Voluntary Pollution Abatement and Regulation

Michael S. Delgado
Department of Economics
State University of New York at Binghamton
mdelgad1@binghamton.edu

and

Neha Khanna
Department of Economics and Environmental Studies Program
State University of New York at Binghamton
nkhanna@binghamton.edu

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Michael S. Delgado and Neha Khanna
Department of Economics, Binghamton University

BINGHAMTON UNIVERSITY
State University of New York

Overview

The increasing popularity of voluntary pollution abatement programs raises the question of their effectiveness as a tool for environmental policy and their interaction with more traditional policy instruments for regulating pollution. We develop a model to:

- explain the existence of a voluntary abatement market in the presence of altruism
- examine the relationship between voluntary abatement and traditional regulation
- examine the change in overall pollution abatement as a result of an increase in regulation
- examine whether or not regulatory policies that ignore private abatement market reactions can effectively reduce pollution.

We find that:

- a voluntarily abatement market may exist if consumers' demand for abatement is sufficiently strong
- an increase in regulation on otherwise non-abating consumers and firms will cause a reduction in the equilibrium quantity of abatement in the private market for voluntary abatement
- regulation will always increase the total level of environmental quality, regardless of the reduction in voluntary abatement
- optimal regulation that recognizes the contraction of the voluntary market in response to regulation may be higher or lower than regulation that does not recognize the contraction of the voluntary market.

Literature and Contributions

There exists a large literature that focuses on cost minimizing motivations for voluntary pollution abatement:

- firms seek to avoid future regulations (Maxwell et al. 2000)
- firm-regulator bargaining (Segerson and Miceli 1998)
- firm strategy with industry-wide targets (Dawson and Segerson 2008)
- product differentiation and duopoly structure (Arora and Gangopadhyay 1995)

Literature examining consumer motivations

- typically use an impure public goods framework to model consumer preferences (Kotchen 2005 and Kotchen and Moore 2007).
- finds the strongest motivations stem from altruism towards the environment (biocentrism) and towards other individuals (altruism), while the weakest motivation is warm-glow (egoism) (Clark et al. 2003 and Kotchen and Moore 2007).

Our framework assumes a standard model of altruism – private provision of a pure public good (Bergstrom et al. 1986), but can be easily generalized to the impure altruism framework (Andreoni 1990) as suggested by empirical evidence (Clark et al. 2003 and Kotchen and Moore 2007).

Our model builds upon previous literature by:

- providing a general model of voluntary abatement
- modeling the indirect link between the voluntary market for environmental attributes and the regulated market
- establishing the relationship between mandatory abatement and environmental quality in the presence of altruistically motivated demand for environmental attributes
- comparing optimal levels of regulation between a naïve regulation policy that does not recognize the reaction of the voluntary market to mandatory regulation with an omniscient regulation policy that does recognize the reaction of the voluntary market.

Model Structure

Demand Side

- Two consumers each with utility given by:
  $U_i = U(X_i, E), \quad i = 1,2,$
- X_i is the numeraire (private) good
- $E = Z_i + Z_{-i} + E_0$ is total environmental quality as a function of abatement purchased by individual i, Z_i, abatement purchased by others, Z_{-i}, and the background level of environmental quality, E_0.
- Both E and Z are pure public goods
- Budget constraint is: $M_i = X_i + PZ_i$ where M is income and P is the price of abatement in the voluntary market.
- Consumers purchase the abatement attribute of a bundled product separately – the price premium for the bundled product over traditional products is the price of abatement.
- A Cobb-Douglas example:
  $\text{Max } U_i = X_i^{\alpha}(Z_i + Z_{-i} + E_0)^{1-\alpha}$ s.t. $M_i = X_i + PZ_i$

Supply Side

- Firm sells abatement attribute in the perfectly competitive private abatement market.
- Firm's cost of abatement is $C(Z) = cZ^2$, $c > 0$
- Firm's problem is to choose the quantity of abatement that maximizes profits:
  $\text{Max } \pi(Z) = PZ - cZ^2$
- The firm's supply curve of abatement: $P = 2cZ$

Market Equilibrium

- Equating the consumer's demand curve for abatement with the producer's supply curve yields the voluntary market equilibrium price and quantity of abatement.
- We assume consumer income is such that only one consumer will choose to purchase abatement in equilibrium (the other consumer free-rides).

Optimal Regulation

- Since only one consumer voluntarily purchases abatement, $E = Z_i + Z_R + E_0$ where Z_R is the level of mandated abatement
- The total benefit from regulation is the increase in utility across both consumers (measured in terms of the numeraire) from regulated abatement
- The marginal benefit from regulation is the marginal utility from environmental quality divided by the marginal utility of income
  $MB(Z_R) = \Sigma_i MB_i(Z_R) = \Sigma_i MU_i(Z_R) / MU_i(X_i)$
- The total cost of abatement is the cost of producing both voluntary and mandatory abatement
- The optimal level of regulation is the level of mandatory abatement that equates the marginal benefit from regulation with the marginal cost of regulation:
  Z_R^* solves $MB(Z_R) = MC(Z_R)$

Results and Propositions

1. We show, consistent with other models of altruistic preferences, that an increase in the level of environmental quality arising from regulation necessarily decreases the equilibrium price and quantity of abatement in the voluntary market.

- An exogenous (to the consumer) increase in the level of the public good reduces demand for voluntary provision of the public good. Hence, the demand curve in the voluntary market shifts to the left.

4. Under <u>pure altruism</u>, we show that an omniscient regulator who recognizes the reaction to mandatory abatement from the voluntary market will choose an optimal level of regulation that is higher than a naïve regulator who does not recognize the voluntary market reaction.

- The marginal benefit of regulation is higher in the case of the omniscient regulator, because of the contraction of the voluntary market. Consumers substitute part of their voluntary abatement with mandatory abatement, which means that consumers can reallocate their income away from abatement and towards the numeraire good. The level of environmental quality is maintained from the exogenously provided abatement coming from regulation.

2. We show, consistent with the assumption that abatement is a normal good, that an increase in the consumer's income increases the price and quantity of abatement in the voluntary market.

- An increase in consumer income shifts the demand curve for abatement in the voluntary market to the right. Hence, the equilibrium price and quantity increase.

5. Under <u>impure altruism</u>, the degree of altruism governs the degree of the response (contraction) in the voluntary market as a response to mandatory abatement.

- A high degree of altruism implies a larger reaction to regulation, while a low degree of altruism implies a smaller reaction to mandatory abatement.
- The marginal cost is smaller relative to the marginal cost for the naïve regulator who assumes that the voluntary market will not react (which is equivalent to the purely warm glow case, in which there is zero altruism).
- It is not necessarily clear as to whether or not the marginal benefit is larger or smaller relative to the marginal benefit for the naïve regulator.
- The optimal level of regulation may be larger or smaller than the level chosen by a naïve regulator, depending on the differences in the marginal benefit and cost.

3. Mandatory regulation necessarily increases total environmental quality.

- An exogenous increase in the public good arising from mandatory abatement leads to a less than one-for-one crowding out of voluntary contributions (because abatement is a normal good) so total environmental quality increases following regulation.
- Mandatory regulation can always be used to improve total environmental quality
- The reaction to mandatory abatement coming from the voluntary market dampens the effectiveness of regulation.
- Traditional regulatory policies that ignore the voluntary market will be unable to achieve the targeted level of environmental quality.

Conclusions and Policy Implications

There is ample theoretical and empirical evidence that voluntary pollution abatement may be demand driven through consumers' altruistic preferences for environmental attributes. Demand driven voluntary abatement that is altruistically motivated implies that:

- Traditional regulatory policies will be less effective due to the contraction of the voluntary market in response to mandated abatement.
- Naïve regulatory policies that do not recognize and incorporate the contraction in the voluntary market into the optimal level of mandatory abatement will not maximize social welfare.
- Under pure altruism, the socially optimal level of regulation will be larger than the level of regulation chosen by a naïve policy.
- Under impure altruism, the optimal level of regulation may be larger or smaller than the level chosen by a naïve policy.

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