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A Rent-Seeking Model of Voluntary Overcompliance

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Abstract We provide an explanation for voluntary overcompliance, the phenomenon in which firms voluntarily choose to overcomply with environmental regulations. In our model, a polluting firm faces a rent-seeking contest with an environmental group. By making a small concession beforehand, i.e. by overcomplying voluntary, the firm lowers the stake the environmental group has in the rent seeking contest, which lowers the group's lobbying effort in that contest. Voluntary overcompliance increases social welfare, yet the firm undersupplies overcompliance from a welfare point of view. An increase in the effectiveness of lobbying of the environmental group, increases the level of overcompliance.

Keywords Voluntary overcompliance · Regulation · Rent-seeking

JEL Classification Q50 · D72 · L51

1 Introduction

An increasing number of firms try to present themselves as responsible corporate citizens. Such firms stress that they do business in a way that takes into account all kinds of social and environmental concerns that their potential customers might have (for a recent survey, see e.g. Kitzmueller and Shimshack 2012). One way to establish such credentials is through voluntary overcompliance. Firms that use voluntary overcompliance set standards for themselves that are stricter than what government requires. In other words, these firms voluntarily choose to overcomply with government regulations. There are many examples of such voluntary overcompliance (see e.g. the discussion in Lyon and Maxwell 2004, or the references cited in Shimshack and Ward 2008).

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The literature offers a number of explanations for voluntary overcompliance. In Maxwell et al. (2000), an environmental group can be formed at some fixed costs. Firms then choose to voluntary overcomply to such an extent that it is just not worthwhile for the group to form. In effect, these authors thus have an entry deterrence model, where the entry of a lobby group is deterred, rather than that of a potential entrant. Arora and Gangopadhyay (1995) use a model of vertical product differentiation. In such a model, firms in a duopoly can increase their profits by increasing the extent of product differentiation, i.e. by offering different qualities. Suppose that consumers consider the 'greenness' of a product as an aspect of quality. Then if one producer complies with environmental regulation, the other has incentive to provide a higher quality, i.e. to use voluntary overcompliance. Lutz et al. (2000) extend this model and show that if the high-quality firm can precommit to a quality level before minimum quality standards are set, the regulator will be inclined to set a weaker standard. This leads to lower welfare compared to the case where the high-quality firm cannot precommit. In Denicoló (2008) a firm can overcomply to try to signal that compliance is relatively cheap, which then induces the government to impose tougher standards that hurts its competitors. Finally, Shimshack and Ward (2008) note that firms may not always have full control over their emissions. Firms overcomply because they want to be sure that they will avoid being punished if they accidentally pollute too much.

In this paper, we offer an alternative model for voluntary overcompliance. In a nutshell, the argument is as follows. Consider a monopolist firm that behaves in some polluting manner and is allowed to do so. But regulation may be forthcoming. An environmental group is lobbying to get the firm's practices banned. At the same time, the firm is lobbying for this not to be happen. It may then be worthwhile for the firm to restrict its pollution somewhat before the lobbying process takes place. By restricting pollution, the firm lowers the stakes of the environmental group. The group will then spend fewer resources on lobbying. This benefits the firm in two ways. First, it allows the firm to also spend less on lobbying, as the two are strategic substitutes in the sense of Bulow et al. (1985).[1] Second, it lowers the probability that a complete ban on pollution will be implemented. Thus, by polluting less than it is allowed to, and hence by using voluntary overcompliance, the firm is ultimately better off.

A related paper is Glachant (2005)[2] in which a polluting firm may try to negotiate a voluntary agreement with the regulator to avoid that a binding pollution level is put before congress, and it has to enter into a costly lobbying game with an environmental group. Although this model also has a rent-seeking game, the mechanism is different from that in our paper. We compare both models in more detail in the next section .

Our set-up allows us to answer a host of interesting questions. First, we study the welfare effects of voluntary overcompliance. Given that a costly lobbying game will be played, is society better off if the monopolist uses voluntary overcompliance, or would it be better off if the firm could somehow be banned from doing so? We show that the welfare effects are unambiguously positive. Total lobbying costs go down, and the outcome of the game will more often be some intermediate level of emission reduction, which is better for society as a whole. Interestingly, in the equilibrium of our model, voluntary overcompliance yields a Pareto improvement. Yet, we also show that, from a welfare point of view, the firm under-supplies overcompliance: society would be even better off with a higher level of voluntary overcompliance.

[1] That is, the reaction function of one player is decreasing in the action (in this case, the amount of lobbying) of the other player.

[2] Thanks to an anonymous referee for bringing this paper to my attention.

We also study a number of extensions. First, we show that the results we derive also holds for any regulated level of pollution that may be enacted should the firm lose the lobbying contest. The more stringent the proposed regulation is, the more voluntary overcompliance we will see, as the firm has a stronger interest in weakening the incentive of the environmental group to engage in an effective lobby. Second, we show that when the environmental group becomes more effective (for example because of more effective use of social media), the extent of voluntary overcompliance will increase. From a welfare perspective, it would be optimal if the environmental group were less effective in lobbying than the firm. As the firm already makes a concession by engaging in voluntary overcompliance, handicapping the environmental group in this way would level the playing field again. Third, we show that the environmental group cannot improve its position by precommitting to a lobbying effort. Precommitting in itself yields a strategic advantage, but it also implies that the firm no longer has an incentive for voluntary overcompliance. At least in the parametrization that we study, the net effect is negative from the group's perspective.

The remainder of this paper is structured as follows. Section 2 presents the general model, and Sect. 3 solves it. In Sect. 4 we analyze the welfare effects. Section 5 gives a simple example to illustrate our model. That example is also used in Sect. 6.3, where we study a number of extensions. Section 7 concludes.

2 The Model

Suppose a monopolist firm emits an amount of pollution that is normalized to 1. In the status quo, it is allowed to do so. If it were to reduce emissions by an amount R, with $R \in [0, 1]$, this would come at a cost of $c(R)$, twice continuously differentiable, with $c(0) = 0$. The cost of reducing emissions is increasing in R: $c'(R) > 0$ for $R > 0$. Moreover, we assume $c'(0) = 0$. This is a standard assumption that assures that as long as there is some benefit in doing so, the firm will always choose to have a strictly positive abatement level.[3] Also for simplicity, spending on emission reduction is additive. That is, the total costs of moving first to a reduction level of r and then to a reduction level of $R > r$ are equal to the costs of moving to reduction level R right away.

An environmental group has a disutility $D(e)$ for the amount of pollution e that the firm emits, with D twice continuously differentiable. The higher the level of pollution, the higher the group's disutility: $D'(e) > 0$. The group's disutility if there is no pollution is normalized to zero: $D(0) = 0$. For ease of analysis, we write the disutility of the environmental group as a function of emission reduction R rather than the emission level e. We thus write for disutility $d(R) \equiv D(1 - e)$. Note that, given the assumptions on D, this implies $d'(R) < 0$ and $d(1) = 0$.

We consider a two-stage game. In stage 1, the monopolist invests an amount $r \in [0, 1]$ in pollution reduction. Note that, since at this stage the firm is free to pollute, any $r > 0$ represents a case of overcompliance. In stage 2, the firm and the environmental group lobby government. After lobby expenses have been incurred, government decides which policy to implement. We assume that government can only choose between two extremes: either it permits all pollution, or it forbids pollution altogether. Although this is rather crude, we feel the assumption has merit. The political process will often not be able to finetune its policy by choosing the level of pollution that maximizes social welfare or some other objective function. Also, it may simply lack the information to do so. In an extension, we show that

[3] That is, it assures that we do not have a corner solution; see also footnote 4.

our qualitative results continue to hold when the choice is between permitting all pollution, or capping it at some exogenously given level. In our base model, if the environmental group wins the lobby contest, the government will forbid pollution and impose the firm to set a total pollution reduction of $R = 1$. If the firm wins, it does not have to reduce its pollution level any further, so we have $R = r$.

Lobbying takes place in a standard Tullock-type rent-seeking contest (Tullock 1980). This implies that if the firm spends some nonrecoverable amount l_f on lobbying, and the group spends some amount l_g, then the probability that the firm wins is

$$P_f = \frac{l_f}{l_f + l_g},$$

and the probability that the group wins equals

$$P_g = \frac{l_g}{l_f + l_g}.$$

If both refrain from lobbying, so $l_f = l_g = 0$, we make the common assumption that $P_f = P_g = 1/2$.

The values of l_f and l_g will be determined in equilibrium. In our context, winning for the firm means that the emission will be allowed, whereas winning for the group means that the emission will be forbidden. For ease of exposition, we assume no discounting.

As noted in the introduction, a related paper is Glachant (2005) in which a regulator negotiates a voluntary abatement level with a polluting firm. If the bargaining breaks down, the regulator will put a pollution level r before Congress, and a lobbying game between firm and environmental group ensues. The level r is lower than the socially optimal level, as this increases the probability of getting the legislation passed.In equilibrium, a voluntary agreement $\hat{r} < r$ is always reached. The set-up of the game is given in the left-hand panel of Fig. 1, which is a modified version of Glachant (2005), with his notation adapted to ours, to ease comparison. Our model is given in the right-hand panel of Fig. 1.

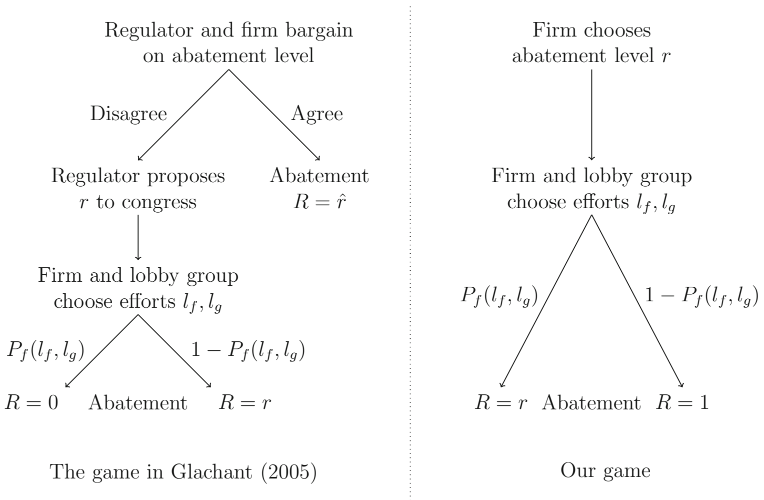

Fig. 1 Comparison between Glachant (2005) and this paper

Although Glachant (2005) also has a rent-seeking game, its mechanism is different from that in our paper. In Glachant (2005) the firm enters into a voluntary agreement to avoid a costly lobbying process. The outcome is deterministic, as in equilibrium, the rent-seeking game will not be played. In our paper the rent-seeking game cannot be avoided. Voluntary overcompliance is used to lower the stakes of the environmental group and hence make them less aggressive in the bargaining game. Thus, while Glachant (2005) is relevant in situations where regulators can strike a deal with the polluting firm before the environmental group can exert its influence, our model is applicable in situations where an environmental group can already start a campaign before the regulator becomes involved.

3 Solving the Model

We solve the model using backward induction. Given the amount of reduction r that the firm sets in stage 1, we can solve for the rent-seeking game in stage 2. Consider a rent-seeking game where the value of winning equals V_f for the firm and V_g for the environmental group. The solution of this game can be found e.g. in Hillman and Riley (1989). For completeness, we repeat the analysis here.

The expected utility of the firm is

$$U_f = P_f V_f - l_f = \frac{l_f}{l_f + l_g} V_f - l_f,$$

Taking the FOC,

$$\frac{\partial U_f}{\partial l_f} = \frac{l_g}{(l_f + l_g)^2} V_f - 1 = 0. \tag{1}$$

For the environmental group,

$$\frac{\partial U_g}{\partial l_g} = \frac{l_f}{(l_f + l_g)^2} V_g - 1 = 0.$$

Equating the two implies

$$l_g = l_f \frac{V_g}{V_f}.$$

Plugging this back into (1) yields

$$\frac{l_f V_g}{\left(l_f \left(1 + \frac{V_g}{V_f}\right)\right)^2} = 1.$$

Hence we have

$$l_i^* = \frac{V_i^2 V_j}{(V_i + V_j)^2}, \tag{2}$$

for $i, j \in f, g$ and $i \neq j$. From this we can derive

$$P_i^* = \frac{V_i}{V_i + V_j}, \tag{3}$$

also for $i, j \in f, g$ and $i \neq j$.

Next, we derive what the values of winning and losing are in the context of our model. In period 1, the firm has already invested r in emission reduction. These costs are sunk. When the firm loses the rents seeking game, it needs to reduce its emission levels to zero. Total costs of doing so are $c(1)$. Yet, the firm has already spent $c(r)$ to reach an amount of emission reduction r in period 1. Therefore, the additional costs of losing the contest are $c(1) - c(r)$. When the firm wins the rent seeking game, it obviously does not have to spend any additional money on emission reduction. For simplicity we define M as the maximum costs the firm can incur: $M \equiv c(1)$. We therefore have

$$V_f = M - c(r) \tag{4}$$

Now consider the environmental group. When it loses the contest, it is stuck with a reduction level of r, which yields disutility of $d(r)$. Winning the contest implies a disutility of zero. Hence

$$V_g = d(r). \tag{5}$$

Using (3), the equilibrium probability of the firm of winning the contest equals

$$P_f^*(r) = \frac{M - c(r)}{M - c(r) + d(r)} \tag{6}$$

For the environmental group

$$P_g^*(r) = \frac{d(r)}{M - c(r) + d(r)} \tag{7}$$

Equilibrium efforts thus are, using (2)

$$l_f^*(r) = \frac{(M - c(r))^2\, d(r)}{(M - c(r) + d(r))^2} \tag{8}$$

and

$$l_g^*(r) = \frac{(M - c(r))\, d(r)^2}{(M - c(r) + d(r))^2}. \tag{9}$$

We now move back to stage 1. The firm sets r to minimize its total expected cost over the entire game, which we denote $C(r)$. We have

$$C(r) \equiv P_f^*(r) \cdot c(r) + P_g^*(r) \cdot M + l_f^*(r) \tag{10}$$

The first term gives its total costs of emission reduction when it wins the contest that ensues. The second term gives its total costs when it loses that contest. The third term gives the expected costs of lobbying in that contest. We now have

Theorem 1 *In the equilibrium of this game, the firm chooses some $r^* > 0$. Hence, we always have voluntary overcompliance.*

Proof In what follows, we suppress the arguments of c and d. Plugging (6), (7) and (8) into (10), we have

$$\begin{aligned} C(r) &= \left(\frac{M - c}{M - c + d}\right) c + \left(\frac{d}{M - c + d}\right) M + \frac{(M - c)^2\, d}{(M - c + d)^2} \\ &= \frac{cM - c^2 + dM}{M - c + d} + \frac{(M - c)^2\, d}{(M - c + d)^2} \\ &= \frac{(M - c)\left(2dM + cM - c^2\right) + d^2 M}{(M - c + d)^2}. \end{aligned}$$

After some additional calculations we have

$$C'(r) = \frac{(M-c)^2\left(\left(c'+2d'\right)(M-c)+3c'd\right)}{(M-c+d)^3}$$

Note that necessarily $M-c \geq 0$, which also implies $M-c+d > 0$. For the FOC to be satisfied, we thus need:

$$f(r) \equiv \left(c'+2d'\right)(M-c)+3c'd = 0 \tag{11}$$

Note that $c'(0) = 0$ implies that $f(0) = 2d'(M-c) < 0$. Moreover, since by definition $M-c(1) = 0$, we have $f(1) = 3c'd > 0$. Since c and d are twice continuously differentiable, we have that f is continuous. Taken together, this implies that we must have at least one $r^* \in (0, 1)$ such that $f(r^*) = 0$ and, moreover, f is increasing at r^*.[4]

We will now establish that $C'(r)$ is increasing at r^*, so r^* is indeed a local minimum. Define $b(r) \equiv \frac{(M-c)^2}{(M-c+d)^3}$, so we can write $C'(r) = b(r)f(r)$. Evaluating C'' at r^*, we have

$$C''(r) = b(r^*)f'(r^*) + b'(r^*)f(r^*).$$

Above we established that $f(r^*) = 0$ and $f'(r^*) > 0$. With $b(r^*) > 0$, this implies $C''(r^*) > 0$ so r^* is indeed a local minimum. In principle, we could have more local minima, hence more r's for which $f(r) = 0$ and $f'(r) > 0$.[5] Naturally, the firm then chooses the local minimum that has the lowest total cost. Note however that, since $C'(0) = b(0)f(0) < 0$ and $C'(1) > 0$, the restriction that $r \in [0, 1]$ is never binding for such r, so the global minimum is one of the local minima. This implies that we always have voluntary overcompliance. □

This result can be understood as follows. Suppose we are in a case without voluntary overcompliance, so $r = 0$. By increasing r slightly, the firm only faces a second-order increase in its reduction costs. Yet, the disutility of the environmental group decreases substantially. This implies that for the group, the stakes in the lobbying contest decrease, so it will put less effort into that contest. This is good news for the firm. Thus, by granting a small concession before the contest, the value of winning the contest for the environmental group decreases, while that of the firm itself is hardly affected. For a given level of its effort, this increases the probability that the firm wins the contest, and does not have to do any additional emission reduction.

4 Welfare Effects

We now consider social welfare. Initially, we look at the case in which social welfare is simply defined as the sum of the expected utility levels of both players in the game; the firm and the environmental group. Yet, if we take a broader perspective, we should also take the welfare of the population at large into account. We do so at the end of this section. Effectively, we initially assume that the environmental group perfectly represents the entire population, and has the exact same disutility of pollution. After that, we allow for any welfare function of the population at large that is proportional to that of the environmental group.

[4] We therefore need the assumption that $c'(0) = 0$: without it, we may have $f(0) > 0$, which could imply that $C'(r) > 0$ for all r. If that were the case, the firm would choose $r^* = 0$. Hence the assumption $c'(0) = 0$ is sufficient (though not necessary) to have voluntary overcompliance.

[5] Note that any r for which $f(r) = 0$ and $f'(r) < 0$ has $C''(r) < 0$ and is a local minimum.

First, restrict attention to the firm and the environmental group. We look at the level of r that maximizes social welfare, given the rent-seeking contest that will ensue. Expected social costs then equal

$$SC(r) = P_f^*(r) \cdot (c(r) + d(r)) + P_g^*(r) \cdot (c(1) + d(1)) + l_f^*(r) + l_g^*(r). \tag{12}$$

The first term gives total costs if the firm wins the contest, weighted by the probability that this event will occur. The second term gives total costs if the environmental group wins the contest, weighted by the probability that this event will occur. The last two terms give the total lobby costs that will be incurred.

Using (10) and the fact that $d(1) = 0$, we can write

$$SC(r) = C(r) + P_f^*(r) \cdot d(r) + l_g^*(r)$$

Again suppressing arguments of $c(r)$ and $d(r)$, and writing $M \equiv c(1)$,

$$\begin{aligned} SC(r) &= C(r) + P_f^*(r) \cdot d(r) + l_g^*(r) \\ &= C(r) + \left(\frac{M-c}{M-c+d}\right) d + \frac{(M-c)\, d^2}{(M-c+d)^2} \\ &= C(r) + \frac{(M-c)\, d\, (M-c+2d)}{(M-c+d)^2} \end{aligned} \tag{13}$$

After some calculations, this implies

$$SC'(r) = C'(r) + \frac{d'\,(M-c)^2\,(M+3d-c) - 2c'd^3}{(M-c+d)^3}. \tag{14}$$

This immediately implies

Theorem 2 *The amount of overcompliance provided by the firm in equilibrium is too low from a welfare point of view.*

Proof By construction, the solution r^* that the firm chooses, is such that $C'(r^*) = 0$. With $c' > 0, d' < 0$ and $M - c > 0$, the fraction on the right-hand side of (14) is strictly negative, which implies that $SC'(r^*) < 0$. Hence, starting at r^*, social costs would decrease, and hence welfare would increase, by choosing a higher r. □

Yet, we also have the following:

Theorem 3 *The amount of voluntary overcompliance provided by the firm in equilibrium yields a Pareto improvement compared to the case without overcompliance.*

Proof The expected costs of the environmental group are given by $P_f^* d(r) + l_g^*(r)$, which equals the fraction at the right-hand side of (13). The derivative with respect to r is given by the fraction at the right-hand side of (14), and is shown to be always negative. This implies that the environmental group is always better off with higher r. Trivially, voluntary overcompliance also makes the firm better off: otherwise, it could simply have chosen $r = 0$. □

Thus, welfare increases when a firm chooses voluntary overcompliance—yet it could increase even more. Note that disutility of the environmental group is very high in a case where there is no emission reduction, whereas the costs of the firm are very high when it is not allowed to emit any pollution. It would be best for social welfare if we would end up somewhere in the middle. With voluntary overcompliance, such a case is more likely to occur. Rather than making the stark choice between reduction levels of 0 and 1, government now effectively chooses between 1 and some $r \in (0, 1)$. Moreover, the total amount of socially wasteful lobbying activities also decreases in r, as we will show below. Both the firm and the environmental group are better off with voluntary overcompliance. Yet, the firm cannot capture all the positive social benefits from its overcompliance. This implies that, in equilibrium, overcompliance is undersupplied.

Theorem 4 *Total lobbying costs are strictly decreasing in the level of overcompliance r.*

Proof Total lobbying costs are

$$\begin{aligned} l_f^*(r) + l_g^*(r) &= \frac{(M-c)^2\, d + (M-c)\, d^2}{(M-c+d)^2} \\ &= \frac{(M-c)\, d}{M-c+d}. \end{aligned}$$

Taking the derivative wrt r yields

$$\frac{\partial \left(l_f^*(r) + l_g^*(r) \right)}{\partial r} = \frac{d'\,(M-c)^2 - c' d^2}{(M-c+d)^2} < 0.$$

□

The intuition for this result is straightforward. As we argued before, voluntary overcompliance implies that the stakes in the rent-seeking contest are lower, hence efforts exerted in that contest will be lower as well.

So far, we have restricted attention to welfare of the firm and that of the environmental group, using the implicit assumption that welfare of the environmental group coincides with that of the population at large. Now assume that the environmental group is an imperfect representation of that population, for example due to the costs of getting organized, or due to free-riding in providing contributions for the lobbying process. We thus assume that the environmental group is a representative subgroup of the entire population: where the disutility of the environmental group is given by $d(r)$, we assume that that of the entire population (including the environmental group) is proportional and given by $\phi d(r)$, with $\phi \geq 1$. Note that with $\phi = 1$, we're back to the situation discussed above.

Total expected social costs now equal

$$SC(r) = C(r) + P_f(r) \cdot \phi d(r) + l_g^*(r)$$

Again suppressing the arguments of $c(r)$ and $d(r)$, and writing $M \equiv C(1)$;

$$\begin{aligned} SC(r) &= C(r) + P_f(r) \cdot \phi d(r) + l_g^*(r) \\ &= C(r) + \left(\frac{M-c}{M-c+d} \right) \phi d + \frac{(M-c)\, d^2}{(M-c+d)^2} \\ &= C(r) + \frac{(M-c)\, d\, [\phi\,(M-c) + (1+\phi)\, d]}{(M-c+d)^2} \qquad (15) \end{aligned}$$

Theorem 5 *When the combined disutility of the environmental group and the population at large is given by $\phi d(r)$,with $\phi \geq 1$, then the amount of voluntary overcompliance provided is still too low from a welfare point of view, but a Pareto improvement compared to the case without overcompliance.*

Proof Taking the derivative of social welfare (15) now yields

$$SC'(r) = C'(r) + \frac{d'(M-c)^2\left[(M-c)\phi + (2+\phi)d\right] - c'd^2\left[d(1+\phi) - (M-c)(1-\phi)\right]}{(M-c+d)^3}$$

Note that this indeed collapses into (14) for $\phi = 1$. For the results to hold, it is again sufficient for the fraction on the right-hand side to be strictly negative. With $d' < 0$ and $c' > 0$, this is true if $(M-c)\phi + (2+\phi)d > 0$ and $d(1+\phi) - (M-c)(1-\phi) > 0$. The first condition is trivially satisfied. For the second condition, note that it is satisfied for $\phi = 1$. With the left-hand side increasing in ϕ, this implies that it is also satisfied for any $\phi > 1$. Taken together, this establishes the result. □

5 Example

In the previous section, we derived our main results for a general specification of emission reduction costs $c(r)$ and disutility $d(r)$. In this section, we choose simple functional forms for $c(r)$ and $d(r)$ as an illustration for our model. This specification will also be the basis for a number of extensions in the next section.

Suppose

$$c(r) = r^2 \text{ and } d(r) = (1-r)^2.$$

It is easy to see that these simple functional forms satisfy the restrictions we put on $c(r)$ and $d(r)$. For the firm, the costs of cleaning up increase at an increasing rate, and for the environmental group the disutility of pollution increases at an increasing rate. Using (4) and (5), this implies for the rent seeking contest that $V_f = 1 - r^2$ and $V_g = (1-r)^2$. From (6) through (9), we thus have

$$P_f^*(r) = \tfrac{1}{2}(1+r) \qquad l_f^*(r) = \tfrac{1}{4}\left(1-r^2\right)^2$$
$$P_g^*(r) = \tfrac{1}{2}(1-r) \qquad l_g^*(r) = \tfrac{1}{4}(1+r)(1-r)^3$$

In stage 1, the firm minimizes

$$C(r) = \frac{1}{2}(1+r)\cdot r^2 + \frac{1}{2}(1-r) + \frac{1}{4}\left(1-r^2\right)^2 = \frac{1}{4}\left(r^4 + 2r^3 - 2r + 3\right)$$

Taking the FOC

$$\frac{\partial C(r)}{\partial r} = \frac{1}{4}\left(4r^3 + 6r^2 - 2\right) = 0.$$

This implies $r^* = \frac{1}{2}$. Note that $\partial^2 C(r)/\partial r^2 = 3r(r+1) > 0$ for $r > 0$, which implies that r^* is indeed a global minimum.

Now consider social welfare. Using (12), expected social costs are

$$SC(r) = C(r) + \frac{1}{2}(1+r)\cdot(1-r)^2 + \frac{1}{4}(1+r)(1-r)^3 = \frac{1}{2}\left(3r^3 - r^2 + 3 - 3r\right).$$

This is minimized for $r \approx 0.699$, yielding expected social costs of 0.7195. The firm's choice, $r^* = 0.5$, yields expected social costs of 0.8125. Hence, the firm undersupplies overcompliance. Yet, without voluntary overcompliance, we have $SC(0) = 1.5$: the level of overcompliance chosen by the firm yields lower expected social costs than a case in which there is no overcompliance.

6 Extensions

6.1 Introduction

In this section we study a number of extensions of our base model. Section 6.2 relaxes the assumption of all-or-nothing legislation. We show that our qualitative results still hold when the firm is faced with the threat of some regulated maximum pollution level. Section 6.3 analyzes how the extent of voluntary overcompliance is affected when the environmental group becomes more effective in its lobbying efforts. Section 6.4 studies the case in which the environmental group moves first and can commit on a lobbying effort.

6.2 A Change in Threatened Legislation

So far, we assumed that, if the firm loses the lobbying game, pollution will be forbidden altogether so the required abatement is $r = 1$. Now suppose that we are in a situation that is somewhat less stark. Suppose that there is an ideological govenment that proposes a required abatement of $r = \mu$. Obviously, a green government would set μ high, while a more conservative government would set a lower μ. Still, before the legislation is enacted, the firm and the lobby group play a rent-seeking game where the stakes are either that the legislation will be enacted, or that pollution will not be restricted.

In this case, we have $M = c(\mu)$ rather than $M = c(1)$. Apart from that, the analysis goes through as above. To analyze the effect of a change in μ (or, equivalently, M), note that the equilibrium r^* is given by (11). Take the total differential:

$$\frac{dr^*}{dM} = -\frac{\partial g/\partial M}{\partial g/\partial r^*} = -\frac{c' + 2d'}{f}$$

With $c'd > 0$, at r^* we necessarily have $c' + 2d' < 0$. We also established $f'(r^*) > 0$, hence $dr^*/dM > 0$.

Hence, as the threaten legislation is more adverse (and μ is higher) implies more voluntary overcompliance.

6.3 Changing the Group's Effectiveness

Voluntary overcompliance seems to have increased recently. Moreover, environmental groups now find it easier to organize and put pressure on firms, for example through the use of smartphones and social media. Using such technologies, it has become much easier to mobilize supporters and coordinate their actions, should some spontaneous protest or lobbying activity be deemed necessary. Also, many groups have grown into professional operations, almost resembling multinational firms themselves. Our model suggests that there may be a link between the increase in voluntary overcompliance and the increase in effectiveness of environmental groups. To show this, we take the simplified model of the previous section as our starting point. Using the more general framework of Sect. 2 would lead to intractible results.

An increase in effectiveness implies that for every dollar spent on lobbying activities, the environmental group can now expect to see a higher return, i.e. a higher probability of winning the contest. Let γ measure the group's effectiveness, $\gamma > 0$. If the group spends an amount l_g in the rent-seeking contest, the effectiveness of that amount is now given by γl_g. This implies that the probabilities of winning the contest are now given by

$$P_f = \frac{l_f}{l_f + \gamma l_g}, \tag{16}$$

and

$$P_g = \frac{\gamma l_g}{l_f + \gamma l_g}. \tag{17}$$

Thus, the parameter γ measures the relative efficiency of lobbying dollars spent by the environmental group. In the previous section, we had $\gamma = 1$. An increase in the effectiveness of the environmental group can be modelled as an increase in γ.

For the general model, we now have that in stage 2, the firm's problem is

$$\max_{l_f} \left(\frac{l_f}{l_f + \gamma l_g} \right) V_f - l_f,$$

with a similar expression for the environmental group. Taking first order conditions yields

$$\frac{\gamma l_g V_f}{\left(l_f + \gamma l_g\right)^2} = 1.$$

We can now derive

$$l_f^* = \frac{\gamma V_g V_f^2}{\left(V_f + \gamma V_g\right)^2} \text{ and } l_g^* = \frac{\gamma V_g^2 V_f}{\left(V_f + \gamma V_g\right)^2}.$$

Since we again have $V_f = M - c(r)$ and $V_g = d(r)$, this implies

$$l_f^* = \frac{\gamma d(r) \left(M - c(r)\right)^2}{\left(M - c(r) + \gamma d(r)\right)^2} \tag{18}$$

$$l_g^* = \frac{\gamma d(r)^2 \left(M - c(r)\right)}{\left(M - c(r) + \gamma d(r)\right)^2} \tag{19}$$

Using (16) and (17), equilibrium probabilities are now given by

$$P_f^* = \frac{V_f}{\left(V_f + \gamma V_g\right)} = \frac{M - c(r)}{M - c(r) + \gamma d(r)} \tag{20}$$

$$P_g^* = \frac{\gamma V_g}{\left(V_f + \gamma V_g\right)} = \frac{\gamma d(r)}{M - c(r) + \gamma d(r)} \tag{21}$$

We now have

Theorem 6 *When the environmental group becomes more effective, the level of voluntary overcompliance increases:* $dr^*/d\gamma > 0$.

Proof Plugging the expressions for P_f^* and P_g^* into (10) and dropping arguments of $c(r)$ and $d(r)$ for ease of exposition, the cost function of the firm is now given by

$$C(r) = \left(\frac{M-c}{M-c+\gamma d}\right)c + \left(\frac{\gamma d}{M-c+\gamma d}\right)M + \frac{(M-c)^2\,\gamma d}{(M-c+\gamma d)^2}$$
$$= \frac{(M-c)\left(2\gamma d M + cM - c^2\right) + \gamma d^2 M}{(M-c+\gamma d)^2}.$$

After some calculations we can show to have

$$C'(r) = \frac{(M-c)^2 \cdot A(\gamma, r)}{(M-c+\gamma d)^3}$$

with $A(\gamma, r) = \left(c' + 2\gamma d'\right)(M-c) + 3c'\gamma d$. Note that necessarily $M - c \geq 0$, which also implies $M - c + \gamma d > 0$. For the FOC to be satisfied, we thus need

$$A(\gamma, r) = 0. \tag{22}$$

For the firm's problem to be well-defined, we need C to be convex at the optimal solution, i.e. $C'' > 0$. We have

$$C''(r) = \frac{(M-c+\gamma d)\left[(M-c)^2 A' - 2A(M-c)c'\right] + 3(M-c)^2 Ac'}{(M-c+\gamma d)^4}.$$

When the FOC is satisfied, we have $A = 0$, so at the optimal solution this simplifies to

$$C''(r) = \frac{(M-c)^2 A'}{(M-c+\gamma d)^3}.$$

For this to be positive, we need $A' > 0$. Taking the total differential of (22),

$$\frac{dr^*}{d\gamma} = -\frac{\partial A/\partial \gamma}{\partial A/\partial r} \tag{23}$$

As we showed above, convexity of $C(r)$ requires that $\partial A/\partial r > 0$. Also note

$$\frac{\partial A}{\partial \gamma} = 2d'(M-c) + 3c'd.$$

From (22), we have that $c'(M-c) + 2\gamma d'(M-c) + 3c'\gamma d = 0$, so $2d'(M-c) + 3c'd = -c'(M-c)/\gamma$, which implies

$$\frac{\partial A}{\partial \gamma} = -c'(M-c)/\gamma < 0,$$

so from (23) the result follows. □

Doing a welfare analysis in this general framework is too tedious. We therefore return to the example in Sect. 5. To consider the effect of a change in γ on social welfare, we first derive the equilibrium amount of total lobbying outlays as function of γ. Using (18) and (19), we have

$$l_f^*(r) + l_g^*(r) = \frac{2\gamma\left(1-r^2\right)(1-r)}{(1+r+\gamma(1-r))^2}$$

Plugging this into (12), using (20) and (21), total social costs now equal

$$SC(r,\gamma)=\left(\frac{(1+r)\left(r^2+(1-r)^2\right)+\gamma(1-r)}{(1+r)+\gamma(1-r)}\right)+\frac{2\gamma\left(1-r^2\right)(1-r)}{(1+r+\gamma(1-r))^2} \tag{24}$$

Solving for $r^*(\gamma)$ and plugging that into social welfare yields

$$SC(r^*,\gamma)=2\frac{1+\gamma+44\gamma^2+80\gamma^3+3\gamma^4-\gamma^5+(\gamma+1)\left(\gamma^3-11\gamma^2-7\gamma+1\right)W}{(1-\gamma)\left((1-\gamma)^2+(1-\gamma)W\right)^2}$$

with $W\equiv\sqrt{\left(\gamma^2+14\gamma+1\right)}$. Minimizing this with respect to γ yields, after some particularly tedious calculations:

Result 1 *Given the game that will be played, expected social costs are minimized when γ is set at $\gamma=-8+5\sqrt{3}\approx .66025$.*

Hence, an increase in the effectiveness of the environmental group has an ambiguous effect on welfare. For very low γ, thus for cases in which the group is relatively ineffective, welfare increases when the group becomes more effective. Yet, for higher γ this is no longer the case, and welfare decreases with γ. The intuition is as follows. From a welfare point of view, it is best if the expected amount of emission reduction ends up somewhere halfway between 0 and 1. For low R, the disutility for the environmental group is very high, whereas for high R, the reduction costs for the firm are. Direct social costs, $c+d$, are minimized at $r=1/2$. When the environmental group is very effective, the expected value of R will be close to 1. When it is very ineffective, the expected value of R will be close to 0. Neither case is attractive from a welfare point of view. Hence, society is best of with some intermediate value of γ.

Note that in the social optimum the firm is more effective in lobbying than the environmental group: $\gamma^*<1$, even though the direct costs for firm and group are symmetric. This is due to the set-up of our model. In stage 1, the firm already makes a concession by committing to emission reduction at least equal to r^*. To still reach the social optimum, this implies the firm needs an advantage in stage 2, in the form of a lobbying techology that is more effective than that of the environmental group. Indeed, in a model without the possibility of overcompliance, using (24), social costs are $SC(0)=1+2\gamma/(1+\gamma)^2$, which are minimized for $\gamma=1$. In that case, we do have equal effectiveness for both agents as the social optimum.

6.4 The Environmental Group Moves First

Suppose that the environmental group could tie its hands by already committing to some lobbying effort l_g in advance.[6] Would that possibility make the group better off? This is an interesting issue. One the one hand, it would imply that there is no longer any voluntary overcompliance; as already argued extensively above, the whole point of overcompliance is to soften the stance of the environmental group, so it does not exert so much effort in the lobbying game. If the group already commits to a lobbying effort, there will be no voluntary overcompliance, as it cannot affect the behavior of the group. This is bad news for the group as we saw that voluntary overcompliance lowers the expected costs of the group. On the other hand, from the industrial organization literature, we know that a player is strictly better off if it can commit to an action by moving first. The net effect of these two counterveiling forces is not a priori clear.

[6] Thanks to an anonymous referee for suggesting this extension.

Unfortunately, it is hard to address this question in our general framework. We therefore look at our example, and generalize that a bit by assuming the following cost functions

$$c(r) = r^2;\ \ d(r) = \tau(1-r)^2.$$

where the parameter τ allows us to vary the group's (marginal) disutility of pollution. Using (4) and (5), this implies for the rent seeking contest that $V_f = 1 - r^2$ and $V_g = \tau\,(1-r)^2$. From (6) through (9), we thus have

$$P_f^*(r) = \tfrac{1-r^2}{1-r^2+\tau(1-r)^2};\ \ P_g^*(r) = \tfrac{\tau(1-r)^2}{1-r^2+\tau(1-r)^2}.$$

Equilibrium efforts thus are, using (2)

$$l_f^*(r) = \tfrac{\left(1-r^2\right)^2\tau(1-r)^2}{\left(1-r^2+\tau(1-r)^2\right)^2};\ \ l_g^*(r) = \tfrac{\left(1-r^2\right)\left(\tau(1-r)^2\right)^2}{\left(1-r^2+\tau(1-r)^2\right)^2}.$$

In stage 1, the firm minimizes

$$\begin{aligned} C(r) &= P_f^*(r)\cdot r^2 + P_g^*(r) + l_f^*(r) \\ &= \left(\frac{1-r^2}{1-r^2+\tau(1-r)^2}\right)r^2 + \frac{\tau(1-r)^2}{1-r^2+\tau(1-r)^2} + \frac{\left(1-r^2\right)^2\tau(1-r)^2}{\left(1-r^2+\tau(1-r)^2\right)^2} \end{aligned}$$

Taking the FOC and putting it equal to zero yields

$$r^* = \frac{1}{\tau-1}\left(\frac{3}{2}\tau - \frac{1}{2}\sqrt{14\tau+\tau^2+1} + \frac{1}{2}\right)$$

The expected costs of the environmental group then are

$$\begin{aligned} &P_f^*(r^*)\cdot\tau(1-r^*)^2 + l_g^*(r^*) \\ &\quad = \tau\left(1+r^*\right)\left(1-r^*\right)^2\frac{2\tau\,(1-r^*)+1+r^*}{(\tau\,(1-r^*)+(1+r^*))^2} \end{aligned} \tag{25}$$

Now consider the game with sequential moves in which the environmental group commits to a lobbying effort befor eth firm can move. In that case, we necessarily have $r = 0$. In the second stage, the firm minimizes $\frac{l_g}{l_g+l_f} + l_f$, which yields

$$l_f = \sqrt{l_g} - l_g. \tag{26}$$

In the first stage, the group minimizes

$$\frac{l_f}{l_g+l_f}\tau + l_g = \frac{\sqrt{l_g}-l_g}{\sqrt{l_g}}\tau + l_g$$

where the inequality follows from (26). Minimizing this with respect to l_g yields $l_f^* = \frac{\tau}{2} - \frac{1}{4}\tau^2$ which yields expected costs for the group of $\tau - \frac{1}{4}\tau^2$. It can be shown that this is always smaller than the expression given in (25). At least for this parametrization the environmental group is always better off moving second.

7 Conclusion

In this paper, we gave an explanation for voluntary overcompliance, the phenomenon in which firms voluntarily choose to overcomply with environmental regulations. In our model, firms do so to influence the lobbying stage that ensues. In that stage, the firm plays a rent-seeking contest with an environmental group. By making small concessions beforehand, the firm can substantially soften the competition from the environmental group. A small concession is relatively cheap for the firm, but very worthwhile for the environmental group. Hence, by making a small investment, the firm lowers the stake the environmental group has in the rent seeking contest, which implies that it will spend less effort in that contest. Voluntary overcompliance increases social welfare, yet the amount of voluntary overcompliance that the firm chooses is too low from a welfare point of view.

An increase in the effectiveness of lobbying of the environmental group, increases the level of overcompliance that the firm chooses. Social welfare is concave in the effectiveness of the environmental group. When the group is either too powerful, or not powerful enough, society is worse off. As the threatened legislation becomes less averse for the firm, it will choose less voluntary overcompliance.

Admittedly, voluntary overcompliance in our model is primary a result of the inefficiency of the political process. When there is a benevolent dictator immune to lobbying that directly implements the first-best social optimum, we would not have a rent-seeking contest. In that case, there is thus no voluntary overcompliance. Our model is also not able to explain voluntary overcompliance in a world where the ultimate policy is a continuous function of the lobbying efforts of the two players. This is for example the case in a menu auction (see e.g. Grossman and Helpman 1994). When there is a continuum of policy options that will be considered, we need a different model to explain voluntary overcompliance.

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