Using Private Politics to Discipline Biased Regulators*

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Preliminary and incomplete version

October, 2012

* We thank participants at various seminars and conferences: Toulouse School of Economics Conference in Honor of Michel Moreaux; Université de Franche-Comté; SURED Conference. We are particularly indebted to David Martimort and to Jean Tirole for early stimulating discussions and helpful advice. The research leading to these results has received funding from the European Research Council under the European Community's Seventh Framework Programme (FP7/2007-2013) grant agreement 249415-RMAC.

Abstract

The paper introduces private politics into a model of public regulation with a biased supervisor. Indeed, public regulation and private politics are the main two channels by which modern societies influence externality-generating industrial decisions. Moreover, in the light of recent regulatory failures in the financial and energy sectors, it seems reasonable to consider that regulatory entities are often biased in favor of the industry they supervise. We extend the conventional setup of the "new economics of regulation" to consider cases of pro-industry regulatory bias. We show that, under certain conditions, a benevolent legislature may want to legally protect the actions of activists; the result applies even if activists are less informed than supervising agencies, thus taking actions that are socially inappropriate, and even if their interventions generate non-negligible dead-weight costs. Activism turns out to be a supervisor-disciplining device that reduces the social cost of regulation.

JEL classification: D02; D74; D82

Keywords: Regulation; Pro-firm bias; Private politics; Activism

1. Introduction

In modern market economies, there are basically two channels through which society can influence externality-generating decisions made by private agents. The first one is to implement and enforce coercive regulations: it is a prerogative of government. The other one consists in strategic actions on the part of private activist parties attempting to further their interests. Such interventions, whether through public regulatory agencies or private third parties, might be needed to prevent some decisions of private firms that might be detrimental to social welfare. On the other hand, both types of intervention have their respective limitations, which are not independent of each other. The purpose of this paper is to make a first step towards understanding their synergies.

Activism, whether individual or collective, has been referred to by Baron (2001) as the manifestation of *private politics*. He coined the expression to mean private initiatives that cannot rely on the law to take part in the resolution of conflicts. Such initiatives have become common practice over the last decades. When successful, they result in various forms of agreements between firms and activists such as private certification or voluntary efforts to mitigate social conflicts. The most noticeable manifestations of private politics go through a process of threats of punishments whose most common form is the call for boycott. As pointed out by Baron, the currently most important facet of private politics is the unobservable pro-active measures adopted by firms in anticipation of activists' reaction.

More often than not, activists are to represent stake-holders who bear the external costs of status-quo. Hence, private politics has an evident Coasian dimension. The appeal of Coasian bargaining to resolve Pareto-inefficient situations essentially relies on its potential to strictly improve total surplus. Were transaction costs sufficiently high, this potential might not be realized. The recent positive literature on boycotts has paid a considerable amount of attention to these side costs of activism; instances include the costs of coordination between individual activists (Baron, 2003), the cost of acquiring information on the targeted firm (Baron, 2003), the effort of participating individuals

(John and Klein, 2003)... Another limitation of Coasian bargaining processes is the presumption that agents are rational maximizers, whether of their own surplus or of other stake-holders' surplus. As Baron puts it, it may be "that the players are ideologues or behavioral types that simply refuse to change their positions. A theory of private politics should allow for the possibility that the activists (...) may be intransigent behavioral or reputational types." (2003, p. 39). This is what we do in this article. Having Baron's remark in mind about rigid behaviors in private politics, we assume that activists are not sensitive to monetary incentives.

Baron (2003) was also the first to suggest that private politics should be examined in combination with public politics, among other reasons because of the plausibility that activists may also attempt to directly lobby regulators (e.g. Kollman, 1998). The theory of incentives in procurement and regulation (Laffont and Tirole, 1993, Ch. 11) adopted this view while extending the conventional regulatory framework to introduce possibilities of regulatory capture by several interest groups. In Laffont and Tirole's setup, both firms and activists can collude with a supervisor with the objective of furthering their interest.

It is a matter of facts that most activists have now given up spending resources on direct lobbying, since they can be "easily counter-lobbied by corporations" (Paul Gilding, former head of Greenpeace; see a more complete quotation later). This view is defended by Baron (2003) and Yu (2005).[1] Both authors point at the activists' alternative strategy to persuade public opinion and policy makers so as to indirectly affect regulatory practices. Much in contrast, the regulation literature has emphasized that the legislature in power has only limited influence on supervisory agencies. In fact, this limitation is at the root of the concept of regulatory capture. Laffont and Tirole tackled this issue by adding one layer to the strategic model. Through the lens of principal-agent relationships, regulation is a task in itself, usually delegated to expert agencies enjoying an informational rent. The analysis suggests the view of a dichotomic regulation, with a legislature (or Congress) in charge of designing the optimal delegation scheme of the regulatory task to a supervisory agency. In presence of interest groups, Congress should rely on collusion-free regulation based on sufficient public-fund transfers from Congress to the agency; the

[1]Relatedly, Chiroleu-Assouline and Lyon (2011) have shown that the strategy of avoiding direct lobbying is particularly relevant for "radical" activists.

threat of collusion thus entails some social costs.

Transfers from Congress to the agency, however broadly they may be interpreted, are the downside of lobbying on the part of interest groups. A relevant and simplifying fashion to incorporate effective regulatory capture consists in assuming, in the manner of Baron and Myerson (1982) and Baron and Besanko (1984), supervisors to pursue biased objectives, as in Hiriart and Martimort's (2012) Congress-agency model. We adhere to this representation which fits nicely with our assumption that interest groups hardly reach their objective by directly lobbying agencies.

In contrast with the aforementioned contributions, we do away with the assumption that biased regulatory agencies are giving less importance to producer surplus than to the surplus of the rest of society. The assumption that regulators are more concerned by consumer surplus than they are by firms' profit is standard in the literature on regulatory issues. A noticeable and recent exception is Hiriart and Martimort (2012). In that paper, the supervisory agency, still pro-consumer biased, is less so than the legislature.[2]

In the light of recent failures to impose adequate standards in the financial and energy sectors, the assumption that regulators are biased towards firms is at least as palatable as the alternative, more traditional assumption of unbiased supervisors.[3] Not only do we extend the conventional setup of the "new economics of regulation" in this respect, but we also borrow Laffont-Tirole's standard assumption that public funds are costly to collect. It will turn out that distortionary forces stem from the combination of both assumptions, providing new insights on the nature of regulatory failures.

In this paper, we first reexamine the optimum regulation problem in the context of pro-industry-biased agencies. To this effect, we adapt standard assumptions from the regulatory literature so as to propose a new model that incorporates biased supervisors. We ask the following question. From the viewpoint of a benevolent legislature bound to rely on biased agencies, is it desirable to allow costly private-politics actions by activists

[2]Hence, following their interpretation, the agency is not pro-industry biased in absolute terms, but only as compared with the Congress.

[3]Often, the assumption of pro-consumer biased regulation is justified on the ground of a suggestive example developed by Bower (1979). The example is to be balanced with political scientists' observations that firms take active interest in the activities of their regulators (e.g. Horn, 1995). Baron's (1988) argument that pro-consumer regulatory bias may arise from the preferences of the median voter is definitely sensible once account is taken of constraints on the delegation exercise, of ex ante informational asymmetries, of inter-individuals' connivance and of ex post career concerns.

that are not sensitive to monetary incentives?

There is another crucial consideration. Asymmetries of information are central to the analyses of both public regulation and private politics, but in very different fashions. The Congress-agency dichotomic framework can be interpreted as one in which Congress ex ante sets down the law under a veil of ignorance while the agency is delegated the regulatory task of supervising projects under this law. The agency is endowed with expertise, resources and legal prerogative to value projects. Activists also rely on their own expertise for that. However, unlike supervising agencies, they cannot directly observe projects' values. As will be further justified later on, public agencies have better information than activists.

In some respects, the question we study is reminiscent of Kofman and Lawarrée's (1993) dual-auditor problem. Their study highlights that uninformed shareholders who contract with an informed manager may appear to be better-off by not only relying on internal, well informed and efficient auditors, but also on external, less-well informed and more costly ones. Random external audits deter possible collusion between the manager and internal auditors. Unlike auditors, activists' actions cannot be contracted upon. From a regulatory perspective, this aspect introduces a sharp distinction with conventional modeling. Because activists are not sensitive to monetary incentives, their actions cannot be finely influenced by the Congress, who only has the choice between completely forbidding these actions, or tolerating them without restrictions.

Another closely related reference is Egorov and Harstad (2012) who study the interplay between government regulation, self regulation and private politics. They represent strategic interactions between the three protagonists (Firm, Regulator and Activists) as a dynamic game and derive testable predictions on the characteristics of boycotts across industries. Our paper complements their positive approach by investigating the characteristics of optimal regulation in the presence of biased supervisors.

Public regulation can pro-actively intervene in a large number of matters; the absence of regulation is a regulatory decision per se. Thus all examples of activists' actions can be interpreted as showing the confrontation of private politics with public regulation. For the sake of concreteness, we shall refer all along this article to one particularly illustrative case study, namely the 1995 Greenpeace-Shell conflict over the dismantlement of the

Brent Spar platform. This conflict arose from the combination of an initial regulatory decision to follow the firm's best option as well as of divergent estimations by the firm and Greenpeace. The approval by the UK Government Department of Trade and Industry of Shell's plan to decommission the platform has been given on the ground of Shell's low estimate of the quantity of crude oil on the platform (50 tonnes); estimate and proposal also substantiated by several external studies by independent organizations. Incorrectly-collected samples while Greenpeace members were temporarily occupying the platform led the association to wrongly assess that there were 5,500 tonnes of oil on the spar. As a result of the dispute, Greenpeace called for the boycott of Shell's products and services, whose widespread success led the firm to voluntarily adopt the activist's prefered dismantlement project.

In our model, the motivation for intervention is that some indivisible project to be undertaken by a firm may have a positive social value that exceeds its private value. The firm's decision only consists in undertaking or not the project, either following the enacted regulation, if any, or following its own interest in its conflict with the activist. Section 2 sets up our regulation model where Congress can only rely on a biased agency. Symmetrically, Section 3 introduces the activist in isolation. In either case, Congress may or not decide to encourage adoption by other means. Sections 4 and 5 combine public regulation with private politics. Such combination raises the issues of incentive compatibility and of communication between the agency and the activist. As far as communication is concerned, we proceed in two steps, each corresponding to a meaningful situation. Section 4 assumes the activist to be independent, in the sense that it does not take any account of signals whose origin is not internal. It is in this setup that the main message is delivered. The result survives the introduction of a Bayesian activist (Section 5) who draws information from the agency's decision.

2. A Model of Pro-Firm Regulation

Consider an indivisible project – dismantling an obsolete oil platform, say – with a non-negative gross social value $v \geq 0$. A single firm – the platform's holder – can implement the project, at a cost $c > 0$. This example of a platform's dismantlement is taken for the sake of concreteness; as shall be argued later on, the following analysis applies to all

kinds of privately-taken actions whose social value exceeds their private value.

Absent any external intervention, the firm will not undertake the project, even when its net social value $v - c$ is positive. This section exclusively focuses on public regulatory interventions.

Assume that there is a benevolent Congress which sets the law in such a way as to maximize social welfare. Were the value of the project v as well as its cost c perfectly observable, the benevolent Congress would legislate that the platform must be dismantled whenever v exceeds c.[4] Let us denote such compulsory dismantlement decision with the indicator variable D_c taking value 1 and the absence of such order with D_c being 0. In this context, total surplus writes $(v - c)D_c$ where $D_c = \mathbb{1}_{v \geq c}$, corresponding to its first-best value.

When v is not directly observable to the Congress, such a rule cannot be immediately applied. Following Laffont and Tirole (1993, Ch. 11) and Hiriart and Martimort (2012), assume that there is an agency which has resources and expertise to perfectly observe the project's value, and to which the task of supervising such matters can be delegated. The resulting two-tiered regulatory structure introduces a neat distinction between the benevolent Congress' objective and that of the supervisor. On the one hand, Congress' decisions then reflect the social desirability of the regulatory outcome, which is particularly well suited to the normative purpose of the analysis. On the other hand, the setting allows the central considerations of regulatory capture.

In the sequel, let π be the firm's profit and $\mathcal{U}$ be the money-metricized surplus of the rest of society. Then the objective of Congress (social surplus) is

$$\mathcal{W} = \mathcal{U} + \pi, \tag{1}$$

where the two surplus components are given the same weight.

Following Baron and Myerson (1982), Baron and Besanko (1984), Hiriart and Martimort (2012), as well as many other treatments of the new economics of regulation, we assume that the supervising agency to which is delegated the regulatory task is biased. Specifically, its objective is

$$\mathcal{V} = \mathcal{U} + \alpha\pi. \tag{2}$$

[4] All along, we assume away limited-liability issues.

However, unlike those studies, we assume that the firm's profit is given a higher weight than to the rest of society's surplus:

$$\alpha \geq 1. \tag{3}$$

When $\alpha = 1$, there is not any conflict of interest between Congress and its supervisor. In this context, a complete delegation of the regulatory task giving a full discretion to the supervisor is optimal. The informational asymmetry vanishes as Congress and supervisor are at one with each other and the model becomes the archetypical one of benevolent regulation under perfect information.[5]

Things are not so when $\alpha > 1$. The strictly-pro-firm bias of the supervisor renders illusory any hope that full discretion would be optimal. In case of dismantlement, the rest of society enjoys $\mathcal{U} = v$ while the firm incurs the cost c so that $\pi = -c$. According to (2), the supervisor would order to dismantle only when $v \geq \alpha c$ so that total welfare, unlike in the first-best outcome, would be $(v - c)D_c$ with $D_c = \mathbb{1}_{v \geq \alpha c}$. That is, from the benevolent legislature point of view, not enough platforms are dismantled.

As a matter of fact, regulatory agencies are not delegated "everything" (Epstein and O'Halloran, 1999, p. 74). McCubbins, Noll and Weingast (1987, 1989) already pointed at ex ante congressional controls to which agencies are subject. It is more generally true that, by other legal, political or commercial means, the legislature or even society as a whole, may encourage potentially valuable actions such as dismantling obsolete oil platforms, even under ex ante lack of information on each specific project. The idea has recently found an echo in the regulation literature with Hiriart and Martimort's (2012) analysis of such limitations to agencies' discretion. We borrow the following assumption from their modeling of incomplete supervisor's discretion.

When dismantling is ordered by the supervisor, the law provides for a non-negative transfer $t_c \geq 0$ to the firm. Such transfers, as modeling devices, should be interpreted in a broader fashion than mere monetary transfers, as for instance any sort of encouragement or support. Irrespective of their actual forms, such a support must proceed from public or tierce resources. To complete the conventional picture of the new economics of regulation (e.g. Baron and Myerson, 1982; Baron and Besanko, 1984; Hiriart and Martimort, 2012),

[5]For instance, when Baron and Myerson's (1982)'s single regulator gives an equal weight to consumer and to producer surpluses, their analysis reduces to Loeb and Magat's (1979) first-best-inducing regulation policy.

we assume a unitary cost of transfers $\lambda > 0$ reflected in their total cost to society $(1+\lambda)t_c$.[6] In line with our normative approach, the transfer t_c is controlled by the benevolent Congress; accordingly, λ might be referred to as the cost of public funds.

Such encouragement to dismantle affects the supervisor's decision. In case of dismantlement, the firm's profit integrates the transfer t_c: $\pi = t_c - c$. The rest of society's surplus should be reduced by the transfer's cost: $\mathcal{U} = v - (1+\lambda)t_c$. According to (2), the supervisor's objective becomes

$$\mathcal{V} = (v - \alpha c + (\alpha - \lambda - 1)t_c)D_c, \tag{4}$$

where the supervisor's biased valuation of the transfer is adjusted to take account of its social cost. In the conventional setting with $\alpha = 1, \lambda = 0$, the supervisor's objective is independent of society-to-firm transfers. When $\lambda > 0$, the view that supervisors are biased towards firms implies that

$$\alpha > 1 + \lambda, \tag{5}$$

which we shall assume all along. In this setting, pro-firm-biased regulatory decisions can be distorted by other means of supporting dismantlements. However, the social cost of transfers renders illusionary any hope to fully restore efficiency as in the first-best. Congress now faces the second-best problem of making the best of a necessarily distortionary regulation.

The pro-industry supervising agency thus orders to dismantle if and only if

$$v \geq \alpha c - (\alpha - \lambda - 1)t_c \equiv \bar{v}. \tag{6}$$

Hence, for any given project's value $v \geq 0$, social surplus equals $(v - c - \lambda t_c)D_c$, with $D_c = \mathbb{1}_{v \geq \bar{v}}$. Unlike the expert supervisor, Congress is unable to observe the project value v, but to the extent that it is drawn from a common-knowledge distribution $h(.)$ over $v \geq 0$, which is assumed, as is usual, to be log-concave (Bagnoli and Bergstrom, 2005).[7] Congress' objective thus writes $\int_0^\infty (v - c - \lambda t_c)\mathbb{1}_{v \geq \bar{v}}\, dH(v)$, or equivalently

$$\mathcal{W} = \int_{\bar{v}}^{\infty} (v - c - \lambda t_c)\, dH(v), \tag{7}$$

[6] See Laffont and Tirole (1993, p. 477) for a justification that transfers are generally inefficient.

[7] In this paper, all functions are assumed to be differentiable to the relevant order.

which is to be maximized by choice of $t_c \geq 0$, taking into account that the supervisor's threshold $\bar{v}$ negatively depends on t_c as per (6).

Intuition suggests a trade-off faced by Congress between lowering the supervisor's intervention threshold (inducing more dismantlements), and the cost of supporting dismantlements to this effect. This is precisely the message delivered by the first-order condition for an interior solution to the choice of t_c,

$$\lambda\big(1 - H(\bar{v})\big) = -\frac{d\bar{v}}{dt_c}(\bar{v} - c - \lambda t_c)h(\bar{v}), \tag{8}$$

where the left-hand side is the marginal cost of transfer in case of dismantlement, i.e. as when $v \geq \bar{v}$, and the right-hand side is the social surplus accruing from the marginal dismantled project.

Taking into account relation (6) and its consequence that $d\bar{v}/dt_c = -(\alpha - \lambda - 1)$, the first-order condition yields a characterization of the optimum level of the threshold $\bar{v}$ in the context of this section (denoted with the superscript S):

$$\bar{v}^S - \frac{\lambda}{\alpha - 1}\frac{\big(1 - H(\bar{v}^S)\big)}{h(\bar{v}^S)} = c(1 + \lambda). \tag{9}$$

The following proposition summarizes the findings of this section (its proof is in Appendix A).

Proposition 1. *(Optimal regulation with pro-firm biased supervision) When the supervising agency is biased toward the industry (i.e. when $\alpha > 1 + \lambda$), then*

1. *encouraging dismantlements by means of transfers to the firm is socially desirable as soon as the supervisor is sufficiently biased, i.e. if $\alpha > \tilde{\alpha}$, where $\tilde{\alpha}$ is some threshold characterized in (A.1); in that case, $\bar{v}^S < \alpha c$ and Congress optimally induces more projects to be undertaken than in the first best;*

2. *the transfer should never exceed the cost of dismantling;*

3. *the first-best regulatory outcome is never attainable by the Congress, unless the cost of public funds is nil.*

As previously argued, were the agency unbiased (i.e. $\alpha = 1$), the first-best regulation would immediately arise from the full delegation of the regulatory task, that is without

any need to rely on encouragements to dismantling (i.e. $t_c = 0$). In that case, the threshold $\bar{v}$ would be set to its first-best level c, independently of the social cost of transfers.

Symmetrically, the third point of Proposition 1 tells that absent any social cost of transfer (i.e. when $\lambda = 0$), the first-best threshold $\bar{v} = c$ would be achievable as well, even when the supervisor is pro-firm biased. To induce it, the transfer should exactly cover the cost of dismantling so as to suppress the firm's stake.

It is thus remarkable that the second-best distortion does not simply stem from the pro-firm-biased supervision or from the social cost of supporting dismantlements, but only appears as a result of their combination.

The following section introduces activism. For simplicity we start with the case without supervisor, so that Congress can only rely on activists' intervention.

3. Modeling Activism

This section introduces private activism in isolation. Thus there is no supervisor in charge of ordering to dismantle. Congress can exclusively rely on activists' efforts for that.

Activism always raises the issue of collective actions. Usually, the intensity of activists' actions essentially depends on the number of individuals participating into the action and on the level of their personal sacrifice. In practice, individuals' coordination and sacrifice have multiple facets ; as a bargaining device, collective action entails substantial transaction costs. As it is sufficient for our analysis, we follow Laffont and Tirole (1993) by assuming a single activist entity, which can be viewed as a group of perfectly coordinated, concerned individuals. As shall be clear shortly below, our setting still takes account of the coordination costs that are inseparable from the intensity of collective actions.

Unlike other agents, activists' raison d'être has an ideologic or however symbolic dimension. Keeping in mind Baron's (2003) remark on rigid behaviors in private politics, we accordingly assume that the activist's preferences are lexicographic, as they should be when agents feel entrusted with a mission. Specifically, the activist is *ready to make every effort* as soon as its estimate of the project's value exceeds a given threshold $\bar{s} \geq 0$.

Indeed, John and Klein (2003) underlined the paradoxical nature of the observed sacrifice of some small individuals for the sake of collective interest. They argue that such

puzzles can only be resolved by departing from regular economic modeling. Moreover, Baron and Diermeier (2007) argued (p. 611) and Lenox and Eesley (2009) showed that activists select targeted projects on the basis of how much is at stake.[8]

"The activist challenge to the firm begins with the identification of the issue." (Baron, 2003, p. 55). Unlike the supervising agency of Section 2, the activist cannot directly observe the project's value v. Activists rely on their own assessment. However, public agencies are likely to have better information than do activists. In his analysis of activist-firm conflicts, Baron (2003) pointed at the asymmetry of information between targeted firms and activists. Once it is reminded that, by law, supervisors have better control on the project than do activists, Baron's remark immediately extends from the realm of activist-firm conflicts to the present activist-regulator framework.[9]

The activist observes a signal of v:

$$s = v + \sigma\varepsilon, \tag{10}$$

where ε is a noise drawn from the log-concave, common-knowledge distribution $F(.)$ and σ measures the precision of the signal. We assume that the activist decides to undertake an action whenever its signal s exceeds some exogenous threshold $\bar{s}$. The event occurs with probability $P(s \geq \bar{s} \mid v)$ that s is greater than $\bar{s}$, conditional on v. When account is taken of the definition (10), it follows that the probability of action for any given value v is

$$P(s \geq \bar{s} \mid v) = 1 - F\big(\frac{\bar{s} - v}{\sigma}\big), \tag{11}$$

which is increasing in the social value v and decreasing in the tolerance threshold $\bar{s}$.[10] Without any consequence on the results of this section, we assume for simplicity that no

[8]Beyond a project's social value, a multitude of other relevant aspects of activists' selection has also been identified, which have to do with characteristics of firms. They may account for why the tolerance level $\bar{s}$ varies with the type of firms, of sectors, of projects. In the present paper, the activist is not concerned with these aspects as, for other purposes, our framework assumes a single firm.

[9]The example of Greenpeace-Shell conflict over the dismantlement of the Brent Spar is particularly illustrative as the dispute mainly arose from divergent estimates. The approval by the UK Government Department of Trade and Industry of Shell's plan to decommission the platform had been given on the ground of Shell's low estimate of the quantity of crude oil on the platform (50 tonnes); estimate and proposal also substantiated by several external studies by independent organizations. Incorrectly-collected samples while Greenpeace activists were temporarily occupying the platform led the association to wrongly assess that there were 5,500 tonnes of oil on the platform. Later independent audit concluded to a 75 to 100 tonnes oil content.

[10]This is the case of a "rigid" activist. In Section 5 we consider the alternative behavior of a "Bayesian" activist, who revises his signal on the basis of the decision taken by the supervisor.

action is ever undertaken when the project has a zero value: $P(s \geq \bar{s} \mid v) = 1 - F\left(\frac{\bar{s}-v}{\sigma}\right) = 0$ when $v = 0$; this amounts to assume that the support of the noise distribution is bounded above by $\frac{\bar{s}}{\sigma}$.

When an action takes place, it is meant to reverse the firm's decision not to dismantle. It thus takes the form of a threat posed to the firm. The activist chooses the intensity $x \geq 0$ of its action, that we normalize in such a way that x is also the dead-weight loss that the firm would incur if no dismantling was decided and the threat was carried out. While it is almost impossible to deliver an exhaustive picture of the current and potential means by which activists might deteriorate targeted firms' situation, the above representation is a simple way to encompass all of them.

The credibility of activists' threat strongly relies on their already-initiated and observable mobilization. Regardless of whether the activist's threat has to be carried out or if the firm pro-actively decides to dismantle, collective actions entail coordination and individual costs.[11] Whether they are exclusively borne by the activist or partly by the rest of society, social costs associated with actions of conflict depend on those actions' intensity. We assume that an intensity x causes a reduction of social welfare by γx, with $\gamma > 0$.

Absent any other intervention, any action of intensity greater than the cost of dismantling surely induces the firm to grant the activist's request, and so to dismantle on a basis we shall term "voluntary" (by opposition to compulsory in Section 2). Such scenario will be denoted with the indicator variable D_v taking value 1. Otherwise, $D_v = 0$. As soon as the activist is sensitive to actions' costs, it will choose the minimum intensity to meet the actions' objective, $\tilde{x} = c$.

Unlike regular agents in the realm of classical mechanism design,[12] the activist entity is non-manipulable ; there is no hope for Congress to influence the activist directly but by encouraging the firm to voluntarily dismantle. In a similar fashion as in Section 2, assume

[11] For instance, the boycott literature (e.g. Baron, 2003, pp. 59-61) has emphasized the dynamic process through which activists and targeted firms respectively discover the required intensity to reverse firms' decisions and activists' level of intransigence. The present paper takes a long-term perspective over which these informational issues are resolved. Hence we represent the activist-firm conflict without incomplete information on the payers' types so as to focus on the regulator-activist asymmetry of information regarding the projets' value. As will be clear shortly below, the activist's threat and the firm's decision are independent of v.

[12] For instance, Myerson's (1982) general setting assumes that all agents are "utility maximizers", whose behavior is responsive to monetary transfers.

that law can provide for such encouragement in the form of a non-negative transfer $t_v \geq 0$ to the firm when $D_v = 1$. Then, the cost to the firm of voluntarily dismantling is $c - t_v$. If the activist undertakes an action, its sufficient intensity to induce dismantling now depends on the provided transfer:

$$\tilde{x} = c - t_v, \tag{12}$$

increasing in c and decreasing in t_v.

Let's now turn to the optimal choice of t_v. From the ex ante Congress' perspective, social welfare in the context of this section should both incorporate the possibility of action on the part of the activist – the social cost $\gamma\tilde{x}$ associated with it – as well as the social cost of funding t_v: $\int_0^\infty (v - c - \lambda t_v - \gamma\tilde{x}) D_v \, dH(v)$. Taking into account the probability (11) and the intensity (12), we obtain

$$\mathcal{W} = \int_0^\infty P(s \geq \bar{s} \mid v)\big(v - (1+\gamma)c - (\lambda - \gamma)t_v\big) \, dH(v). \tag{13}$$

The latter expression makes clear that the private cost c should be adjusted to reflect its contribution to the intensity of activist action. Symmetrically, the net cost of the transfer t_v should now be adjusted by its effect to mitigate the conflict's intensity. Thus, the marginal cost of encouraging voluntary dismantlements via t_v is the difference between the marginal cost of public funds λ and the marginal cost of transaction associated with social conflicts γ.

Hence, the social objective of Congress is linear in t_v, whose marginal effect is $\gamma - \lambda$. If γ exceeded λ, the marginal cost of encouraging voluntary dismantlements would be negative thus rendering social conflicts extraordinarily attractive as a regulation device. Congress would then fully rely on private politics by setting t_v so as to completely cover the cost of dismantling: $t_v = c$; the social cost $\gamma\tilde{x}$ of private politics would simply vanish.

To rule out this uninteresting situation in the rest of the paper, we make the assumption that encouraging the firm to grant the activist's request has a positive net marginal cost:

$$\gamma < \lambda. \tag{14}$$

Then, it is never desirable to encourage voluntary dismantling and $t_v^A = 0$, where the superscript A refers to the context of this section. Thus, social welfare becomes

$$\mathcal{W} = \int_0^\infty P(s \geq \bar{s} \mid v)\big(v - (1+\gamma)c\big) \, dH(v). \tag{15}$$

Although actions on the part of the activist should not be encouraged, the introduction of private politics may positively contribute to social welfare. Suppose that activism could be forbidden by law at no cost. Whether it is desirable or not to allow such practices depends on the sign of $\mathcal{W}$ as expressed in (15). Its examination yields the following proposition which also summarizes the findings of this section (Appendix B).

Proposition 2. *(What to do in the absence of regulation) When Congress can only rely on private actions on the part of a non-manipulable activist that imperfectly observes the project's value, then*

1. *encouraging the firm to voluntarily dismantle is not socially desirable if the marginal cost of public funds λ exceeds the marginal cost of private politics γ; then, $t_v^A = 0$;*

2. *even then, allowing activism improves social welfare if $\imath$) the cost of private politics γ is sufficiently low, or if $\imath\imath$) the activist's tolerance threshold $\bar{s}$ is not too distant from the total cost of voluntarily dismantling $(1+\gamma)c$ while the activist is well enough informed, i.e. when σ is sufficiently low.*

4. Optimal Regulation when Activism is Allowed

The coexistence of private politics with public regulation raises a number of issues. While supervisors are unlikely to influence activists, the latter may try to lobby the former. As Baron put it, "The strategy of the activists to achieve changes in the firm's practices may involve government, as in the case of regulation" (Baron, 2003, p. 34). The view that activists may lobby regulators in such contexts has first been offered by Laffont and Tirole (1993). As a matter of facts, activists have almost given up on the lobby side. Baron continued: "The choice between public and private politics is strategic, and activists may increasingly be choosing private politics", also quoting Paul Gilding (former head of Greenpeace) on the matter.[13] On this ground, we assume away the possibility

[13]To *The New York Times* (June 2, 2001), he said:

> The smart activists are now saying, "O.K., you want to play markets–let's play." [Lobbying government] takes forever and can easily be counter-lobbied by corporations. No, no, no. They start with consumers at the pump, get them to pressure the gas stations, get the station owners to pressure the companies and the companies to pressure governments. After all, consumers do have choices where they buy their gas, and there are differences now. Shell and BP Amoco (which is also the world's biggest solar company) both withdrew from the oil industry lobby that has been dismissing climate change.

that the activist can, or find attractive to, lobby the supervisor.

Second, when Congress can encourage dismantling in two distinct contexts – compulsory dismantlement following the supervisor's order or voluntary under the activist's pressure –, the optimal scheme must further satisfy an incentive compatibility condition. Indeed, unlike in Section 2, it is now always possible for the firm to act on a voluntary basis so as to escape the consequence of public ordering. If so, the bite that encouragements to compulsory dismantlements had in Section 2 would completely vanish. To rule out such possibilities, Congress must restrict his choice to schemes satisfying the incentive compatibility condition

$$t_c \geq t_v. \tag{16}$$

The third issue concerns the structure of strategic interactions. Regulators always have the opportunity to pro-actively make a decision while following Baron's remark, activists' first challenge is to identify the issue. Consistently with our assumption that the asymmetry of observation is in favor of the supervisor, let's assume that the supervisor is also a Stackelberg leader.

Another issue is communication. Communication is unavoidable here because any decision or absence of decision on the part of the informed supervisor conveys information to the activists on the project's value. In the sequel, we will make a clear distinction between two types of activists. Activists may rationally induce information on projects' value from supervisors' decisions. We shall term such activists "Bayesian" and they will be the object of Section 5. A Bayesian activist estimates projects' values not only on the ground of its own expertise, but also on a way that is conditional on the supervisor's decisions; thus their reactions will turn out to be sensitive to the supervisor's incentives to order dismantlement. When activists' reactions are insensitive to supervisors' incentives, we should instead call them "independent" as they estimate projects' values in a way that is not conditional on the supervisor's decision. This analysis starts in this section with the examination of the simplest independent case. Although the extension of Section 5 will bring up important new insights, it will also show that the message of the present section retains its central role in a more sophisticated setting.

With those basic clarifications, much of the models' structures of Sections 2 and 3 can be combined without any further modification.

Following our definition, a "rigid" activist behaves in the same way whether or not it coexists with the supervisor. Precisely, a project's value $v \geq 0$ being given, the probability that the independent activist undertakes an action against the firm is the same whether there is a supervisor as in this section, or not, as in Section 3. Thus, (11) remains valid in the present context. Moreover, the intensity of action that is sufficient to induce the firm to voluntarily dismantle remains $\tilde{x}$ as given by (12).

Things are not so for the supervisor. Like in Section 2, in case of compulsory dismantlement ($D_c = 1$), its objective(2) takes the value
$\mathcal{V} = v - (1+\lambda)t_c + \alpha(t_c - c) = v - \alpha c + (\alpha - \lambda - 1)t_c$.
However, in case of voluntary dismantlement ($D_v = 1$), instead of 0 in Section 2, its objective (2) takes the value $v - (1+\lambda)t_v - \gamma\tilde{x} + \alpha(t_v - c)$ with $\tilde{x} = c - t_v$, i.e.
$\mathcal{V} = v - (\alpha + \gamma)c + (\alpha - \lambda - 1 + \gamma)t_v$.
Thus,

$$\mathcal{V} = \big(v - \alpha c + (\alpha - \lambda - 1)t_c\big)D_c + \big(v - (\alpha+\gamma)c + (\alpha - \lambda - 1 + \gamma)t_v\big)D_v, \tag{17}$$

to be maximized by choice of the decision to order dismantlement $D_c \in \{0, 1\}$, taking into account that if no dismantlement takes place ($D_c = 0$), a voluntary one ($D_v = 1$) may occur with a probability given by (11).

Hence, the supervisor decides to order a compulsory dismantlement if and only if

$$v - \alpha c + (\alpha - \lambda - 1)t_c \geq P(s \geq \bar{s} \mid v)\big(v - (\alpha+\gamma)c + (\alpha - \lambda - 1 + \gamma)t_v\big), \tag{18}$$

where $P(s \geq \bar{s} \mid v) = 0$ when $v = 0$. Given that incentive compatibility requires $t_c \geq t_v$ (16), it turns out that over the range of admissible projects' values $v \geq 0$, the two sides of (18) cross at least once (Appendix C). For simplicity, let us make the assumption that the two sides cross only once, at a value we again denote $\bar{v}$; from this single-crossing assumption, it follows that the supervisor chooses a compulsory dismantlement whenever

$$v \geq \bar{v}, \tag{19}$$

where the threshold $\bar{v}$, instead of being defined by $\bar{v} - \alpha c + (\alpha - \lambda - 1)t_c = 0$ as per (6) in Section 2, now satisfies

$$\bar{v} - \alpha c + (\alpha - \lambda - 1)t_c = P(s \geq \bar{s} \mid \bar{v})\big(\bar{v} - (\alpha+\gamma)c + (\alpha - \lambda - 1 + \gamma)t_v\big), \tag{20}$$

which is negative (Appendix C).

Equivalently, for a given t_c, and for any t_v satisfying the incentive compatibility condition (16), the threshold $\bar{v}$ of the supervisor is lower under the possibility that the activist reverses its decision than in Section 2.

As in Section 2, $\bar{v}$ is decreasing in t_c; here, moreover, it is increasing in t_v. Let us define $\bar{v}$ as a function $\bar{v} \equiv \bar{v}(t_c, t_v)$.

The analysis can now turn to the choice by the benevolent legislature of transfers $t_c \geq 0$ and $t_v \geq 0$ respectively provided for in case of compulsory and voluntary dismantlements. Social surplus of the two components. Either $v \geq \bar{v}$ and the supervising agency orders a dismantlement, in which case social surplus is $(v - c - \lambda t_c)$, or $v < \bar{v}$ and with probability $P(s \geq \bar{s} \mid v)$, the activist induces dismantlement. In the latter case, social surplus is $v - c - \lambda t_v - \gamma \tilde{x}$, where $\tilde{x} = c - t_v$. Hence, social surplus in this context writes

$$\mathcal{W} = \int_{\bar{v}}^{\infty} (v - c\lambda t_c)\, dH(v) + \int_0^{\bar{v}} P(s \geq \bar{s} \mid v)\big(v - (1+\gamma)c - (\lambda - \gamma)t_v\big)\, dH(v) \qquad (21)$$

to be maximized by Congress with respect to $t_c \geq 0$ and $t_v \geq 0$.

Denoting by

$$B(\bar{v}, t_c, t_v) \equiv \big[- (\bar{v} - c - \lambda t_c) + P(s \geq \bar{s} \mid \bar{v})\big(\bar{v} - (1+\gamma)c - (\lambda - \gamma)t_v\big)\big] h(\bar{v}) \qquad (22)$$

the gross marginal benefit of a reduction in the threshold $\bar{v}$, the first-order condition to the choice of t_c writes

$$\frac{d\bar{v}}{dt_c} B(\bar{v}, t_c, t_v) \leq \lambda\big(1 - H(\bar{v})\big), \qquad (23)$$

satisfied with equality when the choice is an interior one with $t_c > 0$. In (23), the left-hand side is the gross marginal benefit of lowering $\bar{v}$ by increasing the encouragement t_c to compulsory dismantlements while the right-hand side is the positive marginal cost of doing so.

Using the same notations, the first-order condition to the choice of t_c writes

$$\frac{d\bar{v}}{dt_v} B(\bar{v}, t_c, t_v) \leq (\lambda - \gamma) \int_0^{\bar{v}} P(s \geq \bar{s} \mid v) h(v)\, dv, \qquad (24)$$

which is satisfied with equality for any interior solution $t_v > 0$. In this expression, the left-hand side is the gross marginal benefit of increasing $\bar{v}$ by increasing the encouragement to voluntary dismantlements while the right-hand side is the net marginal cost of doing so.

As in Section 3, the assumption $\lambda > \gamma$ guarantees that the net marginal cost of relying on encouragements to grant the activist's request is positive.

The intervention of the gross marginal benefit $B(\bar{v}, t_c, t_v)$ into both (23) and (24) shows that the two first-order conditions are linearly dependent. Once it is reminded that, from the supervisor's indifference condition (20), $d\bar{v}/dt_c < 0$ as in Section 2 while $d\bar{v}/dt_v > 0$, it turns out that Congress will never find it desirable to simultaneously rely on encouragements to the two sorts of dismantlements. In optimum, either $t_c = 0$ or $t_v = 0$. In fact, integrating the supervisor's indifference condition (20) in Expression (22), the benefit of lowering $\bar{v}$ becomes

$$B(\bar{v}, t_c, t_v) = (\alpha - 1)\big(t_c - c - P(s \geq \bar{s} \mid \bar{v})(t_v - c)\big)h(\bar{v}). \tag{25}$$

The benefit of increasing $\bar{v}$ is negative when t_c is nil, excluding the possibility that a costly increase in t_v with the view to increasing $\bar{v}$ could be desirable. Even in presence of activism, it remains optimal to induce more dismantlements; Congress should exclusively rely on encouragements to compulsory dismantlements for that. Denoting with a superscript $*$ the optimum values in the context of this section, we have $t_v^* = 0$ and $t_c^* > 0$.

Then, social welfare rewrites as a function of the threshold $\bar{v}$ and of the transfer t_c. These two variables are dependent of each other as is clear from the definition of $\bar{v}$ in (20) taken with $t_v = 0$. Indeed, given that Congress will never find it attractive to manipulate the supervisor's threshold $\bar{v}$ by means of encouragements to voluntary dismantlements, it appears that it can only do so by means of encouragements to compulsory dismantlements t_c as in Section 2. From the Congress' perspective, the choice of t_c is equivalent to the choice of $\bar{v}$ it is meant to induce. Thus, social welfare can be rewritten as a function of $\bar{v}$ in the following way which shows its relation with its expression in absence of private politics.

$$\begin{aligned} \mathcal{W}(\bar{v}) = \mathcal{W}^S(\bar{v}) \quad &+ \quad \frac{\lambda}{\alpha - \lambda - 1}\big((\alpha + \gamma)c - \bar{v}\big)P(s \geq \bar{s} \mid \bar{v})\big(1 - H(\bar{v})\big) \\ &+ \quad \int_0^{\bar{v}} P(s \geq \bar{s} \mid v)\big((v - (1 + \gamma)c\big)\, dH(v), \end{aligned} \tag{26}$$

where $\mathcal{W}^S$ is social welfare in the context of Section 2 which can also be expressed as a function of $\bar{v}$ only.

That way, the social benefit of allowing private politics is clearly reflected by the last two terms on the right-hand side of (26). The question of its desirability is also that of whether the value of $\mathcal{W}$ at its maximizing argument $\bar{v}^*$ is greater or not than the maximum value of $\mathcal{W}^S$ at $\bar{v}^S$.

In (26), $\mathcal{W}^S$ and the term next to it represent the surplus accruing from compulsory dismantlements. Hence, the latter term isolates out the benefit of private politics via public regulatory interventions. Appendix C shows that it is positive at $\bar{v}^S$. It reflects that in presence of activism, public regulation relying on a biased agency is more efficient. As already mentioned, for a given transfer t_c, the mere presence of activism contributes to lower $\bar{v}$. As lowering $\bar{v}$ by means of encouraging compulsory dismantlements with t_c is costly, activism can also be interpreted as reducing the social cost of relying on biased regulators.

The third term on the right-hand side of (26) is identical to the benefit of voluntary dismantling in Section 3, except that in the context of the present section, such outcomes can only occur when the supervisor has not ordered anything, i.e. $v < \bar{v}$.

The analysis of those terms yields the following proposition which also summarizes the findings of this section.

Proposition 3. *(Optimal regulation with biased supervision and an imperfectly-informed activist) When Congress can simultaneously rely on private actions by an imperfectly-informed, non-manipulable activist and on a pro-firm biased supervisor, then*

1. *it is never desirable to simultaneously encourage both compulsory dismantlements and voluntary dismantlements; when the marginal cost of public funds λ exceeds the marginal cost of private politics γ, only compulsory dismantlements should be encouraged;*

2. *even then, the introduction of activism contributes to discipline the supervisor: for the same level of encouragements, more compulsory dismantlements are ordered;*

3. *on the other hand, activism may lead to inappropriate voluntary dismantlements; all in all, activism improves social welfare under the same conditions as in Proposition 2.*

5. Extension to Bayesian Activism

When the activist is Bayesian, its information on projects' values is not restricted to its imperfect signal s. Hence, the condition for private actions against the firm is no longer that the signal s exceeds the exogenous threshold $\bar{s}$. Instead, the activist induces the expected value of v not only on the ground of its signal but also taking into account the decision by the supervisor not to order dismantlement. An action on the part of the activist is undertaken if and only if

$$E(v \mid s, D_C = 0) \geq \bar{s}. \tag{27}$$

Now $D_c = 0$ is equivalent to $v < \bar{v}$ so that $E(v \mid s, D_C = 0) = s - \sigma E\big(\varepsilon \mid \varepsilon \geq \frac{s-\bar{v}}{\sigma}\big)$. Since $E\big(\varepsilon \mid \varepsilon \geq \frac{s-\bar{v}}{\sigma}\big)$ is an increasing function of its argument $(s-\bar{v})/\sigma$ whose slope is always lower than unity[14], the decision rule (27) can be simply rewritten as

$$s \geq \bar{\bar{s}}(\bar{v}), \tag{28}$$

with $\bar{\bar{s}}$ defined by

$$\bar{\bar{s}}(\bar{v}) - \sigma E\big(\varepsilon \mid \varepsilon \geq \frac{\bar{\bar{s}}(\bar{v}) - \bar{v}}{\sigma}\big) = \bar{s}. \tag{29}$$

It is immediate from its definition that $\bar{\bar{s}} \geq \bar{s}$, implying that the Bayesian activist induces less voluntary dismantlements that its independent counterpart. Indeed, on the ground that no dismantlement has been ordered by the supervisor, the Bayesian activist revises its estimation of v downward.

Moreover, $\bar{\bar{s}}$ is a strictly decreasing function of $\bar{v}$ over $(0, +\infty)$ because the higher the threshold $\bar{v}$ the less informative the absence of compulsory dismantlement. Were $\bar{v}$ infinitely high, no dismantlement would not bring any further information to the activist. Then, $\bar{\bar{s}} = \bar{s}$. When $\bar{v} = 0$ and there is no dismantlement, it must be that $v = 0$. Then, there does not exist any report s so as to induce the activist to undertake an action.

Hence, the probability of voluntary dismantlement writes in a way that is similar to (11) except that the relevant threshold is now $\bar{\bar{s}}$:

$$P(s \geq \bar{\bar{s}} \mid v) = 1 - F\big(\frac{\bar{\bar{s}} - v}{\sigma}\big), \tag{30}$$

[14] Appendix D shows that this property of conditional expectation operators is satisfied for any log-concave distribution.

while the intensity of actions remains the same, given by (12).

The supervisor's problem is identical to that of the previous section, except that the probability of voluntary dismantlement now depends on the endogenous variable $\bar{\bar{s}}$ as per (30). $\bar{v}$ should be expressed as a function, not only of transfers t_c and t_v as in Section 4, but also of $\bar{\bar{s}}$:

$$\bar{v} \equiv \bar{v}(t_c, t_v, \bar{\bar{s}}), \tag{31}$$

which is respectively decreasing and increasing in t_c and t_v as before, while it is increasing in $\bar{\bar{s}}$. When $\bar{\bar{s}}$ is infinitely high, the probability of action by the activist becomes nil, so that $\bar{v}$ is defined as in absence activist (Section 2).

Unlike in Section 4 where the activist's tolerance threshold $\bar{s}$ is exogenously given and immediately determines the supervisor's threshold $\bar{v}$, they now arise as a fixed point and are jointly determined by (29) and (31). A simple functional analysis shows that such fixed point exists and is uniquely determined.

The rest of the analysis is similar to that of Section 4. The expression of social welfare (17) should only be modified to the extent that $\bar{s}$ should be replaced by $\bar{\bar{s}}(\bar{v})$. The first-order conditions to the choice by Congress of t_c and t_v are respectively identical to their expressions in Section 4 (23) and (24) once $B(\bar{v}, t_c, t_v)$ is replaced by its counterpart in this section:

$$\begin{aligned} B(\bar{v}, t_c, t_v) \;\equiv\; & \big[-(\bar{v} - c - \lambda t_c) + P(s \geq \bar{\bar{s}}(\bar{v}) \mid \bar{v})\big(\bar{v} - (1+\gamma)c - (\lambda - \gamma)t_v\big)\big] h(\bar{v}) \\ - \;\; & \bar{\bar{s}}'(\bar{v}) \int_0^{\bar{v}} f\big(\bar{\bar{s}}(\bar{v})\big) h(v) \big(v - (1+\gamma)c - (\lambda - \gamma)t_v\big)\, dv, \end{aligned} \tag{32}$$

where the last term now arises because transfers t_c and t_v affect $\bar{\bar{s}}$.

Thus, it remains true that the two first-order conditions are linearly dependent, also implying that it is never desirable to simultaneously use the two types of encouragements. The incentive compatibility condition (16) immediately rule out cases where the encouragement to be used by Congress is that in favor of voluntary dismantlements. Hence, again, $t_v^{**} = 0$, and social surplus can be rewritten as in (26) with $\bar{\bar{s}}$ instead of $\bar{s}$. Its analysis in Section 4 applies here in a similar fashion and thus yields the same conclusion as in Proposition 3.

6. Discussion

Empirical evidence shows activists' behavior in private politics to be rigid (Baron, 2003), implying that activists should be modeled as being insensitive to monetary incentives. In presence of such agents, well-know results on coordination mechanisms in generalized principal-agent models do not apply (Myerson, 1982). Our introduction of private politics into a model of public regulation calls for further investigation of mechanism design in this context.

APPENDICES

A Proof of Proposition 1

$\tilde{\alpha}$ is such that

$$\tilde{\alpha}c - \frac{\lambda}{\tilde{\alpha}-1}\frac{\big(1-H(\tilde{\alpha}c)\big)}{h(\tilde{\alpha}c)} = c(1+\lambda), \tag{A.1}$$

where left-hand side increasing in $\tilde{\alpha}$ and so $\tilde{\alpha} > 1+\lambda$.

B Proof of Proposition 2

$\mathcal{W} > 0$ when $\gamma = 0$; by continuity, there is $\tilde{\gamma} >$ such that $\mathcal{W} > 0$ for any $\gamma < \tilde{\gamma}$.

If σ is 0 with $\bar{s} \geq (1+\gamma)c$, the probability that an action takes place for any $v < (1+\gamma)c$ will be 0 and $\mathcal{W} > 0$.

In particular, if $\sigma > 0$ with $\bar{s} = (1+\gamma)c$, then $\mathcal{W} > 0$. This remains true as $\bar{s}$ is sufficiently close to $(1+\gamma)c$ and σ is sufficiently small. Continuity again.

To be completed. Something elegant might be said about conditional expectation of actions' cost/benefit over $v < (1+\gamma)c$ and $v > (1+\gamma)c$.

C Proof of Proposition 3

Existence of $\bar{v}$ and analysis of single intersection. Comparative statics on transfers t_v and t_c.

First-order conditions derived and analyzed in the main text.

Second term on the right-hand side of (26) positive at $\bar{v}^S$ since $\bar{v}^S \leq \alpha c$.

To show that the maximum value of $\mathcal{W}$ can be greater than the maximum value of $\mathcal{W}^S$, it is sufficient to show that $\mathcal{W}$ is greater than $\mathcal{W}^S$ at the maximizing level of its argument $\bar{v}^S$. Then, the analysis of Section 3 applies to the third term on the right-hand side of (26).

D Conditional Expectation

In this appendix, let's show that the conditional expectation $E(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})$, that we introduce in Section 5 with $\bar{\varepsilon} = (s-\bar{v})/\sigma$ is increasing in $\bar{\varepsilon}$ with a slope lower than unity.

$E(\varepsilon \mid \varepsilon \geq \bar{\varepsilon}) = \int_{-\infty}^{+\infty} \varepsilon P(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})\, d\varepsilon = \int_{-\infty}^{+\infty} \varepsilon \frac{P(\varepsilon, \varepsilon \geq \bar{\varepsilon})}{P(\varepsilon \geq \bar{\varepsilon})}\, d\varepsilon = \int_{\bar{\varepsilon}}^{+\infty} \varepsilon \frac{P(\varepsilon)}{P(\varepsilon \geq \bar{\varepsilon})}\, d\varepsilon$, where the probability $P(\varepsilon)$ that the noise takes the value ε is given by $f(\varepsilon)$ and the probability

$P(\varepsilon \geq \bar{\varepsilon})$ that it takes a value greater than $\bar{\varepsilon}$ is given by $1 - F(\bar{\varepsilon})$. Thus,

$$E(\varepsilon \mid \varepsilon \geq \bar{\varepsilon}) = \frac{\int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon}{1 - F(\bar{\varepsilon})}. \tag{D.1}$$

The derivative of $E(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})$ with respect to $\bar{\varepsilon}$ is

$$\frac{dE(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} = \frac{-\bar{\varepsilon} f(\bar{\varepsilon})\big(1 - F(\bar{\varepsilon})\big) + \int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon f(\bar{\varepsilon})}{\big(1 - F(\bar{\varepsilon})\big)^2}. \tag{D.2}$$

ı) Since $f(\varepsilon) \geq 0$,

$$\int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon \geq \bar{\varepsilon} \int_{\bar{\varepsilon}}^{+\infty} f(\varepsilon)\, d\varepsilon = \bar{\varepsilon}\big(1 - F(\bar{\varepsilon})\big);$$

substituting into (D.2) immediately implies

$$\frac{dE(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} \geq 0.$$

ıı) Let us now show that $\frac{dE(\varepsilon|\varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} \leq 1$.

Using that $-\big(1 - F(\varepsilon)\big)$ is an anti-derivative function of $f(\varepsilon)$ and integrating by parts, yield $\int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon = \big[-\varepsilon\big(1 - F(\varepsilon)\big)\big]_{\bar{\varepsilon}}^{+\infty} + \int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon$, where the assumption that ε is bounded above implies that the first term on the right-hand side reduces to $\bar{\varepsilon}\big(1 - F(\bar{\varepsilon})\big)$. Hence, $\int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon = \bar{\varepsilon}\big(1 - F(\bar{\varepsilon})\big) + \int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon$

Substituting into (D.2) and rearranging give the following expression.

$$\frac{dE(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} = \frac{\int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon}{1 - F(\bar{\varepsilon})} \frac{f(\bar{\varepsilon})}{\int_{\bar{\varepsilon}}^{+\infty} f(\varepsilon)\, d\varepsilon}, \tag{D.3}$$

implying that the proposition $\frac{dE(\varepsilon|\varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} \leq 1$ is equivalent to the inequality

$$\frac{f(\bar{\varepsilon})}{\int_{\bar{\varepsilon}}^{+\infty} f(\varepsilon)\, d\varepsilon} \leq \frac{1 - F(\bar{\varepsilon})}{\int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon}.$$

Once it is noticed that the two terms of this inequality are rates of increase with respect to $\bar{\varepsilon}$, it follows that $\frac{dE(\varepsilon|\varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} \leq 1$ is also equivalent to the proposition that

$$\frac{\int_{\bar{\varepsilon}}^{+\infty} f(\varepsilon)\, d\varepsilon}{\int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon} \text{ is increasing in } \bar{\varepsilon}. \tag{D.4}$$

In the sequel, we show that this proposition is satisfied as a result of the property that the density function $f(\varepsilon)$ is log-concave. Indeed, the log-concavity of $f(\varepsilon)$ implies the log-concavity of $\big(1 - F(\varepsilon)\big)$, which in turn implies that its right-hand integral $\int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon$ is also log-concave (Bagnoli and Bersgtrom, 2005). Thus, the log-differentiation of $\int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon$ is decreasing, which also implies that $\frac{1 - F(\bar{\varepsilon})}{\int_{\bar{\varepsilon}}^{+\infty} \big(1 - F(\varepsilon)\big)\, d\varepsilon}$ is increasing in $\bar{\varepsilon}$, which is also (D.4).

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