Voluntary Agreements under Endogenous Legislative Threats

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Summary

The paper analyzes the welfare properties of voluntary agreements (VA) with polluters, when they are obtained under the legislative threat of an alternative stricter policy option. In the model, the threat is an abatement quota. Both the threat and its probability of implementation are endogenous. The latter is the outcome of a rent-seeking contest between a green and a polluter lobby group influencing the legislature. We show that a welfare-improving VA systematically emerges in equilibrium and that it is more efficient than the pollution quota. We also discuss various VA design aspects.

Keywords: Environmental policy, voluntary agreements, bargaining, legislatures, rent seeking, rent-seeking contests.

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1 Introduction

In the field of environmental policy, the major policy innovation of the nineties is probably the introduction of voluntary agreements (VA). While they were marginal practices in a limited number of countries beforehand (e.g. in Germany, Japan), they are now used almost everywhere. One illustration of this very fast and widespread development is the first generation of climate change policies adopted in OECD countries around the mid-nineties. They mostly relied on voluntary agreements. Japan set the so-called Keidaren voluntary Action Plan covering 37 industry branches and eighty percent of industrial energy consumption. In the US, the Clinton's Administration 1993 Climate Change Action Program was mainly based on voluntary programs including Green Lights, Climate Wise among many others. In the European Union, almost all Member States launched their own voluntary approaches under various names: branch agreements, covenants, environmental agreements, etc.

Although these approaches differ in certain respects,[1] one common feature is that polluters *voluntarily* commit to pollution abatement activities. This use of the term "voluntary" has long been disputed since many agreements are in fact obtained under the threat of an alternative coercive public intervention.[2] The present paper deals with such agreements. We develop a model of voluntary

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[1] We discuss the diversity of VA design in section 2.
[2] For a comprehensive review of the practice of VAs in OECD countries, see OECD (1999).

agreement in which the threat is a pollution quota and is fully endogenous. We use it to assess the efficiency of the VA and we discuss various design issues – the opportunity to involve the pollution victims in the negotiation, the efficiency potential of veto rights by the Congress over VAs, etc.

As VAs have only been developed recently and by practitioners, the academic literature is still limited but it is growing rapidly. Some of these papers deal with the case, similar to ours, where the motivation of the polluters to accept voluntary agreements is the preemption of future regulations. Hansen (1999) has developed a political economy model in which polluters negotiate with a regulator under a background legislative threat. The key feature of his model is that the regulator's objective is biased and differs from that of the threat-making entity, the Congress. A model by Maxwell, Lyon and Hackett (2000) considers firms that voluntarily abate pollution to preempt lobbying by consumers in favor of environmental policy. In this case, firms do no preempt an explicit threat by a regulator but a risk of new legislation possibly triggered by lobbying. These two models essentially generate positive implications relative to the context in which VAs are likely to emerge. The paper closest to ours is probably the one by Segerson and Micelli (1999). They develop a normative model in which the polluter undertakes voluntary action under the threat made by a benevolent regulator to implement an abatement quota.[3]

We extend the Segerson & Miceli' model (S&M) in two ways. First, the threat is completely endogenous in our setting. In S&M, the legislative threat is implemented with a probability described by an exogenous parameter. This assumption is disputable because the probability of adoption of a given piece of legislation depends on its precise contents. For instance, a strict pollution quota is less likely to be adopted than a lenient one due to the political opposition of polluters. To account for that, we consider that the probability of adoption is the outcome of a rent-seeking contest between two lobby groups – the polluter and a green group – competing to influence the probability of adoption of the legislation. Second, contrary to S&M, we make conservative cost assumptions meaning that we do not confer any cost advantage to the VA over the regulatory quota. In our model, the VA is thus as cost effective as direct regulation.

The paper is structured as follows. Section 2 presents the model. In section

[3] Segerson and Miceli also investigate a so-called "carrot" approach whereby the polluters reduce pollution in exchange of public subsidies. Other papers focus on such subsidy seeking VAs; see for instance Lyon and Maxwell (2002).

3, the case where the threat is an abatement quota is analyzed and we show that the VA is systematically more efficient than the legislative abatement quota in this setting. Section 4 makes three simple extensions of the model to address design issues debated in the policy arena: the efficiency potential of involving a green group in VA, the impact of policy delegation on bargaining outcomes and the usefulness of granting a veto right to the Congress over newly adopted VA. Section 5 concludes.

2 The model

The model depicts a situation in which a benevolent environmental regulator R and a polluter P agree to make a voluntary agreement. The VA specifies a pollution abatement level, denoted B, to be met by the polluter. Before going further, it is worth making two remarks. First, the model is sufficiently general for the polluter to be either a single firm or an industry. In practice, certain VAs are signed with a coalition of polluters, usually represented by an industrial branch association. In that case, the model implicitly assumes that the members of the coalition have solved the free riding problem associated with collective action.

The second remark is related to the diversity of VAs encountered in reality. The literature distinguishes three broad categories. Each type ultimately differs with respect to the degree of involvement of the regulator. Under *public voluntary programs*, the firms agree to make abatement efforts to meet goals which are established by the regulator. In a *negotiated agreement*, the polluter and the regulator jointly devise the commitments through bargaining. Under *self-regulation* or unilateral agreements, the polluter takes the initiative. He freely sets up a program of environmental actions without any formal influence from the regulator.

In our model, the agreement is the outcome of a bargaining process between the polluter and the regulator. So it is a negotiated agreement. However, our results could easily apply to public voluntary programs with minor changes. The reason is that public voluntary programs and negotiated agreements share a key feature which ultimately drives the results: the polluter and the regulator's participation constraints must be satisfied in both cases. On the contrary, self-regulation is not a possible application, the main reason being probably that unilateral commitments are usually not triggered by legislative threats.

Consider now the costs and benefits associated with the polluter's commitment to meeting an abatement level B. The abatement cost born by the polluter is described by a twicely differentiable function $C(B)$. It also generates a benefit in terms of avoided environmental damage. For the sake of simplicity, we assume that the benefit equals the abatement level B. The linearity of the benefit function simplifies the analysis without altering any of the results. We make the usual assumptions that C', $C''>0$, $C'(0)<1$ and $C(0)=0$. These hypothesis imply that there are decreasing returns to scale in abatement activities, and that, for low values of B, gross welfare, denoted $W(B) \equiv B\text{-}C(B)$, is positive. Therefore, in the absence of political constraints, the environmental regulator selects the optimal policy level, B^*, defined as follows

$$C'(B^*) \equiv 1 .$$

The agreement is obtained under the threat of an alternative policy. More specifically, we assume that the environmental regulator is the agenda setter of the Congress. He can thus threaten the polluter with legislation. The threat consists in an abatement quota. We do not assume any cost advantage for the VA: the polluter has the same cost function under the VA and under the legislative quota. Doing otherwise would make it too easy to reach conclusions about the superiority of voluntary agreements.

The threat is uncertain.[4] This is a crucial feature of this type of models: if the benevolent regulator was able to pass any new legislation with certainty, he would be able to implement the first best policy B^* through the Congress and would have no reason to use a VA instead. Let π be this probability of adoption. It cannot be considered as an exogenous parameter. It certainly depends on the contents of the Law proposal. For instance, for a given level of environmental benefit, a more costly threat has lower chance of being adopted. One central reason for that is that the potential losers of the policy are trying to influence the legislative process through lobbying, media campaigns, etc. To account for that, we model the legislative process as follows.

We suppose that the proposal of legislation is subjected to a rent-seeking

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[4] The fact that passing a Law is uncertain is definitively supported by evidence. During the last legislative term in France (1997-2002), the Government made 476 Law proposals out of which 351 were finally adopted by the Parliament, corresponding to an average probability of adoption of 0.74. In the US, a paper by Zeckhauser (1981) gives many examples in the field of environmental policy.

contest involving two lobby groups as popularized by the rent-seeking literature. A first group G (the "greens") is concerned by the policy benefit B whereas the second group is simply the polluter P who bears the policy cost $C(B)$. Group G and the polluer P make rent-seeking expenditures in order to influence the Congress' voting process. Expenditures may be campaign contributions (monetary or in kind), or may correspond to the cost of transmitting strategic information to the "median" legislator on the consequences of the Law proposal. The level of expenditures of both lobby groups affects π, the probability of adoption, via a so-called *contest success function.* These functions are routinely used in the rent-seeking literature to model lobbying in noisy political environments.[5] As to the functional form, we use a variant of the standard unit logit function pioneered by Tullock (1980):

$$\pi(x_G, x_P) \equiv \begin{cases} \pi^\circ + (1-\pi^\circ)\dfrac{\lambda x_G}{\lambda x_G + x_P}, & \text{if} \quad x_G + x_P > 0 \\ 0, & \text{if} \quad x_G + x_P = 0 \end{cases} \tag{1}$$

where x_G and x_P are the green group's and polluter's rent-seeking expenditures, respectively. λ is a parameter introducing a heterogeneity in lobby groups' influence technology. It is a routine assumption in the rent seeking literature. When λ lies in between 0 and 1, the green group is less influential than the polluters whereas the contrary holds true beyond 1. Finally, π° is a parameter reflecting the responsiveness of the Congress to lobbying. As a result the probability π cannot fall below π°. Put differently, whatever the intensity of lobbying, any welfare-improving policy is adopted *at least* with a probability π°. This is a less classical assumption aiming at introducing some concern for the general interest in Congress' behavior.

Finally, the timing of events is as follows:

1) The bargaining stage: The regulator and the polluter bargain over a pollution abatement quota. If they agree, the game stops and the abatement quota is implemented.
2) The agenda setting stage: In case of persisting disagreement, the regulator makes a Law proposal to the Congress

[5] Nitzan (1994) is a comprehensive survey of the rent-seeking literature using such contest success functions.

3) The rent-seeking stage: The lobbies simultaneously select their rent-seeking expenditures which determine the probability of adoption of the proposal, π. The Law is adopted with this probability.

3 A VA under the threat of an abatement quota

In this section, we solve the model for the case wherein the threat is a quota. We reason backward, starting with the analysis of the rent-seeking sub-game.

3.1 The rent-seeking stage

Consider any Law proposal involving an abatement quota B. What will be its probability of adoption? According to Eq.(1), it is determined by the rent-seeking expenditures of the two groups. Each simultaneously and non co-operatively selects its level of expenditures by maximizing its expected utility, taking the other's level of expenditures as given. The corresponding maximization problem is:

$$\max_{x_G} \pi(x_G, x_P)B - x_G$$
$$\max_{x_P} - \pi(x_G, x_P)C(B) - x_P$$

Assuming interior solutions, the equilibrium rent-seeking expenditures are given by the first order conditions:

$$(1-\pi^\circ)B\frac{\lambda x_P}{(\lambda x_G + x_P)^2} = 1$$
$$(1-\pi^\circ)C(B)\frac{\lambda x_G}{(\lambda x_G + x_P)^2} = 1$$

Algebraic manipulations of these two conditions then lead to the following levels of expenditures:

$$x_G(B) = \frac{(1-\pi^\circ)}{\lambda} . \frac{B^2.C(B)}{(B+C(B))^2} \tag{2}$$

$$x_P(B) = \frac{(1-\pi°)}{\lambda} \cdot \frac{B.C(B)^2}{(B+C(B))^2} \tag{3}$$

Plugging these expenditures in Eq. (1) yields the equilibrium probability of adoption of the rent-seeking game:

$$\pi(B) = \pi° + (1-\pi°)\frac{\lambda B}{\lambda B + C(B)} \tag{4}$$

3.2 The agenda-setting stage

Having characterized the probability function with respect to B, we consider now the legislation that will be proposed to the Congress. The regulator takes into account the uncertainty of the adoption and makes a Law proposal that maximizes expected gross welfare:[6]

$$\max_B \ \pi(B)[B - C(B)].$$

The first order condition of this maximization problem then implicitly defines the abatement level under legislation, that we denote $\hat{B}$:

$$\pi(\hat{B})\left[1 - C'(\hat{B})\right] \equiv -\pi'(\hat{B})\left[\hat{B} - C(\hat{B})\right]. \tag{5}$$

We then have a very simple lemma which establishes that this level is lower than the first best abatement level.

Lemma 1 Let $\hat{B}$ be the equilibrium regulatory policy under legislation. We have $\hat{B} < B^*$.

Proof. First we show that π' is negative for all λ, $\pi°$ and B. Differentiating (4) yields $\pi'(B) = (1-\pi°)\lambda[C(B) - B.C'(B)]/(\lambda B + C(B))^2 < 0$. It follows that $C'(\hat{B}) < 1$, or alternatively $C'(\hat{B}) < C'(B^*)$. Hence, $\hat{B} < B^*$.□

[6] Note that rent-seeking activities are not an argument in the welfare function since they are transfers between lobby groups and others (legislators, lawyers, experts, etc.). The rent-seeking literature tends to consider them as wasteful activities to be included in the social welfare function. This does not change lemma 1 as shown in appendix. Therefore it has no impacts on the propositions that follow in the rest of the paper.

Lemma 1 states that the first best policy is not attainable under the legislative route. The intuition is simple. The existence of political constraints lowers the probability of adoption. To mitigate the problem, the environmental regulator needs to make a law proposal diverging from the first best optimum. This proposal is lower because of the negative sign of the marginal probability. It is ultimately rooted in the fact that increasing B leads to larger losses in marginal terms than benefits due to the convexity of the cost function. It then provides the polluter with more incentives to increase rent-seeking expenditures.

It is useful to derive some simple results of comparative statics about the equilibrium abatement level $\hat{B}$. From Eq.(5), one immediately derives

$$\hat{B} = \frac{-\pi(\hat{B})}{\pi'(\hat{B})}\left(1 - C'(\hat{B})\right) + C(\hat{B})$$

Simple calculations then lead to:

$$\frac{\partial \hat{B}}{\partial \pi^{\circ}} = -\pi'(\hat{B})\left(1 - C'(\hat{B})\right)\left(1 - \frac{\lambda \hat{B}}{\lambda \hat{B} + C(\hat{B})} + \frac{\pi(\hat{B})}{1 - \pi^{\circ}}\right) > 0$$
$$\frac{\partial \hat{B}}{\partial \lambda} = \frac{\pi^{\circ}\pi'(\hat{B})}{\lambda}\left(1 - C'(\hat{B})\right)\left(1 - \frac{\lambda \hat{B}}{\lambda \hat{B} + C(\hat{B})}\right) < 0$$

Unsurprisingly, we observe that the less responsive the Congress is to lobbying (a high π°), the higher the equilibrium abatement quota and the closer to the first best B^*. Similarly, when the polluter is less efficient in rent seeking than the greens, the abatement level in equilibrium is higher.

3.3 The bargaining stage

Note that the equilibrium policy under legislation, $\hat{B}$, corresponds to the disagreement point of the bargaining game, which we consider now. In this game, polluter and regulator's payoffs are the differences between their expected utility under legislation and their utility in the bargaining equilibrium:

$$U_P(B) \equiv \pi(\hat{B}).C(\hat{B}) + x_P(\hat{B}) - C(B) \qquad \text{(Polluter's payoff)}$$

$$U_R(B) \equiv [B - C(B)] - \pi(\hat{B}).\left(\hat{B} - C(\hat{B})\right) \qquad \text{(Regulator's payoff)}$$

Given these payoffs, it is obvious that any feasible agreement is more efficient than legislation since it satisfies the participation constraint of the welfare-maximizing regulator. The following result establishes the existence of a unique Nash bargaining solution for the game.

Proposition 1 Let $\Omega = \left\{B : U_P(B) \geq 0 \text{ and } U_R(B) \geq 0\right\}$. There exists a unique Nash bargaining solution that solves the following maximization problem

$$\max_{B\in\Omega} \quad \Pi(B) \equiv \left(W(B) - \pi(\hat{B}).W(\hat{B})\right)\left(\pi(\hat{B}).C(\hat{B}) + x^P(\hat{B}) - C(B)\right)$$

Proof. First we establish that Ω is not empty. It is convenient to denote B_P the maximal level the polluter is willing to accept and B_R the minimal level the regulator is ready to accept. They are implicitly defined by $U_P(B_P) \equiv \pi(\hat{B}).C(\hat{B}) + x_P(\hat{B}) - C(B_P) = 0$ and $U_R(B_R) \equiv W(B_R) - \pi(\hat{B}).W(\hat{B}) = 0$. We have $W(B_R) = \pi(\hat{B}).W(\hat{B}) < W(\pi(\hat{B}).\hat{B})$ since $W''(\hat{B}) = -C''(\hat{B}) < 0$. Then $W(B_R) < W(\pi(\hat{B}).\hat{B})$ implies $B_R < \pi(\hat{B})\hat{B}$ since W is strictly increasing below B^*. And so $C(B_R) < C(\pi(\hat{B})\hat{B}) < \pi(\hat{B})C(\hat{B})$ since C' and C'' are strictly positive. Hence, $C(B_R)+x_P(\hat{B}) < \pi(\hat{B})C(\hat{B})+x_P(\hat{B})=C(B_P)$. Since $x_P(\hat{B})>0$, we finally obtain that $C(B_R)< C(B_P)$ and thus $B_R< B_P$. Hence, $\Omega =[B_R, B_P] \neq \varnothing$.

The second step of the proof is to show that the Nash product is strictly concave. This is straightforward since the second derivative of the Nash product, $\Pi''(B) = W''(B)U_P(B) - 2C'(B)W'(B) - C''(B)U_R(B)$, is strictly negative.

Finally, let h be the function describing the utility the regulator obtains for a given utility level of the polluter u_P. The last step of the proof consists in establishing that h is strictly decreasing and concave. From the strict monotonicity of U_P, there exists a unique abatement level $\widehat{B} \in \Omega$ such that $U_P(\widehat{B}) = u_P$; i.e., $\widehat{B} = U_P^{-1}(u_P)$, where U_P^{-1} denotes the inverse utility of the polluter. The utility the regulator obtains when the polluter obtains u_P is then given by:

$$h(u_P) \equiv U_P(\widehat{B}) = U_P\left(U_P^{-1}(u_P)\right) = C^{-1}\left(\hat{K} - u_P\right) + u_P - \pi(\hat{B})\hat{B} - x_P(\hat{B}),$$

where $\hat{K} = \pi(\hat{B})C(\hat{B}) + x_P(\hat{B})$. Having characterized h, we can now study the sign of its first and second derivatives. We have:

$$\frac{dh(u_P)}{du_P} = 1 - C^{-1}\,'(\hat{K} - u_P) = 1 - \frac{1}{C\,'\big(C^{-1}(\hat{K} - u_P)\big)} = 1 - \frac{1}{C\,'(\hat{B})}\,.$$

$$\frac{dh^2(u_P)}{du_P{}^2} = \frac{2}{C\,'(\hat{B})^2 . U_P\,'(\hat{B})} = -\frac{2}{C\,'(\hat{B})^3}\,.$$

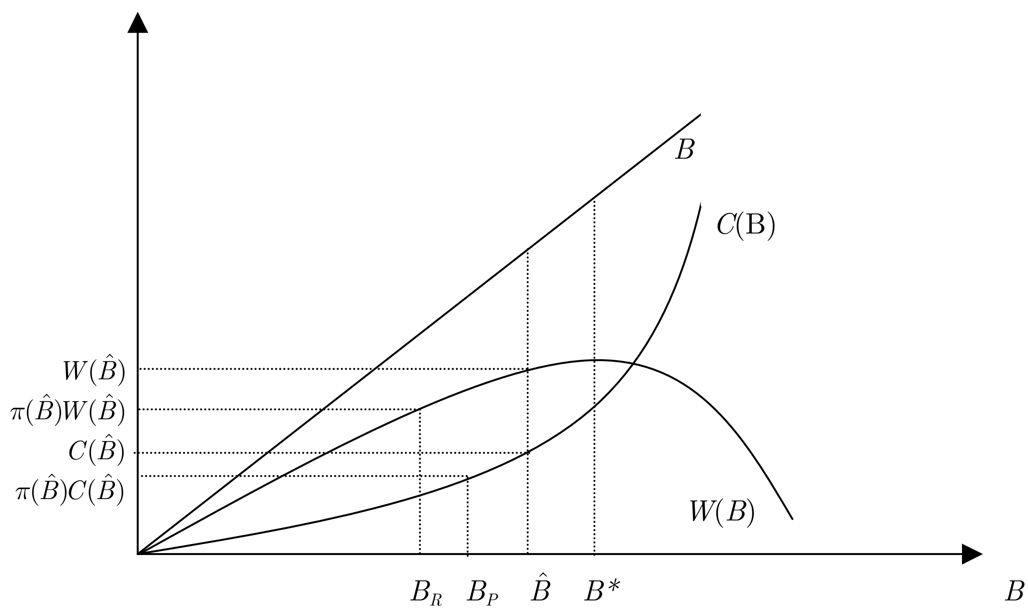
From $\hat{B} < B^*$, it follows $C'(\hat{B}) < 1$ and thus $dh/du_P < 0$. Hence h is strictly decreasing. The second derivative is obviously negative and h is therefore strictly concave. □

Proposition 1 is the first key result of this paper. It establishes the existence of a VA that is more efficient than the legislative (regulatory) option. The result is very robust in that it does not depend on the stringency of the political constraints, as reflected by the values of λ and $\pi°$. In particular, it still holds true when the Congress is very weakly responsive to lobbies' pressure ($\pi° \to 1$) or when the polluter is much less efficient than the green group in influencing the Congress ($\lambda \to +\infty$). However, the VA cannot yield the first best optimum as stated by this simple corollary.

Corollary 1 Let $\tilde{B}$ be the abatement level corresponding to the Nash bargaining solution. We have $\tilde{B} <$ B*

Proof. Obvious since $\tilde{B} \leq B_P < \hat{B} < B^*$.□

What is the intuition underlying proposition 1? In fact the key point in the proof is that the maximal abatement level the polluter is willing to accept, B_P, is lower than the minimal level of abatement for the regulator B_R. One reason for this is the fact that signing a VA provides a specific benefit for the polluter which lowers his reservation level: avoiding the rent-seeking expenditure $x_P(\hat{B})$. This is not the crucial reason, however, since B_P would remain below B_R even if $x_P(\hat{B})$ was equal to zero. The key point lies in the convexity of the cost function as illustrated by Figure 1. It represents the case $\pi(\hat{B})C(\hat{B}) < \pi(\hat{B})W(\hat{B})$, or equivalently $C(B_P) < W(B_R)$. This case is not very favorable to the joint satisfaction of the participation constraints since expected loss associated with the threat for the polluter is less than the expected gain for the regulator. In this situation, we might fear that the maximal abatement level acceptable for the polluter to be lower than the minimal level acceptable by the regulator. In fact, this is not the case as shown in Figure 1: we have $B_R < B_P$ because C is convex and W is concave.



4 Design issues

Having shown that the VA systematically dominates regulation in a second best world where legislative action is constrained by lobby groups' influence, we use the model to analyze three design issues that arise in the policy debate on VAs: the efficiency potential of involving environmental associations in the negotiation, the impact of policy delegation on bargaining outcomes, and the interest of an ex post veto right of the Congress over any new VA. [7]

[7] A recent report published by OECD study makes a comprehensive review of these issues (OECD, 2000).

4.1 Associating the green group to the VA

A frequent criticism is that VAs exclude the pollution victims from the negotiation. In this respect, they diverge from classical Coasean bargaining since not all affected parties are around the table. The Coase theorem then suggests that it would improve welfare to include them in the process. The involvement of green associations in the negotiation of VAs is a recurrent policy recommendation even though it rarely happens in practice (OECD, 2000). Does our model plead for such a recommendation? To answer the question, it is necessary to compare the bargaining outcome of the traditional 2-party VA analyzed in the previous section, $\tilde{B}$, with that of the 3-party VA game involving a green group representing the victims. The payoff to the green group in the bargaining game is

$$U_G(B) \equiv B - \pi(\hat{B}).\hat{B} - x_G(\hat{B})$$

No simple equilibrium concept is available for 3-player bargaining games without side payments. To bypass the problem, we assume that bargaining only takes place between the two lobby groups. The environmental regulator only influences the outcome through his participation constraint which still needs to hold. Hence, he has no bargaining power and plays a role of arbitrator (or facilitator) of the negotiation. This hypothesis about the allocation of bargaining power actually corresponds to that of a Coasean negotiation. With this assumption the maximization problem of the three-player game is:

$$\max_{B \in \Gamma} \Pi_{ter}(B) \equiv U_P(B).U_G(B)$$

where $\Gamma = \left\{ B : U_G(B) \geq 0 \right\} \cap \Omega$. The following result establishes the existence of the bargaining outcome of the three-player game and states that it is more efficient than the traditional bilateral VA.

Proposition 2. There exists a unique abatement level, denoted $\breve{B}$, which is the outcome of the 3-party VA. Furthermore, $\tilde{B} < \breve{B} < B^*$ for any λ and π°, implying that the 3-party VA is more efficient than the traditional one.

Proof. Establishing the existence and uniqueness of $\tilde{B}$ follows closely the proof of Proposition 1 and is thus left in appendix. As regards the second part of the proposition, consider the Nash product of the 3-party VA game:

$$\Pi_{ter}(B) = \Pi(B) + \left[\pi(\hat{B}).C(\hat{B}) + x_P(\hat{B}) - C(B)\right]^2$$

Its first derivative is $\Pi_{ter}'(B) = \Pi'(B) - 2((\pi(\hat{B}).C(\hat{B}) + l(\hat{B})) - C(B))C'(B)$. As $\tilde{B}$ is the maximum of $\Pi(B)$, then $\Pi'(\tilde{B})=0$. Hence we have $\Pi_{\text{ter}}'(\tilde{B}) = -2((\pi(\hat{B}).C(\hat{B}) + l(\hat{B})) - C(\tilde{B}'))C'(\tilde{B}')$, which is strictly negative. It implies $\tilde{B} < \breve{B} < B^*$.□

Proposition 2 establishes that the involvement of green groups in VAs is a relevant policy recommendation. This is so because, in the case of a simple VA excluding the green group, the participants are the polluter – who only cares about abatement costs - and the regulator – who is concerned with both costs and benefits. In this setting, the cost is taken into account twice in bargainers' payoffs while the benefit is only counted once. This is reflected in the bargaining outcome which places more weight on the cost side. Involving the greens - who are only concerned with the benefit - suppresses this distortion since costs and benefits are both taken into account twice in participants' payoffs.

4.2 Delegating the negotiation of VA

The intuition behind proposition 2 is the starting point for discussing a further design aspect. In practice, the government often delegates the negotiation of VAs to specialized environmental agencies (e.g., the EPA in the US) or Ministries of the Environment. In comparison with the ideal benevolent regulator of the basic model, it is reasonable to assume that these entities are biased in favour of the environment. The model can illustrate the fact that such a policy delegation and the bias it introduces in the objective of the bargaining regulator in fact promote the efficiency of the VA. Put differently, an *inefficient* regulator leads to more *efficient* VA outcomes. The reason is the same as the one supporting the involvement of the greens in VAs. A pro-environment regulator pays more attention to the benefit than to cost, resulting in a more efficient bargaining outcome. Let us investigate this point.

Consider that, for efficiency purposes, the benevolent regulator delegates VA bargaining to a biased agency denoted A. To organize the delegation relationship, he devises a contract, which specifies the bias. More specifically, the delegation contract attributes to the bargaining agency the following objective function

$$\beta B - (1\text{-}\beta)\, C(B) \qquad \text{with } \beta \in [0,1]$$

The bias is reflected by the parameter β which equals 0, if the contract requires the agency to care only about abatement cost, and 1, if the contract requires paying only attention to environmental benefit. We assume that the delegation contract is perfectly enforceable. More generally, we neglect all the transaction costs potentially attached to policy delegation. The question we address is then as follows: what should be the bias β^* so that the bargaining outcome maximizes social welfare?

There is a simple way to answer the question by considering the participation constraints. Keeping the notations previously introduced, the maximal level the polluter is willing to accept, B_P, and the minimal level for the bargaining agency, B_β, are now given by:

$$U_P(B_P) \equiv \pi(\hat{B}).C(\hat{B}) + x_P(\hat{B}) - C(B_P) = 0\,. \tag{6}$$

$$U_A(B_\beta) \equiv \beta B_\beta - (1-\beta)C(B_\beta) - \pi(\hat{B})\big(\beta\hat{B} - (1-\beta)C(\hat{B})\big) = 0 \tag{7}$$

Note that the threat policy $\hat{B}$ is the same as before since the benevolent regulator is still the agenda-setter of the Congress. Assume that there exists an agreement involving an equilibrium abatement level $\tilde{B}$. It follows that we necessarily have $B_\beta \leq B_P$ and $\tilde{B} \in [B_\beta, B_P]$. From Eq. (6), we see that B_P does not depend on β. Hence, modifying the bias will not affect the upper bound of the interval $[B_\beta, B_P]$. It only influences the lower bound. Moreover, we know from proposition 1 that $B_P < B^*$. Hence the VA equilibrium abatement level $\tilde{B}$ is thus necessarily below the first best level. In this context, the higher $\tilde{B}$ and the closer to the first best B^*, the more efficient the VA. In particular, if we are able to show that there exists a bias β such that $\tilde{B} = B_P$, we would have characterized the efficient bias β^*. In fact, this bias exists and is given by

$$B_\beta = B_P \tag{8}$$

This is so because, in this case, the bargaining set is restricted to one point and we are sure that $\tilde{B} = B_P$. Substituting Eq.(6) and (7) in Eq.(8) then yields the efficient bias:

$$\beta^* = 1 - \frac{B_P - \pi(\hat{B})\hat{B}}{\left[B_P - \pi(\hat{B})\hat{B}\right] + \left[C(B_P) - \pi(\hat{B})C(\hat{B})\right]} \tag{9}$$

We are then able to establish the following result.

Proposition 3 The efficient bias, β^*, of the VA delegation contract is such that $\beta^* > 1/2$. The bargaining agency is thus biased in favor of the environment.

Proof. From Eq.(6), we know that $C(B_P) - \pi(\hat{B})C(\hat{B}) = x_P(\hat{B})$ and is thus positive. It follows that the legislative quota is less costly in terms of expected abatement cost than the VA. Put differently, gross VA abatement cost relative to the legislation is negative. Since the VA is overall welfare improving, the environmental benefit of the VA relative to the legislation $B_P - \pi(\hat{B})\hat{B}$ is necessarily positive and higher in absolute terms than the associated gross abatement cost, that is: $B_P - \pi(\hat{B})\hat{B} > \pi(\hat{B})C(\hat{B}) - C(B_P)$. This inequality implies that the last term of Eq.(9) is strictly inferior to ½. Hence $\beta^* >$ ½.□

This proposition essentially relies on the same intuition as the one justifying the involvement of the green group in the VA. A pro-environment bias compensates for the polluter's bias in favor of the abatement cost and then leads the bargaining outcome to be more efficient in the end. This proposition has institutional implications: VA negotiation should be preferably delegated to environmental agencies. There exist instances where VA are in fact delegated to the ministries or agencies in charge of industrial or economic affairs. The Dutch CO2 Long Term Agreements is an example. Our model suggests that it is not the best choice.

4.3 Granting a veto right to the Congress

A further design question refers to the interest of granting a veto right to the Congress over every new VA. Belgium or the Netherlands are countries which have already adopted this rule. The underlying rationale is to compensate for the lack of democratic legitimacy of the VA process as compared to traditional legislative action. Is it justified on economic efficiency grounds? In our setting, it adds a further (veto) stage to the sequential game. At this final stage, we must assume that, like any proposal made in the Congress, the adoption of the VA is the subject of a further rent-seeking contest between the two lobby groups.

Basically, there is no difference with the rent-seeking sub-game analyzed in section 3.1. The probability that the VA is definitively adopted is therefore equal to $\pi(B)$ given by Eq.(4) and the corresponding rent-seeking expenditures are $x^P(B)$ and $x^G(B)$ for the polluter and the green group, respectively given by Eq.(2) and Eq.(3). Moving on to the bargaining sub-game, the bargainers' payoffs are now:

$$U_P(B) = \pi(\hat{B})C(\hat{B}) + x^P(\hat{B}) - \pi(B)C(B) - x^P(B)$$

$$U_R(B) = \pi(B)W(B) - \pi(\hat{B})W(\hat{B})$$

We then have the following proposition:

Proposition 4 When the Congress enjoys a veto right, no VA emerges in equilibrium.

Proof. Keeping using B_R to denote the minimal level the regulator is ready to accept, defined by $\pi(\hat{B}).W(\hat{B}) \equiv \pi(B_R).W(B_R)$. The left-hand side and the right-hand side of this condition have the same functional form. Furthermore $\pi(.)W(.)$ is strictly monotonic below $\hat{B}$. Hence $B_R = \hat{B}$.
Consider now B_P defined by $\pi(\hat{B}).C(\hat{B}) + x_P(\hat{B}) \equiv \pi(B_P)C(B_P) + x_P(B_P)$. The same argument applies to establish that $B_P = \hat{B}$ if $\pi(.).C(.) + x_P(.)$ is monotonic. To show that this is the case, consider the Nash product $\Pi(B) = U_P(B).U_R(B)$. If there exists a VA, we have $\Pi'(B) = U_P'(B).U_R(B) + U_P(B).U_R(B)' = 0$. As we are below $\hat{B}$, $U_R'(B) > 0$ and

thus $U_P\,'(B) = -(\pi(B)C(B) + x_P(B))' < 0$. Therefore, $\pi(.).C(.) + x_P(.)$ is monotonic and $B_P = \hat{B}$. In the end, $B_P = B_R$ and the bargaining set is restricted to the disagreement point.□

Therefore, introducing a veto right damages social welfare, preventing VAs from emerging in equilibrium. Intuitively, this is so because, in the absence of veto right, the gains for both sides are ultimately rooted in bypassing the legislative route. Offering a veto on the result of the negotiation *de facto* re-introduces the legislative option in the VA route. As a result, the interest for making a VA vanishes for both parties.

5 Conclusion

We have developed a model of voluntary agreement under legislative threat wherein the regulator sets the threat while its probability of adoption is the outcome of a rent-seeking contest between the polluter and a green group influencing the legislature. The model demonstrates that, in this setting, the VA is systematically more efficient than the threat abatement quota.

We also use the model to analyze a set of design issues that are frequently discussed in the policy arena. First, it is shown that involving a green group in the negotiation of the VA improves welfare. The underlying intuition is that this (partly) compensates for the bias in favor of pollution abatement cost attached to the participation of the polluter in the VA decision process. The same intuition applies for the second extension of the model, which considers the interest for the benevolent regulator to delegate the negotiation of the VA to a biased agency. Such a delegation frequently takes place in practice when the responsibility for developing VA lies upon specialized environmental agencies or ministries. We demonstrate that this strategy improves welfare if the agency is biased in favor of the environment. The last extension of the model assesses the relevancy of granting a veto right to the Congress over each new VA as done in certain countries (e.g., Belgium, the Netherlands). The model demonstrates that this prevents the emergence of any welfare-improving VA.

All in all, these results are quite favorable to voluntary agreements in comparison with the traditional Command and Control approach. It should however be noted that potential drawbacks of the approach are not taken into account in this modeling exercise. For instance, the polluters perfectly comply with their commitments in the model whereas many commitments are in fact non-binding in reality. Furthermore, the model does not address free riding issues which can hinder the emergence of VAs when, as it is frequent in practice, they involve a group of polluters. A further limit providing the opportunity for future work is that we only consider a threat consisting in an abatement quota. It would be interesting to consider more efficient policy options, such as a pollution tax or an emission-trading program.

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Appendix

Proof of lemma 1 when when rent-seeking is wasteful

If the regulator considers that rent-seeking is a wasteful activity, it enters negatively in his objective function and he maximizes

$$\pi(B)[B - C(B)] - x_G(B) - x_P(B) \,,$$

which leads to

$$\pi'(B)[B - C(B)] + \pi(B)[1 - C'(B)] - x_G'(B) - x_P'(B) = 0$$

$\hat{B}$, the welfare maximizing regulatory policy under legislation, still satisfies $\hat{B} < B^*$ since $\pi(\hat{B})\left(1 - C'(\hat{B})\right) = -\pi'(\hat{B})\left[\hat{B} - C(\hat{B})\right] + x_G'(\hat{B}) + x_P'(\hat{B}))$. Furthermore, we have:

$$x_G'(\hat{B}) + x_P'(\hat{B}) = \frac{1-\pi^\circ}{\lambda}.\frac{\hat{B}^3.C'(\hat{B}) + \hat{B}.C^2(\hat{B}) + \hat{B}^2.C(\hat{B}).C'(\hat{B}) + C^3(\hat{B})}{\left(\hat{B} + C(\hat{B})\right)^3} > 0$$

As $\pi' < 0$, then $1 - C'(\hat{B})$ is positive implying that $\hat{B} < B^*$. □

Proof of Proposition 2

First we show that Γ is non-empty. Let B_G denote the abatement level corresponding to the green group's participation constraint, that is $U_G(B_G) \equiv B_G - \pi(\hat{B})\hat{B} - x_G(\hat{B}) = 0$. We use the notation as in proposition 1 for the abatement levels corresponding to the polluter's and regulator's participation constraints, B_P and B_R respectively. Proposition 1 has already established that $B_R<B_P$. Therefore, for Γ to be non-empty only requires that $B_G<B_P$, i.e., the polluter's and green group's participation constraints jointly hold. From $U_G(B_G)=0$, we derive that $x_P(\hat{B}) = C(\hat{B})(B_G - \pi(\hat{B})\hat{B}) / \hat{B}$ since $x_G(\hat{B}) = \hat{B}x_G(\hat{B}) / C(\hat{B})$. Plugging $x_G(\hat{B})$ in $U_P(B_P) = \pi(\hat{B}).C(\hat{B}) + x_P(\hat{B}) - C(B_P) = 0$, we obtain that $C(B_P) = \left(C(\hat{B}) / \hat{B}\right).B_G$ and thus $C(\hat{B}) / \hat{B} = (C(B_P) / B_P)(B_P / B_G)$. From $B_P < \hat{B}$ and $C'' > 0$, it follows that $C(\hat{B}) / \hat{B} < C(B_P) / B_P$. Hence $B_G<B_P$. Γ is thus non-empty.

Second it is straightforward to show that the Nash product is strictly concave: $\Pi''(B) = -C''(B)U_G(B) - 2C'(B) < 0$. Last, we need to establish the existence and uniqueness of the equilibrium. If g denotes the green group' utility, we have to show that it is a strictly decreasing and concave function of the polluter's utility u_P. We have:

$$g(u_P) \equiv U_G\left(U_P^{-1}(u_P)\right) = C^{-1}\left(\hat{K} - u_P\right) - \pi(\hat{B})\hat{B} - x_G(\hat{B}) \ ,$$

where $\hat{K} = \pi(\hat{B})C(\hat{B}) + x_P(\hat{B})$. The first and second derivative are respectively:

$$dg/du_P = C^{-1}{}'(\hat{K} - u_P) = -1/C'(\hat{B})$$

and

$$dg^2/du_P^2 = -2/C'(\hat{B})^3 ,$$

which are both strictly negative. Therefore the Nash bargaining solution exists and is unique. □

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(l) This paper was presented at the Workshop "Growth, Environmental Policies and Sustainability" organised by the Fondazione Eni Enrico Mattei, Venice, June 1, 2001

(li) This paper was presented at the Fourth Toulouse Conference on Environment and Resource Economics on "Property Rights, Institutions and Management of Environmental and Natural Resources", organised by Fondazione Eni Enrico Mattei, IDEI and INRA and sponsored by MATE, Toulouse, May 3-4, 2001

(lii) This paper was presented at the International Conference on "Economic Valuation of Environmental Goods", organised by Fondazione Eni Enrico Mattei in cooperation with CORILA, Venice, May 11, 2001

(liii) This paper was circulated at the International Conference on "Climate Policy – Do We Need a New Approach?", jointly organised by Fondazione Eni Enrico Mattei, Stanford University and Venice International University, Isola di San Servolo, Venice, September 6-8, 2001

(liv) This paper was presented at the Seventh Meeting of the Coalition Theory Network organised by the Fondazione Eni Enrico Mattei and the CORE, Université Catholique de Louvain, Venice, Italy, January 11-12, 2002

(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

(lvi) This paper was presented at the ESF EURESCO Conference on Environmental Policy in a Global Economy "The International Dimension of Environmental Policy", organised with the collaboration of the Fondazione Eni Enrico Mattei , Acquafredda di Maratea, October 6-11, 2001

(lvii) This paper was presented at the First Workshop of "CFEWE – Carbon Flows between Eastern and Western Europe", organised by the Fondazione Eni Enrico Mattei and Zentrum fur Europaische Integrationsforschung (ZEI), Milan, July 5-6, 2001

(lviii) This paper was presented at the Workshop on "Game Practice and the Environment", jointly organised by Università del Piemonte Orientale and Fondazione Eni Enrico Mattei, Alessandria, April 12-13, 2002

(lvix) This paper was presented at the ENGIME Workshop on "Mapping Diversity", Leuven, May 16-17, 2002

(lvx) This paper was presented at the EuroConference on "Auctions and Market Design: Theory, Evidence and Applications", organised by the Fondazione Eni Enrico Mattei, Milan, September 26-28, 2002

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