A signaling theory of nonmonetary sanctions

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Abstract

It is a widely accepted conclusion of the economic literature on optimal law enforcement that nonmonetary sanctions should be introduced only when fines have been used up to their maximum extent. In this paper it is shown that when the sanctioning policy conveys information about the harmfulness of the sanctioned behavior, the use of nonmonetary sanctions can be optimal even when the monetary fine is not maximal. The argument is formalized in a model with rational but uninformed individuals, who know that the enforcer has better information about the harmfulness of actions but are uncertain about the true objectives of the enforcer.

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1. Introduction

In order to deter individuals from engaging in harmful activities, monetary penalties are often supplemented by nonmonetary sanctions. Since the former are simply transfers, and therefore imply lower social costs than the latter, economists have tried to assess when and to what extent it is optimal to use nonmonetary sanctions. It is a widely accepted conclusion that these should be introduced only when fines have been used up to their maximum extent.[1]

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[1] This conclusion has been formally stated by Polinsky and Shavell (1984), although we already find in Becker (1968, p. 193) that "social welfare is increased if fines are used *whenever feasible*". See also the surveys by Garoupa (1997) and Polinsky and Shavell (2000a).

In this paper we argue that such a conclusion may not hold when a sanctioning policy is intended not only to deter individuals, but also to inform them about the harmfulness of certain activities as, in this case, nonmonetary sanctions may present some advantages over monetary ones. We show that, when the sanctioning policy conveys information about the possible effects of individuals' behavior, the use of nonmonetary sanctions can be optimal even when the monetary sanction has not been used up to its maximum extent.

Public law enforcement is motivated by the presence of externalities. However, we observe that a relevant characteristic of certain activities (such as driving or smoking) is that they can be harmful to the individual engaging in them, and not only to others. Moreover, individuals may have other-regarding preferences, so that they care about the possible effects of their activities on others. As a consequence, the belief in the riskiness of individual activities is an important determinant of behavior. If the government knows better than individuals how risky or harmful such activities are, sanctions can affect the amount of harm produced not only by directly increasing the costs for the wrongdoers, but also by modifying the individuals' perception of the likely consequences of their actions.

The logic of our argument goes as follows. We assume rational individuals facing a better informed enforcer whose true objectives are not known with certainty by the individuals. If the "credibility" of the enforcer becomes a concern, it is important for a benevolent enforcer to signal that the enforcement policy is actually aimed at deterring violations, rather than at reaching competing objectives. Indeed, different kinds of sanctions can score differently in this regard. Consider the case of individuals who are not sure that the enforcer is maximizing social welfare, and believe that it has a stake in the revenue accruing from monetary sanctions[2]: a high monetary sanction will not be seen as an optimal deterrence policy in the face of a very harmful activity, but as motivated by the desire to raise revenue.[3] Under these circumstances, nonmonetary sanctions may have an advantage over monetary fines for a welfare maximizing government. The use of nonmonetary sanctions may be a more credible signal, compared to monetary sanctions, of the enforcer's commitment to reducing the amount of harm produced.

Our signaling theory can rationalize the use of nonmonetary sanctions in cases where the sanctioning policy observed is hard to reconcile with the standard conclusions on optimal deterrence.[4] Consider for instance the deterrence of driving offenses. In this case, costly nonmonetary sanctions (e.g. license withdrawal or vehicle forfeiture) are often used together

[2] In the theory of public enforcement of law, the hypothesis that government can be interested in revenue rather than social welfare was first examined by Garoupa and Klerman (2002), who compared the optimal enforcement policies chosen by a social welfare maximizing government and by a rent-seeking one. In a related paper, Dittmann (2006) derives the optimal type of punishment under the assumption that the detection probability is chosen by a rent-seeking government and shows that exclusive mandatory imprisonment for serious crimes is welfare maximizing. Other papers that consider the possibility of a rent-seeking government are Wickelgren (2003) and Friedman (1999).

[3] A recent report on parking enforcement in London issued by the Greater London Authority Transport Committee opened claiming that "[i]n a city which has too many cars to move around or park without associated rules, we accept restrictions and penalties—so long as their purpose is to alleviate traffic problems and not to raise revenue" (our emphasis).

[4] An alternative argument to explain the use of nonmonetary sanctions may refer to incapacitation, since a sanction such as driving license suspension has the effect of keeping the driver from doing harm for some time. According to Shavell (1987) it is optimal to incapacitate an individual if the per period harm he can cause exceeds

with non-maximal fines, and should we replace the prescribed nonmonetary sanctions with a monetary sanction of equivalent value for the wrongdoer, fines would be much lower than individual's wealth, which according to the standard theory should represent the upper limit of a monetary sanction.[5] Other examples may be crimes related to minor copyright violations (for instance recent reforms in the Italian law prescribe the possibility of imprisonment for music piracy), or crimes typically committed by wealthy individuals, such as some financial or commercial crimes.[6]

Note that the use of nonmonetary sanctions is even less reasonable if the upper limit to the applicable sanction is represented by some social or ethical constraint rather than by the wrongdoer's wealth.[7] In this case, the same upper limit would presumably apply both to monetary and nonmonetary sanctions, and it would be equally difficult to explain why the fine is not raised up to this maximum level and a more costly nonmonetary sanction is used.

The paper joins a large stream of literature that qualifies Becker's (1968) theory of deterrence. In recent years some contributions resorted to information related arguments (Bebchuk & Kaplow, 1992; Ben-Shahar, 1997; Garoupa, 1999), focusing on imperfect information about the probability of detection or apprehension. To our knowledge, the present contribution is the first to introduce imperfect information about the probability of undesired consequences for the wrongdoers themselves, and to emphasize the role played by nonmonetary sanctions as a signal of the harmfulness of sanctioned behaviors.[8]

The paper proceeds as follows. Section 2 introduces the basic hypotheses and the model setup. Section 3 discusses the optimal sanctioning policy: we will consider the case of perfect information (Section 3.1), compare it to that of asymmetric information (Section 3.2), and examine the possibility that an upper limit applies to the total sanction rather than to the monetary sanction alone (Section 3.3). Section 4 summarizes and provides concluding remarks.

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the per period social cost of incapacitation, and to keep him incapacitated as long as this condition holds. However, apart from license suspension for drunk driving or similar cases in which the necessity to reduce an impending danger is obvious, this argument seems unable by itself to provide a rationale for the use of nonmonetary sanctions in most of the cases we can observe.

[5] Concerning driving offenses, a recent empirical study supports the idea that fines could substitute for license suspensions without violating any individual wealth constraint: Jorgensen and Wentel-Larsen (2002) estimate that the average willingness to pay of Norwegian car drivers to have their license back (suspended for six months) was about 600$ in 1997.

[6] As reported by Dittmann (2006), the United States Sentencing Commission Guidelines Manual provides for mandatory imprisonment for several crimes that are expected to be committed by wealthy people. For instance: commercial bribery if the bribe or the improper benefit to be conferred exceeds 5000$; embezzlement if the loss exceeds 120,000$; evasion of export controls; repetitive discharge of a hazardous or toxic substance into the environment.

[7] For instance, if the penalty were defined according to the principle that the penalty should fit the crime, then neither a fine of thousands of Euros nor imprisonment would be accepted as a sanction for double parking. The inclusion of notions of fairness in the theory of optimal sanctioning is discussed, among others, by Polinsky and Shavell (2000b) and Kaplow and Shavell (2001).

[8] Barigozzi and Villeneuve (2006) present a similar argument about taxation. They show that taxes may have a signaling function in situations in which the government is more informed than consumers about the consequences of their consumption choices.

2. Model setup and hypotheses

Consider a population of identical individuals who gain a benefit b from violating a legal rule, where b is a random variable.

The violation of the rule will cause an accident with probability q. The accident produces an externality E and, additionally, a cost K for the wrongdoer himself. K includes liability costs and any other negative effect of the accident that the wrongdoer internalizes, such as a damage suffered (consider the case of a car accident where the driver or his relatives are among the victims) or altruistic concern; note that it may be the case that K is by far the larger component of the social cost of the accident.

2.1. Benevolent enforcer, rent-seeking enforcer and individuals' inferences

We make the assumption that the probability q can take two possible values: high or low (respectively q_{H} and q_{L}, with $q_{\mathrm{L}} < q_{\mathrm{H}}$). At the outset, potential wrongdoers do not know q; they have a prior expectation r that the probability of an accident is high (q_{H}). However, the probability is known to the enforcer, who has access to more reliable sources of information than individuals. It would be in the interest of the parties (enforcer and potential wrongdoers) that this information is shared, but we assume that the enforcer cannot produce verifiable evidence about the value of q, or it can do so only at a considerable cost.

Even if direct communication of q is not possible, individuals can learn something about q and update their beliefs on the risk of an accident by observing the sanctioning strategy chosen by the enforcer. We assume that the enforcer's objective function is not known with certainty by the potential wrongdoers: individuals assign a positive probability to the case that the enforcer maximizes a function which is different from the social welfare.[9] For instance, individuals may believe that with probability β the enforcer maximizes the fine revenue R rather than social welfare.[10]

We label, respectively, "benevolent" an enforcer (government) that maximizes social welfare, and "nonbenevolent" or "rent-seeking" an enforcer that maximizes fine revenue. We want to characterize the optimal sanctioning policy of a benevolent enforcer who takes into account the uncertainty of individuals about its objective function (i.e. about its "type" being benevolent or rent-seeking) and about the risk of an accident.

We choose not to explicitly model the political mechanism that can induce a government to act in a benevolent way. However, we make the assumption that the political system is effective enough that even a nonbenevolent government could not overtly behave in a way that reveals its type. In other words, the individuals must not be able to infer from the

[9] The main reason for this assumption is that, if individuals in the population knew the objective function of the enforcer, they would be able to overcome the information asymmetry simply by inferring the value of q from the sanctioning policy selected by a welfare maximizing enforcer.

[10] The reason why the budget R enters the objective function may be that the enforcer (the government) earns a rent from managing public funds (the rent is assumed to be proportional to the funds). The model can be easily extended to the case in which the enforcer is believed to maximize a function of both social welfare and fine revenue.

behavior of the enforcer that it is nonbenevolent (though in some circumstances they may be able to tell it apart from a benevolent enforcer). To be more precise, we assume that (1) the nonbenevolent government cannot choose a strategy which would never be chosen by a benevolent government; and (2) the nonbenevolent government cannot choose a low deterrence policy when the risk of accident is high; although it can overdeter violations when the risk is low. An explanation for assumption (2) is that with underdeterrence individuals can detect that the government has chosen the "wrong" policy by observing a high number of accidents; on the contrary, overdeterrence is difficult to detect, because although individuals see that there have been high sanctions and a small number of accidents, the counterfactual is missing, i.e. it is hard to know what the number of accident would have been with lower deterrence.

2.2. *Monetary versus nonmonetary sanctions*

Let π be the probability that a wrongdoer who violates is caught. Since the cost of detection plays no fundamental role in the model, we assume that π is exogenously given and fixed. The model can be extended without difficulty to the case of a variable π.

In order to deter violations, the enforcer will sanction the wrongdoer using monetary and nonmonetary sanctions. Let F be the monetary fine to be paid when the wrongdoer is caught, and H the equivalent in money of the nonmonetary sanction.

The theory of optimal monetary sanctioning points to the wealth of individuals as an upper bound for monetary sanctions: we have $F \leq \bar{F}$, while H is not subject to such a limit.[11] However, we will extend our model to allow for alternative possibilities, including customary rules constraining the maximal sanction that can be imposed for a violation: in this case, the upper bound will be on the total amount of the sanction $F+H$.

As it is well known, an important difference between monetary and nonmonetary sanctions is that the latter imply a social cost, while the former are simply a transfer, and therefore the cost for those sanctioned is exactly offset by a gain for those who receive the fine revenue. We consider that a nonmonetary sanction whose amount is H implies a social loss of δH, with $\delta > 0$ (if $\delta = 0$, the nonmonetary sanction would be equivalent to a monetary transfer). The social cost of the nonmonetary sanction includes both the cost for the wrongdoer of being sanctioned and the net cost for the enforcer of imposing the sanction.[12]

Another aspect, which is relevant in our model, is that the rent-seeking enforcer has a direct interest in increasing the fine revenue, while there is no gain from increasing a nonmonetary sanction.

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[11] More precisely, even when there is a limit (e.g. the time in prison is constrained by age), the classical theory implicitly assumes that this is higher than the optimal interior solution for the nonmonetary sanction.

[12] It is worth noting that the sanction can bring about some social benefits too; for example, when we consider driving offenses and drivers who are required to attend a course in order to have their driving license back after a withdrawal, the course may increase the ability of the drivers, and affect the future risk of accidents: in this case, the benefit for society corresponds to the reduction in future externalities. In addition, nonmonetary sanctions may prevent the individual from doing harm for a certain period (this is the incapacitation argument we mentioned in footnote 4). Of course, we rule out the possibility that these gains are higher than the total social cost of sanctions, as in this case the imposition of the sanction would be optimal irrespective of its deterrence effect.

By mimicking the strategy of the benevolent enforcer facing $q = q_{\mathrm{H}}$, the nonbenevolent enforcer may be able to extract a rent from individuals. It will pretend that $q = q_{\mathrm{H}}$ (i.e. that the risk of an accident is high) and set a high monetary sanction, when it is actually $q = q_{\mathrm{L}}$. This means that a high monetary sanction does not unambiguously signal that $q = q_{\mathrm{H}}$, since it may well be compatible with $q = q_{\mathrm{L}}$ and a nonbenevolent enforcer. In other words, the possibility that the enforcer is rent-seeking rather than benevolent makes the monetary sanction a "noisy" signal about the riskiness of sanctioned actions. A nonmonetary sanction, although more costly, does not suffer such a drawback.

It is worth emphasizing that it is because of the presence of K, i.e. because the accident is costly to the wrongdoer as well, that the signaling role of sanctions is important for deterrence.

3. Optimal sanctions

In order to analyze the optimal policy it is convenient to refer directly to the expected sanction $S = \pi F$. $\bar{S} = \pi \bar{F}$ will denote the maximum possible value of S, corresponding to the highest possible monetary sanction $\bar{F}$.

Similarly, let N indicate the expected (equivalent monetary) value of the nonmonetary sanction: $N = \pi H$.

Given S and N, an individual will violate the rule if

$$b - (S + N) - pK > 0 \tag{1}$$

where p is the probability (not necessarily equal to q) that potential wrongdoers assign to the occurrence of an accident. The social benefit from the violations of the rule net of loss is

$$U(S, N, p) \equiv \int_{S+N+pK}^{\infty} [b - q(E + K) - \delta N]\, \mathrm{d}G(b) \tag{2}$$

where G is the cumulative distribution of b, or $G(x) = \mathrm{Prob}\{b \le x\}$, with density g. In function U it is made explicit that deterrence (and therefore social welfare) depends on individuals' perception of the risk incurred by violating the rules.

3.1. Perfect information

Assume that individuals are perfectly informed about q, i.e. they know the "true" probability of getting into an accident when violating a legal rule (i.e. $p = q_i$, with $i = \mathrm{L}, \mathrm{H}$).

We first restate the standard conclusion about the optimal mix of monetary/nonmonetary sanctions; namely, that a nonmonetary sanction should be used only to supplement a monetary one when the latter has been used up to its maximum extent. In our context, this can be expressed as follows.

Proposition 1. *When $p = q$ (perfect information), it is never optimal that at the same time $N > 0$ and $S < \bar{S}$.*

Proof. We simply show that if $S < \bar{S}$ and $N > 0$, it is always possible to increase (2) by increasing S. Consider the effect of an increase in S exactly offset in terms of deterrence by a decrease in N, or $\mathrm{d}N = -\mathrm{d}S$: since $\mathrm{d}N + \mathrm{d}S = 0$, the change in social welfare is $[1 - G(N + S + qK)]\delta S > 0$. $\square$

When the probability is q_i, the enforcer selects S and N to solve

$$\max_{S,N} U(S, N, q_i) \quad \text{s.t.} \quad S \le \bar{S}. \tag{3}$$

In order to align individual incentives and social costs/benefits, when the probability is q_i the optimal expected sanction S^i is $q_i E$ if this level is lower than $\bar{S}$; the expected sanction corresponds to the Pigouvian corrective tax for the externality. Consistently with Proposition 1, the optimal expected nonmonetary sanction N^i will be zero in this case.

If the constraint on the maximum monetary sanction is binding (because $q_i E > \bar{S}$), we will have $S^i = \bar{S}$ and N^i is either a positive value satisfying

$$[q_i E - (1 - \delta)N - \bar{S}]g(N + \bar{S} + q_i K) - \delta[1 - G(N + \bar{S} + q_i K)] = 0 \tag{4}$$

or it is zero (this will be the case if the left-hand side of (4) is nonpositive for $N = 0$).

This corresponds to the common conclusion about the use of a nonmonetary sanction as a supplement to a maximal monetary sanction.

In the following we will refer to the optimal solution with perfect information as the first best solution, and we will assume that $S^i < \bar{S}$ (so that $N^i = 0$) for $i = \mathrm{L}, \mathrm{H}$.

3.2. *Asymmetric information*

When information about q is asymmetrically distributed, individuals update their expectation on the probability of an accident by observing the sanctioning policy and considering the possible strategies of a benevolent and a nonbenevolent enforcer. In the equilibrium, each type of enforcer maximizes its payoff according to the expected optimal response of the individuals in the population; and potential wrongdoers choose on the basis of their beliefs, which are formed according to the observed behavior of the enforcers.

Consider the case in which the benevolent enforcer fixes the expected sanctions at the perfect information levels. This strategy will result in an efficient outcome only if the potential wrongdoers can infer the “true” risk of accident from the sanctions observed.

An individual observing a low sanction will infer that the probability is low, since by our assumptions it is not possible for the enforcer, even if it is nonbenevolent, to choose a low sanction when the risk is high. Therefore, when the risk is low there is no difference with respect to the perfect information case, and the optimal sanction will be S^{L}.

However, an individual observing $S > S^{\mathrm{L}}$ might not be able to infer that the risk is high, as the nonbenevolent enforcer might find it convenient to fix a high sanction even when the risk is low, if it can increase its fine revenue by doing so. In other words, we might end up with a “pooling” equilibrium where potential wrongdoers observe the same policy in the case of a high risk and in the case of a nonbenevolent enforcer facing a low risk of accident. In such a pooling equilibrium potential wrongdoers update their beliefs when they observe

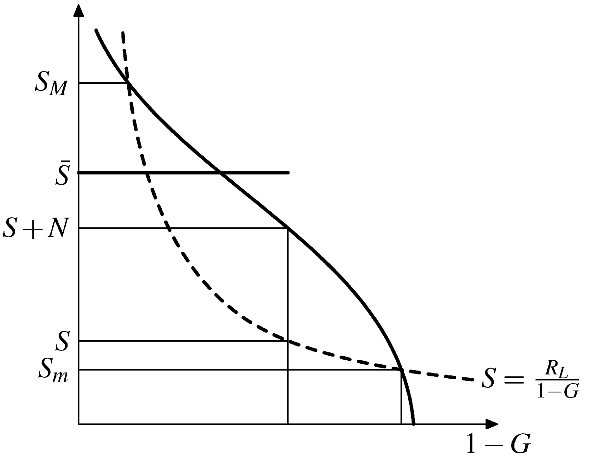

Fig. 1. Expected monetary sanctions and frequency of violations.

$S > S^L$ but, as the enforcer may be a rent-seeking one, they are not able to know the "true" probability q.

We indicate by $\tilde{p}$ the posterior belief when potential wrongdoers cannot tell apart the case of high risk from that of a nonbenevolent enforcer, with[13]

$$q_L < \tilde{p} \leq q_H. \tag{5}$$

The last inequality is strict if β (the probability that the enforcer is rent-seeking) is positive, and the difference between $\tilde{p}$ and q_H is higher the higher β is.

When the risk of accident is q_L, by imposing the sanctions (S, N) chosen by the benevolent enforcer when $q = q_H$, the rent-seeking enforcer gets a payoff

$$R(S, N) \equiv S[1 - G(\tilde{p}K + S + N)]. \tag{6}$$

Therefore, in order to give potential wrongdoers the proper signal about the riskiness of their behavior when $q = q_H$, the benevolent enforcer will set the sanctions so that $R(S, N) \leq R_L$ (incentive compatibility constraint), where $R_L \equiv S^L[1 - G(q_L K + S^L)]$ is the payoff the rent-seeking enforcer would obtain by selecting the welfare maximizing strategy S^L.

In Fig. 1 the curve drawn in a continuous line represents the total sanction corresponding to each frequency of violation $1 - G$ when $p = q_H$; the dashed curve gives the maximum monetary sanction consistent with the incentive compatibility constraint ($S = R_L/(1 - G)$).

[13] Let p_0 be the prior probability that potential wrongdoers assign to the eventuality of an accident; it is $p_0 = q_L + r(q_H - q_L)$ where $r \in (0,1)$ is the prior probability that $q = q_H$ (see above). By simple application of Bayes' rule, the posterior probability is

$$\tilde{p} = q_L + \frac{r}{r + (1 - r)\beta}(q_H - q_L)$$

with $\tilde{p} \geq p_0$, $\tilde{p} = q_H$ for $\beta = 0$ and $\tilde{p} = p_0$ for $\beta = 1$.

To simplify our analysis, we will assume that the two curves cross only twice, at levels S_{m} and S_{M} (so that $R(S_{\mathrm{m}}, 0) = R(S_{\mathrm{M}}, 0) = R_{\mathrm{L}}$), and that $\tilde{S} < S_{\mathrm{M}}$, as depicted in the figure. This implies that levels of sanctions higher than S_{m} can satisfy the constraint only if the monetary sanction is supplemented by a nonmonetary one. Equivalently: $R(S,0) > R_{\mathrm{L}}$ if $S_{\mathrm{m}} < S \leq \bar{S}$, while $R(S,0) < R_{\mathrm{L}}$ for $S < S_{\mathrm{m}}$. Note also that $S^{\mathrm{L}} < S_{\mathrm{m}}$.

If we had $R(S^{\mathrm{H}}, 0) \leq R_{\mathrm{L}}$, it would never be optimal for the rent-seeking enforcer to disguise (the incentive compatibility constraint would be satisfied in the first best). Therefore, in order to focus on the case in which asymmetric information affects the outcome, we assume that $R(S^{\mathrm{H}}, 0) > R_{\mathrm{L}}$, or $S^{\mathrm{H}} > S_{\mathrm{m}}$.

We now characterize the optimal sanctioning strategy for a benevolent enforcer faced with a high risk of accident ($q = q_{\mathrm{H}}$). This can result in either a pooling or a separating equilibrium. The latter is obtained by solving

$$\max_{S,N} U(S, N, q_{\mathrm{H}}) \quad \text{s.t.} \;\; S \leq \bar{S}, \quad R(S, N) \leq R_{\mathrm{L}}. \tag{7}$$

We have a pooling equilibrium when, faced by a low risk ($q = q_{\mathrm{L}}$), the rent-seeking enforcer mimics the benevolent enforcer's optimal strategy for $q = q_{\mathrm{H}}$ (i.e. the incentive compatibility constraint is not satisfied); we solve in this case

$$\max_{S,N} U(S, N, \tilde{p}) \quad \text{s.t.} \;\; S \leq \tilde{S}, \quad R(S, N) > R_{\mathrm{L}}. \tag{8}$$

We assume that $(q_{\mathrm{H}} - \tilde{p})K + q_{\mathrm{H}}E > \bar{S}$. Since

$$U((q_{\mathrm{H}} - \tilde{p})K + q_{\mathrm{H}}E, 0, \tilde{p}) = U(q_{\mathrm{H}}E, 0, q_{\mathrm{H}}), \tag{9}$$

this assumption rules out the possibility that a monetary sanction alone can induce a first best level of deterrence in the pooling equilibrium, which would make the problem uninteresting.

We summarize the solution to the above problem in

Proposition 2. *Let $\bar{S}$ be the upper limit on monetary sanctions. Assume that there is asymmetric information and there is no monetary sanction inducing a first best level of deterrence. The problem admits a separating equilibrium where potential wrongdoers learn the true probability q_{H}. In this equilibrium we may have $N > 0$ even when $S < \bar{S}$. This outcome is more likely the higher $(q_{\mathrm{H}} - \tilde{p})K$ is.*

Proof. See Appendix A.1.

The proposition states that, due to the incentive compatibility constraint, there is a role to be played by nonmonetary sanctions even if the monetary sanction is not maximal. Although less costly in principle, an increase in the monetary sanction can be unadvisable because it makes the signal about harmfulness "noisy" (the benevolent and the rent-seeking enforcer are "pooled"), with adverse effects on deterrence. Nonmonetary sanctions, though more costly, make it possible to increase deterrence while controlling potential wrongdoers' beliefs about the real objective of the enforcer's policy.

Note that $(q_{\mathrm{H}} - \tilde{p})K$ is higher the higher the own-effect of violations K is, the higher the belief that the enforcer is rent-seeking (β) is and the higher the uncertainty about the probability of an accident is.

3.3. *Upper limit to the total sanction*

Our result about the signaling role of nonmonetary sanctions extends to the case in which the upper bound applies to the *total* amount of the sanction, monetary and nonmonetary, rather than only to monetary sanctions. This is the case when the upper limit to sanctions is not related to the wealth of individuals, but reflects some other external constraint. For instance, the government may want to respond to some view of fairness shared by the individuals, who believe that the sanction should "fit the crime".[14]

The existence of an upper limit to the total sanction can be expressed by the constraint $F+H \leq \bar{F}$, or $S+N \leq \bar{S}$. When sanctions are subject to an upper limit to the total sanction, Proposition 1 implies that under perfect information it must always be $N=0$, and there is no role at all for nonmonetary sanctions. Hence, the conclusion that the use of nonmonetary sanctions can be part of the optimal strategy is more striking here than in the case considered above.

After substituting $S+N \leq \bar{S}$ for $S \leq \bar{S}$ in problems (7) and (8), we proceed as in the previous section. We obtain the following result:

Proposition 3. *Let $\bar{S}$ be the upper limit on total sanctions, monetary and nonmonetary. Assume that there is asymmetric information and there is no monetary sanction inducing a first best level of deterrence. The problem admits a separating equilibrium in which potential wrongdoers know the true probability q_{H}. In this equilibrium we will have $S < \bar{S}$ and, in spite of this, we may have $N>0$. This outcome is more likely the higher is $(q_{\mathrm{H}} - \tilde{p})K$ is and the lower δ is.*

Proof. See Appendix A.2.

With respect to Proposition 2, we have here that a low δ unambiguously makes the separating equilibrium, the only one in which nonmonetary sanctions can be used, more likely than the pooling equilibrium. The result seems to better suit the case of nonmonetary sanctions with a low (though strictly positive) social cost; this is the case for sanctions that bring about some social benefits, for example because they incapacitate or re-educate the wrongdoer.

4. Concluding remarks

In this paper, we develop a signaling theory of nonmonetary sanctions. We have incorporated educational and informative concerns into the standard theory of deter-

[14] Polinsky and Shavell (2000b) consider the case of a government which responds to fairness oriented preferences of the citizens: "When the issue of fairness is added to the analysis, however, the usual solution is generally not optimal because a very high sanction will be seen as unfair, or more precisely, will result in the lowering of individuals' fairness-related utility. With respect to double parking, even a sanction of $100 might be considered unfair, let alone a sanction of $10,000". Our analyses differ in that, for simplicity, we take the upper limit as a constraint in the enforcer's objective function, rather than introducing a concern for fairness in the objective function itself.

rence by considering a situation in which the public enforcer is better informed than the potential wrongdoer about the possible negative consequences of violations.

The paper provides a contribution to the theory of optimal law enforcement by showing that the traditional conclusion on the optimal use of nonmonetary sanctions, namely that fines should be used to their maximum extent before nonmonetary sanctions are introduced, does not hold when the signaling power of different sanctions is taken into account. Indeed, monetary and nonmonetary sanctions are not perfect substitutes not only because they imply different costs, but also because they provide different signals to individuals. In particular, we have shown that nonmonetary sanctions may be more credible in transmitting information about the harmfulness of actions.

Finally, it is worth discussing how our analysis is affected by the availability of alternative means of transmitting information, whose use we have implicitly ruled out. For instance, the government may disseminate information by means of a large scale informative campaign. However, it is clear that such a campaign should be costly to be credible; otherwise, the (welfare maximizing) enforcer would find it optimal to save on sanctioning and detection costs by always claiming that the risk is high, even when it is in fact low. Given this remark, the access to relatively cheaper channels of information does not seem to represent a compelling argument against the use of nonmonetary sanctions as a signaling device.

Besides, it could be claimed that sanctioning is a fairly effective way to attract the attention of the wrongdoers and be sure that the information reaches the desired target. In this regard, using sanctions may be better than relying on the expectation that the individuals watch TV ads or read informative booklets.[15] As these actions are costly for the individuals, they may decide not to bear these additional costs, thus making the information campaigns ineffective.

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[15] An objection might be that it is not clear why potential wrongdoers should have more incentives to acquire information on sanctions than on the harmfulness of their behavior. Indeed, sanctions are an effective way to transmit information when they are actually used, i.e. after the occurrence of the offence. This means that they might be more effective when offences are of a recurrent kind.

Appendix A

A.1. Proof of Proposition 2

First note that if in the optimum $N=0$, then $S=S_{\mathrm{m}}$. This follows from the assumption that $R(S, 0)<R_{\mathrm{L}}$ for $S=S_{\mathrm{m}}$ and from the fact that for $S=S^{\mathrm{H}}$ it is $\partial U(S, 0, q_{\mathrm{H}})/\partial S>0$. Note that $S=S_{\mathrm{m}}$ cannot be part of an optimal strategy.

If on the other hand $N>0$ and $S<\bar{S}$, then it must be $R(S, N)=R_{\mathrm{L}}$ (we can prove that $R(S, N)<R_{\mathrm{L}}$ cannot be part of an optimal strategy using an argument similar to the proof of Proposition 1). Let $\varphi(S)$ be defined by $R(S, \varphi(S)\equiv R_{\mathrm{L}}$, so that the incentive compatibility constraint can be written as $N\geq\varphi(S)$.

If the problem has a maximum with $N>0$ and $S<\bar{S}$, this will satisfy $N=\varphi(S)$ and the first order condition $\mathrm{d}U/\mathrm{d}S=0$, where

$$\frac{\mathrm{d}U}{\mathrm{d}S}=-(1+\varphi')[S+N-q_{\mathrm{H}}E-\delta N]g(S+N)-\delta\varphi'[1-G(S+N)]. \tag{10}$$

Note that, in order to simplify notation, we have implicitly considered (and will consider hereafter) $b-q_{\mathrm{H}}K$ instead of b as the integration variable.

Finally, we might have a maximum with $S=\bar{S}$ and

$$N^{*}=arg\max_{N\geq\varphi(\bar{S})}U(\bar{S}, N, q_{\mathrm{H}}). \tag{11}$$

To prove Proposition 2, we must first show that it is possible that neither S_{m} nor $\bar{S}$ constitute an optimal strategy. This will indeed be the case if there exists $S\in(S_{\mathrm{m}}, \bar{S})$ such that $U(S, \varphi(S), q_{\mathrm{H}})$ is higher than both $U(S_{\mathrm{m}}, 0, q_{\mathrm{H}})$ and $U(\bar{S}, N^{*}, q_{\mathrm{H}})$. The two inequalities imply, respectively

$$\delta\varphi(S)[1-G(S+\varphi(S))]<\int_{S_{\mathrm{m}}}^{S+\varphi(S)}[b-q_{\mathrm{H}}E]\,\mathrm{d}G(b) \tag{12}$$

and

$$\delta\varphi(S)[1-G(S+\varphi(S))]<\int_{S+\varphi(S)}^{\bar{S}+N*}[b-q_{\mathrm{H}}E]\,\mathrm{d}G(b)+\delta N^{*}[1-G(\bar{S}+N^{*})]. \tag{13}$$

To illustrate when such conditions are likely to be satisfied, consider for instance S such that $S+\varphi(S)=S^{\mathrm{H}}$, as in Fig. A.1. A sufficient condition for an internal solution is that the hatched rectangle scaled by the factor δ, representing the cost of the nonmonetary sanction $N=\varphi(S)$, is less than each of the two shaded triangles, representing, respectively, the cost of overdeterrence from imposing a sanction[16] $\bar{S}$ plus N^{*}, and the cost of underdeterrence from imposing only a monetary sanction S_{m}. Such a condition will be met if δ (the share of

[16] Note that the cost of imposing the sanction N^{*}, i.e. the last term on the right side of (13), should be added to the cost of overdeterrence. We expect that in general this cost will be quite small: in the figure, it is represented by the rectangle on the left of the upper triangle and above $\bar{S}$.

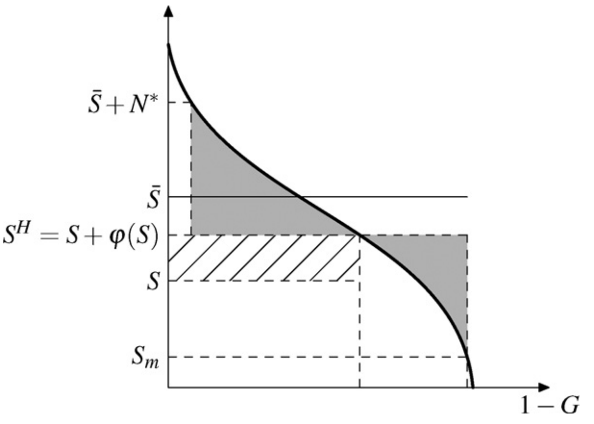

Fig. A.1. Cost of overdeterrence and underdeterrence.

nonmonetary sanction which represents a social loss) is sufficiently low, although nothing excludes that it can be satisfied even when $\delta = 1$, i.e. when the sanction is totally wasteful.

We have shown that a separating equilibrium with $S < \bar{S}$ and $N > 0$ may exist. We now show that it may well be preferred to the pooling equilibrium.

In the pooling equilibrium, setting $S < \bar{S}$ cannot be optimal. This is easily proved considering that Proposition 1 holds without the incentive compatibility constraint, implying $N = 0$; therefore $S < \bar{S} < (q_H - \bar{p})K + q_H E$ implies

$$\frac{\partial U(S, 0, \tilde{p})}{\partial S} = -[S - q_H E - (q_H - \tilde{p})K] > 0 \tag{14}$$

which allows us to conclude that S should be set as high as possible.

Hence, the optimal nonmonetary sanction will be N^{**} which solves[17]

$$\max_N U(\bar{S}, N, \tilde{p}) \quad \text{s.t.} \;\; 0 \leq N < \varphi(\bar{S}). \tag{15}$$

Depending on the parameters of the model, $U(\bar{S}, N^{**}, \tilde{p})$ can be either higher or lower than what we have in the separating equilibrium. It can be easily checked that the social welfare in the separating equilibrium is more likely to be higher than in the pooling equilibrium the higher $(q_H - \tilde{p})K$ is.

In particular, a sufficient condition for the separating equilibrium to dominate the pooling equilibrium is that

$$\bar{S} < S_m + (q_H - \tilde{p})K. \tag{16}$$

This is easily proved. If $\bar{S} + N^{**} < S_m + (q_H - \tilde{p})K$, the pooling equilibrium is clearly dominated by the separating equilibrium with S_m and $N = 0$ (the latter implies higher

[17] Note that this problem may admit no proper optimum in the open interval $0 \leq N < \varphi(\bar{S})$; this may be the case if U is increasing in N near $\varphi(\bar{S})$.

deterrence at lower cost, since only monetary sanctions are used). If on the other hand $\bar{S} + N^{**} < S_m + (q_H - \tilde{p})K$, consider the sanction $S > S_m$ such that

$$S + \varphi(S) + (q_H - \tilde{p})K = \tilde{S} + N^{**}. \tag{17}$$

The separating equilibrium with S and $N = \varphi(S) > 0$ yields the same level of deterrence as the pooling equilibrium. However, since $S > S_m$, it follows from (16) and (17) that $N^{**} > \varphi(S)$; since the frequency of violation is the same in the two cases, they differ only in the cost of monetary sanctions, which is higher in the pooling than in the separating equilibrium.

A.2. *Proof of Proposition 3*

This is analogous to the proof of Proposition 2. Just like in that case, $N = 0$ implies $S = S_m$ while $N > 0$ implies $N = \varphi(S)$. Here, in addition, it follows that $S < \bar{S}$ in the separating equilibrium.

A separating equilibrium with $N = \varphi(S) > 0$ is found solving

$$\max_S U(S, \varphi(S), q_H) \quad \text{s.t.} \quad S + \varphi(S) \leq \bar{S} \tag{18}$$

which gives the following alternatives: either $S + N = \bar{S}$ and $dU/dS > 0$; or $S + N < \bar{S}$ and $dU/dS = 0$, where dU/dS is given by (10). As in the previous proof, the condition for $N > 0$ to be part of the optimal strategy is given by the inequality (12), which ensures that $S = S_m$ and $N = 0$ is not optimal.

Finally, the social welfare in the separating equilibrium must be compared with that of the pooling equilibrium, which in this case (being never optimal $N > 0$) is $U(\bar{S}, 0, \tilde{p})$. The condition for the optimality of the separating equilibrium is

$$\delta\varphi(S)[1 - G(S + \varphi(S))] < \int_{\bar{S}-(q_H-\tilde{p})K}^{S+\varphi(S)} [b - q_H E]\, dG(b) \tag{19}$$

where on the left side we have the cost of the nonmonetary sanction $N = \varphi(S)$ and on the right side the gain in terms of deterrence from signaling that the risk of accident is high.[18] The separating equilibrium will be preferred for high values of $(q_H - \tilde{p})$ and of K, and for low values of δ.

We finally observe that (16) also holds in this case as a sufficient condition for the optimality of the separating equilibrium.

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[18] Note that the integral in (19) is positive (a necessary condition for the inequality to be satisfied) only if $(q_H - \tilde{p})K > \bar{S} - (S + \varphi(S))$.

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