Strategic use of environmental information

Geir B. Asheim*

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Preliminary

Abstract

This paper presents modeling indicating that strategic use of environmental information may have as a consequence that a benevolent environmental agency will choose not to disclose information leading to reduced moral motivation. Thus, decision makers will not have access to such information, implying that they will not be able to adjust their decisions to available information on the state of the environment. In contrast, if the benevolent environmental agency instead bases its regulation on standard economic instruments, these instruments will incorporate all available information.

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*Department of Economics, University of Oslo, P.O. Box 1095 Blindern, 0317 Oslo, Norway (e-mail: g.b.asheim@econ.uio.no).

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1 Introduction

In order to prevent degradation of environmental quality and to ensure sustainable development, strategies that protect the natural environment and the livelihood of future generation must be implemented. In principle, such implementation can be achieved in two ways:

(i) Through environmental policies (i.e., by use of Pigovian taxes or other economic instruments) designed to make consumers and firms internalize the environmental costs of their actions, and endow them with bequest motives for the (natural and man-made) capital stocks they manage.

(ii) Through spread of information about the environmental consequences of the actions of consumers and firms, given that these agents have an underlying concern for the protection of the natural environment and the promotion of sustainable development.

The first method of implementation, e.g., through Pigovian taxes, is transparent, as it asks agents to pay the social costs of external effects that their actions lead to, without interfering with decision-making in other respects.

On the other hand, information about the future development of the environment can be highly important for the emergence of moral motivation leading to environmentally friendly behavior and in the formation of the bequest motives needed to ensure sustainable development. It is likely that individual decision makers will be more concerned about the environment if there is awareness about possible grave consequences that a lack of such concern will lead to. Hence, one must be open for the possibility that individual preferences are formed by information about the aggregate consequences of their actions. In addition, such information may have impact on the political feasibility of the environmental policies mentioned under (i).

The authorities, e.g., an environmental regulatory agency, can partially control the spread of information on the environmental consequences of actions taken by consumers and firms. Both the extent and presentation of such information can influence the actions consumers and firms wish to take, so that behavior is changed in an environmentally friendly direction. One may conjecture that a more aggressive informational policy may serve as a substitute for the kind of environmental instruments that economists normally suggest. In particular, by using information to influence peoples environmental values and preferences, external effects may to some extent be internalized with less use of explicit instruments.

However, strategic use of information raises normative questions of the following type: How can authorities be under democratic control if they use information to manipulate the interests of their constituency? How can information be trusted if it is suspected (or known) that information is spread for strategic purposes?

In this paper, I will not address the former question. Rather, I will assume that the environmental agency is benevolent, seeking to foster the interests of the individuals.

Instead I will be concerned with the latter question. The present paper will present modeling designed to show that strategic use of environmental information may have as a consequence that a benevolent environmental agency will choose not to disclose information leading to reduced moral motivation. This means that decision makers will not have access to such information, implying that they will not be able to adjust their decisions to available information on the state of the environment. In contrast, if the benevolent environmental agency instead bases its regulation on standard economic instruments, these instruments will incorporate all available information.

The model, which will be presented in Section 2, will be based on the rationale for morally motivated behavior suggested by Brekke, Kverndokk and Nyborg (2003). While voluntary private provision of public goods (Bergstrom, Blume and Varian,

1986) will be negligible without social preferences and the "warm glow" theory of giving (Andreoni, 1990) does not specify a connection between actual and ideal behavior, Brekke, Kverndokk and Nyborg's theory suggests that morally motivated behavior will depend on the behavior individuals believe will maximize social welfare. Therefore, information about the environmental consequences of their behavior will affect what they decide to do. This in turn creates an incentive for a benevolent environmental agency to analyze information dissipation strategically.

Proposition 1 provides condition under which the unique perfect Bayesian equilibrium has the property that information reducing the individuals' moral motivation will not be disclosed. An example provided in Section 3 illustrates the results and verifies that these assumptions are compatible. A few remarks in Section 4 concludes the paper.

2 Model

Consider an abstract economic situation, where there are n individuals, each choosing the action e_i, which can be thought of as *effort*. I assume that all individuals are identical, with the same set of feasible actions, and with the following utility function:

$$u(e_i, e_{-i}; e^*, \hat{e})\,.$$

Here, $e_{-i} := (e_1, \ldots, e_{i-1}, e_{i+1}, \ldots, e_n)$ is the effort profile of the other $n-1$ individuals, e^* is the socially optimal effort, while $\hat{e}$ is the effort believed to be socially optimal by the individual and thus the effort level that drives his/her moral motivation.

In their analysis, Brekke, Kverndokk and Nyborg (2003) assumes that the individuals are informed of the socially optimal effort, so that $\hat{e} = e^*$. In this case, e^* is

the effort, which if made by all, would maximize each individual's utility:

$$e^* = \arg\max_e u(e, \underbrace{(e, \ldots, e)}_{n-1 \text{ times}}, e^*, e^*)$$

Hence, for a morally motivated person correctly believing that e^* is the socially optimal effort, e^* is indeed what the individual ideally should do. I will assume, like Brekke, Kverndokk and Nyborg (2003) do, that the moral motivation is not sufficient to ensure that the actual effort of the individuals equals e^*, even if their beliefs are correct. Rather, they will trade-off their moral obligation against their personal gain from shirking.

Here, I will allow for the possibility that individual are not perfectly informed of the socially optimal effort. Moreover, I will assume that the environmental agency receives signals that provide hard information concerning what the socially optimal effort is. *Hard information*, a concept introduced in information economics by Grossman (1981), Milgrom and Roberts (1986) and Tirole (1986), means that, if a signal has been received, the environmental agency can convey the informational content of the signal to the general public in a credible way. However, the environmental agency can conceal that a signal has been received, and it cannot credibly demonstrate that a signal has not been received.

In the present setting one can imagine that the agency is able to spread the informational content of a received signal in a publicity campaign, and that independent experts can testify that the publicized information is true if and only if the signal has actually been received. Thus, if the information is based on a received signal, individuals can look at the evidence and convince themselves that the agency has announced correct information.

In general, the environmental agency will receive signals that affect its belief of e^* both positively and negatively. However, given the assumption that moral motivation is not sufficient to ensure that individuals make the socially optimal effort, it follows that a received signal affecting the belief of e^* in a positive direction

will be conveyed to the general public, since it will push effort in a welfare-enhancing direction. Therefore, only signals affecting the belief of e^* in a negative direction are of interest for our analysis.

A parsimonious way of modeling an interesting situation is to assume that e^* can take on only two values: e_h^* with probability p and e_ℓ^* with probability $1-p$, where $e_\ell^* < e_h^*$. One can think of e_h^* and e_ℓ^* as two possible *states of the environment*, where effort to protect the environment is particulary needed if $e^* = e_h^*$. If the true value is e_ℓ^*, then the environmental agency receives a signal which can, if the agency chooses to do so, be credibly conveyed to the general public. If the true value is e_h^*, then the environmental agency does not receive a signal and cannot credibly convey information to the general public.

Hence, the environmental agency is perfectly informed of e^*. The agency knows that e^* equals e_h^* if it does *not* receive the signal and equal to e_ℓ^* if it *does* receive the signal. The strategy of the agency specifies what to do if a signal is received; choosing d (for *disclose*) means to convey the informational content of the signal or choosing n (for *not disclosing*) means to conceal receipt of the signal. Say that *the environmental agency uses information strategically if it adopts the strategy* n.

The individuals has the prior belief that e^* equals e_h^* with probability p and e_ℓ^* with probability $1-p$. If the signal is received and disclosed, it has received hard information demonstrating that e^* equals e_ℓ^*. If a signal is not disclosed, the beliefs of the individual depends on the strategy of the agency. If the individual believe that the agency chooses d — hence, disclosing the signal if and only if it is received — then their posterior belief is that e^* equals e_h^* (with probability 1). However, if individual believe that the agency chooses n — hence, not disclosing the signal even if it is actually received — then their posterior belief is the same as their prior belief: e^* equals e_h^* with probability p and e_ℓ^* with probability $1-p$.

This means that there are three situations to consider; two in which the individuals believe that they are informed of the environmental consequences of their

effort, and one for which their posterior belief equals their prior belief. Assume that there exists a unique Nash equilibrium in each of these situations, and that all three Nash equilibria are symmetric.

If the individual believe that e^* equals e_h^*, then their Nash equilibrium effort in the symmetric equilibrium satisfies

$$e_h = \arg\max_e u(e, \underbrace{(e_h, \ldots, e_h)}_{n-1 \text{ times}}, e_h^*, e_h^*) .$$

If the individual believe that e^* equals e_ℓ^*, then their Nash equilibrium effort satisfies

$$e_\ell = \arg\max_e u(e, \underbrace{(e_\ell, \ldots, e_\ell)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*) .$$

Finally, if the individuals maintain their prior belief, then their Nash equilibrium effort satisfies

$$e_m = \arg\max_e \big(pu(e, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_h^*, e_h^*) + (1-p)u(e, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*)\big) .$$

The environmental agency is benevolent, entailing that it wants to maximize the welfare of the individuals. In its evaluation of welfare, it will take into account both the actual state of the environment since this matters for the material well-being of the individuals, and the effect of the believed state of the environment since this drives the moral motivation of the individuals.

Let $x \in \{\ell, m, h\}$ and write $u_x(1)$ for the welfare of each individual in the Nash-equilibrium where individuals choose the effort level x and the state of the environment is e_h^*, $u_x(0)$ for the welfare of each individual in the Nash-equilibrium where individuals choose the effort level x and the state of the environment is e_ℓ^*, and $u_x(p)$ for the welfare of each individual in the Nash-equilibrium where individuals choose the effort level x, from an ex ante perspective where the state of the environment equal e_h^* with probability p and e_ℓ^* with probability $1-p$.

Hence, ex post welfare equals

$$u_h(1) = u(e_h, \underbrace{(e_h, \ldots, e_h)}_{n-1 \text{ times}}, e_h^*, e_h^*)$$

if the individuals correctly believes that $e^* = e_h^*$, and ex post welfare equals

$$u_\ell(0) = u(e_\ell, \underbrace{(e_\ell, \ldots, e_\ell)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*)$$

if the individuals correctly believes that $e^* = e_\ell^*$. Furthermore, ex post welfare equals

$$u_h(0) = u(e_h, \underbrace{(e_h, \ldots, e_h)}_{n-1 \text{ times}}, e_\ell^*, e_h^*)$$

if the actual state is e_ℓ^* but the individuals incorrectly believes that $e^* = e_h^*$ (i.e., the agency uses information strategically, while individuals believe that the agency conveys the signal whenever it is received), while ex post welfare equals

$$u_m(0) = pu(e_m, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_\ell^*, e_h^*) + (1-p)u(e_m, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*)$$

if the actual state is e_ℓ^* and the individuals correctly believes that the agency uses information strategically.

The first result provides assumptions under which the strategy n is the only equilibrium behavior of the environmental agency. Hence, under these assumption, the environmental agency will (and will be believed to) use environmental information strategically.

Proposition 1 *Assume that $u_h(0) > u_\ell(0)$ and $u_m(0) \geq u_\ell(0)$. There exists a unique Perfect Bayesian equilibrium where the environmental regulatory agency does not disclose hard information showing that the environmental state is ℓ.*

Proof. The proof is divided into two parts. The first part shows that there exists one Perfect Baysian equilibrium where the agency chooses n. The second part shows that there does not exist any Perfect Bayesian equilibrium where the agency chooses d. (A complete proof should also show that there does not exist any Perfect Bayesian equilibrium where the agency chooses both strategies with positive probability. This would require us to consider the ex post welfare levels where the

environmental state is e_ℓ^*, but the individuals believe that the environmental state is e_h^* with probability between p and 1. This is omitted here.)

Part 1. If the individuals believe that the agency chooses n, then they will choose e_m if no signal is conveyed, and e_ℓ if a signal is conveyed. If the agency chooses n, then the ex post payoff if $e^* = e_\ell^*$ equals $u_m(0)$. If instead the deviates and chooses d, then the ex post payoff if $e^* = e_\ell^*$ equals $u_\ell(0)$. Ex post payoff if $e^* = e_h^*$ is not affected by the agency's choice. Hence, the agency will not want to deviate from n if $u_m(0) \geq u_\ell(0)$.

Part 2. If the individuals believe that the agency chooses d, then they will choose e_h if no signal is conveyed, and e_ℓ if a signal is conveyed. If the agency chooses d, then the ex post payoff if $e^* = e_\ell^*$ equals $u_\ell(0)$. If instead the deviates and chooses n, then the ex post payoff if $e^* = e_\ell^*$ equals $u_h(0)$. Ex post payoff if $e^* = e_h^*$ is not affected by the agency's choice. Hence, the agency will want to deviate from d if $u_h(0) > u_\ell(0)$. ■

Under the assumptions of Proposition 1, the individuals does not obtain information that will enable them to update their prior belief since the agency uses and it is believed to use information strategically. Hence, ex ante welfare equals

$$u_m(p) = pu(e_m, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_h^*, e_h^*) + (1-p)u(e_m, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*)\,.$$

It follows that

$$\begin{aligned} u_m(p) &= pu(e_m, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_h^*, e_h^*) + (1-p)u(e_m, \underbrace{(e_m, \ldots, e_m)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*) \\ &\leq pu(e_h, \underbrace{(e_h, \ldots, e_h)}_{n-1 \text{ times}}, e_h^*, e_h^*) + (1-p)u(e_\ell, \underbrace{(e_\ell, \ldots, e_\ell)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*) \\ &= pu_h(1) + (1-p)u_\ell(0)\,, \end{aligned}$$

which would have been the ex ante welfare had the agency disclosed if and only if it is receives the signal. Hence, there is an informational cost — over and beyond the

fact that moral motivation is insufficient to induce the optimal effort — of trying to internalize externalities without use of explicit instruments. Since information will be strategically concealed, even though the agency is benevolent with aligned interests, the individuals will not have access to all information, implying that they will not be able to adjust their decisions to available information on the state of the environment.

If instead the environmental agency has access to and is allowed to use perfect economic instruments, similar informational problems will not be present. The agency will use instruments leading the optimal effort of e_h^* if the signal is not received and to the optimal effort of e_ℓ^* if the signal is received. The individuals will realize that the agency has no reason to conceal information, given that there is no ... between what individuals ideally should do and what they actually do. For the same reason, individuals will not feel a cost associated with not fulfilling their moral motivation. Hence, the ex ante welfare under the assumption that perfect economic instruments are used will be:

$$pu(e_h^*, \underbrace{(e_h^*, \ldots, e_h^*)}_{n-1 \text{ times}}, e_h^*, e_h^*) + (1-p)u(e_\ell^*, \underbrace{(e_\ell^*, \ldots, e_\ell^*)}_{n-1 \text{ times}}, e_\ell^*, e_\ell^*)\,.$$

In this regulatory regime, optimal effort will be induced and all available information will be utilized.

3 Example

In this section I provide an example which illustrates the results of Section 2 and verifies that the assumptions of Proposition 1 are compatible.

Assume that the utility function has a quasi-linear logarithmic form with a linear loss function capturing the cost of deviating from the ideal:

$$u(e_i, e_{-i}; e^*, \hat{e}) = 1 - e_i + e^* \ln\left(\sum\nolimits_{j=1}^{n} e_j\right) - a|\hat{e} - e_i|\,.$$

Assume that $e^* = e_h^*$ with probability p and $e^* = e_\ell^*$ with probability $1-p$, where

$$0 < e_\ell^* < e_h^* < 1 \qquad \text{and} \qquad 0 < p < 1\,.$$

Furthermore, assume that

$$0 < a \leq \tfrac{e_\ell^*}{e_h^*} - \tfrac{1}{n}\,; \tag{1}$$

this assumption will ensure that the conditions of Proposition 1 are satisfied. The following are parameter values that satisfy these restrictions: $p = \frac{1}{2}$, $n = 8$, $e_\ell^* = \frac{3}{10}$, $e_h^* = \frac{2}{5}$ and $a = \frac{5}{8}$. Write $e_m^* = pe_h^* + (1-p)e_\ell^*$.

Nash-equilibrium efforts are given by

$$\begin{aligned} e_h &= \tfrac{e_h^*}{(1-a)n}\,, \\ e_\ell &= \tfrac{e_h^*}{(1-a)n}\,, \\ e_m &= \tfrac{e_m^*}{(1-a)n}\,. \end{aligned}$$

We can now calculate ex post welfare levels:

$$\begin{aligned} u_\ell(0) &= 1 - \tfrac{e_\ell^*}{(1-a)n} + e_\ell^* \ln \tfrac{e_\ell^*}{1-a} - a \cdot e_\ell^* \left(1 - \tfrac{1}{(1-a)n}\right) \\ u_h(0) &= 1 - \tfrac{e_h^*}{(1-a)n} + e_\ell^* \ln \tfrac{e_h^*}{1-a} - a \cdot e_h^* \left(1 - \tfrac{1}{(1-a)n}\right) \\ u_m(0) &= 1 - \tfrac{e_m^*}{(1-a)n} + e_\ell^* \ln \tfrac{e_m^*}{1-a} - a \cdot e_m^* \left(1 - \tfrac{1}{(1-a)n}\right) \end{aligned}$$

Hence, the differences that matter for Proposition 1 are:

$$\begin{aligned} u_h(0) - u_\ell(0) &= -\tfrac{e_h^* - e_\ell^*}{(1-a)n} + e_\ell^* \ln \tfrac{e_h^*}{e_\ell^*} - a\,(e_h^* - e_\ell^*) \left(1 - \tfrac{1}{(1-a)n}\right)\,, \\ u_m(0) - u_\ell(0) &= -\tfrac{e_m^* - e_\ell^*}{(1-a)n} + e_\ell^* \ln \tfrac{e_m^*}{e_\ell^*} - a\,(e_m^* - e_\ell^*) \left(1 - \tfrac{1}{(1-a)n}\right)\,. \end{aligned}$$

Lemma 1 *Under assumption (1) we have that $u_h(0) > u_\ell(0)$ and $u_m(0) > u_\ell(0)$.*

Proof. Define $f : [e_\ell^*, e_h^*] \to \mathbb{R}$ by

$$f(x) = -\tfrac{x - e_\ell^*}{(1-a)n} + e_\ell^* \ln \tfrac{x}{e_\ell^*} - a\,(x - e_\ell^*) \left(1 - \tfrac{1}{(1-a)n}\right)\,.$$

Since

$$u_h(0) - u_\ell(0) = \int_{e_\ell^*}^{e_h^*} f'(x)dx \quad \text{and} \quad u_m(0) - u_\ell(0) = \int_{e_\ell^*}^{e_m^*} f'(x)dx\,,$$

it is sufficient to show that $f'(x) > 0$ for all $x \in (e_\ell^*, e_h^*)$. Since

$$f'(x) = -\tfrac{1}{(1-a)n} + \tfrac{e_\ell^*}{x} - a \cdot \left(1 - \tfrac{1}{(1-a)n}\right) = \tfrac{e_\ell^*}{x} - a - \tfrac{1}{n} > \tfrac{e_\ell^*}{e_h^*} - a - \tfrac{1}{n} \leq 0\,,$$

where $x < e_h^*$ implies the strict inequality and (1) implies the weak inequality. ■

4 Concluding remarks

During the last few years, there has been much literature on the crowding-out effect of economic instruments (add references). Such theoretical analysis and empirical evidence points to a cost of using economic instruments, since it weakens the intrinsic motivation that would otherwise guide peoples actions.

Does this mean that we should not apply economic instruments, and instead base environmental policy on the promotion of intrinsic motivation? This paper has developed one argument against this view, namely that promotion of intrinsic motivation may deter disclosure of information on the environmental effects of economic behavior. This will in turn foster a public opinion with the view an environmental agency will only disclose information which proves that behavior has serious economic effects, while information showing the opposite will not be made available. The analysis has shown that a benevolent environmental agency may indeed choose to behave in this manner if asked to based environmental policy on the promotion of intrinsic motivation, but will not do so when instructed to use economic instruments that can ensure efficient behavior.

In this paper I have modeled the interaction between the environmental agency and the individuals as a one-time interaction. If the agency and the individuals have a one-going relationship, then one must also consider reputational effects. It is in the interest of the benevolent agency to build up a reputation for disclosing all

information. It is outside the scope of this paper (in its present version) to consider this question.

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