

WORKING PAPER SERIES
n°2007-03

**Economic Empirical Analysis of Sanctions
for Environmental Violations: a Literature Overview**

S. ROUSSEAU (ETE – CES, KULEUVEN)

May 2007



secretariat:

Isabelle Benoit
KULeuven-CES

Naamsestraat 69, B-3000 Leuven (Belgium)

tel: +32 (0) 16 32.66.33

fax: +32 (0) 16 32.69.10

e-mail: Isabelle.Benoit@econ.kuleuven.ac.be

<http://www.kuleuven.be/ete>

Economic Empirical Analysis of Sanctions for Environmental Violations: a Literature Overview

Sandra Rousseau¹

*Center for Economic Studies, K.U. Leuven
Naamsestraat 69, B-3000 Leuven, Belgium
Sandra.Rousseau@econ.kuleuven.be*

2007

I. INTRODUCTION

In order to have an effective and efficient environmental policy, it is necessary to complement the legislative texts with a monitoring and enforcement strategy. Without such a strategy, the regulation's target group will have little or no incentive to comply with the rules and the environmental objectives are not likely to be met. Over recent years an extensive theoretical literature on the monitoring and enforcement aspects of environmental regulations has emerged (see Cohen (2000b) and Polinsky and Shavell (2000) for literature overviews). However, the volume of empirical studies has been lagging behind and still not much is known about the use and the impact of various instruments used by environmental agencies.

This paper provides an overview of several empirical studies with respect to sanctioning decisions for environmental offences. Our main objective is to determine the factors that might influence the level of the sanctioning instruments. Thus we focus on the stringency of the sanctions that are imposed on violators. We do not consider the impact of these sanctions on the compliance behaviour of the firms and individuals. However, Cohen (2000a) provides a review of the empirical research on the effectiveness of monitoring and enforcement of environmental policy in deterring individuals and firms from violating environmental laws. Also we do not investigate the empirical research on monitoring the compliance status of firms. Several studies have looked at the factors that influence the inspection decisions of environmental agencies. Some examples of such studies are Dion et al. (1998), Helland (1998b), Stafford (2002), Anderson and Stafford (2003) and Rousseau (2007).

In section 2 we provide some general background on the motivation of using penalties against environmental violators. Section 3 describes five categories of variables that might influence the sanction that is imposed. Next a summary of empirical findings is presented in section 4. Section 5 concludes.

¹ I would like to acknowledge the financial support of the SBO project 60034 'Environmental law enforcement: a comparison of practice in the criminal and the administrative tracks'. Moreover I would like to thank Carole M. Billiet for her useful suggestions.

II. GENERAL BACKGROUND

Environmental violations are disciplined largely through legal and regulatory penalties. The traditional justification in criminal law for imposing punishment is the observation that a punishment should be imposed that reflects the perceived gravity of the crime and the culpability of the offender. This model is generally accepted as the most significant one for criminal penalties, although other factors such as deterrence, and approaches such as restorative justice, are widely acknowledged and debated. This model is less dominant for regulatory penalties since many of the relevant provisions are directed at enhancing social or economic organisation, and contraventions are, therefore, regarded as having less need for moral condemnation (Australian Law Reform Commission, 2002). As a case in point, the US Environmental Protection Agency (EPA) states that penalties promote environmental compliance and help protect public health by deterring future violations by the same violator and deterring violations by other members of the regulated community.

One important purpose of penalties for environmental offences is thus deterrence. There are two aspects to deterrence: specific and general. Specific deterrence seeks to deter the offender from re-offending by pricing and punishing the breach. General deterrence seeks to signal to others the price of a breach, or conversely, the benefits of compliance. Moreover, once the decision to violate has been taken, the size of the violation depends only on the marginal, not the average, properties of the expected penalty function. It is not the size of the penalties that matters, but rather the ‘speed’ with which they increase with the degree of violation. This is the theory of marginal deterrence (Mookherjee and Png, 1994).

Glicksman and Earnhart (2007) provide additional insights into the comparative effectiveness of government interventions on the environmental performance of regulated firms. This study compares the effects of administrative and civil fines on environmental performance and focuses on the industrial sector of chemical and allied products in the US. If civil fines typically receive more publicity than administrative fines, then one would expect civil fines to act as stronger general deterrents than administrative fines. The multivariate regression analysis identifies both the effect of an additional dollar from an administrative fine and the effect of an additional dollar from a judicial fine on wastewater discharges relative to permit limits. They find that administrative fine-related specific deterrence is more effective than civil fine-related specific deterrence. However, civil fines are significantly more effective than administrative fines in terms of their general deterrence. Further they find that federal fines (civil and administrative fines combined) are effective as general deterrents but ineffective as specific deterrents. In contrast, state fines are ineffective as general deterrents and even counterproductive as specific deterrents.

In 2002 the Australian Law Reform Commission (ALRC) performed an inquiry into the role of civil and administrative fines. The potential scope of this inquiry is enormous since it refers to a vast array of legislation and regulation, including environmental rules. For example, it must consider where civil and administrative penalties are appropriate and the limitations, if any, on their application to particular sorts of offences. In

particular, the ALRC is directed to report on principles for setting the level of penalties, both in relation to the maximum penalties for a particular offence and those to be applied and determined by the relevant decision-making forum in any particular case. The enforcement of penalties is also to be considered. With respect to penalty setting, the Australian Law Reform Commission (2002) reports three major categories of information taken into account in sentencing:

- the general aims of the penalty, to achieve one or more of the following: to exact retribution; deter others from committing similar offences; rehabilitate the offender; denounce the action; and protect the community;
- the particular circumstances of the offence such as: its gravity compared to others in the same category; social danger; harm actually done; the prevalence of the type of offence; and the degree to which the offender was responsible for the offence;
- the characteristics of the offender that may mitigate his or her culpability for the offence or indicate the likelihood or otherwise of re-offending.

III. CATEGORISATION OF PENALTY DETERMINANTS

Based on a literature overview, we distinguish five different categories of factors that can influence the type and level of the sanction for environmental violations: *(i)* characteristics of the defendant, *(ii)* violation characteristics, *(iii)* environmental characteristics, *(iv)* political characteristics and *(v)* legal characteristics. Subsequently we discuss each category in more detail.

3.1 Defendant characteristics

The relevant characteristics of the individual or firm can be captured by the following variables:

- firm size (number of employees)
- financial health (gross rate of return, turnover, profitability, liquidity)
- probability that plant will close during industry contraction (growing versus declining industry)
- percentage of county work force employed at plant
- industry/economic activity (agriculture, heavy industry, government, military)
- industry size
- international company
- plant ownership
- company trades on stock exchange
- yearly emissions
- type of industrial process used (type of technology)
- compliance history (number of violations in previous year, number of sanctions)

- number complaints (in previous year)
- community demographics (unemployment rate in plant's county, median household income, percentage college graduates, percentage home owners, number of people in neighbourhood)
- firm location (inspection region, city)

The fine which is imposed should reflect the means of the individual or company concerned. Ability to pay is a factor correlated with size as well as financial health. In the case of a large company the fine should be substantial enough to have a real economic impact which, together with the bad publicity resulting from prosecution, will create sufficient pressure on management and shareholders to tighten regulatory compliance and change company policy (Sentencing Advisory Panel, 2000). It should be recognised that where pollution on a substantial scale has been occasioned by a large company, it is only the company itself (rather than individual directors) which will have the financial means to meet a fine proportionate to the degree of damage which has occurred. Yeager (1991) found that large firms tended to be treated less harshly than small ones in his study of water pollution regulation, while DiMento (1986) found that large firms tended to require larger sanctions in order to modify their behaviour. For smaller companies, the courts should bear in mind that a very large fine may have a considerable adverse impact. A crippling fine may close down the company altogether, with employees being thrown out of work, and with repercussions on the local economy. Alternatively, a large fine may make it even more difficult for the company to improve its procedures in order to comply with the law. Similar considerations apply to non-profit-making organizations, which do not have shareholders.

Before arriving at the sentence, the court should take account of personal mitigating factors, including the defendant's good environmental record. Firms from industries with bad reputations for environmental compliance can be expected to receive higher penalties (Hawkins, 1984 and Kagan and Scholz, 1984). If the defendant has previous convictions for similar offences, or has failed to respond to previous sentences, this should be treated as a factor that increases the sentence, but not to an extent that would be disproportionate to the facts of the case. As shown by, among others, Polinsky and Rubinfeld (1991) repeat offenders can be fined more heavily.

Environmental justice advocates have suggested that penalties for violating environmental violations are systematically lower in poor and minority areas. The empirical evidence for this claim has, however, been scarce (Ringquist, 1998, Lynch et al., 2004 and Atlas, 2001).

3.2 Violation characteristics

Several attributes of the environmental violation are likely to have a sizeable influence on the penalty that is imposed. These attributes include:

- type of legislation that was violated
- medium (surface water, ground water, air, soil)
- type of violation (permit, emission, administrative)
- type of damage (noxious, widespread, pervasive, long-lasting effects)

- effects on human health / animal health / flora
- high priority violations
- multiple media
- contaminant (oil, chemical, other)
- duration
- seriousness (categories)
- measured damages
- financial gain associated with violation (profit or cost saving)
- compliance cost
- cause (human error, technical error, poor storage, transport, improper maintenance, other, unknown, natural)
- intent (accidents, unforeseeable circumstances)
- discovery of violation (voluntary report, random inspection, complaint)
- mitigating actions (cleanup, damage control)
- enforcement effort of authorities (previous warnings, advices or cautions)
- year / season

Any of the following factors may be taken to enhance the culpability of a defendant, whether an individual or a company, and thereby to aggravate the seriousness (Sentencing Advisory Panel, 2000):

- (a) the offence is shown to have been a deliberate or reckless breach of the law, rather than the result of carelessness;
- (b) the defendant has acted from a financial motive, whether of profit or of cost saving, for example by neglecting to put in place the appropriate preventative measures or by avoiding payment for the relevant license;
- (c) the defendant has failed to respond to advice/caution/warning from the relevant regulatory authority;
- (d) the defendant has ignored relevant concerns voiced by employees or others;
- (e) the defendant is shown to have had knowledge of the specific risks involved, e.g. when he has knowingly dumped “special” waste;
- (f) the defendant’s attitude towards the environment authorities was dismissive or obstructive.

The following factors, which relate to the actual or potential extent of the damage, may also be taken to aggravate the seriousness of the offence (Sentencing Advisory Panel, 2000):

- (a) the pollutant was noxious, widespread or pervasive, or liable to spread widely or have long-lasting effects;
- (b) extensive clean-up, site restoration or animal rehabilitation operations were required;
- (c) other lawful activities were prevented or significantly interfered with.

It is important that the sentence takes full account of any economic gain achieved by the offender by failure to take the appropriate precautions; it should not be cheaper to offend

than to prevent the commission of an offence. Conversely, the expense of any remedial action already taken by the defendant might lead the court to reduce the level of the fine it would otherwise have imposed. Penalties should ensure that the firm gains no financial benefit from its illegal emissions and should closely approximate the pollution abatement costs that the firm has avoided (corrected for the probability of detection).

The level of the fine should reflect how far below the relevant statutory environmental standard the defendant's behaviour actually fell. The assessment of seriousness requires that the court should consider the culpability of the defendant in bringing about, or risking, the relevant environmental harm. Among the factors that may be taken to reduce the seriousness of any of the offences under consideration are the fact that the individual defendant played a relatively minor role in the commission of the offence, or had relatively little personal responsibility for it; the fact that the defendant genuinely and reasonably lacked awareness or understanding of the regulations specific to the activity in which he was engaged; the fact that the offence was an isolated lapse. Intentional violations are expected to bring about higher penalties compared to accidents or unforeseeable circumstances. The cause of the incident (human error, technical error, poor storage or other) gives an indication of corporate and/or employee negligence (Earnhart, 2000).

Before arriving at the sentence, the court should take account of personal mitigating factors, including: the defendant's prompt reporting of the offence and ready co-operation with the enforcement authorities; the fact that the defendant took steps to remedy the problem as soon as possible; and a timely plea of guilty. The relationship between the firm and the regulatory agency (i.e. the firm's cooperative history) also influences the penalty that is imposed. Moreover, the way the violation is discovered matters: voluntary reports can be expected to result in lower penalties than situations where the inspection agency discovers the violations on its own or receives third-party complaints.

3.3 Environmental characteristics

Since the environmental damage depends on the particular geographical and temporal context of the violation, the characteristics of the physical environment also matter:

- surface water quality
- air quality
- soil quality
- weather conditions
- vulnerable habitats (endangered species)

The seriousness of the offence increases if human health, animal health, or flora were adversely affected, especially where a protected species was affected, or where a site designated for nature conservation was affected. The extent of the damage that has actually occurred or has been risked needs to be balanced against the defendant's culpability (Sentencing Advisory Panel, 2000). The level of the fine should be high where the defendant's culpability was high, even if a smaller amount of environmental damage has resulted from the defendant's actions than might reasonably have been

expected. Such a case might arise where damage (or more extensive damage) has been avoided through prompt action by the authorities, or through some fortuitous element, such as helpful weather conditions. Conversely, in a case where much more damage has occurred than could reasonably have been expected, the sentence, while giving weight to the environmental impact, should primarily reflect the culpability of the offender (Sentencing Advisory Panel, 2000).

3.4 Political characteristics

Political factors influencing sanctioning decisions include:

- the composition of regional and federal government
- the political party dominating city council.

Changes in the political environment might change, among other things, the preferences of administrations, budget allocation rules, policy priorities or sentencing guidelines. Consequently these changes might have an impact on the penalty imposed on environmental violators.

3.5 Legal characteristics

The final category of determinants is related to the legal institutions and procedures that are associated with the enforcement of environmental regulations. These determinants are, among others,

- the party bringing the action
- the type of court
- judge characteristics
- the number of plaintiffs
- the number of defendants
- the presence of third parties
- whether the defendant is an individual or a company
- the number of violations charged against defendant
- dummy if court's decision is published
- costs for public prosecutor
- the court costs (number of cases filed in court during the year)

Penalties will typically increase with the costs that are associated with the sanctioning procedure. As, for instance, Polinsky and Shavell (2000) state, the optimal fine should rise with the enforcement costs. Also, the presence of third parties might imply that the violation was potentially more damaging to other persons and thus the sanction might be higher. Moreover, different courts can have different objectives. As Billiet en Rousseau (2003) and Rousseau and Billiet (2005) show, the fines imposed by the court of appeal are differently motivated from the fines imposed by the courts of first instance in Flanders.

IV. EMPIRICAL FINDINGS

First we summarise the descriptive information on the level and type of penalties that can be found in the empirical literature. Next we go over several empirical estimations of penalty functions for environmental offences.

4.1 Data and descriptive information

An important source of data on environmental enforcement is the Environmental and Compliance History Online (ECHO) database provided by US EPA (United States' Environmental Protection Agency). This online database (previously called DOCKET) provides, among other things, data on the enforcement actions of the agency. From 2001 onwards all judicial cases which were filed in court, had a settlement entered or were concluded can be searched. Also the database can be searched for all administrative enforcement cases with a complaint or proposed order issued, a final order issued or with an enforcement action closed. It is also possible to search outcomes of the enforcement cases with respect to the federal penalty assessed or agreed to, the value of the complying actions and the value of Supplemental Environmental Project activities. Prior research that used this database includes Lavelle and Coyle (1992), Ringquist (1998), Atlas (2001) and Helland (2001).

We now discuss some descriptive information on enforcement strategies for environmental violations in Europe, Canada and the US.

4.1.1 Europe

Billiet and Rousseau (2005) and Rousseau (2007) investigate the enforcement actions taken after or during an inspection which found a Flemish textile firm in violation. The environmental agency can issue advices, warnings or notices of violations.² An advice is given to recommend the firm to make sure that the present situation of compliance with regulations continues in the future.³ A warning, on the other hand, is provided to instruct the firm to end the present situation of non-compliance and abide with all appropriate laws, decrees, and permits. A notice of violation (NOV)⁴ formally documents a violation. This document can be used as evidence in a court of law and a copy is sent to the Public Prosecutor. Moreover, the agency can also use administrative sanctions, such as making a motivated proposal to the administration in power to suspend or withdraw the firm's environmental permit. The latter sanctioning instrument does not occur in the sample.

² The use and definitions of these enforcement instruments can be found in art. 30 of the Environmental Permit Decree and art. 64 of Vlarem I.

³ In practise this instrument is also used for minor administrative violations (such as the presence of a fire safety report) and to enforce previously issued warnings. In our sample, 19 of 20 advices follow a violation.

⁴ Internal regulations of AMI state that the civil servants do not always have to issue a notice of violation when violations are discovered. They have the power to evaluate the situation and use their professional competences to decide on the level of precaution and care displayed by the firm. However, a warning will always be sent to the firm if a violation was detected.

After detecting a violation, the inspection agency took some type of enforcement action in 20 to 30 % of the cases. This does not mean that the agency only reacts to 20 or 30 % of total violations. After all, it might take several visits – during which the firm is in violation – to formally prove the violations. It is also plausible that after the notice of violation accompanied by a warning has been issued, the firm’s violation will continue for quite some time. After all, it often takes time to comply. Requesting a new or extended license can take months. Building a new water purification station can even take years. Throughout this period, the agency is likely to pay some follow-up visits. During these visits they find the firm in violation (which they already knew) and take no further action (because they already did).

Table 1 analyzes what happens after an inspection that found a firm in violation and focus, more specifically, on the monetary penalties imposed. As mentioned above, in the majority (72 %) of the cases no enforcement action was taken. The authors concentrate on the notices of violations that are issued, since a copy of those is always sent to the Public Prosecutor in order to start criminal prosecution. These violations can potentially lead to monetary penalties.

Table 1: Enforcement actions (Billiet and Rousseau, 2005 and Rousseau, 2007)

Noncompliant during inspection	Enforcement action taken		Information on follow-up ⁵		Legal consequence		Average monetary penalty
709	NOV	140	Info	69	Court of Appeal	2	7165 Euro
					First instance	15	2869 Euro
					Settlement	16	260 Euro
					Dismissal	36	0
			No info	71			
	Warning	38					0
	Advice	21					0
	No action	510					0

In the sample, only 25 percent of the cases (17 out of 69) are actually brought to trial. In 23 percent of the cases (16 out of 69) a settlement is negotiated and the remaining cases (52%) are dismissed without further consequences. Looking at the average monetary penalty, we see that the average settlement amount is 260 Euro, the average fine at the first instance is 2869 Euro and the average fine at the Court of Appeal is 7165 Euro. The monetary penalty for violating environmental regulations in Flanders is apparently limited. The expected monetary sanction, combining fines and settlements, after a violation is detected equals only 87.7 Euro. There must therefore be other motivations for firms to comply with environmental policies. Typically, the environmental agency starts

⁵ We process here the information received by AMI on the follow-up on NOV's by the Prosecutor's Office.

with more lax instruments only to move up to harsher ones and thus it proceeds through the different stages of an enforcement pyramid (Ayres and Braithwaite, 1995) until it has secured an offender's compliance. This threat of harsher punishment (e.g. firm closure) can be sufficient to make firms comply.

Ogus and Abbot (2001) explore the deterrence dimension of using administrative penalties in the context of UK environmental regulation policy. The authors also consider the revocation and suspension of licenses. It is noted that these administrative penalties of revocation and suspension have potentially large financial consequences for operators and yet they are subject to administrative procedures, without the protection offered to offenders by the criminal process.

There is evidence that the environmental agency in the UK fails to prosecute (Ogus and Abbot, 2001). Although the normal response to Category 1 ('major') incidents is prosecution, only 23% of such incidents, where the offender was identified, led to such action being taken and in 17% of cases, no action was taken at all. With regard to Category 2 ('significant') incidents, prosecution or formal caution are the possible responses. In only 27% of cases where the offender was identified was either action taken and in 30% of cases, no action was taken at all. There was also extensive non-compliance with the recommended response to Category 3 ('minor') incidents, that being a warning letter or in some areas such as waste, a formal caution. Out of the five regions that provided data, warning letters or notices were issued in 4% to 29% of cases, with prosecutions or formal cautions being the response to another 2% to 10% of incidents. The average level of fines imposed by courts was £2786 in 1998 and £4750 in 1999. In 1999 the average fine for prosecuted businesses and individuals was £9000 and £1000 respectively. The amounts imposed are low relative to the profitability of the contravening activity.

Nyborg and Telle (2006) present Norwegian data on enforcement and compliance with environmental regulations. The maximum criminal penalty for violations of environmental regulations is 15 years of imprisonment. In a criminal trial, fines may also be imposed upon persons or corporations, and profits gained through non-compliance may be confiscated. A criminal penalty (i.e. imprisonments or criminal fines) requires an investigation by the police, prosecution and a court conviction. In cases where imprisonment is not considered, the prosecution authority normally suggests a fine in lieu of prosecution. If the alleged criminal accepts the fine, the case is settled without a trial. The agency (NPCA) can initiate prosecution by filing a formal accusation.

Usually, however, the first thing NPCA does when a violation is detected (or suspected) is to mail the firm a warning letter, stating in what ways the firm is believed to be out of compliance, indicating the seriousness of the violations, requesting documentation that the firm is in compliance within a given deadline, and pointing out the firm's legal duty to comply with the instructions. If a firm provides the requested documentation within the deadline, the NPCA will normally take no further action. Violators failing to respond adequately to the warning, however, seem to be met by more formal and direct sanctions. Coercive fines or even withdrawal of emission permits are available to the NPCA (without prosecution). The use of administrative sanctions has not, at least until recently, been considered to rule out criminal sanctions. In practice, NPCA often awaits filing

formal accusations till informal and administrative sanctions are unsuccessfully exhausted. This implies that if a criminal sanction is imposed, the firm will usually already have paid (additional) administrative fines (Nyborg and Telle, 2006).

4.1.2 Canada and US

Further we mention two studies for Canada. Eckert (2004) examines the use of inspections and warnings to enforce environmental regulations for petroleum storage sites in Canada. Between 1983 and 1998, there were 3182 inventory inspections, 1567 violations, 1531 warnings and 36 prosecutions. However, the data used do not include information on monetary sanctions. Foulon et al. (2002) study whether public disclosure programs can create incentives for pollution control in addition to the incentives normally set in place through traditional means of enforcement such as fines and penalties. Their empirical analysis uses data from the pulp and paper industry in Canada (BOD and TSS). Over the period 1987-1996, 24 pulp and paper plants were in operation in British Columbia but only the data from 15 plants were used for the estimation. There were 126 prosecutions against the plants in the sample; however, only 17 of these resulted in a fine being imposed. These fines totalled \$582400. The average fine was \$34250. The distribution of the fines that were imposed is shown in Figure 1. The analysis presents evidence that the public disclosure of environmental performance does create additional and strong incentives for pollution control.

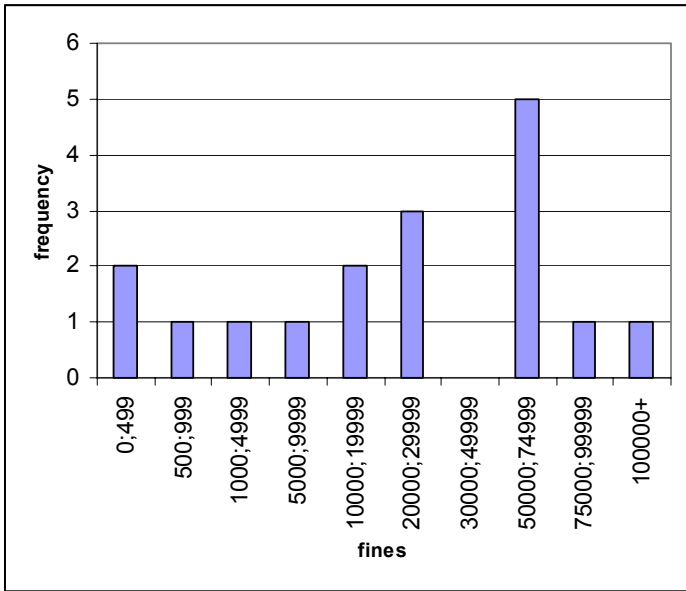


Figure 1: Distribution of fines in US\$ (Foulon et al., 2002)

In the US regional and national EPAs use a mixture of fines, injunctions, civil prosecutions and even criminal prosecutions against recalcitrant violators. Helland (1998a) studies the US pulp and paper industry. Because of the lack of data, fines are not included in the analysis. However, some anecdotal evidence is provided. A RFF survey

found the average state penalty per notice of violation (NOV) to be \$393 between 1978 and 1983 with 15% of the inspections resulting in a NOV. More recent data from Louisiana (1995-1996) found an average fine per NOV of \$619 and an average fine of \$45080. Next to state fines the EPA has several other methods of sanctioning. In EPA region 5, 1995-1996 judicial actions resulted in an average penalty of \$283487. In addition notices of violations are often used in court cases when individuals bring legal action against paper mills for damages. Additionally, mills in repeated violation are pressured into installing new and more costly abatement technology. The Region 5 data for 1995-1996 puts the average cost of correcting violations for which the authorities have obtained injunctive relief at \$1310848. Finally, violations can also be used as evidence in criminal prosecution.

4.2 Estimated penalty functions

In this section the results of several studies that estimate penalty functions are described. The signs of the significant variables are indicated between brackets. We first discuss some European studies before turning to estimates of the US enforcement policy.

4.2.1 Europe

Billiet and Rousseau (2003) and Rousseau and Billiet (2005) examine the fines pronounced by the Court of Appeal in Ghent (Belgium) as well as the fines that were first imposed by the court of first instance for these cases. The empirical exercise uses the jurisprudence of the Court of Appeal 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).

The fines pronounced in first instance (F) or in appeal (A) were explained as a function of:

- Environmental factors: duration of the violation, a dummy if serious damage or nuisance was caused
- Legal factors: costs for the public prosecutor, charges within the scope of the Law on Surface Waters (A -), the Environmental Permit Decree (F +), the Labour Safety Law, the Manure Decree (F +) or others, dummy if third parties were involved in the law suit (A +), dummy if defendant had criminal record (F +), level of intent of offence (A +), fine pronounced in first instance (A +)
- Firm factors: dummy if defendant worked in growing / stagnating / declining industry
- Other: dummy if case started in first instance before 1994 (A -)

The analysis showed 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 account as well as the harm caused to third parties.

Another European study was executed by Earnhart (1997, 2000). Earnhart (2000) examines enforcement rules in two dimensions. The first involves the proper combination of corporate and employee penalties. The second dimension involves the choice of a liability rule (strict versus negligence). These choices typically depend on the ability of firm to penalise its employees internally. The database incorporates data on water-damaging accidents in the Czech Republic. In addition to corporate penalties (among other things, remediation requirements or mandatory cleanup) and employee fines, this database includes extensive details on accidents (e.g. date, location, cause, type of contaminant, economic classification of responsible party and resulting damages).

Authorities in the Czech Republic can impose two types of corporate penalties: monetary fines and remediation requirements. According to the Water Administration Act, the monetary fine depends on the following factors: the quantity and nature of the harmful substance, the level of damages, the sensitivity of and the degree of protection granted to the affected water, remediation efforts and other circumstances. In addition, authorities may impose monetary fines on employees or organisations that help cause an accident, unless the employees' actions represent a criminal offence. None of the three penalty types restricts the use of the other two types. Corporate monetary fines actually imposed average 2222\$ (average wage in 1990 was 135\$). Second, remediation costs required by the Czech water authorities were on average 1822\$. Third, employee fines actually imposed average about 35\$, which is roughly one week's pay and is significantly smaller than the average measurement of damages (i.e. 809\$) (Earnhart, 2000).

The empirical application includes the following factors in order to select a penalty combination (corporate or employee penalties or both):

- Primary cause indicators (human error, technical error, poor storage, transport, other, unknown, natural)
- Secondary cause indicators (human error, technical error, poor storage, transport, other, unknown, natural)
- Economic activity (agriculture, heavy industry, other industry, citizen, military or foreign)
- Political economy (communist, democratic)
- Water (surface, ground)
- Contaminant (oil, chemical, other)
- Remediation cost
- Measured damages
- Surface water quality
- Year

The results indicate that the choice of penalty depends on the links between accident causes and negligence. Moreover the estimation reveals an apparent variation across firms in their ability to penalise their employees internally.

Earnhart (1997) analyses the different enforcement strategies implemented under two political regimes (communism versus democratic). The most interesting result is the strong effect of political influence on penalty decisions, especially under communism. The penalty that is imposed is estimated by the same factors as Earnhart (2000) plus some extra:

- location of the accident (inspection region)
- fish killed by the accident (yes or no)

The driving forces behind penalty decisions divide into five main categories: information on preventive effort, measured damages, environmental factors, regional factors and political influence.

The tobit estimation of monetary fines under the communist regime found significant coefficients for:

- other cause (-)
- transport cause (-)
- measured damages (+)
- remediation costs (-)
- other industry (-)
- military/foreign entities (-)
- oil contaminant (+)
- some regional dummies

The tobit estimation of monetary fines under the democratic regime found significant coefficients for:

- other cause (-)
- secondary human cause (+)
- remediation costs (+)
- military/foreign entities (-)
- surface water quality (+)
- some regional dummies

4.2.2 United States of America

The other empirical studies on the penalty for environmental offences investigate the enforcement practices in the US. We divide these studies according to the environmental regulation they are dealing with.

Oil spills

Epple and Visscher (1984) focus on oil spills by tank ships and tank barges in the US. The law makes the polluter responsible for the cost of cleaning up a spill in all cases and also provides for a civil penalty for intentional spills resulting from negligence. They seek to determine the extent to which the frequency of imposition of sanction and the severity of sanctions vary with the resources devoted to enforcement, characteristics of spills and characteristics of polluters. The data clearly confirm the increase in assessment of penalties and enforcement of cleanup as spill size increases, as the vessel size increases and as coast guard enforcement effort (man hours per transfer) increases.

Cohen (1987) also focuses on the US Coast Guard's oil spill prevention program and describes how the optimal enforcement strategy can be derived from the principal-agent literature. The analysis shows that the optimal penalty should depend on the

environmental damage, on the cleanup costs and on the probability of detection. The Coast Guard's enforcement policy consists of a combination of detection, monitoring and penalties. Failure to report a discharge of oil is a criminal offence that carries a maximum penalty of \$10000 and/or one year jail. The polluter is responsible for removal costs plus a penalty of \$5000 is stated in the law. However, the actual fines imposed have generally been much less.

The estimation of the penalty by Cohen (1987) includes the following variables:

- vessel size (+)
- spill size (+)
- enforcement effort of authorities (+)
- fraction cleaned up (-)
- time (-)
- spill location (inland waterway, beach)
- type of oil (crude oil, gasoline (-), distillate fuel oil, diesel oil, residual fuel oil)
- cause of spill (personnel error (+), improper maintenance (+), equipment failure (+), intentional discharge (+), natural cause)
- seasonal dummy

Most of these variables were statistically significant. As before, their signs are indicated between brackets.

Steel industry

Deily and Gray (1991) and Gray and Deily (1996) estimate the compliance and enforcement decisions for US integrated steel plants. The data include the number of enforcement actions directed toward each plant each year. These actions include inspections, letters, phone calls and enforcement orders. No data on fines were available. Firm characteristics had significant impacts on enforcement, although the signs were not always as expected.

The enforcement equation includes the following variables:

Variable	Predicted sign	Significant?
predicted plant compliance	-	Y (-)
past compliance	-	Y (-)
yearly emissions (in tons)	+	Y (+)
attainment status of plant's county (CAA)	-	Y (-)
compliance cost	-	N
probability that plant will close during industry contraction	-	Y (-)
percentage of county labour force employed at plant	-	Y (-)
unemployment rate in plant's county	-	Y (+)

past enforcement actions	+	Y (+)
past inspections	+	Y (+)
firm's gross rate of return	+	Y (-)
plant ownership	?	Y (+)
Year dummies		
Regional dummies		

Tort litigation

Eaton et al. (2005) examine the effect of the decision to seek punitive damages on several major decision points in the tort litigation process. The impact of trial outcomes on cases that are settled or not resolved by trial is often referred to as the 'shadow effect'. With extensive control variables, the authors find that seeking punitive damages has no statistically significant effect on most phases of the tort litigation process. The decision points include (see Figure 2):

- whether a case filed in any given year was disposed or pending
- whether a disposed case was resolved by trial or by some other procedure (incl. settlement)
- whether a case disposed without trial was more likely to be disposed by settlement
- whether a case disposed without trial was more likely to be disposed by a voluntary dismissal without prejudice so that it could be refilled
- whether a case disposed by trial involved a jury or bench trial
- whether punitive damages were awarded in trials in which the plaintiff prevailed

The control variables are:

- type of disposition (pending, without trial, settlement, with option to relitigate, trial, bench trial or jury trial)
- type of case
- case information (superior court, state court, request for punitive damages, wrongful death, number of plaintiffs, number of defendants)
- plaintiff type (individual, insurance, business, finance, medical, government, other)
- defendant type (individual, insurance, business, finance, medical, government, other)
- county
- year

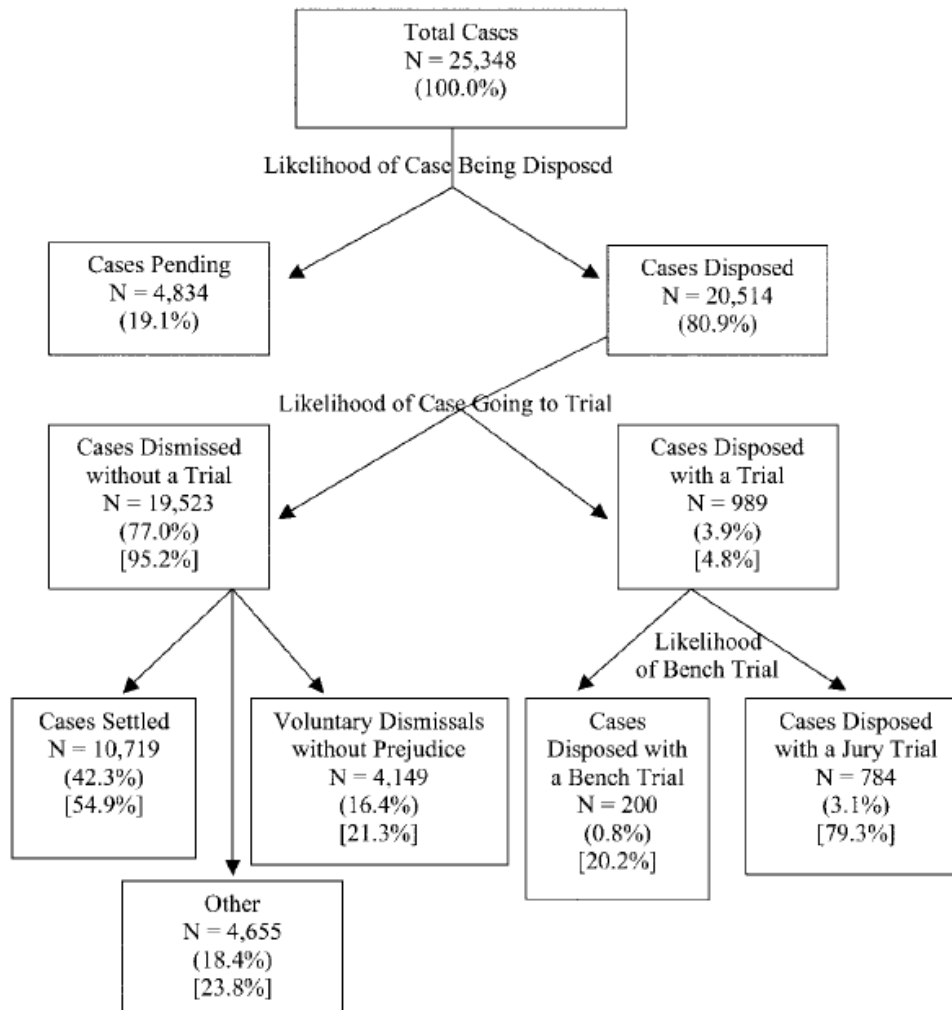


Figure 2: Processing of tort claims (Eaton et al., 2005)

White (2006) uses a data set of all asbestos claims that were filed in court between 1987 and 2003 to investigate how forum shopping and procedural innovations affect asbestos trial outcomes. The analysis estimates the factors that influence:

- whether the defendant was found liable
- the amount of compensatory damages (if positive)
- whether the defendant had to pay punitive damage if found liable
- the amount of punitive damages (if positive)
- the amount of expected total damages

The determinants include:

- plaintiff-specific variables (the plaintiff's alleged disease, whether the plaintiff died before trial, age at trial, whether the plaintiff smoked, the number of defendants)

- trial-specific variables (state or federal court, state in which trial occurred, the county in which trial occurred, the number of claims that were consolidated before trial, whether the trial was bifurcated or was a bouquet trial)

The results indicate that forum shopping and procedural innovations have contributed to the growth of the asbestos mass tort both directly by raising damage awards and indirectly by raising settlement levels and the number of claims filed.

Water pollution

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. Kleit et al. (1998) include the following factors in order to explain the amount of the civil penalty paid by the firms:

- number of previous enforcement actions (+)
- number of excursions committed by respondent (+)
- dummy if (no) permit (+)
- dummy for submission Monitoring Reports (-)
- dummy if permit expired (+)
- dummy if illegally discharged substance (+)
- regional dummies (-)
- political dummies (+)

Oljaca et al. (1998) estimate a penalty function for water quality violations of private firms in Georgia (US). They find that the seriousness of the infraction and historical compliance records strongly influence penalty levels, while the intentionality of violations and the method of discovery do not. Oljaca et al. (1998) focus on penalties levied through consent decrees. Thus the penalties examined cover those cases where a cooperative enough climate exists for both firm and regulator to avoid the expense of more formal sanctions since these cases reached the consent decree stage.

The fine paid was a function of the following explanatory variables:

Explanatory variables	Expected sign	Significant?
Major violations	Positive	Y (+)
Intentional violations	Positive	N (+)
Accidental violations	Negative	N
Minor but frequently repeated violations	Positive	Y (+)
Permit holder	?	N
Previous violations	Positive	Y (+)
Violations discovered by citizens	Positive	N

Emergency response	Negative	N
No emergency response	Positive	Y (+)
From paper industry	Positive	Y (+)
Violators who employ 20-99 workers	Positive	Y (+)
Violators who employ more than 100 workers	Positive	Y (+)

Magat and Viscusi (1990) deal with water pollution caused by the US pulp and paper industry. Based on the discharge reports (by firms and states), as well as on the findings of inspections, the EPA takes enforcement actions against violators. Informal actions include telephone calls, warning letters, and notices of violation, as well as inspections. If these measures do not achieve the intended results, the control agencies can proceed with formal actions such as administrative orders, permit revision, formal listing of companies as ineligible for government contracts, grants and loans; and, finally, civil and criminal judicial responses. During the period 1975-1985, the EPA commenced 64 judicial actions in the pulp and paper industry. Of these, 42 cases resulted in fines that varied from \$1500 to \$750000, with an average of \$89437. Due to lack of data, the determinants of the penalty could not be estimated.

Nadeau (1997) focuses on the length of time that plants in the US pulp and paper industry spend in violation of EPA regulation. The paper explicitly separates the effect of monitoring (i.e. determining the firms' compliance status) and enforcement activities (e.g. administrative orders, legal actions and penalties). The application estimates the enforcement activities using the following variables:

- Type of technology (kraft pulping (-) and pulp bleaching (+))
- Plant size (+)
- Past compliance history (-)
- Potential amount of emissions (+)
- Attainment areas (-)
- State in which plant is located
- Time
- EPA administrator

The signs of the significant variables are indicated between brackets.

Environmental justice

Environmental justice advocates have suggested that penalties for violating environmental violations are systematically lower in poor and minority areas. The empirical analysis performed by Ringquist (1998) shows, however, that such penalties are not smaller in these areas. The severity of the penalties is explained by the following variables:

- Equity concerns (% of all households head by minority group, per capita personal income in ZIP code, percent college graduates, percent home owners)
- Case characteristics (regulatory dummies (-), number of violations charged against defendant (+), dummy for fortune 500 company (+), dummy for government entities, number of previous penalties (+), dummy for published decisions (+), dummy for multi-location penalties(+))
- Judge attributes (dummy for appointees of each president)
- District political environment (value added by manufacturing of those industries most responsible for pollution as a percentage of gross state product in each state (+), League of Conservation Voters score of the senators, average LCV score)
- National political institutions (dummy for republican president (-), dummy for DOJ attorneys (+))

Atlas (2001) starts by criticising the work by Lavelle and Coyle (1992) and Ringquist (1998) and shows that their results might be unreliable. He then re-estimates the penalty function using an improved methodology. The analysis includes the following variables:

- minority proportion (+)
- median household income
- number of people in area
- year case ended (+)
- settled case (+)
- public defendant (-)
- type of violation (legislation (+), administrative order violation (-), failure to obtain permit)

With respect to race characteristics, the analyses consistently revealed a modest relationship with penalties: penalties tended to be higher as the presence of minorities increased.

Lynch et al. (2004) determine whether monetary penalties assessed against petroleum refineries for environmental violations differ depending on the racial, ethnic and income characteristics of communities surrounding the penalised refinery. In the period between 2001 and 2003 the US EPA and state regulatory agencies assessed fines that ranged between \$0 and \$9999999. Nearly 50% of all fines were for amounts less than \$15000.

The control variables used to explain the monetary penalties imposed are:

- community demographics (proportion of African American residents, the proportion of Hispanic residents and median tract household income)
- compliance and enforcement history (significant non-compliance or high priority violations, past actions at the refinery)
- case characteristics (type of law violated (- for CWA), dummy for multimedia violations, number of facilities covered by penalty, dummy for state or federal agency (+), dummy judicial action or less formal order or negotiation)

- company and facility characteristics (total annual company sales (+), the total number of company employees (-), dummy for subsidiary companies, score (1/2/3) for pollution performance prevention)
- political and economic climate (political party affiliation of state governor, value added by petroleum refinery industry as a percentage of the gross state product (-), US region)

The result of the study on the association between race, ethnicity, income and penalty assessed is mixed.

Combinations of environmental regulations

Helland (2001) examines the political determinants of the EPA's litigation strategy between 1977 and 1996. It studies the government's choice of which cases to settle, which to litigate and how much to accept as a settlement. The ultimate resolution of a case is the result of a sequence of conditional choices. The decision to settle a case rather than proceed to trial is conditional on the expected outcome of the trial. In this model trial outcomes are assumed to be exogenous.

The data for Helland (2001) are derived from EPA's enforcement DOCKET database, which tracks civil and administrative enforcement cases under all environmental statutes. In the sample 94.5% of the 10478 cases are settled. Six percent of the cases are litigated. Of these cases EPA wins only 28.5%.

The decision to go to trial rather than to settle is a function of:

- court costs (congestion = log of number of cases filed in federal court during the year (-), number of defendants (-), EPA budget (-)),
- the type of case (dummy for cases that involve an injunction (+), dummy for administrative case (-)),
- the type of defendant (dummy for individual (+)),
- the current administration (+),
- the preferences of the oversight committee (DNOMINATE scores measure the legislator's position on a left-right continuum for House and Senate (-) oversight committee),
- the expected outcome at trial (+)
- risk aversion (probability of an EPA victory multiplied by predicted award squared, variance of expected award (-))

The probability that the EPA wins is determined by:

- the laws that were violated (+)
- the scope of the infraction
- the administration (-) and congressional variables
- region

The settlement amount is a function of:

- the type of case (dummy for cases that involve an injunction (-))

- number of defendants (+)
- the administration (-)
- expected trial outcome (-) and variance of expected award (+)

The award at trial is determined by:

- laws that were violated (-)
- type of violation (asbestos, container violations, discharging pollution without a permit (+), improper disposal of pollution, excessive discharge of effluent, excess emissions, permit violations, failure to pre-treat discharge (+), violation of reporting requirements (+), spills and wetland protection (+))
- number of facilities involved (+)
- administration (+)

Karpoff et al. (2005) claim that environmental violations are disciplined largely through legal and regulatory penalties and not through reputational penalties. Reputational penalties measure the extent to which market-imposed penalties (e.g. consumer boycotts, increases in violators' cost of capital or decreases in firms' market value) impose significant costs on firms that violate environmental legislation. The total penalty consists of explicit legal sanctions imposed through regulatory, civil and criminal proceedings, plus reputational penalties.

SIZES OF THE LEGAL PENALTIES LEVIED FOR ENVIRONMENTAL VIOLATIONS,
BY TYPE OF ENVIRONMENTAL HARM

Penalty	Air	Surface or Drinking Water	CERCLA/ Contaminated Site	Miscellaneous or Multiple Media	Total
Actual fines and damage awards:					
Mean	31.7	4.0	11.0	6.1	13.2
Median	1.2	.8	3.0	1.5	1.5
Observations	26	32	32	17	107
Actual compliance and cleanup costs:					
Mean	123.0	36.7	108.0	102.0	93.6
Median	27.9	5.7	18.8	17.8	13.5
Observations	12	16	33	9	70

NOTE.—Data on the legal penalties imposed for 148 events in our sample for which penalty data are available in the *Wall Street Journal* or Factiva database, 1980–2000. Twenty-nine cases appear in the top and bottom sections because they have both fine and cleanup cost data. Amounts are in millions of constant year 2000 dollars. CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.

Table 2: Penalty (Karpoff et al., 2005)

Using data from 478 environmental violations by publicly traded companies for US, Karpoff et al. (2005) find that economically meaningful and statistically significant losses in the firm's share values correspond with these violations. However, it turns out that these losses are similar in size to these firms' legal penalties. The legal penalties include fines, payments to damaged parties, compliance costs and cleanup expenses. For a subsample of 148 firms, the mean fine or damage award is \$13.2 million, and the mean

forced compliance or remediation cost is \$93.6 million (see Table 2). Table 3 provides summary information about the sample.

ENVIRONMENTAL VIOLATIONS SAMPLE

Event Classification	Number
Type of environmental harm:	
Air	127
Surface or drinking water	121
CERCLA/contaminated site	167
Miscellaneous or multiple media	63
Total	478
Type of action:	
Criminal lawsuit	28
Civil lawsuit	197
Regulatory fine/action	146
Consent order	31
Product recall	38
Liability assignment	38
Total	478
Party bringing the action:	
State or local agency	101
Environmental Protection Agency	221
Justice Department	86
Environmental group	8
Individuals or class-action lawsuits	62
Total	478

NOTE.—Distribution of 478 environmental violation events identified from the *Wall Street Journal* and Factiva database during the period 1980–2000. CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.

Table 3: Sample information (Karpoff et al., 2005)

V. CONCLUSION

In this literature overview we investigate several empirical studies in order to analyse the sanctioning decision of environmental offences. We are able to distinguish five different groups of determining factors: (i) characteristics of the defendant, (ii) violation characteristics, (iii) environmental characteristics, (iv) political characteristics and (v) legal characteristics.

Bibliography

- Anderson, L.R. and Stafford, S.L. (2003). Punishment in a regulatory setting: experimental evidence from the VCM. *Journal of Regulatory Economics* 24(1), 91-110
- Atlas, M. (2001). Rush to judgment: an empirical analysis of environmental equity in US environmental protection agency enforcement actions. *Law & Society Review* 35(3), 633-682
- Australian Law Reform Commission (2002). *Securing compliance: Civil and administrative penalties in federal regulation*. Discussion paper 65
www.austlii.edu.au/au/other/alrc/publications/dp/65/
- Ayres, I. and Braithwaite, J. (1995). *Responsive regulation: Transcending the deregulation debate*. Oxford University Press.
- Billiet, C.M. en Rousseau, S. (2003). De hoogte van strafrechtelijke boetes. Een rechtseconomische analyse van milieurechtspraak (1990-2000) van het Hof van Beroep te Gent. *Tijdschrift voor Milieurecht* 2, 120-134.
- Billiet, C.M. en Rousseau, S. (2005). Zachte rechtshandhaving in het bestuurlijke handhavingsspoor: de inspectiebeslissing en het voortraject van bestuurlijke sancties. Een rechtseconomische analyse. *Tijdschrift voor Milieurecht* 1, 2-33.
- Cohen, M.A. (1987). Optimal enforcement strategy to prevent oil spills: An application of a principal-agent model with moral hazard. *Journal of Law and Economics* 30, 23-51
- Cohen, M.A. (2000a). Empirical Research on the deterrence effect of environmental monitoring and enforcement. *The Environmental Law Reporter* 30, 10245-10252
- Cohen, M.A. (2000b). Monitoring and enforcement of environmental policy. In: Tietenberg, T. and Folmer, H. (eds.), *International yearbook of environmental and resource economics*, volume III. Edward Elgar Publishers.
- Deily, M.E. and Gray, W.B. (1991). Enforcement of pollution regulation in a declining industry. *Journal of Environmental Economics and Management* 21, 260-274
- DiMento, J.F. (1986). *Environmental law and American business: dilemmas of compliance*. New York, Plenum Press
- Dion, C., Lanoie, P. and Laplante, B. (1998). Monitoring of pollution regulation: do local conditions matter? *Journal of Regulatory Economics* 13(1), 5-18
- Earnhart, D. (1997). Enforcement of environmental protection laws under communism and democracy. *Journal of Law and Economics* 40, 377-402
- Earnhart, D. (2000). Environmental crime and punishment in the Czech Republic: Penalties under firms and employees. *Journal of Comparative Economics* 28, 379-399
- Eaton, T.A., Mustard, D.B. and Talarico, S.M. (2005). The effects of seeking punitive damages in the processing of tort claims. *Journal of Legal Studies* 34, 343-369
- Eckert, H. (2004). Inspections, warnings, and compliance: the case of petroleum storage regulation. *Journal of Environmental Economics and Management* 47, 232-259
- Environmental and Compliance History Online (ECHO). www.epa.gov/echo

- Epple, D. and Visscher, M. (1984). Environmental pollution: Modeling occurrence, detection, and detection. *Journal of Law and Economics* 27, 29-60
- Foulon, J., Lanoie, P. and Laplante, B. (2002). Incentives for pollution control: Regulation or information? *Journal of Environmental Economics and Management* 44, 167-187.
- Glicksman, R.L. and Earnhart, D.H. (2007). The comparative effectiveness of government interventions on environmental performance in the chemical industry. *Stanford Environmental Law Journal* 26
- Gray, W.B. and Deily, M.E. (1996). Compliance and enforcement: Air pollution regulation in the US steel industry. *Journal of Environmental Economics and Management* 31, 96-111
- Hawkins, K. (1984). *Environment and enforcement: Regulation and social definition of pollution*. Oxford, Clarendon Press
- Helland, E. (1998a). The revealed preferences of state EPAs: Stringency, enforcement, and substitution. *Journal of Environmental Economics and Management* 35, 242-261
- Helland, E. (1998b). The enforcement of pollution control laws: inspections, violations and self-reporting. *Review of Economics and Statistics* 80,141-153
- Helland, E. (2001). Prosecutorial discretion at the EPA: Some evidence on litigation strategy. *Journal of Regulatory Economics* 19(3), 271-294
- Heyes, A.G. (1998). Making things stick: Enforcement and compliance. *Oxford Review of Economic Policy* 14(4), 50-63
- Kagan, R.A. and Scholz, J.T. (1984). The criminology of the corporation and regulatory enforcement strategies. In: Hawkins and Thomas. *Enforcing regulation*. Boston, Kluwer-Nijhoff Publishing.
- Karpoff, J.M., Lott Jr, J.R. and Wehrly, E.W. (2005). The reputational penalties for environmental violations: empirical evidence. *Journal of Law and Economics* 48, 653-675
- Kleit, A.N., Pierce, M.A. and Hill, R.C. (1998). Environmental protection, agency motivations and rent extraction: the regulation of water pollution in Louisiana. *Journal of Regulatory Economics* 13, 121-137
- Lavelle, M. and Coyle, M. (1992). Unequal protection: the racial divide in environmental law. *National Law Journal* 21, S1-S7
- Lynch, M.J., Stretesky, P.B. and Burns, R.G. (2004). Determinants of environmental law violation fines against petroleum refineries: race, ethnicity, income and aggregation effects. *Society and Natural Resources* 17, 343-357
- Magat, W.A. and Viscusi, W.K. (1990). Effectiveness of the EPA's regulatory enforcement: The case of industrial effluent standards. *Journal of Law and Economics* 33, 331-360
- Mookherjee, D. and Png, I.P.L. (1994). Marginal deterrence in enforcement of law. *Journal of Political Economy* 102(5), 1039-1066

- Nadeau, L.W. (1997). EPA effectiveness at reducing the duration of plant-level noncompliance. *Journal of Environmental Economics and Management* 34, 54-78
- Nyborg, K. and Telle, K. (2006). A dissolving paradox: Firms' compliance to environmental regulation. *Environmental and Resource Economics* 35(1), 1-18
- Ogus, A. and Abbot, C. (2001). Pollution and penalties. *Paper presented at the Symposium on Law and Economics of Environmental Policy, University College London.*
- Oljaca, N., Keeler, A.G. and Dorfman, J. (1998). Penalty functions for environmental violations: evidence from water quality enforcement. *Journal of Regulatory Economics* 14, 255-264
- Polinsky, A.M. and Rubinfeld, D.L. (1991). A model of optimal fines for repeat offenders. *Journal of Public Economics* 46, 291-306
- Polinsky, A.M. and Shavell, S. (2000). The economic theory of public law enforcement. *Journal of Economic Literature* 38, 45-67
- Ringquist, E.J. (1998). A question of justice: equity in environmental litigation, 1974-1991. *Journal of Politics* 60 (4), 1148-1165.
- Rousseau, S. (2007). Timing of environmental inspections: Survival of the compliant. *Journal of Regulatory Economics*. (<http://dx.doi.org/10.1007/s11149-006-9013-9>)
- Rousseau, S. and Billiet, C.M. (2005). How to determine fining behaviour in court? Game theoretical and empirical analysis. *ETE WP* 2005-10.
- Sentencing Advisory Panel (2000). *Sentencing guidelines: Environmental offences*. www.sentencing-guidelines.gov.uk/advice/index.html#enviro
- Stafford, S.L. (2002). The effect of punishment on firm compliance with hazardous waste regulations. *Journal of Environmental Economics and Management* 44, 290-308
- White, M.J. (2006). Asbestos litigation: Procedural innovations and forum shopping. *Journal of Legal Studies* 35, 365-398
- Yeager, P.C. (1991). *The limits of law: the public regulation of private pollution*. New York, Cambridge University Press



The Center for Economic Studies (CES) is the research division of the Department of Economics of the Katholieke Universiteit Leuven. The CES research department employs some 100 people. The division Energy, Transport & Environment (ETE) currently consists of about 15 full time researchers. The general aim of ETE is to apply state of the art economic theory to current policy issues at the Flemish, Belgian and European level. An important asset of ETE is its extensive portfolio of numerical partial and general equilibrium models for the assessment of transport, energy and environmental policies.

ETE WORKING PAPER SERIES 2007

- N°2007-03 Rousseau S. (2007), Economic Empirical Analysis of Sanctions for Environmental Violations: a Literature Overview
- N°2007-02 Delhaye E., Proost S., Rousseau S. (2007), Catching or Fining Speeders: A Political Economy Approach
- N°2007-01 Saveyn B; Van Regemorter D. (2007), Environmental Policy in a Federal State. A Regional CGE Analysis of the NEC Directive in Belgium

ETE WORKING PAPER SERIES 2006

- N°2006-08 Rousseau S., Moons E. (2006), Handleiding voor een Economische Evaluatie van het Milieubeleid: Toepassing op het Vlaamse Bosbeleid
- N°2006-07 De Borger B., Dunkerley F. And Proost S. (2006), The Interaction Between Tolls And Capacity Investment In Serial And Parallel Transport Networks
- N°2006-06 Rousseau S., Moons E. (2006), Auctioning Conservation Contracts: An Application to the Flemish Afforestation Policy
- N°2006-05 Dunkerley F., de Palma A., Proost S. (2006), Trip chaining, who wins who loses?
- N°2006-04 Saveyn B. (2006), Are NIMBY's commuters?