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Abstract

We analyze the consequences of activism in a regulated industry where the regulator has been captured by the industry. Unlike ordinary economic agents, activists are insensitive to monetary incentives. Moreover, they are less well informed than regulators and their actions generate dead-weight costs. Yet we find that activism may increase social welfare because it disciplines captured regulators and reduces the social cost of imperfect regulatory systems.

JEL-Code: D020, D740, D820.

Keywords: public regulation, regulatory capture, pro-industry bias, private politics, activism.

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1. Introduction

In modern economies, negative externalities generated by productive activities are usually mediated either by courts of justice or by regulatory agencies. Both systems have their own limitations. In an ideal world, courts would perfectly enforce tort laws that would provide polluting industries with appropriate incentives to systematically internalize the externalities they generate. In practice however, courts are less efficient, as shown for example by Glaeser, Johnson and Shleifer (2001) and Glaeser and Shleifer (2003). Similarly, Shleifer (2012, Page 1) argued that resolutions by actual courts are "costly, unpredictable, and ineffective".

The performance of regulators is not any better. The Global Financial Crisis of 2008-2009 and the Fukushima disaster of 2011 have shown that regulators/supervisors often fail to impose adequate standards to the industry they are supposed to monitor. The optimistic view that regulators benignly supervise an industry on behalf of the uninformed and defenseless public has been rejected by the facts (e.g. Hardy, 2006); the notion of regulatory capture (Stigler, 1971; Buchanan, Tollison and Tullock, 1980) is receiving renewed attention.[1]

Activism can be viewed as a tentative response to these inefficiencies. Non Governmental Organizations such as environmental groups or consumer associations try to curb the behavior of industrial firms when they consider that these firms hurt the interests of the public. Such "private politics" activities have been extensively studied by Baron (2001, 2003). To influence industrial firms, activists cannot usually rely on the judicial system (see Dixit, 2004);[2] moreover they are usually not in a position to rely on ordinary private orderings, especially when the industry's stakes are high. The only thing activists can do is use their private potential to deteriorate firms' situation so as to directly induce them to

[1] On the question of regulatory capture in the financial sector, see e.g. Hardy (2006) and the references therein, Acemoglu and Johnson (2012) and International Centre for Financial Regulation (2012).

[2] In a Coasian perspective, externalities only arise from ill-defined property rights, thus activism is reminiscent of Dixit's (2004, Chapter 5) lawless situations where property rights must be privately secured.

voluntarily change their conduct (Baron and Diermeier, 2003). Activism has the dimension of Coasian-bargaining devices; yet, it is associated with substantial costs, that are necessary to establish an effective nuisance potential. This paper analyzes the consequences of activism in a regulated industry where the regulator has been (at least partially) captured by the industry.

The 1995 Greenpeace-Shell conflict over the dismantlement of the Brent Spar platform gives a clear illustration of the interaction between regulation and activism. In brief, the conflict arose from the initial regulatory decision to follow the company's choice of dismantlement option while activists had a diverging assessment. 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 remaining on the platform (50 tonnes); this estimate had been confirmed by several external studies by independent organizations. Greenpeace's own estimate was much bigger: 5,500 tonnes of oil. 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 activists' preferred dismantlement option. It turned out ultimately that Shell's estimate was accurate.

In this example, the activists happened to be wrong: their action resulted in a socially inefficient outcome. However there may be other cases in which the action of activists (or the mere threat of it) could discipline a captured regulator. Imagine indeed a symmetric situation, where Shell had envisaged a socially inefficient mode of dismantlement while Greenpeace had had an accurate estimate of the quantity of oil remaining in the platform, and would have recommended the socially efficient technique. In the absence of activism, a captured regulator would have allowed Shell to use the socially inefficient dismantlement technique. However, if the same regulator had anticipated that a boycott would ultimately lead Shell to yield to Greenpeace's request, he would have ordered it from the start, just to avoid the private and social costs associated with the boycott.[3] Thus activism can be socially useful.[4]

Of course, public authorities (the legislature) have to decide whether or not activists' actions like boycotts should be allowed and also how regulation should be organized, before information is available to anyone. Thus we take the ex ante perspective of Hiriart and Martimort (2012). The legislature is benevolent (i.e. it aims at maximizing social welfare)[5] but it has to rely on a regulator that is partially captured by the industry. Our activists differ from the classical economic agents of mechanism design theory (e.g. Myerson, 1982) in an important way: they are "rigid", meaning that they are perfectly insensitive to monetary incentives. Such behavior can be justified on the ground of ideological, behavioral or reputational motives (Baron, 2003). This is the main difference between our analysis and that of Kofman and Lawarrée (1993) and Acemoglu and Gietzmann (1997), who studied how external auditors can be used by the shareholders of a firm to avoid collusion between the internal auditors and the managers.[6] One can sign a contract with external auditors,

[3]A very recent example is that of the regulation of hydraulic fracturing oil-drilling operations. Since its invention, "fracking" has been very loosely regulated in the United States. The EPA regulatory body supposed to assess the environmental and health impacts of such technique has sometimes been suspected to be influenced by the oil industry (e.g. *The New York Times*, November 2, 2009). Suspicions that the lax regulation of fracking was serving the industry's interests has surely contributed to trigger the anti-fracking activist movement. In reaction to this movement, regulation of the practice is to be consolidated in some states (e.g. California, Alaska...).

[4]The legal status of activism is ambiguous in most countries. Activism is generally tolerated by law; sometimes, it is even guaranteed some financial independence. For instance, the Dutch government financially supports human rights activist groups. Yet the right to protest only applies as long as protesting does not break the law. When warning campaigns involve spectacular actions, activists often take the risk of engaging their legal responsibility. Even peaceful actions such as calls for boycotts may violate refusal-to-deal, anti-discrimination and anti-defamation laws. It is on these grounds, for example, that several calls for boycott by the French consumer association UFC have been declared unlawful. For its call for boycott of Shell in response to the wreck of the Amoco-Cadiz oil tanker, the UFC was even fined an enormous amount, corresponding to the estimated lost sales of Shell.

[5]If the legislature is also captured by the industry, a meta-principal (the Constitution) is needed to limit the discretion of Congress. The issue remains outside the scope of the present paper.

[6]Kofman and Lawarrée's (1993) dual-auditor optimal-contracting problem assumes that uninformed shareholders contract with an informed manager on the basis of the information produced by internal auditors who are well informed and efficient. In that context, they showed that shareholder value can be increased by hiring external auditors, even if they are less efficient and less well informed than internal auditors. Ran-

not with our activists.

Thus allowing activism is analogous to introducing an additional agent on which the mechanism designer has no direct control. On the one hand, activists' actions are socially costly and may even be inappropriate, either because activists misvalue projects or because they overreact to them. On the other hand, we show that the presence of activists disciplines the regulator by making him behave as if his pro-industry bias was less strong. Under some conditions, activism improves the performance of the regulatory system.

The rest of the paper is organized as follows. Section 2 discusses the interaction between activism and regulation. Section 3 sets up our model of a regulated industry with a captured regulator, in the absence of activism. Symmetrically, Section 4 studies the impact of activism in the absence of regulation. Section 5 combines public regulation with private politics. Section 6 discusses various extensions. Technical proofs are gathered in the Appendix.

2. Regulation and Activism

2a. Captured Regulators

We seek to represent situations where regulators are inevitably swayed by the interests of the industry they supervise. A simple way to represent regulatory capture[7] is to assume that regulators' objective is biased. We use the paradigm of the "new economics of regulation" developed by Tirole (1986) and Laffont and Tirole (1991, 1993):[8] an agency is delegated the regulatory task by the legislature; the legislature has limited resources for monitoring the agency; the agency has its own objective function, distinct from that of the legislature. In

dom external audits help shareholders deter possible collusion between the manager and internal auditors. Acemoglu and Gietzmann (1997) considered an incomplete contract version of a similar set-up and studied how imposing potential legal liability on an auditor remedies contracts' incompleteness.

[7] In Laffont and Tirole's setup, the regulatory agency may collude with the regulated firm. In general, it is optimal for the legislature to design a regulation system that is "collusion free". However there are cases where some limited form of collusion should be allowed (Laffont and Tirole, 1993, Page 486, Footnote 20).

[8] See also Laffont (1994).

their analysis of how much discretion should be left to regulators, Hiriart and Martimort (2012) assumed that the regulator gives a smaller weight to consumer surplus than the legislature. We make the similar assumption that the regulator gives a higher weight to the firm's profit than the legislature.

2b. How Regulators and Activists Interact

Activists do not directly lobby regulators. Unlike the general multiple-interest-group setting of Laffont and Tirole (1993, Chapter 11), activists seem to have given up on the lobbying side. As Baron (2003) put it, "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 that point; as a matter of fact, any attempt to lobby by activists is now "easily counter-lobbied by corporations".[9]

In some cases, activists can influence the general public, and thus indirectly legislatures.[10] Yet the idea that such influence can reach regulators does not fit well with our focus on situations where legislatures lack of control on agencies. When regulators are inevitably captured and activists are non manipulable, their interaction is only indirect, and solely arises through their joint influence on firms' conduct.

[9]See Gilding's statement to *The New York Times* (June 2, 2001):

> 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.

[10]See Kollman (1998) for empirical evidence. Besides financial constraints, Yu (2005) pointed at the activists' comparative advantage in public persuasion. Chiroleu-Assouline and Lyon (2011) emphasized the role of activists' ideology; "radical" groups may not be credible lobbyists.

2c. The Potential Limitations of Activism

The most noticeable manifestations of private politics go through a process of threats of punishments, as for instance to call for a boycott, to file a lawsuit, or to deteriorate firms' situation, image or reputation in any manner. As pointed out by Baron, it has now become common that firms take corrective measures on a voluntary basis[11] in anticipation of such processes (Baron and Diermeier, 2007; Egorov and Harstad, 2012).[12]

By their threats, activists target firms directly, on behalf of non-industry stakeholders who are hurt by firms' decisions, with the view to mitigating damages. Thus private politics has a Coasian bargaining dimension. As such, its potential to improve Pareto-inefficient situations depends on transaction costs: were transaction costs associated with private politics too high, this potential would not be realized. Whether activists' threats are carried out or not, their credibility always relies on already-initiated efforts. The positive literature on private politics and boycotts has paid a considerable amount of attention to the various side costs of activism: for instance, that of mobilizing the public (Kollman, 1998); that of coordinating individual participants (Baron, 2003); the individual efforts of each participant (John and Klein, 2003); the cost of acquiring information on targeted firms (Baron, 2003)...

Coasian bargaining processes have another limitation. Their appeal relies on the assumption that the agents involved are rational maximizers, whether of their own surplus or of that of other stakeholders. We already pointed out that our activists are not like conventional economic agents, because they are "rigid": for ideological, behavioral or reputational

[11]Clearly, such changes in firms' conduct are self-interested. Voluntary "self-regulation" by morally-motivated firms in the sense of Baron (2010) is out of the scope of our analysis.

[12]The war-of-attrition mixed-strategy equilibrium of Egorov and Harstad (2012) elegantly describes the joint process by which firms pro-actively change their practices in anticipation of activists' boycotts and by which activists start and stop boycotts so as to induce firms to do so. Egorov and Harstad's paper can be seen as the positive, dynamic counterpart of our normative study. They examined the interplay between activism-induced regulation and public regulation of a particular activity, taking the regulation structure as given.

reasons, activist groups are committed to reject any compromise (Baron, 2003).[13] When their tolerance is exceeded, they feel entrusted with the mission of inducing their preferred outcome; no monetary transfer exists that may compensate them for resigning. In other words, their preferences are of a lexicographic type.[14]

Finally, informational issues are central to the analyses of both public regulation and private politics. In two-tiered regulatory frameworks, legislatures design the law before knowing the exact nature of industrial projects; regulatory agencies are endowed with expertise, resources and legal prerogative to evaluate those projects. By contrast, as suggested by Baron (2003), activists are likely to be less well informed than regulators.[15] Moreover, activists are often committed to a high degree of independence, also vis-à-vis legislatures and regulatory bodies. Thus, legislatures cannot provide activists with the same legal prerogatives as regulators.

3. A Model of Captured Regulation

Consider an indivisible project – say, dismantling an obsolete oil platform – with a non-negative gross social value $v \geq 0$. The firm that owns the platform can implement the project at a publicly observable cost $c > 0$, but for no private benefit. Absent any external intervention, the firm will never undertake the dismantlement of the platform, even when

[13] As Baron put 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, Page 39).

[14] Samuelson and Swinkels (2003) showed that lexicographic preferences arise as a limiting case of more conventional preferences that exhibit continuous trade-offs across various objectives, with some objectives much more important than others. In our context, lexicographic preferences clearly provide the most meaningful formal representation.

[15] The example of the Greenpeace-Shell conflict over the dismantlement of the Brent Spar is particularly illustrative of this point. The dispute mainly arose from divergent estimates. On the one hand, Shell's 50-tonne estimate and proposal had been substantiated by several studies by organizations that had authorized access to the Brent Spar. On the other hand, Greenpeace activists incorrectly collected samples while they were temporarily illegally occupying the platform, which led them to the wrong assessment that it contained 5,500 tonnes of oil. Later independent audits concluded to a 75 to 100 tonnes of oil content, more in line with the firm's estimate delivered to the regulator.

the net social value $v - c$ of the project is positive.

This section exclusively focuses on public regulatory interventions. There is a legislature – call it Congress – that sets the law in such a way as to maximize expected social welfare. Were the value of the project v, like its cost c, perfectly observable, the benevolent Congress would legislate that the platform must be dismantled whenever v exceeds c.[16]

Since v is not directly observable to Congress, the above rule cannot be applied. There is a regulatory agency, which has resources and expertise to perfectly assess the project's value. We assume throughout that the agency's expertise is valuable to Congress: the latter delegates to the former the regulatory task of deciding whether or not the project will be undertaken. The associated two-tiered regulatory structure is similar to the approach followed by Laffont and Tirole (1993, Chapter 11) and Hiriart and Martimort (2012). It models the conflict between the objective of Congress and that of the agency. Congress is benevolent: its decisions reflect the social desirability of the regulatory outcome. This fits well our normative purpose. By contrast, the regulatory agency is partially captured by the industry.

In the sequel, let π be the firm's profit and $\mathcal{U}$ be the surplus of the rest of society. The objective of Congress is the social surplus

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

whose two components are given the same weight. Like Hiriart and Martimort (2012), we assume that the regulatory agency is biased in favor of the industry.[17] Specifically, its

[16]All along, we assume that the revenue generated by the firm's other activities covers the dismantlement cost c. Thus limited liability of the firm's shareholders is not violated.

[17]In Baron and Myerson (1982) or Baron and Besanko (1984) there is no conflict between Congress and the regulator, but their common objective function gives a higher weight to consumer surplus. See Baron (1988) for a justification. In their context, if the regulator gives an equal weight to consumer and to producer surpluses, the first-best outcome is attainable, as in Loeb and Magat's (1979).

objective is

$$\mathcal{V} = \mathcal{U} + (1+\alpha)\Pi, \tag{2}$$

where $\alpha \geq 0$ measures the pro-industry bias of the regulator or the degree of regulatory capture.[18]

When $\alpha = 0$, there is no conflict of interest between Congress and the agency. In that case, it is optimal for Congress to give full discretion to the agency in spite of the informational asymmetry. The first-best outcome is implemented. Let us denote the regulator's decision with the indicator variable D_c: it takes value 1 when a compulsory dismantlement is ordered and $D_c = 0$ otherwise. Then, total surplus is $(v-c)D_c$, which is maximized by the first-best rule that $D_c = \mathbb{1}_{v \geq c}$.

Things are not so with $\alpha > 0$. When Congress has to rely on a captured regulator, full delegation is not desirable anymore. Dismantling brings the rest of society the surplus $\mathcal{U} = v$ and makes the firm incur the cost c, that is $\Pi = -c$. Since the regulator gives a relative weight $1+\alpha > 1$ to the firm's profit, he would only decide a compulsory dismantlement when $v \geq (1+\alpha)c > c$. Total welfare in that context still writes $(v-c)D_c$, but with $D_c = \mathbb{1}_{v \geq (1+\alpha)c}$, unlike the first best. From the viewpoint of the benevolent legislature, not enough platforms are dismantled.

When dismantling is ordered by the regulator, the law designed by Congress may provide for a transfer $t_c \geq 0$ to the firm.[19] The cost to society of the subsidy t_c is $(1+\lambda)t_c$, where

[18] In all our analysis, the parameter α is exogenous. One possible way to endogenize it is to adopt Grossman and Helpman's (1994) approach to the influence of special-interest groups; an approach shown to be consistent with trade protection data by Goldberg and Maggi (1999). Following Grossman and Helpman, assume that the firm can ex ante induce any bias $\alpha \geq 0$ at some increasing cost $C(\alpha)$. Letting the firm maximize the difference between its ex-post profit (at the outcome chosen by the regulator) and the cost of influencing the regulator allows to endogenize α, as in Hiriart and Martimort (2012, Page 303). See Martimort and Semenov (2008) for a case where the regulator has an intrinsic bias that is not observable.

[19] We exclude negative transfers (taxes). In our partial-equilibrium setup, where the marginal cost of public funds is exogenous and constant, an infinite tax would be optimal. This shows that our framework is not adapted to the study of corporate taxation.

$\lambda > 0$ is the unit cost of public funds.[20]

Subsidies t_c to compulsory dismantlements affect the regulator because they affect the firm. When the regulator decides a compulsory dismantlement, the firm is partly compensated by the transfer t_c: its profit becomes $\pi = t_c - c$. The surplus of the rest of society is reduced accordingly, i.e. $\mathcal{U} = v - (1+\lambda)t_c$. By (2), the agency's objective becomes

$$\mathcal{V} = [v - (1+\alpha)c + (\alpha - \lambda)t_c]\, D_c. \tag{3}$$

We assume that the agency's bias is higher than the cost of public funds:

$$\alpha > \lambda. \tag{4}$$

This assumption ensures that the regulator positively values transfers to the firm. In this context, subsidies $t_c \geq 0$ may be used to influence the regulator. However, the first-best allocation is not attainable anymore, due to the cost of public funds. According to (3), the regulator orders to dismantle if and only if[21]

$$v \geq \bar{v} \equiv \bar{v}(t_c) = (1+\alpha)c - (\alpha - \lambda)t_c. \tag{5}$$

Hence $D_c = 1\!\!1_{v \geq \bar{v}}$ and social surplus equals $(v - c - \lambda t_c)1\!\!1_{v \geq \bar{v}}$.

Unlike the expert regulator, Congress is unable to observe the social value v of the project, which is drawn from a common-knowledge distribution with density $h(.)$ over $v \geq 0$. We assume that $h(.)$ is log-concave (Bagnoli and Bergstrom, 2005). Congress' objective thus

[20] See Laffont and Tirole (1993).

[21] When the regulatory agency is indifferent between ordering a dismantlement or not, we assume for simplicity that it chooses the best decision from a social perspective ("tie-breaking" assumption). Hence the weak inequality in (5) implicitly assumes that ordering a dismantlement when $v = \bar{v}$ is socially desirable. This is true whenever $t_c \leq c$, as will be checked ex post.

writes

$$\mathcal{W} = \int_{\bar{v}}^{\infty} (v - c - \lambda t_c) \, dH(v), \tag{6}$$

where $H(.)$ is the cumulative distribution function of v; this objective is to be maximized with respect to $t_c \geq 0$, taking into account the relation (5) between the regulator's intervention threshold $\bar{v}$ and the transfer t_c. We obtain

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

where the R superscript stands for "regulator".

Intuition suggests a trade-off faced by Congress, between inducing more dismantlements by lowering the regulator's intervention threshold, and the cost of the associated transfers. This intuition is confirmed by the first-order condition for the choice of t_c. At an interior solution where $t_c > 0$, we have

$$\lambda \left[1 - H(\bar{v})\right] = -\frac{d\bar{v}}{dt_c}(\bar{v} - c - \lambda t_c) h(\bar{v}). \tag{8}$$

The left-hand side is the marginal cost of transfer in case of dismantlement, i.e. when $v \geq \bar{v}$, and the right-hand side is the social surplus brought about by the marginal dismantled project.

Relation (5) implies $d\bar{v}/dt_c = \lambda - \alpha$, and an expression of marginal social surplus as a function of $\bar{v}$ only: $\bar{v} - c - \lambda t_c = \alpha \left[\bar{v} - (1 + \lambda)c\right] / (\lambda - \alpha)$. Thus we obtain a characterization of the optimum level of the induced threshold $\bar{v}^R \equiv \bar{v}(t_c^R)$ in the case of public regulation without activism:

$$\bar{v}^R - \frac{\lambda}{\alpha} \frac{\left[1 - H(\bar{v}^R)\right]}{h(\bar{v}^R)} = (1 + \lambda)c. \tag{9}$$

The following proposition establishes the consequences of regulatory capture (its proof is relegated to Appendix A).

Proposition 1. *(Regulation without activism: the consequences of regulatory capture)*

1. *Regulatory capture reduces social welfare:* $\partial \mathcal{W}^R / \partial \alpha \leq 0$;

2. *For a sufficiently large bias* $\alpha > \tilde{\alpha}$, *with* $\tilde{\alpha}$ *characterized in (A.2), dismantling subsidies* $t_c^R > 0$ *become optimal; they increase with the degree of regulatory capture* ($\partial t_c^R / \partial \alpha > 0$);

3. *The probability of dismantlement* $1 - H(\bar{v}^R)$ *is lower than in the first best but higher than in absence of regulation, i.e.* $c < \bar{v}^R \leq (1 + \alpha)c$; *it varies with the degree of regulatory capture in the same direction as subsidies* ($\partial \bar{v}^R / \partial \alpha < 0$); *moreover, it decreases with the cost of public funds* ($\partial \bar{v}^R / \partial \lambda > 0$);

4. *In the limit case of complete regulatory capture where* $\alpha = \infty$, *the optimal subsidy* $t_c^R = c$ *fully covers the cost: the regulation threshold becomes* $\bar{v}^R = (1 + \lambda)c$ *and social welfare is* $\mathcal{W}_\infty^R = \int_{(1+\lambda)c}^{\infty} [v - (1 + \lambda)c] \, dH(v)$.

When regulatory capture is complete ($\alpha = \infty$), the regulator has the same objective as the firm. Dismantlement can only happen if the transfer fully covers the cost: $t_c^R = c$. The regulator is then indifferent as to whether the dismantlement takes place. By our tie-breaking assumption (see Footnote 21), the intervention threshold maximizes social welfare, which yields $\bar{v}^R = (1 + \lambda)c$.

If Congress could rely on an unbiased agency ($\alpha = 0$), the first-best regulation would naturally arise from the full delegation of the regulatory task; that is, Congress would not need to subsidize dismantling. The first-best allocation would be implemented without using any public funds. Symmetrically, the third part of Proposition 1 shows that absent any cost of public funds (i.e. if $\lambda = 0$), the first-best threshold $\bar{v}^R = c$ can be implemented despite regulatory capture. For that, it is sufficient for Congress to fully cover the cost of dismantling with $t_c^R = c$, which does not entail any social cost in that case. Thus distortions do not simply stem from regulatory capture or from the social cost of public funds, but only arise from their combination.

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

4. Modeling Activism

This section introduces private activism in isolation. Thus there is no regulator that can force the firm to dismantle the platform. Congress can exclusively rely on activists' efforts for that. We examine two questions: should "voluntary"[22] dismantlements be subsidized? Should activists' actions such as boycotts be allowed in the first place?

Activism is a form of collective action. The intensity of activists' efforts essentially depends on the number of individuals participating into the action and on the level of their personal sacrifice. Individuals' coordination and sacrifice have multiple facets, which makes collective actions socially costly bargaining devices. We adopt the classical approach (see for example Laffont and Tirole, 1993, Chapter 11, or Baron, 2001) that consists in modeling activists as a single entity, viewed as a group of concerned, perfectly coordinated and identical individuals. The inefficiencies arising from the collective-action issues will be incorporated into the activist group's cost function.

Unlike the regulatory agency of Section 3, activists may not directly observe the project's value v – in general they are not "experts". Activists only observe a noisy signal

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

where ε is a noise drawn from a log-concave, common-knowledge distribution with density $f(.)$ and σ measures the precision of the signal.

As previously argued, activists are not like conventional agents in principal-agent models. In the light of Baron's (2003) remark on their rigid behavior (Section 2), we assume that

[22] To be precise, these dismantlements are decided by the firm under the pressure of activists; they are self-interested rather than morally motivated as in Baron (2010).

the activists' preferences are of a lexicographic type. Specifically, activists are *ready to make every effort* to have the project implemented as soon as their estimate s of the project's value exceeds a given tolerance threshold $\bar{s} \geq 0$.[23]

Thus activists decide to undertake an action (e.g. to call for a boycott) whenever their signal s exceeds the threshold $\bar{s}$; for a given project of value v, activists intervene with the conditional probability $P(s \geq \bar{s} \mid v)$. From relation (10), this probability is given by

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

where $F(.)$ is the cumulative distribution function of the noise ε; this probability is increasing in the social value v and decreasing in the tolerance threshold $\bar{s}$. We assume that $P(s \geq \bar{s} \mid v) = 0$ for $v = 0$, which amounts to assuming that the distribution of ε has a bounded support: $\varepsilon < \bar{s}/\sigma$ with probability one.

Activists can impose many types of threats on firms' profit. We propose a simple way to encompass all of them. Activists choose the intensity $x \geq 0$ of their action, that we measure directly by the dead-weight loss incurred by the firm if the threat is carried out. The credibility of these threats strongly relies on activists' already-initiated mobilization. Regardless of whether the activists' threat is carried out, this mobilization entails coordination and individual costs.[24] Whether they are exclusively borne by the activists or partly by the rest

[23]Besides Baron's (2003) remark, John and Klein (2003) underlined the paradoxical nature of the observed sacrifice of some individuals for the sake of collective interest. They argued that such puzzles can only be resolved by departing from regular economic modeling. Moreover, Baron and Diermeier (2007) and Lenox and Eesley (2009) argued that activists select targeted projects on the basis of how much is at stake. Beyond a project's social value, a multitude of other relevant aspects of activists' decisions has also been identified, including the characteristics of firms they target. This suggests that the tolerance level $\bar{s}$ varies with the type of firms, of sectors, of projects. These aspects are outside the scope of the present paper.

[24]For instance, the boycott literature (e.g. Baron, 2003, Pages 59-61) has emphasized the dynamic process through which activists and targeted firms respectively discover the intensity required 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 players' types so as to focus on the regulator-activist asymmetry of information regarding projets' value.

of society, social costs associated with credible threats of conflict depend on the intensity of the activists' planned action. We assume that these social costs equal γx (with $\gamma > 0$) i.e. are proportional to the intensity of action x.

Absent any public intervention, any action of intensity greater than the cost of dismantling surely induces the firm to yield to the activists' request, and so to dismantle on a basis that we shall term "voluntary" (as opposed to "compulsory" in Section 3). Such a scenario will be denoted with the indicator variable D_v taking value 1, where v stands for "voluntary". Otherwise, the firm does not dismantle and $D_v = 0$. Because of their lexicographic preferences, activists always choose the minimum intensity that meets their objective: $\tilde{x} = c$.

As already discussed, our activists cannot be directly influenced by monetary transfers. Their lexicographic preferences reflect the very high priority they give to dismantlement when their tolerance threshold is exceeded. In that case, there is no way for Congress (or for the firm) to directly influence them. However, Congress can indirectly influence the cost of activists' intervention. As in Section 3, we assume that the law provides for a dismantling subsidy $t_v \geq 0$ to the firm when $D_v = 1$. Then, the cost of a voluntary dismantlement is reduced to $c - t_v$. Accordingly, the intensity of activists' action that is sufficient to induce the firm to dismantle the platform is reduced to

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

Let us now turn to the optimal choice of t_v by the benevolent Congress. From an ex ante perspective, social welfare depends on the realization of v. A dismantlement only takes place if activists induce it: $D_v = 1$ if and only if $s \geq \bar{s}$. In such a case, the net value of the project $v - c$ is reduced by the social cost λt_v of the transfer t_v and by the social cost $\gamma \tilde{x}$ of activism. Expected social welfare writes

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

where the intensity of activism is given by (12). Hence,

$$\mathcal{W} = \int_0^\infty P(s \geq \bar{s} \mid v)\left[v - (1+\gamma)c - (\lambda - \gamma)t_v\right]\ dH(v). \tag{14}$$

In this expression, the private cost c is magnified by a coefficient γ that reflects its contribution to the intensity of activism $\tilde{x}$. Indeed, as (12) shows, the higher the cost of dismantling, the higher the minimum intensity of conflict $\tilde{x}$ that can induce the firm to dismantle. On the other hand, (12) also shows that the transfer t_v mitigates the intensity of activism $\tilde{x}$: hence its coefficient λ is reduced by γ.

As (14) makes clear, the objective of Congress is linear in t_v. Indeed, the social marginal cost of encouraging voluntary dismantlements via t_v is the difference between the unit cost of public funds λ and the unit social cost of activism γ. We only consider the most interesting case where[25]

$$\lambda > \gamma. \tag{15}$$

In that case it is never desirable to subsidize "voluntary" dismantlements: $t_v^A = 0$ and $\tilde{x} = c$, where the superscript A stands for "activism". Maximum social welfare that can be attained with activism but without regulation is

$$\mathcal{W}^A \equiv \int_0^\infty P(s \geq \bar{s} \mid v)\left[v - (1+\gamma)c\right]\ dH(v). \tag{16}$$

[25] The alternative case brings no further insight. If γ exceeds λ, the marginal cost of encouraging voluntary dismantlements is negative. Congress then fully relies on private politics and sets t_v so as to completely cover the cost c of dismantling. Thus $t_v^A = c$ and the social cost $\gamma\tilde{x}$ of activism vanishes. Thus in general, social welfare equals $\mathcal{W}^A = \int_0^\infty P(s \geq \bar{s} \mid v)\left[v - (1 + \min\{\lambda, \gamma\})c\right]\ dH(v)$. Our analysis extends to this case by replacing γ by $\min\{\lambda, \gamma\}$.

Even though the dismantlements provoked by activists must not be subsidized, the introduction of private politics may positively contribute to social welfare. This depends on the sign of $\mathcal{W}^A$ as expressed in (16).

The following proposition summarizes the findings of this section (see Appendix B for more details).

Proposition 2. *(Activism without regulation) Assume that regulation is impossible and that the marginal cost of public funds λ exceeds the marginal cost of activism γ. Then,*

1. *"Voluntary" dismantlements must not be subsidized: $t_v^A = 0$;*

2. *Allowing activism improves social welfare if and only if $\mathcal{W}^A$ in (16) is positive; this is more likely when $\imath$) the cost of private politics γ is sufficiently low, and $\imath\imath$) the threshold $\bar{s}$ is not too far from the social cost of voluntarily dismantling $(1+\gamma)c$ while activists are sufficiently well informed, i.e. as σ is sufficiently low;*

3. *In the limit case where activists are perfectly informed ($\sigma = 0$), social welfare is maximum when $\bar{s} = (1+\gamma)c$; allowing activism improves welfare as long as $\bar{s}$ is sufficiently close to this threshold.*

In the limit case where $\sigma = 0$, activists perfectly observe the projects' value. Then, they induce a dismantlement if and only if $v \geq \bar{s}$. In this context, social welfare becomes $\mathcal{W}^A = \int_{\bar{s}}^{\infty} [v - (1+\gamma)c] \ dH(v)$; it is increasing in $\bar{s}$ when $\bar{s} < (1+\gamma)c$ and decreasing otherwise. For $\bar{s} = (1+\gamma)c$, the firm is led to undertake all projects of positive net social value, and activism thus enhances social welfare. By continuity, this is also true when σ is small or when $\bar{s} - (1+\gamma)c$ is close to zero.

5. Optimal Regulation with Activism

The coexistence of private politics with public regulation raises a number of issues. The plausibility of direct interactions between activists and the regulatory agency has already

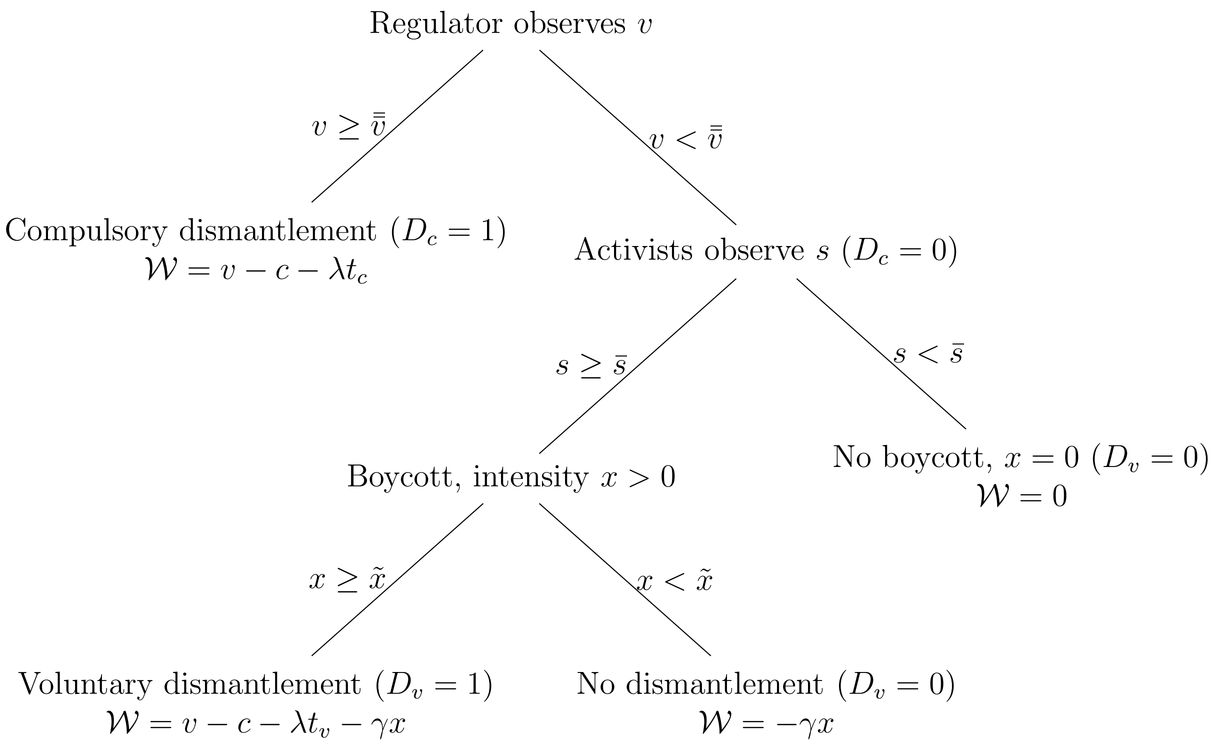

Figure 1: Game form

been mentioned. On the one hand, our activists are not influenceable. On the other hand, for the reasons detailed in Section 2, they cannot, or find it too costly to, lobby the agency.

Hence, interactions between activists and the regulator are indirect and only arise through their respective influence over the firm. Now comes the question of the timing of actions. Since the regulator always has the possibility to pro-actively intervene, before activists become aware of the issue at stake, we model these interactions in a dynamic game where the regulator is a Stackelberg leader.[26]

Finally, communication between activists and regulators is unavoidable. In the context of our analysis, any decision on the part of the informed regulator conveys information to

[26]As Baron (2003, Page 55) put it, "The activist challenge to the firm begins with the identification of the issue."

activists on the project's value. For simplicity, we will first neglect this effect: in this section, activists are assumed myopic. In the discussion of Section 6, with details in the Appendix, we consider the case of Bayesian activists.

Those basic clarifications being made, the models of Sections 3 and 4 can be combined without any further modification. The resulting game form is represented in Figure 1. Consider a given project with value $v \geq 0$. If the regulator orders a compulsory dismantlement to the firm ($D_c = 1$), activists never undertake any action ($D_v = 0$). Otherwise, that is absent any regulatory intervention ($D_c = 0$), the probability that activists will induce the firm to voluntarily dismantle is given by (11). When activists do so ($D_v = 1$), they always choose an action of intensity $\tilde{x}$, as given by (12).

However the regulator's choice is now affected by the possibility of activism. When the regulator orders a compulsory dismantlement, his objective function still takes the value given by (3) with $D_c = 1$. If he does not ($D_c = 0$), there is a positive probability (11) that activists induce a voluntary dismantlement ($D_v = 1$). In that case, the ex-post payoff of the regulator amounts to the difference between the net benefit of a dismantlement $v - (1+\alpha)c + (\alpha - \lambda)t_v$ as in Section 3, and the social cost of activism $\gamma\tilde{x} = \gamma(c - t_v)$ as per (12): that is $\mathcal{V} = v - (1 + \alpha + \gamma)c + (\alpha - \lambda + \gamma)t_v$.

Appendix C shows in detail how the introduction of activism affects the regulatory decisions of the agency. The decision rule of the regulator turns out to take the same form as in Section 3: he orders a compulsory dismantlement ($D_c = 1$) if and only if the project's value v is higher than a threshold that we now denote $\bar{\bar{v}}$. But the choice of the regulator now integrates the possibility of activism-induced voluntary dismantlements. Thus, his intervention threshold $\bar{\bar{v}}$ not only depends on Congress' subsidies t_c to compulsory dismantlements, but also on its subsidies t_v to voluntary dismantlements:

$$\bar{\bar{v}} \equiv \bar{\bar{v}}(t_c, t_v). \tag{17}$$

The function $\bar{\bar{v}}(t_c, t_v)$ is characterized by (C.7) in Appendix C.

Public policies that treat differently similar conducts always raise the issue of incentive compatibility. Here, the problem arises because of the coexistence of different subsidies for dismantling in two distinct contexts. With transfers t_c and t_v, Congress can differently encourage dismantlements that follow the regulator's order and voluntary dismantlements. Unlike Section 3, it is now possible for the firm to act on a voluntary basis so as to escape the consequence of a public ordering. The firm finds attractive to do so as soon as voluntary dismantlements are compensated at a higher rate than compulsory ones. Thus incentive compatibility requires that

$$t_c \geq t_v, \tag{18}$$

a condition that will be verified below.

Let us now further examine the decision rule of the regulator in presence of activists. Assuming (18), Appendix C analyzes the new intervention threshold $\bar{\bar{v}}$ of the regulator. Everything else given, the introduction of activists turns out to cause a decrease in that threshold; that is,

$$\bar{\bar{v}}(t_c, t_v) \leq \bar{v}(t_c), \tag{19}$$

for any given admissible transfers $0 \leq t_v \leq t_c \leq c$, where $\bar{v}(t_c)$ is the regulator's intervention threshold in the context of Section 3. The equality only arises if no activism ever takes place when projects have value $\bar{v}$, i.e. if $P(s \geq \bar{s} \mid \bar{v}) = 0$, as when the distribution of the noise ε has a support bounded at a low level $\varepsilon < (\bar{\bar{s}} - \bar{v})/\sigma$. In all other cases, the inequality (19) is strict. Thus with activists, more projects are undertaken as a result of the regulator's order. Indeed, when the regulator is not ordering a compulsory dismantlement, activism may now arise, that would make the captured regulator worse-off for two reasons. First, the intensity $\tilde{x}$ of activism deteriorates social welfare. Second, the firm is less compensated for voluntary, activism-induced dismantlements than for compulsory dismantlements ordered by the regulator himself. Those losses provide the captured regulator with incentives to order more dismantlements: confronted with activists, a captured regulator behaves as if he was less biased.

Let us now turn to the optimal choice of $t_c \geq 0$ and $t_v \geq 0$. For $v \geq \bar{\bar{v}}$, the regulator orders a dismantlement and social surplus is the same as in Section 3. For $v < \bar{\bar{v}}$, a voluntary dismantlement occurs with probability (11); then, social surplus is $v - c - \lambda t_v - \gamma \tilde{x}$, where $\tilde{x} = c - t_v$, as in Section 4. Expected social surplus therefore writes

$$\mathcal{W} = \int_{\bar{\bar{v}}}^{\infty} (v - c - \lambda t_c)\ dH(v) + \int_0^{\bar{\bar{v}}} P(s \geq \bar{s} \mid v)\,[v - (1+\gamma)c - (\lambda - \gamma)t_v]\ dH(v), \quad (20)$$

which is to be maximized by Congress by the appropriate choice of $t_c \geq 0$ and $t_v \geq 0$.

For the same reason as in Section 3, the intervention threshold $\bar{\bar{v}}(t_c, t_v)$ of the regulator is decreasing in t_c; moreover, it is now increasing in t_v. The following lemma shows that there is no need to use both instruments simultaneously.

Lemma 1. *When the firm is simultaneously under the influence of a regulatory agency and of activists, Congress must never subsidize both compulsory dismantlements ordered by the agency and voluntary dismantlements induced by activists: either* $t_c = 0$ *or* $t_v = 0$.

It has been earlier established that, for given transfers, the mere presence of activists causes the regulator's intervention threshold $\bar{\bar{v}}$ to decrease. Yet in addition, Appendix C shows that it is always desirable to design transfers so as to induce this threshold to further decrease: even more projects must be undertaken. Since the threshold $\bar{\bar{v}}(t_c, t_v)$ increases with $t_v > 0$, subsidizing voluntary dismantlements can never be optimal. Therefore Congress exclusively relies on subsidies t_c to compulsory dismantlements. Denoting with the superscript $*$ the optimum values in the context of this section, we obtain

$$t_v^* = 0 \text{ and } t_c^* \geq 0, \quad (21)$$

which satisfies the incentive-compatibility condition (18). Lemma 1, together with the incentive-compatibility condition, implies that optimal transfers necessarily satisfy (21).

Using (21), social welfare (20) may be rewritten as a function of only two variables: the regulatory threshold $\bar{\bar{v}}$ and the transfer t_c. Moreover, the characterization of $\bar{\bar{v}}$ in (C.7), taken with $t_v = 0$, shows that only one value of t_c is compatible with any choice of $\bar{\bar{v}}$. Thus social welfare can be expressed as a function of $\bar{\bar{v}}$ only. Easy computations yield

$$\begin{aligned}\mathcal{W}(\bar{\bar{v}}) = \mathcal{W}^R(\bar{\bar{v}}) \quad &+ \quad \frac{\lambda}{\alpha - \lambda} \left[(1+\alpha+\gamma)c - \bar{\bar{v}}\right] P(s \geq \bar{s} \mid \bar{\bar{v}}) \left[1 - H(\bar{\bar{v}})\right] \\ &+ \quad \int_0^{\bar{\bar{v}}} P(s \geq \bar{s} \mid v) \left[v - (1+\gamma)c\right] \; dH(v), \end{aligned} \tag{22}$$

where $\mathcal{W}^R(\bar{\bar{v}})$ is social welfare evaluated in the context of Section 3, defined as a function of the intervention threshold $\bar{\bar{v}}$, taking into account the value t_c of the transfer that would induce this threshold.[27]

This expression singles out the impact of activism on social welfare, identified by the last two terms on the right-hand side of (22). Indeed, the contribution of activists to social welfare is twofold.

The last term on the right-hand side of (22) shows the direct effect of activists via the voluntary dismantlements they induce. This term is similar to (16), the contribution to social welfare of activists in Section 4, except that now, it only applies over the range of projects $v < \bar{\bar{v}}$ for which no dismantlements have been ordered by the regulator.[28] Thus, this term may be negative, as activism-induced dismantlements are not always desirable.

Activists also contribute indirectly to social welfare via their effect on regulatory decisions. For a given regulatory threshold $\bar{\bar{v}}$, expected social welfare when activism is not allowed is given by $\mathcal{W}^R(\bar{\bar{v}})$. The second term on the right-hand side of (22) can be interpreted as the

[27] Formally, $\mathcal{W}^R(\bar{\bar{v}})$ defines as $\mathcal{W}$ in (6), where t_c has been replaced by its implicit definition by (5).

[28] In the present section, this term takes the same form regardless of Condition (15). Indeed, since $t_v^* = 0$, the cost of public funds λ is now irrelevant in cases of voluntary dismantlements.

reduction in the costs of transfers brought about by activism. Indeed, as already established, the introduction of activists makes the captured regulator behave as if he was less biased; equivalently, a regulatory intervention threshold being given, public regulation is less costly when it is confronted with activists. Accordingly, Appendix C shows that the second term on the right-hand side of (22) is indeed positive.

All in all, whether allowing activism improves social welfare depends on the total (direct and indirect) contribution of activists, that is, formally, on whether $\mathcal{W}(\bar{\bar{v}})$ in (22), evaluated at its maximum $\bar{\bar{v}}^*$, is greater than the maximized value $\mathcal{W}^R = \mathcal{W}^R(\bar{\bar{v}})$ of (7) or not.

The following proposition summarizes the findings of this section.

Proposition 3. *(Regulation with activism) When Congress can simultaneously rely on a captured regulator and on costly actions by rigid and imperfectly-informed activists, then*

1. *Only compulsory dismantlements ordered by the regulator must be subsidized:* $t_v^* = 0$ *and* $t_c^* \geq 0$*;*

2. *The introduction of activism contributes to discipline the regulator: for the same level of transfers, more compulsory dismantlements are ordered;*

3. *Even if activists sometimes induce inappropriate dismantlements, they may still improve social welfare if the third term on the right-hand side of (22) is not too low;*

4. *Suppose that the regulator is completely captured ($\alpha = \infty$) and that activists are perfectly informed ($\sigma = 0$) and have a lower tolerance threshold $\bar{s}$ than $\bar{v}$ (the regulatory threshold in absence of activism);*[29] *then optimal regulation with activism involves no subsidies ($t_c^* = 0$) and a lower intervention threshold $\bar{\bar{v}}^* = \bar{s}$: allowing activism improves social welfare as long as $\bar{s}$ is not too distant from c.*

In the limit case considered by the last point of Proposition 3, activists systematically induce voluntary dismantlements as soon as v exceeds their tolerance threshold $\bar{s}$. In anticipation, the regulator reluctantly chooses to order a dismantlement, so as to avoid the

[29] Clearly in this context, if $\bar{s} > \bar{\bar{v}}$, activists never have any impact on regulatory decisions.

social cost of activists' intervention. Thus the regulator is led to adopt the same intervention threshold $\bar{s}$ as activists, and no compensations are provided to the firm. Social welfare in that context is $\mathcal{W}^* = \int_{\bar{s}}^{\infty}(v - c)\ dH(v)$. Remember that when activism is not allowed (Proposition 1), and the regulator is completely captured ($\alpha = \infty$), dismantlements are fully subsidized ($t_c^R = c$) and the optimal regulatory threshold is $\bar{v}^R = (1 + \lambda)c$; thus $\mathcal{W}^R = \int_{(1+\lambda)c}^{\infty} [v - (1 + \lambda)c]\ dH(v)$. When the activists' threshold $\bar{s}$ is lower than the cost of dismantling c, Figure 2 illustrates the welfare effect of allowing activism as the difference between $\mathcal{W}^*$ and $\mathcal{W}^R$. On the one hand, activists improve regulation over the range of projects that would be undertaken in absence of activism. On the other hand, activism induces projects to be undertaken when it is not desirable. The effect of allowing activism is the difference between the hatched area above the horizontal axis and the hatched area below it, where areas are weighted according to the density $h(v)$.

In general, despite the difference between the benefit (or cost) of voluntary dismantlements without public regulation (Section 4) and with it (this section), the analysis of social welfare in Section 4 resembles that of the third term of (22). It follows from the third point of Proposition 3 that allowing activism improves social welfare if $\imath$) the cost of private politics γ is sufficiently low, or if $\imath\imath$) the activists' tolerance threshold $\bar{s}$ is not too distant from the total cost of voluntarily dismantling $(1 + \gamma)c$ while the activists are well enough informed, i.e. σ is sufficiently low.

6. Discussion

The synthetic model of Section 5 illustrates how activism can improve distortionary regulatory systems, in spite of the various limitations inherent to private politics.

In addition to the modes of intervention modeled in this paper, activism may also involve additional agents, such as a judge. Indeed, one common way by which activists can deteriorate a firm's situation consists in filing a lawsuit against it. In an ideal world (Shleifer,

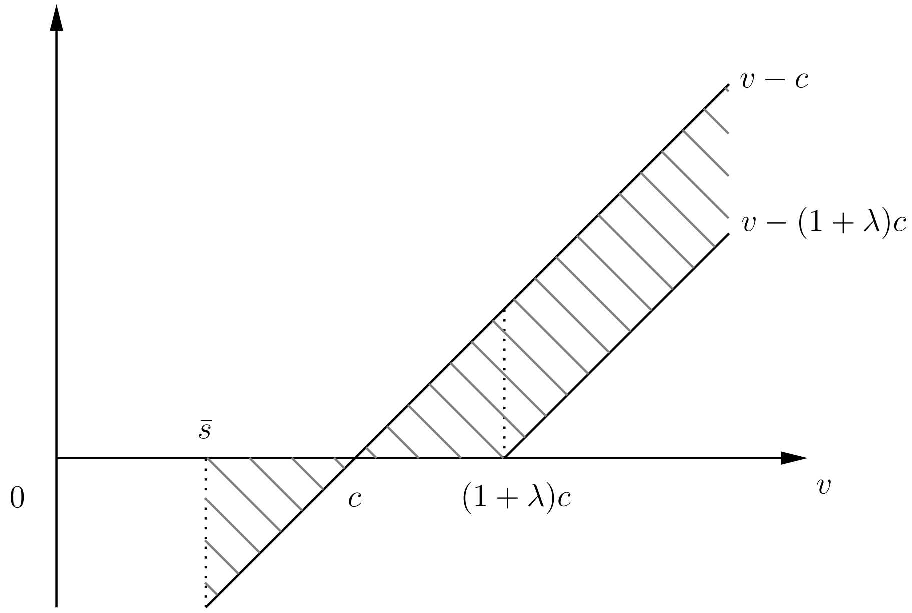

Figure 2: Social contribution of activism in the limit case where $\alpha = \infty$ and $\sigma = 0$

2012, Chapter 1), courts can systematically induce firms to internalize externalities. "Judicial activism" can also be viewed as a means to penalize firms. However, judges have legal prerogatives to make parties reveal more information than they would privately do outside the court. The intervention of a judge, or the effective threat of such an intervention, can effectively limit the occurrence of socially-inefficient dismantlements such as that of the Brent Spar.

The influence of the industry over regulatory bodies certainly results from complex collusion processes. Those processes are outside the scope of this paper. Yet, the bias of regulators in favor of the industry they supervise can be considered endogenous. The now standard approach of Grossman and Helpman (1994) easily accounts for such an influence: see Footnote 18 for further details. Alternatively, Heyes and Maxwell (2004) built on Lewis' (1996) assumption that public regulation is more successful when the industry's stake is lower. Their approach brings up a simple insight that is complementary to ours: the coexistence of activism with public regulation may soften the resistance of the industry to public regulation.[30]

The assumption that the activists' evaluation of projects is unaffected by the regulator's decision is a simplifying one. In practice, information collection and analysis are essential to activists' long-run efficacy and reputation. Appendix D extends Section 5 to the case of Bayesian activists that rationally revise their priors after observing the regulator's decision. Bayesian activists estimate projects' value not only on the ground of their private imperfect signal, but also taking into account what the regulator's decision reveals. Appendix D shows that Bayesian activists provide a less powerful disciplining device than do myopic activists. This is because activists may only intervene when the regulator does not. In that case indeed, Bayesian revision always causes a reduction in the activists' estimate of the project's social value.

One reason why activism has an ambiguous legal treatment in most countries is the recurrent suspicion, substantiated by some examples, that activists may be corrupt or captured by concerned parties (e.g. competitors of the firm). Activists' manipulability is certainly an argument in favor of limiting their nuisance potential. Introducing the possibility that the industry manipulates the activists would clearly undermines our results. While the possible selection/certification/regulation of activists' groups is out of the scope of the present paper, it is an important practical matter that may also be theoretically challenging.[31]

On the other hand, our assumption that activists are rigid seems to be in line with casual and empirical evidence (e.g. Baron, 2003). As soon as activists' preferred option is

[30] Heyes and Maxwell (2004) examined the proposal for an international environmental agency in charge of imposing compulsory minimum standards to firms, and its possible interplay with voluntary compliance efforts induced by independent certification. Industry resistance is not unlike regulatory capture; yet the relevance of the mechanism goes beyond the realm of environmental regulation. The comparison of conventional public regulation with private politics further underlines shortcomings of the latter that have to do with information asymmetries and transaction costs.

[31] For example, the French currently-planned legislation over class-action suits provides that they will have to be brought through one of France's 16 officially recognized consumer associations.

to reverse the firm's conduct, no finite monetary transfer exists that may compensate them for resigning. No principal can use direct monetary transfers to influence such "agents".[32] Our analysis calls for further investigation of mechanism design with agents characterized by lexicographic preferences. As far as activism and regulatory capture are concerned, one important issue concerns the design of communication between Congress, informed regulators, less-informed activists and potential intermediates in the spirit of Dixit (2003). As suggested by Dequiedt and Martimort (2007), the communication structure is crucial for the optimal design of mechanisms.

The view that benevolent, expert regulators act in the best interests of uninformed and defenseless stakeholders (consumers, investors or taxpayers) is now largely obsolete. The picture offered by the present paper incorporates two new elements that fit well with the current behavior of modern economic agents. First it is almost impossible to subtract regulators from the influence of the industry they are supposed to monitor. The stakes of regulation have become too large and regulatory agencies lack the resources that are needed to compete with the private sector for hiring experts. Second, even if individual stakeholders still lack the time, resources and expertise to evaluate increasingly more complex projects, modern technologies have triggered the emergence of benevolent "experts" in the Internet community. Provided the relevant data are made publicly available, benevolent experts may spontaneously spend the time and energy necessary to deeply examine and digest these data and provide independent assessments to the general public. Like the Wikipedia phenomenon, these assessments can reveal extremely useful, provided inaccurate or biased assessments can be detected and eliminated. It is to be hoped that such independent assessments, combined with credible threats of corrective actions by agents like NGOs may induce existing regulatory systems to enhance their performance.

[32] Our case differs from other departures from principal-agent strategic relationships as for instance the case of so-called "agents without principals" (e.g. Bertrand and Mullainathan, 2000), where agents are assumed to manipulate principals.

APPENDICES (For Online Publication)

A Proof of Proposition 1

1. By definition of $\mathcal{W}^R$ in (7), of $\bar{v}(t_c)$ in (5), and of the solution t_c^R, optimal social welfare without activism is given by

$$\mathcal{W}^R = \int_{(1+\alpha)c-(\alpha-\lambda)t_c^R}^{\infty} (v - c - \lambda t_c^R) \, dH(v).$$

It immediately follows

$$\frac{\partial \mathcal{W}^R}{\partial \alpha} = -(c - t_c^R)[(1+\alpha)c - (\alpha - \lambda)t_c^R - c - \lambda t_c^R]h(\bar{v}^R) = -(c - t_c^R)^2 \alpha h(\bar{v}^R), \qquad \text{(A.1)}$$

which is negative since $t_c^R \leq c$, as will be shown shortly below.

$2-3$. By (5), $t_c^R = 0$ if and only if $\bar{v}^R = (1+\alpha)c$. Otherwise, the solution is interior: $t_c^R > 0$ and $\bar{v}^R < (1+\alpha)c$. In any interior solution, $\bar{v}^R$ is characterized by (9).

Since the density function h is log-concave, the ratio $h(v)/[1 - H(v)]$ is non-decreasing in v (Bagnoli and Bergstrom, 2005). Thus the left-hand side of (9) is continuous and strictly increasing in $\bar{v}^R$. It is also continuous and strictly increasing in $\alpha > 0$, while the right-hand side does not depend either on $\bar{v}^R$ or on α. It follows that $\bar{v}^R$ is continuously, strictly decreasing in $\alpha > 0$; by (5), $\partial \bar{v}^R/\partial \alpha = c - t_c^R - (\alpha - \lambda)\partial t_c^R/\partial \alpha < 0$ where $c - t_c^R \geq 0$, which implies that t_c^R is strictly increasing in $\alpha > 0$.

Thus interior values $\bar{v}^R < (1+\alpha)c$ and $t_c^R > 0$ are only compatible with sufficiently high values of α. More precisely, $\bar{v}^R < (1+\alpha)c$ and $t_c^R > 0$ is equivalent to $\alpha > \tilde{\alpha}$ where $\tilde{\alpha}$ is implicitly defined by taking (9) with $\bar{v}^R = (1+\alpha)c$:

$$\tilde{\alpha}c - \frac{\lambda}{\tilde{\alpha}} \frac{[1 - H((1+\tilde{\alpha})c)]}{h[(1+\tilde{\alpha})c]} = \lambda c. \qquad \text{(A.2)}$$

The left-hand side of (A.2) is increasing in $\tilde{\alpha}$. Clearly, since its second term is negative, the left-hand side evaluated at $\tilde{\alpha} = \lambda$ falls short of the right-hand side. Therefore, $\tilde{\alpha} > \lambda$, and $\tilde{\alpha}$ satisfies (4).

The fact that $\bar{v}^R$ is strictly larger than $(1+\lambda)c$ is easily shown by adding the positive term $\lambda \left[1 - H(\bar{v}^R)\right] / \alpha h(\bar{v}^R)$ to both sides in (9); thus

$$c < (1+\lambda)c < \bar{v}^R \leq (1+\alpha)c,$$

and equivalently, by (5),

$$0 \leq t_c^R \leq c.$$

In (9), the left-hand side and right-hand side are respectively strictly decreasing and strictly increasing, continuously in λ. An interior solution for $\bar{v}^R$ must be continuously, strictly increasing in λ.

Once it is noted that $H(\bar{v}^R)$ is increasing in $\bar{v}^R$, the third point of the proposition immediately applies.

4. When $\alpha > \tilde{\alpha}$, the solution is interior and $\bar{v}^R$ is determined by (9). In particular, in the limit case where α tends to infinity, the second term on the left-hand side of (9) vanishes, so that we are left with the solution $\bar{v}^R = (1+\lambda)c$, its lowest level. By (5), it also implies that $t_c^R = c$, its highest level.

B Proof of Proposition 2

1. This is shown in the main text under Assumption (15). See also Footnote 25.

2 − 3. That $\partial \mathcal{W}^A / \partial \gamma$ is negative is immediate from (16). When $\bar{s} = (1+\lambda)c$, (16) is equivalent to $\mathcal{W}^A = \int_0^\infty [1 - F((\bar{s} - v)/\sigma)] (v - \bar{s})\ dH(v)$. Its derivative with respect to $1/\sigma$ is $\int_0^\infty f\left(\frac{\bar{s}-v}{\sigma}\right)(v-\bar{s})^2\ dH(v)$, which is positive.

When $\sigma = 0$, activists perfectly observe the value v: the probability of action $P(s \geq \bar{s} \mid v)$ is one for any $v \geq \bar{s}$, and zero otherwise. Thus (16) rewrites $\mathcal{W}^A = \int_{\bar{s}}^\infty [v - (1+\lambda)c]\ dH(v)$. In that case, its maximum with respect to $\bar{s}$ is reached for $\bar{s} = (1+\lambda)c$. Then, $\mathcal{W}^A = \int_{(1+\lambda)c}^\infty (v - (1+\lambda)c)\ dH(v)$, which is non-ambiguously positive.

By continuity of $\mathcal{W}^A$ in γ, $\bar{s}$ and σ, it follows that $\mathcal{W}^A$ is positive if σ is sufficiently low, if $\bar{s}$ is sufficiently close to $(1+\lambda)c$ and if γ is sufficiently low.

C Proof of Proposition 3 (also Lemma 1)

1−2. It immediately follows from the main text of Section 5 that the pay-off of the regulatory agency writes

$$\mathcal{V} = [v - (1+\alpha)c + (\alpha - \lambda)t_c]\, D_c + [v - (1+\alpha+\gamma)c + (\alpha - \lambda + \gamma)t_v]\, D_v. \tag{C.1}$$

The agency seeks to maximize this objective by choosing whether to order a dismantlement or not, $D_c \in \{0,1\}$, taking into account that if no such compulsory dismantlement takes place ($D_c = 0$), a voluntary one ($D_v = 1$) may occur with a probability given by (11).

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

$$v - (1+\alpha)c + (\alpha - \lambda)t_c \geq P(s \geq \bar{s} \mid v)\, [v - (1+\alpha+\gamma)c + (\alpha - \lambda + \gamma)t_v]\,. \tag{C.2}$$

In what follows, we will make use of the simplifying notations

$$\phi \equiv \phi(v) = P(s \geq \bar{s} \mid v) \tag{C.3}$$

and

$$u \equiv u(t_v) = (1 + \alpha + \gamma)c + (\alpha - \lambda + \gamma)t_v. \tag{C.4}$$

Let us also remind that by (5) the intervention threshold $\bar{v}$ in the context of Section 3 is $\bar{v}(t_c) = (1+\alpha)c + (\alpha - \gamma)t_c$. With those notations, the necessary and sufficient condition for intervention (C.2) writes

$$v - \bar{v}(t_c) \geq \phi(v)\left[v - u(t_v)\right]. \tag{C.5}$$

Without loss of generality, we now restrict the analysis to an admissible range of candidate subsidies t_c and t_v. On the one hand, incentive compatibility requires that $t_c \geq t_v$ as per (18). On the other hand, optimum t_c and t_v must be lower than c. Indeed, $t_c = c$ and $t_v = c$ are sufficient to suppress any firm's stake in any possible outcome, and so to induce the regulator to make welfare-maximizing decisions; because of the cost of public funds, higher transfers would be unnecessarily costly to society, and can thus not be optimal. The admissible range for t_c and t_v is thus

$$c \geq t_c \geq t_v \geq 0, \tag{C.6}$$

to which we restrict the rest of the analysis.

Note that $u(t_v)$ as defined above may rewrite $u(t_v) = \bar{v}(t_c) + (\alpha - \lambda)(t_c - t_v) + \gamma(c - t_v)$, where in the admissible range (C.6) for t_c and t_v, the last two terms are clearly positive; hence $\bar{v}(t_c) \leq u(t_v)$, the equality case can only arise for $t_c = t_v = c$.

First, one can eliminate the case where $\bar{v} = u$ as follows. From the above analysis, this equality may only hold if optimal transfers are $t_c = t_v = c$; it will shortly turn out that those transfers cannot be optimal. When $\bar{v} = u$, condition (C.5) can only be verified when $\phi(v) = 1$. From (C.3) and (11) it follows that $\phi'(v) = f(.)/\sigma$, so that ϕ is continuously increasing. Thus with $\bar{v} = u$, condition (C.5) is satisfied if and only if $v \geq \bar{\bar{v}}$, where $\bar{\bar{v}}$ is the minimum v, if it exists, such that $\phi(v) = 1$. Note that such $\bar{\bar{v}}$ is insensitive to transfers t_c and t_v. Consider social welfare as expressed in (20) in that case: when $\bar{\bar{v}}$ is independent of t_c and t_v, $\mathcal{W}$ clearly appears to be decreasing in both t_c and t_v. Hence, any pair of transfers $0 \leq t_c < c$ and $0 \leq t_v < c$ would yield a higher welfare than $t_c = t_v = c$, which contradicts that they can be optimal.

It follows that $\bar{v} < u$. Examine now (C.5) in that context. There are 3 possible cases.
i) If $\bar{v} < u \leq v$, then $v - \bar{v} > v - u \geq 0$; since $\phi(v) \leq 1$, it also implies that (C.5) always holds.
ii) If $\bar{v} < v < u$, then $v - \bar{v} > 0 > v - u$; since $\phi(v) \geq 0$, it also implies that (C.5) always holds.
iii) If $0 \leq v \leq \bar{v} < u$, we now show that (C.5) only holds when v exceeds a threshold. On the one hand, for $v = 0$, $\phi(v) = 0$ by the assumption made on (11). Thus (C.5) does

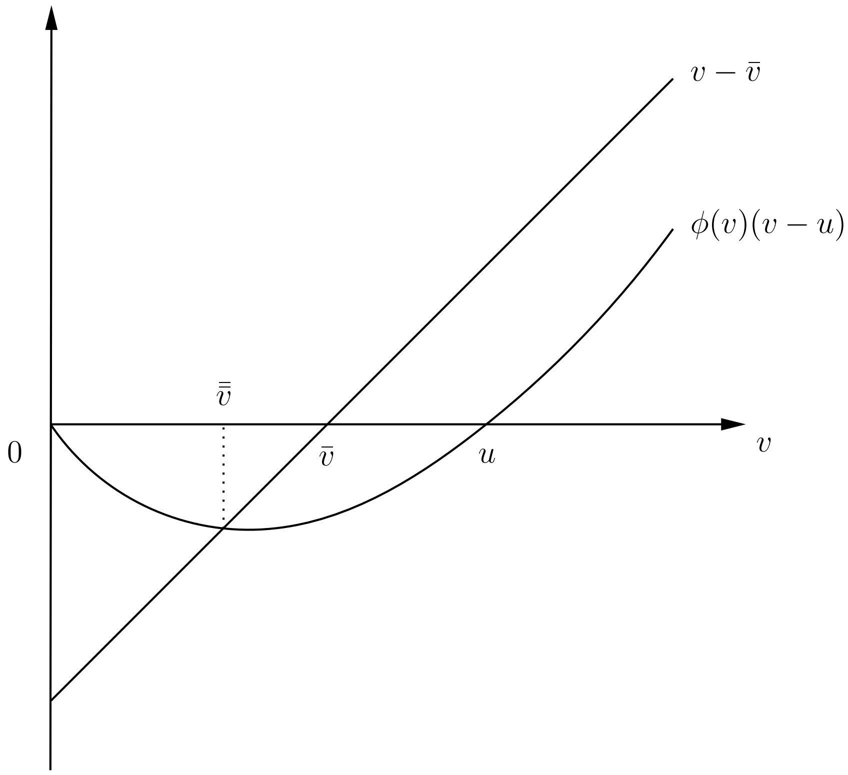

Figure 3: Regulatory decision rule with activism

not hold for $v = 0$. On the other hand, for $v = \bar{v}$, (C.5) is satisfied because $\phi(\bar{v}) \geq 0$ and $\bar{v} < u$. By definition, $\phi(v) = P(s \geq \bar{s} \mid v) = 1 - F[(\bar{s} - v)/\sigma]$. Hence $d\phi(v)(v-u)/dv = f[(\bar{s} - v)/\sigma](v-u)/\sigma + \phi(v)$ which is lower than unity since $v - u < 0$. By continuity, it turns out that $v - \bar{v}$ intersects $\phi(v)(v-u)$ at some value $\bar{\bar{v}}$, $0 \leq \bar{\bar{v}} \leq \bar{v}$ that satisfies $\bar{\bar{v}} - \bar{v} = \phi(\bar{\bar{v}})(\bar{\bar{v}} - u)$; the two curves are represented in Figure 3. More explicitly, $\bar{\bar{v}}$ is characterized by

$$\bar{\bar{v}} - (1+\alpha)c + (\alpha - \lambda)t_c = P(s \geq \bar{s} \mid \bar{\bar{v}})\left[\bar{\bar{v}} - (1+\alpha+\gamma)c + (\alpha - \lambda + \gamma)t_v\right]. \qquad \text{(C.7)}$$

If $\phi(\bar{v}) = P(s \geq \bar{s} \mid \bar{v}) < 1$, as when there exists $\varepsilon < (\bar{s} - \bar{v})/\sigma$ such that $f(\varepsilon) > 0$, then $\phi(v) < 1$ for all $v \leq \bar{v}$ and $d\phi(v)(v-u)/dv = f[(\bar{s} - v)/\sigma](v-u)/\sigma + \phi(v) < 1$, so that the intersection point $\bar{\bar{v}}$ is unique. Otherwise, the set of values satisfying (C.7) is an interval and we define $\bar{\bar{v}}$ uniquely as the inferior value of this interval. Hence, condition (C.2) – also its equivalent (C.5) – is satisfied if and only if $v \geq \bar{\bar{v}}$.

In general, $\bar{\bar{v}} \leq \bar{v}$, where the equality case only arises when $\phi(\bar{v})(\bar{v} - u) = 0$. If $\phi(\bar{v}) = P(s \geq \bar{s} \mid \bar{v}) > 0$, as when there exists $\varepsilon \geq (\bar{s} - \bar{v})/\sigma$ such that $f(\varepsilon) > 0$, then the inequality is strict: $\bar{\bar{v}} < \bar{v}$.

The intervention threshold defined by (C.2) is a function $\bar{\bar{v}} \equiv \bar{\bar{v}}(t_c, t_v)$ of transfers t_c and t_v. As in Section 3, it is decreasing in t_c; it is moreover increasing in t_v.

The analysis can now turn to the choice by Congress of transfers $t_c \geq 0$ and $t_v \geq 0$ respectively provided for in case of compulsory and voluntary dismantlements. Social surplus consists of two components. For $v \geq \bar{\bar{v}}$, a compulsory dismantlement is ordered, in which case social surplus is $(v - c - \lambda t_c)$. For $v < \bar{\bar{v}}$, with probability $P(s \geq \bar{s} \mid v)$, a voluntary dismantlement is induced. 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 as in (20), which is to be maximized by Congress with respect to $t_c \geq 0$ and $t_v \geq 0$.

Denoting by

$$B(\bar{\bar{v}}, t_c, t_v) \equiv \big[-(\bar{\bar{v}} - c - \lambda t_c) + P(s \geq \bar{s} \mid \bar{\bar{v}})\big(\bar{\bar{v}} - (1+\gamma)c - (\lambda - \gamma)t_v\big)\big] h(\bar{\bar{v}}) \qquad \text{(C.8)}$$

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

$$\frac{\partial \bar{\bar{v}}}{\partial t_c} B(\bar{\bar{v}}, t_c, t_v) \leq \lambda \left[1 - H(\bar{\bar{v}})\right], \qquad \text{(C.9)}$$

which is satisfied with equality when the choice is an interior one with $t_c > 0$. In (C.9), the left-hand side is the gross marginal benefit of lowering $\bar{\bar{v}}$ by increasing the subsidy t_c to compulsory dismantlements while the right-hand side is the positive marginal cost of doing so.

Using the same notation, the first-order condition for the choice of t_c writes

$$\frac{\partial \bar{\bar{v}}}{\partial t_v} B(\bar{\bar{v}}, t_c, t_v) \leq (\lambda - \gamma) \int_0^{\bar{\bar{v}}} P(s \geq \bar{s} \mid v)\, dH(v), \qquad \text{(C.10)}$$

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 $\bar{\bar{v}}$ by increasing the subsidy t_v to voluntary dismantlements while the right-hand side is the net marginal cost of doing so. Like Section 4, the net marginal cost of relying on encouragements to yield to the activists' request is positive or negative depending on whether λ exceeds γ or not.

The intervention of the gross marginal benefit $B(\bar{\bar{v}}, t_c, t_v)$ into both (C.9) and (C.10) shows that the two first-order conditions are linearly dependent. Once it is reminded that, from the agency's indifference condition (C.7), $\partial \bar{\bar{v}} / \partial t_c < 0$ as in Section 3 while $\partial \bar{\bar{v}} / \partial t_v > 0$, it turns out that Congress will never find it desirable to simultaneously rely on subsidies to the two sorts of dismantlements. Thus at the optimum, either $t_c = 0$ or $t_v = 0$: this shows Lemma 1. In fact, using the regulator's indifference condition (C.7) to transform expression

(C.8), the benefit of lowering $\bar{\bar{v}}$ becomes

$$B(\bar{\bar{v}}, t_c, t_v) = \alpha \left[t_c - c - P(s \geq \bar{s} \mid \bar{\bar{v}})(t_v - c)\right] h(\bar{\bar{v}}). \tag{C.11}$$

The benefit of increasing $\bar{\bar{v}}$ is negative when $t_c = 0$, thus excluding the possibility that a costly increase in t_v (to increase $\bar{\bar{v}}$) could be desirable. Hence, $t_v^* = 0$ and $t_c^* > 0$.

3. This is explained in the main text preceding the proposition.

4. When $\sigma = 0$, activists perfectly observe v so that the probability $P(s \geq \bar{s} \mid v)$ is zero for $v < \bar{s}$ and one for $v \geq \bar{s}$. Hence, the only state of indifference for the regulator between ordering a dismantlement or not may occur when $v = \bar{s}$. For $v < \bar{s}$, activists will never induce a dismantlement; moreover in that case, the assumption that $\bar{s}$ is lower than the threshold $\bar{v}$ of Section 3 implies that the benefit of a compulsory dismantlement is negative for the regulator. For $v > \bar{s}$, activists always induce a dismantlement when there is no compulsory dismantlement ordered by the regulator. Under the same restrictions as above, with $P(s \geq \bar{s} \mid v) = 1$, Condition (C.2) is always strictly satisfied.

The regulator's behavior in that context is independent of t_c. Thus maximizing social welfare requires that this transfer be zero.

D Extension to Bayesian Activism

When activists are Bayesian, their information on projects' value is not restricted to their imperfect signal s, as defined in (10). Hence, the condition for a private action to be undertaken against the firm is no longer simply that the signal s exceeds the exogenous threshold $\bar{s}$. Instead, Bayesian activists rationally revise their assessment of v given their signal s, conditionally on the decision of the regulator not to order a compulsory dismantlement. An action on the part of activists is undertaken if and only if

$$E(v \mid s, D_c = 0) \geq \bar{s}. \tag{D.1}$$

Denoting $\hat{v}$ the regulatory intervention threshold in the context of this appendix, $D_c = 0$ is equivalent to $v = s - \sigma\varepsilon < \hat{v}$ so that $E(v \mid s, D_c = 0) = s - \sigma E\left[\varepsilon \mid \varepsilon \geq (s - \hat{v})/\sigma\right]$. By Lemma 2 (Appendix E), $E\left[\varepsilon \mid \varepsilon \geq (s - \hat{v})/\sigma\right]$ is an increasing function of its argument $(s - \hat{v})/\sigma$, with a slope always lower than one.[33] Thus the decision rule (D.1) can be simply rewritten as

$$s \geq \hat{s}(\hat{v}), \tag{D.2}$$

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

where $\hat{s}$ is the intervention threshold of Bayesian activists, defined implicitly by

$$\hat{s}(\hat{v}) - \sigma E\left[\varepsilon \mid \varepsilon \geq \frac{\hat{s}(\hat{v}) - \hat{v}}{\sigma}\right] = \bar{s}. \tag{D.3}$$

It is immediate from its definition that $\hat{s} \geq \bar{s}$, implying that Bayesian activists induce less voluntary dismantlements than their myopic counterpart. Indeed, on the ground that no dismantlement has been ordered by the regulator, Bayesian activists may only revise their estimation of v downward.

Moreover, $\hat{s}$ is a strictly decreasing function of $\hat{v}$ over $(0, +\infty)$: the higher the threshold $\hat{v}$, the less informative the absence of compulsory dismantlement. Were $\hat{v}$ infinitely high, compulsory dismantlements would never occur, so that no dismantlement would not bring any further information to activists. In that case, $\hat{s} = \bar{s}$. When $\hat{v} = 0$ and there is no compulsory dismantlement, it must be that $v = 0$. Then, there does not exist any signal s that can induce activists to undertake an action.

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

$$P(s \geq \hat{s} \mid v) = 1 - F\big(\frac{\hat{s} - v}{\sigma}\big), \tag{D.4}$$

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

The regulator's problem is identical to that of Section 5, except that the probability of voluntary dismantlement now depends on the endogenous variable $\hat{s}$ as per (D.4), instead of the exogenous tolerance threshold $\bar{s}$. $\hat{v}$ should be expressed as a function, not only of transfers t_c and t_v as per (17) in Section 5, but also of $\hat{s}$:

$$\hat{v} \equiv \hat{v}(t_c, t_v, \hat{s}), \tag{D.5}$$

which is respectively decreasing and increasing in t_c and t_v as before, while it is now increasing in $\hat{s}$. When $\hat{s}$ is infinitely high, the probability of action by activists becomes nil, so that $\hat{v}$ is then defined as in absence of activism (Section 3).

Unlike Section 5 where the activists' tolerance threshold $\bar{s}$ was exogenously given and immediately determines the regulator's threshold $\bar{\bar{v}}$, $\hat{s}$ and $\hat{v}$ now arise as a fixed point and are jointly determined by (D.3) and (D.5). From the properties just derived on these two relations, a simple reasoning shows the existence of a unique fixed point.

The rest of the proof is similar to that of Proposition 3. The expression of social welfare (C.1) should only be modified to the extent that $\bar{s}$ should be replaced by $\hat{s}(\hat{v})$ and $\bar{\bar{v}}$ by $\hat{v}$. The first-order conditions for the choice by Congress of t_c and t_v are identical to their respective expressions in Section 5 (C.9) and (C.10) once $B(\bar{\bar{v}}, t_c, t_v)$ is replaced by its counterpart in this section:

$$
\begin{aligned}
B(\hat{v}, t_c, t_v) \;\equiv\; & \big[-(\hat{v} - c - \lambda t_c) + P(s \geq \hat{s}(\hat{v}) \mid \hat{v})\big(\hat{v} - (1+\gamma)c - (\lambda - \gamma)t_v\big)\big]\, h(\hat{v}) \\
- \; & \hat{s}'(\hat{v}) \int_0^{\hat{v}} f\left[\hat{s}(\hat{v})\right] h(v) \left[v - (1+\gamma)c - (\lambda-\gamma)t_v\right]\, dv, \qquad \text{(D.6)}
\end{aligned}
$$

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

Thus, it remains true that the two first-order conditions are linearly dependent and Lemma 1 still applies: it is never desirable to simultaneously use the two types of transfers. The incentive-compatibility condition (18) immediately rules out cases where voluntary dismantlements are subsidized. Hence, $t_v^{**} = 0$, and social surplus can be rewritten as in (22) with $\hat{s}$ instead of $\bar{s}$ and $\hat{v}$ instead of $\bar{\bar{v}}$. The analysis of Section 5 applies in this case in a similar fashion and thus yields the same conclusions as those of Proposition 3.

E The Derivative of the Conditional Expectation

This appendix demonstrates the following lemma, used in Appendix D.

Lemma 2. *If ε has a log-concave density function and a bounded support, then*

$$
0 \leq \frac{dE(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} \leq 1.
$$

The proof of Lemma 2 goes as follows. Let $F(.)$ denote the cumulative distribution function of ε and $f(.)$ its density. By definition

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

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

$$
\frac{dE(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})}{d\bar{\varepsilon}} = \frac{-\bar{\varepsilon} f(\bar{\varepsilon})\left[1 - F(\bar{\varepsilon})\right] + \int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon f(\bar{\varepsilon})}{\left[1 - F(\bar{\varepsilon})\right]^2}. \qquad \text{(E.2)}
$$

Using that $-\left[1 - F(\varepsilon)\right]$ is a primitive of $f(\varepsilon)$ and integrating by parts, yields $\int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon = \left[-\varepsilon\big(1 - F(\varepsilon)\big)\right]_{\bar{\varepsilon}}^{+\infty} + \int_{\bar{\varepsilon}}^{+\infty} \left[1 - F(\varepsilon)\right]\, d\varepsilon$. Since ε is bounded above, the first term on the right-hand side reduces to $\bar{\varepsilon}\left[1 - F(\bar{\varepsilon})\right]$. Hence, $\int_{\bar{\varepsilon}}^{+\infty} \varepsilon f(\varepsilon)\, d\varepsilon = \bar{\varepsilon}\left[1 - F(\bar{\varepsilon})\right] + \int_{\bar{\varepsilon}}^{+\infty} \left[1 - F(\varepsilon)\right]\, d\varepsilon$.

Substituting into (E.2) and rearranging gives the following expression:

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

which immediately implies that

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

It remains to be shown that $dE(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})/d\bar{\varepsilon} \leq 1$. This is equivalent to the inequality

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

The two terms of this inequality are log-derivatives of, respectively, $1-F(\bar{\varepsilon})$ and $\int_{\bar{\varepsilon}}^{+\infty} [1 - F(\varepsilon)] \ d\varepsilon$. It follows that $dE(\varepsilon \mid \varepsilon \geq \bar{\varepsilon})/d\bar{\varepsilon} \leq 1$ is equivalent to the proposition that

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

Now the log-concavity of f implies the log-concavity of $1 - F(\varepsilon)$, which in turn implies that its upper integral $\int_{\bar{\varepsilon}}^{+\infty} [1 - F(\varepsilon)] \ d\varepsilon$ is also log-concave (Bagnoli and Bersgtrom, 2005). Thus, the log-derivative of $\int_{\bar{\varepsilon}}^{+\infty} [1 - F(\varepsilon)] \ d\varepsilon$ is decreasing. This also implies that $[1 - F(\bar{\varepsilon})] / \int_{\bar{\varepsilon}}^{+\infty} [1 - F(\varepsilon)] \ d\varepsilon$ is increasing in $\bar{\varepsilon}$, which establishes (E.4).

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