and expected long run economic performance of a firm. While a large part of the costs of participation are likely to be incurred immediately following the participation decision, many of its benefits may only be realized in the long run. Therefore the impact of Program participation on current and on long-term economic performance of firms needs to be measured separately.

An extensive survey of the literature by Capon, Farley and Hoenig (1996) shows that accounting measures, such as return on assets and return on investment, are used most frequently to measure a firm's economic performance. Accounting rates of return are, however, backward-looking since they register the success of past and current investments (Rappaport, 1983; Ross, 1983). Among the accounting measures, return on investment (ROI) has been shown by

Jacobson (1987) to be superior to alternative accounting measures as a measure of a firm's current performance. We therefore measure current economic performance of a firm by its ROI [6].

Jacobson's (1987) analysis, however, also shows that the ROI should be expected to understate long-term profitability of a firm because it does not reflect market expectations. On the other hand, market value data provide a future-oriented measure of a firm's economic performance. Under the efficient capital markets hypothesis a firm's market value fully reflects the discounted value of the future profits of the firm after incorporating all available information about it (Fama, 1991). The market value of a firm therefore reflects ex-ante rates of return on investment, that is, current expectations about a firm's ability to achieve profits in the future. A widely adopted market-value based measures of profits is EV/S which is defined as the excess of market value over the book value of assets normalized by sales (Hirschey and Wichern, 1984; Thomadakis, 1977): EV/S= [Market Value of a firm-Book Value of Assets] / Sales

An attractive feature of EV/S is that it controls for variation in capital intensity and size across firms. It provides a measure of the value premiums or discounts accorded by the market to a firm based on how the market evaluates the future prospects of that firm. Cochrane and Wood (1984) find a positive and significant relationship between an index of corporate social responsibility of firms and their EV/S. To the extent that participation in the 33/50 Program improves a firm's economic performance in the long run we would expect it to have a positive impact on EV/S. Since there are information and transactions costs, both ROI and EV/S should be viewed as noisy indicators of economic performance.

The variables hypothesized as determinants of ROI and EV/S in this study have been frequently used in the literature (see survey in Capon, Farley and Hoenig, 1996). These include a firm's sales, capacity utilization ratio (measured by its sales-asset ratio), rate of sales growth, age of equipment, innovativeness, the riskiness of return, the nature of the products it sells and measures of environmental/social responsibility. Lower sales imply lower revenues, while a lower sales-asset ratio indicates idle capacity. Since lower values of both these variables also imply lower expenditures on variable inputs their net impact on profits is an empirical issue. Firms with high rates of growth of sales are likely to demand higher rates of investment in capital. Assuming that there are imperfections in the operation of the market and that rapid expansion is more profitable than slower expansion, one might expect higher rates of return on investments in such firms due to slow adjustments in the supply of capital to such firms (Nerlove, 1968). To the extent that future rates of growth of demand can be proxied by past ones, a high rate of growth of sales should also have a positive impact on future profitability of a firm and thus on EV/S.

The age of a firm's assets could also have conflicting effects on its profits, since newer equipment could be more productive but also more expensive than existing equipment. The impact on profits of restructuring/expansion, of CMA's Responsible Care Program, and of innovativeness is captured by including number of facilities, CMA-membership, and prior R&D expenditures per unit sales as explanatory variables. We control for the impact of riskiness of a firm's investments on its ROI and future profits by including Beta as an explanatory variable. A beta value greater than 1 implies a more volatile stock relative to the general market. The traditional theory relating risk and rate of return assumes that most stockholders are risk averse and therefore require a higher return, a "risk premium" for taking on more risk (Tobin, 1957). Thus we expect a positive correlation of beta with ROI and EV/S under this hypothesis.

In addition we also expect firms listed as PRPs for Superfund sites to experience a negative impact on their current and future profits due to adverse publicity, legal expenses, and clean-up costs. Cohen et al. (1995) find that firms listed as PRPs for a smaller number of

Superfund sites had higher average stock market returns than firms listed as PRPs for a larger number of sites. Additionally, we expect that while the impact of a larger volume of hazardous air pollutants on current profits could be positive or negative, investors are likely to anticipate that a high volume of these pollutants will impose high costs of clean up (and thus lower profits) in the future under the proposed MACT standards. Finally, we expect that participation in the program could directly impact a firm's economic performance for reasons discussed in Section 2.

4. DATA

This study utilizes firm-level data on environmental and financial variables for publicly traded firms having primary business in Standard Industrial Classification (SIC) code 28, the code associated with chemicals and allied products. These firms were identified using the Standard & Poor's Compustat (S&P) database, the CD Corporate database, the TRI, and the list of members of the CMA. The TRI reports information on on-site toxic releases and off-site transfers on a facility-specific and a chemical-specific basis. The other databases provide information at the corporate or parent company level. Each facility reporting to the TRI is identified by its name, its four-digit primary SIC code, its parent company name, and the Dun and Bradstreet (D&B) number of its parent company. Facilities reporting to the TRI were grouped together by their parent company name or by the D&B number of their parent company in order to compile the TRI data at the parent company level. Ward's Business Directory and the Directory of Corporate Affiliations were used to identify the parent companies of facilities that did not list parent company name or D&B number.

Using these criteria, 165 firms were initially identified as being part of the chemical industry. From this set, 24 firms that were not considered "eligible" to participate in the 33/50 Program were excluded. Eligible firms are those that report emissions of at least one of the 17 targeted chemicals in 1988 or 1989. Of the remaining firms, complete financial data were not available for 18 firms for all years. Their exclusion resulted in a sample of 123 firms. These 123 firms accounted for 21 percent of the 33/50 Releases generated by all firms reporting to the TRI in 1988. Of these 123 firms, 59 firms were included in the first phase of invitations by the EPA for participation in the 33/50 Program in March 1991. Forty-four of these firms and 11 of those included in a second invitation group (invited later in 1991) had agreed to participate by the end of 1991. Of the remaining 68 firms, 13 agreed to participate in 1992 and 7 agreed to do so in 1993, bringing the total number of participants in our sample to 75.

The first part of our empirical analysis is an investigation of the determinants of the participation decision of firms, over the period 1991-93, using a probit model with pooled time-series and cross-section data. Firms that committed their participation in the 33/50 Program did so for the entire duration of the Program (1991-95). The decision making process of a firm that agreed to participate in 1991 is therefore observed only once. However, companies that did not participate initially had subsequent opportunities to change their decision, and several firms that were initially invited to participate by the EPA did not choose to do so until one or two years later. A firm that participated in 1991 is therefore included only once in the pooled data. Firms that chose not to participate until 1992 appear twice in the pooled data: once as a non-participant in 1991 and once as a participant in 1992. Firms that decided to participate in 1993 or did not participate at all appear three times in the pooled data. The dependent variable D_{it} in (2) is equal to zero if the *ith* firm does not participate in the Program at time t. The variable D_{it} is equal to one if the firm participates for the first time at time t and the *ith* firm is then excluded from the sample for the remaining years. This leads to 246 pooled observations.

The explanatory variables used in the participation model (2) include both dummy variables and time-dependent continuous variables. All time-dependent explanatory variables are measured at time *t-1* so that they are not endogenous with the participation decision. We include 33/50 RELEASES as an explanatory variable to examine the direct effect of the volume of these releases by a firm on its participation decision. We define annual 33/50 Releases for each firm (parent company) as the aggregate of all annual on-site releases (to air, land, water, and underground injections) and annual off-site transfers (to treatment, storage, and disposal facilities) of the 17 chemicals by each facility of a parent company[7]. In order to measure the incentives provided by previously achieved reductions in 33/50 Releases for Program participation, we include the variable PERCENT PRIOR REDUCTION IN 33/50 RELEASES. It is defined as the percentage reduction in the level of 33/50 Releases between the base year 1988 and the year (*t-1*) prior to the one in which a firm decides whether or not to participate in the Program. Larger prior reductions in 33/50 Releases imply a larger positive value of this variable.

The direct benefits of Program participation in the form of public recognition and technical assistance are expected to benefits firms that are closer to final consumers and firms that have high waste-output ratios respectively. We create a dummy variable, FINAL GOOD, equal to one if the firm sold finished products such as pharmaceutical preparations, soaps, other detergents, and cosmetics. The dummy variable is equal to zero if the firm produced intermediate goods such as industrial chemicals[8]. We use the 4-digit secondary SIC code of the sample firms to identify firms that sold final goods. The waste-output ratio (RELEASE-OUTPUT RATIO) of a firm is measured by the ratio of annual 33/50 RELEASES to annual SALES. The impact of input substitutability is measured by including the ratio of 33/50 Releases to total TRI releases (33/50-TRI RELEASES RATIO) as an explanatory variable.

We proxy the impact of the Superfund Act on participation by including the NUMBER

OF SUPERFUND SITES for which a firm is a PRP as an explanatory variable. Data on the number of sites for which a firm is listed as a PRP were obtained from the Site Enforcement Tracking System (EPA, 1996). To measure the impact of the proposed MACT standards which are expected to be imposed on hazardous air pollutants (HAP) on incentives for participation we construct a variable, HAP-33/50 RELEASES RATIO. This is the ratio of the aggregate volume of the 189 hazardous air pollutants (HAP) generated by a firm per unit of its 33/50 Releases. This allows us to examine the additional incentives for participation among firms with a high volume of HAP relative to their 33/50 Releases. It also allows us to distinguish the incentives created by NESHAP from those created by the high volume of 33/50 Releases itself. Information on the 189 HAP chemicals covered by NESHAP was obtained from EPA (1990) and their firm-specific volumes were obtained from the TRI.

Data on several variables such as a firm’s return on investment (ROI), its excess value per unit sales (EV/S), annual sales (SALES), age of assets (AGE), R&D expenditures per unit sales (R&D/SALES), NUMBER OF FACILITIES, rate of growth of sales (SALES GROWTH) and sales per unit assets (SALES/ASSETS) were obtained from the S&P Compustat database. A measure of AGE of assets is obtained by dividing the total assets of a firm by its gross assets (Cohen et al., 1995). Total assets are defined as current assets plus net property plant and equipment plus other non-current assets. Gross assets are defined as total assets plus accumulated depreciation on property, plant, and equipment. AGE takes a value between 0 and 1 with higher values indicating newer plant and equipment with more current assets and smaller accumulated depreciation. Year-end values of Beta are obtained from the Center for Research in Security Prices database. Firms that are CMA-members are distinguished by a dummy variable, CMA (=1 for a CMA-member and 0 otherwise). CMA-membership is considered an exogenous variable because all sample firms that were CMA-members had been members before the inception of the 33/50 Program. We construct a dummy variable, FIRST INVITATION GROUP (=1 if a firm was included in the first invitation group and 0 otherwise)[9].

Summary statistics (Table 1) show that on an average the participants were generating larger volumes of the 33/50 Releases and had larger sales. They also had larger release-output ratios, older assets, and a higher HAP-33/50 Releases ratio. Two-thirds of the participants in our sample were CMA-members, while about one-third of participants were selling final goods.

In the second part of the study, we examine the impact of the Program on the 33/50 Releases generated by firms and on their current and long run economic performance. We estimate three regression equations, with 33/50 Releases, ROI or EV/S as dependent variables using panel data estimation methods. We use a six-year balanced panel data set covering the period 1988-1993 for 123 firms, which results in 738 pooled observations. This data set enables us to assess the impact of the Program by analyzing the trend in the endogenous variable for each of the two groups, participants and non-participants, both before (1988-90) and during the Program years (1991-93). It also allows us to base our assessment of the Program on a comparison of the behavior of participants relative to non-participants during the Program years 1991-93.

In addition to the explanatory variables described above we construct the predicted PROBABILITY OF PARTICIPATION of the *ith* firm at time t (*=1991, 1992, 1993*). It is estimated using the estimated parameters of equation (2) (as in Hartman, 1988). It takes a value of zero in the years 1988-90 when the Program was not in existence. The HAP-33/50 Releases ratio, R&D/Sales, Release-Output ratio, 33/50-TRI Releases ratio and Beta are measured at time $t-1$ to prevent endogeneity. The HAP-33/50 Releases ratio is also assigned a value of zero for the years up to 1990, since the CAA Amendments became effective after 1990.

The recursive structure of the two-stage-least-squares model specified here requires that there be at least one variable in X_{2it} that does not appear in X_{1it} (Heckman, 1978). Two variables included in (2), namely first invitation group and percent prior reduction in 33/50 Releases are excluded from (3). While invitation group is likely to have influenced the participation decision, it is unlikely by itself to have any influence on a firm's subsequent level of 33/50 Releases or profits, except through Program participation. Similarly percent prior reduction in releases (over the period 1988-90) is likely to have created incentives for participation in the program but is not a meaningful variable to explain the level of releases or profits in a given year, particularly during the years 1988-90. We confirm the validity of excluding them by computing the F-test statistic (F_2 in Table 4) (MacKinnon, 1992).

5. RESULTS

5.1. *The Participation Decision*

We estimate two alternative specifications to analyze the factors motivating participation in the 33/50 Program. The results of these two models are presented in Table 2. Model I includes 33/50 Releases, while Model II includes First Invitation Group as an explanatory variable. As expected, the volume of 33/50 Releases is strongly positively correlated with First Invitation Group indicating that the EPA first invited firms with the largest 33/50 Releases. We therefore exclude the variable 33/50 Releases from Model II. The Davidson and Mackinnon (1984) test for heteroskedasticity due to variability in firm size (as measured by 33/50 Releases) rejects the presence of heteroskedasticity at the 5 percent level in all models.

Both models show that the desire for public recognition and increased consumer goodwill provide statistically significant incentives for firms selling final goods to participate in the Program. Larger reductions in releases achieved prior to Program participation have an insignificant effect on participation. This suggests that participants were not simply free-riding on reductions achieved prior to the initiation of the Program. These results reinforce the findings of Arora and Cason (1996). Additionally, we find that firms with larger release-output ratios are more likely to participate. The potential for liabilities under the Superfund Act and costs of compliance with NESHAP also create strong motivations for participation in the Program.

CMA-members are significantly more likely to participate than non-members. The negative sign of age of assets indicates that firms with older assets are more likely to participate. Firms with a high ratio of 33/50 Releases to total toxic releases are less likely to participate in the program because these firms would find it more difficult to substitute other chemicals for 33/50 chemicals. The innovativeness of firms does not have a significant impact on the participation decision in Models I and II. Model I shows that firms with larger 33/50 Releases were significantly more likely to participate. However, as compared to its volume of 33/50 Releases, a firm's inclusion in the first invitation group appears to be better at explaining its participation decision. It not only has a significant positive impact on the participation decision but also improves the number of correct predictions in Model II. This implies that in many cases firms with relatively low emissions participated simply because they had been invited first by the EPA.

In other words, these results show that firms that participate are those that expect larger benefits or have relatively lower costs of participation. This includes firms that stand to benefit from increased consumer goodwill, from reducing potential liabilities by changing their current pattern of pollution generation, and from lower costs of abatement in the future under the proposed MACT regulations. Firms that had initiated efforts to control toxic pollution under the initiative of CMA, had assets close to retirement and could substitute other chemicals for 33/50 chemicals more easily have lower costs of participation and are more likely to participate. Greater predictive power of Model II as compared to Model I and a lower value of the Akaike information criterion (0.89 for Model II as compared to 1.005 for Model 1) led us to use the parameters of Model II to estimate the predicted probabilities of participation for estimating (3).

To analyze the importance of factors such as the threat of mandatory regulations and the design of voluntary programs for inducing participation, we examine the impact of marginal changes in these factors on the probability of participation, using the parameters of Model II, evaluated at the median value of all the explanatory variables in the model (Table 3). Each entry in Table 3 shows the effect of an incremental change in the indicated variable (or a change from 0 to 1 in the case of dummy variables) on the estimated participation probability while holding all other variables constant. EPA's policy of targeting the invitations first towards firms with the largest 33/50 Releases increased the probability of participation by 29 percent. The provision of public recognition increased the probability of participation by 8.9 percent. Marginal increases in the potential costs of compliance with NESHAP or in the potential liabilities for Superfund sites from the sample median level also increased the probability of participation significantly.

These results suggest the importance of designing voluntary programs such that they have features that provide direct benefits to participants. Appropriate targeting of these programs to potential participants can also increase participation. Furthermore, these results show that mandatory regulations that provide a credible threat of penalties and compliance costs if pollution is not voluntarily controlled can induce environmentally proactive behavior by firms. Voluntary programs and mandatory regulations should therefore be regarded as complementary instruments.

5.2. *Determinants of 33/50 Releases and Economic Performance*

The results of the estimation of the Program outcome models analyzing the determinants of 33/50 Releases, ROI, and EV/S are presented in Table 4[10]. In column 1, the dependent variable 33/50 Releases is logged. The output variable (Sales) used here is also logged. Since pollution can be considered an input into the production process with a positive marginal product, we expect a positive relationship between pollution and output. A log-log relationship between pollution and output is preferable to a linear one because we anticipate that firms with a large pollution-output ratio would be able to reduce their pollution much more by reducing production as compared to firms that have a small pollution-output ratio. A linear relationship implies that the marginal impact on pollution levels of a change in output is the same across all firms[11]. A grid search for the appropriate specification using the Box-Cox Model confirms the validity of this model by indicating that the optimal value of λ is zero with a p-value of 1 (Table 4) (Green, 1990). We also test for the appropriateness of a fixed/random effects model instead of a classical ordinary least squares regression model (that is, with an intercept, $\delta_i=\delta$) by using the LM test. The LM test statistic (Table 4) supports the former model. Since there are some explanatory variables (FINAL GOOD and CMA) that are invariant over time, the Program outcome model in (3) cannot be estimated as a fixed-effects model (Hsiao, 1986). We therefore use FGLS to estimate (3) as a random-effects model.

The results of this estimation are in Table 4. They show that mandatory regulations and several firm-specific characteristics had a direct effect on 33/50 Releases irrespective of participation. Large and increasing potential liabilities under the Superfund Act and costs of compliance with the proposed NESHAP standards had statistically significant deterrent effects on the level of 33/50 Releases generated by a firm. Sales is positively and significantly related to the volume of 33/50 Releases. As sales per unit assets fall indicating the presence of idle capacity in a firm, pollution levels also decline significantly. Firms with newer assets (larger value of the AGE variable) or those with a high rate of asset replacement had lower 33/50 Releases. The positive coefficient of CMA-membership could be due to the cross-sectional effect of CMA-members having much larger releases than non-members at any point in time.

These results bring forth the factors that explain the reduction in releases among both participants and non-participants over the period 1988-93. These factors would have led to a decline in releases even in the absence of the 33/50 Program. However, even after controlling for the direct effects of these variables on the level of releases, we find that Program participation led to a statistically significant decline in these releases. Thus both mandatory regulations and the voluntary program complement each other in inducing a reduction in a firm's releases. The coefficient of the predicted probability of participation variable implies that a 10 percent increase in the probability of participation of a firm reduces its 33/50 Releases by 5.1 percent.

Sigman (1996) provides empirical evidence that media-specific regulations lead firms to engage in cross-media substitution of toxic releases, that is to reduce emissions to one type of media (air, water or land) by increasing emissions to another media. In order to determine whether that was the case with the 33/50 chemicals we examine the impact of program participation on various components of 33/50 Releases by media, that is, releases to air, water, land and disposal facilities as well as on toxic chemicals other than 33/50 chemicals. The dependent variable in each of these models and the explanatory variable sales are both in logs. We find that program participation had a significant negative impact on emissions to all major media to which they were discharged: air, land, water and disposal facilities (Table 5). This is likely to be a consequence of the fact that the goals of the 33/50 Program were not media specific. Instead the Program encouraged integrated environmental management and reduction in total emissions. Hence it did not create incentives for cross-media substitution. We also find that program participation has a negative impact on non 33/50 Releases but it was less significant than on 33/50 Releases. This suggests that process and product changes induced by Program participation had scope effects that led to a reduction in releases of other chemicals as well.

The model specifications for the models with ROI and EV/S as dependent variables are also determined using the Box-Cox Model. It indicates the appropriateness of a linear model with ROI as the dependent variable and a semi-log model with EV/S as the dependent variable. In both these models we find that rate of growth of sales and the sales-asset ratio have a positive and significant impact on economic performance (Table 4). As sales increase, EV/S increases significantly. The number of Superfund sites for which a firm is a PRP has a significant negative impact on EV/S while the impact on ROI is negative but not statistically significant. Firms selling final goods are more profitable than those selling intermediate goods. Firms that are more risky have higher ROI and EV/S confirming the risk premium hypothesis.

After controlling for the effects of firm-specific factors, we find that the Program led to a statistically significant decline in ROI. This suggests that strategies pursued by participants to reduce their 33/50 releases imposed costs on them that were not fully offset in the current period. However, the effect of the Program on EV/S is positive and statistically significant, indicating that investors expect the costs of participating and improving environmental performance to be offset in the future by lower environmental liabilities, lower abatement expenditures, increased consumer goodwill, and savings in input-costs due to increased efficiency in production. Therefore, while the immediate impact of participation in the program on profits is negative relative to the non-participants, in the long run, participants are expected to be more profitable.

6. EVALUATION OF THE IMPACT OF THE 33/50 PROGRAM

We now use the parameters of the participation model and the Program outcome model to examine the extent to which changes in the volume of 33/50 Releases, ROI and EV/S of firms can be attributed to Program participation. We first estimate the predicted probability of participation for each firm for each of the years 1991-93. In order to examine the variability in the impact of Program participation on firms with different characteristics, we categorize firms according to their membership in the CMA, inclusion in the first invitation group, and the type of goods sold. The median predicted probability of participation of CMA-members (0.68) is much higher than that for CMA non-members (0.09) (Table 6). Firms that sold final goods and those included in the first invitation group have higher probability of participation than others.

We next estimate the predicted aggregate levels of annual 33/50 Releases for sample firms at the start of the 33/50 Program using the parameters of Table 4 and assigning a value of zero to the probability of participation while specifying all other firm-specific variables at their values for 1990 (col. 4, Table 6). We then use the predicted probability of participation in the Program for each of the sample firms and the estimated value of the coefficient a from (3) (as reported in Table 4) to estimate the predicted reduction in 33/50 Releases by each firm in each of the years, 1991-93. This predicted annual reduction due to the Program in each of the years (1991-93) is calculated relative to the pre-Program (1990) level of emissions. The average of these predicted annual reductions over the three years yields the expected impact of the Program on 33/50 Releases over the period 1991-93 while keeping all other factors constant at their pre-Program level in 1990 (col. 6, Table 6). Aggregating the expected reductions in releases due to the Program for all firms, we find that the expected reduction that can be attributed to the Program is 0.67 million pounds. This implies that the Program led to an expected reduction of 27.92 percent relative to the pre-Program level over the period 1991-93.

The impact of participation on 33/50 Releases varies across firms depending on their characteristics and probability of participation. The expected impact of Program participation is larger for CMA members than for non-members (28.4 percent by members relative to 14.95 percent by non-members). This is because CMA members had a much higher probability of participation than CMA non-members. Program participation also led to larger reductions in releases by firms that sold final goods and were included in the first invitation group.

We similarly calculate the impact of Program participation on ROI and EV/S. For brevity we only report the summary results for all firms in Table 7. These results show that the Program led to an expected decline of 1.2 percent in average ROI of firms but an expected increase of 2.2 percent in average EV/S over the period 1991-93. This suggests that while the immediate impact of program participation on firms was negative, possibly due to the increased expenditures on pollution control, investors expect such firms to be more profitable in the long run.

7. CONCLUSIONS

Voluntary programs for pollution control offer an innovative approach to environmental regulation. They are likely to increase the cost-effectiveness of environmental protection by allowing firms flexibility in their method of pollution control and by reducing the information and administrative costs of regulation. This paper evaluates the potential of voluntary programs as instruments for regulating toxic releases as well as their role vis-à-vis mandatory regulations. It also analyzes the impact of participation in such programs on the short run and long run economic performance of firms. This paper focuses in particular on the 33/50 Program during its first three years, 1991-93, and its impact on the US chemical industry. The evaluation of this Program is based on a two-stage generalized least squares method that corrects for self-selectivity bias and controls for the impact of firm-specific characteristics.

The empirical analysis demonstrates that the participation decision of firms was motivated by rational economic self-interest. Expected gains due to public recognition and technical assistance offered by the Program and the potential to avoid liabilities and high costs of compliance in the future under mandatory environmental regulations provided incentives for participation in the Program. This suggests that participation in voluntary programs depends to a considerable extent on the existence of a regulatory framework that would impose penalties on firms that do not undertake proactive measures for self-regulation. Voluntary programs are likely to be less effective without the backstop of mandatory regulation. Both approaches, however, need to be designed to take into account the exposure patterns generated by toxics in order to increase the efficiency of pollution control (Markowitz and Considine, 1996).

Our analysis also demonstrates that the 33/50 Program had a significantly negative impact on the releases generated by firms even after controlling for sample-selection bias and the impact of mandatory regulations and firm-specific characteristics. While the amount of pollution reduction that can be attributed to the Program is less than the total observed reduction by participants, the Program is estimated to have led to a reduction of 27.92 percent in expected 33/50 Releases relative to the pre-Program level over the period 1991-93. The immediate effect of the Program on the ROI of firms was significantly negative. The costs of pollution control were apparently not fully offset in the short run by improvements in consumer goodwill and gains in input-use efficiency. However, the Program had a positive and statistically significant impact on Excess Value/ Sales, implying that investors anticipate that in the long run the current efforts at pollution control by participants will improve their expected profitability.

Table 1: Descriptive Statistics Mean levels and Standard Deviations

Variable	Participants	Non-Participants	All Firms
Sales ($M)	10109.50 (16812.94)	1227.75 (2010.27)	6643.45 (13854.26)
No. of Facilities	25.23 (23.59)	8.19 (8.46)	18.58 (20.85)
No. of Superfund Sites	14.25 (14.15)	3.44 (5.50)	10.03 (12.70)
AGE of Assets	0.73 (0.10)	0.83 (0.08)	0.78 (0.10)
HAP-33/50 Releases ratio	3.16 (5.47)	2.29 (5.02)	2.69 (5.23)
33/50 Releases (M Lbs.)	2.76 (6.24)	0.36 (0.9)	1.82 (5.03)
R&D/Sales	0.05 (0.07)	0.09 (0.20)	0.07 (0.14)
Release-Output Ratio (Lbs per $M)	.0005 (.0009)	.0006 (.0012)	.00059 (.00105)
Sales-Asset Ratio	1.151 (0.36)	1.146 (0.46)	1.148 (0.4)
33/50-All TRI Releases Ratio	.226 (.192)	.381 (.324)	.286 (.262)
Sales Growth	8.07 (11.18)	15.27 (59.4)	10.88 (38.29)
Beta	0.99 (0.34)	0.89 (0.37)	0.95 (0.36)
ROI[a]	12.3 (10.16)	9.3 (9.2)	11.17 (9.89)
EV/S[a]	0.054 (1.07)	0.045 (1.37)	0.05 (1.19)
First Invitation Group*	54	5	59
Final Good*	23	9	32
CMA*	55	9	64
N	75	48	123

Note: Mean levels and standard deviations (in parenthesis) are calculated using 1990 data.
*This is a dummy variable for which total number of firms in each category are reported.
[a]For these variables, data was available for 117 firms; 45 of which were non-participants and 72 were participants.

Table 2: Motivations for Participation in the 33/50 Program

Dependent Variable: Participation in the 33/50 Program

Motivating factors	Variable [a]	Model I	Model II
Program features	Final Good	0.56 (0.25)**	0.48 (0.25)*
	Release-output ratio	0.15E-03 (.11)	0.13E-03 (.69E-04)*
Mandatory environmental regulations	No. of Superfund Sites	0.44E-01 (0.21E-01)**	0.35E-01 (0.2E-01)
	No. of Superfund Sites squared	-0.75E-03 (0.36E-03)**	-0.55E-03 (0.33E-03)
	HAP-33/50 Releases ratio	0.10 (0.69E-01)	0.13 (0.70E-01)*
	HAP-33/50 Releases ratio squared	-0.27E-02 (0.24E-02)	-0.39E-02 (0.24E-02)*
Firm-specific characteristics	AGE of Assets	-1.93 (1.11)*	-1.16 (1.15)
	CMA	0.68 (0.26)***	0.48 (0.27)*
	R&D/Sales	-0.56E-03 (0.96E-03)	0.39E-03 (0.98E-03)
	No. of Facilities	0.31E-02 (0.90E-02)	0.37E-04 (0.86E-02)
	33/50 Releases (M Lbs.)	0.13 (0.75E-01)*	
	33/50 Releases squared	-0.35E-02 (0.20E-02)*	
	First Invitation Group		1.15 (0.24)***
	33/50-All TRI Releases Ratio	-0.76 (.47)*	-0.81 (.47)*
	Percent Prior Reductions in 33/50 Releases	0.12E-01 (0.15E-01)	0.68E-02 (0.14E-01)
	Intercept	0.54E-01 (0.95)	-0.66 (0.99)
No. Classified correctly with N=246	Participants Non-participants	43/75 153/171	53/75 159/171
	Log likelihood value	-104.57	-95.86
	χ^2[14]	93.4{0}	110.83 {0}
	χ^2_{Het}[1]	3.46	1.01

[a] All explanatory variables are lagged by one year relative to the year, 1991-93, in which the dependent variable is observed. Standard errors are in parenthesis. Degrees of freedom are in square brackets. P-value is in curly brackets. χ^2[14] is a chi-square test for all slope coefficients jointly equal to zero. χ^2_{HET}[1] is a Davidson and Mackinnon (1984) LM test for heteroskedasticity using 33/50 Releases as a regressor. $\chi^2_{0.05}$[1] =3.84. *** Statistically significant at the 1% level; ** Statistically significant at a 5% level; *Statistically significant at a 10 % level (two-tailed tests).

Table 3: Impact of Regulatory Variables and Program Features

Variable	% Change in Probability of Participation
No. of Superfund Sites	0.41 (0.25)
HAP-33/50 Releases ratio	1.58 (0.96)*
Final Good	8.98 (3.33)**
Release-Output ratio	.0017 (.00092)*
First Invitation Group	29.93 (3.23)***

Note: Each entry indicates the percent change in probability due to a marginal change in the indicated variable from the median level in the case of continuous variables and from 0 to 1 in the case of dummy variables. Change is calculated using the estimates obtained in Table 2, Model II. Standard Errors are given in parentheses.
*** Indicates significant change at 1% level, ** Indicates significance at 5%, * Indicates significance at 10% level.

Table 4: Determinants of 33/50 Releases and Economic Performance (1988-93)

Independent Variables	33/50 Releases (M Lbs.)	Return on Investment	Excess Value/Sales
Sales	0.811 (0.143)***	-0.37E-04 (0.74E-04)	0.038 (0.014)***
Sales-Asset Ratio	0.637 (0.320)**	12.28 (1.49)***	0.167 (0.033)***
Final Good	-0.234 (0.426)	8.46 (1.8)***	0.12 (0.043)***
Release-Output Ratio	0.838E-04 (0.424E-04)**	-0.2E-03 (0.21E-03)	0.245E-05 (0.43E-05)
No. of Superfund Sites	-0.025 (0.015)*	-0.025 (0.073)	-0.0044 (0.0015)***
HAP-33/50 Releases Ratio	-0.0022 (0.0009)**	-0.004 (0.0045)	0.25E-04 (0.92E-04)
Age of Assets	-0.131 (1.415)	27.25 (6.42)***	-0.19 (0.14)
CMA	1.712 (0.419)***	4.78 (1.72)***	0.045 (0.042)
R&D/Sales	1.263 (0.783)*	1.94 (4.083)	0.067 (0.09)
No. of Facilities	0.087 (0.018)***	-0.0048 (0.0419)	-0.00017 (0.00098)
No. of Facilities Squared	-0.00053 (0.00016)***		
33/50-All TRI Releases Ratio	2.758 (0.444)***	-1.6 (2.2)	-0.33E-01 (0.47E-01)
Sales Growth	0.0011 (0.0031)	0.029 (0.016)*	0.00052 (0.00031)*
Beta		1.77 (1.146)	0.04 (0.023)*
Predicted Probability of Participation	-0.511 (0.26)**	-2.933 (1.33)**	0.054 (0.027)**
Intercept	2.945 (1.641)*	-29.1 (6.23)***	1.3 (0.17)***
N	738	702	702
Adjusted R^2	50.4%	15.1%%	15.4%%
F_1 [K, N-K-1] {p-value}	61.46 {0}	13.86{0}	14.29{0}
F_2[2, N-K-2] {p-value}	1.76 {0}	1.47{0}	0.02 {0}
LM Test statistic [1]	532.43 {0}	282.66{0}	474.75 {0}
λ {p-value under H_o:λ=0}	0{1}	1{0}	0{1}

Notes: Standard errors are in parenthesis. Degrees of freedom are in square brackets. P-value is in curly brackets. F_1 [K, N-K-1] is a F-test for all slope coefficients jointly equal to zero with K=number of explanatory variables. F_2[2, N-K-2] is a F-test for the validity of excluding first invitation group and percent prior reduction in emissions as explanatory variables in above regressions. *** Statistically significant at the 1% level; ** Statistically significant at the 5% level; * Statistically significant at the 10 % level (all two-tailed tests). LM Test statistic is a Breusch-Pagan LM test for testing the random effects model against the classical regression without a firm-specific intercept.

Table 5: Impact of the 33/50 Program on Media-Specific 33/50 Releases and Non 33/50 Releases (1988-93)

Variables	**Air**	**Land**	**Water**	**Offsite**	**Non 33/50 Releases**
Sales ($M)	0.234 (4.75E-02)***	0.185 (8.90E-02)**	2.42E-02 (1.75E-02)	0.132 (4.67E-02)***	0.666 (0.12)***
Sales-Asset Ratio	-0.218 (9.81E-02)**	-0.301 (0.186)*	-1.65E-02 (4.16E-02)	-2.25E-02 (0.104)	-0.296 (0.279)
Final Good	0.311 (0.155)**	0.220 (0.285)	3.13E-02 (4.80E-02)	0.120 (0.139)	-0.77 (0.34)**
Release-Output Ratio	2.38E-05 (1.16E-05)**	2.84E-05 (2.22E-05)	6.17E-06 (6.72E-06)	3.69E-05 (1.38E-05)***	0.117E-03 (0.41E-04)***
No. of Superfund Sites	-5.68E-03 (4.61E-03)	6.82E-03 (8.70E-03)	-1.75E-03 (1.97E-03)	1.68E-03 (4.86E-03)	-0.22E-01 (0.13E-01)*
HAP-33/50 Releases Ratio	-2.31E-04 (2.55E-04)	-1.44E-04 (4.88E-04)	-1.20E-05 (1.39E-04)	-7.75E-05 (2.97E-04)	0.12E-02 (0.87E-03)
Age of Assets	-0.113 (0.440)	-2.243 (0.832)***	-1.60E-03 (0.181)	0.291 (0.461)	-1.396 (1.22)
CMA	0.795 (0.151)***	8.17E-02 (0.27895)	5.85E-02 (4.74E-02)	0.350 (0.137)***	1.276 (0.337)***
R&D/Sales	-0.273 (0.231)	-3.74E-03 (0.439)	2.35E-02 (0.108)	0.211 (0.255)	-1.58 (0.71)**
No. of Facilities	2.75E-02 (5.44E-03)***	1.25E-02 (1.03E-02)	2.63E-03 (2.43E-03)	2.45E-02 (5.90E-03)***	0.74E-01 (0.16E-01)***
No. of Facilities Squared	-6.97E-05 (4.82E-05)	1.21E-06 (9.11E-05)	4.54E-06 (2.02E-05)	-7.36E-05 (5.06E-05)	-0.44E-03 (0.14E-03)***
33/50-All TRI Releases Ratio	0.540 (0.130)***	-0.666 (0.247)***	-6.73E-02 (6.17E-02)	4.79E-02 (0.144)	-2.33 (0.4)***
Sales Growth	-3.05E-04 (8.53E-04)	1.68E-04 (1.64E-03)	4.81E-04 (5.13E-04)	6.73E-05 (1.02E-03)	0.21E-02 (0.31E-02)
Predicted Probability of Participation	-0.349 (7.22E-02)***	-0.444 (0.138)***	-0.149 (4.14E-02)***	-0.586 (8.5E-02)***	-0.429 (0.25)*
Intercept	-3.198 (0.522)***	-5.524 (0.9845)***	-2.405 (0.206)***	-3.141 (0.535)***	9.7 (1.4)***
Adjusted R^2	61.0%	25.6%	7.3%	38.4%	56.9%
LM Test statistic [1]	986.84{0}	800.39{0}	140.32{0}	569.01{0}	400.5{0}

Notes: Standard errors are in parenthesis. *** Statistically significant at 1% level; ** Statistically significant at 5% level; * Statistically significant at 10 % level

Table 6: Implications of Program Participation for 33/50 Releases Among Firms with Different Characteristics

Firm characteristics	No. of Firms	Median Probability of participation in Program 1991-93	Pre-Program 33/50 Releases aggregated over firms 1990 (M lbs)	Average Pre-Program 33/50 Releases 1990 (M lbs)	Average decrease in 33/50 Releases due to Program 1991-93 (M lbs)	Percent change due to Program 1991-93 %
(1)	(2)	(3)	(4)	(5)	(6)	(7)
CMA Members	64	0.68	286.46	4.48	1.27	28.38
with Final Good = 1	13	0.77	61.58	4.74	1.38	29.06
and First Invitation Group=1	12	0.78	61.54	5.13	1.49	29.06
and First Invitation Group=0	1	0.53	0.04	0.04	0.01	23.63
with Final Good = 0	51	0.66	224.88	4.41	1.24	28.19
and First Invitation Group=1	35	0.75	202.15	5.78	1.72	29.72
and First Invitation Group=0	16	0.22	22.74	1.42	0.21	14.65
CMA Non-Members	59	0.09	10.15	0.17	0.03	14.95
with Final Good = 1	19	0.14	6.48	0.34	0.06	18.77
and First Invitation Group=1	5	0.55	3.88	0.78	0.21	27.15
and First Invitation Group=0	14	0.10	2.60	0.19	0.01	6.23
with Final Good = 0	40	0.08	3.67	0.09	0.01	8.22
and First Invitation Group=1	7	0.32	1.16	0.17	0.02	13.81
and First Invitation Group=0	33	0.06	2.51	0.08	0.00	5.63
All Firms	123	0.34	296.61	2.41	0.67 (1.003)[a]	27.92 [20.6, 35.7][b]

Notes: Figures in column 5 are obtained by dividing figures in column 4 by the number of firms in that category in column 2. The percentage change in column 7 is obtained by dividing the figure in column 6 by that in column 5. [a]Standard deviation of the predicted reductions in 33/50 Releases. [b]The figures in square brackets represent the 95% confidence interval on the expected percentage impact of the Program on 33/50 Releases.

Table 7: Implications of Program Participation for Return on Investment and Excess Value

All firms	Return on Investment	Excess Value/Sales
Pre-Program level (1990)	11.67 %	0.0337
Expected annual average after Program participation (1991-93) but all other variables at their 1990 level	10.47 %	0.03445
Expected average percentage change due to Program participation	-1.2 % (0.92)[a] [-1.03%, -1.37%][b]	2.22 % (0.0006)[a] [1.89%, 2.54%][b]

[a]Standard deviation of the predicted impact is in parenthesis. [b]The figures in square brackets represent the 95% confidence interval on the expected percentage impact of the Program.

REFERENCES

Arora, S. and T. N. Cason, "An Experiment in Voluntary Environmental Regulation: Participation in EPA's 33/50 Program," *J. of Environ. Econ. and Mgmt.*, **28**, 271-86 (1995).

__________, "Why do Firms Volunteer to Exceed Environmental Regulations? Understanding Participation in EPA's 33/50 Program," *Land Econ.*, **72**, 413-32 (1996).

Arora, S. and S. Gangopadhyay, "Towards a Theoretical Model of Voluntary Over-compliance," *Journal of Economic Behavior and Organization*, 28, 289-309 (1995).

Barnow, B. S., G. G. Cain, and A. S. Goldberger, "Issues in the Analysis of Selectivity Bias," *Evaluation Studies Review Annual* (W. Stromdorfer and G. Farkas, Eds.) Sage Press, Beverly Hills: 43-59 (1981).

Capon, N., J.U. Farley, and S. Hoenig, *Toward an Integrative Explanation of Corporate Financial Performance*, Kluwer Academic Publishers, Boston, (1996).

Cochran, P.L., R.A. Wood, "Corporate Social Responsibility and Financial Performance," *Academy of Management J.*, **27(1)**, 42-56, (1984).

Cohen, M. A., S. A. Finn, and J. S. Naimon, "*Environmental and Financial Performance: Are They Related?*" Investor Responsibility Research Center, Washington, D.C. (1995).

Davidson, R. and J. G. Mackinnon, "Convenient Specification Tests for Logit and Probit Models," *J. Econom*. **25**, 241-62 (1984).

Davies, T. and J. Mazurek, "*Industry Incentives for Environmental Improvement: Evaluation of U.S. Federal Initiatives*," Global Environmental Management Initiative, Washington D.C. (1996).

EPA (United States Environmental Protection Agency), Office of Science and Technology (Producer). National Technical Information Service, "*Site Enforcement Tracking System (National) (for microcomputers)*," Springfield, VA (1996).

__________, "*33/50 Program Commitment Status Update*," Memorandum for Michael E. Burns, Program Analyst, Special Projects Office, OPPT to David Sarokin, Director, 33/50 Program Management Staff (June 7, 1995).

__________, *U.S. Environmental Protection Agency Pollution Prevention Strategy*, Washington D.C. (1991).

__________, Office of Air and Radiation, *The Clean Air Act Amendments of 1990 Summary Materials*, Washington D.C. (1990).

Esty, D.C., "Clean and Competitive: Business-led Environmental Management," Paper presented at the Annual Meetings of the American Agricultural Economics Association, Toronto, Canada (1997).

Fama, E. F., "Efficient Capital Markets II," *J. of Finance*, **46**, 1575-1617 (1991).

GAO (United States General Accounting Office), "*Toxic Substances: EPA Needs More Reliable Source Reduction Data and Progress Measures*,"GAO/RCED-94-93 (1994).

Glachant, M., "The Cost Efficiency of Voluntary Agreements for Regulating Industrial Pollution: A Coasean Approach," Working paper, ENV 18.97, Fondazione Eni Enrico Mattei, Milan (1997).

Greene, H., *Econometric Analysis*, Second Ed., New York: Macmillan Publishing Co., 1993.

Hamilton, J.T., "Pollution As News: Media And Stock Market Reactions To The Toxics Release Inventory Data," *J. of Env. Econ. and Mgmt*. **28**, 98-113 (1995).

Hansen, L.G., "Environmental Regulation through Voluntary Agreements," Working paper, ENV 23.97, Fondazione Eni Enrico Mattei, Milan (1997).

Hartman, R. S., "Self-selection Bias in the Evaluation of Voluntary Energy Conservation

Programs," *The Review of Economics and Statistics*, **70**, 448-458 (1988).

Heckman, J. J., "Dummy Endogenous Variables in a Simultaneous Equation System," *Econometrics*, **46**, 932-959 (1978).

Henriques, I. and P. Sadorsky, "The Determinants of an Environmentally Responsive Firm: An Empirical Approach," *J. of Environ. Econ. and Mgmt*, **30**, 381-95 (1996).

Hirschey, M. and D.W. Wichern, "Accounting and Market-Value Measures of Profitability: Consistency, Determinants, and Uses," *Journal of Business & Economic Statistics*, **2(4)**, 375-383 (1984).

Hsiao, C., *Analysis of Panel Data*, Econometric Society Monographs, No. 11, Cambridge University Press, Cambridge (1986).

Jacboson, R., "The Validity of ROI as a Measure of Business Performance," *The American Economic Review*, **77(3)**, 470-478 (1987).

Konar, S., and M. A. Cohen, Information as Regulation: The Effect of Community Right to Know Laws on Toxic Emissions, *J. of Env. Econ. and Mgmt* **32**, 109-124 (1997).

Lee, L. and R. P. Trost, "Estimation of Some Limited Dependent Variable Models with Application to Housing Demand," *J. of Econometrics* **8**, 357-382 (1978).

MacKinnon, J.G., "Model Specification Tests and Artificial Regression," Journal of Economic Literature, XXX, 102-146, (March 1992)

Maddala, G. S., *Limited Dependant and Qualitative Variables in Econometrics,* Cambridge University Press, Cambridge (1983).

Marakovits, D.M and T.J. Considine., "An Empirical Analysis of Exposure-Based Regulation to Abate Toxic Air Pollution," *J. of Env. Econ. and Mgmt* **31**, 337-351 (1996).

Muoghalu, M. I., H. D. Robinson, and J. L. Glascock, "Hazardous Waste Lawsuits, Stockholder Returns, and Deterrence," *So. Econ. J.*: 357-370 (1990).

Nerlove, M., "Factors Affecting Differences Among Rates of Return on Investments in Individual Common Shares," *Review of Economics and Statistics*, 312-331, Aug. 1968.

Rappaport, A., "Corporate Performance Standards and Shareholder Value," *The Journal of Business Strategy*, **3**, 28-38, (1983).

Segerson, K., "Voluntary vs. Mandatory Approaches to Nonpoint Pollution Control: Complements or Substitutes?" Working paper, Dept. of Economics, University of Connecticut, Storrs (1997).

Segerson, K and T.J. Micelli, "Voluntary Environmental Agreements: Good or Bad News for Environmental Protection," Working paper, Dept. of Economics, University of Connecticut, Storrs (1997).

Sigman, H., "Cross-Media Pollution: Responses to Restrictions on Chlorinated Solvent Releases," *Land Economics,* 72(3), 298-312 (August 1996).

Thomadakis, S.B., "A Value-Based Test of Profitability and Market Structure," *The Review of Economics and Statistics*, **59(2)**, 179-185 (May 1977).

Tobin, J., "Liquidity Preference as Behavior Towards Risk," *Review of Economic Studies*, **XXV**, 65-86, (Feb. 1957).

Toxics Watch, 1995, Inform Inc., New York, 1995.

[1] Common Sense Initiative encourages firms to take a holistic approach to emissions control through multi-media pollution control projects instead of focusing on specific media such as air, water or land. Green Lights is a voluntary program encouraging the use of energy-efficient lighting in buildings. The 33/50 Program is described in the next section.

[2] Releases include on-site releases to air, water ,land and underground injections and off-site transfers for treatment and disposal.

[3] Since 1987, the EPA has mandated annual reporting of on-site releases and off-site transfers, of over 300 specific toxic chemicals by all manufacturing facilities. This information is compiled by the EPA to form the Toxics Release Inventory (TRI) which is made available annually to the public, through computerized databases.

[4] Arora and Cason (1995, 1996) use advertising expenditures of the industry within which a firm is located as a proxy for the proximity of firms in that industry to final consumers and for a firm's desire for public recognition.

[5] Financial variables, such as sales, sales-asset ratio, and beta are excluded from (2) on the basis of the results of a likelihood ratio test. Arora and Cason (1996) had also found financial variables to have an insignificant effect on the participation decision.

[6] We define ROI as in S&P Compustat as : Income before Extraordinary Items / Total Invested Capital where Total Invested Capital = Total Long Term Debt+Preferred Stock+Minority Interest+Total Common Equity. This ratio is then multiplied by 100.

[7] Until the reporting year 1991, firms were only required to include the quantities of chemicals sent for treatment and disposal in the off-site transfers category. In 1991 these requirements were expanded to include transfers for recycling and energy recovery. Since the goals of the Program were based on the pre-1991 definition of off-site transfers, we exclude the latter two categories from our definition of 33/50 RELEASES (EPA, 1991).

[8] We did not use advertising expenditures by industry as a proxy for public recognition, as in Arora and Cason (1995, 1996) because all firms in our sample were from the same industry and because these expenditures are generally not reported at the firm-level in the S&P database.

[9] The EPA made its decision, about which firms to include in the first invitation group, prior to the participation decision taken by firms. Therefore, firms took their inclusion or exclusion from the first invitation group as given when making their participation decision. We therefore treat invitation group as an exogenous variable for a firm.

[10] For six of the 123 firms complete financial data was not reported in the S&P data base for the six years. Hence these firms were excluded from the model with ROI and EV/S as dependent variables.

[11] $b = \frac{d \log P}{d \log Q} = \frac{dP}{dQ}\frac{Q}{P}$ where b represents the regression coefficient for the sales variable, *P* represents 33/50 Releases and *Q* represents Sales. With b constant across firms, *dP/DQ* increases as *P/Q* increases.