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Ross School of Business Working Paper
Working Paper No. 1254
February 2015

Self-Regulation and Regulatory Discretion: Why Firms May be Reluctant to Signal Green

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February 20, 2015

Abstract

A large literature in strategy and management has focused on why firms self-regulate and "signal green." We show this decision becomes more complex when regulators have enforcement discretion, and both firms and regulators act strategically. We model the managerial decision whether to signal the firm's type through substantial self-regulation, or whether to stay in step with the rest of the industry through modest levels of self-regulation. Self-regulation is a double-edged sword: it can potentially preempt legislation, but it can also lead regulators to demand higher levels of compliance from greener firms if preemption fails. We show how self-regulatory decisions depend upon industry characteristics and political responsiveness to corporate environmental leadership.

Keywords: Self-Regulation, Signaling, Regulatory Discretion, Asymmetric Information, Private Governance

JEL Codes: D83, L31, M14, Q56

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1 Introduction

It has become a commonplace amongst consultants and popular business writers that it "pays to be green" (Porter and Van der Linde, 1995; Esty and Winston, 2006), and indeed there is a significant academic literature that finds a positive association between environmental and financial performance (Klassen and McLaughlin, 1996; Margolis and Walsh, 2001). However, the real question for managers is "when does it pay to be green?" (King and Lenox, 2001), and scholars are still working out the answer. Recent work has found insignificant average market reactions to recognition granted by third parties for environmental performance, and negative reactions to corporate claims of voluntary emissions reductions and awards from nongovernmental sources (Jacobs et al., 2010; Fisher-Vanden and Thorburn, 2011; Lyon et al., 2013). However, the explanation for these varying outcomes remains unclear. We focus on a factor that has received relatively little attention: regulatory discretion.

Much of the literature on industry self-regulation argues that it can profitably preempt mandatory regulatory requirements (Segerson and Miceli, 1998; King and Lenox, 2000; Maxwell, Lyon and Hackett, 2000; Manzini and Mariotti, 2003; Delmas and Montes-Sancho, 2010; Short and Toffel, 2010). In addition, some lines of work have emphasized the private benefits for firms who participate in voluntary self-regulatory schemes in order to "signal" that they are green (Darnall and Carmin, 2005; Potoski and Prakash 2004; Prakash and Potoski, 2005), or elaborated the various ways in which self-regulation can provide private benefits by changing the nature of regulatory threats or their enforcement (Delmas and Terlaak, 2001; Decker, 2003; Heyes, 2005; Maxwell and Decker, 2006; Morantz 2009; Innes and Sam, 2008; Gray and Shimshack 2010). Regardless, self-regulation is typically seen as a profitable way to influence the business environment of the firm, which makes negative market responses to it a puzzle for management scholars.

We argue that regulatory discretion holds a key to unlocking this puzzle. Most of the literature on self-regulation assumes that the stringency of a regulatory threat is fixed and known to the firm, even if there is uncertainty about whether enabling legislation will be passed. In practice, however, regulators have substantial discretion in how they implement and enforce legislation (Olson, 1995; Besley and Coate, 2003; Lyon and Mayo, 2005; Shimshack and Ward, 2005). Firms that "signal green" may thus be treated differently by regulators from other firms, and from the perspective of strategic management it is important to understand whether this special treatment is advantageous or not. As mentioned above, a significant strand of prior work has argued that regulators treat environmental leaders more favorably. However, there is also a risk regulators will infer that leaders have low costs of abatement, and expect higher performance from them, a phenomenon sometimes referred to as the "ratchet effect" (Weitzman, 1980; Laffont and Tirole, 1988). Our paper explores how managers should approach the decision to self-regulate when regulatory discretion influences the way regulatory threats will actually be enforced.

Regulatory discretion arises in many different regulatory settings. Discretion in environmental enforcement has perhaps attracted the most attention (Gray and Deily, 1996; Shimshack and Ward, 2005). However, health and safety regulations also allow for substantial discretion (Verkuil, 1982, p. 249; Olson, 1995), c ommentators note that "OSHA, like other regulators, can (and already does) induce additional compliance by reducing penalties it has levied against an employer in return for the firm's agreement to undertake additional actions to protect workers." (Shapiro and Rabinowitz, 2000, p. 150) In addition, financial regulations include flexibility provisions for small or community banks.[1]

Regulators often pay special attention to the needs of small and medium-sized enterprises (SMEs), for whom regulation is thought to be especially burdensome.[2] Indeed, sometimes regulators are required to offer flexible enforcement, as under the U.S. Regulatory Flexibility Act of 1980 (RFA), which codifies a federal preference for regulatory flexibility in order to protect small businesses from the potentially high costs of compliance with regulation. (Regulatory Flexibility Act, 5 U.S.C. 601-612.) Regulatory discretion is far from a uniquely American phenomenon. In 2003, the EU took steps along lines similar to the RFA, creating a "European Business Test Panel" to examine the potential impact of legislative and regulatory initiatives on small businesses, followed, in 2007, by an Action Programme for Reducing Administrative Burdens in the European Union, which includes a series of specific tests of those burdens on SMEs. Similar policies have been studied by the OECD, and are being discussed in the organization for Asia-Pacific Economic Cooperation (APEC) and the Association of Southeast Asian Nations (ASEAN).

There are many different ways to implement regulatory discretion. It is well documented that regulators are less likely to impose penalties on firms that are major employers in a given area or that are experiencing financial duress (Gray and Deily, 1996). Another familiar form of discretion is the "bubble" concept utilized by the EPA, which "allows businesses some flexibility in reducing total emissions by placing an imaginary bubble over an entire plant and demanding only that overall emissions levels meet established standards rather than requiring each stack within the plant to be of the most efficient design." (Verkuil, 1982, p. 226). As Maloney and Yandle (1980) point out, bubbles can be crafted in a variety of ways, and can be set at

[1] " The Dodd-Frank Act provided for tiered regulation in several areas including an exemption for community banks from Consumer Financial Protection Bureau examination and enforcement, and indemnification of community banks from FDIC premium increases that will result from increasing the Deposit Insurance Fund minimum reserve ratio from 1.15% to 1.35%. Other examples of tiered regulation can be found in the final Basel III rule including allowing community banks to continue using the Basel I mortgage risk weights, the exclusion of accumulated other comprehensive income (AOCI) from the definition of regulatory capital, and the grandfathering of tier one treatment of trust preferred securities (TruPS) for banks with assets under $15 billion." See http://www.cbai.com/index.php/governmental-relations-3/80-alerts-announcements/979-tiered-regulation-regulatory-relief

[2] Congress can choose to prohibit regulatory agencies like the EPA from exercising enforcement flexibility. In overturning part of the EPA's Final Rule on greenhouse gases, the D.C. Circuit Court of Appeals rebuked EPA for proposing to exempt certain types of faciltiies from enforcement, warning that "[T]here exists no general administrative power to create exemptions to statutory requirements based upon the agency's perceptions of costs and benefits." See *Center for Biological Diversity v. EPA and Lisa Perez Jackson*, 2013.

the level of an entire company as well as at the level of a single plant.[3] Another structured approach is the use of regulatory "tiering," which treats firms differentially based on their size. Tiering can be achieved in numerous different ways, including "less frequent inspections, lighter fines for noncompliance, exemptions, waivers, reduced requirements, or simpler reporting requirements for certain types of firms" (Brock and Evans, 1985).

Prior theoretical work shows how regulatory discretion can be used to improve regulatory outcomes (Brock and Evans, 1985; Harrington, 1988; Heyes and Rickman, 1999). However, this work has focused on the regulator's perspective and ignored the implications of regulatory discretion for strategic management. In this paper, we extend the literature on self-regulation by studying a setting with regulatory discretion, in which the public and private benefits of self-regulation may be in tension. We characterize when these conflicting incentives motivate firms to undertake substantial self-regulation, and when they lead instead to modest levels of self-regulation. In contrast to prior work, we show that "signaling green" may subject low-cost firms to more stringent regulation, so they may prefer to pool with brown (i.e., high-cost) firms.[4]

Our analysis has important managerial implications for firms considering self-regulation. As mentioned above, the existing literature has emphasized that self-regulation can stave off stakeholder pressure and potentially preempt regulation. These benefits suggest that managers should find self-regulation a very attractive strategy. Our analysis shows that matters are more complicated. We recognize that preemption does not always succeed, and we show that if it fails then self-regulation may influence the implementation of regulation in a way that raises costs for the self-regulating firm. In particular, low-cost firms confront a tradeoff regarding self-regulation when most firms in the industry have high compliance costs. On one hand, they can blend in with the rest of the industry and take modest self-regulatory steps. This does little to reduce the risk of regulation, but it preserves their ability to take advantage of regulatory discretion should regulation be imposed. On the other hand, they can step up and take substantial self-regulatory steps. This reduces the risk of regulation, but at the cost of signaling that the firm can meet stringent regulations ("signaling green") and thereby subjecting it to tougher regulatory enforcement should regulation pass. Overall, then, our results point out that the self-regulatory decision is complex, and explain why managers may not always be rewarded for self-regulation.

[3] Their analysis found that a regional bubble over a company's entire operations "yielded significantly more clean air than source standards and still generated cost savings of considerable size." (Maloney and Yandle, 1980, p. 51)

[4] The closest work to ours is the small literature in economic theory that examines self-regulation as a signal. Heyes (2005) shows that a high-cost firm may self-regulate to signal that its abatement costs are high and thereby weaken the stringency of future regulation. However, he assumes the probability of legislation is unaffected by self-regulation, whereas we explore the more realistic case where self-regulation can reduce the likelihood of legislation. Denicolo (2008) shows that a low-cost firm may self-regulate to signal that abatement costs are low, thereby inducing the regulator to impose regulation raising the costs of its higher-cost rival. However, he also ignores the possibility of preemption, and in addition he assumes away the possibility of regulatory discretion. Thus, neither paper addresses the relationship between regulatory discretion and preemptive self-regulation that is at the heart of our analysis.

The remainder of the paper is organized as follows. Section 2 lays out the basic structure of the game between the regulator and the firm. Sections 3 through 5 then work through the stages of the game in reverse chronological order. Section 3 studies the regulator's decision regarding how to enforce the law, while Section 4 analyzes the regulator's decision regarding how much effort to put into achieving passage of the law in the first place. Section 5 examines the firm's incentives to engage in self-regulation, emphasizing the differing incentives of low-cost and high-cost firms and the potential for signalling equilibria. Section 6 presents a simple example with functional forms that allow for closed-form solutions, section 7 discusses our results in the context of the literature more generally, and Section 8 concludes.

2 The Model

In this section, we present a simple model of regulatory discretion, within a setting where firms may choose to undertake self-regulatory measures to reduce the probability of legislation. If legislation is passed, the regulator has discretion regarding whether to enforce it in a rigid or a flexible fashion. Industry expectations about enforcement affect firms' incentives for self-regulation, and in turn, industry self-regulation influences the effort with which the regulator pursues passage of legislation. Thus, the presence or absence of regulatory discretion can ultimately affect the likelihood that legislation is passed. To fix ideas we write as if the regulation under consideration requires the abatement of pollution.

We assume the imposition of regulation is uncertain, and occurs with a probability that is a function of regulatory effort. One interpretation is that enabling legislation may not require or even authorize regulatory action, especially if the regulator puts forth little effort to ensure that it does. For example, the Supreme Court's decision in *Massachusetts v. EPA*, 549 U.S. 497 (2007), left the decision whether to regulate greenhouse gases as an air pollutant in the hands of the EPA. A second interpretation is that even though legislation has been passed, the regulator may lack the resources to enforce it in all applications, so firms are uncertain whether it will be enforced against them. For example, the Clean Water Act of 1972 mandated that all navigable waters of the U.S. must be fishable and swimmable by 1983, but by the mid-1990s the number of river miles meeting these requirements had increased by only 6.3 percent, and 4.2 percent, respectively (Freeman 2002); the Environmental Protection Agency (EPA) had nowhere near enough resources to achieve full implementation. A third interpretation is that even though legislation is passed, and the regulator has adequate resources for implementation, court decisions may block the imposition of regulation in certain circumstances. For example, questions over what constitutes a "navigable waterway" have hampered the ability of the EPA to apply the Clean Water Act to many bodies of water within the U.S. (Duhigg and Roberts, 2010)

The model involves two strategic players: a polluting firm ("he") that desires to minimize costs and a regulator ("she") that desires to maximize environmental quality. Following Heyes and Rickman (1999), we assume the firm has environmental impacts on two domains, $j = 1, 2$, and imposes environmental damage d in each domain unless he undertakes abatement. These domains can represent two different pollutants, two different plants, or two different media. (In the case of occupational safety and health, the domains might be different types of injuries or safety requirements.) Regardless, this multi-faceted character is an important feature of most real-world environmental legislation that is typically ignored in theoretical models. Heyes and Rickman (1999), in contrast, present a model of multi-dimensional regulation in which firms face a penalty F for non-compliance on each dimension. Firms differ in their costs of compliance, which are private information, and in the model high-cost firms opt to pay a penalty rather than comply with regulations. The regulator aims to reduce environmental damage, and may offer firms a "deal" in which they are forgiven for being out of compliance on one dimension if they comply on the other dimension. (Gray and Scholtz (1993) find that over 50% of firms inspected by OSHA have violations, but that only about 30% are actually assessed penalties.) This discretion increases overall compliance if the share of high-cost firms is large enough.[5]

Firms have either low costs or high costs of abating their emissions. Low-cost firms comply with regulations on both domains and high-cost firms do not comply on either domain unless they are offered regulatory flexibility. Flexibility allows the high-cost firms to escape the full burden of the regulation while still inducing some compliance. Assuming compliance costs are equal in both domains is the simplest way to achieve this setup.[6] Firms of type $i = L$ have low cost $c_{Lj} = c_L$ per unit of abatement for $j = 1, 2$, and firms of type $i = H$ have high cost $c_{Hj} = c_H$ per unit of abatement for $j = 1, 2$. The fraction of firms that have low costs is λ. The *ex ante* value of λ is known to the regulator, but the compliance costs of each individual firm are private information.[7] Let (q_{i1}, q_{i2}) be a vector of abatement decisions for a firm

[5] In practice, regulatory flexibility can mean either applying different abatement requirements to different firms, or applying the same requirement to all firms but granting firms flexibility in how they choose how to meet it. For example, the former version of flexibility can be implemented through the "grandfathering" of incumbent firms who face less stringent standards than do new entrants; the latter can be implemented through the use of tradable permits instead of "best available technology" requirements. One might argue that the regulator already knows the cost structure of incumbent firms, but in reality incumbent firms are not all the same and there will be some uncertainty about which firms really have costs so high they need to be exempted from compliance. Regardless of how flexibility is implemented, however, it reduces the cost of compliance and thus reduces industry's incentive to resist regulation.

[6] In Heyes and Rickman (1999), costs of abatement are drawn from a continuous distribution. This results in nine possible types of firms, depending upon whether for each dimension j we have $c_{ij} < F, c_{ij} \in (F, 2F)$, or $c_{ij} > 2F$. However, all the action in the paper involves tradeoffs between the likelihood of two types: firms that would comply on neither domain without a regulatory deal, and firms that would comply on both domains without a regulatory deal. Thus, assuming firms have identical costs on both domains captures the key insight of the original paper.

[7] For example, the Regulatory Flexibility Act requires both an initial and a final regulatory flexibility analysis for any new rule unless the promulgating agency certifies that it will not have a "significant economic impact on a substantial number of small entities." (§605b) What constitutes a "significant" impact and a "substantial" number of entities, however, remains vague. This leaves considerable uncertainty regarding how many firms actually suffer high costs of compliance, and exactly how high those costs may be.

of type i with $q_{ij} \in [0, d]$ the level of abatement achieved on domain j. Regulation (if enforced inflexibly) requires a firm to eliminate emissions on both domains, and there is a penalty F for non-compliance on each domain. A firm's objective is to minimize the sum of abatement costs $\sum_{j=1}^{2} c_i q_{ij}$ plus any penalties due to non-compliance if regulation is enforced. Thus, a firm complies on domain j if $c_{ij} d \leq F$. We assume $c_L d < F < c_H d$, so a low-cost firm complies on both dimensions, incurring cost $2c_L$, but a high-cost firm complies on neither, incurring penalties $2F$. Under inflexible regulation, the expected amount of abatement is $2d\lambda$.

The regulator's objective is to minimize expected environmental damages $D = \lambda \sum_{j=1}^{2} (d - q_{Lj}) + (1 - \lambda) \sum_{j=1}^{2} (d - q_{Hj})$. An important feature of our model is that the regulator does not include the penalty revenue from non-compliance in her objective function; she is focused solely on environmental compliance plus her cost of effort. This may seem like a strong assumption, but it is also realistic—environmental enforcement agencies typically do not keep fines they impose on firms that are out of compliance. Even if fines could be designated for environmental remediation, our assumption captures the regulator's preference for mitigation over remediation.

The regulator can choose to implement the regulation inflexibly, in the traditional manner, or can choose to grant the firm flexibility in complying with it. Following Heyes and Rickman (1999), we model this flexibility as allowing the regulator to waive penalties if the firm complies on at least one domain. We assume $c_H d < 2F$, so the high-cost firm prefers to comply on one dimension rather than pay the penalty on two dimensions. Why would the regulator ever find this type of flexibility desirable? If the regulator knew that the firm was of type L, then of course she would never offer flexibility. But if the firm is known to be of type H, then without flexibility the firm will fail to abate on either domain, while with flexibility the firm complies on one domain, generating environmental improvement d. When the regulator is uncertain of the firm's type, she can choose between traditional enforcement, which generates expected abatement $2d\lambda$, or regulatory flexibility, which generates abatement d for certain. Thus, regulatory flexibility is environmentally preferable if $\lambda < 1/2$.

Of course, the firm is also free to undertake voluntary abatement in an attempt to reduce the likelihood of legislation. The linearity of the cost function implies that his costs are the same for any emissions reductions R_1 and R_2 on the two domains that sum to R. (We show below that the firm may have strategic incentives to choose a heterogeneous mix of abatement across the two domains.) Then firm i's minimized cost of meeting a given abatement target is simply $c_i R$. With some level of abatement granted voluntarily by the firm, the regulator may decide that other priorities are more urgent and reduce her efforts to implement rules in a way that would produce even greater reductions.

The game unfolds in three stages that occur subsequent to nature's initial move determining the firm's cost of compliance.

1. The firm can self-regulate at a level $[R_1, R_2]$.

2. The regulator attempts to infer the firm's type, and nature reveals whether regulation will be imposed.

3. If regulation is imposed, the regulator decides whether to offer regulatory flexibility. If she does not, then the firm either complies at abatement level d on each domain or pays a fine F on each domain on which he is out of compliance. If she does offer flexibility, compliance is waived on one domain and the firm complies on the other domain.

As is typical in game-theoretic models, we solve the model in reverse chronological order so as to obtain a Perfect Bayesian Equilibrium.

3 Regulatory Flexibility and Firm Compliance

At stage 3 of the game, the regulator can choose to enforce the legislation in the traditional manner, which means inspecting the firm and imposing a penalty of F for each failure to comply. Alternatively, the regulator can give the firm flexibility to comply on the domain of its choice while the regulator agrees to waive the penalty on the other domain. As noted above, the regulator will not offer flexibility to a firm known to be of type L, but will offer flexibility to a firm known to be of type H. If the regulator is uncertain of the firm's type, traditional enforcement generates expected abatement $R + \lambda[2d - R] = 2d\lambda + (1 - \lambda)R$, while flexibility generates abatement $d + \min[R_1, R_2]$ for certain. Then flexibility is environmentally preferable if $d + \min[R_1, R_2] > 2d\lambda + (1 - \lambda)R$, or if

$$\lambda < \widetilde{\lambda} \equiv (d - \max[R_1, R_2])/(2d - R). \tag{1}$$

Thus we have the following proposition.

Proposition 1 *At stage 3, if the regulator is certain of the firm's type then she offers flexibility iff the firm is of type H. If the regulator is uncertain of the firm's type then she offers flexibility iff $\lambda < \widetilde{\lambda} \equiv (d - \max[R_1, R_2])/(2d - R) \leq 1/2$.*

Proof. Suppose that $\widetilde{\lambda} > 1/2$. In this case we would have $[2d - R] \leq 2d - 2\max[R_1, R_2])$, which simplifies to $2\max[R_1, R_2] \leq R$ or $\max[R_1, R_2] \leq R/2$. But $R = R_1 + R_2$, so $\max[R_1, R_2] \geq R/2$. Hence, $\widetilde{\lambda} > 1/2$ is false, and we must have $\widetilde{\lambda} \leq 1/2$. ■

The regulator's decision to offer flexibility depends on the mix of the firm's self-regulatory abatement choices across the two domains. If the firm does not invest in self-regulation, so that $R = 0$, the expected benefit of regulation is $2d\lambda$ without flexibility, and d with flexibility. Thus $\widetilde{\lambda} = 1/2$ when $R = 0$ and the regulator offers flexibility if and only if $\lambda < 1/2$. If the firm increases his self-regulatory abatement equally across the two domains, then it remains true that the regulator will offer flexibility if and only if $\lambda < 1/2$, because $\widetilde{\lambda}$ remains equal to 1/2. Now consider what happens if the firm allocates his investment in self-regulation differentially across the two domains. As R increases, the change in $\widetilde{\lambda}$ is given by

$$\frac{\partial \widetilde{\lambda}}{\partial R_i} = \begin{cases} \frac{(d-\max[R_1,R_2])}{(2d-R)^2} & \text{if } R_i \leq R_j \\ \frac{-1}{(2d-R)} & \text{if } R_i > R_j \end{cases}.$$

Note that the regulator responds very differently to increases on the two domains, raising $\widetilde{\lambda}$ when self-regulation is increased on the lesser domain (the domain with less abatement), and lowering $\widetilde{\lambda}$ when self-regulation is increased on the greater domain. The reason is that if regulation is imposed and flexibility is granted, the firm can strategically take advantage of an unequal division of abatement. With flexibility, the firm will elect to comply on the domain with greater self-regulation, which means that the regulator *gains less* on the compliance domain than if self-regulation were split equally. As a result, when self-regulation is divided unequally across the domains, the regulator has less incentive to grant flexibility, and restricts the conditions under which she will do so, i.e. she reduces the critical threshold $\widetilde{\lambda}$ below which she grants flexibility when the firm's type is unknown. Thus, as the firm shifts his self-regulatory abatement towards the greater domain, this can cost him the possibility of regulatory flexibility, since the range of values of λ for which the regulator grants flexibility shrinks. At the same time, however, the regulator's incentive to press for regulation falls as the firm shifts his self-regulation toward the greater domain, thereby reducing the likelihood that regulation will be imposed at all. We examine the tradeoff between these two factors, and its impact on the firm's self-regulation decision, in section 5 below.

4 Legislative Stage

At stage 2, nature determines whether or not regulation will be imposed. This probability is decreasing in the firm's self-regulatory investment R. As shown in Proposition 1, the regulator's decision regarding flexibility depends upon whether she knows the firm's costs or not, that is, on whether stage 1 resulted in a separating equilibrium or a pooling equilibrium. Since we are solving the game in reverse chronological order, we must consider both possibilities at stage 2.

We assume the probability ρ with which regulation is imposed is a function of R, the firm's level of self-regulation. The two types of firm either choose the same level of self-regulation, in which case a pooling equilibrium occurs, or they choose different levels, leading to a separating equilibrium. We assume $\rho'(R) < 0$ and $\rho''(R) \geq 0$, with $\lim_{R \to 2d} \rho(R) = 0$. Thus, the probability of regulation is decreasing in the level of industry self-regulation, but at a decreasing rate.

An important element of the analysis to follow is the *inverse hazard rate*

$$\frac{1-\rho(R)}{-\rho'(R)}.$$

The concept of a hazard rate derives from industrial engineering, where it indicates the probability a machine will fail at time t given it has survived up to that point. In our case, we can think of a "failure" from the firm's perspective as the imposition of regulation. Then $\sigma(R) = 1 - \rho(R)$ is the probability that the firm survives unregulated at abatement level R, and the corresponding density function at R is $\sigma'(R) = -\rho'(R)$. We will assume this density function is log-concave, in which case Theorem 3, Corollary 2 of Bagnoli and Bergstrom (2005) implies that the inverse hazard rate is monotone increasing in R. This property is known as the monotone likelihood ratio property (MLRP).

If both types of firm choose the same R at stage 1, then at stage 2 the regulator is uncertain of the firm's type, and chooses whether to offer flexibility based on the criterion in Lemma 1.

5 Self-Regulation

At Stage 1, the firm must decide how much self-regulation to undertake before legislation is proposed. There are two possibilities the firm must consider, one in which the regulator offers flexibility and one in which she does not. As shown above, the regulator prefers to offer flexibility to a high-cost firm, but not to a low-cost firm. Because the firm knows its type, but the regulator does not, the regulator must try to infer the firm's type from its level of self-regulation.

This is obviously a signaling problem, for which there can be different types of equilibria. An equilibrium is a strategy for each type of firm, and a set of beliefs on the part of the regulator that are consistent with these strategies. A pooling equilibrium exists if each type of firm takes the same strategy, and the regulator is unable to update her prior beliefs conditional on the firm's actions. This occurs when one type of firm prefers to mimic the choice of the other type, so that the two types are treated identically, rather than to make a choice that would reveal its type. A separating equilibrium exists if each type of firm takes a different strategy, and the regulator updates her beliefs, conditional on the firm's actions, so that she knows the firm's type with certainty.

The nature of the equilibrium depends crucially on what the regulator does if she is uncertain of the firm's type, which will be the case at Stage 1 if both firm types choose the same level of self-regulation. As shown in Proposition 1, the regulator offers flexibility in this situation if $\lambda < \widetilde{\lambda}$ and refuses to offer flexibility if $\lambda > \widetilde{\lambda}$. Thus, in the remainder of this section, we analyze both these possibilities and characterize fully the conditions under which each type of equilibrium exists.

5.1 Uninformed Regulator Offers Flexibility ($\lambda < \widetilde{\lambda}$)

To begin, suppose that $\lambda < \widetilde{\lambda}$. Thus, if after self-regulation the regulator remains uncertain of the firm's type, then if legislation passes the regulator offers flexibility to both types of firm. If a high-cost firm anticipates flexibility, his expected profits are

$$\pi_{HF}(R) = -c_H R - \rho(R) c_H (d - \max[R_1, R_2]). \tag{2}$$

The expression for expected profits implies that the marginal cost of investing in R_1 and R_2 is the same, but the marginal benefit of investing in $\max[R_1, R_2]$ is greater than the benefit of investing in $\min[R_1, R_2]$ because it reduces the incremental cost of complying with regulation, should it be imposed. The first-order conditions are

$$\frac{d\pi_H(R)}{d\min[R_1, R_2]} = -c_H - \rho'(R) c_H [d - \max[R_1, R_2]] = 0 \tag{3}$$

$$\frac{d\pi_H(R)}{d\max[R_1, R_2]} = -c_H - \rho'(R) c_H [d - \max[R_1, R_2]] + \rho(R) c_H = 0. \tag{4}$$

Since $\rho'' \geq 0$, the second-order conditions are negative. Obviously the two first-order conditions cannot both hold. Investing in $\min[R_1, R_2]$ reduces the likelihood of regulation, but does not change the incremental cost of regulation, should it be imposed, since the firm will comply on the domain in which it has done the most self-regulation. Investing in $\max[R_1, R_2]$ also reduces the likelihood of regulation, but has the additional benefit of reducing the incremental cost of regulation, should it be imposed. Thus, the marginal benefit of abatement on the domain with more self-regulation is always greater than the marginal benefit on the domain with smaller self-regulation. We have thus established the following.

Lemma 2 *The high-cost firm chooses* $\min[R_1, R_2] = 0$.

Without loss of generality we will henceforth assume $R_2 \geq R_1 = 0$ for the high-cost firm, which means the firm elects to comply on domain 2 if granted regulatory flexibility.[8] Note that unlike the high-cost firm, the low-cost firm is indifferent with regard to allocating self-regulatory effort between the two domains. The reason is that the low-cost firm will be required to comply with regulation on both dimensions, so that his self-regulatory choices do not affect his costs at stage 3, unless there is a pooling equilibrium. If the low-cost firm decides to pool with the high-cost firm, he undertakes all self-regulation on domain two, just as the high-cost firm would. Thus we can rewrite the firm's expected profits as

$$\pi_{HF}(R_2) = -c_H R_2 - \rho(R_2) c_H [d - R_2].$$

[8] Note that the high-cost firm does not have to do as much additional abatement as he would if $R = 0$. Hence, if the fine was enough to motivate compliance on one domain when $R = 0$, it is surely enough to motivate compliance when $R > 0$.

Solving first-order condition (4) implies the solution is

$$R_{HF} \equiv d + \frac{1 - \rho(R_{HF})}{\rho'(R_{HF})}, \tag{5}$$

where the subscript H indicates the high-cost firm and the subscript F indicates that the firm received flexibility.[9] Denote the associated maximized level of profits by

$$\pi_{HF}(R_{HF}) = -c_H R_{HF} - \rho(R_{HF}) c_H (d - R_{HF}). \tag{6}$$

Substituting (5) into (6) and rearranging terms yields

$$\pi_{HF}(R_{HF}) = -c_H \left[d - \frac{[1 - \rho(R_{HF})]^2}{\rho'(R_{HF})} \right]. \tag{7}$$

The low-cost firm could mimic abatement level R_{HF}, receive flexibility, and earn

$$\pi_{LF}(R_{HF}) = -\rho(R_{HF}) c_L d - (1 - \rho(R_{HF})) c_L R_{HF}.$$

Alternatively, the low-cost firm could opt not to mimic. In this case the regulator infers that the firm has low costs and requires compliance on both domains if legislation passes. The low-cost firm would then earn expected profits

$$\begin{aligned} \pi_{LN}(R) &= -\rho(R)[2c_L d] - (1 - \rho(R)) c_L R \\ &= -c_L R - \rho_N(R) c_L [2d - R]. \end{aligned}$$

In a separating equilibrium, the low-cost firm's first-order condition is

$$\frac{\partial \pi_{LN}(R)}{\partial R} = -c_L [1 + \rho'_N(R)[2d - R] - \rho_N(R)] = 0. \tag{8}$$

The optimal level of self-regulation thus balances the marginal cost of self-regulation, c_L, (the increase in expected costs if regulation does not occur) against the marginal benefit of self-regulation (the reduction in expected costs if regulation is imposed). The marginal benefit has two components, a reduction in the probability of legislation, and a reduction in the incremental amount of abatement required if legislation passes. The optimal solution is

$$R_{LN} \equiv 2d + \frac{1 - \rho(R_{LN})}{\rho'(R_{LN})}, \tag{9}$$

where the subscript L indicates the low-cost firm and the subscript N indicates that there is no regulatory flexibility. An immediate observation follows.

[9] One might be concerned that if R_2 is so large that $c_H(d - R_2) < F$, then the regulator will revoke the promise of flexibility since the firm will comply on one dimension even without flexibility. However, since the regulator does not keep the penalty revenue, she is indifferent between two outcomes that both offer compliance on one dimension, and she is assumed to continue to offer flexibility regardless of the high-cost firm's choice of R_2.

Proposition 3 $R_{LN} > R_{HF}$.

Proof. We seek to compare the solutions to equations (5) and (9), which can be written as $R = f(R) \equiv d + [1 - \rho(R)]/\rho'(R)$ and $R = g(R) \equiv d + f(R)$, where $f'(R) > 0$ due to the MLRP. Since $g(R) > f(R)\ \forall R$, if we consider the solution to (5) and shift $f(R)$ upwards by d, the solution to (9) moves along the 45-degree line and thus must be greater. ■

Intuitively, a firm that is known to have low costs will face more stringent enforcement of regulation, and thus has stronger incentives to try and preempt that regulation. A high-cost firm can expect more flexible and lenient treatment by the regulator, and thus has less incentive to preempt. This intuition is consistent with the empirical literature on voluntary approaches to regulation, which consistently finds that large firms (which presumably have lower costs) are more likely to participate in voluntary programs (Lyon and Maxwell, 2004; 2007; 2008).

The corresponding maximized level of profits is

$$\pi_{LN}(R_{LN}) = -\rho(R_{LN})[2c_L d] - (1 - \rho(R_{LN}))c_L R_{LN}. \tag{10}$$

Substituting (9) into (10) yields

$$\pi_{LN}(R_{LN}) = -c_L \left[2d - \frac{[1 - \rho(R_{LN})]^2}{\rho'(R_{LN})}\right]. \tag{11}$$

If self-regulation were completely ineffective at reducing the probability of regulation $\rho(R)$, so that $\rho'(R) = 0$, then the firm would make no attempt to preempt regulation, and would eschew self-regulation altogether by choosing $R_{LN} = 0$. Since this is not the case, the low-cost firm chooses a strictly positive level of self-regulation, which is increasing in the level of damages d as can be seen in (9). However, the firm always chooses a self-regulatory level that is strictly less than $2d$ since otherwise the second term on the right-hand side of (9) would be negative, requiring that $\rho(R_{LN})$ be greater than one, which is impossible.

As mentioned above, for a pooling equilibrium to exist, the low-cost type must prefer to receive flexible regulation and pool with the high-cost type, that is we require

$$\pi_{LN}(R_{LN}) < \pi_{LF}(R_{HF}). \tag{12}$$

Intuitively, the firm prefers the pooling equilibrium if the cost of the increase in upfront self-regulation outweighs the reduction in expected incremental costs of regulation. As we have noted before, the latter has two components, the change in the probability of regulation and the change in the incremental abatement required if regulation occurs. Importantly, the separating equilibrium actually imposes a greater demand for abatement, in the amount $2d$ rather than d. This additional cost will only be incurred by the low-cost firm if the $\rho(R)$ function is sufficiently elastic with respect to self-regulatory investment. The following proposition characterizes the low-cost firm's choice regarding self-regulation.

Proposition 4 *If a high-cost firm choosing R_{HF} would be offered flexibility, then the low-cost firm prefers to mimic the high-cost firm's self-regulatory choice, that is,* $\pi_{LN}(R_{LN}) < \pi_{LF}(R_{HF})$.

Proof. From (7) and (11) above,

$$\pi_L(R_{LN}) - \pi_L(R_{HF}) = c_L \left[-d - \frac{[1-\rho(R_{LN})]^2}{-\rho'(R_{LN})} + \frac{[1-\rho(R_{HF})]^2}{-\rho'(R_{HF})} \right].$$

The first two terms inside the braces on the right-hand side of the equation are negative, but the third is positive. Proposition 3 shows that $R_{LN} > R_{HF}$, and the monotone likelihood ratio property implies that $[1-\rho(R_{LN})]/-\rho'(R_{LN})$ is increasing in R. Thus the sum of the second two terms inside the braces is negative, making the entire right-hand side negative, so $\pi_L(R_{LN}) < \pi_L(R_{HF})$. ■

The proposition shows that the low-cost firm prefers to pool with the high-cost firm whenever it can. Intuitively, losing flexibility is very costly for the low-cost firm, as it will have to spend an additional dc_L on compliance in the event regulation is imposed. Although it can offset this cost to some extent by increasing its investment in self-regulation, this is not enough to make it profitable to separate from the high-cost type, if we make the mild assumption of log-concavity of the regulatory density function in conjunction with limits on its magnitude as regulation is completely preempted. The following proposition fully characterizes the set of equilibria when $\lambda < \widetilde{\lambda}$.

Proposition 5 *If* $\lambda < \widetilde{\lambda}$, *there is a unique pooling equilibrium in which both types choose* R_{HF} *and the regulator offers flexibility.*

Proof. Proposition 1 shows that if $\lambda < \widetilde{\lambda}$, then a regulator who does not know the firm's type will offer flexibility. Lemma 4 shows that the low-cost firm prefers to pool with the high-cost firm if he can thereby obtain flexibility. Thus, no separating equilibrium exists, but the conditions for a pooling equilibrium at R_{HF} are met. A pooling equilibrium at another level, $\widetilde{R}$, can exist if the regulator holds off-equilibrium path beliefs that any deviation from $\widetilde{R}$ must be committed by a low-cost type firm. However, equilibria at any $\widetilde{R} \neq R_{HF}$ are strictly dominated for both types of firm. ■

The proposition establishes that when there is a large enough proportion of high-cost firms, the only equilibrium involves pooling at the profit-maximizing level of self-regulation R_{HF}. This equilibrium is supported by the regulator's preference to offer flexibility when she is uncertain of the firm's type. As mentioned earlier, the experience with the EU Emissions Trading System (ETS) provides support for the notion that firms may have incentives to avoid disclosing their types to the regulator prior to the imposition of regulation. Similarly, many electric utilities avoid improving their older coal plants too much in order to avoid triggering New Source Review requirements.

We turn next to the case where she prefers not to offer flexibility when uncertain of the firm's type.

5.2 Uninformed Regulator Does Not Offer Flexibility ($\lambda > \widetilde{\lambda}$)

Turn now to the case where $\lambda > \widetilde{\lambda}$. A pooling equilibrium would exist if both types of firm prefer to take the same choice of R conditional on the regulator's anticipated optimal response. When $\lambda > \widetilde{\lambda}$, Lemma 1 implies that the regulator refuses to offer flexibility if both types of firm take the same choice of R. As shown in the previous section, a low-cost firm's expected profits are maximized at R_{LN} when he does not expect to receive flexibility. Now consider the high-cost firm's incentives. If legislation passes, he must now either abate or pay the penalty F on each dimension. However, by definition a high-cost firm prefers to pay the penalty rather than incur the cost $c_H d$. In this case, the high-cost firm's expected profits are simply

$$\pi_H(R) = -\rho(R)[2F] - c_H R.$$

Then differentiating its profits with respect to R yields

$$\frac{\partial \pi_H(R)}{\partial R} = -\rho'(R)2F - c_H. \tag{13}$$

Would the low-cost firm prefer to pool at this level? If he pools, his expected profits are

$$\pi_L(R) = -\rho(R_{HN})[2dc_L] - [1 - \rho(R_{HN})]c_L R_{HN}.$$

In contrast, if he does not pool, his expected profits are

$$\begin{aligned} \pi_L(R) &= -\rho(R)[2dc_L] - [1 - \rho(R)]c_L R \\ &= -\rho(R)[(2d - R)c_L] - c_L R \end{aligned}$$

which is maximized at R_{LN} defined by equation (9). Since $R_{LN} \neq R_{HN}$, there is no pooling equilibrium when $\lambda > \widetilde{\lambda}$.

A separating equilibrium would exist if the two types of firms choose different levels of R, and the regulator tailors her response to the firm's type, offering flexibility to a high-cost firm but not to a low-cost firm. The analysis in the previous section then shows that conditional on this regulatory response, the low-cost firm would choose R_{LN} and the high-cost firm would choose R_{HN}. Thus a separating equilibrium does exist.

The foregoing analysis has established the following result.

Proposition 6 *If $\lambda > \widetilde{\lambda}$ there is a unique separating equilibrium, with the high-cost type choosing R_{HF} and the low-cost type choosing R_{LN}. The regulator offers flexibility to the high-cost type and not to the low-cost type.*

Together, Propositions 5 and 6 completely characterize the nature of equilibrium in the game. They are illustrated in Figure 1, which plots the firm's choice of R on the vertical axis at the left-hand side of the figure and λ, the probability the firm has low costs, on the vertical axis at the right-hand side of the figure. For $\lambda < \widetilde{\lambda}$, there is a unique pooling equilibrium in which both types choose R_{HF} and the regulator allows flexibility in enforcement. For $\lambda > \widetilde{\lambda}$, there is a unique separating equilibrium, with the high-cost type choosing R_{HF} and the low-cost type choosing R_{LN}. In the separating equilibrium, the regulator offers flexibility to the high-cost type but not to the low-cost type. In both types of equilibria, a high-cost firm chooses the same level of self-regulation, so it is the strategic behavior of a low-cost type that is of primary interest. In the first type of equilibrium, a low-cost firm prefers to stay in step with the rest of the industry through modest levels of self-regulation, and thereby ensure he will receive flexible regulatory treatment should legislation pass. In the second type of equilibrium, a low-cost firm strategically signals his type through substantial self-regulation, even though he foregoes regulatory flexibility should his self-regulatory efforts fail to preempt legislation. Interestingly, this signaling benefits the entire industry by reducing the probability of legislation. Furthermore, a high-cost type is assured of receiving flexible regulatory treatment should legislation pass, so a low-cost type's signaling provides strictly positive gains to a high-cost type. This last observation suggests a high-cost firm might have incentives to try and convince the regulator that λ is high, so as to drive a low-cost type to undertake more self-regulation. Although such persuasive efforts go beyond the scope of our model, they may be of interest for future research.

[Insert Figure 1 about here]

6 Numerical Example

In this section we present a numerical example of our model in order to illustrate its equilibrium behavior. We are particularly interested in how equilibrium behavior changes with ex ante changes in λ, the mix of firm types, and with changes in the level of damages d.

Recall from our model that there are two key possible levels of self-regulation. The high-cost firm always receives regulatory flexibility, and chooses R_{HF} defined by (5). If the low-cost firm decides to separate, its optimal level of self-regulation is R_{LN} defined by (9). These choices of self-regulation, and the decision whether or not to mimic, will depend on the how responsive the threat of regulation is to self-regulatory behavior, as captured in the function $\rho(R)$. For this example we shall assume

$$\rho(R) = \left(1 - \frac{R}{2d}\right)^{\alpha}. \tag{14}$$

Thus, $\rho(0) = 1$, $\rho(2d) = 0$, $\rho'(R) < 0$, and $\rho''(R) > 0$. In particular,

$$\rho'(R) = \frac{-\alpha}{2d}\left(1 - \frac{R}{2d}\right)^{\alpha-1}. \tag{15}$$

Letting $\alpha = 2$, and substituting (14) into (5) we have

$$R_{HF} = d + \frac{1 - \left(1 - \frac{R_{HF}}{2d}\right)^2}{\frac{-1}{d}\left(1 - \frac{R_{HF}}{2d}\right)} = 2d - \frac{2d\sqrt{6}}{3} = .36701d, \tag{16}$$

and substituting (14) into (9) we have

$$R_{LN} = 2d + \frac{1 - \left(1 - \frac{R_{LN}}{2d}\right)^2}{\frac{-1}{d}\left(1 - \frac{R_{LN}}{2d}\right)} = 2d - \frac{2d\sqrt{3}}{3} = .8453d \tag{17}$$

Now we must check whether, in our example, the low cost firm would rather choose R_{LN}, or mimic the high cost firm and choose R_{HF} and thereby receive flexible regulation. Recall from section 5 above that

$$\pi_L(R_{HF}) = -c_L R_{HF} - \rho(R_{HF})c_L[d - R_{HF}],$$

which after a series of definitional substitutions and algebraic calculations is

$$\pi_L(R_{HF}) = -c_L d\left[\frac{12}{9} - \frac{2\sqrt{6}}{9}\right].$$

Similarly, section 5 also shows that

$$\pi_L(R_{LN}) = -c_L R_{LN} - \rho_N(R_{LN})c_L[2d - R_{LN}],$$

which after a series of definitional substitutions and algebraic calculations is

$$\pi_L(R_{LN}) = -c_L d[2 - \frac{4\sqrt{3}}{9}].$$

Thus we can confirm that for this example the low cost firm will prefer to mimic since

$$\begin{aligned} \pi_L(R_{HF}) - \pi_L(R_{LN}) &= \left\{-c_L d\left[\frac{12}{9} - \frac{2\sqrt{6}}{9}\right]\right\} - \left\{-c_L d[2 - \frac{4\sqrt{3}}{9}]\right\} \\ &= 3.9708 c_L d > 0. \end{aligned} \tag{18}$$

Thus, if the regulator will offer flexible regulation when the two firm types pool, a low cost firm will indeed want to pool and choose $R_{HF} = .36701d$.

Recall from section 3 that granting flexibility is preferable for the regulator if $\lambda < \widetilde{\lambda}$ where

$$\widetilde{\lambda} \equiv \frac{(d - R_{HF})}{(2d - R_{HF})}.$$

Using (16) we can compute that

$$\widetilde{\lambda} = \frac{(d - .36701d)}{(2d - .36701d)} = .38763.$$

Thus, when $\lambda < \widetilde{\lambda} = .38763$ the firms will pool and the regulator will offer flexibility. Above this level, the firms will separate with the low cost firm choosing $R_{LN} = .8453d$ and the high-cost firm continuing to choose $R_{HF} = .36701d$.

7 Discussion

Our analysis has highlighted an important trade-off facing a firm with low compliance costs in an industry facing a regulatory threat: stay in step with high-cost members of the industry so as to take advantage of regulatory discretion if regulation passes, or step out and signal green in order to reduce the risk of regulation, even though this means foregoing flexibility should regulation pass. This decision depends crucially on *ex ante* regulatory beliefs. If these beliefs would lead the regulator to offer flexible regulation, then by lowering its level of self-regulation to match that undertaken by a high-cost firm, a low-cost firm can ensure a flexible implementation of the regulation should it pass. The increased likelihood of a more flexible, and therefore less costly, regulation may be more attractive to a low-cost firm than the alternative of a less likely but stricter, and therefore more costly, regulation.

Previous work has examined the potential interplay between the non-market strategy of self-regulation and regulatory decisions, but the settings examined differ from ours in important respects. Much of the literature ignores the possibility that firms know more about their cost structure than do regulators (Segerson and Miceli, 1998; Maxwell, Lyon and Hackett, 2000; Manzini and Mariotti, 2003). However, two prior papers have explored self-regulation in a context of asymmetric information. Denicolo (2008) has shown that if firms compete in the same market, low-cost firms may use self-regulation to signal that the cost of regulation to the industry is low and thereby induce regulation on high-cost rivals. If the total costs to industry are sufficiently low, the regulator will not mind imposing the regulation on the high-cost firms. However, Denicolo (2008) ignores the possibility of regulatory preemption, and also assumes that the regulator adopts a "one size fits all" policy that applies to both types of firms. Thus, the only role of self-regulation in his paper is to induce regulators to impose new rules. In contrast, we allow for self-regulation to preempt regulation, and we allow for regulatory flexibility. Our analysis highlights the differences in strategic behavior when legislators and regulators take into account that regulation has differential cost impacts on firms, and therefore tailor regulations to avoid politically unacceptable costs on certain classes of firms. In such situations, low-cost firms may not benefit from imposing regulation on their high-cost rivals, since their rivals may be held to weaker standards; instead low-cost firms focus on preempting regulation altogether.

Heyes (2005), like Denicolo (2008), assumes that preemption is impossible; in addition, he assumes self-regulation involves a reversible short-run cost (e.g., an effort cost) rather than a long-run commitment. He shows that high-cost firms may use self-regulation to obtain tailored, softer regulatory standards. In his setting, high-cost firms are willing to undertake more self-regulation than low-cost rivals if the costs of regulation, once imposed, will rise with type in a sharply non-linear manner. In contrast, we explore the case where self-regulation involves an irreversible long-run commitment (e.g., a capital investment) that can preempt legislation. In our setting, low-cost firms can always afford to mimic the self-regulatory efforts of their high-cost rivals, frustrating attempts by high-cost firms to signal their type.

Our results are consistent with the long-held notion that strong regulatory threats are needed to induce high levels of self-regulation. The threat of inflexible regulation (as would be applied to firms known to be low-cost) does induce greater industry self-regulation. However, our analysis points to the need to expand the notion of what constitutes a strong regulatory threat, because that threat may endogenously change depending on firm actions. Traditionally, a strong regulatory threat has been modeled by the notion of expected regulatory costs, with each component (the likelihood of regulation and the cost of regulation to the firm) of the expected costs viewed as exogenously fixed. Here we have shown that firm self-regulatory actions may alter both the form and the likelihood of regulation. As a result, firm decisions shape rather than simply respond to the regulatory threat. Ironically, this ability to potentially shape the form of a regulation can lead to lower levels of self-regulation than might arise otherwise. Low-cost firms may cut back on self-regulatory efforts that would provide industry-wide benefits (a reduced regulatory probability) in pursuit of private advantage (more flexible regulation).

Empirical evidence suggests that many self-regulatory actions involve very modest amounts of voluntary improvement. A number of empirical studies have found that participants in voluntary programs undertake self-regulatory actions that differ little from non-participants (King and Lenox, 2000, Rivera and De Leon, 2004). Explanations for the weak behavior of participants range from rules governing industry trade associations (Manzini and Mariotti, 2003) to free riding (Delmas and Montes-Sancho, 2010). Our analysis suggests an additional explanation. Firms may be reluctant to undertake too much self-regulation if this raises the likelihood that they will be targeted for stringent enforcement if regulatory requirements are imposed.

Our work highlights the role of asymmetric information in shaping both self-regulatory actions and the potential sanctions firms might face. We have focused on government regulations, but our insights also apply to potential societal sanctions, or civil regulation. This means that asymmetric information may play an important role in understanding firm choices between substantive self-regulation and lower levels of self-regulation that may be viewed as merely symbolic. Much of the prior literature examines self-regulatory decisions when firms' cost conditions are known (Segerson and Miceli 1998; Maxwell, Lyon and Hackett, 2000; Manzini and Mariotti, 2003). Not surprisingly, self-regulatory decisions become more complex for industries, or industry segments, where cost conditions are not known to regulators. If the cost structure of a subset of firms in an industry is common knowledge, those firms will have incentives to engage in self-regulation according to the principles laid out in these earlier works. However, as we argued in the Introduction, there are also likely to be other industry members, especially smaller firms, whose costs are only known to the firms themselves. For these firms, self-regulation involves a tradeoff between providing industry-wide benefits (via strong preemptive self-regulation) and private gains (from pooling with firms that have high compliance costs).

8 Conclusions

We have studied the strategic role of signaling green via self-regulation in a setting with regulatory threats that can be preempted or implemented with discretion if passed. The possibilities of regulatory preemption and enforcement discretion means that firms with low compliance costs confront a tradeoff regarding self-regulation when most firms in the industry have high compliance costs. On one hand, they can blend in with the rest of the industry and take modest self-regulatory steps. This reduces the risk of regulation somewhat, and preserves their ability to obtain regulatory flexibility should regulation be imposed. On the other hand, they can step forward and take substantial self-regulatory steps. This is more effective in mitigating the risk of regulation, but at the risk of signaling low costs and becoming a target for stringent enforcement should regulation pass.

Our analysis significantly extends the small theoretical literature on signaling green (Heyes 2005; Denicolo 2008), which ignores the possibility of regulatory preemption. When preemption is impossible, Heyes (2005) shows that high-cost firms might paradoxically have incentives to "signal brown" by self-regulating, in order to obtain lenient regulatory treatment; however, this only works if self-regulation involves short-term effort rather than long-term capital investment. Denicolo (2008) shows that low-cost firms might "signal green" via self-regulation in order to convince regulators to impose regulations on their higher-cost rivals, but he ignores the possibility that self-regulation might instead lead to regulatory preemption. In contrast, we show that low-cost firms may "signal green" in order to preempt legislation, even though this may cost them a chance at benefiting from regulatory discretion.

An important feature of our model is that the design of regulation has important effects not just on the firm's incentives for compliance, but also on the likelihood of legislation itself. This would certainly come as no surprise to anyone involved in politics. Moreover, the economic literature on tradable permits has recognized this concern explicitly, both from an empirical perspective (Joskow and Schmalensee, 1998) and from the perspective of policy design (Stavins, 1998). Likewise, the legal literature has demonstrated the importance of grandfathering as a tool for making such legislation at the Clean Air Act of 1972 politically palatable (Ackerman and Hassler, 1981). An important contribution of our approach is to link regulatory design to the regulator's incomplete information about firm types.

We have made a number of simplifying assumptions that could be relaxed in future work. For example, we have assumed that activist groups are not able to challenge regulatory flexibility in court. Heyes and Rickman (1999) present an extension of their model of regulatory flexibility in which an activist group is included, and show that regulatory flexibility may be constrained in this setting. We have also assumed that regulatory penalties are fixed, and are not collected by the regulator. If the regulator were able to allocate penalty revenues toward environmental remediation, this would make enforcement against high-cost firms more attractive, and reduce the value of regulatory flexibility. Nevertheless, we expect that our results would continue to hold qualitatively as long as mitigation is preferred to remediation. In addition, we have assumed that compliance costs are linear, and that within each firm the costs of compliance are the same on each dimension; our results could be made more general by relaxing these assumptions.

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Figure 1: Self-Regulatory Strategies