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Voluntary agreements with Industries - participation incentives with industry-wide targets: a comment

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Abstract

This comment reexamines the problem of free-riding in pre-emptive collective environmental voluntary agreements (VA) analysed by Dawson and Segerson in the context of VAs with a global emission target and a pigouvian tax used as a threat. Completely remaining in the authors' framework, we here reconsider their results about efficiency. While they claim it provides the optimal amount of environmental quality but inefficiently, we show that there exists an optimal threat under which the equilibrium of the game is a cost-effective VA. This result gives an additional indication on the way VAs should be used to be efficient.

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1. Introduction

Collective VAs refer to commitments of groups of firms, possibly an entire industry, to cutting voluntarily their polluting emissions. These commitments are not directly required by law but they may be used by firms to preempt the implementation of a coming enactment and get some costs advantages in the form of regulatory gains [1]. A problem of preemptive collective VAs is that there may be, inside the group of firms which are affected by the coming law, an incentive to free-ride on other firms' preemptive efforts. Namely, it is the case when the sanction is not defined individually but collectively, that is when the implementation of the law threat depends on the global voluntary emission reduction effort and not on private voluntary efforts.

In a recent paper, Na Li Dawson and Kathleen Segerson (Dawson and Segerson, 2008) point out (as have others before them, such as Millock and Salanié, 2000; Lyon, Maxwell and Hackett, 2000; Brau, Carraro and Golfetto, 2000) that these free-riding phenomena may play a crucial role in the emergence of VAs and their efficiency.

In Millock and Salanie (2000), compensation between individual efforts is assumed to be impossible. Therefore one single firm not meeting its own voluntary commitment is enough to cause environmental ineffectiveness. In the frameworks of Lyon, Maxwell and Hackett (2000) and Brau, Carraro and Golfetto (2000), compensation between individual efforts is possible, but it is not always profitable for firms. Consequently, free-riding may result again in under provision of the public good. If we want VAs to be environmental effective despite free-riding phenomena, compensation between individual efforts must not only be possible, but also profitable. Note then that the profitability of making up for free-riders relies on the common sanction which would be implemented in case of environmental ineffectiveness. In Dawson and Segerson (2008), the threat is a pigouvian tax set at a level such that the sum of firms emissions equalizes an exogenous target E. The authors find that, at the equilibrium, a group of firms compensate for the absence of effort of other firms because it is more profitable for her than paying the pigouvian tax. But, while environmental effectiveness is indeed guaranted by the pigouvian tax, a problem of cost inefficiency appears since at the equilibrium only a sub-group of firms with concave costs functions share the depollution burden.

In the present comment, we show that the cost inefficiency in Dawson and Segerson (2008) comes from the fact that the tax threat is exogenously set through E. We suggest to make the tax threat endogenous. Especially, we suggest to set it at some lower level such that compensation is no more profitable but doing the reduction effort is still better for the firms than the implementation of the tax. This weaker threat, that we call 'optimal', solves the problem of inefficiency stressed by Dawson and Segerson (2008).

The model of Dawson and Segerson as well as their main conclusions will be presented in the next section. In section 3, we establish the existence of an optimal threat such that there is no free-riding at the equilibrium and derive a normative result. Section 4 concludes.

2. An overview of Dawson and Segerson's model

N symmetric firms producing a good and pollutant emissions are engaged in Cournot competition. They interact with a regulator in order to choose between a voluntary and a mandatory regulation scheme. The mandatory scheme is a per unit pigouvian tax, fixed at a level t^{pig}, such that the sum of all firms' emissions equalizes a cap set by the regulator. The voluntary scheme let the firms voluntarily and collectively meet the cap.

Dawson and Segerson (2008) represent this interaction by the following game. In a first step, each firm decides if it participates to the VA. The coalition of participating firms must be self-enforced at the equilibrium, that is the coalition must be profitable as well as internally and externally stable. If no firm wants to participate, the negociation fails and the regulator sets a pigouvian tax such that the sum of all firms' emissions equalizes the target E. If at least one firm wants to participate, each non-participating firms chooses non-cooperatively the amount of emission that maximizes its profit while each participating firm chooses the quantity of emission which both maximizes its profit and ensures that the common target is met. In a third and last step, firms compete in a Cournot market.

Let $\pi((e_i)_{i=1}^N)$ be the indirect profit function under VA of the N symmetric firms for given emissions levels, where e_i is the level of emissions of firm i. To determine the optimal levels of emissions, Dawson and Segerson distinguish participating from non-participating firms and study Nash equilibria of the game, restricting themselves to equilibria within groups. They get an indirect profit function for each type of firms, depending on the number of participating firms. For the rest of the present note, the indirect profit functions of participating and non-participating firms, for a given number of participating firms, will be respectively denoted by $\pi_p(N_p)$ and $\pi_n(N_p)$, where N_p is the number of participating firms.

Remark 1. *A special case of interest is the case with no regulation. Let e_{LF} be the level of emission choosen by firms at laisser faire,*

$$e_{LF} = \arg\max_{e} \pi((e_i)_{i=1}^N) \tag{1}$$

As a final step of the backward-solving, it remains for the authors to identify values of N_p such that the VA is self-enforcing. Let $C(y_i, e_i)$ be the cost function of the firm i and y_i its level of production. $C(y_i, e_i)$ is increasing in y_i, decreasing in e_i and continuous. Before moving to the end of the solving, Dawson and Segerson make the further assumption that the cost function of the N firms is strongly separable

$$\frac{\partial C(y_i, e_i)}{\partial y_i \partial e_i} = \frac{\partial C(y_i, e_i)}{\partial e_i \partial y_i} = 0 \quad \forall i \tag{2}$$

Remark 2. *In particular, the separability assumption implies that the indirect profit function of participating firms for a given N_p, is increasing in N_p.*

Indeed, separability entails that N_p has only an impact on participating firms' profits through the direct effect on their emissions choices while all other effects of N_p on firms' profits, ie. the direct effect on non-participants' emission choices and the indirect effects through production levels of participating and non-participating firms, disappear.

Now, still following Dawson and Segerson, let call $N_p^{\boldsymbol{t}}$ the smallest number of participants necessary to make the VA profitable for participating firms. If $\pi_p(1) \geq \pi^{pig}$, then $N_p^{\boldsymbol{t}} = 1$. If not, $N_p^{\boldsymbol{t}}$ is the level of N_p such that

$$\pi_p(N_p^{\boldsymbol{t}}) \geq \pi^{pig} \;\text{ and }\; \pi_p(N_p^{\boldsymbol{t}} - 1) < \pi^{pig} \tag{3}$$

where π^{pig} is the profit that firms get under the pigouvian tax. Note that – and we would like to stress this point – in Dawson and Segerson (2008), this level of alternative profit is a constant exogenously fixed. Indeed, it is the level of profit made by firms when their emissions are taxed at the level t^{pig} per unit, where we recall that t^{pig} is the level of tax which ensures that the sum of all firms' emissions equalizes the cap exogenously set by the regulator.

Dawson and Segerson demonstrate then that a coalition of N_p participating firms is a self-enforcing equilibrium under which the target is met voluntarily if and only if $N_p = N_p^{\boldsymbol{t}}$ (see proposition 2 in Dawson and Segerson (2008) for the proof).

Such a $N_p^{\boldsymbol{t}}$ and thus such an equilibrium always exist, with $1 \leq N_p^{\boldsymbol{t}} \leq N$ (See proposition 1 in Dawson and Segerson (2008) for the proof).

It is not necessarily the only self-enforcing equilibrium though : $N_p = 0$ is a self enforcing equilibrium under which the target is not met voluntarily if and only if $\pi_p^{\boldsymbol{t}}(1) \leq t^{pig}$. (See proposition 4 in Dawson and Segerson (2008) for the proof). But this equilibrium is Pareto dominated by the equilibrium under which the target is met so it might be expected that firms doesn't choose it.

These results induce Dawson and Segerson to claim that a VA is always implemented at the equilibrium and the good level of environmental quality provided, but not all the firms participate. Firms being symmetric and cost functions strictly concave, the abatement burden should be equally shared for the social costs to be minimized. Hence they conclude that the persistence of free-riding makes collective VAs cost ineffective. In the present note we make the comment that this result comes directly from the fact that, in Dawson and Segerson's model, the level of alternative profit that firms take into account in their participation decisions is considered as fixed while actually it depends on the level of tax chosen by the authorities. We argue then that the problem of cost inefficiency can be bypassed if the level of tax threat is considered as an optimization variable.

3. The optimal threat

We have just seen that, for a given E, the level of alternative profit intervenes as a constant in the determining of the minimum number of firms necessary to make the VA profitable for participating firms – Proposition 2 in Dawson and Segerson (2008). Indeed, for the authors, it is the level of profit that firms get under the pigouvian tax and the minimum number derived is then $N_p^{\boldsymbol{t}}$ which is less than N. Now, let consider it as a variable, so the minimum number of participating firms becomes a function of the alternative profit level. This level of alternative profit depending on the tax level, we suggest that there must exist a tax level inducing that the smallest number of participants necessary to make the VA profitable for participating firms is N. For the following of the present note, we call π^{opt} the level of alternative profit such that the minimum participation level is full participation. By definition, π^{opt} satisfies

$$\pi_p(N) \geq \pi^{opt} \quad \text{and} \quad \pi_p(N-1) < \pi^{opt} \tag{4}$$

Now, let denote by $\pi(t)$ the indirect profit function under tax for given level of taxes. It is the objective function $\pi((e_i)_1^N) - te_i$, evaluated at the optimal emissions level, ie. at the symetric Nash equilibrium of the game in emission under tax.

Lemma 1. *There always exists a level of tax, denoted t^{opt}, such that the smallest number of participants necessary to make the VA profitable for participating firms is equal to N.*

PROOF. By construction, given that $C(e_i, y_i)$ is decreasing in e_i, and $\pi_p(N_p)$ increasing in N_p, we have

$$\lim_{t \,!\, 0} \pi(t) = \pi(e^{LF}) \geq \pi_p(e = \frac{E}{N}) = \pi_p(N) \tag{5}$$

on one hand, and

$$\pi_p(N) \geq \pi_p(N_p^{\boldsymbol{t}}) \geq \pi(t^{pig}) \tag{6}$$

on the other hand. Coupled with the continuity of $\pi(t)$, the fact that $\pi_p(N)$ belongs to the interval $[\pi(t=0), \pi(t^{pig})]$, ensures the existence of a tax level, t^{opt}, such that $\pi(t) = \pi^{opt}$. QED

For this result to be of interest, we still have to establish that when $t = t^{opt}$, the smallest number of participants necessary to make the VA profitable for participating firms does remain the equilibrium of the game.

Proposition 1. *When the tax threat is set at t^{opt}, the grand coalition is a self-enforcing equilibrium under which the target is met voluntarily.*

PROOF. Profitability and extern stability are trivially satisfied by the grand coalition. Let us show that the grand coalition is internally stable as well. If one single firm or a subgroup deviates, it is no more profitable to participate for the remaining firms (by definition, π^{opt} is greater than $\pi_p(N-1)$) and the VA fails. The tax t^{opt} is subsequently enforced and deviating firms make less profit than when they participated since they get the same profit than before tax, but now have to pay $\frac{E}{N} \times t^{opt}$. QED

Thus, we have found how to induce full-participation in collective VAs with a global emission target and a tax used as a threat. Now, let mention two appealing consequences of Proposition 1.

Corrolary 1. $t^{pig} \geq t^{opt}$

PROOF. Note that $N \geq N_p^{\boldsymbol{t}}$. Then, by definition of π^{pig} and π^{opt}, it implies that $\pi^{opt} \geq \pi^{pig}$. Since $\pi(t)$ is decreasing in t, we have that $t^{pig} \geq t^{opt}$. QED

So an interesting feature of the tax level inducing full-participation is that it is smaller than the pigouvian tax. Actually, by seting a lower tax level than the one which ensures that E is reached at the tax equilibrium, we make profit under tax higher and therefore drive up the number of participants necessary to make the coalition profitable. The underlying general idea is that in collective pre-emptive VA with incentives to free-ride and free-riding undermining the profit of participating firms under the VA, we have to make the comparison allocation high enough so that the absence of free-riding is necessary for participants to get regulatory gains from the VA. Although this optimal level of tax is not the pigouvian one, it is credible if we assume that the governement is bound to implement the announced threat when the target is not met [2]. And this assumption could even be relaxed without calling the credibility of t^{opt} into question. Indeed, in a world in which demanding mandatory environmental regulation are still quite difficult to implement due to political processes and interest groups[3], it seems reasonnable to say that to threaten to implement a low tax level is more credible than to threaten to implement a higher one.

A second consequence to be stressed is about the effectiveness of the VA.

Corrolary 2. *When the tax threat is set at t^{opt}, the cost of meeting the aggregate reduction emission goal is minimized.*

Indeed, since the N symetric firms participate at the equilibrium, the distribution of reduction emissions is uniform, which, associated with the concavity of the cost function, ensures that the aggregate emission target is met at least cost. Thus, while Dawson and Segerson (2008) concludes with the cost efficiency loss generated by the inequal sharing of abatment between firms, we suggest, in the present note, that this problem can be controled by considering the tax level as an optimization variable.

4. Conclusion

In this note we have used Segerson and Dawson's positive analysis of free-riding in collective environmental VA to derive a result with an important implication for policy design. Indeed, we have shown that a tax set at the level necessary to ensure that the emissions cap would be met under the mandatory regulation scheme may not be the optimal threat under the VA because it does not induce full participation and therefore cost minimization of meeting the emissions cap. Thus, in order to enhance firms participation, the regulator should design the VA with a lower tax threat so that he increases the minimum number of participants necessary to make the participating coalition profitable.

Notes

[1]There is a large literature on regulatory gains derived from VAs. See David [3] for a survey.

[2]The authors don't explicitly make the assumption that the threat of the government is binding, but their game do not include further steps modeling the question of the credibility of the threat.

[3]See Tanguay, Lanoie and Moreau [8] for an empirical analysis on environmental policy and political processes.

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