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How to determine fining behaviour in court? Game theoretical and empirical analysis

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How to determine fining behaviour in court?
Game theoretical and empirical analysis[1]

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Abstract

We build a structural model to understand the fine set in court, which is described as the outcome of a two-stage game between defendant, public prosecutor and judge. The equilibrium fine depends on the harm caused, the costs to society and the probability that the guilty party is punished. This fine influences the severity of prosecution and the defence expenditures. Next we empirically analyse the fines pronounced by the Court of Appeal in Ghent (Belgium) for water related criminal offences. We investigate whether the seriousness of the violation and past convictions, as well as some other characteristics, increase the penalty.

I.   INTRODUCTION

Without a proper monitoring and enforcement policy environmental legislation remains an empty chest. An essential decision factor for firms deciding on compliance is the sanction they can expect if they get caught. Our main objective is to understand which factors determine the stringency of fines. We follow a two-step approach. First, in the second section, we construct a game-theoretic model to predict the level of the fines that result from the game between polluters, the prosecutor and the judge. The decisions on how much to spend on defence and prosecution by the firm and the public prosecutor respectively are influenced by the structure of the fine set in court. Secondly, in the third section, we test the theoretical model by examining fines pronounced by the Court of Appeal in Ghent (Belgium) during the period 1990-2000.

Using a regression analysis we are able to empirically check two hypotheses. We find that, in an indirect way, actual fines increase with the seriousness of the violation. However, we were unable to corroborate the hypothesis that fines increase with the public prosecutor's costs. Our analysis, for example, confirms that the violator's compliance history influences the level of the fine. Violators with a criminal record have a significantly higher probability of receiving a higher penalty.

1.1 Review of the theoretical literature

Although the court trial is incorporated in previous models, see, for example, Kilgour et al.[2] (1992) and P'ng[3] (1983), it is not often explicitly analysed. The outcome of the court

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[2] Kilgour et al. (1992) develop and analyse simple game theoretic models of inspection and enforcement processes. They compare systems using administrative instruments to those relying on court determination of guilt.

game is pre-determined and the decision moment in these models falls before the actual verdict. In our model we start the analysis after the decision to go to court has been taken. The defendant and the public prosecutor have decided not to settle.

The decisions made in court are, however, incorporated in Daughety and Reinganum (1995). They model both the settlement and the litigation process, allowing for incomplete information about the damages incurred by the plaintiff on the part of both the defendant and the court. The model is used to examine the effect of making settlement demands admissible as evidence in court (currently inadmissible) should a case proceed to trial. This model is closely related to our model. However, the authors consider damages paid by the defendant to the plaintiff. We deviate in two respects from this formula. We allow for punitive sanctions and we do not assume that any money is paid to the victim. The revenues from fines go directly to the federal government. Finally, Polinsky and Shavell (1998) made an extensive economic analysis of the optimal level of punitive damages in a variety of circumstances. We make use of their insights in order to obtain optimal deterrence by setting fines.

The results we obtain are in line with previous literature. However, the game theoretical setting of the court game with three players and two stages is not previously used. Moreover, we model the game within the civil law tradition while previous literature was based on the common law tradition. These law traditions differ significantly with respect to how judge-made law is justified. Common law judges traditionally justify their findings of law by reference to precedent and social norms. Civil law judges traditionally justify

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[3] P'ng (1983) models strategic behaviour in litigation, how information is exploited and how the litigants' strategies are linked. The model derives conditions under which suit is filed, the action is settled and the action is tried.

their interpretation of a statute directly by reference to its meaning (Cooter and Ulen, 1997).

1.2 Review of the empirical literature

The methodology we use is based on several studies that estimate comparable functions. A first example is the article of Cohen (1987), which considers the US coast guard's enforcement of oil spill prevention for oil-carrying tankers and barges between 1973 and 1977. The most important result is that the coast guard uses a negligence standard as opposed to a strict-liability standard in its penalty assessment. Moreover, intentional discharges of oil are more heavily penalised than other causes.

Secondly, Earnhart (1997) explores enforcement responses to water-damaging accidents in the Czech Republic from 1988 till 1992 in order to analyse whether Czech enforcement responses changed in noticeable ways between the communist and the democratic political system. The author divides the driving factors behind penalty decisions into five categories: causes of accidents, measured damages, environmental factors, regional factors and political influence. The analysis shows significant differences[4] between the different regions and between the different political systems. Also the size and the cause of the violation influence the level of the fine.

Oljaca et al. (1998) empirically estimate a penalty function for water quality violations of private firms in Georgia (US). They focus on penalties levied through consent decrees, which implies that they estimate a penalty function contingent on at least marginally

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[4] For instance, the liability rule guiding remediation shifts from a negligence rule in the communist period to strict liability rule in the democratic period. Also the preferential treatment given to military and foreign entities under communism was diminished during the democratic period. (Earnhart, 1997).

cooperative behaviour. Their analysis shows that the seriousness of infraction and the historical compliance records strongly influence penalty levels, while the intentionality of the violations and the method of discovery do not. The size of the polluting firm is also an important determinant of financial penalties.

Finally, Kleit et al. (1998) study the civil penalties issued to water polluters by the Louisiana (US) Department of Environmental Quality in 1994. They find that penalties are more likely to occur, and are likely to be higher, the more severely a firm violates the regulation. Penalties are also likely to be higher if a firm has a previous record of environmental violations. Political influence, however, did not play an important role.

These previous studies analyse civil or administrative sanctions. In this paper we examine the determinants of criminal fines and study different verdicts proclaimed by the judges of the Court of Appeal in Ghent.

II.   GAME-THEORETICAL ANALYSIS

In this section we derive some testable hypotheses concerning the factors that influence the criminal fine. First we describe the game we are analysing. We distinguish three parties: the judge, the public prosecutor and the defendant. We assume the defendant is a firm and not a person. Next we discuss the decisions made by each of these players. This allows us to formulate the properties of an equilibrium fine in this game.

2.1 Set-up of the game

Initially the firm i causes an extra discharge of some pollutant. These emissions lead to the, exogenously given, environmental harm $h_i \in \left[0, \overline{h} \right]$. The firm receives a certain

benefit b_i from this extra discharge – e.g. it did not have to invest in abatement or it did not have to pay for disposal. For reasons of simplicity we assume that private and social benefits are equal. We work in a strict liability framework. The cause of the discharge therefore does not matter. All violations, intentional as well as accidental, are treated equally independent of the level of effort and prevention of the polluting firm.

The violating firm now faces a lawsuit with a certain probability λ. This probability will depend in reality on the size of the environmental damage or the seriousness of the violation. Moreover, the probability of a lawsuit also depends on the probability of detection of the harm and on the fact whether the firm can be linked to the damage or not. Especially the latter link is often difficult to prove. However, we do not model this and assume that the probability λ is exogenously given.

Remember that, if a firm faces trial, this implies that it has refused to comply at an earlier stage of the enforcement process. It chose to ignore warnings and notices of violation. When offered the choice by the prosecution, the firm also did not settle. In Shavell (1989, 2003) we find several reasons why a case can proceed to trial. Plaintiffs might want to share information with the defendant in order to avoid a trial. However, they can be unable to establish the credibility of this information due to lack of time or lack of experience. Silence can also create a strategic advantage. The revelation of information may reduce its value because the party may be able to counter it. Finally, it is also possible that the plaintiffs might wish the defendant to be exposed to public scrutiny rather that just obtaining monetary compensation.

Another important assumption is that the defendant is not necessarily the real wrongdoer. Measurement errors, uncertainties or stochastic pollution processes can cause an innocent

firm to stand to trial[5]. Further we also assume that all players – firms, public prosecutor and judge – are risk neutral.
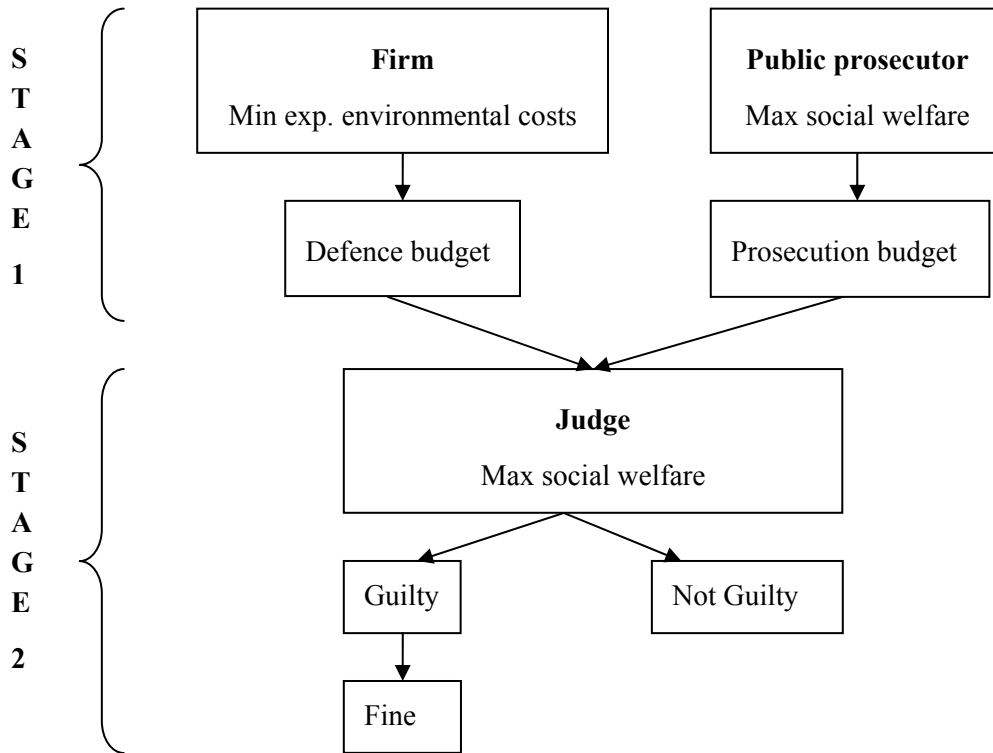

Figure 1: Set-up of the game

Once it is decided that the case goes to trial, the defendant and the public prosecution decide simultaneously on the funds they want to spend on, respectively, defence (B_{di}) and prosecution (B_{pi}). The set-up of the game is illustrated in figure 1. The more the defendant wants to spend on legal representation, experts and/or tests, the lower the estimate of the damage that it can present in court and therefore the lower the fine. The firm takes the decision in order to minimise its expected costs. The more the public prosecutor spends on experts and/or tests, the higher the estimate and the better the proof of the damage caused. We assume that the public prosecutor wants to optimise social welfare or, equivalently,

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[5] For more information on stochastic pollution and measurement errors see Beavis and Walker (1983), Bose (1995) and Brännlund and Löfgren (1996).

optimise deterrence. After all, the public prosecutor cannot change the harm caused but it can try to deter potential future violators. With a certain probability $\hat{\varepsilon}_i$, depending on B_{pi}, B_{di} and h_i, the firm is acquitted. For guilty firms this probability of acquittal represents procedural errors, the capability of the lawyers and the steadfastness of defence and prosecution.

In a second and final stage, see figure 1, the judge decides on guilt of the defendant and on the level of the fine while taking into account the decisions made by the firm and the public prosecutor. The judge first decides on the question of guilt and next chooses the optimal fine in order to optimise deterrence. In Belgium there are no sentencing guidelines for environmental crimes.

We are modelling a civil-law, inquisitorial law system. In its most pure form, according to Posner (1999), this system can be represented by only one searcher for evidence, which is a professional judge. Further, in Dewatripont and Tirole (1999) we read *'in civil-law countries advocates' first duty is to help justice and thus judges'*.[6] These sources lead us to assume the same objective function, i.e. maximisation of social welfare, for both the public prosecutor and the judge. This assumption is further corroborated by the Flemish legal scholar and prosecutor-general to the Court of Cassation Raoul Declercq. In his influential contribution, he states that *'the Public Prosecutor aims for the legality and the regularity of the verdicts and promotes the public interest'* (Declercq, 1999). It is also important to note that public prosecutors in Belgium are appointed for life. This implies that they do not have to worry about keeping their job and being re-elected.

In the following sections we solve the problem by backward induction.

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[6] Dewatripont and Tirole (1999) define advocates as agents that are specifically asked to defend a specific 'cause' and give as examples both defence attorneys and prosecutors.

2.2 Decision on the fine by the judge

As we mentioned before, the judge first resolves whether the defendant is guilty or innocent. We model this as a stochastic process. With probability $\hat{\varepsilon}_i$ the judge finds the defendant not guilty and with probability $1-\hat{\varepsilon}_i$ the firm is considered to be responsible for the environmental damage caused. This probability of acquittal is based on the testimony presented by the defendant and the prosecution and is defined as:

$$
\begin{aligned}
\hat{\varepsilon}_i\left(B_{di}, B_{pi}, h_i\right) &= \overline{\varepsilon} && if\ h_i = 0 \\
&= \varepsilon_i\left(B_{di}, B_{pi}, h_i\right) && if\ h_i > 0
\end{aligned}
$$

with $\varepsilon_i\left(B_{di}, B_{pi}, h_i\right) \in \left[\underline{\varepsilon}, \overline{\varepsilon}\right]$, $\dfrac{d\varepsilon_i}{dB_{di}} > 0$, $\dfrac{d\varepsilon_i}{dB_{pi}} < 0$ and $\dfrac{d\varepsilon_i}{dh_i} < 0$. An innocent firm $\left(h_i = 0\right)$ is exonerated with probability $\overline{\varepsilon}$. This upper limit is not necessarily equal to one since we allow for procedural errors. The probability that a guilty firm $\left(h_i > 0\right)$ is convicted depends on the actual environmental damage and on the resources spent by the defendant and the prosecution.

In order to model the problem of the judge's assessment process, whereby he/she aggregates credible evidence on the harm that was done, we rely on Daughety and Reinganum (2000a, 2000b). These authors show that the court's aggregation of credible evidence, when described as in expression (1), is (1) strictly monotonically increasing in each to the submissions, (2) bounded by the minimum and the maximum of the cases presented, (3) unbiased in the sense that is symmetric in the evidence in both an absolute and proportional sense, and (4) independent of the order in which individual elements of the submissions are compared (Daughety and Reinganum, 2000b). For this reason, we

assume that the judge's estimate of the harm caused by the defendant, if the firm was found liable, equals:

$$\hat{h}_i\left(B_{di}, B_{pi}, h_i; q\right) = \left\{ \frac{\left(h_{di}\left(B_{di}\right)\right)^q + \left(h_{pi}\left(B_{pi}\right)\right)^q}{2} \right\}^{1/q} \tag{1}$$

with h_{di} the estimate of the harm presented by the defendant (see section 2.3.2), h_{pi} the estimate of the harm presented by the prosecution (see section 2.3.1), $h_{di}, h_{pi} \in \left[0, \overline{h}\right]$, $h'_{di} < 0$ and $h'_{pi} > 0$ and also $q \in \left]-\infty, +\infty\right[$, $q \neq 0$; and $\hat{h}_i\left(B_{di}, B_{pi}, h_i; 0\right) = \left(h_{di} h_{pi}\right)^{1/2}$. This q can represent the breadth of the court's interpretation of the applicable law, with a broader interpretation working against the defendant. In particular, $q = 1$ corresponds to the arithmetic mean of h_{di} and h_{pi}, $q = 0$ yields the geometric mean, $q = -1$ yields the harmonic mean, $q \rightarrow -\infty$ yields the minimum of h_{di} and h_{pi}, while $q \rightarrow +\infty$ yields the maximum of h_{di} and h_{pi} (Daughety and Reinganum, 2000a). We assume that q is exogenously given and common knowledge.

The judge wants socially optimal deterrence of potential environmental violations. Socially it is optimal to only allow for discharges if the social benefits b_i exceed the social costs associated with this pollution. So the judge wants firms to internalise their external costs. Firms should only discharge emissions[7] if:

$$b_i > h_i + \lambda.\left(c_s + B_{pi}^* + B_{di}^*\right)$$

with c_s equal to the costs of the trial for society and * denote equilibrium values. Examples of the trial costs c_s are the wage of the judge, infrastructure or administrative costs.

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[7] We assume that the probability that an innocent firm is found liable is symmetric to the probability that a guilty firm is found in compliance. This allows us to equalise the expected values of the parameters to their actual values.

Firms, however, decide to discharge if their benefit exceeds the expected defence costs plus the expected fine:

$$b_i > \lambda.\left(B_{di}^* + (1 - \hat{\varepsilon}_i) F_i\right)$$

Therefore, in order for the firm to make the right decision and assuming an interior solution, we need:

$$\lambda.\left(B_{di}^* + (1 - \hat{\varepsilon}_i) F_i\right) = h_i + \lambda.\left(c_s + B_{pi}^* + B_{di}^*\right) \tag{2}$$

or the socially optimal fine is:

$$F_i = \frac{h_i}{\lambda.(1 - \hat{\varepsilon}_i)} + \frac{c_s + B_{pi}^*}{(1 - \hat{\varepsilon}_i)}$$

The fine F_i^* pronounced by the judge if the defendant was found liable, can only be based on his estimate of the harm $\hat{h}_i$, and is for given efforts B_{pi}^* and B_{di}^*:

$$F_i^* = \frac{\hat{h}_i}{\lambda.(1 - \hat{\varepsilon}_i)} + \frac{c_s + B_{pi}^*}{(1 - \hat{\varepsilon}_i)} \qquad if \ \hat{h}_i > 0 \tag{3}$$

We find that the equilibrium fine for a violator depends on the judge's estimate of the harm caused, weighted by the inverse probability of being punished and on the costs caused to society (court costs and prosecution costs) weighted by the probability of being fined once the defendant stands to trial. This is consistent with the existing literature; see, for example, Polinsky and Shavell (1998) and Cohen (1987).

2.3 Decision of the firm and the public prosecutor

When it is certain that the case will go to court, both the firm and the prosecutor have to decide how much effort they will devote to this lawsuit. We do not consider the parties' strategic decisions before the case actually came to trial. Furthermore, we assume that

there can be false positives. Some firms that are brought to court are innocent. We now discuss each party in turn.

2.3.1 Decision of the public prosecutor

We look at the decision made by the public prosecutor. The amount of resources committed to prosecution is determined simultaneously with the firm's defence decision. The public prosecutor cannot influence the environmental quality since the harm has already been done. However, he can make sure that potential violators, including the current defendant, are deterred from causing future environmental damage. We assume, therefore, that the prosecution wants to optimise deterrence. This is consistent with current practice in Belgium (see section 2.1). Contrary to the judge's behaviour, the public prosecutor does not have to any more decide about the culpability of the defendant. Since the firm is prosecuted, the defendant is assumed to be guilty.

Remember that the more the public prosecutor spends, the higher the judge's estimate of the environmental harm since he will have more and better test results. He will also have more relevant expert witnesses. Generally spoken, the quality of the prosecution will increase. Moreover, the probability of acquittal $\hat{\varepsilon}_i\left(B_{di}, B_{pi}, h_i\right)$ decreases.

In order to optimise deterrence the following condition has to be fulfilled (see expression (2)):

$$\lambda.\left(B_{di}^* + \left(1 - \hat{\varepsilon}_i\right)F_i^*\right) = h_i + \lambda.\left(c_s + B_{pi} + B_{di}^*\right)$$

Backward induction allows us to replace the equilibrium value of the fine and gives:

$$\hat{h}_i = \left\{ \frac{\left(h_{di}\left(B_{di}^*\right)\right)^q + \left(h_{pi}\left(B_{pi}^*\right)\right)^q}{2} \right\}^{1/q} = h_i$$

Optimally, the public prosecutor spends resources on prosecution until the judge's estimate $\hat{h}_i$ of the environmental harm equals the actual damage h_i caused. However, since the actual harm is unknown, the prosecution will use its best available estimate, e.g. the mean $\tilde{h}_i$ of all damage assessments gathered during the preparation of the trial, as an approximation of h_i. For strategic reasons, this best available estimate $\tilde{h}_i$ is not necessarily the one the public prosecutor presents in court, which is $h_{pi}\left(B_{pi}^{*}\right)$. This gives the following reaction function:

$$h_{pi}\left(B_{pi}^{*}\right) = \left\{2\tilde{h}_i^{q} - h_{di}^{q}\left(B_{di}^{*}\right)\right\}^{1/q} \tag{4}$$

The public prosecutor decides to spend money on prosecution until the judge's estimate of the environmental harm caused equals the prosecutor's best estimate ($\hat{h}_i = \tilde{h}_i$).

2.3.2 Firm

We turn to the decision made by the defendant. The firm's defence costs may include hiring a lawyer, consulting experts and gathering test results. The more funds they spend on defence, the lower the estimate of the harm h_{di} they will present to the court and the higher the probability of acquittal.

The accused firm minimises the expected costs associated with the trial:

$$\min_{B_{di}}\left(1 - \hat{\varepsilon}_i\right)F_i + B_{di}$$

$$\min_{B_{di}}\left(1 - \hat{\varepsilon}_i\right)\left(\frac{\hat{h}_i}{\lambda.\left(1 - \hat{\varepsilon}_i\right)} + \frac{c_s + B_{pi}}{\left(1 - \hat{\varepsilon}_i\right)}\right) + B_{di}$$

The first order condition is: $\quad -\dfrac{1}{\lambda}\dfrac{d\hat{h}_i}{dB_{di}^{*}} = 1 \tag{5}$

This first order condition determines the optimal amount B_{di}^{*} to spend on defence when the firm is charged with an environmental violation. We obtain the familiar result that the marginal cost of an extra unit spent on defence should equal the marginal benefit acquired through it. Remark that the optimal decision of the firm is independent of whether or not it is responsible for the environmental damage.

2.3.3 Equilibrium

The Nash equilibrium that determines the optimal amount of resources committed to prosecution B_{pi}^{*} and defence B_{di}^{*} is defined by the following set of equations:

$$\begin{cases} h_{pi}\left(B_{pi}^{*}\right) = \left\{2\tilde{h}_i^{q} - h_{di}^{q}\left(B_{di}^{*}\right)\right\}^{1/q} \\ -\dfrac{1}{\lambda}\dfrac{d\hat{h}_i}{dB_{di}^{*}} = 1 \end{cases}$$

In order to clarify the implications of this equilibrium, we look at an example. Suppose q = 1, which implies $\hat{h}_i = \dfrac{h_{di}\left(B_{di}\right) + h_{pi}\left(B_{pi}\right)}{2}$. We chose a very simple functional form for h_{di} and h_{pi}:

$$h_{pi} = \frac{B_{pi}}{\bar{B}}\bar{h} \qquad \text{and} \qquad h_{di} = \left(1 - \frac{B_{di}}{\bar{B}}\right)\bar{h}$$

These particular functional forms imply that, if you spend enough resources[8] (i.e. $\bar{B}$), you can present in court the environmental damage you prefer $\left(h_{pi} = \bar{h} \; or \; h_{di} = 0\right)$. If you spend no money, then you obtain the worst result possible $\left(h_{pi} = 0 \; or \; h_{di} = \bar{h}\right)$.

We obtain the following result, with probability $1 - \hat{\varepsilon}_i$ or if the firm is not acquitted by the judge,

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[8] We assume that the firm and the prosecutor can always present in court any harm estimate that lies between 0 and $\bar{h}$. That is they always have an amount $\bar{B}$ available for prosecution and defence.

If $\quad 0 \le \tilde{h}_i \le \dfrac{\overline{h}}{2}$

$\quad\quad$ *then* $\quad B_{di}^* = \overline{B}$ *and* $\quad B_{pi}^* = 2\dfrac{\tilde{h}_i}{\overline{h}}\overline{B}$ $\quad\quad\quad$ *if* $\overline{B} \le \tilde{B}_{1i}$ $\quad\quad (case\,1)$

$\quad\quad$ *or* $\quad B_{di}^* = 0$ *and* $\quad B_{pi}^* = 0$ $\quad\quad\quad\quad\quad$ *if* $\overline{B} > \tilde{B}_{1i}$ $\quad\quad (case\,2)$

If $\quad \dfrac{\overline{h}}{2} < \tilde{h}_i \le \overline{h}$

$\quad\quad$ *then* $\quad B_{di}^* = \overline{B}$ *and* $\quad B_{pi}^* = \overline{B}$ $\quad\quad\quad\quad$ *if* $\overline{B} \le \tilde{B}_{2i}$ $\quad\quad (case\,3)$

$\quad\quad$ *or* $\quad B_{di}^* = 0$ *and* $\quad B_{pi}^* = \left(2\dfrac{\tilde{h}_i}{\overline{h}} - 1\right)\overline{B}$ $\quad$ *if* $\overline{B} > \tilde{B}_{2i}$ $\quad\quad (case\,4)$

$\quad\quad\quad$ *with* $\quad \tilde{B}_{1i} = \dfrac{\overline{h}\left(\overline{h} - 2\tilde{h}_i\right)}{2\lambda\left(\overline{h} + 2\tilde{h}_i\right)}$ $\quad\quad$ *and* $\quad \tilde{B}_{2i} = \dfrac{\overline{h}\left(2\tilde{h}_i - \overline{h}\right)}{2\lambda\left(3\overline{h} - 2\tilde{h}_i\right)}$
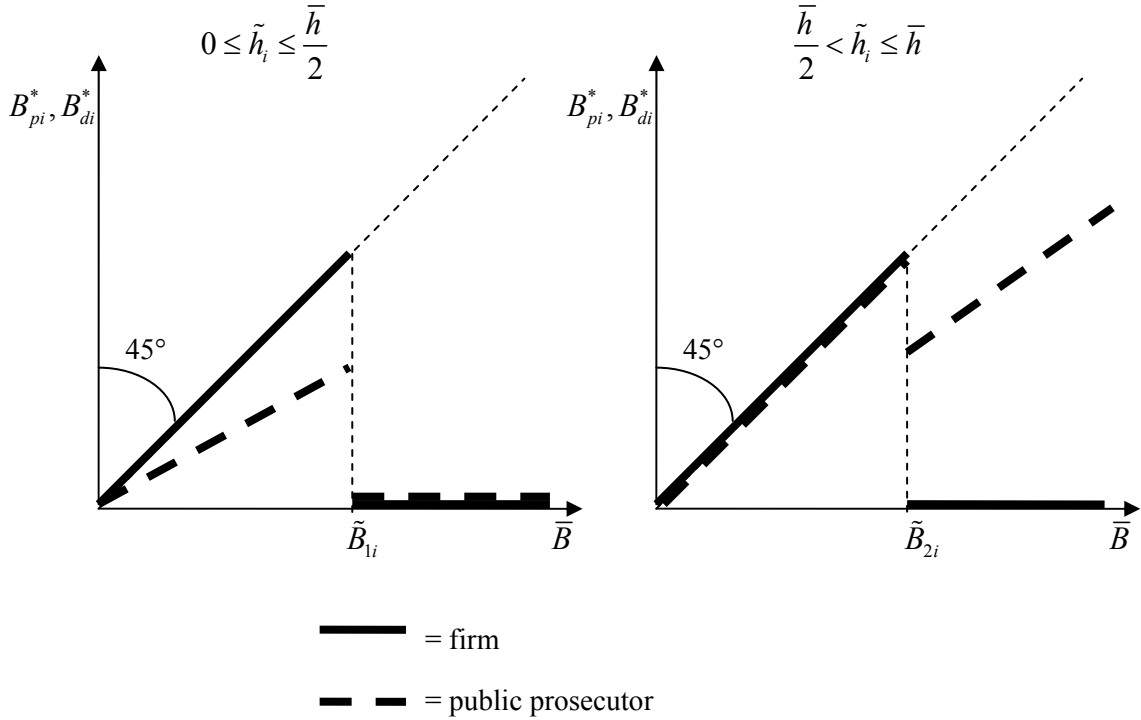
This equilibrium is illustrated graphically in figure 2.

Figure 2: Equilibrium between public prosecutor and firm

Firstly, we find, for small environmental damages $\left(\tilde{h}_i \le \dfrac{\overline{h}}{2}\right)$ and for a small maximum

budget $\left(\overline{B} \le \tilde{B}_{1i}\right)$, that it is worthwhile for the firm to invest $\overline{B}$ in legal defence since it

reduces the judge's estimate of the harm. The public prosecutor decides to spend $2\dfrac{\tilde{h}_i}{\overline{h}}\overline{B}$ on prosecuting the firm since this strategy equalises the judge's estimate of the environmental harm with the prosecutor's estimate. Both the firm and the public prosecutor decide to spend nothing on presenting their case to court if the maximum budget needed is large $\left(\overline{B} > \tilde{B}_{1i}\right)$.

Secondly, for large environmental damages $\left(\tilde{h}_i > \dfrac{\overline{h}}{2}\right)$, the firm chooses to present itself as innocent $\left(h_{di} = 0 \text{ and } B_{di}^* = \overline{B}\right)$ if the maximum necessary budget is small $\left(\overline{B} \leq \tilde{B}_{2i}\right)$. The public prosecutor is limited in his response $\left(h_{pi} \leq \overline{h}\right)$ and spends $\overline{B}$. The judge's estimate is, therefore, smaller than the prosecutor's best available estimate $\left(\hat{h}_i = \dfrac{\overline{h}}{2} < \tilde{h}_i\right)$. This reduction in the resulting fine makes it worthwhile for the firm to invest in legal protection. For large maximum budgets $\left(\overline{B} > \tilde{B}_{2i}\right)$, it does no longer pay for the firm to invest in legal defence and therefore, $B_{pi}^* = 0$. The public prosecutor, however, still finds it optimal to invest in prosecution and $B_{pi}^* = \left(2\dfrac{\tilde{h}_i}{\overline{h}} - 1\right)\overline{B}$.

We now look at the equilibrium fine imposed by the judge and we assume that $\tilde{h}_i = h_i$. We find that budget limitations and limits to acceptable evidence with respect to damage caused, cause the fine to be non-optimal in cases 2 and 3. Moreover, the optimality of the fine pronounced by the judge depends crucially on the best available damage estimate of the public prosecutor. The results are presented in table 1.

	Judge's estimate of harm $\hat{h}_i$	Equilibrium fine F_i^* vs optimal fine F_i
Case 1	$\tilde{h}_i$	$F_i^* = F_i$
Case 2	$\dfrac{\bar{h}}{2}$	$F_i^* \geq F_i$
Case 3	$\dfrac{\bar{h}}{2}$	$F_i^* < F_i$
Case 4	$\tilde{h}_i$	$F_i^* = F_i$

Table 1: Equilibrium fines

2.4 Discussion of the results

This game theoretical analysis gives us the characteristics which we can expect for the equilibrium fine that is an outcome of the court game (see expression (3)). This equilibrium fine level depends on the harm caused by the violation, the costs to society and the probability that the guilty party will be punished.

These results allow us to formulate testable hypotheses about the criminal court outcomes for environmental violations.

Hypothesis 1: The equilibrium fine increases with the seriousness of the harm caused.

Testing this hypothesis also allows to test whether working with a fixed fine is realistic. This is an assumption which is often debated in the literature.

Hypothesis 2: The equilibrium fine increases with the costs of public prosecution.

Hypothesis 3: The equilibrium fine increases with the social costs of a court trial.

Hypothesis 4: The equilibrium fine increases with the probability of acquittal, if the firm is guilty.

Hypothesis 5: The equilibrium fine decreases with the probability of being detected.

We now compare the theoretical results to what happens in reality and test the different hypotheses.

III. EMPIRICAL ANALYSIS

In this part we want to check whether the theoretical model we derive is a realistic one. Due to data limitations we are only able to test the first two hypotheses formulated above. We investigate also the influence of the violator's compliance history on the level of the fine. Analysing the other legal factors, we expect to see a strong influence of the fine level decided in first instance on the fine pronounced by the Court of Appeal. More specifically, this would imply that variables that were significant in first instance, have an additional influence on the level of the fine if they are also significant in the 'appeal' specification.

In our theoretical analysis we did not consider two different instances: the court of first instance and the court of appeal. In Shavell (2004) we find the main rationale behind the existence of appeal courts; i.e. as a threat to judges '*whose decisions would deviate too much from socially desirable ones'*. Other papers discussing the existence of appeal courts and their interaction with lower courts are Daughety and Reinganum (2000a) and Dewatripont and Tirole (1999).

3.1 Determinants of the fine level

In the literature we can distinguish four groups of determinants for the fine: environmental, legal, firm-specific and political factors.

Environmental factors consist of, among others, the size of the damage, the size of the violation and the environment in which the discharge took place. In a legal setting the size of the violation is often measured in terms of the damage caused to the environment or

public health. The size of the violation is difficult to measure. Therefore, one often encounters a legal classification of crimes according to their seriousness and impact.

Among the legal factors that influence the penalty level we find, among others, the compliance history of the violator, the type of legislation that was violated and the offences and penalty - maxima specified in that legislation. Moreover, violators who broke the law on purpose, especially to realise financial benefits, will face higher penalties than those who just had an accidental discharge.

Firm-specific characteristics have received little attention in the theoretical literature. However, in the empirical literature several characteristics, such as the location of the firm, the firm's size or the industry, appeared relevant (e.g. Deily and Gray, 1991).

Political factors include, among others, the program of ruling political parties or the form of government in the country under consideration. Studies that take these factors into account are, for example, Kleit et al. (1998) and Helland (2001). However, in this paper we do not consider this last set of factors since the political process in Belgium is often the result of compromises between the different coalition parties and consequently the resulting political climate did not change much in the last decade[9].

3.2 Background to the case study

Our empirical exercise uses the jurisprudence of the Court of Appeal in Ghent (Belgium) for the period 1990-2000 concerning (a) discharge permits (Law on Surface Waters 1971) and (b) environmental permits (the discharge permit was included in the environmental permit due to the Decree on Environmental Permits 1985). In most cases charges were

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[9] There are of course exceptions, e.g. regulatory policy dealing with illegally built houses.

also filed for other violations[10]. If these additional charges concerned violations of environmental regulations, they were included in the analysis. This is the reason why we also include data on the Labour Safety Law (ARAB 1946; includes a.o. an environmental permit) and on the Manure Decree (Meststoffendecreet 1991). Possible sentences of the previously mentioned regulation can be found in Table 2. The data only include prosecutions of persons[11].

	Imprisonment	Penalty
ARAB 1946 (since 1974) *Labour Safety Law*	8 days – 1 month	1.25 – 1250 EURO[12]
Wet 1971 Oppervlaktewateren *Law on Surface Water*	8 days – 6 months	0.65 – 125 EURO
Milieuvergunningsdecreet 1985 *Environmental Permit Decree*	8 days – 1 year	2.50 – 2500 EURO
Meststoffendecreet 1991 *Manure Decree*	8 days – 2 months or 8 days – 6 months or 8 days – 1 year	2.50 – 1250 EURO or 2.50 – 1875 EURO or 2.50 – 2500 EURO

Table 2: Overview of sentences

3.3 Description of variables and data

The variable we try to explain is the level of the fine pronounced following an environmental violation. We include 38 cases with 53 fines[13] levied. We discuss the fine

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[10] None of the cases included the restitution of illegally acquired benefits. This implies that art. 34 bis of the penal code does not apply.

[11] The Law on Legal responsibility of Legal Bodies 1999 was only relevant towards the end of the research period, as it came into force on 2 July 1999.

[12] We converted all sums from Belgian Franks to Euros and approximate the amounts to improve the ease of exposition. The conversion rate for BEF in Euro is 40.3399 BEF = 1 Euro. These maximal penalties do not include the Belgian legal correction factor ('opdeciemen') since this factor changes over the years.

levied in first instance as well as that in appeal. We immediately take the Belgian legal correction factor[14] ('opdeciemen') into account since the corrected fine is the amount with which the convicted party is confronted and to which it reacts.

As was mentioned previously when we discussed the determinants of the fine level we distinguish three groups[15] of factors that determine the sanctioning of environmental crimes: environmental, legal and firm characteristics. For an overview and the definitions of these variables see appendix A.

The environmental characteristics are represented by the variables DURATION and SERIOUS[16]. Through the variable DURATION we measure the duration of the violation. Some criminal offences (such as the absence of an appropriate permit) could last a long time while others (such as an accidental point discharge) are non-recurrent. The dummy SERIOUS indicates whether the environmental violation 'caused serious damage to the ecology' and/or 'lead to sizeable nuisance for the surrounding community'. These phrases can typically be found in the written verdict, in which the violation and the motivation of the sanction are described.

The legal influences we take into account are estimates of the costs for the public prosecutor in first instance (PPFIRST) and in appeal (PPAPPEAL). The variable TP

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[13] In only one case there was an effective prison sentence set. This case was excluded as an outlier from the analysis. Several other cases included a provisional prison sentence that was conditional on the defendant's future good behaviour. This provisional prison sentence is not a substitute for defaulting on the fine.

[14] The correction factors or 'opdeciemen', which correct for inflation, are for the relevant time period: x80 (Law 22 Dec 1989), x90 (Law 20 July 1991), x100 (Law 26 June 1992), x150 (Law 24 Dec 1993, for violations after 1 Jan 1994) and x199 (Law 24 Dec 1993, for violations after 1 Jan 1995).

[15] Remember that we choose not to consider political factors.

[16] The correlation coefficient between DURATION and SERIOUS is 0.26.

indicates whether there are third parties involved in the case. Moreover we take the type of violated legislation into consideration. We distinguish four types of legislation: Labour Safety Law (LSL), Environmental Permits Decree (EPD), Law on Surface Waters (LSW) and the Manure Decree (MD). The variables count the number of violations of one type of legislation. Further we also measure the influence of the compliance history through the variable RECORD. This 0/1-variable shows whether the accused had a criminal record or not. Finally, we include the variable INTENT that counts the number of aggravating circumstances mentioned against the defendant. They measure the intent of the wrongdoer. When we examine the fines imposed by the Court of Appeal, we also include the fine specified in first instance (FIFINE) in the analysis.

Moreover, we also include the sector in which the defendant works in the analysis. We distinguish several sectors: agriculture, building industry, food industry, sand extraction, scrap yards, furniture industry and some others. We divided the industries into three groups: growing (GROW), stagnating (STEADY) and declining (DECLINE) industries. This division depends on the evolution of the industry's current ratio[17], solvency ratio[18] and the return on total assets[19]. If two or more of these measures[20] increased from 1995 to 1999, the industry is said to be growing. If none of the measures increased, the industry was marked as declining. Further we also observe when the prosecution was initiated. This is summarized in the variable PRE94 that represents whether the trial in first instance started before or after 1994[21]. We use this variable to search for a time trend in our data.

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[17] The current ratio is obtained by dividing the total current assets by the total current liabilities.

[18] The solvency ratio is the total net worth divided by total assets.

[19] The return on total assets divides the income before interest and tax by the sum of fixed and current assets.

[20] These data were obtained from AMADEUS a European financial database.

[21] Choosing 1994 as cut-off year allows us to divide our database in two equivalent samples.

	First instance				Appeal			
	Min	**Max**	**Mean**	**Exp. sign**	**Min**	**Max**	**Mean**	**Exp. sign**
FINES = FINE/1000	0	12.4	3.10		0	44.6	5.08	
FINE	0	12 394.7	3 096.73		0	44 620.8	5 078.96	
DURATION	0.03	159	15.87	+	0.03	136	13.12	+
SERIOUS	0	1	0.61	+	0	1	0.60	+
PPFIRST	0	2 205.2	71.84	+	-	-	-	
PPAPPEAL	-	-	-		0	97.1	48.99	+
LSW	0	3	0.35	+	0	3	0.37	+
EPD	0	5	1.31	+	0	5	1.29	+
LSL	0	1	0.08	?	0	1	0.08	?
MD	0	1	0.06	+	0	1	0.06	+
OTHER	0	3	0.51		0	3	0.48	
TP	0	1	0.24	+	0	1	0.23	+
RECORD	0	1	0.04	+	0	1	0.04	+
INTENT	0	1	0.67	+	0	1	0.67	+
FIFINE	-	-	-		0	99.2	5.09	+
GROW	0	1	0.31	+	0	1	0.35	+
STEADY	0	1	0.26	0	0	1	0.23	0
DECLINE	0	1	0.43	-	0	1	0.42	-
PRE94	0	1	0.28	-	0	1	0.29	-
Number of obs. N	51				52			

Table 3: Descriptive statistics and expected signs

We perform two estimations: one for the verdict in first instance and one for the appeal. The selection of the independent variables is slightly different. The descriptive statistics of the selected variables (minimum, maximum and mean) can be found in Table 3.

3.4 Expected results

We now discuss briefly the expected signs of the different variables. A summary can be found in Table 3.

Hypothesis 1 deduced from our game-theoretical analysis states that serious violators should be punished more harshly than minor violators. We can assume that longer violations (which are usually more serious) will be punished more severely. We, therefore, expect the coefficient connected to DURATION to be positive. We also anticipate a positive coefficient for the variable SERIOUS which indicates if there was serious damage or nuisance caused by the infringement. Andreoni (1991) also finds that optimal fines should rise with the severity of the infraction, that is, the penalty should *'fit the crime'*.

Hypothesis 2 asserts that the optimal fine increases with the costs of public prosecution. Other existing models, e.g. Polinsky and Shavell (1992), also state that the optimal fine should rise with the enforcement costs. Therefore, we expect the variables PPFIRST, PPAPPEAL to show a positive sign.

For each type of violated legislation, we take the maximum allowable sentences (see Table 2) into account. We find that penalties imposed for violating the Law on Surface Waters (LSW) cannot be higher than 125 Euro, times the legal correction factor, while those pronounced for violating the Environmental Permit Decree (EPD) or the Manure Decree (MD) can amount to 2500 Euro, times the legal correction factor. As a result, we expect a positive sign for EPD, MD and LSL.

We also consider the impact of having third parties represented at the trial. We assume that the coefficient of TP is positive. The presence of third parties, after all, implies that the violation was potentially more damaging to human beings.

Next we expect that a violator with a criminal record will be more heavily punished (Polinsky and Rubinfeld, 1991). Following the literature on state-dependent enforcement, which started with Landsberger and Meilijson (1982), the optimal enforcement scheme should depend on the defendant's violation record (for an environmental application, see Harrington, 1988). Therefore, we expect the variable RECORD to have a positive sign. We also assume that the variable INTENT will show a positive sign. Deliberate violators should be punished more stringently than accidental violators.

We assume that the fine in appeal will be higher if the fine (represented by the variable FIFINE) in first instance was higher. FIFINE has therefore a positive expected sign.

Next we consider the industry variables GROW, STEADY and DECLINE. The enforcer is assumed to take the defendant's ability-to-pay into account when deciding on the level of the fine. The focus is on the relative impact on profits rather than on the nominal level of the sanction. Firms from less prosperous industries will, for this reason, face less stringent penalties than wealthier ones. Previous economic research has established that regulations favour struggling industries and slower-growing regions (Deily and Gray, 1991). The regulator is thought to be sensitive to the potential political costs of the trade-off between pollution control and employment. This strand of the literature, therefore, deems it likely that the regulator's enforcement decisions are influenced by this political trade-off. However, we think that these political considerations have only a limited impact on the judge's sanctioning decision compared to the influence of the defendant's ability-to-pay. In conclusion, we expect the sign of GROW to be positive and that of DECLINE to be negative.

For the variable that represents the time trend (PRE94), we expect a negative sign. Environmental awareness has increased considerably during the nineties. The explosive

growth of environmental legislation since mid nineties confirms this. We assume that this development has resulted in a more stringent enforcement of infractions.

3.5 Estimation method

We estimate the penalty function via the Ordinary Least Squares method (OLS). The linear regression model equals:

$$Y = b_0 + b\,X + \varepsilon \qquad\qquad (6)$$

with Y the dependent variable, b_0 the constant, X the vector of independent variables, b the regression coefficients and ε the error term. The variables we include in our two models can be found in Table 3.

We cannot estimate a semilog or loglinear specification since our dependent and most of the independent variables contain zeroes (see descriptive statistics in Table 3).

3.6 Results

As mentioned before we estimate two separate models: the penalty function for the first instance and that for the appeal. Estimating the penalty function for the joint dataset or as a panel set had a very low explanatory power and did not allow us to draw any significant conclusions. We discuss in turn the results for both first instance and appeal.

3.6.1 First instance

The results of the estimation with White or heteroskedasticity-consistent standard errors can be found in Table 4. We obtain an adjusted R²-value of approximately 20 percent. Next we discuss the three groups of determinants we distinguished: environmental, legal and industry factors.

The influence of environmental factors on the level of the fine was measured through the duration of the violation (DURATION) and the presence of serious damage (SERIOUS). Unfortunately both variables were not significant and this does not allow us to comment on our theoretical finding that more serious crime should be punished more severely.

	Specification 1		Specification 2	
	Coefficient	p-value	Coefficient	p-value
(Constant)	* 1.352	0.0583	0.440	0.7603
DURATION			-0.008	0.5286
SERIOUS			0.022	0.9798
PPFIRST			0.0017	0.1486
TP			1.498	0.2881
INTENT			0.022	0.7961
RECORD	*** 7.177	0.0015	*** 7.655	0.0021
LSL			2.438	0.2552
EPD	** 0.924	0.0424	** 1.131	0.0285
MD	* 4.229	0.0719	* 3.248	0.0751
DECLINE			0.686	0.4670
PRE94			-1.220	0.2162
	R² = 0.267 Adj. R² = 0.220 F-stat = 5.70 (***)		R² = 0.367 Adj. R² = 0.188 F-stat = 2.05 (**)	
	N = 51 Dependent variable: FINES = FINE/1000 */**/*** = significant at 10% / 5% / 1% level			

Table 4: Estimation results for first instance

The legal influences included in the analysis take the type of violated legislation into account (LSL, EPD, LSW and MD). Here we can distinguish differences in the sanctioning of the Environmental Permit Decree (EPD – significant at 5% level) and the Manure Decree (MD – significant at 10% level) compared with other legislation. The fine is higher if these particular decrees are violated. Infractions of the Manure Decree often

coincided with infractions of the Law on Surface Waters; e.g. illegal disposal of manure in surface waters. However, in these circumstances, the judge refers to the legislation with the highest maximum sanction[22], which is the MD rather than the LSW (see table 2).

The variable RECORD, measuring the influence of the defendant's compliance history, is significant at the 1 % level and positive. The presence of a criminal record increases the fine with more than 7000 Euro.

Firm-specific factors and the time variable PRE94 were not significant. The increasing environmental awareness does not appear to influence the fines levied in first instance.

3.6.2 Court of Appeal

In Belgium the Court of Appeal reviews the case in its entirety and allows new evidence to be brought forward (Declercq, 1999). If the judge in appeal finds the defendant liable, then the fine of first instance is taken as a reference point in the sanctioning decision. This is why we include FIFINE as an explanatory variable.

The results of the estimation for the Court of Appeal in Ghent, using White or heteroskedasticity-consistent standard errors, can be found in Table 5. The adjusted R^2-value of this estimation is quite high. We could explain more than 73 percent of the variance in the dependent variable. We discuss the three groups of determinants of the sanctioning of environmental crimes: environmental, legal and firm factors.

The estimation results show remarkably different judging behaviour in the Court of Appeal compared to the judging decisions in the courts of first instance[23]. None of the

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[22] Art. 65 al. 1 Penal Code.

[23] The Court of Appeal in Gent is responsible for the appeals from the different courts of first instance: the courts of Oudenaarde, Ghent, Ieper, Brugge, Kortrijk and Dendermonde.

variables that influence the fine set in first instance are significant for the appeal case since these variables have been captured by FIFINE. However, some other variables turn out to be significant and influence the fine set in appeal. These results imply that other aspects of a case are considered in appeal than in first instance.

	Specification 1			Specification 2		
		Coefficient	p-value		Coefficient	p-value
(Constant)		0.8426	0.3849		1.350	0.4821
FIFINE	***	0.444	0.0000	***	0.432	0.0000
DURATION					-0.015	0.5141
SERIOUS					1.542	0.2272
PPAPPEAL					-0.0066	0.7168
TP	**	5.090	0.0150	**	5.509	0.0140
INTENT	**	1.173	0.0343	**	1.216	0.0358
RECORD					3.096	0.1658
LSL					-1.266	0.5169
EPD					-0.315	0.6421
LSW		-0.802	0.1178	*	-1.076	0.0839
MD					-1.047	0.3689
DECLINE					-1.077	0.3730
PRE94	**	-2.383	0.0454	*	-2.385	0.0977
	$R^2 = 0.778$			$R^2 = 0.801$		
	Adj $R^2 = 0.754$			Adj $R^2 = 0.733$		
	F-test = 32.27 (***)			F-test = 11.78 (***)		
	N = 51					
	Dependent variable: FINES = FINE/1000					
	* / ** / *** = significant at 10% / 5% / 1% level					

Table 5: Estimation results for appeal

Again the variables measuring the duration of the violation (DURATION) and the significance of the damage caused (SERIOUS) were not significant.

Among the legal factors we now find that the variable TP, which represents the presence of third parties, is positive and significant at the 5 % level. If third parties are present, the fine after the appeal will be approximately 5000 to 5500 Euros higher. Damage caused to the well-being and property of human beings is taken seriously. Moreover, we take the legislation that was violated into account (LSL, EPD, LSW and MD). In this model the coefficients are insignificant except for the coefficient of the Law on Surface Water (LSW) which is negative and significant at the 10% level for the second model specification. We see here the influence of the low maximal fine which is allowed under the LSW (see table 2).

Next we measure the influence of the defendant's compliance history through the variable RECORD. This variable turns out to be insignificant in appeal. The variable INTENT representing the number of aggravating circumstances is now, in contrast to the first estimation results, significant at the 5 % level. The sign of the coefficient was positive as expected. A very important explanatory variable is without a doubt the fine that was imposed in first instance (FIFINE). The size of this fine is directly and positively related to the one pronounced in appeal.

The variable PRE94, however, is significant and negative. Apparently, the increasing environmental awareness during the nineties has resulted in a more stringent enforcement of infractions at the appeal level.

3.7 Discussion of the results

The optimal fine we derive in section 2 allows us to formulate some testable hypotheses. At first sight, we cannot accept our first hypothesis: actual fines increase with the size of the infringement. However, in the studied environmental jurisdiction the seriousness of the

violation is taken into account, in an indirect way, through the legislation which is taken into consideration by the judge. The Environmental Permit Decree, the only legislative text to be significant at a 5% level, is one of the most relevant legislative texts. This implies that the commonly used modelling assumption of a fine independent of the harm caused by incompliance is not likely to be acceptable.

Our results imply that we can neither accept nor reject our second hypothesis 'fines increase with the costs of the public prosecutor'.

The estimation results reveal some other observations, which are more or less in line with our expectations.

- Firstly, we notice that the judging decisions in the Court of Appeal are based on different characteristics than the judging behaviour in the courts of first instance. The judges of the Court of Appeal take the intentions of the violator into consideration as well as the harm caused to third parties. Higher courts tend to preserve the core principles and values of the laws submitted to them. The backbone of our criminal law is a criminal code from 1867, centred around 19th century ideas of guilt as the reason for punishment and of the necessity to limit the *ius puniendi* to essentials, mainly the integrity of the human life and being and the protection of individual property. It is very interesting to note that this *rationale*, a typical criminal law *rationale*, surfaces in our results. Criminal courts are and remain houses of criminal law, not of environmental law. The instrumental logic behind the use of fines matters. Our results suggest fining practices regarding environmental crime by criminal courts on the one hand and environmental administrations on the other hand might be structurally bound to be different in the factors that determine the fine level.

- Looking at the legal factors, we would first like to mention the large influence of the fine pronounced in first instance on the penalty imposed by the Court of Appeal (variable FIFINE).

Considering the regulation that was violated, the results for the Environmental Permit Decree of 1985 (EPD) and the Manure Decree 1991 (MD) are noteworthy. Breaches of these decrees are sanctioned more severely at the first instance than violations of other regulations.

It was also interesting to see the positive influence of third parties on the level of the fine. This implies that the sanction in appeal is influenced by the harm caused to other people. After analysing the jurisprudence under consideration, the damage consisted mostly of nuisance to neighbours (noise, stench, dust… and also visual hindrance) but also purely material damage was described (e.g. damage to grazing lands making it temporarily unfit for grazing). The fact that the fine is positively influenced by damage caused to the well-being of and property owned by the neighbourhood, is also interesting when looking at the critique made on the anthropocentrism which characterises, mainly older, environmental legislation. This discussion encompasses a fraction which stresses that the environment should be protected as an independent value. This trend challenges the protection of the environment focused on the support of human beings and public health. Our results show that, in practice, the protection of public health and private property still plays a central role in the sanctioning decision.

Considering the variables related to the defendant, we find that the influence of a criminal record (variable RECORD) is really important while the influence of the defendant's state of mind (variable INTENT) is smaller. Obviously the absence or presence of a criminal record provides the judge with a trustworthy signal about the

citizenship of the violator. The less objective variable INTENT scored significant in the appeal case. Fewer monetary consequences are associated with the variable INTENT. This topic could certainly benefit from additional legal research.

- The fact that none of the sector variables DECLINE turns out to be significant prohibits us to comment on the role of the violator's ability-to-pay plays in the sanctioning decision.

- Furthermore, the analysis of the variable PRE94 was as we expected. The positive coefficient in appeal implies that cases that went to court before 1994 were punished less severely.

Even if the maximum fine in appeal is much smaller than the one in first instance, the level of the average fine in appeal is higher than that in first instance (see Table 3, variable FINE). The question of the appropriateness of going in appeal certainly arises.

IV.   CONCLUSION

We have studied the determinants of the level of criminal fines. The criminal fine is an important enforcement instrument for environmental regulations. Using a game theoretical model we find that the equilibrium fine level is expected to depend on the harm caused by the violation, the costs to the government and the probability that the guilty party will be punished. Subsequently, we test these hypotheses with actual court decisions.

In our empirical analysis, lack of data did not allow us to examine the influence of the court costs or the probability that the guilty party will be punished on the level of the fine. However, we are able to empirically check two other hypotheses. We find that, in an

indirect way, actual fines increase with the seriousness of the violation. However, we were unable to corroborate the hypothesis that fines increase with the public prosecutor's costs.

Our analysis also reveals some more characteristics regarding the fining practice. For example, the results show that the violator's compliance history influences the level of the fine. Violators with a criminal record have a significantly higher probability of receiving a higher penalty. The absence or presence of a criminal record is used by the judge as an objective signal of the civil responsibility of the violator.

Finally, we would like to point out that our sample size is relatively small and we lacked the necessary data to correct for the sample selection bias. This is an important caveat when discussing our results.

APPENDIX A – Definition of the variables

Variables	Description
Dependent variable	
FINES	Fine pronounced in first instance or in appeal
Independent variables	
Environmental	
DURATION	Duration of violation (in months)
SERIOUS (0/1)	= 1 if serious damage or nuisance was caused
Legal factors	
PPFIRST	Costs for public prosecutor caused by court case in first instance
PPAPPEAL	Costs for public prosecutor caused by appeal
LSW	Charges within scope of Law on Surface Waters
EPD	Charges within scope of Environmental Permit Decree
LSL	Charges within scope of Labour Safety Law (ARAB) 1946
MD	Charges within scope of Manure Decree
OTHER	Charges within other laws
TP (0/1)	= 1 if third parties are involved in the law suit
RECORD (0/1)	= 1 if the defendant has a criminal record
INTENT	State of mind of defendant (number of negative aspects)
FIFINE	Fine pronounced in first instance
Firm factors	
GROW (0/1)	= 1 if the defendant works in a growing industry
STEADY (0/1)	= 1 if the defendant works in a stagnating industry
DECLINE (0/1)	= 1 if the defendant works in a declining industry
Other	
PRE94 (0/1)	= 1 if the case started in first instance before 1994

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