Monitoring and Enforcement: The L.B. Jefferies Problem

Timo Goeschl and Ole Jürgens*

Early version - Please do not quote

Abstract

A new regulatory paradigm assigning an active role to the public in law enforcement has become an important feature of recent policies. We ask how the design of regulations can enhance the supply of information by citizens. Our model analyses the interaction between the supply of citizen complaints and regulatory standard setting. Complaints can constitute a cheap substitute for regulatory monitoring. The regulator faces a classical trade-off. Heterogeneous benefits for agents point to imposing different standards. However, tailored standards can constrain the reporting of citizens. Individualized regulations lead to uncertain benefits from complaining. This result holds even if citizens have a perfect monitoring technology. Imposing a uniform standard that is communicated to the public can generate efficiency gains whenever the savings in monitoring costs exceed the efficiency losses due to the uniform standard. Optimality of uniform standards is well documented in the literature, especially if the regulator faces uncertainty about agents' types. However, we assume that the regulator knows each agent's type. Uncertain benefits from reporting

*Department of Economics, University of Heidelberg; contact: goeschl@eco.uni-heidelberg.de, juergens@eco.uni-heidelberg.de.

are a new explanation for uniform standards. Finally, the analysis shows that integrating the public into the monitoring process is not unambiguously beneficial.

JEL classification: K22; K32; K42

Keywords: Regulatory standard setting, citizen complaints, inspections, enforcement, regulation

1 Introduction

What is the role for the public in criminal enforcement? The regulatory literature offers two main answers. One role is for the public to carry out private enforcement activities in addition to or in lieu of public enforcement. This definition of the public's role has been studied extensively under the heading of 'private enforcement', starting with the seminal work by Becker and Stigler (1974) and subsequent work by Landes and Posner (1975). Applications of these ideas have influenced the literature on law and development (Hay and Shleifer 1998) and on environmental regulation (Nayerserksy and Tietenberg 1992), to name just two areas. Key issues are to identify the determinants of private enforcement and the extent to which private enforcement is a substitute or a complement to public enforcement activities.

A second role for the public is to supply inputs into public enforcement activities by detecting and reporting to the authorities potentially illegal activities. This second role raises a number of issues that have so far not received a great deal of attention in the literature. While detection and reporting by victims of crime can be readily explained (e.g. Alllen 2007), the reasons for the public to monitor the actions of others, to assess whether these actions might qualify as criminal, and to incur the cost of reporting their observations to institutions of public enforcement are less obvious. Nevertheless, it is a stylized fact that

the public is willing to perform these actions and provides information about actions carried out by others to the enforcement authorities.

Building on a simple behavioral model of public reporting taken from the psychological and whistle-blower literature (Alford 2001, Jos et al. 1989, Miceli and Near 1992, and Heyes and Kapur 2008 among others), we examine the interaction between enforcement policies, i.e. how legal standards are set and enforced, and the reporting by members of the public of observed violations. To do so, we develop a model of monitoring and reporting that tries to capture important elements what could be termed the 'L.B. Jefferies problem', in reference to the main character of a fictional account of a reporter monitoring neighbors' behavior from his rear window. The fictional setting consists of a citizen ('L.B. Jefferies) who observes - with an imperfect monitoring technology - a number of agents engaging in different activities. The citizen does not know the individuals' gains from these different activites, but is self-motivated to report individuals engaging in banned activities to a regulator (the police). While the fictional account centers on the imperfection of monitoring as a dramatic vehicle, our interest focuses on the basic structure of the setting. The setting raises a number of fundamental questions about how the regulator's enforcement policy should take the presence of the citizen into account. Note, for example, that in the fictional setting the citizen is aware that the regulator has spent resources on publicly announcing what types of activites are banned. How important is this announcement in order for L.B. Jefferies to provide his monitoring input? Should the regulator change the definition of what is illegal when citizens are present?

In order to answer these questions, we first reconsider the standard monitoring and enforcement model comprising the regulator and agents. Then, we extend the traditional model by introducing the general public. We consider

the case where for each agent one citizen observes the agent's action with a perfect monitoring technology. Perfect monitoring means in our context that the citizen will observe the relevant action taken by the agent without error, thus removing a major dramatic device from our monitoring situation and abstracting from the question of how much to invest in monitoring technologies. Agents choose whether or not to carry out an activity that may or may not be banned by the regulator. The citizen can choose whether or not to incur the cost of reporting the observed activity to the regulator, who will investigate every report. The regulator can choose whether or not to ban an action, his own monitoring intensity, and whether to make his policy public or not. The information structure is one where both the agent and the regulator know the agent's benefits from carrying out the act, but citizens do not. If the regulator makes her policy public, then this policy becomes common knowledge. If not, then only the agent learns about the enforcement regime under which he operates. We motivate these modeling choices in detail in the following section.

The analysis shows that the often observed demand for integrating the public into the monitoring process is not unambigiuously beneficial without providing information to the general public. The reason is that different types of equilibria can emerge. The equilibria mainly differ in the strategy of the citizens, i.e. on the choice of L.B. Jefferies whether to report his observation. To get a prediction which equilibrium will be the outcome in the monitoring process we make a behavioral assumption about the citizen's choice if he has no information about regulatory standard setting. The analysis shows that one equilibrium is characterized by overeager citizens. Overeager citizens means that in case of observing an act the citizen will report the incidence to the authorities even if he does not know whether the observed act is illegal. As this yields to investigation costs integrating the public in the monitoring process can have negative effects.

The analysis will further highlight the trade-offs between tailoring enforcement policies to individual characteristics of the agents and the harnessing the reporting input of the citizens. We characterize the optimal regulatory policies, i.e. regulatory standard setting, inspection policy and the type of announcement, depending on the different cost structures, benefits and the distribution of agents.

In section 2 we develop the model. The regulatory process is modelled as a game of incomplete and imperfect information. In part three we derive the results and section 4 summarizes.

2 The model

To analyze the relationship between the supply of citizen complaints and regulatory standard setting we build a game-theoretic model. We consider the regulation of a certain act that can be committed by economic agents and that causes external social harm. The example we have in mind is the case of emitting a harmful pollutant by firms. The dynamic game of imperfect and incomplete information comprises three types of players: the regulator, n agents and n citizens.

2.1 Players and actions

In this section we describe the set-up of the game. The players, the actions available, the timing of the game and the information sets are also depicted in figure 1.

Agents decide whether to commit the act under consideration. Committing the act leads to external social harm h and generates private gross benefits for the agent. For example, a firm saves the costs of installing abatement equipment.

We consider two types of agents, one that receives low benefits θ_L and one that receives high benefits θ_H, with $\theta_L < h < \theta_H$. Therefore, it is socially advantageous that high types commit the act whereas it is socially undesirable for low types. In the case of emissions a low type firm is the more efficient one as it has lower abatement costs. We assume that the distribution of types is common knowledge. All players know the number of low (high) type agents n_L (n_H) and therefore all know the fraction $\frac{n_L}{n}$ ($\frac{n_H}{n}$) of low (high) types. Denote the choice of an agent with a_i, $i \in \{L, H\}$, where

$$a_i = \begin{cases} 1 & \text{if an agent of type } i \text{ commits the act} \\ 0 & \text{else} \end{cases} . \tag{1}$$

The regulator knows the type of each agent additionally to the distribution. The regulator makes two types of choices . First, he specifies the *regulatory policies* for all agents. These policies (i) allow or ban the act for an agent (i.e. the regulator sets a standard) and (ii) specify inspection probabilities. Denote the standard $\widehat{a}_i$ ($i \in \{L, H\}$), where

$$\widehat{a}_i = \begin{cases} 1 & \text{if the act is allowed for an agent of type } i \\ 0 & \text{else} \end{cases} . \tag{2}$$

Given (1) and (2) an agent violates the regulatory norm if $a_i > \widehat{a}_i$.

If no citizen lodges a complaint against an agent the regulator commits to inspect that agent with probability p_i at costs c_{Ins}. Inspections truthfully reveal whether the agent committed the act. If instead a citizen lodges a complaint the regulator has to investigate the report at cost c_{Inv}. As inspections do investigations truthfully reveal the agent's decision. If the act is banned but investigations or inspections show that it was committed the regulator levies an

exogenously given fine $F \geq \theta_H$.[1] The regulatory policy for an agent of type i is summarized by the tuple $\{\widehat{a}_i, p_i\}$.

Second, the regulator has to decide about the *announcement of the regulatory policy*. He can choose "private announcement" or "public announcement" (labeled *pr* and *pu* respectively). Private announcement of $\{\widehat{a}_i, p_i\}$ means that the regulatory policy for a given agent is communicated only to that agent. In this case the agent and the regulator know this regulatory policy. All other players, especially the citizens, have no information about this policy. Private announcement allows the regulator to choose different regulatory policies for different types of agents.

Contrary, in the case of public announcement the policy is communicated to all players. Especially the general public, i.e. the set of citizens, is informed about the regulatory policy. However, the use of public announcement is not for free. Public announcement constrains the set of actions available to the regulator. We assume, that if the regulator wants to inform the public about regulations, he has to treat all agents in the same manner, i.e. he has to choose a uniform regulatory policy $\{\widehat{a}, p\}$, where $\widehat{a}$ is in the same way defined as $\widehat{a}_i$ in (2) and p is the inspection probability. In this case the act is allowed or is banned for all agents and all agents face the same inspection probability. The reason for this assumption simply is that, at least in civil law countries, in most settings regulatory authorities are not allowed to make information on an individual level publicly available. Thus, for legal constraints publicly announcend regulations have to be uniform.

The citizens are the third type of players. The risk-neutral and identical citizens are members of the general public. For simplicity we assume that for

[1] We assume $F \geq \theta_H$ to ensure that it is possible to deter all agents from committing the act to avoid the judgement proof problem (Shavell 1986). Further, we assume that agents' wealth w is limited, i.e. $w < \infty$. Therefore, the maximum expected fine is also limited.

each of the n agents there is exactly one citizen and none of them knows "his" agent's type. The one-to-one mapping between citizens and agents allows us to abstract from the possiblity that citizens can gather information from different behaviors by different agents as a citizen observes only one agent's behavior. It also precludes the free-riding problem because every agent's decision is observed by only one citizen. Further, citizens are endowed with a perfect monitoring technology, i.e. every citizen identifies exactly whether his agent has committed the act. This allows us to concentrate on the interaction between standard setting - and in case of private announcement the uncertainty about legality of the act - and the supply of citizen complaints. If instead citizens had an imperfect technology they would face a second source of uncertainty. Analysing the effects of this type of uncertainty and of the enhancement of this technology is beyond the scope of this paper. Stated differently, we assume that the process of enhancing citizens' monitoring technology has already come to an end.

The decision of a citizen whether to report is denoted r with[2]

$$r = \begin{cases} 1 & \text{if the citizen reports} \\ 0 & \text{else} \end{cases} .$$

As a citizen is risk-neutral he will lodge a complaint, i.e. file a report about an incidence, only if the expected benefits are at least as great as the costs of reporting c_R. Absolute benefits of complaining are b with $b \geq c_R$. Several components can be important for the decision whether to complain.

Costs of reporting The literature suggests various costs of lodging a complaint. The two most obvious ones are money and time. An individual observing an act bears the direct costs of driving to the next bureau to file

[2] Since monitors are homogeneous, they all possess the same information and all do not know agents' types. Therefore all monitors will make the same decision and it is not necessary to distinguish monitors due to the type of the agent they are assigned to.

a report. Besides the money for fuel, bus tickets or the like this activity takes time which constitutes opportunity costs. Furher, an individual might not know where the report has to be filed (police, prosecutor, agencies like the EPA etc.). Gathering this information can lead to substantial involvement in time. Finally, if the report results in enforcement actions the complainer might have to spend time in court to witness his observation.

Garoupa (2001) suggests the fear of self-incrimination as a factor. The person observing an act might worry that the officials will treat him as the prime suspect. Also the fear of reprisal can deter individuals from complaining (Singer 1988) and thus act as a cost. That this indeed hinders at least some persons to report an incident is shown by the British Crime Survey 2008/09 (BCS) as reported by Walker et al. (2009). Depending on the type of the incident 1%-6% of the people not reporting said that the reason was fear of reprisal. The National Crime Victimization Survey (NCVS) 2006 (U.S. DoJ 2008) shows a similar finding: 7.3% did not report due to fear of reprisal.

The components mentioned so far can be considered as direct costs of complaining. One can also think of indirect effects that relate to the reporting of an observation. The observer might sympathize with the offender (Garoupa 2001) and wishes no sanctions to be imposed. This can be relevant if the own employer or more general the own region of the potential complainer will be negatively affected (Weersink and Raymond 2007).

In the past most countries initiated several programs to reduce the costs of reporting crimes. Examples are emergency phone numbers like 911 in the US, 999 in the UK and 112 in nearly every European country, the possibility of lodging online-complaints[3] and to issue a guarantee of anonymity for the person complaining. As we assume that the absolutes benefits from reporting already

[3] One example among many is reporting of suspected terrorism or criminal acitivity via the FBI website https://tips.fbi.gov/.

exceed costs for every citizen, it is clear that further initiatives to reduce the costs cannot enhance the supply of complaints in our model. The limits in the supply of reporting arise solely out of the uncertainty from benefits.

Benefits from reporting At a first glance it is not clear why a citizen should make a report. In most cases there is no direct monetary benefit from reporting. However, reality shows that officials do receive complaints from witnesses of wrongdoings. What are the benefits inducing indiviuals to report to authorities? One benefit is the avoidance from harm (Shavell 1993). This argument reflects the deterrence power of citizen complaints. Another benefit an individual receives from complaining is the contribution to the punishment of wrongdoers. A motive often labeled as 'retribution' or 'thirst for revenge' (Wittman 1974, Posner 1980, Shavell 1993). Further, as Shavell (1993) and Posner (1980) point out individuals feel some kind of 'moral duty' to report crimes. The NCVS indeed indicates that these benefits motivate people to report. Three reasons to report that were stated point into the direction of the avoiding harm argument: 'Stop or prevent this incident' (23.8%), 'To prevent further crimes by offender against victim' (20.9%) and 'To prevent crime by offender against anyone' (8.5%). Further, 6.5% said their reason was 'To punish offender'. The reasons 'To improve police surveillance' (3.2%), 'Duty to notify police' (5.2%) and 'Because it was a crime' (13.7%) show that also 'moral duty' can be an important determinant in the decision whether to report.

Finally, there is strong experimental evidence that individuals are motivated to punish wrongdoers even in one-shot games and if punishment is costly but does not generate direct monetary benefits (among the most prominents are Güth et al. 1982, Fehr and Gächter 2000 and 2002, Fehr and Falk 2002 and Falk et al. 2005; see also Fehr and Schmidt 1999 for a meta-analysis). Some of these findings do not only hold for directly affected victims but also for witnesses

of unfair acts.

Uncertainty of benefits Common to all those benefits is that they will accrue to the individual only if further enforcement actions are carried out. Therefore, the decision whether to report will also depend on the likelihood of enforcement after reporting. If the perceived likelihood is small, no one will find it optimal to complain (Mookherjee and Png 1992; MacDonald 2001). This is highly relevant in cases where potential offenders are regulated by individualized standards. A consequence is that people often are unaware of offences (Garoupa 2001). Stated differently, the knowledge of a definition of an illegal act is missing (Shavell 1993). If an individual observes an act and does not know whether this is within the norm the decision is one under uncertainty.

In the NCVS individuals state that some reasons for not reporting were 'Not important enough' (6.2%), 'Not aware crime occurred until later' (0.4%), 'Police would not want to be bothered' (6.3%) and 'Police inefficient, ineffective or biased' (4.6%). The BCS shows a similar pattern. Depending on the type of the offence between 52% and 87% of those not reporting said the reason was 'Trivial/ no loss/ police would not/could not do anything' and 0%-3% mentioned 'Dislike or fear of the police/previous bad experience with the police or courts'. All these reasons indeed show that individuals anticipate that their complaints might not lead to further enforcement actions and thus to no punishment. Finally, Soares (2004) shows that the reporting of criminal activities depends on the accuracy of institutions and especially on the perceived corruption of the police. Hence, as corruption influences the likelihood of further enforcement actions people take into account the uncertainty of benefits. Considering the size of police forces and thereby the uncertainty of benefits from reporting Levitt (1998) points out that " [...] *changes in the perceived likelihood that a crime will be solved may lead a higher fraction of victimizations to be reported to the police.*"

2.2 Pay-offs and objectives

Given the actions described above we can formulate the players' pay-offs. Agents maximize expected net benefits from committing the act. An agent of type i that commits the act receives gross benefits θ_i. Thus, gross benefits are $a_i\theta_i$. Given the citizen's choice and the regulatory policy expected net benefits for an agent of type i are

$$\pi_i = a_i\theta_i - a_i r\left(1-\widehat{a}_i\right)F - a_i\left(1-r\right)\left(1-\widehat{a}_i\right)p_iF$$

in case of private announcement and

$$\pi_i = a_i\theta_i - a_i r\left(1-\widehat{a}\right)F - a_i\left(1-r\right)\left(1-\widehat{a}\right)pF$$

in case of public announcement. If the agent commits the act ($a_i = 1$) he receives benefits θ_i. An agent that committed the act has to pay the fine either if the citizen lodges a complaint ($r = 1$) and the act was not allowed ($1-\widehat{a}_i = 1$ or $1-\widehat{a} = 1$) or he has to pay F with probability p (p_i) if there is no complaint ($1 - r = 1$) and the act is not allowed. Since $\theta_i > 0$, if the act is allowed ($\widehat{a}_i, \widehat{a} = 1$) or without any kind of enforcement actions ($p = r = 0$) each agent will choose $a_i = 1$.

The regulator's mandate is to maximize the difference V between net benefits and enforcement costs. Given a type i agent's decision and citizens' choices the contribution V_i of one agent of type i to V is

$$V_i = a_i\theta_i - a_i h - r\,c_{Inv} - \left(1-r\right)p_i c_{Ins}$$

for private announcement and

$$V_i = a_i\theta_i - a_i h - r\,c_{Inv} - \left(1-r\right)pc_{Ins}$$

for public announcement. If the act is committed V comprises gross benefits and harm. In case of a report the regulator incurs investigation costs and if no report is filed he bears expected inspection costs. As all agents of the same type face the same regulatory policy and all citizens make the same choice, all agents of the same type make the same decision (i.e. the optimal a_i is the same for all agents of type i). Therefore V is

$$V = \sum_{i=L,H} n_i V_i.$$

A citizen assigned to a type i agent receives net utility from reporting $b - c_R$ whenever he reports a committed act that is not allowed. If a citizen reports if the act was not committed or it was committed but allowed that citizen receives no benefits but incurs costs. Thus, utility u for citizens is

$$u = r\left[a_i\left(1 - \widehat{a}_i\right)b - c_R\right]$$

or

$$u = r\left[a_i\left(1 - \widehat{a}\right)b - c_R\right].$$

In case of private announcement a citizen does not know $\widehat{a}_i$. Therefore the decision is one under uncertainty. Obviously, if a citizen observes that the act is not committed it is optimal for him not to report. However, if he observes the act ($a_i = 1$) the decision depends on the perceived probability that the act is not allowed, i.e. on $prob\left(a_i > \widehat{a}_i\right) = prob\left(\widehat{a}_i = 0\right)$, and the expected utility from reporting ($r = 1$) is

$$\begin{aligned} Eu\big|_{r=1} &= \left[prob\left(\widehat{a}_i = 0\right)(b - c_R) - \left(1 - prob\left(\widehat{a}_i = 0\right)\right)c_R\right] \\ &= prob\left(\widehat{a}_i = 0\right)b - c_R \end{aligned}$$

A citizen will lodge a complaint whenever this expression is positive, i.e. if

$$prob\left(\widehat{a}_i = 0\right) \geq \frac{c_R}{b}.$$

Therefore, a report will be filed if the probability that an agent is non-compliant is as least as great as the costs of reporting relative to absolute benefits.

In figure 1 each pay-off vector contains V_i as the first, π_i as the second, and u as the third entry. The vectors are defined as $(i\epsilon\{L,H\})$[4]

$$\alpha_i^1 = \begin{pmatrix} \theta_i - h - c_{Inv} \\ \theta_i \\ -c_R \end{pmatrix},\ \alpha_i^{0,pr} = \begin{pmatrix} \theta_i - h - p_i c_{Ins} \\ \theta_i \\ 0 \end{pmatrix},\ \alpha_i^{0,pu} = \begin{pmatrix} \theta_i - h - pc_{Ins} \\ \theta_i \\ 0 \end{pmatrix}$$

$$\beta = \begin{pmatrix} -c_{Inv} \\ 0 \\ -c_R \end{pmatrix},\ \delta_i^{pr} = \begin{pmatrix} -p_i c_{Ins} \\ 0 \\ 0 \end{pmatrix},\ \delta^{pu} = \begin{pmatrix} -pc_{Ins} \\ 0 \\ 0 \end{pmatrix}$$

$$\gamma_i^1 = \begin{pmatrix} \theta_i - h - c_{Inv} \\ \theta_i - F \\ b - c_R \end{pmatrix},\ \gamma_i^{0,pr} = \begin{pmatrix} \theta_i - h - p_i c_{Ins} \\ \theta_i - p_i F \\ 0 \end{pmatrix},\ \gamma_i^{0,pu} = \begin{pmatrix} \theta_i - h - pc_{Ins} \\ \theta_i - pF \\ 0 \end{pmatrix}.$$

To break ties we assume that in case of indifference a citizen reports, an agent complies with a ban and the regulator allows commmitting the act.

[4] Strategy profiles yielding (i) an "α-vector" have $\widehat{a}_i, \widehat{a} = 1$ and $a_i = 1$, (ii) β have $a_i = 0$ and $r = 1$, (iii) an "γ-vector" have $\widehat{a}_i, \widehat{a} = 0$ and $a_i = 1$ and (iv) an "δ-vector" have $a_i = 0$ and $r = 0$.

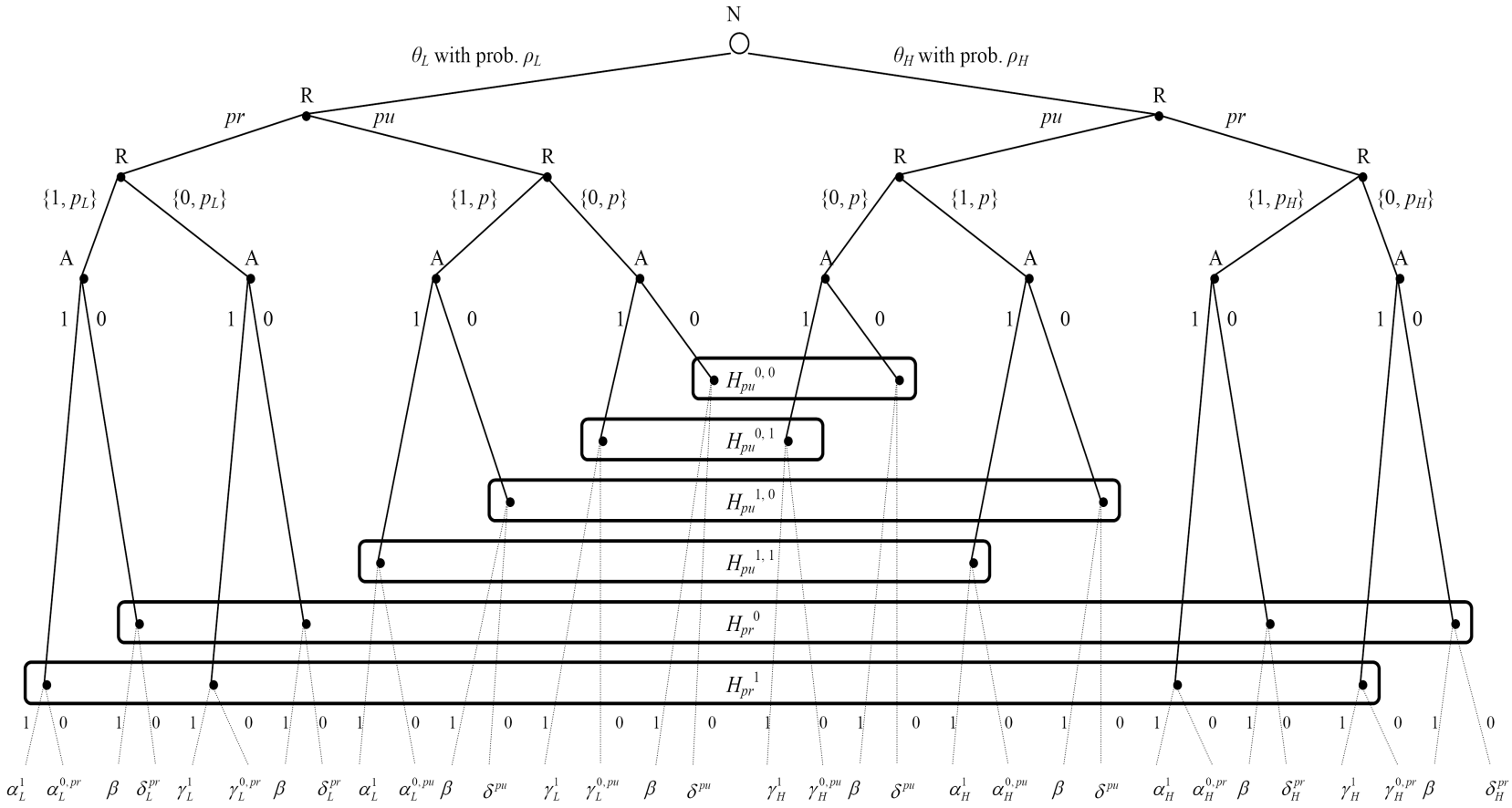

Figure 1: Game Tree

2.3 Timing

Figure 1 contains the game tree. The situation is shown from a citizen's point of view. First, nature assigns a low or a high type agent to every citizen. As both types are existent and the number of agents n as well as that of low types n_L and that of high types n_H is given, the different assignments of types to citizens are not independent. However, the only thing that is important for a citizen is whether he faces a low or a high type. As he has no information about any agents' type, the relevant probability of facing a low (high) type is $\rho_L = \frac{n_L}{n}$ ($\rho_H = \frac{n_H}{n} = 1 - \rho_L$). Second, the regulator chooses the type of announcement, i.e. he chooses pr or pu. This choice applies to all agents. Therefore, this decision can*not* be conditioned on types. Third, the regulator, knowing each agent's types, specifies the regulatory policies for all agents. In case of private announcement the policies $\{\widehat{a}_i, p_i\}$ are not communicated to the public whereas in case of public announcement citizens are told $\{\widehat{a}, p\}$. As stated above private announcement allows the regulator to impose tailored policies whereas public announcement forces him to choose a uniform policy. For example (($\{1,0\}$ if θ_L and $\{0,1\}$ if θ_H) if pu) cannot be part of the regulator's strategy whereas (($\{1,0\}$ if θ_L and $\{0,1\}$ if θ_H) if pr) is feasible. Fourth, observing their type, the announcement decision and their regulatory policy agents decide whether to commit the act. Finally, citizens choose whether to report. In case of public announcement, i.e. at information sets[5] $H_{pu}^{0,0}$, $H_{pu}^{0,1}$, $H_{pu}^{1,0}$ and $H_{pu}^{1,1}$, the citizen knows the type of announcement, the regulatory policy $\{\widehat{a}, p\}$ and his agents decision a_i. The only thing a citizen does not know is of which type θ_i the agent is. For private announcement the citizen knows that the regulator chose pr (as he observes the absence of a public policy) and a_i. Additionally to θ_i the citizen does not know $\{\widehat{a}_i, p_i\}$. The corresponding information

[5] Superscripts for monitors' information sets after public announcement have the format "$\widehat{a}, a_i$" and after private announcement "a_i".

sets are denoted H^0_{pr} and H^1_{pr}.

Note again that figure 1 is drawn from a citizen's point of view, i.e. it captures only a detail of the whole regulatory process. In fact, the process comprises the regulation of n agents each facing one citizen. An agent's pay-off is not affected by other agents' decisions. Therefore, from the citizen's point of view the regulatory process after the announcement decision consists of n 'subgames', each having a probability of ρ_L or ρ_H that the citizen faces a low or a high type. For the regulator a 'subgame' comprising a low (high) type yields V_L (V_H).

The equilibrium concept we apply is perfect bayesian equilibrium (PBE) in pure strategies. For beliefs for information sets not on the equilibrium path we make no restrictions. As we consider only pure strategies deriving the respective systems of beliefs is straightforward. Therefore, we do not state them explicitly.

3 Results

3.1 Enforcement without reporting

Before analyzing how to trade-off gains from enhanced information against losses from uniform regulation we shortly consider standard regulation without citizens. This gives us a reference point for the analysis below as it replicates the standard result in the presence of costly enforcement. If reports are not possible, i.e. $r = 0$ is exogenously given, public announcement is not meaningful. Given the enforcement policy $\{\widehat{a}_i, p_i\}$ profits of an agent of type i are

$$\pi_i = a_i\theta_i - a_i\left(1 - \widehat{a}_i\right)p_iF.$$

If he is allowed to the agent will commit the act. If instead the act is banned, i.e. $\widehat{a}_i = 0$, expected profits are

$$\pi_i|_{\widehat{a}_i=0} = a_i\theta_i - a_i p_i F$$

and the agent will comply with the ban if this expression is non-positive for $a_i = 1$. Thus, an agent will choose $a_i = 0$ if the act is banned and the inspection probability is sufficiently large, i.e. if $p_i \geq \theta_i/F$.

In equilibrium the regulator will choose an inspection probability $p_i \epsilon \{0, \theta_i/F\}$. The regulatory policy can induce an agent to commit the act or not. If $\widehat{a}_i = 1$ the agent will commit and a positive inspection probability will only lead to costs. Now suppose that $\widehat{a}_i = 0$ and $0 < p_i < \theta_i/F$. Then the agent will also commit the act as the inspection probability is too small to deter him from committing. Therefore, $V_i^{nc}(\widehat{a}_i = 0,\ p_i \epsilon (0, \theta_i/F))$[6]$= \theta_i - h - p_i c_{Ins}$ and the regulator can do better by setting $p_i = 0$. Finally, suppose that $\widehat{a}_i = 0$ and $p_i > \theta_i/F$. In this case the inspection probability is large enough to enforce the ban but the regulator can improve by setting $p_i = \theta_i/F$ as the agent will then still comply and inspection costs are reduced. To summarize, if the regulator chooses $\widehat{a}_i = 1$, the inspection probability will equal zero[7]. If instead, he chooses $\widehat{a}_i = 0$ the inspection probability will be θ_i/F as this will be sufficient to enforce compliance.

The optimal regulatory policy is straightforward. As the act is socially advantageous if committed by a high type, the regulator will allow the act for

[6] The superscript in V^k distinguishes the regulator's pay-off in case of enforcement with and without citizen complaints, where $k = nc$ if no complaints are possible and $k = c$ if complaints are possible.

[7] Choosing $\{0, 0\}$ would of course yield the same outcome. However, we assume that the regulator allows the act if he is indifferent.

those agents and will not inspect them, i.e. $\{a_H, p_H\} = \{1, 0\}$ and thus

$$V_H^{nc} = \theta_H - h$$

For low types the regulator will choose either $\{1, 0\}$ or $\{0, \theta_i/F\}$. The first policy induces $a_L = 1$ whereas the second enforces the ban, i.e. $a_L = 0$. Therefore, we get

$$V_L^{nc}(\{1, 0\}) = \theta_L - h$$

in the first case or

$$V_L^{nc}\left(\left\{0, \frac{\theta_L}{F}\right\}\right) = -\frac{\theta_L}{F} c_{Ins}$$

in the second case. If the net harm from the act if committed by a low type is sufficiently large or if inspections are sufficiently cheap, i.e. if

$$h - \theta_L > \frac{\theta_L}{F} c_{Ins} \tag{3}$$

holds, the regulator will ban the act for low types and enforce the ban by setting $p_L = \theta_L/F$ and the regulator receives

$$V^{nc} = n_H(\theta_H - h) - n_L \frac{\theta_L}{F} c_{Ins}. \tag{4}$$

Contrary, if inspections are sufficiently costly or if net damages by low types are sufficiently small (if (3) does not hold), the act will be allowed for low types and they will not be inspected. The reason is that the costs of enforcing the ban exceed net damages. In that case the regulator gets

$$V^{nc} = n_H(\theta_H - h) - n_L(h - \theta_L). \tag{5}$$

In case of costless inspections the first-best solution would ban the act for

all types whose gross benefits fall short off social harm. Rearranging (3) yields

$$\frac{h}{1+c_{Ins}/F} > \theta_L$$

and constitutes a threshold so that types with gross benefits below this value will face a ban that will be enforced. Because $h > h/\left(1+c_{Ins}/F\right)$ in a situation with costly inspections for all types j with $\theta_j \epsilon \left[\frac{h}{1+c_{Ins}/F}, h\right)$ the act will be allowed although the first-best solution would impose a ban on those types. The optimal regulatory policy takes the enforcement costs into account. Contrary to the first-best solution this implies that if low types' benefits θ_L are within $\left[\frac{h}{1+c_{Ins}/F}, h\right)$ uniform standards are optimal. Although the regulator is perfectly informed about each agent's type all these types earn positive rents in the amount of θ_L because of costly enforcement.

3.2 Citizen Reporting

Having analyzed the benchmark case of regulation without public reporting we now allow for citizen complaints. Sequential rationality requires that a citizen will (i) not report if he observes that the act was not committed because $c_R > 0$, i.e. a profile of strategies in a PBE must have $r = 0$ if $a_i = 0$, which means $\left(r = 0 \text{ if } H_{pu}^{0,0}, H_{pu}^{1,0}, H_{pr}^{0}\right)$, (ii) not report if the act was committed but it is publicly announced that the act is allowed for all agents because $c_R > 0$, thus $\left(r = 0 \text{ if } H_{pu}^{1,1}\right)$ in equilibrium and (iii) report if the act was committed but a ban for all agents was publicly announced as $b > c_R$, i.e. $\left(r = 1 \text{ if } H_{pu}^{0,1}\right)$. Since the only information set that exhibits uncertainty about a citizen's payoff is H_{pr}^{1}, where he does not know the standard, for all other information sets of the citizen the equilibrium play is uniquely determined.

An agent i will commit the act if he is allowed to because $\theta_i > 0$. Therefore, an agent's equilibrium strategy has $(a_i = 1 \text{ if } \{1, p_i\}, \{1, p\})$. Further, given

that a citizen's equilibrium strategy comprises $\left(r = 1 \text{ if } H_{pu}^{0,1}\right)$, agents will comply with a publicly announced ban. If a regulatory policy had $\widehat{a} = 0$ and an agent i committed the act he would face a report and had to pay the fine F. Because $\theta_i - F \leq 0$ an agent's equilibrium strategy has $(a_i = 0 \text{ if } \{0, p\})$. Thus, a publicly announced ban exploits the monitoring power of the general public. To summarize, in case of public announcement we get $a_i = \widehat{a}$.

After public announcement there is no report in equilibrium and so the inspection probability affects the regulator's pay-off. As agents commit the act if $\widehat{a} = 1$ and comply with $\widehat{a} = 0$ the regulator will set $p = 0$ to save enforcement costs. In equilibrium agents comply with a private ban if the citizen's strategy has $\left(r = 1 \text{ if } H_{pr}^{1}\right)$. As deterrence is provided by citizens the inspection probability will be $p_i = 0$. Similiar, as shown in the previous section, if in equilibrium there is no report, an agent i will comply with a ban if the inspection probability is at least θ_i/F. Due to the same argument as above the regulator will choose $p_i \epsilon \{0, \theta_i/F\}$[8].

Suppose that the regulator chooses **private announcement** so that tailored regulations are possible. Then the rest of the game refers to the "traditional" regulatory practice extended by the possibility for citizens to lodge complaints. However, the public is not provided with information about regulatory standard setting. Depending on the parameters, two equilibrium strategy profiles given that the regulator chooses private announcement can emerge.

The first equilibrium strategy profile has $(r = 0 \text{ if } H_{pr}^{1})$ as part of a citizen's strategy and thus resembles enforcement without reporting. If a citizen observes that an act was committed he does not report the incidence. Obvioulsy, for high types it is optimal to allow the act and not to inspect them, so $\{\widehat{a}_H, p_H\} = \{1, 0\}$. The optimal policy for low type agents depends on the parameter constellation.

[8] If equilibrium play leads to a report so that no inspections are carried out and therefore do not affect welfare, an equilibrium strategy profile could comprise any inspection probability. In that case, without loss of generality, we set the inspection probability equal to zero.

If net damages from low types are sufficiently large or inspections are sufficiently cheap, i.e. if (3) holds, the act is banned and the inspection probability p_L equals θ_L/F, i.e. $\{\widehat{a}_L, p_L\} = \{0, (\theta_L/F)\}$, and low types comply. The regulator's pay-off $V^c(pr)$ is then as the right-hand side in (4). If (3) does not hold, the act is also allowed for low types and they are as well not inspected, so $\{a_L, p_L\} = \{0, 0\}$. The regulator gets $V(pr)$ as the right-hand side in (5).

Given the regulatory policies and agents' strategies, for both parameter constellations playing $\left(r = 0 \text{ if } H^1_{pr}\right)$ is sequential rational for citizens . In the first situation only if agents turn out to be high types the act is committed as low types will be deterred by setting $p_L = \theta_L/F$. But high types are allowed to commit so that reporting would only lead to costs for the citizen. In the latter situation, both types of agents will be allowed so that again filing no report is optimal.

Whether a second equilibrium is possible depends on the parameters. If investigations are sufficiently costly, i.e. if

$$\theta_H - h < c_{Inv}, \tag{6}$$

the second equilibrium profile of strategies has $\left(r = 1 \text{ if } H^1_{pr}\right)$ as part of the citizens' strategy. As citizens report if they observe the act low type agents can be deterred from committing the act at no costs. Therefore, the optimal regulation in case of low types is to ban the act and not inspect them, i.e. $\{\widehat{a}_L, p_L\} = \{0, 0\}$. For high types the regulator also imposes a ban and does not inspect, so $\{\widehat{a}_H, p_H\} = \{0, 0\}$. Suppose that the act for high types was allowed. Those would then commmit the act but would be reported. The reports would lead to investigation costs. However, as (6) holds, the net benefits from high types are not large enough to offset these costs. The pay-off for the regulator from high types $V^c_H(pr)$ would be negative. By banning the act, the regulator

can do better as then $V_H^c(pr) = 0$ and in total $V^c(pr) = 0$.

If (6) does not hold, there is no equilibrium profile comprising $\left(r = 1 \text{ if } H_{pr}^1\right)$. Regulations would again ban the act for low types which will comply. For high types the regulator would allow the act. As the net benefits from high types now exceed investigation costs, it is optimal to incur these costs to realize the benefits. However, $\left(r = 1 \text{ if } H_{pr}^1\right)$ is then not sequential rational for citizens. Only high types will commit the act. But as they are allowed to do so, a report would only lead to costs c_R for a citizen.

The equilibrium policies and corresponding expressions for $V^c(pr)$ if the regulator had chosen private announcement and V^{nc} are summarized in the following table. The first column shows the equilibrium policies for the equilibrium comprising $\left(r = 0 \text{ if } H_{pr}^1\right)$ as part of the citizen's equilibrium strategy, whereas in the second the equilibrium, if existent, has $\left(r = 1 \text{ if } H_{pr}^1\right)$.

	$\left(r=0 \text{ if } H_{pr}^{1}\right)$ $->\{\widehat{a}_H, p_H\}=\{1,0\}$	$\left(r=1 \text{ if } H_{pr}^{1}\right)$
$\theta_H - h \geq c_{Inv}$, i.e. (6) does not hold. $h-\theta_L \leq (\theta_L/F)\, c_{Ins}$, i.e. (3) does not hold.	$\{\widehat{a}_L, p_L\}=\{1,0\}$ $V^c(pr)=V^{nc}=$ $n_L\theta_L + n_H\theta_H - nh$	No equilibrium
$\theta_H - h \geq c_{Inv}$, i.e. (6) does not hold. $h-\theta_L > (\theta_L/F)\, c_{Ins}$, i.e. (3) holds.	$\{\widehat{a}_L, p_L\}=\{0,\theta_L/F\}$ $V^c(pr)=V^{nc}=$ $n_H(\theta_H-h) - n_L\frac{\theta_L}{F}c_{Ins}$	No equilibrium
$\theta_H - h < c_{Inv}$, i.e. (6) holds. $h-\theta_L \leq (\theta_L/F)\, c_{Ins}$, i.e. (3) does not hold.	$\{\widehat{a}_L, p_L\}=\{1,0\}$ $V^c(pr)=V^{nc}=$ $n_L\theta_L + n_H\theta_H - nh$	$\{\widehat{a}_i, p_i\}=\{0,0\}$ $V^c(pr)=0$ $V^{nc}=n_L\theta_L + n_H\theta_H - nh$
$\theta_H - h < c_{Inv}$, i.e. (6) holds. $h-\theta_L > (\theta_L/F)\, c_{Ins}$, i.e. (3) holds.	$\{\widehat{a}_L, p_L\}=\{0,\theta_L/F\}$ $V^c(pr)=V^{nc}$ $=n_H(\theta_H-h) - n_L\frac{\theta_L}{F}c_{Ins}$	$\{\widehat{a}_i, p_i\}=\{0,0\}$ $V^c(pr)=0$ $V^{nc}=n_H(\theta_H-h) - n_L\frac{\theta_L}{F}c_{Ins}$

If the citizen's strategy has $\left(r=0 \text{ if } H_{pr}^{1}\right)$ imposing tailored regulations after private announcement is optimal only if the net damages from low types exceed enforcement costs for these types. Then it is beneficial to enforce $\widehat{a}_L = 0$. This conclusion is the same as in the case of enforcement without reporting. The reason is that the combination of private announcement and $\left(r=0 \text{ if } H_{pr}^{1}\right)$ leads to the same incentives for agents and the regulator as in the former case. However, the conclusion differs if the equilbrium has $\left(r=1 \text{ if } H_{pr}^{1}\right)$ as part of citizens' strategies. As this kind of equilibrium can only occur if $\theta_H - h < c_{Inv}$ (and therefore $\theta_L - h < c_{Inv}$) for none of the types it is beneficial for the

regulator to incur investigation costs. Thus, the regulator's decision will be such that in equilibrium play there are no reports. To avoid reporting, after private announcement, the regulator imposes a uniform standard, i.e. he bans the act for both types. If (3) does not hold, i.e. without reporting enforcing a ban for low types would not be beneficial, the uniform standards would be $\widehat{a}_L = \widehat{a}_H = 1$ whereas with reporting the standard is still uniform but is now $\widehat{a}_L = \widehat{a}_H = 0$. If instead 3) holds and therefore without reporting tailored standards are optimal in case of enforcement with reporting a uniform standard ($\widehat{a}_L = \widehat{a}_H = 0$) is imposed. Consequently, if equilibrium comprises $\left(r = 1 \text{ if } H_{pr}^1\right)$ neither low nor high types will commit the act and therefore do not earn private benefits.

The results derived so far have important policy implications. Suppose that for some reason the regulator chooses private announcement. This reason could for example be that regulatory authorities do not take into account the possibility of public announcement or that it is two costly to inform citizens about regulations. Then, the described equilibrium strategy profiles given private announcement are the possible equilibria of the regulatory game. If (6) does not hold there is only one equilibrium. Otherwise, two equilibria are possible. A priori it is not clear which of the two one would expect to be played. One approach would impose a behavioral assumption on the reporting behavior of the general public. If one regards citizens as not concerned about the act under consideration one expects $\left(r = 0 \text{ if } H_{pr}^1\right)$ to be part of their strategy profile. Contrary, if citizens are overeager or if the public is highly concerned about lawful behavior one can predict that $\left(r = 1 \text{ if } H_{pr}^1\right)$ is part their strategy profile. As in the case of enforcement without reporting the regulator's pay-off can be $V^{nc} = n_H\left(\theta_H - h\right) - n_L\left(\theta_L/F\right)c_{Ins}$, the effects on the regulator's pay-off also depend on the relationship between these two components, i.e. the effects

depend on whether

$$n_H(\theta_H - h) < n_L \frac{\theta_L}{F} c_{Ins} \tag{7}$$

holds. The effects are summarized in

Proposition 1 *If legal procedures are extended by the possibility of citizen complaints without providing information to the public then V*

(i) remains unchanged if investigations are relatively cheap ((6) does not hold) or if investigations are relatively expensive ((6) holds) but the public is not concerned about the act regulated and

(ii) decreases (increases) if the public is overeager and (iia) $n_H(\theta_H - h) > n_L(\theta_L - h)$ *(*$n_H(\theta_H - h) < n_L(\theta_L - h)$*)in case (3) does not hold or (iib) (7) does not hold ((7) holds) in case (3) holds.*

Proposition 1 shows that satisfying the often observed demand for providing the possibility of citizen complaints without adjusting the regulatory design is not unambiguously beneficial. If investigations are relatively cheap or if they are expensive but the public is not concerned about offences there is no effect. In case of an overeager public citizen complaints can even be counterproductive. With private announcement citizen complaints are only beneficial if the public is overeager (for which relatively expensive investigations are a necessary condition) and the number of high type agents is sufficiently small, i.e. (7) holds if (3) holds or $n_H(\theta_H - h) < n_L(h - \theta_L)$ if (3) does not hold. Utilizing an overeager public's monitoring power is only beneficial if total net benefits from high types are smaller then total social cost from low types (enforcement costs or net damages).

As argued above, in case of **public announcement** we have $a_i = \widehat{a}$ and the optimal inspection probability is $p = 0$. If the act was allowed all agents would commit it anyways. If, however, the act was banned all agents would comply as

in equilibrium a citizen's strategy has ($r = 1$ if $H_{pu}^{0,1}$) which deters agents from committing the act. The regulator has to decide whether to allow the act. In that case his pay-off is $V^c(pu, \{1,0\}) = n_H\theta_H + n_L\theta_L - nh$ whereas a ban yields $V^c(pu, \{0,0\}) = 0$. Given public announcement the regulator will allow the act whenever the former exceeds the latter, i.e. if the average benefit exceeds the average harm

$$\frac{n_H\theta_H + n_L\theta_L}{n} \geq h. \tag{8}$$

Finally we compare **private vs. public announcement**. Again, depending on the parameters two types of equilibria are possible.

The first type has $\left(r = 0 \text{ if } H_{pr}^{1}\right)$ for the citizen. Suppose, that inspections are sufficiently costly, i.e. (3) does not hold. After private announcement the regulator would not enforce a ban for low types, thus $V^c(pr) = n_H\theta_H + n_L\theta_L - nh$. The equilibrium now depends on the relation between average benefits and harm. If (8) holds the regulator is indifferent between (pu, $\{1,0\}$ if pu) and (pr, $\{\widehat{a}_i, p_i\} = \{1,0\}$ if pr) as both yield $V^c = n_H\theta_H + n_L\theta_L - nh$. If (8) does not hold allowing the act would generate a negative pay-off, so that the optimal choice is (pu, $\{0,0\}$ if pu) to realize $V^c(pu, \{0,0\}) = 0$.

Suppose now that inspections are sufficiently cheap or that the net damage from a low type is sufficiently large, i.e. (3) holds. If the regulator had chosen private announcement it would be beneficial to enforce a ban for low types. Publicly allowing the act cannot be optimal in this situation because

$$V^c(pu, \{1,0\}) = n_H(\theta_H - h) - n_L(h - \theta_L) <$$
$$n_H(\theta_H - h) - n_L\frac{\theta_L}{F}c_{Ins} = V^c\left(pr, \left\{0, \frac{\theta_L}{F}\right\}, \{1,0\}\right).$$

Thus, the regulator chooses between (pu, $\{0,0\}$ if pu) and (pr, $\{\widehat{a}_L, p_L\} = \left\{0, \frac{\theta_L}{F}\right\}$ and $\{\widehat{a}_H, p_H\} = \{1,0\}$ if pr). If the net benefits from high types exceed

enforcement costs for low types, i.e. $n_H(\theta_H - h) > n_L \frac{\theta_L}{F} c_{Ins}$, the optimal choice is $(pr,\ \{\widehat{a}_L, p_L\} = \{0, \frac{\theta_L}{F}\}$ and $\{\widehat{a}_H, p_H\} = \{1, 0\}$ if $pr)$ as then V^c is positive. If instead $n_H(\theta_H - h) < n_L \frac{\theta_L}{F} c_{Ins}$ the regulator publicly bans the act generating a zero pay-off[9].

The second type of equilibrium comprises $\left(r = 1 \text{ if } H^1_{pr}\right)$. As shown above this can only be the case if investigation costs are sufficiently large or if the net benefits from high types are sufficiently small, i.e. if (6) holds. In this situation the outcome does not depend on inspection costs as deterrence in case of private announcement is provided by citizens. As citizens would report an observed act after private announcement and incurring the resulting investigation costs for reports on high types is not beneficial the regulator bans the act for both types after private announcement and thus $V^c(pr) = 0$. If average benefits exceed harm, i.e. (8) holds, the optimal choice is $(pu,\ \{1, 0\}$ if $pu)$ yielding $V^c(pu) = n_H\theta_H + n_L\theta_L - nh$. By telling the public that the act is allowed, the regulator avoids banning the act (which on average is beneficial) after private announcement. If instead (8) does not hold the regulator is indifferent between $(pu,\ \{0, 0\}$ if $pu)$ and $(pr,\ \{\widehat{a}_i, p_i\} = \{0, 0\}$ if $pr)$ both generating a zero pay-off.

The profiles of equilibrium strategies $s = \left\{\left(s^R\right),\ \left(s^A\right),\ \left(s^C\right)\right\}$ with s^R (s^A,

[9] If $n_H(\theta_H - h) = n_L \frac{\theta_L}{F} c_{Ins}$ the regulator is indifferent between public and private announcement.

s^C) as the equilibrium strategy of the regulator (agent, citizen)[10] are[11]

$$s_{(a)} = \left\{ \begin{array}{c} \left(\begin{array}{c} (pu \text{ or } pr)\,, \\ (\{1,0\} \text{ if } pu;\ \{\widehat{a}_i, p_i\} = \{1,0\} \text{ if } pr) \end{array} \right) \\ \left(\begin{array}{c} 1 \text{ if } pu,\ \{1,p\}\,;\ 0 \text{ if } pu,\ \{0,p\}\,;\ 1 \text{ if } pr,\ \{1,p_i\}\,; \\ 1 \text{ if } pr,\ \left\{0, p_i \in \left[0, \frac{\theta_i}{F}\right)\right\};\ 0 \text{ if } \left\{0, p_i \in \left[\frac{\theta_i}{F}, 1\right]\right\} \end{array} \right) \\ \left(\begin{array}{c} 0 \text{ if } H_{pu}^{0,0};\ 0 \text{ if } H_{pu}^{1,0};\ 1 \text{ if } H_{pu}^{0,1}; \\ 0 \text{ if } H_{pu}^{1,1};\ 0 \text{ if } H_{pr}^{0};\ 0 \text{ if } H_{pr}^{1} \end{array} \right) \end{array} \right\},$$

$$s_{(b)} = \left\{ \begin{array}{c} \left(\begin{array}{c} (pu)\,, \\ (\{0,0\} \text{ if } pu;\ \{\widehat{a}_i, p_i\} = \{1,0\} \text{ if } pr) \end{array} \right) \\ \left(\begin{array}{c} 1 \text{ if } pu,\ \{1,p\}\,;\ 0 \text{ if } pu,\ \{0,p\}\,;\ 1 \text{ if } pr,\ \{1,p_i\}\,; \\ 1 \text{ if } pr,\ \left\{0, p_i \in \left[0, \frac{\theta_i}{F}\right)\right\};\ 0 \text{ if } \left\{0, p_i \in \left[\frac{\theta_i}{F}, 1\right]\right\} \end{array} \right) \\ \left(\begin{array}{c} 0 \text{ if } H_{pu}^{0,0};\ 0 \text{ if } H_{pu}^{1,0};\ 1 \text{ if } H_{pu}^{0,1}; \\ 0 \text{ if } H_{pu}^{1,1};\ 0 \text{ if } H_{pr}^{0};\ 0 \text{ if } H_{pr}^{1} \end{array} \right) \end{array} \right\},$$

[10] As agents and the regulator know types ex ante, their strategies do not depend on the observation of types. Actually, s^A comprises two distinct strategies, one for low and one for high types. As these two strategies have the same structure, we put them into one expression using the subscript $i \in \{L, H\}$ if necessary. If in equilibrium the regulator imposes a uniform standard after private announcement we use $\{\widehat{a}_i, p_i\}$ to indicate that this policy applies to both types.

[11] The subscript $k \in \{a, b, c, d, e, f\}$ in $s_{(k)}$ distinguishes equilibria due to the different parameter constellations possible and citizen play at H_{pr}^1 and refer to the categorization in the three tables below which summarize the outcomes for the regulator.

$$s_{(c)} = \left\{ \begin{array}{c} \left(\begin{array}{c} (pr)\,, \\ \left(\left\{\widehat{a}^{12}, 0\right\} \text{ if } pu;\ \left\{\widehat{a}_L, p_L\right\} = \left\{0, \frac{\theta_L}{F}\right\} \text{ and } \left\{\widehat{a}_H, p_H\right\} = \{1, 0\} \text{ if } pr\right) \end{array} \right) \\ \left(\begin{array}{c} 1 \text{ if } pu,\ \{1, p\};\ 0 \text{ if } pu,\ \{0, p\};\ 1 \text{ if } pr,\ \{1, p_i\}; \\ 1 \text{ if } pr,\ \left\{0, p_i \in \left[0, \frac{\theta_i}{F}\right)\right\};\ 0 \text{ if } \left\{0, p_i \in \left[\frac{\theta_i}{F}, 1\right]\right\} \end{array} \right) \\ \left(\begin{array}{c} 0 \text{ if } H_{pu}^{0,0};\ 0 \text{ if } H_{pu}^{1,0};\ 1 \text{ if } H_{pu}^{0,1}; \\ 0 \text{ if } H_{pu}^{1,1};\ 0 \text{ if } H_{pr}^{0};\ 0 \text{ if } H_{pr}^{1} \end{array} \right) \end{array} \right\},$$

$$s_{(d)} = \left\{ \begin{array}{c} \left(\begin{array}{c} (pu)\,, \\ \left(\{0, 0\} \text{ if } pu;\ \left\{\widehat{a}_L, p_L\right\} = \left\{0, \frac{\theta_L}{F}\right\} \text{ and } \left\{\widehat{a}_H, p_H\right\} = \{1, 0\} \text{ if } pr\right) \end{array} \right) \\ \left(\begin{array}{c} 1 \text{ if } pu,\ \{1, p\};\ 0 \text{ if } pu,\ \{0, p\};\ 1 \text{ if } pr,\ \{1, p_i\}; \\ 1 \text{ if } pr,\ \left\{0, p_i \in \left[0, \frac{\theta_i}{F}\right)\right\};\ 0 \text{ if } \left\{0, p_i \in \left[\frac{\theta_i}{F}, 1\right]\right\} \end{array} \right) \\ \left(\begin{array}{c} 0 \text{ if } H_{pu}^{0,0};\ 0 \text{ if } H_{pu}^{1,0};\ 1 \text{ if } H_{pu}^{0,1}; \\ 0 \text{ if } H_{pu}^{1,1};\ 0 \text{ if } H_{pr}^{0};\ 0 \text{ if } H_{pr}^{1} \end{array} \right) \end{array} \right\},$$

$$s_{(e)} = \left\{ \begin{array}{c} \left(\begin{array}{c} (pu)\,, \\ (\{1, 0\} \text{ if } pu;\ \{\widehat{a}_i, p_i\} = \{0, 0\} \text{ if } pr) \end{array} \right) \\ \left(\begin{array}{c} 1 \text{ if } pu,\ \{1, p\};\ 0 \text{ if } pu,\ \{0, p\}; \\ 1 \text{ if } pr,\ \{1, p_i\};\ 0 \text{ if } pr,\ \{0, p_i\} \end{array} \right) \\ \left(\begin{array}{c} 0 \text{ if } H_{pu}^{0,0};\ 0 \text{ if } H_{pu}^{1,0};\ 1 \text{ if } H_{pu}^{0,1}; \\ 0 \text{ if } H_{pu}^{1,1};\ 0 \text{ if } H_{pr}^{0};\ 1 \text{ if } H_{pr}^{1} \end{array} \right) \end{array} \right\} \text{ and}$$

$$s_{(f)} = \left\{ \begin{array}{c} \left(\begin{array}{c} (pu \text{ or } pr)\,, \\ (\{0, 0\} \text{ if } pu;\ \{\widehat{a}_i, p_i\} = \{0, 0\} \text{ if } pr) \end{array} \right) \\ \left(\begin{array}{c} 1 \text{ if } pu,\ \{1, p\};\ 0 \text{ if } pu,\ \{0, p\}; \\ 1 \text{ if } pr,\ \{1, p_i\};\ 0 \text{ if } pr,\ \{0, p_i\} \end{array} \right) \\ \left(\begin{array}{c} 0 \text{ if } H_{pu}^{0,0};\ 0 \text{ if } H_{pu}^{1,0};\ 1 \text{ if } H_{pu}^{0,1}; \\ 0 \text{ if } H_{pu}^{1,1};\ 0 \text{ if } H_{pr}^{0};\ 1 \text{ if } H_{pr}^{1} \end{array} \right) \end{array} \right\}.$$

The outcomes and resulting expressions for V^c are summarized in the following tables. For comparison to the situation of enforcement without reporting we also state V^{nc}. The first table has $\left(r = 0 \text{ if } H^1_{pr}\right)$ and (3) does not hold, the second $\left(r = 0 \text{ if } H^1_{pr}\right)$ and (3) holds and the third has $\left(r = 1 \text{ if } H^1_{pr}\right)$ which implies that (6) holds.

$\left(r = 0 \text{ if } H^1_{pr}\right)$	$\frac{n_H\theta_H + n_L\theta_L}{n} \geq h$ (8) holds	$\frac{n_H\theta_H + n_L\theta_L}{n} < h$ (8) does not hold
$h - \theta_L \leq \frac{\theta_F}{F} c_{Ins}$ (3) does not hold	$(pu,\ \{1,0\} \text{ if } pu)$ or $(pr,\ \{\widehat{a}_i, p_i\} = \{1,0\} \text{ if } pr)$ $V^c = n_H\theta_H + n_L\theta_L - nh$ $V^{nc} = n_H\theta_H + n_L\theta_L - nh$ (a)	$(pu,\ \{0,0\} \text{ if } pu)$ $V^c = 0$ $V^{nc} = n_H\theta_H + n_L\theta_L - nh$ (b)

$\left(r = 0 \text{ if } H^1_{pr}\right)$	$n_H(\theta_H - h) \geq n_L \frac{\theta_L}{F} c_{Ins}$ (7) does not hold	$n_H(\theta_H - h) \leq n_L \frac{\theta_L}{F} c_{Ins}$ (7) holds
$h - \theta_L > \frac{\theta_F}{F} c_{Ins}$ (3) holds	$\left(\begin{array}{c} pr,\ \{\widehat{a}_L, p_L\} = \left\{0, \frac{\theta_L}{F}\right\}, \\ \{\widehat{a}_H, p_H\} = \{1,0\} \text{ if } pr \end{array}\right)$ $V^c = n_H(\theta_H - h) - n_L \frac{\theta_L}{F} c_{Ins}$ $V^{nc} = n_H(\theta_H - h) - n_L \frac{\theta_L}{F} c_{Ins}$ (c)	$(pu,\ \{0,0\} \text{ if } pu)$ $V^c = 0$ $V^{nc} = n_H(\theta_H - h) - n_L \frac{\theta_L}{F} c_{Ins}$ (d)

$\left(r=1 \text{ if } H_{pr}^{1}\right)$	$\frac{n_H\theta_H+n_L\theta_L}{n} \geq h$ (8) holds	$\frac{n_H\theta_H+n_L\theta_L}{n} < h$ (8) does not hold
(3) holds	$(pu,\ \{1,0\} \text{ if } pu)$	$(pu,\ \{0,0\} \text{ if } pu)$ or $(pr,\ \{\widehat{a}_i,p_i\}=\{0,0\} \text{ if } pr)$
	$V^c = n_H\theta_H + n_L\theta_L - nh$	$V^c = 0$
	$V^{nc} = n_H(\theta_H - h) - n_L\frac{\theta_L}{F}c_{Ins}$ or $V^{nc} = n_H\theta_H + n_L\theta_L - nh$	$V^{nc} = n_H(\theta_H - h) - n_L\frac{\theta_L}{F}c_{Ins}$ or $V^{nc} = n_H\theta_H + n_L\theta_L - nh$
(3) does not hold	(e)	(f)

If the legal system allows for citizen complaints and the regulator can publicly announce only uniform regulations then just in one situation it is optimal to choose private announcement together with tailored standards. If the public is not concerned about offences ($(r=0)$ if H_{pr}^{1}), (3) holds and (7) does not hold (situation (c)) the regulator gets $V^c(pr) = n_H(\theta_H - h) - n_L\frac{\theta_L}{F}c_{Ins}$ which exceeds $V^c(pu,\{0,0\}) = 0$ because total benefits from high types are greater than enforcement costs for low types and exceeds $V^c(pu,\{1,0\})$ as net damages from low types exceed enforcement costs $(h-\theta_L > (\theta_L/F)\,c_{Ins})$ and thus

$$V^c(pu,\{1,0\}) = n_H(\theta_H - h) - n_L(h-\theta_L) < n_H(\theta_H - h) - n_L\frac{\theta_L}{F}c_{Ins} = V^c(pr). \tag{9}$$

In situation (c) the efficiency gains from a publicly announced uniform standard in terms of saving enforcement costs are smaller than efficiency losses in terms of forfeiting benefits from high types ($\widehat{a}=0$) or incurring net damages from low types ($\widehat{a}=1$). Contrary, as in situation (d) the savings in enforcement costs exceed total benefits from high types so that $V^c(pu,\{0,0\}) > V^c(pr)$ (and as (9) shows $V^c(pr) > V^c(pu,\{1,0\})$) it is optimal to impose a publicly announced uniform ban.

In situation (a) the regulator is indifferent between public and private announcement as in both cases allowing the act for both types is optimal. In situation (b) the efficiency gains from a publicly announced uniform ban in terms of avoiding net damages from low types exceed effiency losses in terms of forgone benefits from high types.

In situations (a)-(d) the regulator balances efficiency gains from public announcement against efficiency losses. In situations (e) and (f) the reason for public announcement is different. As citizens' strategies comprise $\left(r = 1 \text{ if } H_{pr}^{1}\right)$ and thus $\theta_i - h < c_{Inv}$ the regulator designs policies in order to avoid citizen reports and the resulting investigation costs. In case of private announcement the only possibility to avoid these costs is to ban the act for both types. Therefore, in both situations the decision depends on whether average benefits exceed harm. If that is not the case (situation (f)) the regulator is indifferent between a privately and a publicly announced ban as on average the act is not beneficial. If instead on average the act is beneficial (situation (e)) it is optimal to avoid investigation costs by publicly allowing the act to induce both types to commit it.

The effects of integrating the public into the monitoring and enforcement process of offences by allowing for citizen complaints and public announcement of uniform regulations are summarized in

Proposition 2 *If legal procedures are extended by the possibility of citizen complaints and communication of uniform standards to the public then V*

(i) remains unchanged (increases) if (3) does not hold and (8) holds ((8) does not hold) independent of the public's reporting behavior, i.e. situation (a) and the second case in situation (e) (situation (b) and the second case in situation (f)),

(ii) remains unchanged (increases) if (3) holds, (7) does not hold ((7) holds),

and the public is not concerned about offences, i.e. situation (c) (situation (d)),

(iii) decreases if (3) and (8) hold and the citizens are overeager, i.e. the first case in situation (e) and

(iv) increases (decreases) if (3) holds, (8) does not hold, (7) holds ((7) does not hold) and the citizens are overeager, i.e. the first case in situation (f).

In *(iii)* V is unambiguously decreasing for the same relationship as stated in (9).

Proposition 3 shows that in case of a public that is not concerned about offences introducing citizen reporting does not yield a decrease in the regulator's pay-off. The reason is that the regulator can archieve at least the same outcome as in the case of enforcement without reporting. He can do so by choosing private announcement and setting the same regulatory policies as in the latter situation. The regulator can improve if his pay-off would be negative under enforcement without the public. That is by choosing public announcement and banning the act for both types it is socially beneficial to incur the efficiency losses, for high types the act is also banned, due to uniform standards. These losses are offset by either avoiding net damages from low types at no costs or saving enforcement costs for low types. These gains occur as the publicly communicated uniform standard exploits the citizens monitoring power.Although citizens would not report an act in case of private announcement they would do so after public announcement as they then know that they get benefits from reporting for sure

If citizens are overeager the analysis is more subtle. First, note again, that because (6) holds (and therefore also $\theta_L - h < c_{Inv}$) the regulator's decision will be such that in equilibrium there are no reports to avoid investigations.

If now the average benefit exceeds harm allowing for citizen complaints has at best no effect on V. To avoid citizen reports the regulator publicly allows

the act for both types because on average the act is beneficial[13]. Therefore, the policy for high types is the same in both situations. If net damages from low types are suffiently small ((3) does not hold) the regulator would allow the act for both types as well if citizen complaints were not possible. Thus, introducing the possibility of complaints does not affect V. However, if net damages from low types are sufficiently large (3) holds) the regulator would enforce a ban in the case without reporting. Thus, in the situation without reporting the regulator incurs enforcement costs for low types whereas in the situation with reporting he incurs net damages from low types. As the enforcement costs are smaller than the net damages V decreases if complaints are introduced.

Now suppose that the harm exceeds the average benefit. The effect of introducing citizen complaints is ambiguous. To avoid citizen reports the regulator bans the act for both types (privately or publicly), so that the regulatory policy for high types differs in the two situations. If the net damages from low types are sufficiently small ((3) does not hold) the regulator would allow the act for both types in case of enforcement without reporting. Switching to enforcement with reporting and imposing a uniform ban is then unambiguously beneficial because on average the act is not beneficial. However, if net damages from low types are sufficiently large ((3) holds) under enforcement without reporting the regulator would enforce a ban for low types. As under enforcement with reporting V equals zero, the effect on V depends on the relationship between net benefits from high types $n_H(\theta_H - h)$ and enforcement costs for low types $n_L(\theta_L/F)\, c_{Ins}$. If the former exceeds the latter ((7) does not hold) citizen complaints are not beneficial because the efficiency losses in terms of loosing high types' net benefits are greater than the efficiency gains in terms of saving enforcement costs for low types. Finally, if the losses are smaller than the savings

[13] As shown above because (6) holds the regulator would ban the act for both types after private announcement.

((7) holds) citizen complaints are beneficial[14].

4 Summary

In this paper we demonstrated that there is a link between the policy a regulatory agency adopts and the supply of citizen complaints. The supply of complaints, i.e. the reporting of observations by members of the general public, depends on the expected benefits from reporting. In many situations an observer of an act knows that he witnesses an offence or even a crime. One person shooting at another is most likely to be an illegal act. However, one can easily think of different situations. For instance, in terms of environmental regulations it is often observed that different agents, i.e. different facilities, face different regulatory standards. This widely used practice leads to uncertainty for members of the general public. Even if citizens could accurately, i.e. without error, identify an act (for example waste disposal, measuring certain types of pollutants) they face uncertain benefits from reporting. Benefits are only received if the cited facility is found to be in violation and the regulator conducts further enforcement actions. Even observing someone shooting at another one is not that clear as it might appear in the first place. The person firing the gun might act in a situation of self-defense or he might even be some kind of intelligence agent with a licence to kill.

The paper investigated regulations of harmful activities. The regulator has to choose whether to inform citizens about regulations. In that case he is bound to treat all agents in the same way. If he decides not to disclose information standards can be tailored to individual characteristics. The regulator benefits from exploiting the public's monitoring power if he publicly announces his pol-

[14] Of course, if $n_H(\theta_H - h) = n_L(\theta_L/F)c_{Ins}$ there is no difference between the two situations.

icy as this eliminates uncertainty for citizens. However, the resulting savings in enforcement costs have to be balanced against the efficiency losses due to uniform regulations. Besides cost structures, private benefits and the distribution of this benefits, the optimal policy and type of announcement depends on the citizen's equilibrium strategy. We suggested a behavioral assumption for the public's reporting behavior to get a prediction for equilibrium play. If the public is not concerned about offences integrating the public into the monitoring process by providing the possibility of citizen complaints cannot be unbeneficial. If, however, citizens are overeager then, depending on the parameters, the best regulatory design can be the traditional regulatory framework that does not allow for citizen complaints.

References

[1] Alford, C. F. (2001), "Whistleblowers," Ithaca, N.Y.: Cornell University Press.

[2] Allen, W. D. (2007), "The Reporting and Underreporting of Rape," *Southern Economic Journal*, 73(3), pp. 623-641.

[3] Becker, G. S., and Stigler, G. J. (1974), "Law Enforcement, Malfeasance, and Compensation of Enforcers," *The Journal of Legal Studies*, 2(2), pp. 1-18.

[4] Falk, A., Fehr, E. and Fischbacher, U. (2005), "Driving Forces behind Informal Sanctions," *Econometrica*, 73(6), pp. 2017-2030.

[5] Fehr, E. and Falk, A. (2002), "Psychological foundations of incentives," *European Economic Review*, 46(4-5), pp. 687-724.

[6] Fehr, E. and Gächter, S. (2000), "Cooperation and Punishment in Public Goods Experiments," *American Economic Review*, 90(4), pp. 980-994.

[7] Fehr, E. and Gächter, E. (2002), "Altrusitic punishments in humans," *Nature*, 415(10 January 2002), pp. 137-140.

[8] Fehr, E. and Schmidt, K. M. (1999), "A Theory of Fairness, Competition, and Cooperation," *The Quarterly Journal of Economis*, 114(3), pp. 817-868.

[9] Garoupa, N. (2001), "Optimal law enforcement when victims are rational players," *Economics of Governance*, 2(3), pp. 231-242.

[10] Güth, W., Schmittberger, R. and Schwarze, Bernd (1982), "An Experimental Analysis of Ultimatum Bargaining," *Journal of Economic Behavior and Organization*, 3(4), pp. 367-388.

[11] Hay, J. R., and Shleifer, A. (1998), "Private Enforcement of Public Laws: A Theory of Legal Reform," *The American Economic Review*, 88(2), Papers and Proceedings of the Hundred and Tenth Annual Meeting of the American Economic Association, pp. 398-403.

[12] Heyes, A. and Kapur, S. (2008), "An Economic Model of Whistle-Blower Policy," *The Journal of Law, Economics, and Organization*, Advance Access published January 3, 2008.

[13] Landes, W. M., and Posner, R. A. (1975), "The Private Enforcement of Law," *The Journal of Legal Studies*, 4(1), pp. 1-46.

[14] Levitt, S. D. (1998), "The Relationship Between Crime Reporting and Police: Implications for the Use of Uniform Crime Reports," *Journal of Quantitative Criminology*, 14(1), pp. 61-81.

[15] MacDonald, Z. (2001), "Revisiting the Dark Figure - A Micoreconometric Analysis of the Under-reporting of Property Crime and Its Implications," *The British Journal of Criminology*, 41(1), pp. 127-149.

[16] Micele, M. and Near, J., "Blowing the Whistle: The Organizational and Legal Implications for Companies and Employees," New York, N.Y.: Lexington Books.

[17] Mookherjee, D. and Png, I. P. L. (1992), "Monitoring vis-à-vis Investigation in Enforcement of Law," *The American Economic Review*, 82(3), pp. 556-565.

[18] Naysnerski, W. and Tietenberg, T. (1992), "Private Enforcement of Federal Environmental Law," *Land Economics*, 68(1), pp. 28-48.

[19] Posner, R. A. (1980), "Retribution and Related Concepts of Punishment," *The Journal of Legal Studies*, 9(1), pp. 71-92.

[20] Shavell, S. (1986), "The Judgement Proof Problem," *International Review of Law and Economics*, 6(1), pp. 45-58.

[21] Shavell, S. (1993), "The Optimal Structure of Law Enforcement," *Journal of Law & Economics*, 36(1), pp. 255-287.

[22] Singer, S. I. (1988), "The Fear of Reprisal and the Failure of Victims to Report a Personal Crime," *Journal of Quantitative Criminology*, 4(3), pp. 289-302.

[23] Soares, R. R. (2004), "Crime Reporting as a Measure of Institutional Development," *Economic Development and Cultural Change*, 52(4), pp. 851-871.

[24] U.S. Department of Justice (2008), "Criminal Victimization in the United States, 2006 Statistical Tables," *National Crime Victimization Survey*, Office of Justice Programs, Bureau of Justice Statistics, NCJ 223436.

[25] Walker, A., Flatley, J., Kershaw, C. and Moon, D. (ed.) (2009), "Crime in England and Wales 2008/09 - Volume 1: Findings from the British Crime Survey and police recorded crime," *Home Office Statistical Bulletin.*

[26] Weersink, A. and Raymond, M. (2007), "Environmental regulations impact on agricultural spills and cititzen complaints," *Ecological Economics*, 60(3), pp. 654-660.

[27] Wittman, D. (1974), "Punishment as Retribution," *Theory and Decision*, 4(3-4), pp. 209-237.