

On social and market sanctions in deterring non compliance in pollution standards

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***Selected Paper prepared for presentation at the American Agricultural
Economics Association Annual Meeting, Portland, Oregon,
July 29-August 1, 2007***

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On social and market sanctions in deterring illegal behavior*

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Very preliminary and incomplete draft.

Please do not cite.

April 2007

Abstract

In this paper, we theoretically explore the implications of social norms in deterring pollution standard fraud along with economic incentives provided both by markets and regulatory activities. The model assumes that a large number of risk-averse individuals differ not only in their private cost of compliance with the environmental standard but also in their individual aversion to fraud. The aversion of fraud is influenced by the extent of social norms. We show that there may be multiple equilibrium rates of compliance for a given enforcement policy. We also show that under risk aversion the potential loss in market revenues has an ambiguous effect on the equilibrium rates of compliance. Similarly, increasing the probability of audit may decrease the equilibrium rate of compliance when stochastic events make involuntary non compliance possible. Last, we show that the information brought to the market is crucial for polluters' behavior. For this, we explore the impact of self-reporting procedures and public disclosure of criminal records.

JEL : Q50, Z13.

Key-words: social norms, asymmetric information, audit, pollution.

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1 Introduction

Human behavior seems to be influenced both by economic incentives and social norms. While economists have largely emphasized economic incentives, social norms have been largely neglected although this is a major topic in other social sciences like sociology (Ellickson 1998, Elster 1989, Posner 1997). It is only recently that some economists have analyzed the economic consequences of social norms and status seeking in societies (see e.g. Akerlof 1980 for a seminal paper and more recently Lindbeck et al. 1999). The basic idea is that individuals when considering decisions not only take into account the private economic incentives (for example, the expected penalty when being non compliant with respect to an environmental standard) but also the intensity of social norms against certain actions. In other words, individual decisions can be influenced by the aggregate behavior observed in the population.

Recently, Lai et al. (2003) have suggested that the presence of social norms may explain why one observes that a surprisingly large number of firms comply with pollution standards even though expected penalties for non compliance are low (see Russell, Harrington and Vaughan, 1986, for evidence in the US and Livernois and McKenna, 1999, for the Canadian case). Cropper and Oates (1992) suggest that “perhaps public opprobrium is a stronger disciplinary force than economists are typically inclined to believe”. Hatcher et al. (2000) have empirically explored social norms in the context of compliance in fisheries. Various papers have analyzed the role of non-economic motivations for being compliant with pollution standards: both Bontems and Rotillon (2000) and Heyes (2001) assume the existence of an *exogenous* proportion of firms that always comply and show that increasing this proportion may have adverse impacts on welfare.

The purpose of the paper proposed here is to theoretically explore the implications of social norms in deterring pollution standard fraud along with economic incentives. The model assumes that a large number of risk-averse individuals differ not only in their private cost of compliance with the environmental standard but also in their individual aversion to

fraud. The aversion of fraud is influenced by the extent of social norms: if the rate of fraud is rationally expected to be high then the individual cost of being caught while being non compliant is low *ceteris paribus*. And conversely. This contrasts with Bontems and Rotillon (2000) and Heyes (2001) by endogenizing the compliance decisions not only through the economic incentives provided both by regulatory activities and by markets, but also through the presence of social norms against frauding behavior.

The analysis yields to multiple instable or stable equilibria for a given enforcement policy (i.e. for a given penalty and rate of inspection). This explains why some gradual change in policy may cause a sudden and drastic move in the value that individuals attach to the norm. We also show that under risk aversion the potential loss in market revenues has an ambiguous effect on the equilibrium rates of compliance. Similarly, increasing the probability of audit may decrease the equilibrium rate of compliance when stochastic events make involuntary non compliance possible.

Last, we concentrate on the situation where besides penalties non compliant individuals may also suffer from market sanctions. The model assumes that consumers are ready to pay a premium to obtain unobservable environmental attributes. In a context where imperfectly informed consumers on the “green” market are able to form rational expectations regarding the extent of illicit activities, multiplicity of equilibria is also obtained. This yields to several interesting results. First, it is necessary for the regulator to distinguish voluntary from involuntary non compliance. Second, the amount of information provided to the market by the regulator (through identifying non compliant products) is crucial and there exist some conditions for which providing information to the market through public disclosure of criminal records is welfare decreasing. Last, incorporating the possibility for non compliant firms to self-report their status before any inspection allows to save audit costs but also modify the rational expectations of consumers in a sense which is not always desired by a welfare-maximizing regulator.

2 The model

We consider a continuum population of risk-averse individuals, where each individual faces a binary choice: whether or not to engage into compliance with regards to an (exogenous) environmental law (or standard). The cost of compliance is c but we assume that compliance is stochastic from the individual's point of view. Indeed, with probability μ , the individual that has spent the compliance cost c will be non compliant in the end due to external circumstances. Also, we assume that there is no chance that an individual that has chosen not to spend c will be found compliant. If we denote p the probability of being audited and convicted, then the probability of being found non compliant while having spent the cost c is μp .

In order to induce individuals to conform to the standard, the regulator imposes a penalty upon non-compliant agents. With probability p , the individual who has not spent c has to pay a fine F through random audits. However, we allow the regulator to distinguish between involuntary non compliance from voluntary non compliance by imposing a fine $f \leq F$ to the formers. Such a fine might be needed in cases where a compensation to the victims of violation even if involuntary is to be paid.

We denote λ the expected (and actual) rate of compliance in the population. Besides the incentives brought by the regulator, we introduce also the possibility that individuals may suffer from a loss in market revenue if found non compliant. Assume that an individual who is found non compliant and convicted gets a market revenue equal to $V = r - \delta$ where $r \geq 0$ is the potential maximal revenue and $\delta \leq r$ is the loss of revenue due to non compliance. We assume that the market faces incomplete information on the true status of any individual but observes convictions. Hence, if the market anticipates a compliance rate λ , then the revenue

R that any non convicted individual gets is given by

$$\begin{aligned}
R &= (r - \delta) \Pr(\text{not compliant} \mid \text{not convicted}) + r \Pr(\text{compliant} \mid \text{not convicted}) \\
&= \frac{(1 - \lambda)(1 - p) + \mu\lambda(1 - p)}{(1 - p)(1 - \lambda) + \lambda(1 - \mu) + \lambda\mu(1 - p)}(r - \delta) + \frac{\lambda(1 - \mu)}{(1 - p)(1 - \lambda) + \lambda(1 - \mu) + \lambda\mu(1 - p)}r \\
&= r - \frac{(1 - \lambda + \mu\lambda)(1 - p)}{1 - p + \lambda p(1 - \mu)}\delta \in (r - \delta, r).
\end{aligned}$$

Note that R is increasing in λ (with $\lim_{\lambda \rightarrow 1} R = r - \mu(1 - p)/(1 - \mu p)$), is decreasing in μ (with $\lim_{\mu \rightarrow 1} R = r - \delta$) and is increasing in p (with $\lim_{p \rightarrow 1} R = r$).

Besides market sanctions, the non compliant individual also suffers from a psychic cost or social sanction due to illegal behavior equal to $\theta\psi(\lambda)$ where $\theta \geq 0$ denotes the individual adherence to the norm and where $\psi(\cdot)$ is increasing in the rate of compliance. An extreme case is where $\theta = 0$ so that such an individual does not suffer at all from social sanctions in case of compliance. The higher θ is, the more reluctant to non compliance the agent is. This phenomenon is reinforced by the presence of a positive externality of λ through the function ψ on the social sanction. The social sanction is higher when the compliance rate is large in the population. We assume that this social sanction appears only in cases where non compliance is voluntary.

We are now in a position to derive the expected payoffs relative to a compliance or non compliance decision. A type- (θ, c) individual who chooses compliance gets an expected payoff equal to

$$(1 - \mu p)U(R(\lambda) - c) + \mu p U(V - f - c)$$

where $U(\cdot)$ is an increasing utility function of net monetary revenue.¹ Similarly, a type- (θ, c) who chooses non compliance gets

$$pU(V - F) + (1 - p)U(R(\lambda)) - \theta\psi(\lambda).$$

¹If one were unable to distinguish voluntary from involuntary non compliance, then the expected payoff of a compliant agent would write

$$(1 - \mu p)U(R(\lambda) - c) + \mu p U(V - F - c) - \mu\theta\psi(\lambda).$$

3 The equilibrium rate of compliance

If each individual chooses the alternative with the highest expected utility, then compliance is optimal for a type- (θ, c) individual if and only if:

$$(1 - \mu p)U(R(\lambda) - c) + \mu pU(V - f - c) > pU(V - F) + (1 - p)U(R(\lambda)) - \theta\psi(\lambda),$$

or equivalently

$$\theta > \tilde{\theta}(c, \lambda) \equiv \frac{\Delta W(c, \lambda)}{\psi(\lambda)}$$

where

$$\Delta W(c, \lambda) = pU(V - F) + (1 - p)U(R(\lambda)) - (1 - \mu p)U(R(\lambda) - c) - \mu pU(V - f - c)$$

is the expected utility gain from being non compliant as compared with compliance.

The following lemma indicates the basic properties of the minimal adherence to the norm $\tilde{\theta}(c, \lambda)$, needed for compliance to be optimal.

Lemma 1 *The minimal adherence to the norm $\tilde{\theta}(c, \lambda)$ is continuous, decreasing in the compliance rate λ and increasing in the compliance cost c .*

Proof: Indeed, we get

$$\text{sign} \frac{\partial \tilde{\theta}}{\partial \lambda} = \text{sign} \left\{ \frac{\partial \Delta W}{\partial \lambda} \psi - \psi' \Delta W \right\}$$

Recall that ψ is increasing in λ while ΔW is decreasing in λ as shown below:

$$\frac{\partial \Delta W}{\partial \lambda} = [(1 - p)U'(R) - (1 - \mu p)U'(R - c)] \frac{\partial R}{\partial \lambda} < 0$$

because $1 - \mu p \geq 1 - p$ and $U'(R - c) > U'(R)$ as U is concave.

Moreover, we have $\text{sign} \frac{\partial \tilde{\theta}}{\partial c} = \text{sign} \left\{ \frac{\partial \Delta W}{\partial c} \right\} = \text{sign} \left\{ (1 - \mu p)U'(R(\lambda) - c) + \mu pU'(V - f - c) \right\} =$

+. This concludes the proof. ■

Intuitively, the minimal adherence to the norm for compliance to be chosen must be higher when the compliance cost c increases. Furthermore, this threshold level decreases with the

rate of compliance λ as an increase in the compliance rate increases both the social norm and the market revenue effects. Indeed, the expected utility gain of non compliance $\Delta W(c, \lambda)$ decreases in λ because of the market revenue effect. The following lemma indicates some further comparative results for $\Delta W(c, \lambda)$.

Lemma 2 *The expected utility gain of non compliance $\Delta W(c, \lambda)$*

- (i) *is increasing in the penalty f for unvoluntary non compliance and the probability μ of unvoluntary non compliance,*
- (ii) *is decreasing in the penalty F for voluntary non compliance,*
- (iii) *varies ambiguously with the loss δ in market revenue if non compliant, under the assumption of risk aversion*
- (iv) *varies ambiguously with the probability p of being inspected, as long as the probability of unvoluntary non compliance μ is strictly positive.*

Proof: First, we have

$$\frac{\partial \Delta W}{\partial f} = \mu p U'(V - f - c) > 0$$

and

$$\frac{\partial \Delta W}{\partial \mu} = \frac{\partial \Delta W}{\partial R} \frac{\partial R}{\partial \mu} + p [U(R - c) - U(V - f - c)] > 0$$

because $\frac{\partial \Delta W}{\partial R} < 0$, $\frac{\partial R}{\partial \mu} < 0$ as shown above and $R > V$. This proves (i).

Next, we have

$$\frac{\partial \Delta W}{\partial F} = -p U'(V - F) < 0$$

which proves (ii). Considering the impact of δ , we have

$$\begin{aligned} \frac{\partial \Delta W}{\partial \delta} &= \frac{\partial \Delta W}{\partial V} \frac{\partial V}{\partial \delta} + \frac{\partial \Delta W}{\partial R} \frac{\partial R}{\partial \delta} \\ &= [p U'(V - F) - \mu p U'(V - f - c)] \frac{\partial V}{\partial \delta} + [(1 - p) U'(R) - (1 - \mu p) U'(R - c)] \frac{\partial R}{\partial \delta} \end{aligned}$$

Recalling that both V and R decrease in δ , we still have that $\frac{\partial \Delta W}{\partial R} < 0$ while $\frac{\partial \Delta W}{\partial V}$ is ambiguous in general. In the special case where $\mu = 0$, then $\frac{\partial \Delta W}{\partial V} > 0$ and the sign of $\frac{\partial \Delta W}{\partial \delta}$ is *a priori* ambiguous. We now prove that the ambiguity disappears if one makes the risk-neutrality assumption (as in Rasmussen 1996). Indeed, under risk neutrality, we have

$$\begin{aligned} \frac{\partial \Delta W}{\partial \delta} &= [p - \mu p] \frac{\partial V}{\partial \delta} + [(1 - p) - (1 - \mu p)] \frac{\partial R}{\partial \delta} \\ &= p(1 - \mu) \left(\frac{\partial V}{\partial \delta} - \frac{\partial R}{\partial \delta} \right) \\ &= p(1 - \mu) \left(-1 - \frac{\partial R}{\partial \delta} \right) < 0 \end{aligned}$$

as $\frac{\partial V}{\partial \delta} = -1 \leq \frac{\partial R}{\partial \delta} \leq 0$. This proves (iii).

Finally, with regards to p , we get

$$\frac{\partial \Delta W}{\partial p} = U(V - F) - U(R) + \frac{\partial \Delta W}{\partial R} \frac{\partial R}{\partial p} + \mu [U(R - c) - U(V - f - c)]$$

The two first terms are non positive because $R > V$ and $\frac{\partial R}{\partial p} > 0$ together with $\frac{\partial \Delta W}{\partial R} < 0$. In the last term, the expression between the brackets is positive as $R > V$. This proves the ambiguity of the sign of $\frac{\partial \Delta W}{\partial p}$ and thereby part (iv). ■

Parts (i) and (ii) of Lemma 2 yield to expected results. If the probability and the penalty for involuntary non compliance increase then non compliance appears to be increasingly a better strategy than compliance. On the contrary, an increase in the penalty for voluntary non compliance reduces the utility gain of non compliance. More surprising are the last two results (parts (iii) and (iv)). Part (iii) suggests that the market loss δ has an ambiguous effect on ΔW and hence on $\tilde{\theta}$. Indeed, it is easy to construct examples where $\frac{\partial \Delta W}{\partial \delta} > 0$ that is where the gain to be non compliant increases with the market loss. In turn, the threshold $\tilde{\theta}$ increases too. As shown by Lemma 2 this result comes from the non linearity of the utility function under the assumption of risk aversion. Last, part (iv) indicates that an increase in the inspection probability p may yield to an increase in the utility gain of non compliance and hence a similar pattern for the threshold $\tilde{\theta}(c, \lambda)$. As shown in the proof of Lemma 2, this phenomenon is purely due to the fact that $\mu > 0$ and expresses the fact that when compliance

is stochastic and μ sufficiently large *ceteris paribus* then an increase in p may favor the non compliance strategy.

Having characterized the basic properties of the crucial variables $\tilde{\theta}$ and ΔW , we now turn to the determination of the equilibrium rate of compliance. We denote $G(\theta, c)$ the joint distribution of the adherence to the norm and the compliance cost, on the product of their respective supports. We assume that all individuals simultaneously choose between compliance and non compliance for given parameters $(p, \mu, f, F, r, \delta)$. If all individuals expect a compliance rate equal to λ , then λ must be equal to the population share $H(\lambda)$ that finds compliance as being optimal. We thus obtain the following result.

Proposition 3 *An equilibrium rate of compliance exists and is defined by a fixed point of:*

$$\lambda = H(\lambda) \equiv \int_{\underline{c}}^{\bar{c}} \int_{\tilde{\theta}(c, \lambda)}^{\bar{\theta}} dG(\theta, c) \quad (1)$$

From Lemma 1, it follows that $H(\cdot)$ is a continuous non decreasing function of λ , mapping the interval $[0, 1]$ into itself. Hence, there exists at least one compliance rate satisfying equation (1) for any policy (p, f, F) . This follows from the intermediate value theorem applied to $f(\lambda) = \lambda - H(\lambda)$ which is a continuous function with $f(0) \leq 0$ and $f(1) \geq 0$. However, multiplicity of equilibria is possible and it is actually a general feature of this class of models with aggregate externality (see e.g. Weibull and Villa 2005 or Lindbeck et al., 1999). Equilibria may be stable or unstable.

Given the results contained in Lemma 2, it is not surprising that it is easy to find examples where an increase in the audit probability p or in the market loss δ nevertheless induce a decrease in equilibrium rate of compliance, whether it is stable or not. [to be completed]

4 The role of information

We examine in the following the crucial role of information provided to the market. For simplicity, we concentrate on the case where social norms are absent and we successively analyze the impact of self-reporting and public disclosure of information.

In the particular situation where there is absence of social norms ($\theta = 0$), then there exists a unique value $\tilde{c}(\lambda)$ such that if $c \leq \tilde{c}(\lambda)$ then a type- c firm chooses to be compliant. The threshold value $\tilde{c}(\lambda)$ is increasing in λ and is defined implicitly by

$$(1 - \mu p)U(R(\lambda) - \tilde{c}(\lambda)) + \mu p U(V - f - \tilde{c}(\lambda)) = pU(V - F) + (1 - p)U(R(\lambda))$$

and consequently the equilibrium compliance rate is defined by

$$\lambda = \int_{\underline{c}}^{\tilde{c}(\lambda)} dG(0, c).$$

Note that in the absence of social norms, then compliance is possible only if $f < F$. Otherwise, no individual would find an interest in being compliant. Hence, it is necessary for the regulator to observe whether c has been spent in order to distinguish between voluntary and involuntary non compliance.

Let us look at how $\tilde{c}(\lambda)$ varies with δ . Differentiating, we get

$$\begin{aligned} - [(1 - \mu p)U'(R(\lambda) - \tilde{c}(\lambda)) + \mu p U'(V - f - \tilde{c}(\lambda))] \frac{d\tilde{c}}{d\delta} + (1 - \mu p)U'(R(\lambda) - \tilde{c}(\lambda)) \frac{\partial R}{\partial \delta} \\ + \mu p U'(V - f - \tilde{c}(\lambda)) \frac{\partial V}{\partial \delta} - pU'(V - F) \frac{\partial V}{\partial \delta} - (1 - p)U'(R(\lambda)) \frac{\partial R}{\partial \delta} = 0 \end{aligned}$$

Thus the sign of $\frac{d\tilde{c}}{d\delta}$ is given by the sign of $(1 - \mu p)U'(R(\lambda) - \tilde{c}(\lambda)) \frac{\partial R}{\partial \delta} + \mu p U'(V - f - \tilde{c}(\lambda)) \frac{\partial V}{\partial \delta} - pU'(V - F) \frac{\partial V}{\partial \delta} - (1 - p)U'(R(\lambda)) \frac{\partial R}{\partial \delta}$, which is ambiguous as shown above, because of risk aversion.

4.1 The impact of self-reporting

If one allows self-reporting as part of the mechanism, then an individual has always the option to declare his status (compliant/non compliant) before being inspected at random. If he declares to be non compliant, we assume that the individual will pay a sanction $s \leq f$ with probability one if c has been spent and $S \leq F$ if c has not been spent. Hence, if an individual is non compliant because he has not spent c , he declares his status if and only if

$$U(V - S) > pU(V - F) + (1 - p)U(R(\lambda)).$$

Note that this inequality does not depend on the cost of compliance, c . This means that all individuals voluntarily non compliant and sharing the same preferences $U(\cdot)$ will take the same decision whatever their private cost of compliance. Suppose for now that $\mu = 0$ so that involuntary non compliance does not exist. Then, the situation where self-reporting appears at the equilibrium is such that all non compliant individuals declare their status. Otherwise, we would be back to the case in which there is no self-reporting. Consequently, a type- c individual chooses to comply if and only if,

$$U(R(\lambda) - c) > U(V - S)$$

where $R = r$ and $V = r - \delta$. Indeed, the direct consequence of truthtelling by all non compliant individuals is that the market faces no more asymmetric information. The threshold level is given by $R(\lambda) - c = V - S$ or equivalently by $\tilde{c} = \delta + S$ and consequently, there exists a unique equilibrium compliance rate given by $\lambda = G(0, \delta + S)$. We thus obtain the following result.

Proposition 4 *Assume that non compliance can only be voluntary, i.e. $\mu = 0$. Whenever self-reporting appears at the equilibrium, it implies complete information for the market and thereby selects a unique equilibrium compliance rate. Consequently, introducing the possibility of self-reporting yields ambiguous welfare results.*

Indeed, introducing self-reporting is ambiguous from a welfare point of view as we may select an equilibrium with a lower compliance rate than the one we get before. And conversely.

Now consider the situation where involuntary non compliance exists, i.e. $\mu > 0$. An individual who is involuntarily non compliant chooses to declare his status if and only if

$$U(V - s - c) > pU(V - f - c) + (1 - p)U(R(\lambda) - c). \quad (2)$$

Note first that if $f = s$, i.e. there is no rebate for truthtelling, then the inequality simply becomes

$$U(V - f - c) > U(R(\lambda) - c)$$

and the decision is now independent of c . Moreover as $V < R(\lambda)$ then nobody will declare his status. Hence we obtain the following result.

Proposition 5 *A rebate for truthtelling is necessary for unvoluntary non compliance to be declared, i.e. $s < f$.*

Let us examine the inequality (2) more closely:

$$\begin{aligned} U(V - s - c) &> pU(V - f - c) + (1 - p)U(R(\lambda) - c) \\ V - s - c &> U^{-1}[pU(V - f - c) + (1 - p)U(R(\lambda) - c)] \\ c + U^{-1}[pU(V - f - c) + (1 - p)U(R(\lambda) - c)] &< V - s \end{aligned}$$

The LHS of this inequality is non monotonic in c so that the set of values for c such that the inequality is satisfied is ambiguous at this level of generality.

4.2 The impact of information public disclosure

In the absence of public information on criminal records, the market forms beliefs so that the expected revenue for any individual is given by

$$\begin{aligned} R^{NPI}(\lambda) &= \lambda(1 - \mu)r + (1 - \lambda + \lambda\mu)(r - \delta) \\ &= r - (1 - \lambda(1 - \mu))\delta \end{aligned}$$

where NPI stands for non public information. Note that $R^{NPI}(\lambda) > V = r - \delta$. Also R^{NPI} does not depend on p . Moreover, we have $R^{NPI}(\lambda) < R(\lambda)$. Indeed,

$$\begin{aligned} R(\lambda) - R^{NPI}(\lambda) &= r - \frac{(1 - \lambda + \mu\lambda)(1 - p)}{1 - p + \lambda p(1 - \mu)}\delta - r + (1 - \lambda(1 - \mu))\delta \\ &= \left(1 - \lambda(1 - \mu) - \frac{(1 - \lambda + \mu\lambda)(1 - p)}{1 - p + \lambda p(1 - \mu)}\right)\delta \\ &= \lambda p(1 - \mu) \left(\frac{1 - \lambda(1 - \mu)}{1 - p + \lambda p(1 - \mu)}\right)\delta \geq 0. \end{aligned}$$

Hence, if criminal records are non public, the expected market revenue is lower than the expected market revenue under public criminal records and non conviction.

Hence, the decision of being compliant is taken if and only if

$$(1 - \mu p)U(R^{NPI}(\lambda) - c) + \mu p U(R^{NPI}(\lambda) - f - c) > pU(R^{NPI}(\lambda) - F) + (1 - p)U(R^{NPI}(\lambda))$$

Let us denote $\hat{c}(\lambda)$ the marginal individual indifferent between being compliant or not:

$$(1 - \mu p)U(R^{NPI}(\lambda) - \hat{c}(\lambda)) + \mu p U(R^{NPI}(\lambda) - f - \hat{c}(\lambda)) = pU(R^{NPI}(\lambda) - F) + (1 - p)U(R^{NPI}(\lambda))$$

and the equilibrium compliance rate is defined by

$$\lambda = \int_{\underline{c}}^{\hat{c}(\lambda)} dG(0, c).$$

Note that when $\lambda = 0$, then $R^{NPI}(0) = R(0) = V = r - \delta$. Hence, $\hat{c}(0) = \tilde{c}(0)$. This means that the two curves start from the same point.

Proposition 6 *Under risk neutrality, in the absence of public information on criminal records, there is an unique equilibrium compliance rate given by $\lambda^{NPI} = G(0, p(F - \mu f))$ while under public information there are potentially multiple equilibria. Hence, there exists some circumstances where hiding criminal records from the public's eye might increase the equilibrium compliance rate.*

Proof: Under risk neutrality, $\hat{c}(\lambda)$ is given by

$$(1 - \mu p)(R^{NPI}(\lambda) - \hat{c}(\lambda)) + \mu p (R^{NPI}(\lambda) - f - \hat{c}(\lambda)) = p(R^{NPI}(\lambda) - F) + (1 - p)(R^{NPI}(\lambda))$$

which simplifies into $\hat{c}(\lambda) = p(F - \mu f)$. ■

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