Bulletin of Economic Research 54:2, 2002, 0307–3378

REGULATORY ENFORCEMENT WITH DISCRETIONARY FINING AND LITIGATION

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ABSTRACT

In this paper, we focus on the determination of the optimal fine set by a regulator when a firm can litigate to avoid paying the fine and the monitoring agency has discretionary power to negotiate with the firm the size of the fine. The regulator needs to balance the positive effect of the fine's size on the degree of non-compliance and the possibility of litigation if the fine is too high. We find that the optimal fine is not necessarily set at its maximum level.

I. INTRODUCTION

Becker (1968) argued that fines should be set as high as possible to enhance compliance with a law or regulation. However, the optimality of such maximal fines has been challenged by several papers. This is important, because in the real world, high compliance rates are observed although expected fines are low. Harrington (1988) reconciled these puzzling facts in a dynamic model in which expected fines were contingent on previous compliance status.[1] In a static model where the regulatory agency interacts with the firm in more than one environmental context, Heyes and Rickman (1999) show that tolerating non-compliance in one context in 'exchange' for compliance in the other can

*I gratefully acknowledge the financial support given by the Basque Government (Research Project HU-1998-133). I also thank the editor and two anonymous referees for their helpful suggestions.

[1] Raymond (1999) reconsidered Harrington's results to show that they do not necessarily hold when uncertainty about compliance costs are introduced.

improve aggregate compliance. Kaplow (1992) shows that if the individuals are risk averse, optimal fines are not maximal. Even with risk neutrality, social welfare does not necessarily increase with the magnitude of the fines when the monitoring agency can make mistakes which punish innocent individuals.[2]

When the firms try to hide their non-compliance, or when they can engage in litigation to modify the probability of actually paying the fine, setting maximal fines can induce less compliance and reduce social welfare because more resources must be spent either to detect non-compliance or to obtain convictions.[3] When litigation is socially costly, a regulator who cares about litigation costs may then choose a lower fine. A question remains as to whether this is also the case when neither the monitoring agency nor the regulator care about these costs.

We explore this issue in a model where a firm accused of not complying can bring legal action to avoid paying the fine and where the monitoring agency has some degree of discretionary power to decide the effective fine paid by the guilty firm. We introduce ex-post asymmetric information between the monitoring agency and the firm about the cost borne by the firm if it engages in litigation. We model the interaction between the firm and the agency as a game in which simultaneously they decide, respectively, the probability of compliance and monitoring. When the agency finds that the firm did not comply with the regulation, she can pursue strict enforcement, which may trigger litigation, or reduce the fine to a level acceptable for the firm to avoid litigation. As the agency is interested in maximizing net collected fines, her decision depends on the initial fine set by the regulator and the probability of litigation. Incentives for litigation are given by the fact that there is a positive probability that a non-complying firm escapes the payment of the fine.

When low litigation costs are more likely, we show that the agency's best strategy is to avoid litigation by offering a reduction in the fine. The regulator anticipates this behaviour and sets the fine at its maximal level to increase compliance and reduce monitoring. On the other hand, when the probability that the firm has high litigation costs is high, the agency's best strategy depends on the initial fine set by the regulator. For a sufficiently high fine, the agency allows partial litigation. Although litigation happens in equilibrium with positive probability, the expected

[2] See Bose (1995) for a model of regulatory enforcement in the presence of mistakes.

[3] Heyes (1994), Watabe (1992) and Kambhu (1989) develop models in which higher penalties induce a more defensive behavior by the firms that obstructs the enforcement process. Malik (1990) shows that, when there is a possibility of engaging in socially costly activities that lower the probability of being fined, setting maximal fines is not optimal. Nowell-Shogren (1994) also show that, when the firm is allowed to challenge the enforcement of a regulation, neither increasing the probability of monitoring nor the severity of the fine guarantee higher compliance rates.

collected fine is higher than the fine the agency has to offer to avoid fully litigation. For lower fines, it is optimal for the agency to avoid litigation. It turns out that the regulator may prefer a situation in which there is no litigation, and set the fine at a level lower that the maximum feasible one. This result is not derived, as is usual in the literature, from cost considerations as the litigation costs are not included in the regulator's objective function. The result follows from considering how the feasibility of litigation affects the incentives for compliance and the use of discretionary fining.

This paper is related to the papers by Jost (1997a) and (1997b) which study the rates of compliance achieved by different legal procedures. Both papers assume ex-ante asymmetric information between the agency and the firm and consider sequential decision making. Our model departs from both papers in several aspects. We consider a simultaneous move game and introduce ex-post asymmetric information. We also allow the agency to modify the fine set by the regulator. While, qualitatively, the result about the optimality of less than maximal fines is similar, the mechanism through which the result arises in our model is substantially different.

We introduce the model in Section 2. In Section 3, we focus on the interaction between the agency and the firm and characterize the conditions under which litigation takes place. After considering the monitoring-compliance game in Section 4, we determine the optimal fine in Section 5. Finally, some conclusions are presented.

II. THE MODEL

We consider a hierarchical model of regulatory enforcement with three risk-neutral players: a regulator, a firm and a monitoring agency.[4] Let $c > 0$ be the cost of complying with the regulation. The firm can be monitored by the agency. Let $M(\alpha)$ be the monitoring costs when the agency inspects the firm with probability $\alpha \in [0, 1]$. We assume that $M(\alpha)$ is a continuous and twice differentiable function with $M'(\alpha) > 0$ and $M''(\alpha) \geqslant 0$ for $\alpha > 0$. We also assume that $M(0) = 0$ and $M'(0) = 0$. If the firm is inspected, the agency discovers whether the firm complied or not. If the firm complies, it pays no fine. Otherwise, after inspection, the agency decides whether to pursue strict enforcement or to offer a reduction in the fine. The firm must decide whether to contest the agency's findings and appeal, or to accept the payment of the fine (either

[4] A hierarchical structure appears to give a better description of the enforcement of real world regulations. Enforcement of environmental regulations is delegated to the EPA in the United States and field agents (inspectors, police officers, etc.) have the task of enforcing other kind of regulations.

the original or the reduced one) and return to compliance. To simplify the analysis, we consider that the incentives for appealing are given by the fact that there is an exogenous probability $q > 0$ that a non-complying firm escapes the payment of the fine.[5]

Let t be the firm's litigation costs. After the inspection has taken place, the firm learns privately the value of t. With probability $p \in (0, 1)$, the cost of litigating is low ($t = t_l$) and with probability $1 - p$, this cost is high ($t = t_h$), with $t_h > t_l > 0$. The probability distribution is common knowledge, although the agency does not know the realization of t. If the firm appeals and loses the case, it pays $f + c$, where f is the fine chosen by the regulator.[6] If the firm wins, it pays no fine. We assume that the firm's litigation costs are not verifiable by the court. Thus, even if the firm wins the case, it does not recover the litigation costs. Non-compliance generates a social damage $d > c$.

The decision that the firm makes after the inspection depends on the incentives given by the agency and its litigation costs t. The firm chooses the probability of compliance $\beta \in [0, 1]$ to minimize its expected costs.[7] The monitoring agency chooses the probability of monitoring $\alpha \in [0, 1]$ to maximize the collected fines net of monitoring costs. The regulator chooses the fine $f \geqslant 0$ for non-compliance. We assume that $f \leqslant \bar{f}$, where $\bar{f}$ is the maximum available fine.[8] The regulator's goal is to minimize the sum of the expected compliance costs, the monitoring costs and the

[5] In a more general model, the probability of winning the case would depend on the merits of each party in presenting their arguments. The following alternative formulation of the enforcement process could have been considered. The agency inspects the firm with probability one, although inspection reveals only the compliance status of the firm (yes or no). Collecting evidence of non-compliance is costly. We can reinterpret α as the amount of evidence on non-compliance and $M(\alpha)$ as the cost of collecting evidence of size α. Let $t(e, \theta)$ be a convex function measuring the firm's litigation costs, where e is the firm's effort in preparing its case and θ is a parameter that denotes the firm's private information. Finally, the probability of winning the case $q(\alpha, e)$ depends on the agency and the firm's allegations, with $q_\alpha < 0$, $q_e > 0$, $q_{\alpha\alpha} \geqslant 0$, $q_{ee} \leqslant 0$, $q_{e\alpha} < 0$, $q(0, e) = e$ and $q(\alpha, 0) = 0 \forall \alpha \geqslant 0$. This formulation would complicate substantially the analysis without adding new insights. We think that the mechanism through which our main result arises would still work.

[6] We assume that administrative court costs are zero.

[7] This is standard in this class of models. See, for example, Bose (1995). Regarding the agency, α can be interpreted as the proportion of firms that are monitored when we have N identical firms. The analysis does not change, and the firm in our model can be seen as the representative one. One referee suggested that the firm chooses between imperfect compliance technologies whose outcome is stochastic. The more expensive the technology, the lower the probability of non-compliance. This would change slightly the analysis but not the main result.

[8] There are several justifications for assuming an upper bound for the feasible fine. Financial constraints on the side of the firm lead to reasonable fines in order to avoid bankruptcy. There may be also political limits to the size of the fine that can be levied. The 'penalty-fits-the-crime' principle from law enforcement is another reason for assuming a restriction on the feasible fine.

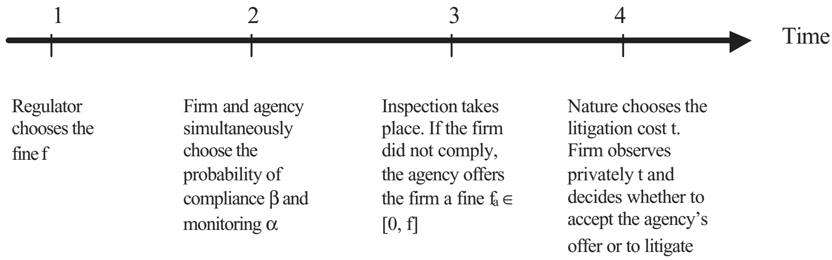

Fig. 1. The game

expected social damage. The regulator does not care about any cost related to the litigation process.[9]

We consider the following game. At date 1, the regulator chooses the fine $f \in [0, \bar{f}]$. Given the fine, at date 2, the firm and the agency simultaneously choose the probability of compliance and monitoring respectively. If the firm is not monitored, the game is over. If inspection takes place and the firm did not comply, the agency offers the firm at date 3 a fine $f_a \in [0, f]$. At date 4, the firm learns its litigation costs privately and decides, contingent on the agency's strategy, whether to accept the fine f_a or to litigate. The timing of the game is described in Figure 1.

III. ENFORCEMENT DECISION AND LITIGATION

We begin by analysing the firm's litigation decision at date 4. Given the fine f and the agency's strategy $f_a \leqslant f$ at date 3, firm i, $i = l, h$ does not litigate if:[10]

$$f_a + c \leqslant t_i + (1 - q)(f + c) \tag{1}$$

If firm i does not litigate, it pays the fine f_a and returns to compliance. If it litigates, it spends t_i and pays $f + c$ if it loses the case. Let $r_i(f, f_a)$ be the firm i's probability of litigation, $i = l, h$. From (1), this probability is:

$$r_i(f, f_a) = \begin{cases} 0 & \text{if} \quad f_a \leqslant q f^i + (1 - q) f \\ 1 & \text{otherwise} \end{cases} \tag{2}$$

where $f^i = t_i/q - c$, $i = l, h$. We assume that $f^l > 0$ and $f^h < \bar{f}$.

[9] Including the litigation costs in the regulator's objective function makes the optimality of less than maximal fines more likely, because the incentives to allow litigation are reduced We avoid this bias by excluding them from the objective function.

[10] When the firm is indifferent between litigating and accepting the agency's offer, we assume that it does not litigate.

At date 3, the agency, after detecting non-compliance, chooses a fine $f_a \leqslant f$ to maximize the expected fine collected. Let us assume that the agency pursues strict enforcement ($f_a = f$). Under strict enforcement, the agency tries to enforce the fine f set by the regulator. Let $f \leqslant f^l$. Given this fine, from (2), no firm litigates and the agency has no incentives to reduce the fine. For higher fines, strict enforcement triggers litigation. Depending on the fine, we can have total litigation (both types of firm litigate) or partial (the low-cost firm litigates). The agency compares the expected collected fine under litigation with the highest fine compatible with no litigation. The next Propositions state the agency's strategy and the firm's litigation decision.

Proposition 1: Let $p \geqslant \hat{p} = f^h - f^l/f^h$. The agency's strategy $f_a(f)$ at date 3 is:

$$f_a(f) = \begin{cases} f & \text{if} \quad f \leqslant f^l \\ qf^l + (1-q)f & \text{if} \quad f > f^l \end{cases}$$

Let $p < \hat{p}$. The agency's strategy is given by:

$$f_a(f) = \begin{cases} f & \text{if} \quad f \leqslant f^l \\ qf^l + (1-q)f & \text{if} \quad f \in (f^l, \hat{f}(p)] \\ f & \text{if} \quad f \in (\hat{f}(p), f^h] \\ qf^h + (1-q)f & \text{if} \quad f > f^h \end{cases}$$

where $\hat{f}(p) = f^l/1 - p$.

Proof: See Appendix A.

Proposition 2: Let $p \geqslant \hat{p} = f^h - f^l/f^h$. There is no litigation: $r_i(f, f_a(f)) = 0 \ \forall f,\ i = l, h$. When $p < \hat{p}$:

$$r_h(f, f_a(f)) = 0 \ \forall f$$

$$r_l(f, f_a(f)) = \begin{cases} 0 & \text{if} \quad f \leqslant \hat{f}(p) \\ 1 & \text{if} \quad f > \hat{f}(p) \end{cases}$$

Proof: It follows immediately from (2) and Proposition 1.

Unless the fine set by the regulator is low, the agency chooses a lower fine when the probability of the low-cost firm is high. When this probability is below a threshold value $\hat{p}$, the agency pursues strict enforcement for both low and intermediate values of f. Given the agency's strategy, the high-cost firm never litigates while the low-cost firm litigates when the fine f is above the threshold value $\hat{f}(p)$ and $p < \hat{p}$. Note that litigation may take place even if the agency does not pursue strict enforcement.The agency's strategies and the litigation decisions are shown in Figure 2.

From Propositions 1 and 2, the expected effective fine for non-compliance $F(f)$ when $p \geqslant \hat{p}$ is simply $f_a(f)\ \forall f$. Note that there is no litigation and the firm, regardless of its type, accepts the fine offered by the agency. When $p < \hat{p}$, $F(f)$ is given by:

$$F(f) = \begin{cases} f & \text{if} \quad f \leqslant f^l \\ qf^l + (1-q)f & \text{if} \quad f \in (f^l, \hat{f}(p)] \\ f(1-pq) & \text{if} \quad f \in (\hat{f}(p), f^h] \\ f(1-pq) - q(1-p)(f - f^h) & \text{if} \quad f > f^h \end{cases}$$

When the enforcement is strict and the low-cost firm litigates, the expected effective fine is $(1-p)f + p(1-q)f = f(1-pq)$. The high-cost firm pays the fine while the low-cost firm pays the fine with probability $(1-q)$. When the enforcement is not strict but the low-cost firm litigates,

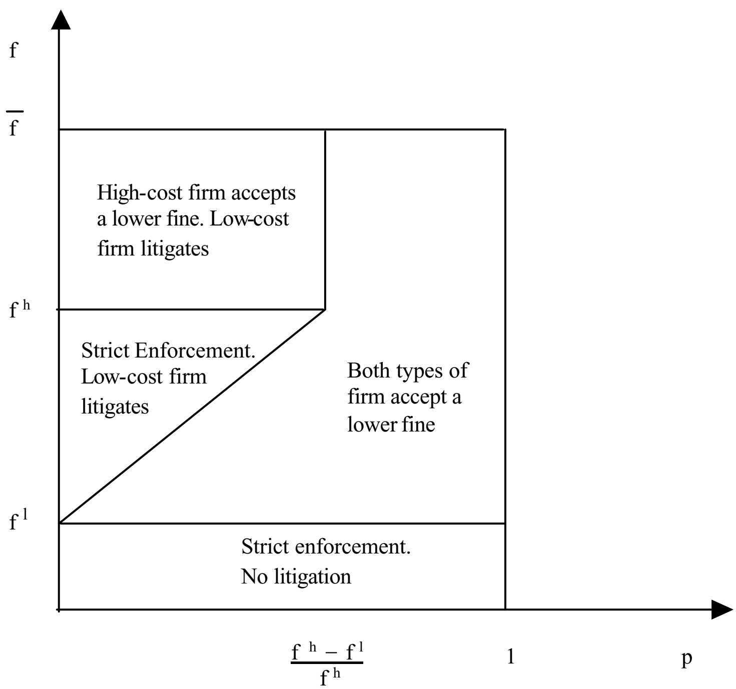

Fig. 2. Enforcement and litigation decisions

the expected effective fine is $(1-p)(qf^h + (1-q)f) + p(1-q)f = f(1-pq) - q(1-p)(f - f^h)$. The high-cost firm accepts a smaller fine while the low-cost firm pays the initial fine with probability $(1-q)$.

IV. THE MONITORING-COMPLIANCE SUBGAME

In this section, we determine the behavior at date 2. Given the fine f, the agency and the firm simultaneously decide their monitoring and compliance strategies. The firm chooses the probability of compliance $\beta \in [0, 1]$ to minimize the expected cost

$$\begin{aligned} C(f) &= \beta c + (1-\beta)\alpha[F(f) + E(c)] \\ &= \beta[c - \alpha(F(f) + E(c))] + \alpha[F(f) + E(c)] \end{aligned}$$

where $E(c)$ denotes the expected compliance and litigation costs.[11] This yields the best response correspondence of the firm as:

$$\beta(\alpha, f) = \begin{cases} 1 & \text{if} \quad \alpha > \dfrac{c}{E(c) + F(f)} \\ [0, 1] & \text{if} \quad \alpha = \dfrac{c}{E(c) + F(f)} \\ 0 & \text{if} \quad \alpha < \dfrac{c}{E(c) + F(f)} \end{cases} \tag{3}$$

The agency chooses the probability of monitoring $\alpha \in [0, 1]$ to maximize the expected net collected fine $\alpha(1-\beta)F(f) - M(\alpha)$. The agency's best response function $\alpha(\beta, f)$ satisfies the first-order condition:

$$(1-\beta)F(f) - M'(\alpha) = 0$$

and is continuous in both its arguments. It can be easily checked that α is decreasing in β and increasing in f.

The Nash equilibrium of the compliance-monitoring game is a pair of probabilities $(\alpha^*(f), \beta^*(f))$ such that $\alpha^*(f) = \alpha(\beta^*(f), f)$ and $\beta^*(f) = \beta(\alpha^*(f), f)$. Given $\beta^*(f)$, the agency maximizes the expected net collected fines by choosing a probability of monitoring $\alpha^*(f)$. Given $\alpha^*(f)$, the firm minimizes its expected costs by choosing a probability of compliance $\beta^*(f)$.

[11] When there is no litigation, $E(c)$ is simply the compliance cost c. Under litigation, besides the expected compliance costs $(1-p)c + p(1-q)c$, we have to take into account the expected litigation costs pt_l.

Proposition 3: Assume that $0 \leqslant (M')^{-1}(0) < c/E(c) + F(f)$ *and* $c/E(c) + F(f) < (M')^{-1}(F(f)) \leqslant 1 \, \forall f > 0$.[12] *The Nash equilibrium is:*

$$\alpha^*(f) = \frac{c}{E(c) + F(f)}$$

$$\beta^*(f) = 1 - \frac{M'(\alpha^*(f))}{F(f)}$$

Proof: If $\alpha^*(f) > c/E(c) + F(f)$, the firm's best response is $\beta = 1$, from (3). But the agency's best response to this is $\alpha < c/E(c) + F(f)$, given the assumptions. Hence, $\alpha^*(f) > c/E(c) + F(f)$ can not be an equilibrium. Similarly, $\alpha^*(f) < c/E(c) + F(f)$ can not be an equilibrium. Therefore, $\alpha^*(f) = c/E(c) + F(f)$. From $\alpha^*(f) = \alpha(\beta^*(f), f)$, it follows immediately that $\beta^*(f) = 1 - M'(\alpha^*(f))/F(f)$. □

It is easy to see that the higher the fine, the lower the equilibrium probability of monitoring and the higher the equilibrium probability of compliance. Figure 3 shows the Nash equilibrium and the shifts in the best response correspondences when the fine increases.

V. THE DETERMINATION OF THE OPTIMAL FINE

At date 1, the regulator sets the optimal fine taking into account how the agency and the firm respond to changes in the fine. The regulator chooses the fine f to minimize the expected regulatory costs $ERC(f)$ defined as the sum of the expected compliance costs, the monitoring costs and the expected damage from non-compliance:

$$ERC(f) = M(\alpha^*(f)) + c + (d - c)\delta^*(f) \tag{4}$$

where $\delta^*(f)$ is the probability that the firm does not comply and avoids returning to compliance.[13]

Let $p \geqslant \hat{p}$. The regulator knows that the agency, regardless of the fine, uses discretionary fining to avoid litigation. The negative effect of the

[12] Given that $M'(0) = 0$, this assumption guarantees that the equilibrium is interior for all positive fine. We focus on the more interesting case of equilibrium partial compliance. If there is full compliance in equilibrium with a positive probability of monitoring, we would have a consistency problem. Given that monitoring is costly, there is no incentive to monitor, and knowing that, the firm does not comply.

[13] When litigation is avoided, $\delta^*(f)$ is simply $(1 - \beta^*(f))(1 - \alpha^*(f))$. Under partial litigation, there are two ways the firm fails to return to compliance: either it is not inspected or after inspection, it wins the case in court. Thus, $\delta^*(f)$ is $(1 - \beta^*(f))(1 - \alpha^*(f)(1 - pq))$.

feasibility of litigation on compliance disappears, and the regulator can use the fine to its maximum extent to increase compliance and reduce the probability of monitoring. Hence, the optimal fine is $\bar{f}$.

Let $p < \hat{p}$. Unlike the case $p \geqslant \hat{p}$, there are two regimes depending on the fine: for $f \leqslant \hat{f}(p)$, there is no litigation and for $f > \hat{f}(p)$, the low-cost firm litigates. Within each regime, the expected regulatory costs diminish with f. Thus, we have two candidates for the optimal fine: $\hat{f}(p)$ and $\bar{f}$. Avoiding litigation has a positive effect on compliance although the smaller fine in this regime tends to reduce compliance. The feasibility of litigation provides less incentives to comply although a higher fine compensates for that. As the expected effective fine is larger for the litigation regime, it follows that the optimal probability of monitoring is higher when there is no litigation, while the optimal probability of compliance is smaller. The first term in (4) is lower under partial litigation. However, the functional form of $\delta^*(f)$ is different in each regime. (See Footnote 13)

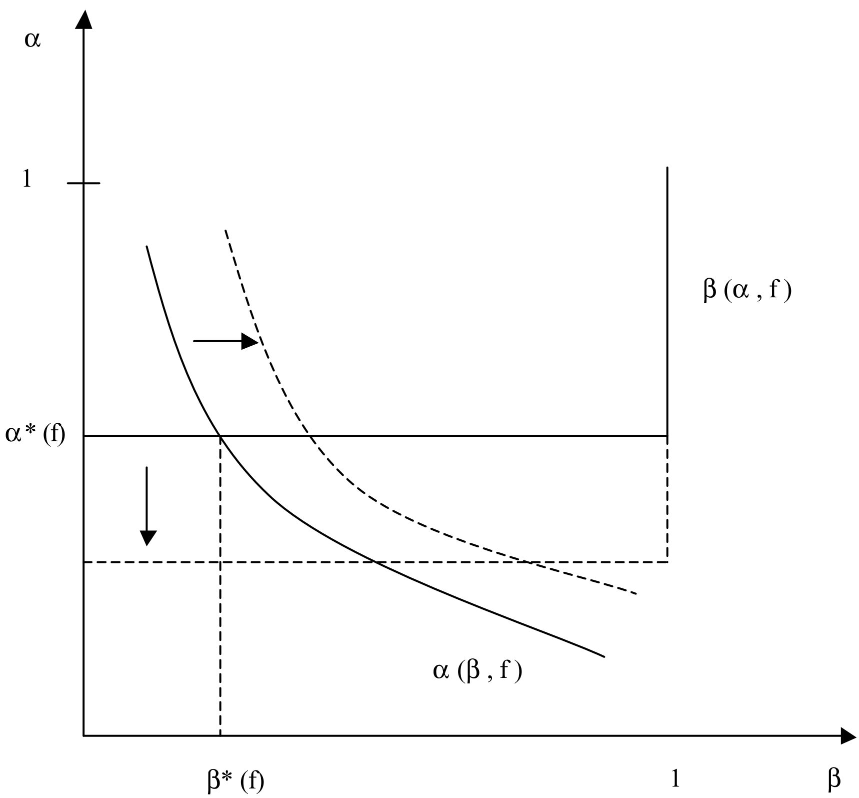

Fig. 3. The Nash equilibrium

The expected regulatory costs $ERC(f)$ have a discontinuity at $\hat{f}(p)$. The upward jump corresponds to the switch from a no litigation regime to a regime in which litigation takes place with probability p. When f exceeds $\hat{f}(p)$ from below, the optimal probabilities of compliance and monitoring do not change but the low-cost firm litigates. Thus, the expected regulatory costs exceed those under no litigation. The size of the jump is given by $p\ q\ \alpha^*(\hat{f}(p))(1-\beta^*(\hat{f}(p)))(d-c)$, the extra expected cost caused by the litigating firm that escapes from returning to compliance. If p is relatively small, we should expect a negligible impact of the feasibility of litigation on compliance, and the regulator would choose the maximum fine $\bar{f}$. The larger p, the more important the litigation effect. This suggest that there may exist a threshold value $\bar{p}$ such that the regulator is indifferent between $\bar{f}$ and $\hat{f}(\bar{p})$. For $p > \bar{p}$, the regulator chooses $\hat{f}(p) < \bar{f}$. From (4), a sufficient condition for the optimal fine to follow a cut-off rule is:

$$M(\alpha^*(\hat{f}(\hat{p}))) + (d-c)\delta^*((\hat{f}(\hat{p}))) < M(\alpha^*(\bar{f})) + (d-c)\delta^*(\bar{f}) \qquad (5)$$

Condition (5) simply states that the expected regulatory costs under litigation are higher than those when litigation is avoided at $p = \hat{p}$. Figure 4 shows the optimal fine.

It is worth noticing that the optimal fine may be less than maximal when the regulator does not care about any kind of litigation costs. (See

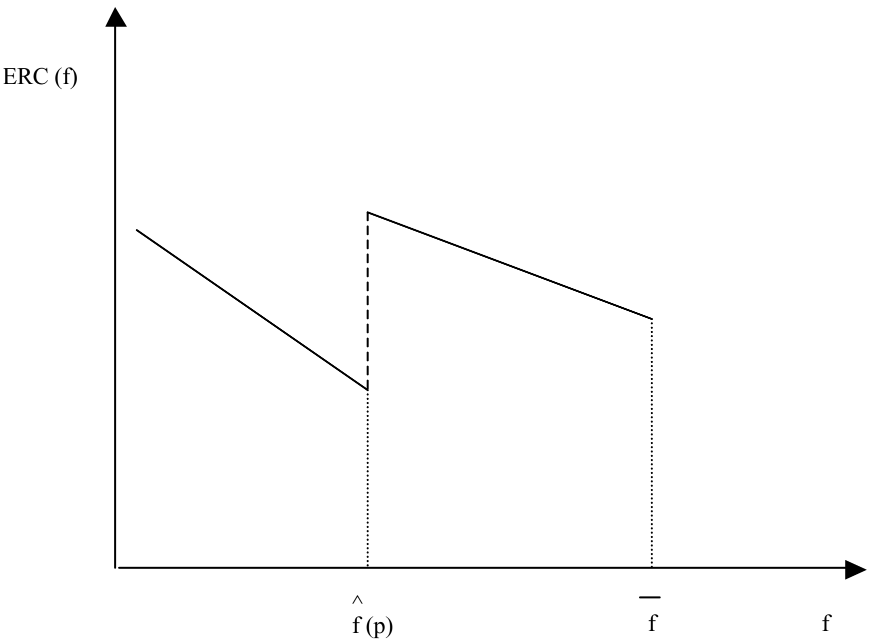

Fig. 4 Expected regulatory costs when $p < \hat{p}$ and condition (5) is satisfied

Footnote 9) As the equilibrium probability that the firm does not comply and avoids inspection in the no-litigation regime ($\delta^*\hat{f}(p)$) decreases with p and the equilibrium probability that the firm does not comply and avoids returning to compliance in the litigation regime $\delta^*(\bar{f})$ increases with p,[14] for high enough p, we can have $(d-c)(\delta^*\hat{f}(p)) - \delta^*(\bar{f})) < 0$ and the savings in monitoring costs under litigation may be more than compensated for.

We should expect that as $\bar{f} - f^h$ becomes smaller and $\hat{p}$ becomes larger, it will be more likely than the regulator chooses an optimal fine that follows a cut-off rule. The use of a less than a maximal fine is not driven, then, by the costs caused by litigation, but by the interaction between the firm and the agency and the existence of a positive probability under litigation of avoiding compliance. The main result is presented in the following Proposition.

Proposition 4: If condition (5) is not satisfied, the regulator chooses the maximum fine available regardless of p. If condition (5) is satisfied, the optimal fine is smaller than the maximum one for $p \in [\bar{p}, \hat{p}]$. *Otherwise, the fine is set at its maximum level* $\bar{f}$.

VI. CONCLUSIONS

In this paper, we have analysed the determination of the optimal fine by a regulator to enforce a regulation when the firm can litigate to avoid compliance. In practice, firms may prefer to contest the monitoring agency in a court of law. A high fine has a beneficial effect on the degree of non-compliance, but it may trigger litigation. When the regulator allows the agency to negotiate with the firm a reduction in the fine, litigation may be avoided. The impact of a high fine on the degree of non-compliance is reduced because the firm faces an expected fine that is lower than that set by the regulator. The existence of discretionary fining moves the regulator towards choosing a high fine. On the other hand, as the firm has private information about its litigation costs, setting a high fine can make impossible to reach an agreement between the agency and the firm; regulation takes place. Our model takes these trade-offs into account and shows that the optimal fine is not necessarily the maximum one. Depending on the likelihood that the firm has a low litigation cost, the optimal fine is set below the maximum level because the regulator prefers to avoid fully litigation.

For the sake of simplicity, we have consider a linear model and we have assumed that all the players are risk-neutral. Nevertheless, the intuition for the main result of the paper is robust.

[14] A proof of this is available upon request.

APPENDIX A

Proof of proposition 1

For $f \leqslant f^l$, we showed in the main text that the agency pursues strict enforcement and there is no litigation. Let $f > f^h$. If $f_a = f$ (strict enforcement), it follows, from (2), that both types of firm litigate. Thus, the agency collects $(1-q)f$.

Alternatively, the agency can avoid litigation by offering a fine $f_a^b < f$ that is accepted by the firm regardless of its type. This fine is chosen to make the low-cost firm indifferent between paying the fine and litigating: $f_a^b + c = t_l + (1-q)(f+c)$. Thus, the agency collects:

$$f_a^b = qf^l + (1-q)f \tag{A1}$$

The agency can also allow partial litigation (the low-cost firm litigates) by offering a fine $f_a^h < f$ that makes the high-cost firm indifferent between paying the fine and litigating: $f_a^h + c = t_h + (1-q)(f+c)$. The expected fine collected under partial litigation is:

$$f_{pl} = (1-p)f_a^h + p(1-q)f = (1-q)\,f + (1-p)qf^h \tag{A2}$$

The agency chooses the strategy that maximizes the expected collected fine. It is easy to see from (A2) that the agency never pursues strict enforcement. From (A1) and (A2), we have:

$$f_a^b - f_{pl} = qf^l - (1-p)qf^h = pqf^h - q(f^h - f^l)$$

Let $\hat{p} = f^h - f^l/f^h$. For $p \geqslant \hat{p}$, $f_a^b \geqslant f_{pl}$ and the optimal strategy is to offer $f_a^b = qf^l + (1-q)f$. When $p < \hat{p}$, the agency allows partial litigation and chooses a fine $f_a^h = qf^h + (1-q)f$.

Let $f \in (f^l, f^h]$. From (2), the high-cost firm does not litigate, while the low-cost firm litigates unless the agency avoids it. Under strict enforcement, the expected fine is:

$$f_s = (1-p)f + p(1-q)f \tag{A3}$$

If the agency offers a fine that is accepted by the firm regardless of its type, it collects f_a^b. As the high-cost firm does not litigate, it is not worthwhile lowering the fine down to a level acceptable only to that type of firm. From (A1) and (A3), we have:

$$\begin{aligned} f_s - f_a^b &= (1-p)f + p(1-q)f - (1-q)\,f - qf^l \\ &= fq(1-p) - qf^l \end{aligned} \tag{A4}$$

Let $\hat{f}(p) = f^l/1-p$ be the fine such that the agency is indifferent between strict enforcement and no litigation. Note that $\hat{f}(0) = f^l$ and $\hat{f}(\hat{p}) = f^h$. Let $p < \hat{p}$. It follows from (A4) that the agency chooses f (strict enforcement) if $f \in (\hat{f}(p), f^h]$ and $f_a^b = qf^l + (1-q)f$ if $f \in (f^l, \hat{f}(p)]$. When $p \geqslant \hat{p}$, $f_a^b \geqslant f_s$ and the agency chooses $qf^l + (1-q)f$. □

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