Negotiating a Voluntary Agreement when Firms Self-Regulate

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Abstract

Does self-regulation improve social welfare? We develop a policy game featuring a regulator and a firm that can unilaterally commit to better environmental or social behavior in order to preempt future public policy. We show that the answer depends on the set of policy instruments available to the regulator. Self-regulation improves welfare if the regulator can only use mandatory regulation: it reduces welfare when the regulator opts for a voluntary agreement. This suggests that self-regulation and voluntary agreements are not good complements from a welfare point of view. We derive the policy implications, and extend the basic model in several dimensions.

Keywords: Self-Regulation, Negotiation, Regulation Preemption, Voluntary Agreement.

JEL classification: D72, Q28.

Contents

1 Introduction

Companies increasingly wish to appear Green. Marks & Spencer have announced their intention to become carbon neutral by 2012. The Coca-Cola Company has implemented a comprehensive corporate policy, including quantified objectives regarding packaging recycling, water stewardship, energy conservation, etc. Air France is funding projects to combat deforestation in Madagascar. Such practices, whereby firms unilaterally commit to environmental and social activities beyond those required by law and regulations, are usually termed self-regulation. In this paper, we develop a political-economy model in which firms undertake environmental self-regulatory activities in order to preempt future public policies.

Crucially for our analysis, self-regulation is not the only form of voluntary commitment. In particular, with Voluntary Agreements (hereafter VAs), firms also commit to environmental objectives on a voluntary basis. However, unlike self-regulation, a VA is a public-policy instrument as the regulator is involved in the setting out of these commitments. In Europe and Japan, VAs are mostly *negotiated agreements* in which the firms and the regulator jointly define the commitments through bargaining. As an illustration, the European Commission has secured negotiated agreements with European (ACEA), Japanese (JAMA) and Korean (KAMA) car manufacturers to reduce new cars' CO2 emissions.[1] In the United States, the usual form is the *public voluntary program*, in which firms are invited to meet goals that are pre-established by the regulator.[2]

The coexistence of self-regulation and voluntary agreements triggers the questions addressed in this paper: From the regulator's perspective, what role can VAs have today

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[1] A similar bargaining logic is found in national environmental forums which bring together firms, NGOs and regulators to set out new policies. The French 'Grenelle de l'environnement' is one example of such a forum.

[2] The Environmental Protection Agency web site lists 62 such programs in place as of June 24th 2008. See: http://www.epa.gov/partners/programs/.

in a context where self-regulation is becoming pervasive? Should regulators give up VAs and restrict themselves to the use of mandatory regulation?

We examine how self-regulation influences the welfare properties of VAs and mandatory legislation in a simple model involving a firm and a welfare-maximizing regulator. The firm moves first and can commit to self-regulatory activities which consist in abating pollution. The regulator then seeks to reach a VA with the firm in stage 2. In the case of persistent disagreement, the regulator initiates a legislative process which potentially leads to the adoption of a mandatory quota for pollution abatement with probability p. Critically for our results, the regulator can make efforts to increase p.

The model shows that environmental self-regulation is not always good news for the common interest. It reduces welfare when a VA is reached in stage 2. Intuitively, this is because firms strategically self-regulate to reduce the regulator's incentives to increase p, thereby weakening the legislative threat that drives the emergence of the VA. In contrast, self-regulation improves welfare if the policy sequence does not include the VA stage.

This finding suggests that self-regulation and VAs do not complement each other. Given that prohibiting self-regulation is not a feasible policy option, should VAs be forbidden? We establish that the answer to this question is ambiguous, and depends on the allocation of bargaining power between the firm and the regulator. The results carry through when we consider the case of several firms[3] and the possibility of lobbying by the firm in Congress. In the base model, the regulator can increase the probability that a quota is adopted; however she cannot influence the level of the quota. In a variant of the model, we show that our results no longer hold when we consider the alternative hypothesis that the probability is fixed but the regulator can try to bring the quota closer to the social optimum. In this case, self-regulation becomes welfare neutral.

A substantial body of theoretical work has now produced a number of explanations for the existence and welfare effects of VAs and self-regulation (for a recent review, see

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[3]We consider this case in Appendix B.

Lyon and Maxwell, 2008). It is convenient to classify these contributions into two categories, which are ultimately based on firms' motives. In the first category firms engage in voluntary environmental activities for market-driven purposes: to extract the consumer surplus of Green consumers (Arora and Gangopadhyay, 1995; Fisman et al., 2006; Besley and Ghatak, 2007), incentivize workers and managers (Brekke and Nyborg, 2004; Baron, 2008) and attract investors. The starting point of this research stream is the idea that, in the real world, certain economic agents – consumers, workers and shareholders – have personal preferences for contributing to social or environmental causes, and may choose to reward environmentally-friendly companies. Against this background, the purpose of voluntary commitments is to signal firms' environmental performances.

Our paper belongs to the second branch of the literature in which firms make voluntary efforts for political reasons: they anticipate that voluntary commitments can preempt or shape future public policies. More precisely, the premise is that improving environmental performance is costly. Consequently, self-regulation or a VA emerges only when they are less costly than the public policies that the firms would face in the absence of voluntary commitments. In this research stream, some papers deal with VAs (Manzini and Mariotti, 2003; Segerson and Miceli, 1998; Glachant, 2007), while others look at self-regulatory actions but do not consider voluntary agreements (Maxwell et al., 2000; Heyes, 2005; Denicolo, 2008). In the real world, however, regulatory agencies clearly have the VA arrow in their quiver, but it is equally clear that firms are free to undertake self-regulation. The current paper studies the advocacy of VAs in this more realistic setting.

Lyon and Maxwell (2003) also analyze the interplay between VAs and self-regulation in a unified framework. However, there are two major differences with our paper. First, the sequence of moves is different. Once the firm has chosen its level of self-regulation in Stage 1, they assume that the regulator initiates a legislative process leading potentially to a tax with a probability p in Stage 2. A VA is made in Stage 3 only if the relevant law is not passed. In our model, the regulator tries to implement a VA in Stage 2. It then only

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legislates in Stage 3 in the case of persistent disagreement.

The second difference is the VA design. In Lyon and Maxwell (2003), the scheme consists in a voluntary commitment by the firm to meet an environmental target which is associated with a subsidy by the regulator. The subsidy allows for the emergence of voluntary efforts in the last stage. We assume that the VA does not include a subsidy. In our set-up, legislation defines the threat which makes voluntary abatement possible in Stage 2.

Strictly speaking, real-world VAs do not include monetary payments. But Lyon and Maxwell argue that they may be associated with technical assistance or other in-kind compensation, particularly in the U.S, which can be assimilated to implicit subsidies. Our approach is arguably more realistic for European or Japanese voluntary schemes in which firms' commitments are usually driven by legislative threats. Note that these differences in the sequence of moves and VA design lead to opposite results: self-regulation is welfare reducing in our model whereas the opposite holds in Lyon and Maxwell (2003).[4]

The paper is organized as follows. In Section 2, we introduce the basic version of the model with a single firm. We fully solve the model in Section 3. Section 4 then carries out the analysis with only legislation, and compares the policy outcomes under the two sequences. This enables us to explore whether VAs should be prohibited or not. In Section 5 we consider other models of political influence in the legislative arena. Finally, the concluding Section wraps up the main findings. The Appendices contain some proofs and the generalization of our main results to the case of several firms.

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[4]In addition, public voluntary programs may be socially detrimental in their paper, whereas in our paper a VA is welfare improving in the absence of self-regulation.

2 The base model

We consider a sequential policy game involving a firm and a regulator where q is the only policy-relevant variable. In the following we will refer to q as the level of pollution abatement. However, this variable can represent any other performance indicator capturing self-regulatory outcomes.

The firm moves first and can commit to self-regulatory activities which consist in abating pollution. The regulator, which moves second, is in charge of policy definition and legislative activity. The regulator tries to reach a VA with the firm in the second stage, and in the case of persistent disagreement initiates a legislative process leading to a quota requiring a specified level of abatement.

In reality, certain VAs involve a coalition of firms represented by an Industry Association. Our model can also apply to this case if we assume that the members of the coalition have solved their collective action problem. This assumption is usual in the VA literature. We consider the alternative case of several firms that do not coordinate and can free-ride on self-regulation efforts in Appendix B. The case of n firms brings a new dimension into the picture, but we show that this does not qualitatively affect our results.

2.1 Gross payoffs

The firm's abatement cost is $C(q)$, with $C(0) = C'(0) = 0$ and $C, C', C'' > 0$. This assumption deserves comment. The introduction mentioned the literature in which abatement is profitable for market reasons: our hypothesis is compatible with this point of view. The case $q = 0$ is exactly the point at which all profitable abatement opportunities have been exploited. This implies that the two perspectives – voluntary efforts driven by market forces or political factors – are analytically separable.

The regulator maximizes a social welfare function $U(q)$, which is assumed to be twice-continuously differentiable and concave with a maximum at some positive and finite level

q^*. The function U obviously includes the abatement cost.[5] We assume that $U'(0) > 0$, and, without loss of generality, we apply the normalization $U(0) = 0$.

2.2 Legislation

As in real-world environmental agencies, the regulator does not directly enact the abatement quota: this is the task of legislators. The regulator only initiates the process by proposing a given quota L. However, political imperfections exist in Congress which prevent the systematic adoption of this proposal. More specifically, we assume that the proposed quota is enacted with probability $p < 1$; otherwise, no legislation is passed.

We furthermore posit that the probability p of adopting the regulation depends on the regulator's effort to present the case successfully in Congress. For example, the regulatory agency has to produce evidence that the type of pollution should indeed be regulated, that the competitiveness of the firm would not be over-harmed by the new legislation, and so on. Formally, obtaining adoption with probability p costs the regulator $\gamma(p)$. The parameter γ can represent administrative resources, but also the opportunity cost of not pursuing other welfare-improving policies. We assume that the probability of obtaining the quota is zero when no effort is expended: $\gamma(0) = 0$. This assumption simplifies the presentation but does not change the results. In addition, we assume that $\gamma'(0) = 0$: the assumption of zero marginal cost at the minimum probability allows us to focus on interior solutions. Otherwise, legislative action would be irrelevant in some cases, because it would never be used. Finally, we make the standard assumption that the cost is increasing and convex: $\gamma', \gamma'' > 0$.

The assumption that the adoption of legislation is subject to uncertainty is both realistic and common in papers dealing with voluntary abatement;[6] assuming that the regula-

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[5]U may represent any utility function giving various weights to consumer surplus, producer profits, environmental concerns, employment and so on.

[6]Glachant (2005); Lyon and Maxwell (2003); Heyes (2005); Segerson and Miceli (1998) and Manzini and

tor can affect this probability is also realistic but more original.[7]

In the existing literature, p is either purely exogenous (Segerson and Miceli, 1998) or affected by pressure groups. Lobbying can be modeled explicitly, as in Glachant (2005), or implicit, as in Lyon and Maxwell (2003), who assume that p decreases with L to reflect the political efforts of polluters which presumably increase with the strictness of environmental legislation. In Section 5 we consider a variant of the model with firm lobbying competing with the regulator in the determination of p, and obtain similar results.

Note also that γ does not depend on the strictness of the abatement quota L in the base model. To test the robustness of our results, we also develop in Section 6.2 a second variant in which the regulator does not influence the adoption probability but rather the level of the quota, L. We show in particular how our results change under this alternative assumption.

2.3 Timing

The game has three stages:

1. (Self-regulation) The firm unilaterally abates a quantity of pollution r.

2. (Voluntary Agreement) The regulator and the firm bargain over an abatement level, q^{VA}. If both parties agree, the firm complies.

3. (Legislation) In the case of disagreement, the regulator initiates the legislative process by choosing the probability p and the legislative quota L. The new regulation is adopted with the probability p and the firm complies. Otherwise the abatement level remains r.

Mariotti (2003) all use this assumption.

[7]See Maxwell and Decker (2006) for the related case of costly enforcement. In their model self-regulatory activity facilitates compliance to existing regulation.

In this sequence, the policy process continues even when the firm undertakes self-regulatory activities in Stage 1 ($r > 0$). This captures the fact that self-regulation is purely unilateral: the regulator does not commit to anything. This is the key difference between self-regulation and traditional VAs in which the regulator commits to refrain from making further policies.

Furthermore, the timing we consider for public action - negotiating first and then legislating in the case of disagreement - is the only relevant sequence for a regulator who has both options. The legislative option provides the threat that renders the agreement feasible. Reversing the order - legislating first and then negotiating a VA - would remove the firm's incentive to enter the VA.

3 Equilibrium analysis

3.1 Legislative stage

Reasoning backwards, we start the analysis of the legislative subgame by assuming that the polluter has voluntarily committed to abate some quantity of pollution r in the first stage. Under our assumptions, the regulator will obviously propose the quota $L = q^*$ as its strictness has no impact on the adoption probability. The effort to bring the case to Congress is implicitly given by:

$$p(r) \equiv \underset{p}{argmax} \ pU(q^*) + (1 - p)U(r) - \gamma(p)$$

The optimal probability p is determined uniquely as a function of r. Note that:

Lemma 1 (Preemption Effect) *The probability of successful legislative action is strictly decreasing in the level of self-regulation: $p'(r) < 0$.*

Proof. The first-order condition $\gamma'(p(r)) = U(q^*) - U(r)$ has to hold, otherwise $r > q^*$, which is strictly dominated for the firm. Differentiating the first-order condition yields $p'(r) = -U'(r)/\gamma''(p(r))$, which is negative since $r \leq q^*$. ∎

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Self-regulation decreases the strictness of legislation as the regulator has less of an incentive to make efforts in the legislative process: there is less to gain in Congress given that some abatement has already taken place.

3.2 VA stage

The negotiation of the VA target, q^{VA}, takes place under the two following individual rationality constraints:

$$U(q^{VA}) \geq p(r)U(q^*) + (1 - p(r))U(r) - \gamma(p(r)) \tag{1}$$

$$C(q^{VA}) \leq p(r)C(q^*) + (1 - p(r))C(r) \tag{2}$$

In the following we denote by $\overline{U}(r)$ and $\overline{C}(r)$ the reservation utility level of the regulator and the reservation cost of the firm, respectively:

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\begin{aligned}
\overline{U}(r) &\equiv p(r)U(q^*) + (1 - p(r))U(r) - \gamma(p(r)) \\
\overline{C}(r) &\equiv p(r)C(q^*) + (1 - p(r))C(r)
\end{aligned}
$$

Clearly, as U and C are respectively concave and convex, the set of acceptable q^{VA} is not empty. For example, $q^{VA} = p(r)q^* + (1 - p(r))r$ satisfies (strictly) both constraints.[8] Also, since the two participation constraints are continuous, the feasible set is an interval of the form $[\underline{q}^{VA}, \overline{q}^{VA}]$, with the lower bound corresponding to a binding participation constraint for the regulator - $U(\underline{q}^{VA}) = \overline{U}(r))$ - and the upper bound to a binding participation constraint for the firm - $C(\overline{q}^{VA}) = \overline{C}(r)$. In summary,

Lemma 2 *A VA always emerges in equilibrium and improves social welfare compared to regulation.*

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[8]As U is concave, we have $U[p(r)q^* + (1 - p(r))r] > p(r)U(q^*) + (1 - p(r))U(r)$. This directly implies that (1) holds. Similarly, $C[p(r)q^* + (1 - p(r))r] < p(r)C(q^*) + (1 - p(r))C(r)$ as C is convex.

Intuitively the VA systematically emerges for two reasons. First, although it is less constraining than the ex-post optimal level of regulation ($q^{VA} < q^*$), it is obtained with certainty. This benefits both the regulator and the firm, as they are both risk-averse (U and C are respectively concave and convex). Second, entering the agreement saves the legislative cost $\gamma(p)$ borne by the regulator. This replicates a usual result in the literature on VAs: the existence of political imperfections in the legislative route makes a mutually-beneficial agreement possible, and the agreement improves welfare because it is negotiated by a benevolent regulator.

It can be objected that pushing this line of reasoning further may yield that the most efficient policy is to abolish Congress altogether and give all power to the regulator, including control over the legislative threat. We justify our assumptions by exploring possible ways of re-balancing the relative efficiency of the two routes in the context of our model.

We could first assume a less-distorted legislative process. Of course, if we adopt the extreme hypothesis that the legislative process is fully efficient, the whole story of the paper vanishes as the game will always end with the socially-optimal quota in Stage 3. However, less extreme assumptions do not affect our results, as even the tiniest bit of inefficiency in Congress induces a VA.

Another option could be to assume a less efficient VA design. For instance, Glachant (2007) introduces the realistic hypothesis that VAs are imperfectly enforced. This would change the Lemma by restricting the existence of equilibria with VAs to a subset of parameter values. As our paper focuses on the impact of self-regulation on VAs, we would then concentrate the rest of the analysis on this subset. This would not change the results below since, as we will see, the mechanism does not depend on the parameter values.[9]

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[9] This does not even qualitatively affect the results of Propositions 1 and 3, which depend on the regulator's bargaining power α. By definition, the bargaining weights do not affect the bargaining set, and thus the existence of a VA.

Finally we could assume a non-benevolent regulator, but this would slightly change the nature of the paper. Our work is normative in that we aim to identify the best instrument choice for a welfare-maximizing regulator. In this respect, our approach is not original: Segerson and Miceli (1998), Lyon and Maxwell (2003), and Glachant (2007) all make this assumption.

In what follows, it will prove useful to work with a single equilibrium abatement level q^{VA} in the feasible set $[\underline{q}^{VA}, \overline{q}^{VA}]$. This obviously depends on the allocation of bargaining power between the regulator and the firm. To derive the equilibrium, we consider the generalized Nash bargaining solution[10] with bargaining powers of α and $1 - \alpha$ for, respectively, the regulator and the firm ($0 \leq \alpha \leq 1$). The Nash program is then:

$$\max_{q} \quad [U(q) - \overline{U}(r)]^{\alpha} [\overline{C}(r) - C(q)]^{1-\alpha}$$

The solution $q^{VA}(\alpha, r)$ to this program is implicitly given by the first-order condition:

$$\left(\frac{\alpha}{1-\alpha}\right) \frac{U'(q^{VA}(\alpha,r))}{C'(q^{VA}(\alpha,r))} = \frac{\Delta U(\alpha,r)}{\Delta C(\alpha,r)} \tag{3}$$

where we use the notation:

$$\Delta U(\alpha, r) \equiv U(q^{VA}(\alpha,r)) - \overline{U}(r) \qquad \text{and} \qquad \Delta C(\alpha, r) \equiv \overline{C}(r) - C(q^{VA}(\alpha,r))$$

3.3 Self-regulation stage

We have just seen that the firm and the regulator always settle for a VA in stage 2. Therefore, when choosing its unilateral commitment in the first stage, the firm seeks to minimize the cost of meeting the VA target:

$$\min_{r} \quad C(q^{VA}(\alpha,r)) \tag{4}$$

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[10]We discard alternating-offer bargaining procedures, as they do not parameterize the *Pareto*-frontier in our model, whereas the Nash solution does. Alternating-offers bargaining is not ex-ante optimal in terms of risk-sharing, given the concavity of the utility functions in q and the absence of monetary transfers.

where $q^{VA}(\alpha, r)$ is implicitly defined by (3). We use superscript 1 to denote the solution to this program.

We are now in a position to establish a central result. If the firm undertakes self-regulatory activities in equilibrium ($r^1 > 0$), we necessarily have $C(q^{VA}(\alpha, 0)) > C(q^{VA}(\alpha, r^1))$ and thus $q^{VA}(\alpha, 0)) > q^{VA}(\alpha, r^1)$. That is, the VA abatement level falls with self-regulation. This implies that $U\left(q^{VA}(\alpha, 0)\right) > U\left(q^{VA}(\alpha, r^1)\right)$, as U is an increasing function below q^*. We then identify in the Appendix the conditions under which self-regulation actually occurs in equilibrium by solving the firm's optimization program (4). This is summarized in Proposition 1.

Proposition 1 *When the regulator negotiates a VA:*

1. *The firm's strictly positive self-regulatory efforts in equilibrium ($r^1 > 0$) reduce the regulator's payoff.*

2. *Let α denote the regulator's bargaining power. There exists a unique value $\hat{\alpha} \in (0,1)$ such that the firm undertakes self-regulatory abatement ($q^* > r^1 > 0$) if and only if $\alpha > \hat{\alpha}$.*

   Proof. See Appendix A. ∎

The immediate intuition of part 1 of the Proposition is simple. If self-regulation emerges in equilibrium, this necessarily implies less VA abatement (otherwise the firm would not self-regulate). Social welfare then declines as less abatement means that the gap with the first-best abatement level q^* widens.

How then might self-regulation reduce q^{VA}? It does off course not directly influence the VA target, but rather affects the legislative threat which drives the VA. Lemma 1 notes that self-regulation reduces the legislative probability p, which is good news from the firm's perspective. However, it also increases abatement in the event with probability $1 - p$ where legislation is not adopted (as the firm abates a quantity r), which is bad news.

These two opposite factors explain why it is not always profitable for the firm to self-regulate, as noted in the second part of proposition 1. The effect of bargaining power is then very intuitive: with limited bargaining power on the public authority's side ($\alpha \leq \hat{\alpha}$), the firm has no interest in preempting regulation since it will appropriate a high fraction of the surplus in the voluntary agreement. On the contrary, facing a tough negotiator ($\alpha > \hat{\alpha}$), the firm prefers to reduce the stakes in the upcoming negotiations, as greater unilateral abatement makes the regulator more lenient.

Proposition 1 suggests that bargaining power might have an ambiguous effect on social welfare: on the one hand, higher α helps the regulator to obtain a stricter VA target; on the other hand, greater bargaining power increases self-regulatory abatement, which reduces regulator utility. In fact, the former effect outweighs the latter:

Lemma 3 *In equilibrium, VA abatement increases with the regulator's bargaining power. Therefore, the regulator is always better off with greater bargaining power.*

Proof. See Appendix A. ∎

We can now discuss the policy implications of the results obtained so far. We have seen that self-regulation and VAs are not good complements, as self-regulation weakens the VA abatement level. How can we solve this problem? Two policy solutions come to mind. The first consists in prohibiting self-regulatory activities while the regulator continues to use VAs. This is clearly not feasible in a market economy.[11] The second option is to prohibit the regulator from making VAs, which is legally more feasible. Note that this *ex ante* rule must be binding, as opting for a VA in Stage 2 always improves the utility of both the regulator and firms. To explore this solution, we now analyze a policy game without VAs.

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[11] Although public authorities can to an extent find ways of discouraging these activities.

4 A game without VAs

We now simply eliminate the second stage of the game. As we have already characterized the legislative subgame equilibrium in Lemma 1, we only need to analyze the first stage when the polluter commits to self-regulation.

4.1 Self-regulation stage

Let r^2 denote the equilibrium level of self-regulation of abatement in this scenario. The firm minimizes its expected cost of abatement under legislation:[12]

$$\min_r \ \overline{C}(r) = p(r)C(q^*) + (1 - p(r))C(r) \tag{5}$$

We then establish that

Proposition 2 *In the absence of VAs, the firm always commits to self-regulatory activities ($r^2 > 0$).*

Proof. At $r = 0$, we have:

$$\overline{C}'(0) = p'(0)C(q^*) < 0$$

Hence, the minimum r^2 is strictly positive. ∎

The firm systematically prefers to preempt legislation, whereas in the previous case self-regulatory activities occurred only when the regulator's bargaining position was strong. Why does this come about? Lemma 1 noted that self-regulation reduces the probability of legislation, p. This does not necessarily mean that the regulator is worse off than without self-regulation. In fact, for any given level of self-regulatory abatement r, the regulator's expected utility in the regulation game is

$$\overline{U}(r) = p(r)U(q^*) + (1 - p(r))U(r) - \gamma(p(r))$$

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[12]Note that this expected cost is exactly $\overline{C}(r)$, the reservation utility in the VA.

and the effect of r can be seen via differentiation:

$$\overline{U}'(r) = p'(r)\left[U(q^*) - U(r) - \gamma'(p(r))\right] + (1 - p(r))U'(r) \tag{6}$$

This expression shows that self-regulation has an ambiguous effect on social welfare: on the one hand, it lowers p, which reduces efficiency; on the other hand, it reduces γ and increases $U(r)$, which increases efficiency. However, we know from Lemma 1 that the regulator's choice of regulatory efforts in stage 3 comes from setting the marginal cost of increasing p equal to the marginal benefit: $\gamma'(p) = U(q^*) - U(r)$. Substituting this condition into (6) yields $\overline{U}'(r) = (1 - p(r))U'(r)$, which is positive ($U'(r) > 0$, as $r < q^*$). We thus obtain a result which, again, differs sharply from that in the base model:

Proposition 3 *In the absence of VAs, self-regulation is socially beneficial as the regulator's payoff increases with self-regulatory activity.*

Another way of explaining this intuition is to consider the legislative probability $p(0)$ that the regulator would select in the absence of self-regulation. If this were the same as that chosen under positive self-regulatory efforts, the regulator's payoff would be strictly higher: legislation would be adopted with the same probability; costs would be the same; but if the legislation fails, the regulator's payoff will be higher, given the positive level of self-regulation. Unlike the scenario with VAs, there is no drawback to self-regulation.

4.2 Prohibiting VAs?

We have just seen that, in the absence of VAs, the firm systematically undertakes desirable self-regulatory activities. Does this then justify the prohibition of VAs? We here compare the outcomes of the two policy games. For simplicity, we will consider the rule to be exogenous.[13] That is, it was set in the past and is now binding (recall that the regulator is always willing to make a VA in Stage 2).

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[13]Or constitutional in contract-theory parlance. We could alternatively endogenize the rule by assuming that it was proposed by the regulator and then adopted with a probability p contingent on the regulator's

We first focus on the particular case where the regulator has no bargaining power: $\alpha = 0$. In the VA scenario, the regulator's participation constraint (1) is binding, $U(q^{VA}) = \overline{U}(r)$, so that the VA arising in equilibrium satisfies

$$U(q^{VA}) = p(r^1)U(q^*) + (1 - p(r^1))U(r^1) - \gamma(p(r^1))$$

Hence, from the regulator's perspective, the VA and legislation are payoff-equivalent.

In the scenario without VAs, the regulator's equilibrium utility is similar:

$$\overline{U}(r^2) = p(r^2)U(q^*) + (1 - p(r^2))U(r^2) - \gamma(p(r^2))$$

The only difference lies in the level of self-regulatory abatement. In this regard, Proposition 1 states that $r^1 = 0$ when $\alpha = 0$, while Proposition 2 states $r^2 > 0$. As more self-regulation improves the social welfare of legislation (Proposition 3), we can conclude that prohibiting VAs would improve welfare in this case.

Turning now to the other extreme case, $\alpha = 1$, we have

$$C(q^{VA}) = p(r^1)C(q^*) + (1 - p(r^1))C(r^1)$$

with $r^1 > 0$. The VA and legislation are now cost-equivalent for the firm. One consequence is that the self-regulatory abatement level is identical under legislation and the VA ($r^1 = r^2$). Furthermore, the regulator's participation constraint is not binding, so that

$$U(q^{VA}) > p(r^1)U(q^*) + (1 - p(r^1))U(r^1) - \gamma(p(r^1))$$

As $r^1 = r^2$, the right-hand side of this inequality is also equilibrium utility under legislation. The use of VAs now benefits the regulator.

In the intermediate case, $\alpha \in (0, 1)$, Lemma 3 tells us that social welfare under the VA increases with α while it obviously has no effect in the scenario without VAs. Hence, there

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efforts. This would add stages to the beginning of the policy game, but without fundamentally changing the result. The cost - benefit analysis of the rule would be modified by including the regulator's effort to have the rule adopted in Congress.
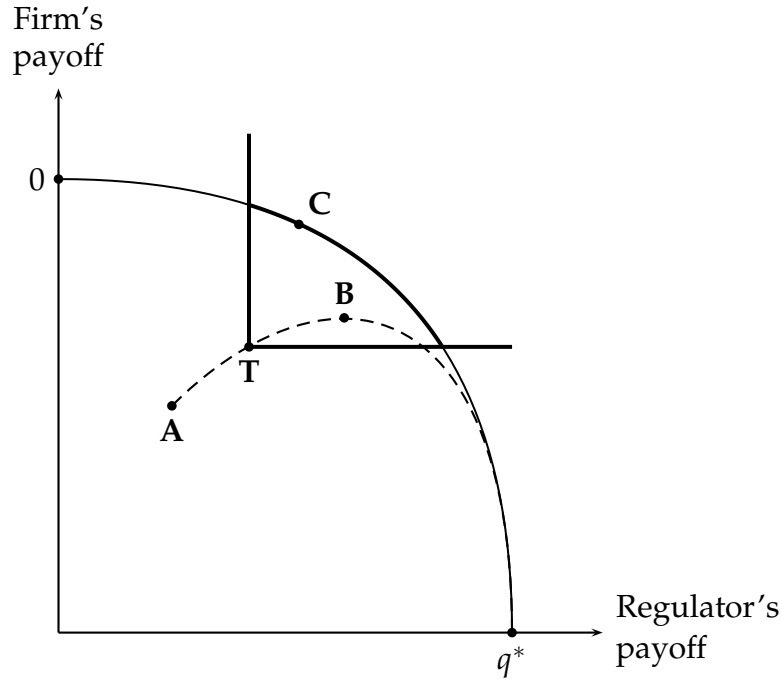
Figure 1: Equilibrium payoffs with and without a VA

is a unique threshold value of α such that the prohibition of VAs increases social welfare below this threshold and reduces it above. We summarize these findings in:

Proposition 4 *There exists a unique value of the regulator's bargaining power $\tilde{\alpha} \in (0,1)$ such that prohibiting the use of VAs improves (reduces) social welfare if $\alpha \leq \tilde{\alpha}$ ($\alpha > \tilde{\alpha}$).*

4.3 A graphical summary

Before turning to various extensions of the model, we should summarize our results so far. Figure 1 offers a full overview of the various regulatory alternatives. Point A corresponds to a case in which only regulation would be used, and the firm does not self-regulate. In this case, $r = 0$, and the regulator controls via the effort expended the lottery between $q = 0$ if regulation fails, and $q = q^*$ if regulation is successfully implemented.

The dashed line is the locus of payoff pairs as the level of self-regulation varies from $r = 0$ (point A) to $r = q^*$. Point B corresponds to the equilibrium in the scenario with-

out VAs. It is clear that from A to B, any increase in r is a Pareto-improvement. There-fore, the firm takes self-regulatory actions to reach point B, and self-regulation is welfare-improving (Proposition 3).

The thick line on the Pareto-frontier is the locus of feasible VAs. The two thick lines starting at T represent the participation constraint of the regulator (the vertical line) and that of the firm (the horizontal line). Point T is the threat point in the VA when the firm has chosen some (equilibrium) level of self-regulation in the first period. The payoffs at this status-quo option of the VA bargaining are the expected payoffs in the case where the legislative process is launched. Point C on the frontier corresponds to the point reached for some bargaining level $0 < \alpha < 1$. Two extreme cases are worth mentioning: if $\alpha = 1$ then, for any level of self-regulation the bargaining outcome is on the horizontal line, and the firm will therefore choose the same r as in the case without a VA. At the other extreme, the bargaining outcome is on the vertical line, and the firm has no incentive to engage in self-regulation, so that $r = 0$ in equilibrium. The equilibrium C shown iqwn the figure corresponds to a situation in which $\alpha < \hat{\alpha}$, and the regulator would be better off at point B (Proposition 4).

5   Influencing legislative action

The legislative dimension of the model is quite straightforward. We believe that there are two critical assumptions. First, political distortions concern only p and not the quota level (recall that the first-best quota q^* is implemented whenever legislation is enacted). Second, the regulator can influence the probability of adoption p whereas the firm(s) can-not. In other words, the firm is not able to lobby Congress. In this section, we relax these two assumptions in turn.

5.1 Influencing the level of the quota

In the first model variant the regulator can influence the *level* of the legislative quota. We will show below that our results no longer hold in this revised setting, so that they hinge crucially upon the assumption that the regulator affects the probability of adoption.

Formally, we suppose that Congress' ideal legislative quota is q^C, which is different from the social optimum. Congress can be more environmentally friendly than the regulator ($q^C > q^*$) or less so ($q^C \leq^*$).

The regulator can exert effort δ to shift the quota from q^C. As to the relationship between δ and the quota L, we assume that δ is U-shaped with a minimum at q^C, convex ($\delta'' > 0$) and $\delta'(q^C) = 0$. We also assume that Congress' ideal quota will be adopted if the regulator exerts no effort ($\delta(q^C) = 0$). We finally assume for simplicity that $p = 1$.

We first consider the legislative stage. The regulator selects the quota L so as to maximize

$$U(L) - \delta(L) \text{ s.t. } U(L) - \delta(L) > U(r)$$

The legislative quota contingent on r is thus

$$L(r) = \begin{cases} \hat{q} \text{ such that } U'(\hat{q}) = \delta'(\hat{q}), \text{ if } U(r) < U(\hat{q}) - \delta(\hat{q}) \\ 0, \text{ otherwise} \end{cases} \tag{7}$$

This expression is critical. Compared to the base model, the preemption effect is much more clear-cut: either r is lower than a threshold defined by the condition $U(r) \geq U(\hat{q}) - \delta(\hat{q})$ and self-regulation has no effect on the legislative quota that is finally adopted, or self-regulation leads to the suspension of legislative action ($L = 0$) if r is higher.

Turning next to the VA stage, the two individual rationality constraints are:

$$U(q^{VA}) \geq U(L) - \delta(L)$$
$$C(q^{VA}) \leq C(L)$$

The similarity to (1) and (2) immediately implies that the two parties always make a VA which saves the legislative cost $\delta(L)$.

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Turning now to the self-regulation stage, we show that:

Lemma 4 *When the policy sequence includes a VA, CSR never emerges in equilibrium ($r^1 = 0$).*

Proof. To preempt the VA with $r^1 > 0$, we must have $U(r^1) > U(q^{VA})$. Otherwise, the regulator makes a VA. But this also means that $C(r^1) > C(q^{VA})$: preempting is costly to the firm. As a result, we always have $r^1 = 0$. $\blacksquare$

This result contrasts with Proposition 1 where the firm will self-regulate in stage 1 if the regulator's bargaining power is sufficiently high. The intuition is as follows. Self-regulation is now very close to a VA as it suspends legislation. The only difference is that the regulator has zero bargaining power. As a result, Stage 2 may be viewed as the renegotiation of the self-regulation commitment. Self-regulation in Stage 1 is therefore useless to the firm.

What happens in the scenario without the VA? In the first stage, the firm sets its level of self-regulation by minimizing $C(r)$ under the constraint that $C(r) < C(L)$. Given (7), we easily establish the following:

Lemma 5 *When the policy sequence does not include a VA, there are always self-regulatory activities in equilibrium ($r^2 > 0$). This prevents legislation. For the regulator, the presence of self-regulation is neutral as its utility always equals $U(\hat{q}) - \delta(\hat{q})$.*

Proof. Consider first that $L = \hat{q} \Leftrightarrow U(\hat{q}) - \delta(\hat{q}) > U(r)$. In this case, the firm selects r^2 so that $U(r^2) = U(\hat{q}) - \delta(\hat{q}) + \varepsilon$, where ε is small and negligible. In the case where $L = 0$, the firm selects r^2 so that $U(r^2) = U(\hat{q}) - \delta(\hat{q})$. The firm is better off in the latter case. In equilibrium, we thus have $L = 0$ and $U(r^2) = U(\hat{q}) - \delta(\hat{q})$, implying that social welfare is the same with and without self-regulation. $\blacksquare$

The intuition behind this lemma is as follows. As highlighted above, self-regulation is now equivalent to a VA where the firm has all the bargaining power. The firm then always

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opts for self-regulation as, due to the influence cost δ, the regulator is ready to (implicitly) accept a level of self-regulation which is lower than that with legislation. Moreover, moving first allows the firm to reap the entire benefit so that both options are utility equivalent for the regulator.

We summarize this analysis in the following:

Proposition 5 *When the regulator influences only the level of the quota, self-regulation does not affect social welfare. In particular,*

1. *When the policy sequence includes a VA, self-regulation never emerges in equilibrium.*

2. *When the policy sequence does not include a VA, self-regulation always emerges in equilibrium and this prevents the adoption of legislation ($L = 0$), but social welfare is the same as that under legislation.*

This proposition has two implications for robustness. First, it shows that the results of the base model hinge decisively on the assumption that the regulator affects the adoption probability of legislation. They no longer hold when political imperfections only affect the strictness of the quota. Second, the assumption that the regulator influences quota strictness does not produce results that contradict our previous analysis. If both dimensions of influence are present at the same time, then our results carry through.

5.2 Lobbying by the firm

In the second model variant, we assume that the firm competes with the regulator to affect the adoption probability. Just like the regulator, the firm exerts effort to convince legislators that the proposed law is not adequate. Let β denote the firm's expenditure on influence. In order to be able to derive results, we need to specify the relationship between influence expenditure and the adoption probability, p. In this respect, we adopt

the unit logit function:

$$p(\gamma, \beta) = \frac{\gamma}{\gamma + \beta} \tag{8}$$

where γ is the regulator's influence cost. The functional form (8) is the contest success function pioneered by Tullock (1980), which is often used in rent-seeking models.[14] Note that, under these assumptions, the regulator still makes a proposition including the socially-optimal quota q^*. We now analyze the impact of lobbying when the policy sequence involves a VA.

At the legislative stage, the firm minimizes $p(\gamma, \beta)C(q^*) + [1 - p(\gamma, \beta)]\, C(r) + \beta$. This function is concave in γ: $(\partial^2 p / \partial \gamma^2)\, (\gamma, \beta)[C(q^*) - C(r)] < 0$. It is moreover decreasing at $\beta = 0$ since $(\partial p / \partial \gamma)\, (\gamma, 0)[C(q^*) - C(r)] < 0$. Hence, the private optimum is given by the FOC:

$$-\frac{\gamma \Delta C(r)}{(\gamma + \beta)^2} = -1 \tag{9}$$

Similarly, the regulator's minimization program leads to

$$\frac{\beta \Delta U(r)}{(\gamma + \beta)^2} = 1 \tag{10}$$

Combining (9) and (10), the equilibrium probability of passing the legislation in the lobbying game is therefore:

$$p(r) = \frac{\Delta U(r)}{\Delta U(r) + \Delta C(r)}$$

It is then easily shown that Lemma 1's preemption effect continues to operate, as

$$p'(r) = \frac{C'(r)\Delta U(r) - U'(r)\Delta C(r)}{[\Delta U(r) + \Delta C(r)]^2}$$

is negative,[15] and the equilibrium probability p has the same qualitative features as in the original setting. As a consequence:

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[14]The exact functional form is unimportant here. Other contest-success functions yield probabilities of legislation with the same qualitative properties.

[15]From $U'' < 0$ it follows that $\Delta U(r) > U'(r)[q^* - r]$. Hence, $p'(r) < U'(r)\frac{C'(r)[q^* - r] - \Delta C(r)}{[\Delta U(r) + \Delta C(r)]^2}$. Furthermore, $C'' > 0$ implies $C'(r)[q^* - r] < \Delta C(r)$. Therefore, $p'(r) < 0$.

Proposition 6 *When the firm can lobby Congress, the results of the base model remain valid.*

Proof. See Appendix A. ∎

This result is relatively unsurprising. There is no reason why the relationship between the regulator's cost of influence γ and p should be particularly strongly affected by firms carrying out lobbying activities.

6 Conclusion

We have developed a policy game in which the regulator needs to exert effort in order to have its optimal regulation adopted by Parliament. The regulator needs to prepare the case, gather evidence to convince legislators that the regulation will improve social welfare, and so on. In this context, the time and resources devoted to the regulation of a given industry will depend on how important it is to the regulator. In other words, the incentives to prepare a case are *endogenously determined by how much the new Law will improve on the status-quo situation*. This implies that unilateral (preemptive) self-regulation can be used by firms to diminish the regulator's incentives to incur legislative costs.

Against this background, we show that self-regulation improves social welfare when the regulator opts for the legislative route. However, it reduces welfare when the regulator tries to make a VA before legislation. The general intuition is that self-regulation reduces the threat of regulation and improves the firm's bargaining position in the VA. Crucially, these results are valid only when the regulator's efforts increase the probability of passing legislation. In contrast, self-regulation does not affect social welfare when the regulator exerts effort to affect the quota level.

The above findings suggest that self-regulation and VAs might not be good complements. As it is impossible to prevent self-regulatory activities in a market economy, it might be wondered whether prohibiting VAs constitutionally would solve the problem.

We show that this ultimately depends upon the allocation of bargaining power between the regulator and the firm. When the regulator enjoys a strong bargaining position, the negative impact of self-regulation on VAs is smaller than the welfare gains potentially achieved by a VA as compared to legislation. This means that, in this case, prohibiting VAs would be socially inefficient. However, the reverse holds for a weak regulator.

A Appendix: Proofs

A.1 Proof of Proposition 1

Program (4) is equivalent to min_r $q^{VA}(\alpha, r)$. We solve the latter program as follows: 1) We compute $\partial q^{VA}/\partial r$ when $r = 0$; 2) We show that $\partial q^{VA}(\alpha, 0)/\partial r$ falls with α over the interval $[0, 1]$; 3) We show that $\partial q^{VA}(0, 0)/\partial r > 0$, meaning that $r^1 = 0$ when $\alpha = 0$; and 4) We show that $\partial q^{VA}(1, 0)/\partial r < 0$, meaning that there exists $\alpha^1 < 1$ such that $r^1 > 0$ for $\alpha > \alpha^1$.

1) Differentiating (3) and rearranging leads to

$$\frac{\partial q^{VA}}{\partial r} = \frac{\Delta C(\alpha, r)(1 - p(r))U'(r) + \Delta U(\alpha, r)\left[p'(r)(C(q^*) - C(r)) + (1 - p(r))C'(r)\right]}{U'(q^{VA})\Delta C(\alpha, r) + \Delta U(\alpha, r)C'(q^{VA}) - \alpha\Delta C(\alpha, r)\frac{U''(q^{VA})C'(q^{VA}) - U'(q^{VA})C''(q^{VA})}{(1-\alpha)\left[C'(q^{VA})\right]^2}}$$

The denominator is strictly positive as $U', \Delta C(\alpha, r), \Delta U, C' > 0$ and $U'' < 0$. Hence, it suffices to consider the sign of the numerator. Let Ω denote this expression in the particular case where $r = 0$. We have

$$\Omega(\alpha) = \Delta C(\alpha, 0)(1 - p(0))U'(0) + \Delta U(\alpha, 0)p'(0)C(q^*)$$

2) We differentiate Ω with respect to α:

$$\Omega'(\alpha) = \frac{\partial q^{VA}}{\partial \alpha}\left[-C'(\alpha, 0)(1 - p(0))U'(0) + U'(\alpha, 0)p'(0)C(q^*)\right]$$

The term in brackets is negative. Also, $\partial q^{VA}/\partial \alpha q_\alpha^{VA} > 0$. This is shown by differentiating (3):

$$\frac{\partial q^{VA}}{\partial \alpha} = \frac{U'\Delta C + C'\Delta U}{U'C' - \alpha U''\Delta C + (1 - \alpha)C''\Delta U} > 0 \tag{11}$$

where all of the functions are evaluated at (α, r). The fact that this expression is positive is easily established by remarking that any solution to the bargaining program should be such that $q^{VA}(\alpha, r) < q^*$, the delta functions are positive, and U and C are respectively concave and convex.

Hence $\partial q^{VA}(\alpha, 0)/\partial r$ falls with α over the interval $[0, 1]$.

3) When $\alpha = 0$, $\Delta U = 0$ so that $\Omega(0) = \Delta C(0,0)(1 - p(0))U'(0) > 0$. Thus $q^{VA}(0,0)/\partial r > 0$.

4) When $\alpha = 1$, $\Delta C = 0$ and thus $\Omega(1) = \Delta U(\alpha,0)p'(0)C(q^*) < 0$.

A.2 Proof of Lemma 3

Let $r^1(\alpha)$ denote the equilibrium level of self-regulation contingent on α. We have:

$$\frac{dq^{VA}(\alpha, r^1(\alpha))}{d\alpha} = \frac{\partial q^{VA}(\alpha, r^1(\alpha))}{\partial \alpha} + \frac{\partial r^1(\alpha)}{\partial \alpha} \frac{\partial q^{VA}(\alpha, r^1(\alpha))}{\partial r} \tag{12}$$

Then, differentiating (3) with respect to α and rearranging, we obtain:

$$\frac{\partial q^{VA}}{\partial \alpha} = \frac{U'\Delta C + C'\Delta U}{U'C' - \alpha U''\Delta C + (1 - \alpha)C''\Delta U}$$

where all of the functions are evaluated at (α, r). This derivative is positive, as any solution to the bargaining program should be such that $q^{VA}(\alpha, r) < q^*$, the delta functions are positive, and U and C are respectively concave and convex.

Furthermore, Proposition 1 tells us that $r^1 = 0$ if $\alpha \leq \hat{\alpha}$, and thus $\partial r^1(\alpha)/\partial \alpha = 0$. This implies that $dq^{VA}/d\alpha = \partial q^{VA}/\partial \alpha > 0$. If $\alpha > \alpha^1$, r^1 satisfies $\partial q^{VA}(\alpha, r^1(\alpha))/\partial r > 0$. Once again, $dq^{VA}/d\alpha = \partial q^{VA}/\partial \alpha > 0$.

A.3 Proof of Proposition 6

We first consider the policy sequence with the VA. Moving backwards to the VA stage, the two individual rationality constraints are:

$$U(q^{VA}) \geq \overline{U}(r)$$
$$C(q^{VA}) \leq \overline{C}(r) + \beta(r)$$

These are similar to (1) and (2) except that signing a VA provides the firm with the additional benefit of avoiding $\beta(r)$. Hence, the firm's incentives to make an agreement are greater than before and Lemma 2 still holds.

Part 1 of proposition 1, which says that any positive self-regulatory effort reduces social welfare, obviously continues to hold since this result follows directly from the general property that C is strictly increasing.

We now turn to the existence of self-regulation in equilibrium. In the base model, proposition 1 says that this depends on the bargaining power parameter α. This is still true here. For the sake of simplicity, we restrict the analysis below to the two extreme cases $\alpha = 0$ and $\alpha = 1$:

- When $\alpha = 0$, the equilibrium VA is defined by $U(q^{VA}) = \overline{U}(r)$. As $\overline{U}'(r) > 0$ (see Lemma 3), q^{VA} increases with r as well. Hence, the firm has no interest in undertaking self-regulatory activities ($r^1 = 0$).

- When $\alpha = 1$, the VA is such that $C(q^{VA}) = \overline{C}(r) + \beta(r)$. As $\overline{C}'(0) < 0$ and $\beta'(0) < 0$, we necessarily have $r^1 > 0$.

The same line of reasoning allows us to fully extend Proposition 1.

We now consider the policy sequence without VAs. In Stage 1, the firm selects r^1 which minimizes $\overline{C}(r) + \beta(r)$. Combining (9) and (10) yields β as a function of r:

$$\beta(r) = \frac{\Delta C(r)[\Delta U(r)]^2}{[\Delta U(r) + \Delta C(r)]^2}$$

Substituting $p(r)$ in this function yields $\beta(r) = \Delta C(r)p(r)^2$. Hence,

$$\overline{C}(r) + \beta(r) = p(r)C(q^*) + (1 - p(r))C(r) + \Delta C(r)p(r)^2$$

We then compute

$$\overline{C}'(0) + \beta'(0) = p'(0)\Delta C(r)\left[1 + 2p(r)\right]$$

which is obviously negative as $p' < 0$. We deduce $r^2 > 0$ (Proposition 2).

In order to establish that self-regulation improves social welfare (Proposition 3), we first differentiate $\overline{U}$

$$\overline{U}'(r) = \left(\frac{\partial p}{\partial \gamma}\gamma'(r) + \frac{\partial p}{\partial \beta}\beta'(r)\right)\Delta U(r) + (1 - p(r))U'(r) - \gamma'(r)$$

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Substituting in for $\gamma'(r)$, and plugging in (9) and (10) yields

$$
\begin{aligned}
\overline{U}'(r) \;=\; & \left(\frac{\partial p}{\partial \beta}\right) \beta'(r)\Delta U(r) + (1 - p(r))U'(r) \\
& -\beta'(r)\frac{\Delta U(r)}{\Delta C(r)} + (1 - p)U'(r)
\end{aligned}
$$

which is strictly positive, as $\beta'(r) = 2p'(r)\Delta C(r)p(r) - C'(r)p(r)^2 < 0$. Hence, $\overline{U}$ increases with the level of self-regulation.

References

Arora, S., Gangopadhyay, S., 1995. Toward a theoretical model of voluntary overcompliance, Journal of Economic Behavior and Organization 28, 289-309.

Baron, D.P. 2008. Managerial contracting and corporate social responsibility, Journal of Public Economics, 92, 268-288.

Besley, T., Ghatak M., 2007. Retailing public goods: the economics of corporate social responsibility, Journal of Public Economics, 91, 1645-1663.

Brekke, K., Nyborg, K., 2004. Moral hazard and moral motivation: Corporate social responsibility as labor market screening, Mimeo, Department of Economics, University of Oslo.

Denicolo, V., 2008. A Signaling Model of Environmental Overcompliance, Journal of Economic Behavior & Organization 68, 293-303.

Fisman, R., Heal, G., Nair, V., 2006. A Model of Corporate Philanthropy, mimeo Columbia Business School.

Glachant, M., 2005. Voluntary Agreements in a Rent Seeking Environment, in E. Croci (Ed.) Handbook of Environmental Voluntary Agreements, Dordrecht, Holland, Kluwer Academic Publishers, 49-67.

Glachant, M., 2007. Non-binding Voluntary Agreements, Journal of Environmental Economics and Management 54, 32-48.

Heyes, A., 2005. A Signaling-motive for Self-regulation in the Shadow of Coercion, Journal of Business and Economics 57, 238-246.

Lyon, T., Maxwell, J., 2003. Self-regulation, taxation and public voluntary environmental agreements, Journal of Public Economics 87, 1453-1486.

Lyon, T., Maxwell, J., 2008. Corporate Social Responsibility and the Environment: A Theoretical Perspective, Review of Environmental Economics and Policy 1, 1-22.

Lutz, S., Lyon, T., Maxwell, J., 2000. Quality Leadership When Regulatory Standards Are Forthcoming, Journal of Industrial Economics 48, 331-348.

Maxwell, J., Decker, C., 2006. Voluntary Environmental Investment and Responsive Regulation, Environmental and Resource Economics 33, 425-439.

Maxwell, J., Lyon, T., Hackett, S., 2000. Self-regulation and social welfare: the political economy of corporate environmentalism, Journal of Law and Economics 43, 583-617.

Manzini, P., Mariotti, M., 2003. A bargaining model of voluntary environmental agreements, Journal of Public Economics 87, 2725–2736.

Segerson, K., Miceli, T., 1998. Voluntary Environmental Agreements: Good or Bad News for Environmental Protection? Journal of Environmental Economics and Management 36, 109-130.

Segerson, K., Wu, J., 2006. Non-point pollution control: Inducing first-best outcomes through the use of threats, Journal of Environmental Economics and Management 51, 165-184.

Tullock G. (1980) Efficient rent seeking, in Towards and Theory of the Rent Seeking Society, eds J.M. Buchanan, R. Tollison, and G. Tullock, Texas A&M Press, pp 269-282.

B Appendix: An extension with several firms

The base model with one firm misses out on one important issue: legislation is not firm-specific, and applies to a number of firms, if not all firms in a given industry, while self-regulation is a firm-level decision. Consequently, if one firm self-regulates, this reduces the probability of legislation for other firms. Since the political benefit of self-regulation is thus collective, whereas the cost is private, there are obvious free-riding concerns. In this section we extend the model to a setting with n identical firms which choose self-regulation non-cooperatively. We will see below that this does not affect the results from the single-firm model regarding the preemption effect of self-regulation and its consequences.

B.1 A Game with VA

Following Manzini and Mariotti (2003), we assume that *all* firms have to participate in the VA, otherwise legislation is triggered.[16] This allows us to compare our results to theirs. Assuming a quorum of less than 100% would introduce a form of attrition in participation, but would not drastically change the results. More complicated optimal VA designs are outside of the scope of this Appendix. From a purely descriptive point of view, full participation is particularly relevant as VAs are most often implemented at the branch level: this is almost always the case in Europe and Japan. Although this does not totally eliminate the incentive to free-ride, the central role of branch associations in the negotiation and implementation of the agreement does mitigate the problem. This is arguably less true with respect to US Public Voluntary Programs, which are based on the individual participation of companies. Even so, the presence of a public authority necessarily implies the stronger integration of individual firm behavior in policy-setting,

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[16]This setting shares some features with non-point pollution, in which firms are made collectively responsible: see Segerson and Wu (2006).

as compared to purely decentralized self-regulatory policies.

Given firm symmetry, total optimal abatement will be nq^*, where q^* is the optimal uniform quota for the regulator. Firms are indexed by i and their self-regulatory activity levels are denoted by r_i. We use the following definition:

$$R \equiv \sum_i r_i$$

In the final (legislative) stage, the regulator chooses p to maximize

$$pU(nq^*) + (1-p)U(R) - \gamma(p)$$

which defines $p(R)$ implicitly through the first-order condition

$$U(nq^*) - U(R) = \gamma'(p) \tag{13}$$

The properties of $p(R)$ are therefore the same as those with one single firm: it is decreasing and convex.

For the sake of brevity we now focus on the two extreme cases of bargaining power,[17] $\alpha = 0$ and $\alpha = 1$.

Firm bargaining power ($\alpha = 0$)   Under unanimous VA, the regulator obtains its reservation utility (since $\alpha = 0$), and firms' payoffs should be such that they all participate. There clearly exists a level q^{VA} which satisfies all firms' participation constraints: the regulator is ready to accept a laxer policy than the legislation, as this saves the regulatory cost γ. Therefore, the regulator's participation constraint determines the equilibrium VA:

$$U(nq^{VA}) = p(R)U(nq^*) + (1-p(R))U(R) - \gamma(p(R)) \tag{14}$$

Finally, in the first stage, firm j chooses its self-regulation level. By differentiating (14) with respect to r_j, which is defined for any collection $\{r_i\}$, and by using the envelope

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[17]Another modeling option would be two-stage negotiation, as in Manzini and Mariotti (2003), with firms collectively choosing an offer to make in a subsequent alternating-offer bargaining game against the regulator.

theorem, we have:

$$nU'(nq^{VA})\frac{\partial q^{VA}}{\partial r_j} = (1-p(R))U'(R) > 0$$

which implies $\partial q^{VA}/\partial r_j > 0$. Therefore firms do not commit to self-regulation when $\alpha = 0$, just as they did not in the base model.

Regulator bargaining power ($\alpha = 1$) We now turn to the other extreme case. The analysis here is a little more complicated as, at the VA stage, a set of constraints – and not just one single one – characterizes the VA. Under unanimous VAs, *all* of the following firm participation constraints must hold:

$$C(q^{VA}) \leq p(R)C(q^*) + (1-p(R))C(r_i) \qquad \text{with } i = 1,..n \qquad (15)$$

Note that if some firm i chooses $r_i \geq q^{VA}$ in the first stage, its participation constraint is immediately satisfied. But as self-regulation is assumed to be a perfect commitment, the firm needs to abate the quantity r_i. As a result its cost is $C(r_i)$ which is greater than $C(q^{VA})$. Obviously, this cannot hold in equilibrium.

A key observation in the following analysis is that among the constraints (15), the only binding ones correspond to the lowest self-regulation levels. We therefore divide the firms into two groups:

$$\mathbb{L} = \{l \in \{1..n\}|r_l = \min_i r_i\} \quad \text{and} \quad \mathbb{M} = \{m \in \{1..n\}|r_m > \min_i r_i\}$$

We refer to group $\mathbb{L}$ as the laggards, and generically use r_l to denote their self-regulatory activity. In a unanimous VA, we necessarily have:

$$C(q^{VA}) = p(R)C(q^*) + (1-p(R))C(r_l) \qquad (16)$$

Intuitively this is so because laggard firms are those which lose less under the legislative route, as their abatement efforts are limited in the event that the Law is not passed. This resembles the 'toughest firm principle' in Manzini and Mariotti (2003). But while in

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their paper asymmetry between firms is given, it is here endogenous as it results from endogenously-determined self-regulatory activities. Regarding the shape of the putative equilibria, we note the following:

Lemma 6 *Provided it exists, in any equilibrium there is exactly one laggard firm which exerts a strictly positive self-regulatory effort, and all other firms choose the same level of self-regulation equal to the forthcoming VA level. Formally:*

$$\mathbb{L} = \{l\}, \ \mathbb{M} = \{1..n\} \backslash \{l\}$$

$$0 < r_l < r_m = q^{VA} \quad \forall \, m \in \mathbb{M}$$

Proof. To prove the first assertion, assume by contradiction that $\mathbb{L}$ contains at least two firms in equilibrium. Then if one of the laggards unilaterally increases its self-regulation by some small $\varepsilon > 0$, the VA still emerges as the participation constraint of the other laggard still holds. Hence the cost for the deviating laggard under deviation is now:

$$C(q^{VA}) = p(R + \varepsilon)C(q^*) + (1 - p(R + \varepsilon))C(r_l)$$

which is smaller than the cost before deviation $p(R)C(q^*) + (1 - p(R))C(r_l)$ as p is a decreasing function. Therefore there is exactly one laggard in any equilibrium.

The laggard exerts a strictly positive self-regulatory effort as the derivative at $r_l = 0$ of its cost is

$$\frac{\partial C(q^{VA})}{\partial r_l} \bigg|_{r_l = 0} = p'(R)C(q^*) < 0.$$

Turning next to the other firms, by the same reasoning, any firm m which is not a laggard will want to increase self-regulation when $r_m < q^{VA}$: this is a strict best-reply as it only reduces the legislative probability, and thus the equilibrium VA level in (16). This is true up to $r_m = q^{VA}$. Going further ($r_m > q^{VA}$) would cost $C(r_m)$ which is greater than $C(q^{VA})$. As a result, for any firm i in $\mathbb{M}$, $r_m = q^{VA}$ has to hold in equilibrium. ∎

We now establish the existence of a VA in equilibrium. From Proposition (6) it follows directly that the equilibrium VA satisfies the following two equations:

$$p'(r_l + (n-1)q^{VA})(C(q^*) - C(r_l)) + (1 - p(r_l + (n-1)q^{VA}))C'(r_l) = 0 \quad (17)$$

$$C(q^{VA}) = p(r_l + (n-1)q^{VA})C(q^*) + (1 - p(r_l + (n-1)q^{VA}))C(r_l) \quad (18)$$

where (17) is the first-order condition for the laggard's level of self-regulation, and (18) states that the other firms commit at the self-regulation stage to abate exactly the amount that will be prescribed by the VA. We show below that this system of equations always has a unique solution. The following can thus be stated:

Lemma 7 *There exists an essentially unique equilibrium (i.e. up to the identity of firms) when $\alpha = 1$. This is characterized by (17) and (18).*

Proof. See the end of this Appendix. ∎

We now sum up the results obtained so far. We have shown that firms do not undertake self-regulatory activities when $\alpha = 0$, while they all do so when $\alpha = 1$. Any positive self-regulatory effort reduces social welfare as it is associated with a lower VA abatement level q^{VA}. These results are identical to those derived in the base model with a single firm. Does this then imply that prohibiting VAs is still a useful policy when the regulator's bargaining power is low, as established in Proposition 4 for the base model? We now consider the policy sequence without the VA.

B.2 Legislation only

In the absence of a VA, the regulator's effort is still determined by (13). It is therefore clear that any positive effort of self-regulation ($R > 0$) increases the regulator's utility as in the base model, as

$$\overline{U}'(R) = p'(R)\left[U(nq^*) - U(R) - \gamma'(p(R))\right] + (1 - p(R))U'(R)$$

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is positive given (13).

In the first stage, the firms play a self-regulation subgame with payoffs

$$\overline{C}_i(\{r_i\}) = p(R)C(q^*) + (1 - p(R))C(r_j)$$

This subgame is solved in the following lemma:

Lemma 8 *There exists a unique symmetric equilibrium with self-regulation level $r^3 > 0$, which is decreasing in n. Furthermore, $0 < r_l < r^3 < q^{VA}$.*

Proof. The first and second derivatives of the expected costs of firm j with respect to r_j are:

$$
\begin{aligned}
\frac{\partial \overline{C}_j}{\partial r_j} &= p'(R)(C(q^*) - C(r_j)) + C'(r_j)(1 - p(R)) \\
\frac{\partial^2 \overline{C}_j}{\partial r_j^2} &= p''(R)(C(q^*) - C(r_j)) - 2C'(r_j)p'(R) + C''(r_j)(1 - p(R))
\end{aligned}
$$

As in Proposition 2, $p'' > 0$ given $\gamma''' \geq 0$. Thus $\overline{C}_j(\{r_i\})$ is strictly convex in r_j. The level of self-regulation is thus given by the first-order condition, and, again as in Proposition 2, $r_j > 0$.

Now, consider two firms j and k in equilibrium. By combining the two corresponding FOCs, we obtain:

$$p'(R)(C(r_j) - C(r_k)) = (1 - p(R))(C'(r_j) - C'(r_k))$$

As $p' < 0$, and C and C' are increasing functions, the only solution is $r_j = r_k$ for any pair (j, k). This proves that any equilibrium is symmetric.

Now let r^3 be the (uniform) equilibrium level of self-regulation. This satisfies the FOC, so that:

$$p'(nr^3)(C(q^*) - C(r^3)) = -(1 - p(nr^3))C'(r^3)$$

Using Lemma 10 at the end of this Appendix, we establish that there is a unique equilibrium level of self-regulation. The inequalities follow directly from the proof of the previous proposition. ∎

This result directly parallels that in the one-firm case. The only difference is that firms free ride on self-regulation. As they do not internalize the positive effect they have on others by raising their self-regulatory activity, the proposition implies that firms invest less in self-regulation than they would were they to act cooperatively.[18] Both the regulator and the firms would be better off under cooperation. Self-regulation would be higher, which is beneficial to the regulator, as established previously. The firms would also benefit from a reduced regulation risk premium which, by revealed preference, would more than offset the loss due to self-regulatory investment.

B.3 Prohibiting VAs

As in the one-firm case, it is plain to see that prohibiting VAs increases social welfare when the regulator's bargaining power is zero. Firms do not undertake self-regulatory activities in this case, and the VA is equivalent to legislation for the regulator. In contrast, firms commit to some self-regulatory abatement $r^3 > 0$ when VAs are not allowed, and this improves welfare in the legislative option.

When the regulator has all of the bargaining power, the welfare comparison is less straightforward. However, we show that:

Lemma 9 *When $\alpha = 1$, the level of self-regulation is higher with a VA than under legislation only.*

Proof. We first establish two useful facts.

$$\frac{d}{dr}\left(\frac{C'(r)}{C(q^*) - C(r)}\right) = \frac{C''(r)(C(q^*) - C(r)) + C'(r)^2}{(C(q^*) - C(r))^2} > 0$$

which indicates that $C'(r)/(C(q^*) - C(r))$ is an increasing function of r, and

$$\frac{d}{dR}\left(\frac{-p'(R)}{1 - p(R)}\right) = \frac{-p''(R)(1 - p(R)) - p'(R)^2}{(1 - p(R))^2} < 0$$

---

[18]The proof of this claim is trivial, and comes from comparing the result of Proposition 2 with $C \equiv nC$ to those in Proposition 8.

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since p is convex, as we have already seen. Therefore $-p'(R)/(1-p(R))$ is a decreasing function of R.

From the previous analysis, we know that the level of self-regulatory abatement in the case of regulation only is given by the first-order condition:

$$\frac{C'(r^3)}{C(q^*)-C(r^3)} = \frac{-p'(nr^3)}{1-p(nr^3)}$$

while in the case of a VA, i.e. in the laggard equilibrium, from (17) it follows that:

$$\frac{C'(r_l)}{C(q^*)-C(r_l)} = \frac{-p'(r_l+(n-1)q^{VA})}{1-p(r_l+(n-1)q^{VA})}$$

Since $r_l < r^3$ from Proposition 7, the LHS's are increasing functions and the RHS's are decreasing functions, we conclude that $r_l + (n-1)q^{VA} > nr^3$. ∎

This allows us to compare social welfare. When a VA is allowed, the regulator obtains strictly more than if she initiates the legislative process (recall that $\alpha = 1$). In addition, the level of abatement already granted is higher than if no VA were allowed. Carrying out a VA improves welfare.

We summarize these developments as follows:

Proposition 7 *When $\alpha = 0$, prohibiting VAs is socially desirable, while it is not if $\alpha = 1$.*

As a consequence, extending the model to n firms which can free ride at the self-regulation stage does not alter our results. In fact, our last result becomes even stronger if we consider *collective* self-regulation. Some sectors indeed define their rules-of-conduct at the branch level. It is worth remarking that there are incentives for such behavior in our model, since there is free-riding at the first-stage of the game over the level of self-regulation: the firms do not internalize the positive externality they have on others by reducing the regulatory threat. This free-riding is damaging for them, but also for the regulator since we have shown that more self-regulation is always beneficial in the absence of VAs.

In turn, the coordination of firms should be avoided when VAs are used. We have seen that at the (non-cooperative) equilibrium there is a laggard firm whose level of self-regulation determines the future strictness of the VA. If firms were allowed to coordinate, they would reach an agreement by which one of them would exert no self-regulatory effort at all, producing an even lower level of abatement in the subsequent VA. The conclusion to be drawn here is that it is better for the regulator to use a divide-and-conquer approach in negotiating VAs, and not deal with firms that have previously coordinated. This suggests interesting directions for future research in the design of the optimal VA, both in terms of the quorum in the VA and the regulator's negotiation strategies.

B.4 Proof of Lemma 7

We begin by proving a lemma that will be useful in the following.

Lemma 10 *There exists a unique $r \in (0, q^*)$ such that*

$$p'(nr)(C(q^*) - C(r)) + (1 - p(nr))C'(r) = 0.$$

Proof. The LHS is an increasing function of r since its derivative is

$$np''(nr)(C(q^*) - C(r)) - (n+1)p'(nr)C'(r) + (1 - p(nr))C''(r) > 0$$

This is equal to $p'(0)C(q^*) < 0$ when $r = 0$, and to $C'(q^*) > 0$ when $r = q^*$. The desired result follows. ∎

The equilibria that we want to construct correspond to the intersections of the graphs of (17) and (18) in the (r_l, q^{VA}) plane. We will prove 1-2) that each equation defines q^{VA} as a (continuous) function of r_l, 3) that the corresponding curves intersect, implying that equilibrium exists, and 4) that they intersect exactly once. The conditions of the laggard equilibrium described in lemma 6 will be presented together with the proof.

1) Consider first (17). Let $F(q^{VA}, r_l)$ be its LHS. This is a strictly increasing function of q^{VA} since $\partial F / \partial q^{VA} = (n-1)p''(r_l + (n-1)q^{VA})(C(q^*) - C(r_l)) - p'(r_l + (n-1)q^{VA})C'(r_l) > 0$, and it is also an increasing function of r_l, by the convexity of p and C.

We require that $p'(nq^*) = 0$. By differentiating the first-order condition defining p with respect to nq^* we obtain $\gamma''(p(r))p'(r) = -U'(r)$. Since $\gamma'' > 0$ and $U'(nq^*) = 0$ by assumption, $p'(nq^*) = 0$. This implies that, for any $r_l \leq q^*$, there exists q^{VA} such that $F(q^{VA}, r_l)$ is positive. Namely, it is sufficient to take q^{VA} such that $(n-1)q^{VA} + r_l = nq^*$, since then $F(q^{VA}, r_l) = C'(r_l)$.

From the preceding lemma, let r be the unique solution of $F(r, r) = 0$. Since F is increasing in its second argument, $F(r, s) < F(r, r) = 0$ for any $s < r$. Therefore, for any $r_l < r$, there exists $q^{VA} > r_l$ such that $F(q^{VA}, r_l)$ is negative. Overall, since F is continuous, for any $r_l \leq r$, there always exists a q^{VA} satisfying (17), and this is unique since F is increasing in q^{VA}. Let $q_1(r_l)$ denote the corresponding implicit function which is continuously differentiable by the regularity of F.

2) Now consider (18). Since $0 \leq p(R) \leq 1$, and the LHS is a convex combination of $C(r_l)$ and $C(q^*)$, there exists a solution q^{VA} such that $r_l \leq q^{VA} < q^*$ for all $r_l < q^*$. Moreover, the LHS rises with q^{VA}, while the RHS falls with q^{VA}, so that the solution is unique. This allows us to express q^{VA} as a function of r_l for (18) as well. We denote by $q_2(r_l)$ this function, which is also continuously differentiable.

3) From these previous results, we know that $q_1(0) = n/(n-1)q^*$, while $C(q_2(0)) = p((n-1)q_2(0))C(q^*)$, which implies $q_1(0) > q_2(0)$. Also, $q_1(r) = r$, while $q_2(r) > r$. Since both functions are continuous, there exists $r_l \in (0, r)$ such that $q_1(r_l) = q_2(r_l) > r_l$. This guarantees equilibrium existence.

4) Finally, from (17) we obtain by differentiation:

$$(n-1)\left[p''(R)(C(q^*) - C(r_l)) - p'(R)C'(r_l) \right] q_1'(r_l) =$$
$$- p''(R)(C(q^*) - C(r_l)) - (1 - p(R))C''(r_l) + 2p'(R)C'(r_l)$$

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in which the coefficient of q'_1 is positive and the RHS is negative. Thus q_1 is a decreasing function.

In turn, by differentiating (18), we obtain:

$$\left[C'(q_2(r_l)) - (n-1)p'(R)(C(q^*) - C(r_l))\right] q'_2(r_l) = F(q_2(r_l), r_l)$$

Consider any intersection of the curves q_1 and q_2 (i.e. $q_1(r_l) = q_2(r_l)$). The coefficient of q'_2 is strictly positive, and the RHS is equal to zero as $F(q_2(r_l), r_l) = F(q_1(r_l), r_l) = 0$. Therefore $q'_2(r_l) = 0$. As $q'_1 < 0$, the two curves cannot be tangent to each other, and the graph of q_2 necessarily crosses that of q_1. But for any r_l such that $q_2(r_l) > q_1(r_l)$, we have $F(q_2(r_l), r_l) > 0$ and thus q_2 is increasing for any r_l on the right-hand side of the intersection. On the other hand, as q_1 is always decreasing, there can only be one intersection. This proves that the equilibrium is essentially unique up to the identity of the laggard.