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Voluntary Agreements and Private Enforcement of Environmental Regulation

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Abstract

This paper focuses on a type of voluntary pollution abatement agreement (VA) in which the regulator offers regulatory relief for the participating firm in exchange for environmental improvements. If the regulator does not have statutory authority to provide regulatory relief, the VA can leave the firm more vulnerable to legal challenges through citizen lawsuits. I use a model of negotiated VAs to examine the impact of citizen enforcement on the likelihood of an agreement and on the outcome of a VA. The results indicate that both the probabilities of enforcement by the regulatory agency and of private enforcement through a citizen lawsuit affect the likelihood of a VA and the level of abatement when an agreement is reached. A VA can result in higher abatement and net social benefits than regulation if the probability of private enforcement and accompanying costs are high and the probability of agency enforcement is low.

JEL Codes: Q53, Q58

1. Introduction

During the previous two decades policy makers have increasingly relied on Voluntary Agreements (VAs) to improve environmental quality as a complement to both conventional command-and-control regulation and market-based alternatives such as pollution fees or tradable permits (Alberini and Segerson 2002; Glachant 2007; Dawson and Segerson 2008; McEvoy and Stranlund 2010). This shift has come about for a variety of reasons.

First, there is growing recognition of the inflexibility of traditional standard-based regulation and increasing doubts about its effectiveness. At the same time, regulators have recognized the difficulty and cost of designing and implementing incentive-based instruments for large numbers of sources (Khanna 2001). Second, regulatory enforcement is notoriously difficult for a variety of reasons, as documented by a large body of literature (see Heyes 2000 for a review). The Environmental Protection Agency (EPA) is tasked with implementing an increasingly complex body of legislation in an environment characterized by a large number of polluters and growing political resistance to regulation. Furthermore, technological change has rendered pollution abatement equipment increasingly sophisticated and costly. This in turn has generated incentives for regulated firms to further oppose regulatory enforcement, making it more costly and difficult (Lyon and Maxwell 2004). Finally, these mounting enforcement challenges have been accompanied by shrinking real budgets and enforcement staffing levels for the EPA (Lyon and Maxwell 2004, Gray and Shimshack 2011). The combination of these factors led the EPA to promote the use of VAs starting in the early 1990s as an attempt to lower regulatory costs and overcome increasing difficulties in implementing existing environmental laws (Lyon and Maxwell 2004).

VAs promise to address these concerns through potential cost savings due to increased flexibility, better cooperation between regulators and polluters, and improved environmental outcomes. However, critics fear that the voluntary nature of the agreements and the fact that they are mostly not enforceable can translate into decreased pollution abatement effort. There is also concern that, by focusing on the firms most willing to participate and hence to abate pollution, VAs can shift the focus of regulators away from more problematic polluters (Alberini and Segerson 2002; Glachant 2007).

VAs can take different forms, but a common underlying characteristic is that firms offer to improve their environmental performance without an explicit legal obligation while the regulator corresponds by offering rewards such as public recognition, technical assistance, or regulatory relief. The most common types of VAs are public voluntary programs and negotiated agreements. In a public voluntary program the regulator sets both the requirements and the rewards of the program, and firms can choose whether to participate or not. In a negotiated agreement, abatement targets and rewards are determined by negotiation between the regulator and the firm.[1]

In this paper I focus on a type of negotiated agreement in which the regulator offers regulatory relief for the participating firm in exchange for environmental improvements. Specifically, as part of the VA the regulator commits to giving up "letter of the law" compliance with an existing environmental statute in return for environmental performance exceeding what traditional regulation, constrained by practical and budgetary limitations in enforcement, is expected to produce. For instance, participating firms may be allowed flexibility in developing pollution abatement strategies in lieu of existing regulatory requisites, even if these strategies

[1] A third type of voluntary arrangements usually mentioned in this context is a unilateral commitment, in which a polluter develops initiatives without any regulatory involvement. Given their unilateral nature, it is not clear that they can be considered a voluntary "agreement."

lead to noncompliance with a narrowly defined statutory requirement. This may be acceptable to the regulatory agency if costs and practical or political limitations constrain its ability to monitor individual polluters' compliance with the regulatory standard or to pursue violations.[2] Under these circumstances, such alternative abatement strategies may lead to better environmental outcomes than can be expected from imperfect regulatory enforcement. The closest example to this type of agreement is Project XL, introduced in 1995, in which the Environmental Protection Agency (EPA) waved existing regulatory requirements for participating firms in return for these firms achieving "superior environmental performance" (Marcus et al. 2005).

An important caveat in such an arrangement arises when the regulator does not have explicit statutory authority to provide this kind of regulatory relief. In this case, the VA can leave the firm more vulnerable to legal challenges by environmental advocacy groups, who seek to ensure compliance with statutory requirements through citizen lawsuits (Mank 1998; Delmas and Mazurek 2004). [3] This is a key characteristic of the institutional context of negotiated VAs, which can have important consequences for the viability of these programs and the environmental outcomes they yield.[4] In fact, the possibility of citizen enforcement may help explain the relative lack of popularity of these programs in the U.S. (Khanna 2001). [5] For instance, great expectations were built around Project XL, which was billed as a prototype for a

[2] A recent review of trends in enforcement indicators suggests that EPA budgets and staffing levels have declined (in real terms) over time, and that only a fraction of regulated entities are subject to compliance monitoring or to penalties when noncompliant (Gray and Shimshack 2011).

[3] The regulator may offer regulatory relief despite lacking the authority to do so because a private lawsuit is not certain and because the resulting abatement level may nevertheless yield a higher net benefit than what can be expected from imperfect enforcement.

[4] This is generally not relevant for public voluntary programs to the extent that they are not legally binding and usually offer public recognition or technical assistance rather than regulatory relief, hence shielding the EPA and firms from legal action (Lyon and Maxwell 2004). However, citizen enforcement and the issues raised here for negotiated agreements would apply to public voluntary programs as well if they offered polluters a waiver from regulatory enforcement.

[5] Although opportunities for involvement of private groups in environmental enforcement are increasing in Europe, citizen suit cases remain relatively infrequent because many national legal systems have traditionally restricted standing for environmental nongovernmental organizations (Kelemen 2006).

new approach to environmental regulation and as the flagship of the EPA's regulatory reinvention initiative. Yet, Project XL failed to elicit significant interest from regulated firms and in general fell short of policy makers' expectations. The threat of citizen lawsuits is often cited, without a formal argument, as one of the main causes for this lack of success (Boyd et al. 1998; Mank 1998; Caldart and Ashford 1999; Blackman and Mazurek 2001; Marcus et al. 2002; Lyon and Maxwell 2004).

I use a model of negotiated VAs to examine the impact of citizen enforcement on the likelihood of an agreement and on the outcome of a VA. I build on the framework developed by Segerson and Miceli (1998) and introduce random compliance to allow for the possibility that alternative pollution abatement strategies agreed to as part of a VA may lead to regulatory noncompliance by the participating firm. I assume that the regulator agrees not to enforce the regulation, and that as a result an environmental advocacy group may file a citizen suit when a participant in a VA is noncompliant. I derive conditions for a VA to be an equilibrium outcome of the interaction between the firm and the regulator, conditional on the possibility of citizen enforcement. Then I use a Nash bargaining framework to characterize the abatement level that results when an agreement is reached, as well as to examine how the probabilities of agency enforcement and citizen enforcement affect the outcome of a VA.

Introducing private enforcement into the model changes some key results from the received literature. I find that both the probabilities of enforcement by the regulatory agency and of private enforcement through a citizen lawsuit affect the likelihood of a VA, as well as the level of abatement when an agreement is reached. In contrast to the result in the standard model (Segerson and Miceli 1998), an agreement is not necessarily reached for any positive probability of agency enforcement, and a higher probability of agency enforcement does not necessarily

increase the abatement level. This is the case only when the probability of a citizen suit in the absence of an agreement is low enough. Finally, I show that the abatement level and the net social benefits resulting from a VA exceed the abatement effort and net benefits attainable from compliance with the regulatory standard if the probability of enforcement is low enough, the expected cost from a citizen suit is high enough, and the bargaining power of the firm is low enough.

In the next section I provide background on citizen suits and review the literature. In section 3, I introduce the basic setup of the model. Section 4 identifies conditions for the existence of an agreement, and section 5 examines the effect of agency enforcement and private enforcement on the outcome of a VA. Finally, I discuss the results and conclude in section 6.

2. Background

2.1 Private Enforcement

In the United States citizen suits are authorized under all major federal environmental laws, including the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act. When permit or statutory violations are not pursued by the Environmental Protection Agency (EPA) or state regulatory authorities, private parties may initiate civil proceedings directly against the polluting firm or against the regulator to compel an enforcement action. Citizen suits are relatively common: Naysnerski and Tietenberg (1992) reported over 1200 cases between 1978 and 1987, Smith (2004) found 287 cases between 1995 and 2000, and a recent exhaustive search of the PACER (Public Access to Court Electronic Records) database yielded 7800 lawsuits between 1973 and 2011.

A key aspect of private enforcement is that a citizen suit is preempted if the EPA or the state regulator are “diligently prosecuting” a violation. Statutes require the private plaintiffs to

notify the EPA, the state authority, and the alleged violator 60 days prior to filing a suit. The citizen suit can be officially filed in a district court only if, after this notice-of-intent period expires, the regulator has not commenced enforcement actions (Thompson 2000). [6]

The costs of private enforcement to sued facilities are often considerable. Successful suits may require the violator to pay substantial fines to the US treasury and comply with costly action-based consent decrees. Even when cases settle before reaching court the resulting legal fees, settlement terms, and consent decree remediation payments can add up to substantial costs (Smith 2004).

2.2 Literature

The increasing reliance on voluntary approaches has been accompanied by a growing literature in economics, which has examined various aspects surrounding VAs and their performance, both theoretically and empirically (for comprehensive reviews see Khanna 2001; Alberini and Segerson 2002; and Lyon and Maxwell 2008). Recent papers focusing on negotiated agreements have built on the seminal work of Segerson and Miceli (1998) to examine bargaining with several firms (Manzini and Mariotti 2003), non-enforceability of VAs (Glachant 2007), costly enforcement of VAs (McEvoy and Stranlund 2010), and the relationship between VAs and self-regulation (Fleckinger and Glachant 2011).

Some of the literature on voluntary pollution abatement has accounted for the role of environmental advocacy groups through boycotts (Maxwell et al. 2000; Sinclair-Desgagne and Gozlan 2003; Innes 2006; Lyon and Maxwell 2011) or endorsements (Heyes and Maxwell 2004). However, although several studies acknowledge that participation in a VA may increase the risk of citizen lawsuits (Marcus et al. 2002; Delmas and Mazurek 2004; Lyon and Maxwell 2004), the role of citizen enforcement through lawsuits has not yet been analyzed.

[6] An agency decision not to prosecute, no matter how well founded, will not bar a citizen suit.

There is also a growing literature that examines the role of private lawsuits in environmental enforcement. A number of papers examine the efficiency of citizen suits (Naysnerski and Tietenberg 1992; Baik and Shogren 1994; Heyes 1997; Heyes and Rickman 1999), whereas others analyze the implications of private enforcement for self-reporting of compliance status (Langpap 2008) and the interaction between private enforcement and agency enforcement (Langpap 2007; Langpap and Shimshack 2010). By considering the possibility that participants in a VA may be sued by an environmental advocacy group and assessing the implications of private enforcement for the likelihood of reaching an agreement and for the outcome of a VA, this paper makes a contribution to these two strands of literature. It also contributes to the broader literatures on voluntary pollution control and environmental enforcement.

3. Model

The model captures the interaction between a polluting firm, a regulator, and a private environmental advocacy group. Costs and other constraints imply that the regulator's enforcement is imperfect in the sense that noncompliance with an emissions standard cannot always be discovered and penalized. Hence, the regulator and the firm negotiate a voluntary pollution abatement agreement. The regulator agrees not to enforce the standard and allows the firm to develop alternative pollution control strategies in return for environmental performance exceeding what traditional regulation is expected to bring. However, I assume the regulator does not have statutory authority to waive enforcement of the law as part of the VA.

3.1 The Firm

The firm's level of abatement for the regulated pollutant is denoted a. I assume that emissions are random with a stochastic component ε, which is uniformly distributed over the range $[-\theta, \theta]$

(Mrozek and Keeler 2004). Emissions can be random for a variety of reasons, including stochastic events such as malfunctions of pollution control equipment or variations in the quality of inputs (Beavis and Walker 1983). In the context of the agreements examined in this paper, randomness can also be caused by the inherent uncertainty in the outcome of the alternative pollution control strategies allowed by the VA.

The maximum level of emissions, corresponding to no abatement ($a = 0$), is $\bar{e}$. Expected emissions are $E[e] = \bar{e} - a$, and actual emissions are $e = \bar{e} - a + \varepsilon$. The emissions standard set exogenously by the regulatory statute is *S*. The firm is in compliance if $\bar{e} - a + \varepsilon \leq S$; that is, if emissions do not exceed the standard. Since emissions are stochastic, so is the firm's compliance status. However, the firm can affect the probability of compliance through changes in the level of abatement. The probability of compliance for a given abatement level *a* is given by

$$G(a) \equiv \Pr(\bar{e} - a + \varepsilon \leq S) = \Pr(\varepsilon \leq S - \bar{e} + a) = \int_{-\theta}^{S-\bar{e}+a} \frac{1}{2\theta} d\varepsilon = \frac{S - \bar{e} + a + \theta}{2\theta} \qquad (1)$$

which implies $G'(a) > 0$ and $G''(a) = 0$. When the abatement level negotiated in a VA does not result in compliance ($e > S$) the regulator, as agreed, does not enforce the standard. In this case, the firm may be sued by the environmental group.[7]

3.2 The Environmental Group

VAs in the U.S. typically exclude environmental advocacy groups. Private groups may require greater abatement than the regulator, so firms have little incentive to include them in negotiations. Additionally, different groups may have diverse objectives, which may cause free-rider or coordination problems. Furthermore, non-participating groups are not bound by the terms of an agreement. Firms may consequently not trust the outcome of agreements reached

[7] Note that the abatement level *a* is observable, and thus the regulator can verify whether the firm follows through on the negotiated agreement. The focus here is on the conditions that lead to a VA and on the resulting abatement levels. Hence I assume that the firm complies with the conditions of the agreement. This is consistent with the behavior of firms who enter this type of VAs in practice.

with a negotiator that does not broadly represent environmental group interests (Lyon and Maxwell 2004). Therefore, I assume that the private group does not participate directly in the VA process and that its role is limited to reacting to the agreed upon level of abatement. Specifically, the private group may use the courts to enforce the environmental statute by filing a citizen suit if the firm is not in compliance and the regulator does not pursue the violation.[8] Litigation is costly for the private group, and the outcome of a suit is uncertain. Hence, a successful citizen suit takes place with a probability less than one. To model the legal contest that determines this probability I follow Baik and Shogren (1994), Heyes (1997), and Langpap (2007) and use a simple lottery auction framework. Within this framework, the probability of winning a suit depends on the relative expenditures of the two parties. Specifically, assume that when the firm is sued it spends an amount d in legal defense expenditures in an attempt to win the case. If it loses, it has to pay a civil penalty of p. This penalty, which is exogenously set by the court, is bounded by the assets of the firm or by what the court considers reasonable and is not paid to the private group, but instead to the US Treasury (Fadil 1985). The total cost of a citizen suit to the firm is given by $F = p + d$.[9]

The private group spends an amount l in litigation expenditures in an attempt to win the case. Given that civil penalties are not paid to the private group, I assume that the benefit U it derives if it wins the suit takes the form of added publicity and a boost in membership and donations. In addition to both parties' expenditures, the probability of winning the lawsuit

[8] An alternative modeling approach would allow the private group to participate in the negotiation of the VA. All else equal, the abatement level resulting from the VA would be higher, since the private group would negotiate for more abatement. On the other hand, one can imagine that if there is an agreement and a VA is the equilibrium outcome of the negotiation between the regulator, the firm, and the environmental group, the threat of a lawsuit given a VA would disappear. Firms could only be sued in the absence of an agreement. Thus this is a different way of incorporating private group participation in a VA. Given that the focus here is on the threat of a suit when there is a VA, this alternative is left for further research.

[9] To keep the contest model tractable, I have abstracted from the possibility that the private group may receive reimbursement for its legal expenditures if it wins the suit. See Baik and Shogren (1994) for a discussion of the efficiency properties of reimbursement rules.

depends on the firm's emissions (normalized by its emissions capacity). Specifically, the probability that the private group wins the legal contest is given by $\left(e/\overline{e}\right)\left[l/(l+d)\right] \in [0,1]$. Hence, for given legal expenditures, the probability of winning the suit is larger the higher the firm's emissions.

Given this probability, the private group chooses its litigation expenditure to maximize its expected net payoffs:

$$Max_l \quad \frac{e}{\overline{e}}\frac{l}{l+d}(U-l)-\left(1-\frac{e}{\overline{e}}\frac{l}{l+d}\right)l. \tag{2}$$

The corresponding first-order condition yields the private group's reaction function:

$$l(d)=\left(\frac{e}{\overline{e}}Ud\right)^{\frac{1}{2}}-d. \tag{3}$$

Similarly, the firm chooses its defense expenditures to minimize its expected costs:

$$Min_d \quad \frac{e}{\overline{e}}\frac{l}{l+d}(p+d)+\left(1-\frac{e}{\overline{e}}\frac{l}{l+d}\right)d. \tag{4}$$

The corresponding first-order condition can be solved to give the firm's reaction function:

$$l(d)=\left(\frac{e}{\overline{e}}Ud\right)^{\frac{1}{2}}-d. \tag{5}$$

Reaction functions (3) and (5) are used to derive the Nash equilibrium legal expenditures:

$$l^*=\frac{U^2p\left(e/\overline{e}\right)}{\left(U+p\right)^2};d^*=\frac{Up^2\left(e/\overline{e}\right)}{\left(U+p\right)^2},$$

which in turn give the probability of a successful citizen suit as a function of the firm's emissions for given benefit *U* and civil penalty *p*:

$$\pi(e)=\pi(e;U,p)=\frac{e}{\overline{e}}\frac{l^*}{l^*+d^*}=\frac{e}{\overline{e}}\frac{U}{U+p}. \tag{6}$$

with $\partial\pi(e)/\partial e > 0$. In what follows it will be useful to express this probability as a function of abatement rather than emissions. Given that $e = \bar{e} - a + \varepsilon$, we can write $\pi(a) = \pi(e(a))$, with

$$\pi'(a) = \frac{\partial \pi(e)}{\partial e}\frac{\partial e}{\partial a} < 0.$$

3.3 The Regulator

The environmental benefits generated by the abatement level a are given by the function $B(a)$, with $B'(a) > 0$, $B''(a) < 0$, and $B(0) = 0$. Abatement is costly to the firm, with costs given by $C(a) = ca$. Net social benefits from a given abatement level are given by $NSB(a) = B(a) - ca$. If the firm and the regulator fail to reach an agreement, the firm becomes part of the pool of polluters subject to traditional regulatory enforcement. The regulator enforces the law with probability $p \in (0,1)$ (see, for example, Kaplow and Shavell 1994; Mookherjee and Png 1994; Montero 2002) and the firm is required to implement a_S, the abatement level necessary to achieve a desired probability of compliance $G(a_S)$. If the regulator does not enforce the law, the environmental group sues with probability $\pi(a)$, and the firm faces cost F.[10] Hence, the firm chooses an abatement level a_0 to minimize abatement costs plus expected private enforcement penalties: $a_0 = \arg\min_a \{ca + (1 - G(a))\pi(a)F\}$.[11] To simplify notation let $\gamma = \pi(a_0)$, the probability of private enforcement when there is no agreement and no public enforcement. In the next section I use this setup to derive conditions under which the regulator and the firm reach an agreement.

4. Conditions for the Existence of a Voluntary Agreement

To establish conditions for which a VA is an equilibrium outcome, I start by examining the firm's and the regulator's payoffs.

[10] Because civil penalties and litigation costs in citizen suits cases are generally high, I assume that $F > ca_S$, that is, the cost from private enforcement exceed the compliance costs associated with agency enforcement.
[11] I assume that $a_0 < a_S$, since it is reasonable to expect that the firm will choose less abatement than required by regulation.

4.1 The Firm's Participation Decision

If the firm participates in a VA it agrees to abatement level a_V , with corresponding abatement cost ca_V .With probability $G(a_V) = \left(a_V + S - \bar{e} + \theta\right)/2\theta$ the firm is in compliance with the standard and is not sued by the environmental group. With probability $1 - G(a_V) = \left(\theta - a_V - S + \bar{e}\right)/2\theta$ the firm is not in compliance and may be sued, facing an expected cost of $\pi(a_V)F.$ The expected cost of participating in a VA is therefore given by $G(a_V)ca_V + \left(1 - G(a_V)\right)\left[\pi(a_V)(ca_V + F) + (1 - \pi(a_V))ca_V\right] = ca_V + \left(1 - G(a_V)\right)\pi(a_V)F$.

When the firm does not participate in a VA the regulator enforces the law with probability *p*. The firm must implement abatement level a_S with corresponding cost ca_S . With probability (1 – *p*) the regulator does not enforce, but the environmental group may sue. The firm chooses abatement level a_0. Hence the expected cost of not participating in a VA is given by $pca_S + (1-p)\left[ca_0 + \left(1 - G(a_0)\right)\gamma F\right].$

Given these expected costs, the firm participates in a VA if and only if $ca_V + \left(1 - G(a_V)\right)\pi(a_V)F \le pca_S + (1-p)\left[ca_0 + \left(1 - G(a_0)\right)\gamma F\right].$ The maximum abatement level the firm is willing to accept to participate is implicitly defined by

$$ca_V^{\max} + \left(1 - G(a_V^{\max})\right)\pi(a_V^{\max})F = pca_S + (1-p)\left[ca_0 + \left(1 - G(a_0)\right)\gamma F\right]. \qquad (7)$$

Expression (7) can be used to examine how the maximum level of abatement acceptable to the firm, and hence the likelihood that it is willing to participate in a VA, are affected by changes in the probability of agency enforcement and of a citizen suit in the absence of an agreement. I present the results in the following lemma (all proofs are available in an online appendix).

Lemma 1:

(i) The maximum abatement level acceptable to the firm is increasing in the probability of agency enforcement if the probability of a citizen suit when there is no VA is low enough: $\partial a_V^{\max} / \partial p > 0$ *if* $\gamma < c(a_S - a_0)/(1 - G(a_0))F$; $\partial a_V^{\max} / \partial p \leq 0$ *otherwise.*

(ii) The maximum abatement level acceptable to the firm is increasing in the probability that the firm is sued when there is no VA: $\partial a_V^{\max} / \partial \gamma > 0$.

To understand the intuition underlying the first part of this result, note that when γ is small a citizen suit is unlikely when the firm does not participate in a VA. If public enforcement is unlikely as well (*p* is small), the expected cost of not participating in a VA is low and the firm is only willing to accept low levels of abatement to participate. As *p* increases the cost of not participating goes up and the firm is willing to accept higher levels of abatement in a VA, so $a_V^{\max}$ increases with *p*. If γ is high, on the other hand, the cost of not participating decreases as *p* goes up because agency enforcement is more likely to preempt a more costly citizen suit. Hence the firm is willing to accept lower levels of abatement as part of a VA, and $a_V^{\max}$ decreases with *p*.

To understand the second part of the lemma, note that an increase in γ raises the cost of not participating for a given enforcement probability. The firm is therefore willing to accept a higher abatement level to participate, and hence $a_V^{\max}$ increases with γ.

4.2 The Regulator's Participation Decision

For the regulator the expected benefit of participating in a VA with abatement level a_V is $B(a_V)$. The resulting net social benefits are $B(a_V) - ca_V = NSB(a_V)$. If the regulator does not participate he enforces the regulation and mandates enforcement level a_S with probability *p*, which yields expected net benefit $p\left(B(a_S) - ca_S\right) = pNSB(a_S)$. With probability (1 – *p*) the regulator does not

enforce, and the firm chooses abatement level a_0. Therefore, the regulator participates in a VA if and only if $NSB(a_V) \geq pNSB(a_S) + (1-p)NSB(a_0)$ and the minimum level of abatement required by the regulator to participate in an agreement is implicitly defined by[12]

$$NSB(a_V^{\min}) = pNSB(a_S) + (1-p)NSB(a_0). \quad (8)$$

Using expression (8) it can be verified that the minimum level of abatement required by the regulator is increasing in the probability of agency enforcement and independent of the probability of a citizen suit when there is no VA.[13] A higher probability of enforcement increases the regulator's expected payoff from not participating in a VA. Hence, he demands more abatement from the firm to be willing to participate. On the other hand, the probability of a citizen suit in the absence of an agreement does not affect the regulator's payoff, and thus has no impact on the level of abatement he requires for participation in a VA.

4.3 Conditions for a VA

The firm's and the regulator's requirements for participation can now be used to establish when an agreement is reached. A VA is an equilibrium outcome if and only if $a_V^{\max} \geq a_V^{\min}$. Since the maximum and minimum acceptable abatement levels depend on the probabilities of enforcement and of a citizen suit, p and γ determine whether the two parties reach an agreement. I examine the effect of each probability separately while keeping the other constant. For a fixed γ, I obtain the following result.

Proposition 1: *For a given probability of private enforcement γ, a VA is an equilibrium outcome if and only if the probability of enforcement is low enough: $a_V^{\max} \geq a_V^{\min}$ if and only if $p \leq \overline{p}$.*

[12] Equation (8) also defines a maximum level of abatement the regulator is willing to accept (see Segerson and Miceli 1998), but the relevant bound for this analysis is the lower one, $a_V^{\min}$.

[13] It is straightforward to see that $\partial a_V^{\min} / \partial p = \left[NSB(a_S) - NSB(a_0) \right] / NSB'(a_V^{\min}) > 0$ since by construction $NSB(\cdot)$ is increasing at $a_V^{\min}$, and that $\partial a_V^{\min} / \partial \gamma = 0$.

This result is shown in Figure 1. In contrast to the model without citizen suits, where a VA is the outcome for any positive p, the firm and the regulator reach an agreement only when the likelihood of agency enforcement is sufficiently low.[14] To understand why introducing the possibility of a citizen suit changes the result, note that a positive $\pi(a)$ unambiguously increases the firm's expected cost of participating in a VA, but the effect on the cost of not participating depends on the probability of agency enforcement. If p is very high, agency enforcement is very likely when not participating and thus a citizen suit is possible (almost) only in a VA. The firm can reduce the likelihood of being sued and increase the probability of compliance by agreeing to higher levels of abatement. However, abatement is costly. Hence, the firm will be unwilling to agree to a level of abatement higher than a_S because, given a high probability of agency enforcement, this is what it can expect with near certainty if not participating. On the other hand, a high p increases the regulator's expected payoff from not participating, so he will require abatement levels of at least a_S to participate. Therefore, an agreement is unlikely. When p is very low, the chance of a citizen suit when not participating in a VA is higher. This raises the firm's expected cost of not participating and hence its willingness to accept higher abatement levels in a VA. For the regulator, a very low p means the expected payoff when not participating is lower, so he is willing to accept smaller levels of abatement to participate. Thus, a VA is more likely.

Next, I examine the effect of γ on the possibility of an agreement for a given probability of agency enforcement. I obtain the following result.

Proposition 2:

[14] It is easy to verify that if $\pi(a) = 0$, which corresponds to the model without citizen suits, $a_V^{\max} = a_S$ for $p = 1$, so $a_V^{\max} \geq a_V^{\min}$ for all $p > 0$ and a VA is the equilibrium outcome for any positive enforcement probability (as in Segerson and Miceli 1998).

Given a high enough probability of agency enforcement, a VA is the outcome if and only if the probability of a citizen suit when there is no agency enforcement is high enough. Otherwise, a VA is the outcome for any probability of a citizen suit: if $p > p^*, a_V^{\max} \geq a_V^{\min}$ *if and only if* $\gamma \geq \overline{\gamma}$*;* *for* $p \leq p^*, a_V^{\max} \geq a_V^{\min}$ *for all* $\gamma \in [0,1]$.

The threshold probability p^* is defined in the appendix. This result is illustrated in Figure 2. To understand the underlying intuition, consider first the case of a sufficiently low probability of enforcement ($p \leq p^*$). The regulator's expected payoff from not participating in a VA is low, and he is willing to accept low abatement levels to participate. When additionally the probability of a citizen suit γ is very low the maximum abatement acceptable to the firm is close to the abatement level expected from not participating ($a_V^{\max} \approx a_0$). The regulator is risk averse (given the concavity of the benefit function) and is thus willing to accept a lower abatement level ($a_V^{\min} < a_0$). Therefore, the firm and the regulator will reach an agreement when p is low and a citizen suit is unlikely. As γ increases the firm is willing to accept higher abatement levels in a VA (as shown in Lemma 1), hence $a_V^{\max}$ remains higher than $a_V^{\min}$ and a VA is the equilibrium outcome for any γ. For a higher probability of enforcement ($p > p^*$), the regulator's payoff from not participating in a VA goes up, so the minimum abatement required increases as well. At the same time, with a higher p a citizen suit outside of a VA becomes less likely, decreasing the firm's expected cost of not participating and thus reducing its maximum acceptable abatement. Hence, a sufficiently high γ is necessary to counteract this effect and ensure that $a_V^{\max} \geq a_V^{\min}$ and hence that a VA is the outcome.

To summarize, the results in propositions 1 and 2 suggest that when the probability of agency enforcement is low enough, a VA is the equilibrium outcome regardless of the

probability of a citizen suit. However, with a higher probability of enforcement a VA is the equilibrium outcome only when the probability of a citizen suit in the absence of enforcement is high enough. Finally, the regulator and the firm will not reach an agreement if the probability of enforcement is sufficiently high.

The key driver of these results is the relationship between the probabilities p and γ. A high probability of agency enforcement means that the regulator requires higher levels of abatement to enter into a VA. It also means that a citizen suit is likely to be preempted when there is no agreement, and hence that the possibility of a citizen suit has a greater impact on the firm's cost of participating than on its cost of not participating. This makes the firm less willing to participate, since the expected cost from a citizen suit is high. The firm is only willing to accept relatively low abatement levels, and hence an agreement is unlikely. A low probability of agency enforcement has the opposite effect. The regulator requires only modest abatement levels to participate in a VA. A citizen suit is not likely to be preempted by regulation, and increases in the probability of a citizen suit have a bigger impact on the firm's cost of not participating. The firm is thus willing to accept higher abatement levels in a VA, and an agreement is more likely.

5. Pollution Abatement in a Voluntary Agreement

5.1 Equilibrium Abatement Level

Having established the conditions for a VA, I examine the abatement level that results when an agreement is reached. Given that the abatement effort provided by the firm when it participates in a VA is the result of a bargaining process with the regulator, I use an asymmetric Nash bargaining framework to model the negotiation process (Langpap and Wu 2004; Fleckinger and Glachant 2011). The abatement level a_V is chosen to maximize the Nash criterion function

$$N(a_V) = \left[-ca_V - \left(1 - G(a_V)\right)\pi(a_V)F + pca_S + (1-p)\left(ca_0 + \left(1 - G(a_0)\right)\gamma F\right)\right]^{\alpha} \times$$

$$\left[NSB(a_V) - pNSB(a_S) - (1-p)NSB(a_0)\right]^{1-\alpha} \tag{9}$$

where $\alpha \in (0,1)$ represents the firm's bargaining power. The equilibrium abatement level a_V^N is implicitly defined by the corresponding first order condition:

$$(1-\alpha)NSB'(a_V^N)\left[ca_V^N + \left(1-G(a_V^N)\right)\pi(a_V^N)F - pca_S - (1-p)\left(ca_0 + \left(1-G(a_0)\right)\gamma F\right)\right] +$$

$$\alpha\left[c - G'(a_V^N)\pi(a_V^N)F + \left(1-G(a_V^N)\right)\pi'(a_V^N)F\right]\left[NSB(a_V) - pNSB(a_S) - (1-p)NSB(a_0)\right] = 0 \tag{10}$$

Condition (10) can be used to examine how the probabilities of agency enforcement and of a citizen lawsuit, costs, and the firm's bargaining power affect the abatement level resulting from a VA. The relationship between *p* and γ determines the minimum and maximum abatement levels acceptable to the firm and the regulator $(a_V^{\min}, a_V^{\max})$, which bind the solution to the Nash bargaining problem. Hence, the interaction between agency and private enforcement probabilities also affects the abatement level resulting from an agreement. This is summarized in the following result.

Proposition 3:

The level of abatement agreed to in a VA:

(i) Increases with the probability of agency enforcement if the probability of a citizen suit when there is no agreement is low enough: $\partial a_V^N / \partial p > 0$ *if* $\gamma < c(a_S - a_0)/\left(1-G(a_0)\right)F$;

(ii) Increases with the probability of a citizen suit: $\partial a_V^N / \partial \gamma > 0$;

(iii) Increases with the cost of a citizen suit if the probability of agency enforcement is low enough: $\partial a_V^N / \partial F > 0$ *if* $p < \left[\left(1-G(a_0)\right)\gamma - \left(1-G(a_V^N)\right)\pi(a_V^N)\right] / \left(1-G(a_0)\right)\gamma$;

(iv) Decreases with the bargaining power of the firm: $\partial a_V^N / \partial \alpha < 0$.

This proposition indicates that the level of abatement agreed upon in a VA increases when the probability of agency enforcement goes up, but only if the probability of citizen enforcement in the absence of an agreement is sufficiently low. This is in contrast to the result in a model that does not allow for the possibility of citizen suits, where abatement always increases with the threat of legislative enforcement (Segerson and Miceli 1998). The reason for this is that both $a_V^{\min}$ and $a_V^{\max}$ increase with the probability of agency enforcement when the probability of a citizen suit is low, and hence the agreed upon abatement level a_V^N increases as well. However, if the probability of a citizen suit is high, $a_V^{\max}$ decreases when *p* goes up. If this effect dominates, a higher probability of agency enforcement may lead to a lower level of abatement in a VA.

Similarly, the abatement level in a VA increases as the probability of a citizen suit goes up because $a_V^{\max}$ increases with γ, but $a_V^{\min}$ is not affected by this probability. An increase in the costs of a citizen suit to the firm leads to higher equilibrium abatement when the probability of agency enforcement is sufficiently low because otherwise a suit is more likely to be preempted in the absence of a VA, lowering the expected cost of not participating. Finally, given that abatement is costly higher bargaining power for the firm yields lower abatement levels in a VA.[15]

5.2 Comparing VAs with Regulatory Enforcement

Given that in negotiated agreements such as those modeled here the regulator gives up regulatory compliance in exchange for voluntary abatement, it is also relevant to examine how the agreed upon abatement level compares with the abatement required for compliance with statutory

[15] Note that a situation in which the regulator simply makes a take-it-or-leave-it offer to the firm, akin to a public voluntary program, corresponds to a special case in the model presented here in which the regulator has all the bargaining power, so that $\alpha = 0$ (Segerson and Miceli 1988). In this case the regulator is essentially maximizing his payoff (*NSB*) subject to a participation constraint for the firm. Hence the outcome would be $a_V = \min\{a_V^{\max}, a^*\}$.

requirements. Specifically, I identify conditions for which the abatement level resulting from a VA will be at least as high as that attainable through compliance with regulation. This depends on the stringency of the standard. The following result presents sufficient conditions for a VA to yield higher abatement levels than compliance with the regulatory standard.

Proposition 4:

Let a^* *be the abatement level that maximizes net social benefits. For* $a_S \leq a^*$, $a_V^N \geq a_S$ *if p is low enough,* γ *and F are high enough, and* α *is low enough. For* $a_S > a^*, a_V^N < a_S$.

This result suggests that for a relatively less stringent standard the abatement level in a VA is at least as high as that resulting from regulatory compliance if the probability of agency enforcement is low enough, the probability of citizen enforcement in the absence of an agreement and the corresponding cost (hence the expected cost) are high enough, and the firm's bargaining power is low enough. However, for a more stringent standard the abatement level agreed to in a VA is always lower than that attainable from regulatory compliance. The intuition behind this proposition is driven by the same logic underlying the preceding results. A low probability of enforcement means the firm is more willing to accept higher abatement levels as part of an agreement, and a high expected cost from citizen enforcement provides additional incentives to accept higher abatement levels in a VA. Finally, less bargaining power by the firm translates into more abatement effort. Given the right combination of these factors, a VA can yield higher abatement than regulatory compliance.

So far I have established conditions for which the abatement level agreed to in a VA can exceed the abatement level associated with regulatory compliance. It is also pertinent to ask when a VA leads to greater social payoffs than regulatory compliance. The following corollary

suggests that the same conditions leading to higher abatement are also sufficient for higher net social benefits.

Corollary 1:

If p is low enough, γ and F are high enough, and α is low enough, then $NSB(a_V^N) \geq NSB(a_S)$.

If the standard is relatively less stringent ($a_S \leq a^*$) these sufficient conditions ensure that the abatement level agreed to in a VA will be higher than the abatement required for regulatory compliance, and thus yield greater net social benefits. On the other hand, when the standard is excessively stringent ($a_S > a^*$) and the sufficient conditions are satisfied, the abatement level in a VA, although lower than the regulatory requirement, is closer to the net-benefit-maximizing abatement level, and hence results in a higher net social benefit as well.

To summarize, these results suggest that it is possible for negotiated agreements to yield higher abatement levels than compliance with incompletely enforced regulatory requirements, as well as higher net social benefits. Perhaps somewhat counter intuitively, this is the case when the probability of agency enforcement is relatively low, and the expected penalty from a citizen suit is relatively high. Under these circumstances, agency enforcement is unlikely to preempt a citizen suit when the firm does not participate in a VA, and the combination of high expected costs from private enforcement and a firm with a relatively weak bargaining position can yield more abatement than the regulatory standard.

6. Discussion and Conclusions

This paper examines an aspect of negotiated voluntary pollution control agreements that thus far has not been addressed by the literature on VAs. Firms entering into negotiated agreements that provide regulatory relief may be subject to private enforcement in the form of citizen suits. I

build on existing models of VAs by allowing for the possibility that participation in an agreement may result in noncompliance and thus lead to a citizen suit against the firm.

Private enforcement reduces the likelihood that the firm and the regulator reach an agreement. Specifically, given a positive probability of a citizen suit a VA is reached only if the probability of regulatory enforcement is low enough. This contrasts with the result from a model that does not include private enforcement, in which an agreement is reached for any positive enforcement probability. When an agreement is reached, a higher probability of agency enforcement does not lead to more abatement if the threat of a citizen suit is high, which also contrasts with previous results. However, a VA can result in higher abatement and net social benefits than regulation if the probability of private enforcement and accompanying costs are high and the probability of agency enforcement is low.

A key factor driving these results is the relationship between the probability of regulatory enforcement and the probability of a citizen suit. The probability p reflects the likelihood of regulatory enforcement, which is usually assumed to be more costly than participating in a VA. In a model without private enforcement a higher p has one effect: to increase the expected cost of not participating. Private enforcement introduces an important additional role for p: to preempt a more costly citizen suit. A high p means a citizen suit is more likely when participating in an agreement than when not participating. This makes a VA relatively less appealing, since the only way to reduce the likelihood of a suit is to increase abatement, which is costly for the firm. Hence, private enforcement entails a more nuanced effect of agency enforcement, which implies that when p is high the firm may be less, rather than more, willing to participate in a VA.

These results provide a framework that helps explain the anecdotal evidence suggesting that the threat of private enforcement may limit the potential of negotiated

agreements offering regulatory relief. For instance, in a Project XL agreement with 3M, the Natural Resources Defense Council raised objections to permit conditions negotiated as part of the agreement. Both the EPA and 3M expressed concern about the possibility of litigation, which made them less willing to proceed with the agreement (Marcus et al. 2002). More generally, it has been argued that few firms have sought the flexibility offered by Project XL because its legality is not assured (Boyd et al. 1998). Hence, these results offer insights about the important role private enforcement and its interaction with traditional regulatory enforcement can play in the success of VAs, and suggests this role should be taken into account in designing and implementing negotiated agreements.

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Figure 1. The effect of changes in p on $a_V^{\max}$ and $a_V^{\min}$

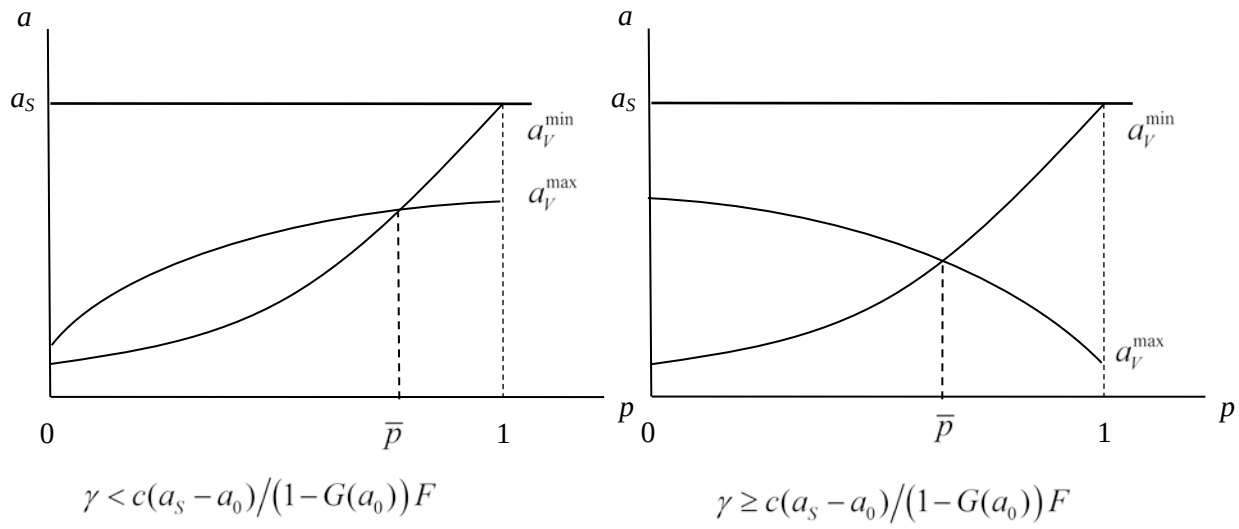

Figure 2. The effects of changes in γ on $a_V^{\max}$ and $a_V^{\min}$