Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism

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Abstract

We extend the economic theory of regulation to allow for strategic self-regulation that preempts political action. When political "entry" is costly for consumers, firms can deter it through voluntary restraints. Unlike standard entry models, deterrence is achieved by overinvesting to raise the rival's welfare in the event of entry. Empirical evidence on releases of toxic chemicals shows that an increased threat of regulation (as proxied by increased membership in conservation groups) indeed induces firms to reduce toxic releases. We establish conditions under which self-regulation, if it occurs, is a Pareto improvement once costs of influencing policy are included.

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I. INTRODUCTION

"While some of the environmental changes now emerging in corporate America are genuine and welcome, a good many are superficial, some are downright diversionary, and a few are being specifically designed to preempt more stringent public policies from emerging."

Brent Blackwelder, President
Friends of the Earth[1]

"In an effort to head off legal restrictions on privately traded derivatives, six of Wall Street's biggest securities firms have agreed to voluntarily tighten their controls on the most hotly contested aspects of their derivatives sales and trading."

Wall Street Journal
March 9, 1995[2]

"In today's society any industry as conspicuous as the major home appliance industry is continually faced with the threat of government regulation. In my opinion, the only way to avoid government regulation is to move faster than the government. The alternative to government regulation is judicious self-regulation."

Herbert Phillips, Technical Director
Association of Home Appliance Manufacturers[3]

To most economists, "regulation" means restraints imposed upon firms by government. In many cases, however, firms voluntarily restrain their own conduct; they "self-regulate."[4] Examples include establishment of financial exchanges, licensing of professionals, setting of safety standards, control of entertainment content, advertising restrictions, and voluntary pollution abatement. While self-regulation may have a variety of motives,[5] in this paper we model it as a way to preempt government regulation, examining the conditions under which preemption is possible and, if it occurs, its welfare consequences. We present our analysis in the context of "corporate environmentalism," *i.e.* voluntary adoption of cleaner products or processes, but it should be clear from the above examples that the basic story has broader applicability.

Some intriguing evidence of self-regulation is presented in Figure 1, which plots—for U.S. states over the period 1987-1992---total releases of seventeen selected toxic chemicals against the dollar value of shipments from the main industries emitting these chemicals.[1] While there is a positive relationship between emissions and shipments, as one would expect, the ratio of the two has dropped rapidly during this time period, as can be seen by examining the datapoints for individual states. In fact, the aggregate emissions of these chemicals fell by 40% from 1987 to 1992. Government regulation is not driving the reductions, as these seventeen chemicals are currently unregulated. This paper presents a theory of self-regulation in which this voluntary abatement can be explained by increases in the threat of federal and/or state regulation.

While corporate environmentalism is on the rise, it remains controversial.[6] The “Big Three” automakers’ Vehicle Recycling Partnership is limited to creating labeling standards for plastic components, and falls well short of the German program of comprehensive automotive disassembly and reuse. Selective cutting in old growth forests is more environmentally friendly than clear cutting, but many argue that such forests should not be cut at all. The "Responsible Care" program initiated by the Chemical Manufacturers Association (CMA) may be used as a rationale for refusing to adopt more stringent environmental practices; according to Barnard (1990, p. 5), at least one CMA member---Union Carbide---has already done just that. Such considerations raise questions about how social welfare is affected when self-regulation preempts government action. This concern is likely to become increasingly important, since as Walley and Whitehead (1994) point out, "win-win" situations---in which pollution prevention raises both corporate profits and consumer well-being---are increasingly difficult to find.[7]

We model self-regulation and social welfare in a three-stage game where Cournot oligopolists face the possibility of stricter pollution abatement regulations. Following Becker (1983), we model these regulations as arising from a political influence game between consumers and firms, with consumers favoring stricter abatement regulations than do firms.[8] Following Stigler (1971) and Peltzman (1976), we assume it is costly for interested parties to organize themselves to enter the political process and to

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[1]Note, in this pdf version of the paper figure 1 is contained on page 48.

influence policymakers once involved in the political process. In the first stage of our game, symmetric firms choose (possibly zero) levels of voluntary abatement. In the second stage, identical consumers observe the voluntary abatement activity and determine whether to enter the influence game; if they do so, they and the firms exert pressure on government for their desired level of regulations, and an abatement policy is determined. In the third stage, firms play a Cournot production game.

From a methodological viewpoint, our analysis extends the economic theory of regulation in two directions.[9] First, by adding an initial stage of voluntary actions by firms, we allow for the possibility of strategic self-regulation that preempts government action. As a result, we obtain some striking parallels and contrasts with the standard industrial organization literature, which typically takes regulation as either exogenously fixed or as a set of controls to be optimized. Second, by modeling explicitly the dimension of product quality (in this case, pollution abatement), we can address directly issues of regulatory efficiency discussed only informally by Becker.

We identify a range of consumer organizing costs for which firms can preempt the influence game by engaging in voluntary pollution abatement. This range is strictly larger when firms can collude in their self-regulatory efforts, rather than engaging in non-cooperative preemption. As one might expect, if organizing costs are too high then consumers are blockaded from the political process and abatement becomes an unnecessary expenditure. More surprisingly, however, if organizing costs are too low, preemption may not be observed because it may become prohibitively costly to keep consumers from entering the political process. Consumer fixed costs are not necessary for preemption to occur; all that is needed is that consumers' equilibrium lobbying costs are high enough.

The key positive implication of our model is that an increased threat of government regulation induces firms to voluntarily reduce pollution emissions. Although the main thrust of our paper is theoretical, we complement our theoretical work with a detailed discussion of the massive cuts in U.S. toxic chemical releases since 1987, (illustrated in Figure 1), and the role of potential regulatory entry in stimulating these cuts. We investigate state-level variation in the threat of regulation using a unique panel dataset on releases of toxic chemicals over the period from 1987 to 1992. We take state conservation group membership per capita as our key proxy for the threat of regulation. Because membership may itself be affected by the extent of toxic releases in a state, we use two-stage least squares to allow for the endogeneity of this variable. The empirical estimates indicate that states with proportionally higher estimated membership in conservation groups indeed enjoy a lower level of toxic releases. Other variables, such as per capita income and the water area of a state, also affect the threat of regulation and the level of voluntary abatement. In addition, we find a convergence in emissions rates (measured by toxic releases per value of manufacturing shipments) across states over the sample period, with the sole exception of Montana, where emissions rates have not fallen. We cautiously interpret this as evidence that the public disclosure of toxics information, mandated by the federal government as of 1987, has significantly increased the threat of toxics regulations in most of the states with high consumer organizing costs; only in Montana does interest group pressure for toxics abatement remain blockaded.

In addition to the foregoing positive predictions and empirical results, we also derive some striking normative results. We show that interest group rivalry (the influence game) produces weaker pollution regulation than is socially optimal. Somewhat disturbingly, self-regulation may generate abatement levels even further from the social optimum. In the absence of an omniscient social planner, however, a more relevant question is how self-regulation affects the welfare of firms and consumers relative to what they would have received had no self-regulation occurred.

The key to this question lies in how voluntary abatement affects the outcome of the influence game. We focus on the case where the direct effects of voluntary abatement on equilibrium "pressure" levels outweigh the strategic effects mediated through changes in the rival's behavior; in other words, pressure by one interest group has a "small" effect on the marginal effectiveness of the rival group's pressure activities. In this case, voluntary abatement reduces consumers' equilibrium lobbying expenditures[10] while increasing firms' expenditures; if the influence game is played, voluntary abatement leads to a reduction in mandatory abatement. However, the rate of substitution between mandatory and voluntary abatement is less than one-for-one. Thus, if the influence game is played, voluntary abatement increases the ultimate level of abatement firms are required to undertake.

We show that when the costs of influencing policy are included, *if* voluntary abatement occurs then it represents a Pareto improvement over the status quo. More importantly, social welfare under preemption also Pareto-dominates that which would have arisen from the influence game, had it been played. Firms, of course, will only preempt if doing so raises profits, but might consumers be made worse off than if---in the absence of self-regulation---they had lobbied for stiffer standards? The answer would be yes if self-regulation weakened consumers' threat to invoke the influence game. However, under the conditions noted above, when firms self-regulate they raise the ultimate level of abatement that would result from the influence game. Should consumers choose not to fight when they have this advantage, they must benefit from being preempted.

Our analysis has two implications for public policy. First, it lends support to an antitrust policy allowing industries to coordinate on voluntary abatement strategies, since such coordination increases beneficial self-regulation. Second, it raises questions about government financing of consumer intervention into the political process: if consumer involvement becomes *too* easy, firms may eschew voluntary abatement, with the result that both they and consumers are worse off than when consumer involvement was difficult.

Before proceeding, we briefly contrast our paper with related work in the literature. Despite the ubiquity of self-regulation, the phenomenon has received little attention from economists. There have been several interesting case studies and institutional analyses,[11] and a few papers that apply a vertical product differentiation framework to model the idea that firms voluntarily reduce pollution to attract "green" consumers.[12] Arora and Cason (1995) study empirically which types of firms are most likely to participate in programs aimed at voluntary abatement.

In a more strategic vein, Braeutigam and Quirk (1984) and Lyon (1991) analyze models wherein a regulated firm voluntarily reduces its price to avoid a rate review that would cut rates even further. Similarly, Glazer and McMillan (1992) show that the threat of price regulation may induce a monopolist to price below the unregulated monopoly level. Our analysis is related to these earlier strategic analyses, but richer in several important respects. We consider an oligopolistic industry in which consumers have both price and non-price (*e.g.*, pollution) concerns. We model explicitly the incentives of interest groups (producers and consumers) to expend resources on lobbying for their preferred policies, and allow the stringency of regulations to be determined endogenously. We complement our theoretical analysis with empirical evidence from a unique panel dataset that provides support for our theoretical predictions. Finally, we assess the social welfare implications of regulatory preemption, and address policy questions about appropriate antitrust treatment of self-regulation and about government subsidy of consumer intervention in the political process.

Our results are also related to the literature on entry deterrence.[13] In a sense, our oligopoly invests in pollution control to deter "entry" by consumers to the influence game. Unlike standard entry deterrence models, however, here the "fat cat" strategy—under which investment raises the rival's welfare in the event entry occurs---is effective in preempting entry.[14] The reason is that in ordinary deterrence games staying out yields the potential entrant a fixed reservation level of profits. Here, in contrast, consumers' utility of staying out of the influence game rises as firms invest. Welfare-enhancing preemption is possible because as voluntary abatement increases, consumers' utility of staying out rises faster than the utility of entering.[15]

The remainder of the paper is organized as follows. Section II presents the model, while Section III develops two key propositions about the conduct of firms and of consumers. Section IV examines our positive hypotheses using a panel dataset. Section V establishes welfare results and explores policy implications, while section VI concludes and discusses directions for future research. All proofs are presented in the Appendix.

II. THE MODEL

In this section we present a three-stage model of voluntary pollution control. We view pollution control costs as continuous in nature, thus being amenable to traditional marginal analysis techniques. For simplicity, we assume symmetric firms and we do not discount payoffs over time. The sequence of moves in the model is as follows. First, firms choose a level (possibly zero) of voluntary pollution control that is assumed to be binding.[16] For example, it could be built into the production technology, or firms could sell a conservation easement to an environmental group (e.g., the group buys the right to dictate a production technology to the firms, such as selective rather than clear-cut logging), or irrevocably link their image to voluntary abatement through advertising. Second, firms and consumers (who receive utility from the good but disutility from pollution) engage in interest-group rivalry for the purpose of influencing pollution control policy.[17] Third, after pollution control policy has been determined, firms produce and sell output in a Cournot oligopoly. As is standard in multistage games, subgame perfection is achieved by solving the model in reverse chronological order, hence the exposition below is presented from a backward-induction perspective.

Stage 3: Output Market Equilibrium

Production occurs in the last stage of the game following voluntary pollution control by firms and any additional mandatory pollution control generated from the political process. As in Besanko (1987), we consider a situation in which N^f identical firms engage in Cournot-style quantity rivalry in an industry featuring pollution externalities.[18] Firm i chooses an output level q_i, and the firms face industry demand curve $P(Q)$, where $Q = \Sigma_i q_i$; we will also use the notation $Q_{-i} = \sum_{j \neq i} q_j$. Firms install a pollution control input, in the amount Z, which is the sum of a voluntary choice Z^V from stage 1 and mandatory control level Z^M from stage 2 of the game.[19] Firms are then confronted with per-unit output cost $c(Z)$ that is constant with regard to output, and a fixed capital cost $k(Z)$, both of which are increasing and convex in Z. In order to focus on the strategic aspects of voluntary abatement, we assume the costs of self-regulation and government regulation are equal, and are only a function of Z.[20] Given Q_{-i}, firm i's problem is to

$$\max_{q_i} \; [P(Q_{-i} + q_i) - c(Z)]q_i - k(Z). \tag{1}$$

In the symmetric Cournot-Nash equilibrium,[21] firms have equal outputs, defined by

$$q_i^* = -\frac{[P(Q^*) - c(Z)]}{P'(Q^*)}, \tag{2}$$

aggregate quantity traded is $Q^* = N^f q_i^*$, and the market clearing price is $P(Q^*)$. Henceforth we shall drop the subscript "*i*," as in equilibrium all firms are identical. There should thus be no confusion in proceeding to use subscripts to indicate derivatives. Equilibrium earnings per firm, given Q^*, are $\pi^N(Z)$, where the superscript "N" indicates no influence costs are included at this stage. Note that our convexity assumptions on costs imply $\pi_Z^N = -c_Z q^* - k_Z < 0$ and $\pi_{ZZ}^N = -c_{ZZ} q^* - k_{ZZ} < 0$.

Stage 2: Influence Game

Following Becker (1983) we model pollution-control policy as the outcome of rival "influence inputs" being transformed through political institutions. For example, political institutions determine the extent of permissible lobbying activities and election campaign contributions, and tolerated forms of bribery such as revolving-door arrangements, junkets, and honoraria. In our influence game there are two interest groups, each made up of a number of identical agents.[22] The interest groups differ in terms of their desired policy outcomes, and engage in rivalry by investing resources in "pressure" activities that act as inputs in the policy production process.

In our model, one interest group is made up of the N^f firms whose costs are increased by additional pollution-control restraints, while the other is made up of N^c consumers who purchase the good produced by the firms and who also have disutility over pollution emitted by the firms. All individuals and firms allocate influence inputs noncooperatively.[23] Firms, if they enter the influence game, always attempt to influence policy makers to reduce mandatory pollution control (the per-firm resources they allocate for this purpose are referred to by the variable l).[24] While consumers care about their consumer surplus from buying the good produced by firms, and thus oppose higher prices, they also have disutility over pollution. Thus it is possible for firms to choose a level of voluntary abatement sufficiently high that consumers would actually prefer less than the voluntary level of pollution control.

This is never profitable for firms, however, so consumers---if they enter the political process---always allocate resources (in the amount of m per person) to influence policy makers to choose more pollution control.

Following Stigler and Peltzman, we assume that consumers wishing to influence the process of policy formation must bear in the aggregate a fixed cost $F(N^c)$; each of the identical consumers then bears a cost $f(N^c) = F(N^c)/N^c$ if the consumer group enters the influence game.[25] In the present context, individuals must inform themselves of the implications of pollution control for their well-being,[26] and of the efficacy of various feasible policy remedies. Individuals of similar interests must then coordinate on a mutual lobbying strategy. We will refer to these various costs collectively as organizing costs. Firms face similar tasks, but their organizing costs are typically less than those of consumers, since assessing the costs of regulation to the firm is usually much easier than assessing the health and aesthetic benefits to consumers, and the number of firms in an industry is typically very small relative to the number of consumers. Without loss of generality, then, we normalize firms' cost of organizing to zero.

Since the N^f firms are identical, aggregate firm resources allocated to political pressure are $L = N^f l$. Similarly, the N^c consumers devote $M = N^c m$ aggregate resources to pressure activities if they choose to incur the fixed cost of entering the political process. These aggregate resources are transformed into influence through a process that features diminishing marginal returns. For example, each additional dollar generates a smaller increase in lobbyist effectiveness than the previous dollar spent: policy makers have a finite amount of time and resources to devote to a particular issue. We represent the influence process through a function $Z^M(M,L)$ which gives the mandatory abatement level as a function of influence inputs; when the firm undertakes voluntary abatement, total abatement is then $Z(M,L) = Z^V + Z^M(M,L)$. We assume $Z_M>0$, $Z_L<0$, $Z_{MM}<0$, and $Z_{LL} > 0$. (We will often suppress the dependence of Z on influence for notational ease.) The cross-partial derivative Z_{LM} is important for welfare analysis, though not for positive analysis, and is discussed in detail in Section V of the paper.

Consider a representative firm's optimization problem in the influence game. Firm i, given the influence choices of the other parties (M by consumers, L_{-i} by the other firms), must choose influence input *l* to maximize:

$$\pi^N(Z^V + Z^M[M, L_{-i} + l]) \;-\; l. \qquad \textbf{(3)}$$

Note that $\pi^N(Z)$ in expression (3) has already been optimized with regard to *q*, and so reflects the equilibrium output vector from the oligopoly output game. Thus, while resources invested in influencing Z^M have a direct effect on $\pi^N(Z)$ through unit cost *c(Z)*, from the envelope theorem their indirect effect on profit through q^* is zero. A firm's optimal choice of *l* is given by the following equation:

$$\pi_Z^N \, Z_l \;=\; 1. \qquad \textbf{(4)}$$

Consumers are utility maximizers, and choose their per-person lobbying expenditures *m* independently. (As we discuss more fully in section V, both firms and consumers suffer from free-riding problems, but the problem is worse for consumers since they are more numerous.) Utility falls as the price of the good rises and as the total amount of pollution in the environment increases. Since firms are symmetric, we let $d = f(Z,q)$ be the total environmental degradation caused by an individual firm, and $D = D(N^f,Z,q)$ be the total amount of degradation. Recognizing that q^* is chosen by firms in stage 3 and that the number of firms is fixed, we suppress the dependence of *D* on *q* and N^f, and the total welfare of a consumer[27] is then

$$U^N(P(Z), D(Z)) \;-\; m. \qquad \textbf{(5)}$$

A consumer's optimal choice of *m* is given by the following equation:

$$[U_P^N P_Z + U_D^N D_Z] Z_m \;=\; 1. \qquad \textbf{(6)}$$

Using the shorthand notation $U^N(Z) \equiv U^N(P(Z),D(Z))$, (6) can be simplified to $U_Z^N Z_m = 1$. We assume $U_{ZZ}^N < 0$; note that U_Z^N is initially positive, but declines and so can become negative.

Equations (4) and (6) generate reaction functions $l^*(m,Z^V)$ and $m^*(l,Z^V)$ for firms and consumers, respectively, in the influence game. It is straightforward to show that the reaction functions are upward sloping, as illustrated in Figure 2, indicating that lobbying expenditures are strategic complements. Note that we assume regulation never mandates an increase in pollution; as a result, firms will curtail their expenditures on influence when $Z^M(M,L)$ reaches zero. This effect is shown in the figure for the case where firm and consumer pressure is equally effective: firms' reaction curves are the upper envelope of the 45-degree line and the $l^*(m,Z^V)$ function that would apply if regulations could force firms to become dirtier. Equilibrium levels of pressure are $l^e(Z^V) \equiv l^*(m^e,Z^V)$ and $m^e(Z^V) \equiv m^*(l^e,Z^V)$.

Stage 1: Voluntary Pollution Control

Prior to the interest group rivalry process that generates pollution-control policy, firms can choose a level (possibly zero) of voluntary pollution control. Let $Z(Z^V) \equiv Z^V + Z^M(Z^V)$ and assume that $Z(0) > 0$, which avoids the uninteresting case in which the external costs of pollution to consumers are too small to generate any legislative requirements for pollution control. Firms thus choose Z^V to maximize the following equilibrium profit function:

$$\pi^I(Z^V) = \pi^N(Z(Z^V)) - l^e(Z^V) \quad \textbf{(7)}$$

where the superscript I indicates that profits are measured net of influence costs. We also denote consumer utility, net of influence costs, by $U^I(Z^V) = U^N(Z(Z^V)) - m^e(Z^V)$.

A crucial effect of voluntary abatement is to change the outcome of the influence game. It is straightforward to establish how the players' reaction curves shift as Z^V rises. Totally differentiating (4) and (6) and gathering terms yields $\frac{dl^*}{dZ^V} = \frac{-\pi_{ZZ}Z_l}{\pi_{ZZ}Z_l^2 + \pi_Z Z_{ll}} > 0$ and $\frac{dm^*}{dZ^V} = \frac{-U_{ZZ}Z_m}{U_{ZZ}Z_m^2 + U_Z Z_{mm}} < 0.$ Thus, self-regulation makes the firms "tough" in the influence game while also making consumers "soft."[28] Figure 2 illustrates the shifts in consumer and firm reaction functions in response to an increase in voluntary abatement. Functions superscripted with a 0 represent reaction functions when the level of voluntary abatement is zero, while those represented with a + superscript are reaction functions resulting from a positive level of voluntary abatement. With positive voluntary abatement, a consumer's reaction function shifts downward, reflecting a reduced marginal value of further emissions control. At the same time, a firm's reaction function shifts outward, reflecting a higher marginal cost of further control. Note, however, that the lower portion of the firm's reaction curve does not shift. This reflects the constraint that firms are not allowed to become "dirtier," so they just match consumer expenditures on influence once the level of mandatory abatement falls to zero.

III. CONDUCT OF FIRMS AND CONSUMERS

In this section, we analyze the behavior of firms and consumers in the model presented above. We are particularly interested in the question of when preemption via voluntary abatement is profitable. U.S. antitrust law makes illegal all collusive attempts to restrict sales quantity or raise price. To the best of our knowledge, however, these laws do not preclude firms from choosing cooperative levels of voluntary pollution abatement. In fact, firms often use trade associations to self-regulate via uniform product and production standards; for example, a recent survey of firms that emit toxic pollutants found that companies were more likely to participate in pollution programs sponsored by the firm's trade association.[29] Proposition 1 establishes conditions under which firms' profits can be enhanced by cooperative voluntary pollution abatement that preempts mandatory controls.

Proposition 1: *There exists a range of consumer fixed costs of organizing on which a perfectly collusive oligopoly chooses a positive level of voluntary abatement and thereby preempts consumer intervention in the regulatory process. Let* $[f_{Z^V_{max}}, f_{blockade}]$ *be this range. Then* $f_{Z^V_{max}} \geq 0$, *and for* $f_{Z^V_{max}} < f(N^c) < f_{blockade}$ *the firm's choice of* Z^V *is decreasing in* $f(N^c)$*; for* $f(N^c) > f_{blockade}$*, consumer intervention is "blockaded," i.e. preempted with* $Z^V = 0$*.*

The basic intuition of the proposition is simple: political costs drive a wedge between the consumer utility of voluntary abatement and mandatory abatement, and firms can take advantage of this wedge to preempt regulation. The relationship between the industry's optimal choice of Z^V and the level of fixed costs faced by consumers is illustrated in Figures 3A and 3B. $Z^V_{\max}$ is the maximum voluntary abatement level for which successful preemption is more profitable than choosing $Z^V = 0$ and fighting the influence game. There is a corresponding level of consumer fixed costs such that $Z^V_{\max}$ is just sufficient to preempt; we denote this level by $f_{Z^V_{\max}}$. For organizing costs above $f_{Z^V_{\max}}$, preemption is always profitable, and the requisite level of voluntary abatement declines with *f*. Of course, if fixed costs are large enough, i.e. $f \geq f_{blockade}$, consumers will decide not to lobby even if $Z^V = 0$; in this case we say that entry is blockaded.

Whether $f_{Z^V_{\max}} > 0$ is ambiguous in general. The two parts of Figure 3 represent two possible patterns for low levels of consumer fixed organizing costs.[30] In Figure 3A, the bold line depicts voluntary abatement for the case when $f_{Z^V_{\max}} \leq 0$, in which case the level of voluntary abatement declines monotonically from the level it takes on when $f(N^C) = 0$. In Figure 3B, $f_{Z^V_{\max}} > 0$, so it is unprofitable to preempt when consumer fixed costs are zero; in this case the bold line shows that no voluntary abatement is observed unless $f \geq f_{Z^V_{\max}}$. In this latter case, there is a sharp drop in voluntary abatement if consumer fixed costs fall below $f_{Z^V_{\max}}$.

It is important to emphasize that, in general, consumer fixed costs are not necessary for preemption to occur. Whether preemption is profitable at $f(N^c) = 0$ (and hence which of the foregoing cases applies) depends on the magnitude of equilibrium consumer influence costs $m^e(Z^V)$: if these are high enough then preemption can be profitable even if consumers' fixed organizing costs are zero. These influence costs, in turn, depend on the curvature of the profit and utility functions.

Consumer expenditures on influence tend to be high when U_Z is large and/or U_{ZZ} is small, since then the marginal consumer benefit of further abatement is high and declines slowly. Consumer lobbying costs also tend to be high when π_Z and/or π_{ZZ} is large, since in this case abatement rapidly becomes very costly to the firms, and they will fight hard to avoid mandatory abatement. In any event, as long as organizing costs are above $f_{Z^V_{\max}}$, voluntary abatement declines with f.

While firms may be able to preempt collusively, it is not obvious that preemption is possible when firms must select voluntary abatement levels noncooperatively. The following proposition addresses this issue. While a continuum of asymmetric preemption equilibria exist, we choose to focus on symmetric equilibria for simplicity and clarity.

Proposition 2: *Symmetric preemption by a noncooperative oligopoly is possible for* $f(N^c) \in [f_{Z^V_{NC}}, f_{blockade}]$, *where* $f_{Z^V_{NC}} > f_{Z^V_{\max}}$.

When the firms cannot coordinate on voluntary abatement, free-riding occurs. At the collusive level of voluntary abatement, any given firm prefers to eschew voluntary abatement and allow the influence game to occur. By so doing, it enjoys at no cost the reduced level of mandatory abatement made possible by its rivals' voluntary abatement activities. As a result, the collusive level of voluntary abatement cannot be sustained as a non-cooperative equilibrium. Nevertheless, the threat of mandatory abatement in the second stage of the game will still support an equilibrium with some degree of non-cooperative preemption. The key point is that for small enough voluntary abatement levels, firm *i* is willing to match or exceed the levels undertaken by the other firms, since its action is pivotal to preempting regulation. Thus preemption will still occur for large consumer fixed costs, but there are some lower levels of $f(N^c)$ for which preemption would have occurred collusively but not non-cooperatively, i.e. $f_{Z^V_{NC}} > f_{Z^V_{\max}}$.

Our results in Proposition 2 contrast sharply with those of Gilbert and Vives (1986) and Donnenfeld and Weber (1995), who find that oligopolies have incentives to provide excessive levels of output or quality when engaging in entry deterrence. The key difference is that in those models, firms derive private benefits from contributing to the "public good" of entry deterrence, while in our model contributions carry private costs but not private benefits.

One might think that as the number of firms, N^f, increases, growing free-rider problems would make preemption more difficult. In our model, however, whether preemption occurs depends upon two factors: 1) the firms' ability to coordinate sufficient voluntary abatement ("supply"), and 2) the level of voluntary abatement required to preempt consumer entry into the political process ("demand"). The "supply" of preemption falls with N^f, since free-rider problems plainly worsen. The "demand" for preemption, however, depends on the mandatory abatement level determined in the influence game, which may either rise or fall with the number of firms. Put another way, if the influence game does occur, aggregate lobbying activity by firms and by consumers is ambiguously affected by N^f.[31] The empirical work of Arora and Cason (1995) suggests that the "demand" effect dominates, since they find voluntary abatement is more likely to occur in unconcentrated industries.

To sum up, the results of this section identify conditions under which firms can profitably preempt, taking advantage of the wedge that lobbying and organization costs drive between voluntary and mandatory abatement. Lobbying costs alone may not be enough to support preemption, and thus a strictly positive level of fixed organizing costs may be required for preemption to be profitable. In either case, once preemption becomes profitable, the equilibrium level of voluntary abatement declines monotonically with consumer organizing costs. The threshold level of consumer organizing costs at which preemption becomes profitable is higher when firms act non-cooperatively than when they coordinate on voluntary abatement.

IV. TOXIC CHEMICAL RELEASES AND THE THREAT OF REGULATION

While the main purpose of our paper is to present a new theory of self-regulation, we believe a discussion of self-regulation as it occurs in practice is a useful complement to the theory. In this section we use the case of toxic chemical releases to help assess the key positive implication of our model, namely that firms engage in more voluntary pollution abatement when they perceive a greater threat of government regulation. Toxic chemicals are of special interest because of their potentially important health impact, recent improvements in the availability of public data on toxic releases, and the threat of both federal and state regulation. Starting in 1987, the Environmental Protection Agency (EPA) stepped up its collection of toxics data as a result of Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA). This law mandates that companies report releases of over 400 different toxic chemicals, many of which are otherwise unregulated. It applies to all manufacturing facilities that have 10 or more employees and that manufacture or process more than 25,000 pounds or use more than 10,000 pounds of any of the reportable chemicals. The EPA makes this information available to the public through the Toxic Release Inventory (TRI). The first year for which data are available is 1987; this information was released to the public in June of 1989.

Our theory, of course, predicts that the release of the TRI would significantly lower the information costs faced by consumer and environmental groups, thereby increasing the threat of regulation faced by firms and increasing the incentives for self-regulation. In fact, there have been massive cuts in emissions since 1987, ranging from 38% to 51% for different classes of chemicals,[32] although it is impossible to determine with any precision the role of the TRI in stimulating these reductions since data were not available before its release. Hamilton (1995) did find that the stock value of firms reporting TRI releases fell by $4.1 million on the day the pollution data were first released. Furthermore, Konar and Cohen (1997) found that firms that faced the largest stock price decline upon the initial release of the TRI to the public subsequently reduced their emissions more than their industry peers. These findings are consistent with the notion that the TRI has reduced information costs and increased the threat of regulation.

The availability of the TRI data also supported the use of new "voluntary" regulatory strategies by the EPA. In February 1991, the EPA announced the "33/50 Program," a voluntary scheme designed to induce firms to cut their emissions of 17 key toxic chemicals 33% by 1992 and 50% by 1995, relative to a 1988 baseline, by providing some favorable publicity and some limited technical assistance. The EPA has been criticized for the program's weak incentives (there are no penalties for failure to participate or failure to achieve the stated goals), and for overstating its results. Nevertheless, the existence of the program may have signalled an increased threat of federal regulation for these chemicals: emissions of the 33/50 chemicals fell 42% from 1991 to 1994, while emissions of all other TRI chemicals fell only 22%.[33]

In this section, we use state-by-state variation in the threat of regulation to analyze how abatement of the 33/50 chemicals has varied across states over the period 1987-1992. (This variation may reflect differing chances of state regulation and/or the stringency with which federal regulation is likely to be enforced in a given state.) As we showed in the preceding section, this threat is in turn a function of consumers' disutility of pollution and their costs of becoming informed and organized. We consider various measures that may increase the threat of regulation by raising consumers' disutility of toxic pollution. In addition, we consider per capita membership in environmental groups, since such membership indicates both high valuation of environmental amenities and an existing organizational structure that lowers the fixed costs of organizing to press for toxics regulation. We collected data on membership in the Sierra Club and the Natural Resources Defense Council (NRDC), by state, from 1987 to 1992. In order to control for state size in determining lobbying effectiveness, we divided the sum of these annual membership numbers by total state population to obtain the variable **GRNPRCAP** ("green" membership per capita).

To control for the important link between production and pollution we collected data on the value of shipments for the seven two-digit manufacturing industries responsible for over 70% of the releases of our 17 toxic chemicals. These industries are Chemicals (28), Petroleum Refining (29), Rubber and Plastics (30), Primary Metals (33), Fabricated Metals (34), Electrical Equipment (36), and Transportation (37). A simple scatter plot of total releases of the 17 toxic chemicals (**TOTREL**) against the value of shipments from these seven industries (**VALUE**) is presented in Figure 1, with each data point identified by a two-letter state code. (Note that each state code appears six times, since we have six years of data.) Several observations are immediately apparent from examination of the figure. First, there is a very strong and positive correlation between total releases and the value of shipments. Second, larger values of shipments are correlated with greater variance in total releases, indicating that heteroscedasticity is a concern; we use White-corrected standard errors to control for this problem. Third, in most states there has been a significant shift in the ratio of toxic releases to shipments over the sample period. It is precisely this evolving relationship that we wish to probe further.

Our focus is on the dependent variable **TOTPRVAL,** total releases of the 17 toxic chemicals per dollar value of shipments. We allow for the possibility that this measure is itself a function of **VALUE**, the total value of shipments, perhaps reflecting scale effects in pollution abatement, or perhaps reflecting the political influence wielded by the polluting industries. Since we want to examine changes in the pattern of releases over time, we include a time trend (**YR**) as an independent variable. In addition, we include **GRNPRCAP**, a measure of the number of conservation group members per capita in each state. Descriptive statistics for these and our other variables are presented in Table 1. Unless otherwise stated, all variables contain one observation per state for each year.

Given the possibility that conservation group membership is endogenous, and determined in part by the level of toxics emissions in each state, we used two-stage least squares as our estimating technique. We report first our estimation of per capita conservation group membership, and then turn to the estimation of toxics releases. In estimating conservation group membership, we included as independent variables (with respective expected signs) state population (negative, as free rider problems grow with population size), income (positive, assuming membership is a normal good), income squared (negative, to account for diminishing returns in the income/membership relationship), educational attainment (positive, measured by the percentage of the state’s population with a bachelor’s degree or higher), the percentage of registered voters who voted Republican in the

1988 presidential election (negative), a time trend (**YR**, no obvious sign prediction), a dummy variable for California (**CALDUM**, positive), and a dummy variable for the post-1990 period (**DUM9192**, negative since many states exhibit a downturn in membership during this time). The results are presented in Table 2.

Our estimation explains nearly three-quarters of the observed variation in conservation group membership per capita. The overall time trend over the sample period has been upward, though a decline was observed in 1991 and 1992. Membership per capita rises sharply with educational attainment, and falls with the percentage of the electorate voting Republican. Interestingly, membership is not significantly related to income. California has many more environmentalists per capita than the typical state. Per capita membership declines modestly with state population, suggesting that free rider problems indeed become more pronounced as population increases. Finally, membership is negatively and significantly associated with the total level of toxics releases in a state (an endogenous variable), suggesting that citizens who strongly value the environment may choose to locate in states with lower levels of toxic releases.

Our estimation of toxic releases per value of shipments is presented in Table 3. Here we probe the link between voluntary abatement and a number of variables that may affect the threat of regulation. We include as explanatory variables the estimated level of per capita conservation membership, expecting greater membership to reduce releases. The sign prediction for value of shipments is unclear, since value may indicate possible scale economies in the reduction of toxics emissions (negative sign), the political influence of the manufacturing industries we study (positive sign), or some combination of the two. We expect a negative time trend for releases, reflecting the lagged effects of the release of the TRI as well as the possibility of technological change in production processes. We also include as control variables state population (expecting a negative sign, since toxics create greater health risks when more people are exposed to them), and per-capita income and its square (expecting negative and positive signs, respectively). Finally, we include measures of land and water area, expecting greater land area to ease pressure for abatement, and greater water area to increase pressure for abatement since it makes safe disposal more difficult.

The results reported in Table 3 are consistent with the theory presented in section II of the paper. To begin with, greater (estimated) conservation membership has a negative and highly significant effect on the level of toxic releases per dollar of shipments. States with greater levels of shipments from our seven key industries have higher releases per dollar shipped, presumably because manufacturing industries have greater political clout in these states. There is a highly significant trend toward cleaner production processes (or at least greater end-of-pipe abatement) over the sample period, as evidenced by the negative and highly significant effect of the time trend on releases. A larger population, given the land area of the state, raises the marginal health cost of toxic releases and the value of regulation, and tends to reduce releases. The income variables enter with the expected signs and are highly significant statistically, which may suggest both that abatement is a normal good and that wealthier individuals are more likely to be politically active. States with larger land areas have higher levels of toxic releases (though the effect is only significant at the 12% level), which is sensible since they have a greater ability to absorb wastes. Larger water area, however, has a significant negative effect on releases, which is again sensible because water flows are an important pathway by which toxics may affect human health. Having identified a strong relationship between conservation group membership and voluntary abatement, we return to the role of the TRI itself in the self-regulation observed during the sample period. As mentioned earlier, the TRI greatly reduced the fixed costs of gathering information faced by consumers and by conservation groups. Our model indicates that this reduction in fixed costs should have induced greater self-regulation, pushing firms to adopt cleaner production processes. As can be seen in Figure 3, however, the TRI could have different types of effects in different states. In states where conservation groups faced very high organizing costs and were effectively blockaded from the political process, the TRI may have caused a shift from a regime with no self-regulation to one with positive levels of voluntary abatement. (It is also possible that even after the TRI, some states have organizing costs so high that self-regulation is not observed.) In states with conservation groups that were already large and well-organized, the TRI may have strengthened conservation groups, but had a more marginal effect. Groups in these states, for example, may have already been collecting their own data on at least some forms of toxics releases, so the TRI's incremental contribution may have been lower. Finally, it is possible that in states with extremely strong conservation lobbies, such as California, the TRI could have lowered organizing costs to the point where firms abandon self-regulation altogether, calculating that regulation is inevitable. In the aggregate, we would expect a convergence over time in the emissions rates of non-blockaded states, as a result of the foregoing considerations combined with the fact that states with relatively dirty production processes should have lower marginal abatement costs, and should thus be able to make large improvements fairly rapidly.

We examine the possibility of a convergence in emissions rates (**TOTPRVAL**) in Figure 4. The left-hand panel shows a marked pattern of convergence in all states but Montana over the sample period.[2] The right-hand panel shows that Montana has, if anything, increased its level of toxic releases per dollar of shipments. While we cannot perform conclusive tests, since we do not have data prior to 1987, Figure 4 suggests that Montana is the only state where even with the availability of the TRI consumers remain blockaded.[34]

To complement the visual display of Figure 4, we ran a simple regression attempting to explain the total reduction in **TOTPRVAL** from 1987 to 1992 based on the initial value of **TOTPRVAL** in 1987 and on the (estimated) average level of conservation membership by state over the sample period. The results are presented in Table 4. States that were dirtier initially have indeed cleaned up significantly more than other states. In addition, higher average conservation membership (**GRNHATAV,** using predicted values from the regression in Table 2) over the sample period induced significantly greater reductions in emissions rates.

Overall, the large reduction in toxic chemical releases between 1987 and 1992, and the

[2] Note in this pdf version of the paper Figure 4 is contained on two page. The "left hand side of figure 4 is contained on page 49 and the right had side of figure 4 is contained on page 50.

pattern of variation in reductions across states, seem entirely consistent with notion that the threat of government regulation drives firms to self-regulate. The EPA's 33/50 Program provided an implicit "threat" of federal regulation, although the program's effect is difficult to measure. The threat of state regulation (or strict state enforcement of federal rules) appears relevant as well, for the greater is conservation group membership per capita in a given state, the fewer toxic chemicals firms in that state emit. In addition, the convergence in emissions rates that has occurred in the wake of the TRI across all states but Montana suggests that the TRI did indeed significantly reduce consumer organizing costs and that Montana is the only remaining state where interest group pressure for toxics reduction is blockaded. "Potential regulatory entry" appears to be a powerful force.

V. WELFARE IMPLICATIONS

In this section, we assess welfare from two perspectives. First, we establish a benchmark for the socially optimal amount of pollution control and compare it against the outcome of the influence game; we then examine whether self-regulation results in a move toward the social optimum. Second, we examine the more limited, but perhaps more important, question of whether voluntary pollution control Pareto-dominates the outcome of the influence process when there is no voluntary abatement.

A welfare maximizing social regulator would choose Z to maximize

$$N^f \pi^N(Z) + N^c U(Z) \qquad \textbf{(8)}$$

yielding

$$\frac{\pi_Z^N}{U_Z} = -\frac{N^c}{N^f}. \qquad \textbf{(9)}$$

On the other hand, equations (4) and (6) imply that the equilibrium of the influence game is characterized by[35]

$$\frac{\pi_Z^N}{U_Z} = \frac{Z_m}{Z_l}. \qquad \textbf{(10)}$$

The social optimum, given by (9), differs in two ways from the equilibrium of the influence game. First, the welfare maximum weights firms and consumers equally. As a result, equation (9) does not include the relative impact of lobbying expenditures, unlike the equilibrium result shown in (10). Because the effectiveness of lobbying is subject to diminishing returns, the group that spends more on lobbying will be worse off in the influence game than in the welfare maximum. Second, the welfare maximum reflects the relative number of firms and consumers (as can be seen in the right-hand side of (9)), but the equilibrium result does not.[36] The reason for the second difference is that the influence game reflects our assumption that all players make their influence decisions non-cooperatively. Thus, each consumer or firm equates the last dollar of lobbying expenditures to his own individual marginal benefit from a change in the level of abatement. The effects of that marginal expenditure on other parties are ignored, however, so free-rider effects distort the equilibrium away from the welfare maximum. Free-rider problems increase with the number of members in an interest group, so relative to the welfare maximum, the influence game is biased toward the group with the smaller number of members.

It is important to note that both effects---diminishing returns to lobbying and free-rider problems---work against consumer interests. We focus on the case where without voluntary abatement consumer involvement leads to some pollution regulation, *i.e.* consumers in the aggregate devote more resources to lobbying than do firms. Because of diminishing returns to lobbying, the influence game is worse for consumers than is the welfare maximum. In addition, we assume there are more consumers than firms, so consumers face worse free-rider problems, further reducing consumer welfare in the influence game. We state the foregoing observations as Proposition 3.

Proposition 3: *If an industry has more consumers than firms, and will in equilibrium face some regulatory requirements for pollution control, the political influence game generates less abatement than is socially optimal.*

It is indeterminate in general whether self-regulation moves the level of pollution control closer to the socially optimal level. Proposition 1 guarantees the existence of a preemptive level of abatement if $f(N^c)$ is large enough. As $f(N^c)$ tends toward $f_{blockade}$, this preemptive level goes to zero, and consequently will be *lower* than the total abatement that would result from the influence game alone. Conversely, when $f(N^c)$ is low, firms may self-regulate to a level *beyond* what would result from the influence game in order to economize on lobbying costs.

A more meaningful question, however, is whether voluntary abatement improves welfare beyond what it would have been with no voluntary abatement. In order to address this question, we first establish a lemma that will provide a sufficient condition for the welfare effects of self-regulation to be positive. The key requirement is that positive or negative "complementaries" between the influence inputs of the two groups (as measured by the magnitude of Z_{ml}) are not too great. As Becker (1983, p. 376) points out, there is no *a priori* rationale for either a positive or negative sign on these complementarities, and we take no position as to their sign, simply considering limits on their magnitude.

Lemma: *There exists* $\epsilon > 0$ *such that if* $|Z_{ml}| < \epsilon \ \forall \ (m,l)$, *then as* Z^V *increases,* $Z(Z^V)$ *rises,* $m^e(Z^V)$ *falls, and* $l^e(Z^V)$ *rises.*

As we noted in section II, voluntary abatement shifts the reaction curves of consumers and firms in the influence game, making consumers "soft" and firms "tough." The lemma provides a simple sufficient condition under which the direct effects of voluntary abatement on each interest group's lobbying expenditures (holding the rival's expenditures constant) are greater than the strategic effects (mediated through a change in the rival's expenditures). In this case, voluntary abatement mollifies consumers and reduces their equilibrium expenditures on lobbying for further emissions reductions, while it simultaneously raises the marginal cost to firms of further abatement and thus raises their equilibrium lobbying expenditures. Since consumer pressure falls while firm pressure rises, voluntary abatement leads to a reduction in mandatory abatement, but this reduction is less than one-for-one; as a result, total abatement rises when voluntary abatement does so. When the conditions of the Lemma hold, it is straightforward to show that voluntary abatement raises consumer welfare, relative to the case where firms undertake no voluntary abatement.

Proposition 4: *If preemption occurs, and the conditions of the Lemma hold, then both consumer welfare and profits are increased, relative to their levels were government regulation imposed in the absence of voluntary abatement.*

If the industry chooses to preempt, then preemption must be profitable. It is less obvious that consumers are better off; it is not enough simply to show that consumers are better off at $Z = Z^V$ than at $Z = 0$. It is necessary to establish that consumers are better off than they would have been *if no voluntary abatement had taken place and they had lobbied for standards Z(0)* that might have been stricter than Z^V. The argument proceeds in two steps. First, observe that as long as consumers enter the influence game, they are always better off when firms have engaged in voluntary abatement. This is so because total abatement increases with Z^V and consumers' lobbying expenditures decrease with Z^V, as shown in the Lemma. Together the two effects must raise consumer welfare. Second, observe that if the firm preempts, it chooses a voluntary abatement level Z^V such that consumers are just indifferent between entering the influence game to obtain $Z(Z^V)$, and avoiding the influence game altogether. However, the preceding point shows that consumers prefer the influence game with $Z^V > 0$ to the influence game with $Z^V = 0$. Thus, if consumers allow themselves to be preempted by some $Z^V > 0$, they must be better off than they would have been had they fought to impose standards on an industry with no voluntary abatement.

Proposition 4 has two main policy implications. First, it supports allowing industry to coordinate on a choice of pollution limits, as long as the strategic effects of self-regulation on consumers' lobbying effectiveness is not too great. As Proposition 2 indicates, in some situations firms acting non-cooperatively will choose not to engage in voluntary abatement, but would do so if they could coordinate their actions. Proposition 4 shows that welfare would be enhanced by such coordination, as long as Z_{ml} is not too large. In this context, antitrust prosecution of "collusion" will reduce welfare. It is worth noting that as part of the 33/50 Program, the EPA has convened several conferences on voluntary abatement that "promoted collaborative action and partnerships among the conference participants."[37]

A second implication of our analysis is that government should not necessarily subsidize consumer involvement in the regulatory process. State regulatory agencies have increasingly taken to funding branches with names like "Division of Ratepayer Advocates" or "Office of Consumer Counsel" to intervene in utility rate cases. These actions appear designed to offset the high costs to consumers of intervening in the regulatory process, and indeed our analysis shows that such subsidies can shift the policy regime from one of no government regulation (because consumer organizing costs are too high) to one of preemption. On the other hand, our results also indicate that these efforts may unintentionally make consumers worse off by substituting government regulation for less costly industry self-regulation. The fixed cost of organizing implicitly commits consumers to an "acceptable" level of self-regulation beyond which they will not enter the political process. If organizing costs fall too low, this commitment may be eroded and firms may find preemption unprofitable; by Proposition 4 this may make consumers worse off.

Our analysis also identifies a linkage between the effects of antitrust and regulatory policy.

Granting industry the right to collude on pollution control lowers the threshold of consumer organizing costs below which self-regulation becomes unprofitable. Thus, for any given $f(N^c)$, antitrust policy allowing such cooperation reduces the danger that regulatory subsidization of consumer political action will undermine self-regulation.

V. CONCLUSIONS AND EXTENSIONS

We have developed a model in which firms can use self-regulation to preempt government-imposed regulations. When it is costly for consumers to organize and to influence the political process, firms can match the net utility consumers expect from regulatory controls with a *lower* level of voluntary controls, and can thereby deter consumer groups from mobilizing to enter the political process. As the threat of regulation grows, *e.g.* because of reductions in consumers' informational and organizational costs, self-regulation becomes more stringent.

Evidence on the emissions of toxic chemicals provides broad support for our thesis. When Congress reauthorized Superfund in 1986, Title III of the legislation required companies to report their emissions of over 300 toxic chemicals, thereby dramatically lowering consumer information costs. In our framework, after this data began to be collected total releases of toxic chemicals should have dropped significantly. This hypothesis cannot be tested directly, since the data were not collected prior to the passage of the law, but the massive cuts in emissions since 1987 (ranging from 38% to 51% for different classes of chemicals) are certainly consistent with our model's predictions. In addition, the convergence in emissions rates that occurred between 1987 and 1992 across almost all states suggests that the disclosure of the toxics data has significantly reduced organizing costs in most formerly high-cost states; only in Montana do consumer groups remain blockaded. Furthermore, the EPA's voluntary 33/50 Program, initiated in 1991, may have signalled a greater threat of federal regulation for the 17 chemicals it encompasses; emissions of these 17 chemicals fell 42% from 1991 to 1994, while emissions of the other TRI chemicals fell by 22%, further suggesting that the threat of regulation matters. Finally, we can also use the new data on toxic releases to examine how state-level variation in the threat of regulation affects incentives for voluntary abatement. We find that states with higher income, greater water area, and higher per capita membership in conservation groups experience lower rates of emissions of unregulated toxic chemicals, supporting our model's prediction that the threat of regulation leads firms to undertake voluntary abatement.

There are many potentially interesting extensions of our model. For example, if firms sink investment in a technology with an upper limit on pollution control capability, then they must scrap that technology and adopt a new one if standards exceed the current technology's limit. Stiffer standards would thus be highly costly, and preemption would be more likely when such a technology is used. Allowing for asymmetric firms and for voting behavior would also be interesting extensions of the model.

Another promising direction is a marriage of our interest-group model with a vertical product differentiation model, in which voluntary abatement attracts customers willing to pay a premium for environmentally friendly products. Lutz, Lyon and Maxwell (1998) study a vertical differentiation model with minimum quality standards set by a welfare-maximizing regulator. Combining their framework with our political economic analysis should allow for a rich set of results.

APPENDIX

Proof of Proposition 1: We first establish that feasible preemption exists. The firms can always preempt consumers by choosing a level of voluntary abatement that will yield consumers the same utility they would receive from engaging in the influence game, *i.e.* Z^V such that $U^N(Z^V) = U^I(Z^V) - f(N^c)$. (Note that in what follows we drop the functional dependence of f on N^c to avoid excessive notation.) To show that such Z^V exists as a feasible choice, we need to show that $\pi^N(Z^V) > \pi^N(Z(0)) - l(0) = \pi^I(0)$. That is, it must be more profitable to engage in preemption than not to engage in preemption and enter the influence game. It is clear that for sufficiently large f such a Z^V exists since for sufficiently large f, $U^I(0) - f = U^N(0)$ and $\pi^N(0) > \pi^I(0)$. Call this level of fixed cost $f_{blockade}$, since at this level consumers will not enter the influence game even if the firms undertake no abatement.

Note that there is a maximum level of voluntary abatement, $Z^V_{\max}$, that the firms will be willing to undertake, where $\pi^N(Z^V_{\max}) = \pi^I(0)$. The relevant comparison point on the right-hand side of the equality is zero abatement because $d\pi^I/dZ^V < 0$. Since π^N is also declining in Z^V, any level of voluntary cleanup beyond $Z^V_{\max}$ will not be profitable. Next we define the minimum level of Z^V required to preempt consumers. For any given f this level is given by $U^N(Z^V_{\min}) = U^I(Z^V_{\min}) - f$. Consequently we write $Z^V_{\min}(f)$ as a function of the level of consumer fixed costs. It remains to be shown that $Z^V_{\min}(f)$ is decreasing in f. This result follows from two observations. First, $U^N(Z^V)$ is independent of f, and second ,$U^I(Z^V) - f$ is strictly decreasing in f. Now consider two levels of f, with $f_A < f_B < f_{blockade}$. Then $U^I(0) - f_B > U^N(0)$, because consumers cannot be preempted by a zero level of voluntary abatement. Now define $\theta_B(Z^V) = U^I(Z^V) - f_B - U^N(Z^V)$, a continuous function. Then $\theta_B(0) > 0$. Recall that $Z^V_{\min}(f_A)$ is defined such that $U^I(Z^V_{\min}(f_A)) - f_A = U^N(Z^V_{\min}(f_A))$. Thus, since $f_B > f_A$, $\theta_B(Z^V_{\min}(f_A)) < 0$. By Bolzano's Theorem, there exists a $\hat{Z} \in (0, Z^V_{\min}(f_A))$ such that $\theta_B(\hat{Z}) = 0$. By the definition of $\theta_B(Z^V)$, we see that $\hat{Z} = Z^V_{\min}(f_B)$. Therefore,

$Z^V_{\min}(f_B) < Z^V_{\min}(f_A)$. **Q.E.D.**

Proof of Proposition 2: Let $\pi^N(Z^V_{-i}; Z^V_i)$ be firm *i*'s profit when the influence game is preempted, all firms but *i* abate to (scalar) level Z^V_{-i} and firm *i* abates to level Z^V_i. Similarly let $\pi^I(Z^V_{-i}; Z^V_i)$ and $l^e(Z^V_{-i}; Z^V_i)$ be firm *i*'s profit when the influence game is played and its optimal lobbying expenditure, given the aforementioned voluntary abatement levels. The maximum symmetric collusive level of voluntary abatement, denoted $Z^{V/C}_{\max}$ is defined by $\pi^N(Z^{V/C}_{\max}; Z^{V/C}_{\max}) = \pi^I(0;0)$. On the other hand, the maximum non-cooperative level of voluntary abatement, denoted $Z_{\max}^{V/NC}$, is defined by

$\pi^N(Z_{\max}^{V/NC};Z_{\max}^{V/NC}) = \pi^I(Z_{\max}^{V/NC};0)$. Two things must be shown. First, non-cooperative voluntary abatement is possible. Note that there exists Z_i such that $\pi^N(0;Z_i) \geq \pi^I(0;0) \equiv \pi^N(0;0) - l^*(0;0)$. This is easy to see, assuming $l^e(0;0) > 0$: there must exist some small Z_i that is profitable *if* it successfully preempts, since the firm is thereby spared the lobbying cost $l^e(0;0)$. From the continuity of $\pi^N(Z_{-i}^V;Z_i^V)$, similar results hold for small Z_{-i}^V. Thus, some noncooperative preemption is possible for sufficiently high levels of consumer fixed costs. Second, it must be shown that $Z_{\max}^{V/NC} < Z_{\max}^{V/C}$. Consider firm i's best response when all other firms play $Z_{\max}^{V/C}$, which is determined by $\pi^N(Z_{\max}^{V/C};Z_i) = \pi^I(Z_{\max}^{V/C};0)$. Note that $\pi^N(Z_{-i}^V;Z_i^V)$ passes through $\pi^N(Z_i^V)$ but is rotated clockwise. Note also that $\pi^I(Z_{\max}^{V/C};0) > \pi^I(0;0)$, so it cannot be a best response for firm i to select $Z_i = Z_{\max}^{V/C}$. Instead, since $d\pi^N(Z_{-i}^V;Z_i^V)/dZ_i < 0$, firm i's best response requires $Z_{\max}^{V/NC} < Z_{\max}^{V/C}$. Thus, the maximum level of non-cooperative voluntary abatement is lower than the maximum collusive level. As a result, there are some values of the consumer fixed cost f for which collusive preemption is possible but non-cooperative preemption is impossible. **Q.E.D.**

Proof of Lemma: Note first that

$$\frac{dm^e}{dZ^V} = \frac{\frac{\partial m^*}{\partial l}\frac{\partial l^*}{\partial Z^V} + \frac{\partial m^*}{\partial Z^V}}{1 - \frac{\partial m^*}{\partial l}\frac{\partial l*}{\partial m}}$$

and similarly that

$$\frac{dl^e}{dZ^V} = \frac{\frac{\partial l^*}{\partial m}\frac{\partial m^*}{\partial Z^V} + \frac{\partial l^*}{\partial Z^V}}{1 - \frac{\partial l^*}{\partial m}\frac{\partial m*}{\partial l}}.$$

These expressions show that the equilibrium change in lobbying levels as a function of Z^V depends on both the shift in the player's own reaction curve as well as the movement along his reaction curve caused by the shift in the rival's reaction curve. Letting $\lambda \equiv 1 - (\partial m^*/\partial l)(\partial l^*/\partial m)$, we note that $\lambda > 0$ because the reaction curves are assumed to be stable. We can now write $dm^e/dZ^V = (\theta/\lambda)(dZ/dZ^V)$ and $dl^e/dZ^V = (\phi/\lambda)(dZ/dZ^V)$, and some expansion of terms yields

$$\theta = \frac{U^I_{ml}}{U^I_{mm}}\frac{\pi_{zz}Z_l}{\pi^I_{ll}} - \frac{U^I_{ZZ}Z_m}{U^I_{mm}}$$

and

$$\phi = \frac{\pi^I_{lm}}{\pi^I_{ll}}\frac{U^I_{zz}Z_m}{U^I_{mm}} - \frac{\pi^I_{ZZ}Z_l}{\pi^I_{ll}}.$$

Now we can write $dZ/dZ^V = 1 + dZ^M/dZ^V = 1 + Z_m\,(dm^e/dZ^V) + Z_l\,(dl^e/dZ^V) = 1 + Z_m(\theta/\lambda)\,dZ/dZ^V + Z_l(\phi/\lambda)\,dZ/dZ^V$. Rearranging terms yields $dZ/dZ^V = 1/(1 - Z_m\theta/\lambda - Z_l\phi/\lambda)$. Thus, sufficient conditions for $dZ/dZ^V > 0$ are $\theta < 0$ and $\phi > 0$.

Next, note that $U^I_{ml} = U^I_{ZZ}\,Z_m\,Z_l + U_Z\,Z_{ml}$, and if $Z_{ml} = 0$ then $U^I_{ml} = U^I_{ZZ}\,Z_m\,Z_l$. Substituting this into the expression for θ, and noting that $\pi^I_{ll} = \pi^I_{ZZ}\,(Z_l)^2 + \pi^I_Z\,Z_{ll}$, we obtain:

$$\theta = \frac{-U^I_{ZZ}Z_m}{U^I_{mm}}\frac{\pi_z Z_{ll}}{\pi^I_{ll}} < 0.$$

Similar reasoning yields

$$\phi = \frac{-\pi^I_{ZZ}Z_l}{\pi^I_{ll}}\frac{U^I_z Z_{mm}}{U^I_{mm}} > 0.$$

Hence $dZ/dZ^V > 0$. Furthermore, $dm^e/dZ^V = (\theta/\lambda)(dZ/dZ^V) < 0$ and $dl^e/dZ^V = (\phi/\lambda)(dZ/dZ^V) > 0$. All of the above arguments will still go through for Z_{ml} of sufficiently small absolute value. **Q.E.D.**

Proof of Proposition 4: If the firms preempt, they choose Z^V so that

$$U^N(Z^V) = U^N(Z(Z^V)) - m^e(Z^V) - f(N^c).$$

Note that the Lemma shows that $m^e(Z^V) < m^*(0)$ and that $Z(Z^V) > Z(0)$, so $U^N(Z(Z^V)) > U^N(Z(0))$. Therefore

$$U^N(Z^V) = U^N(Z(Z^V)) - m^e(Z^V) - f(N^c) > U^N(Z(0)) - m^e(0) - f(N^c).$$

Q.E.D.

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Endnotes

1. Smart (1992), p. 200.

2. *Wall Street Journal*, March 9, 1995, p. C1.

3. Quoted in Hunt (1975), page 45.

4. When self-regulation involves restrictions on quantity or sales territory, the terms "cartel" and "collusion" are applied and antitrust investigation may be expected. A large body of economic literature is devoted to identifying when such activities reduce social welfare. Kaserman and Mayo (1995) provide a good overview of this research.

5. Self-regulation may increase consumer demand by reducing uncertainty about product quality or ensuring interoperability of the products of different firms. It may enhance employee satisfaction by improving the safety or other quality aspects of the workplace. It may also serve more strategic purposes, such as softening competition or preempting stricter government regulations. If self-regulation is more cost-effective than government regulation, firms might self-regulate even if doing so has no impact on the ultimate level of restraint required.

6. For a survey of corporate environmental programs, see Smart (1992). The idea that "pollution prevention pays" has been widely promoted in the popular and trade press. For example, Cairncross (1992) notes that firms may engage in the production of "green" products to serve a high margin market niche, and that a reputation for cleanliness may ease the burden of plant location. Michael Porter's influential article in *Scientific American* (1991) argued that American companies that adopt greener production processes may enhance their competitiveness in world markets. Hemphill (1993) points to another motive for pollution prevention: courts often treat more leniently environmental offenders that have established their own in-house audit and compliance programs.

7. Many of the opportunities for painless Pareto-improvements have already been implemented. For example, 3M's "Pollution Prevention Pays" program has reduced the company's emissions by over 1 billion pounds since 1975, and has saved 3M roughly $500 million in the process. Walley and Whitehead argue, however, that many recent corporate environmental initiatives have had negative effects on company profits, suggesting that most companies now face sharply rising costs should cleanup standards be further increased. They cite (p. 46) the following example: "A major North American chemical company...was enjoying an internal rate of return of 55% on employee-generated environmental initiatives...But when those impressive returns were added to the internal rate of return on *all* corporate environmental projects, the return dropped to a negative 16%."

8. One could also devise a somewhat more complex model that subdivides consumers according to their relative disutilities for price increases and for environmental degradation. Even so, there will always be one consumer group with the strongest preference for environmental protection, whose interests are most strongly opposed to those of the firms; other consumer groups will fall somewhere on the spectrum between these two extremes. Consider, for example, a group of consumers who are concerned about price but not about pollution. The interests of these consumers are aligned with those of the firms when it comes to investments in pollution control, since installation of the technology both raises price and reduces profits. Because all consumer groups will on balance align with either the firms (lobbying for weaker regulations) or environmentalists (lobbying for stronger regulations), including additional consumer groups would complicate the modeling but seems unlikely to generate substantial new insights.

9. Although there is a vast literature on the economics of regulation, we take the "economic theory of regulation" to mean the strand of the literature associated with the work of Stigler (1971), Peltzman (1976) and Becker (1983).

10. We often use the term "lobby" as a shorthand for the array of actions interest groups can take to obtain political influence, which includes campaign contributions, direct lobbying, political advertising, revolving-door arrangements, junkets, and honoraria.

11. Four informative case studies appear in Caves and Roberts (1975), covering appliance manufacture, farm machinery, computers, and entertainment. Abolafia (1985) offers a helpful overview of the phenomenon of self-regulation and discusses three case studies of financial exchanges. Pirrong (1995) argues that self-regulation is an inefficient way to reduce monopoly power in financial markets. Ayres and Braithwaite (1992) argue that voluntary self-regulation is unlikely to be effective when it involves actions that increase firms' costs, and instead propose a process of negotiation between government and individual firms that they term "enforced self-regulation." Jochem and Eichhammer (1997) discuss German companies' voluntary reductions of carbon dioxide emissions. Interestingly, European "voluntary" agreements often involve explicit signed agreements with government, and a clear threat of regulation if the agreed-upon voluntary reductions do not materialize.

12. Arora and Gangopadhyay (1995) present a model where firms voluntarily reduce emissions of pollutants to attract "green" consumers. Bagnoli and Watts (1995) perform a similar analysis, and show that voluntary reductions generally cannot achieve the socially optimal level of abatement. Lutz, Lyon and Maxwell (1998) study a vertical differentiation model with minimum quality standards and show that high-quality firms may have incentives to act strategically so as to shape future regulatory requirements.

13. See Tirole (1989), chapter 8, for a good overview.

14. Tirole (1989), section 8.3, presents a taxonomy of business strategies based upon animal analogies such as the "fat cat effect" and the "puppy dog ploy."

15. Note also that, unlike Gilbert and Vives (1986) or Donnenfeld and Weber (1995), our oligopolists never have an incentive to engage in excessive (i.e., Pareto-dominated levels of) entry deterrence, since individual firms do not obtain private benefits from voluntary abatement.

16. If the technology is not binding, it has no commitment value and thus no strategic effect.

17. Note that since voluntary pollution control is binding, policy cannot result in lower levels of pollution control.

18. By assuming homogeneous products, we in effect assume that consumers cannot observe the emissions of an individual firm, though they may be able to observe aggregate environmental damage (*e.g.*, air quality in the Los Angeles basin or water quality in the Great Lakes).

19. Because the firms are symmetric, the level of Z determined in stages 1 and 2 of the game is the same for all firms and we treat it as a scalar; we avoid vector notation for notational simplicity.

20. Obviously self-regulation looks even better if it is cheaper than government regulation.

21. We assume the existence of a unique pure-strategy equilibrium. See Tirole (1989), pp. 224-226 for conditions guaranteeing such an equilibrium exists, and further references on the subject.

22. As we explain in footnote 8, the analysis could be expanded to multiple interest groups, though the costs of the exercise appear to outweigh the benefits.

23. While environmental groups and trade associations may coordinate the collection of funds from members, we emphasize the fact that the financial contributions of members are made individually and on a non-cooperative basis.

24. Because firms are symmetric and there is no possibility of entry, it is not profitable to lobby for stricter regulations as a means of raising rivals' costs.

25. Stigler (1971) and Peltzman (1976) present a theory that shows the effects of fixed organizing costs on the effectiveness of pressure exerted by interest groups. In their model, fixed costs are incurred by pressure groups in the process of entering the political influence process. These costs arise in part because of the resources

necessary for interest group members to acquire relevant information and to successfully organize and coordinate their activities. Individuals of similar interests must then organize themselves around a clear position. In the Stigler/Peltzman framework, interest groups experience diseconomies of scale -- organization costs increase faster than group size. For example, the larger the group the more diffuse are the benefits, and thus the free-rider incentive increases faster than group size.

26. These costs are often very high due to the incomplete state of scientific knowledge and its inaccessibility to those who are not experts in the relevant fields.

27. We assume the social costs of environmental degradation can be measured in money units and combined with consumer surplus from the consumption of the good to generate a welfare measure that is denominated in money equivalents.

28.See Tirole (1989), p. 327, for further discussion of the terms “tough” and “soft” in multistage commitment games.

29. In surveying a group of firms, some of which participated and some of which declined to participate in the EPA’s voluntary “33/50" program, Clark (1996), p. 23, notes that “One of the most significant findings of our study was the identification of a potentially more positive response from some companies for a pollution prevention program sponsored by the company’s trade association.”

30. Numerical examples show that either case can easily occur.

31. With respect to the firms' pressure activities, Peltzman shows that firms' aggregate influence eventually falls as the number of firms grows, but one cannot predict in general whether an additional group member strengthens or weakens the pressure group. Consumer pressure activities are also ambiguously affected by an increase in N^f. On the one hand, if demand is not too convex consumers become more hesitant to press for an increase in abatement, since now more of the cost of such an increase is passed through into price. On the other hand, they more aggressively push for an increase in abatement because each increase in the required level of abatement now has a greater effect on total pollution. Again the net effect is ambiguous.

32. Davies and Mazurek (1996), Chapter 1, p. 15.

33. For an overview of the performance of the 33/50 Program, see Davies and Mazurek (1996).

34. According to Malone and Roeder (1976), the historical relationship between business, government, and the public in Montana has been quite different from that in most states. “During its heyday, from 1900 until the 1940s, the Anaconda Copper company wielded such enormous power in the state that Montana gained the unenviable reputation of being little more than a company asset. In the mid-1940s, for example, John Gunther wrote these famous words in his *Inside U.S.A.*: ‘Anaconda, a company aptly named, certainly has a constrictorlike grip on much that goes on, and Montana is the nearest to a ‘colony’ of any American state...’ ” (p. 248). While the times have certainly changed since then, our data suggest that consumers continue to face high costs of obtaining political representation.

35. Recall that $Z_l < 0$, so the right-hand side of (13) is negative.

36. Of course, the number of firms and consumers still affects the equilibrium of the influence game through the left-hand side of (13), as discussed above.

37. Davies and Mazurek (1996), Chapter 1, p. 12.

Figure 1: Total Emissions of 17 Toxic Chemicals against
Value of Shipments from 7 U.S. Manufacturing Industries, by State, 1987-1992

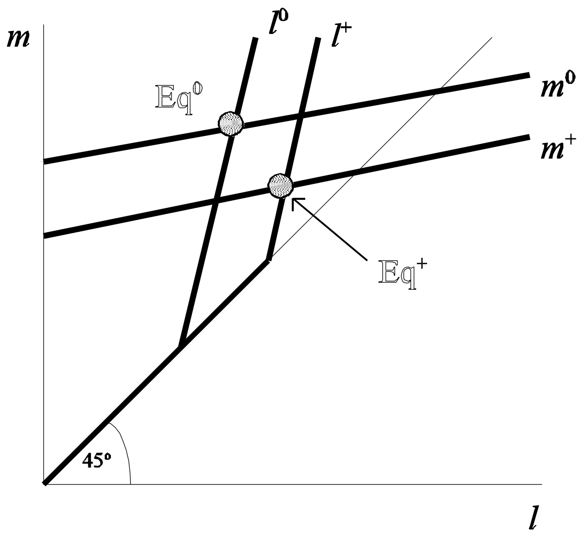


Figure 2: Firm (*l*) and Consumer (*m*) Reaction Functions in the Influence Game

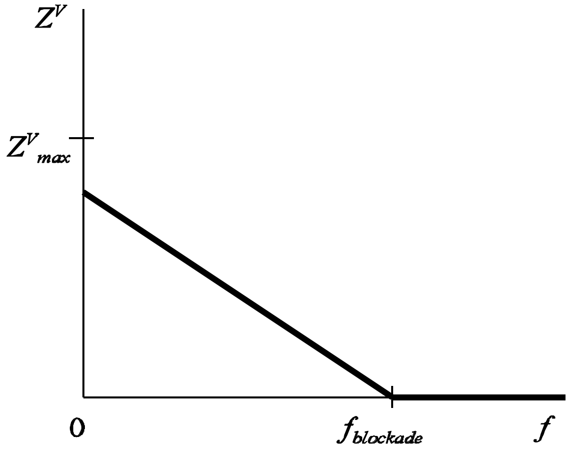


Figure 3A: Optimal
Voluntary Abatement Z^V if Preemption is Profitable
Even when Consumer Fixed Costs *f* are Zero

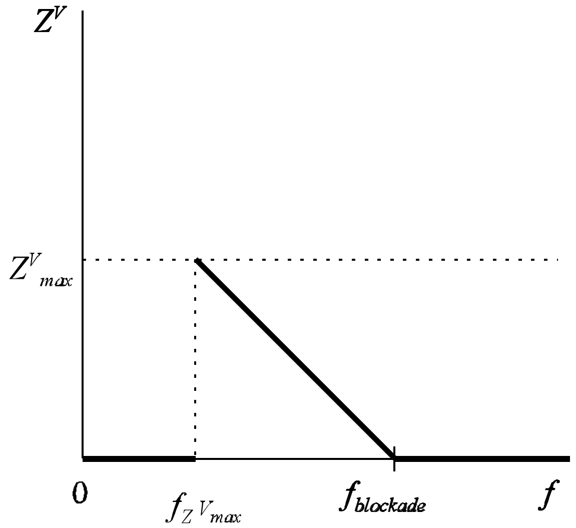


Figure 3B: Optimal Voluntary Abatement Z^V if Preemption is Unprofitable
when Consumer Fixed Costs *f* are Zero

Figure 4: Total Emissions per Value of Shipments by Year for
(a) All U.S. States except Montana, and (b) Montana.

Table 1
Summary Statistics

Variable	Definition	Mean	Std. Dev.	Min.	Max.
VALUE	Value of shipments from 7 selected manufacturing industries in millions of $1987	55.5	58.8	2.1	306
TOTREL	Million pounds of 17 selected toxic chemicals released	18.1	17.7	0.2	78.7
TOTPRVAL	= TOTREL/VALUE	0.357	0.201	0.032	1.089
POP	State population (thousands)	4953	5382	454	30867
INCOME	State income per capita in $1987	13947	2690	8570	22129
VREP88	Percentage of 1988 Presidential votes that were Republican	54.7	5.1	44.4	66.2
EDUCATION	Percentage of state population with a bachelor's degree or higher in 1990	19.7	3.7	12.3	27.2
GREEN	Number of members of NRDC and Sierra Club	13060	29929	411	245227
GRNPRCAP	= GREEN/POP (conservation group members per thousand state residents)	2.233	1.376	0.334	8.24
LANDAREA	Land area of state in square miles	70725	85083	1045	570374
WATERAREA	Surface water area of state in square miles	5039	13027	145	86051

Table 2: Determinants of Conservation Group Membership using 2SLS
Dependent Variable: GRNPRCAP

INDEP. VARIABLE	Coefficient (t-stat)
YR	0.15922*** (3.150)
TOTPRVAL	-3.03585*** (-3.493)
POP	-0.00006*** (-6.617)
INCOME	-5.82e-06 (-0.025)
INCOMESQ	3.87e-11 (0.006)
VREP88	-0.03279*** (-3.996)
EDUCATION	0.16872*** (9.499)
CALDUM	5.05120*** (17.387)
DUM9192	-0.56302*** (-3.419)
CONSTANT	-12.0086** (-2.069)
Adj. R-Squared	0.7144

* denotes significance at the 10% level
** denotes significance at the 5% level
*** denotes significance at the 1% level

Table 3: Determinants of Toxics Emissions Levels using 2SLS

Dependent Variable: TOTPRVAL

Independent Variables	
GRNPRCAP	-0.01838**
	(-2.060)
VALUE	1.49e-09***
	-6.168
YR	-0.03321***
	(-6.422)
POP	-0.00002***
	(-6.289)
INCOME	-0.0002***
	(-5.187)
INCOMESQ	5.48e-09***
	(-4.904)
LANDAREA	2.41e-07
	(-1.561)
WATERAREA	-1.70e-06*
	(-1.892)
CONSTANT	5.07945***
	-9.692
Adj R-Squared	0.419

* significant at the 10% level

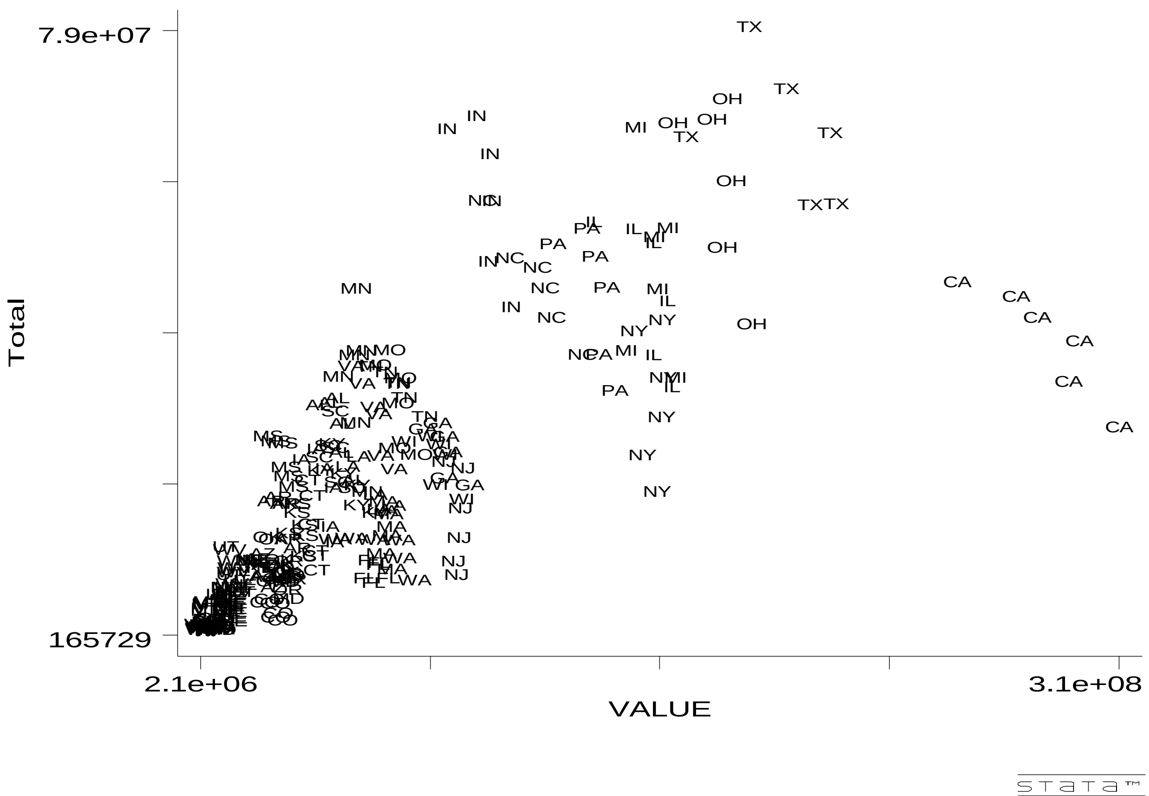
** significant at the 5% level

*** significant at the 1% level

Table 4: Reductions in Toxic Emissions 1987-1992

Indep. Variable	Coefficient
TOTPRVAL87	0.67856***
	(13.833)
GRNHATAV	0.03947***
	(6.403)
CONSTANT	0.18361***
	(6.295)
F STAT.	247.3
R-Squared	0.5797

* denotes significance at the 10% level
** denotes significance at the 5% level
*** denotes significance at the 1% level



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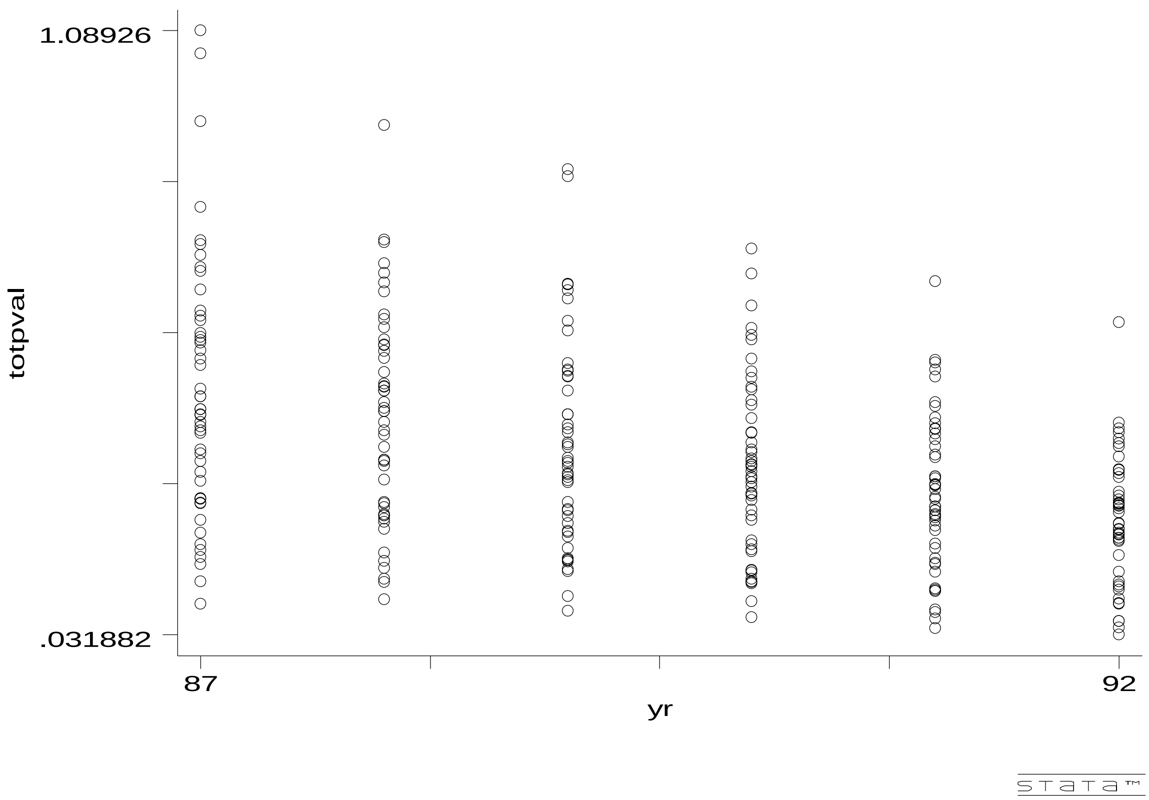
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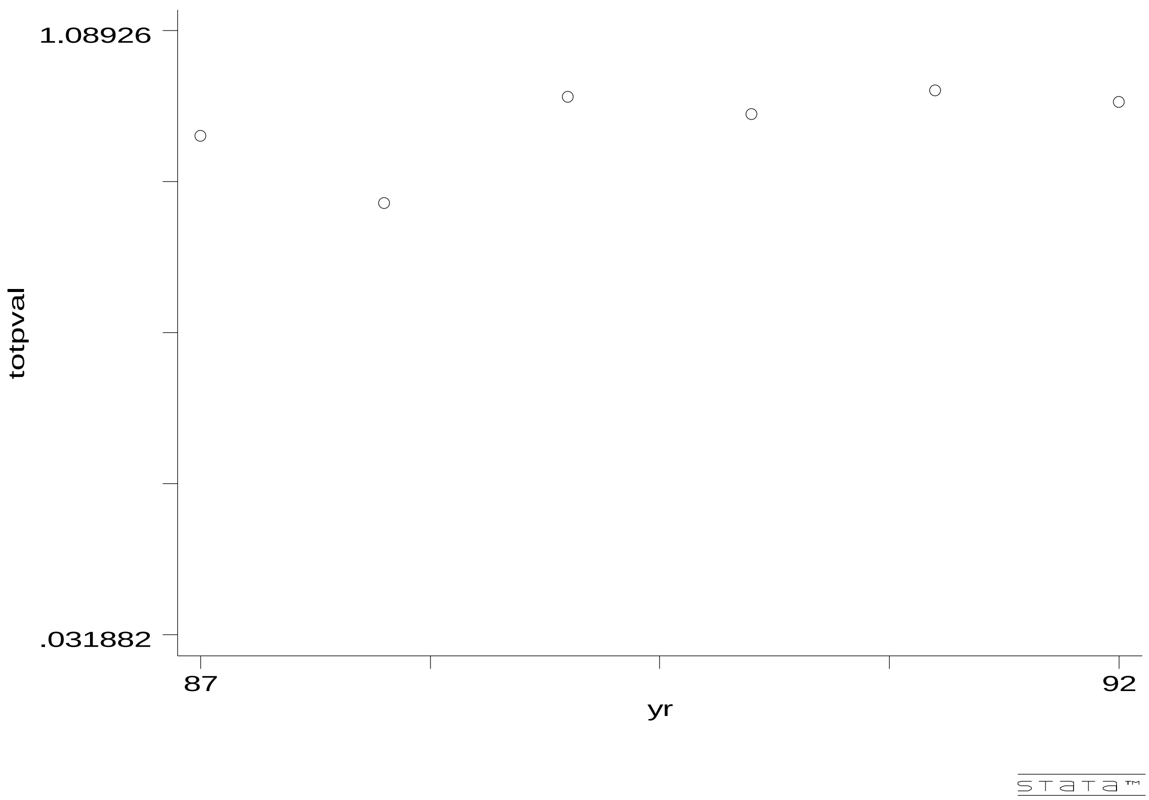
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