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Environmental Effectiveness of Voluntary Approaches: Does the Number of Participants Matter?[1]

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Abstract: A poorly-selected level of pollution per firm can lead to a sub-optimal net effect on the environment. We define the optimal individual pollution level required for participants to maximize overall environmental effectiveness. We stress several implications for economic policy.

Key words: Voluntary instruments; Environmental effectiveness; Environmental policy.

JEL Classification Numbers: K32; Q28.

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1. Introduction

Historically, policymakers have relied on command-and-control and market-based instruments to ensure adequate protection of environmental quality. However, a new generation of environmental problems such as non point pollution has emerged for which the traditional instruments appear ill-equipped. Attention has turned to the use of voluntary approaches as a complementary solution to the difficulties encountered by traditional instruments. Voluntary approaches cover a large variety of commitments of producers to pursue actions leading to the improvement of the environment. The expected net effect is an improvement in overall environmental quality (Alberini and Segerson, 2002; OECD, 2003). However, the environmental effectiveness of voluntary approaches depends, to some extent, on the selection of an optimal level of pollution per firm. Indeed, the design of a voluntary approach frequently supposes the definition of the individual target required from each participant. This target requirement shapes the adoption costs of the voluntary approach, which determine, in return the number of participants. A level of individual requirement which is too high (or too low) may discourage (encourage) agents to participate, and in certain cases, the overall effect on the environment may be sub-optimal compared to the potential results where an optimal individual requirement is selected. Although the intuitive rationale for such a result seems rather diagrammatic, the trade-off between the individual level of requirement and the number of subsequent participants expresses a real concern of practitioners and policymakers (e.g. the choice of ecolabel selectivity to maximize overall environmental effectiveness). As far as we know, the problem of the optimal requirement has not been analyzed in economic literature. The remainder of the paper is organized as follows: In the next section, we derive the main insights in a basic model. Section three outlines the relevance of the results for policy makers. Section four provides concluding remarks and stresses potential extensions.

2. The model

Consider the introduction of a voluntary approach under some restrictive hypotheses: (1) The number of potential adopters (i.e. the total population, n) remains constant, which seems realistic in a short time horizon. (2) In the initial period, producers have the same level of environmental performance $\bar{i}$ considered here as a constant. The voluntary approach requires a pollution level per participant which we refer to as $i < \bar{i}$. (3) The level of i shapes the adoption[3] rate and consequently the overall environmental performance. (4) Selecting a higher level of individual requirement (diminishing i) implies higher production and transaction costs for adopting than the initial situation (without adoption) or the situation with a less stringent individual requirement.

Let us assume that the overall level of pollution *I* is a function of several parameters:

$$I = \alpha n\bar{i} + (1-\alpha)ni = \alpha n(\bar{i} - i) + ni \qquad (1)$$

Where α is the proportion of non-participants in the voluntary approach i.e. $\alpha \in [0;1]$. The functional form for α has to satisfy two important properties. (1) The proportion of non-participants depends on the initial level of pollution $\bar{i}$ and the required abatement down to i and the difference between them.

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[3] We reason under a *ceteris paribus* clause. However, agents are not necessarily sensitive to small variation of the required level of abatement. Thus, we assume that *i* is sufficiently great to influence participation.

If $i = \bar{i}$, no effort is required, everyone participates and $\alpha = 0$. If $i = 0$ -no pollution at all- the effort required from each participant is high and costly, nobody participates and therefore $\alpha = 1$. (2) The proportion of non-participants in the voluntary approach is shaped by the relative ease of reaching the required abatement- *grosso modo* its costliness. Indeed, the more expensive the costs of switching from the conventional process to the ecofriendly one embedded in the voluntary approach are, the less participants there are, i.e. with infinite switching costs, $\alpha = 1$. Conversely, the cheaper the switching costs are, the more participants there are, i.e. with zero switching costs, $\alpha = 0$.
We have tested several functional forms and selected the following one:

$$\alpha = \left(\frac{\bar{i} - i}{\bar{i}} \right)^a \qquad (2)$$

Where the parameter *a* is the ease of adopting the voluntary approach.

By integrating α in (1), we find:

$$I = n \times \left(\frac{(\bar{i} - i)^{a+1}}{\bar{i}^a} + i \right) \qquad (3)$$

To minimize the overall level of pollution, we calculate the first order condition:

$$\frac{\partial I}{\partial i} = n \times \left(1 - \frac{1}{\bar{i}^a} (a+1) \times (\bar{i} - i)^a \right) \qquad (4)$$

We have an extremum with: $i = \bar{i} \times \left(1 - \frac{1}{(a+1)^{\frac{1}{a}}} \right)$ (5)

To get a minimal overall level of pollution I, i.e. the maximum environmental effectiveness, the second order condition has to be positive $\frac{\partial^2 I}{\partial^2 i} \rangle\, 0$, which is the case.

$$\frac{\partial^2 I}{\partial^2 i} = \frac{na}{\bar{i}^a} \times (a+1) \times (\bar{i} - i)^{a-1} \qquad (6)$$

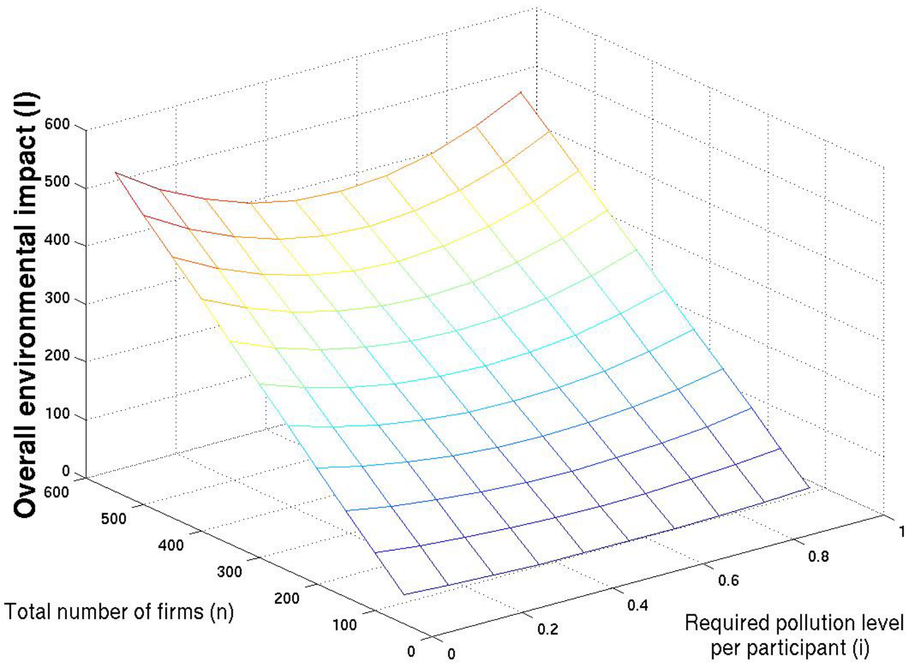
As an application of the previous model, Table 1 presents the overall level of pollution for $\bar{i} = 1$ and $a = 1$.

Table 1. Overall environmental impact for $\bar{i}=1$ and $a=1$

n	100	100	100	100	100	200	200	200	200	200	300	300	300	300	300
i	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1
I	100	81.25	75	81.25	100	200	162.5	150	162.5	200	300	243.8	225	243.8	300
n	400	400	400	400	400	500	500	500	500	500	600	600	600	600	600
i	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1
I	400	325	300	325	400	500	406.3	375	406.3	500	600	487.5	450	487.5	600
n	700	700	700	700	700	800	800	800	800	800	900	900	900	900	900
i	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1	0	0.25	0.5	0.75	1
I	700	568.8	525	568.8	700	800	650	600	650	800	900	731.3	675	731.3	900

Table 1 shows that (1) the same suboptimal result can be reached by two different levels of i and (2) $i = 0.5$ is the optimal individual requirement to maximize the environmental effectiveness. Figure 1 provides a graphical representation of the overall level of pollution (I) as a function of individual requirement (i) in the voluntary approach and the total number of enterprises (n).

Figure 1: Overall environmental performance (I) as a function of required level of pollution per participant in the voluntary approach (i) and the total number (n) of enterprises ($\bar{i}=1$, $a=1$)



3. Policy implications

Several policy implications for firms and voluntary approach designers may be derived from the previous framework. To compute the previous model, the knowledge of the parameter *a* seems crucial. How can policymakers in a broad sense -governments, industry associations or environmental associations- determine *a priori* the ease of adopting the voluntary approach for a homogeneous group of potential adopters?[4] This hidden information can be acquired through well-designed surveys. One limit is possible biased responses since agents could anticipate the implementation of a voluntary approach and answer according to their best interests. Another way is to exploit existing data (i.e. historical trends) to deduce the relative ease of adopting a voluntary approach. A third way is to undertake pilot studies by proposing similar voluntary approaches which only differ in their required pollution levels. A limitation of this method would be its cost. A fourth way is to own a representative firm, which would allow the policymaker to gather information to compute *a*. These different methods are neither exhaustive nor mutually exclusive and can be combined.

In certain plausible circumstances, the optimal i can not be precisely computed for various reasons. The designer can only approximate the interval, i.e. $i \in [\, i_1 ; i_2 \,]$, where the bounds correspond to two levels of participation inducing the same overall environmental performance (see figure 1). From an efficiency viewpoint, if there are enforcement costs, C, increasing with the participation level, i.e. $\delta C/\delta\alpha<0$, the designer will prefer the level of i to correspond to the lowest number of participants.

Moreover an optimal i can constitute a signaling device capable of influencing beliefs about other firms' participation. This signal can mitigate the "assurance problem" where some contributors hesitate to contribute to the production of an environmental public good believing that the good will not be produced anyway. It is important to note that agents want to contribute but are afraid of suffering the "sucker's payoff" if a participation threshold is not reached (Schmidtz, 1991).

The selection of an individual environmental requirement can induce strategic behavior. An interest group may use its influence or superior resources to extract an individual requirement, i , which produces private benefits greater than those for the society. Identifying the optimal i can avoid this form of "regulatory capture" and its perverse effects, such as disadvantaging rivals. In most cases the incentives for adoption of a voluntary approach are benefits reserved exclusively for adopters of the approach. Assuming that the individual benefit decreases with the number of participants, the designer has to build a more sophisticated model taking into account this counterbalancing effect[5].

4. Conclusion

We have shown that the required pollution level per participant in a voluntary approach affects the number of participants, which affects in return the overall environmental effectiveness of the considered approach. We have defined the optimal required pollution level per participant to produce the highest environmental performance. Some relevant policy implications have been stressed, notably the strategic importance of defining the required pollution level per participant. Frequently, designers of voluntary approaches balance overall environmental effectiveness with other considerations, notably economic efficiency. For a given environmental effectiveness, the relevant question is whether the approach generates benefits greater than costs and whether the benefits are achieved in the less costly way. Our model does not take into account possible interactions between potential adopters, which may influence the results. In certain plausible circumstances, positive spillovers can occur,

[4] When a group of potential adopters includes several homogeneous subgroups characterized by a similar ease of adopting a voluntary approach, the model can be computed for each subgroup.

[5] Consider a voluntary approach for which the main incentive for adoption is the possibility of an environmentally product differentiation associated with significant willingness to pay of purchasers. We can suppose that the required level of pollution per participant will derive from a trade-off between the private interest of adopters -that want to erect deterrence barriers- and the public interest of maximizing overall environmental performance.

when adoption encourages non-participants to improve their individual performance, without reaching the required level. Moreover, empirical studies are necessary to effectively assess the role of required pollution level per participant in overall performance. Experimental markets seem suitable for testing the insights developed in this paper since it enables highly controlled environments. These extensions constitute a challenging topic for further research.

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