Estimation of fine determinants for administrative sanctions[1]

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Abstract

In this paper, we empirically analyze which are the determinants of an administrative environmental regulator's decision whether to impose a sanction or not, and also which components determine the amount of the fine imposed. The data consist of a set of cases dealt with at the Brussels environmental enforcement institute between the years 2004 and 2006. We use a two step estimation procedure to empirically detect the relationships between the fines imposed and a set of explanatory variables that describe certain characteristics of the offence.

1 Introduction

In general, there are two different tracks which can be used for imposing sanctions on environmental violators: a criminal one and an administrative one. In this paper, our focus is on the administrative track. The degree through which both tracks are used for penalizing environmental offenders varies among different European countries (Koeman, 1999). In Belgium, a mixed enforcement model has been used, but recently there is a tendency to increase sanctioning through administrative procedures. The enforcement decree issued by the Flemish government which gives the Flemish environmental enforcement body more penalization competences is illustrative for this evolution. The reason for 'decriminalization' of sanctions is a search for 'simpler' and 'more cost-effective' penalization procedures. There is some recent evidence that enforcement systems should rely more on administrative fines and less on the criminal law because of cost-effectiveness reasons (Macrory, 2006). In a different contribution, Bowles et al. (2008) claim that criminal law is likely to be the best enforcement system for offences that cause serious damages or for offences causing damages of a diffuse kind. In this view, only the more severe cases of the environmental offences remain under the criminal track and the bulk of small environmental crime cases are dealt with through administrative procedures. Considering these legal evolutions, it is useful to empirically analyze past cases dealt with under both tracks. At the time of writing, there are no data yet available of administrative cases for the Flemish region. Therefore, we analyze penalizations imposed through the administrative track for the region of Brussels, where administrative sanctioning has already been developed since some years. In another paper, we analyze the criminal track for the Flanders region during a similar time frame. The eventual aim of both papers is to execute a quality check of administrative sanctioning procedures in order to see to which extent the same judicial quality principles, such as the proportionality principle or the duty to hear the defendant's case, can be maintained as in the criminal track.

Glicksman & Earnhart (2007a) have conducted an investigation, related to our analysis, in which they assess the comparative effectiveness of different government instruments for enforcing the federal Clean Water Act regulation on facilities in the US chemical industry. More specifically, they investigate the effects of inspections, monetary fines, injunctive relief and supplemental environmental projects on general and specific deterrence. Thereby, they make a double distinction between federal and state sanctions, imposed through the administrative and the criminal track respectively. Their methodology is twofold: they conduct an empirical analysis of the level of wastewater discharges relative to facility-specific effluent limitations and they conduct a survey among facilities in the same industry to analyze self-reported effectiveness of government interventions. The authors found that there is significant variability in the effectiveness of intervention technique, depending on the level of government which is responsible (federal or state) and on the implementation track chosen (criminal or administrative). In a further contribution, Glicksman & Earnhart (2007b) investigate competing theories of regulatory behavior to induce firm compliance. Based on the same survey of facilities regulated under the Clean Water Act, they assess the existence of deterrence-based and cooperative enforcement efforts. They find that both approaches are present in the regulator-regulated entity relationship and that there is not one single dimension which accurately reflects the ways in which both parties interact. In our paper, in contrast, we go beyond the survey methodology and look for the relationships between the fines imposed and a set of explanatory variables representing the characteristics of the offence. For a general overview of the empirical literature on enforcement of environmental regulations, see Rousseau (2007).

We analyze the administrative sanctions that were imposed in the district of Brussels for the period 2004-2006. For a general overview of the database and a first analysis of the data we refer to Billiet et al. (2009). In section 2, we give an overview of decision making processes for penalizing environmental violations in the district of Brussels. In section 3, we proceed to empirical estimation of the main determinants for the decisions whether to impose a fine and on the amount of the fine.

2 Overview of the administrative penalization track

We give a brief overview of the sanctioning procedure that follows after committing an environmental infraction for the region of Brussels capital in Belgium. For an in-dept analysis of this procedure, we refer to Billiet (2008). There are a number of fixed steps involved. The procedure originates with the draw up of a notice of violation documenting the type of offence. This step may be followed by the issue of a warning, or by a sanctioning procedure. The criminal track has a preferential competence in this matter. The BIM, the Brussels Institute for Environmental Policy, has a facultative competence of starting a penalization procedure after a statement of non-prosecution is made in the criminal track or after the criminal prosecutor does not take any procedural action during a period of at least six months. If the BIM seizes the opportunity to start up an administrative sanctioning procedure, punitive sanctions may be imposed as well as measures to limit environmental damages or to reduce certain risks for society.

With respect to the way of punishing the violator, we can group sanctions into three categories. Situational sanctions aim at improvement of a particular situation for which the defendant was found in violation. An example would be a clean-up requirement. A second type of sanction is called 'license withdrawal & suspension' and aims at suspending licenses or at withdrawal of authorizations to take certain actions. The third type of sanction is a fine. It targets directly the financial means of the defendant, be it a natural or a legal person. Safety and problem solving measures take the form of the first or second type of sanction, or a combination of both. In this analysis, we mainly focus on the decision whether to impose a fine and on the amount of that fine. As in the criminal track, the defendant has the possibility to object to the result of the penalization procedure and ask for a second 'trial' case. The case then goes to the 'Environmental College', which acts in a similar way as the Court of Appeal in the criminal track. A schematic outline of the entire procedure is given below. We highlighted the decisions on which we focus in this paper: the decision whether to impose a fine and the decision on the amount of the fine.

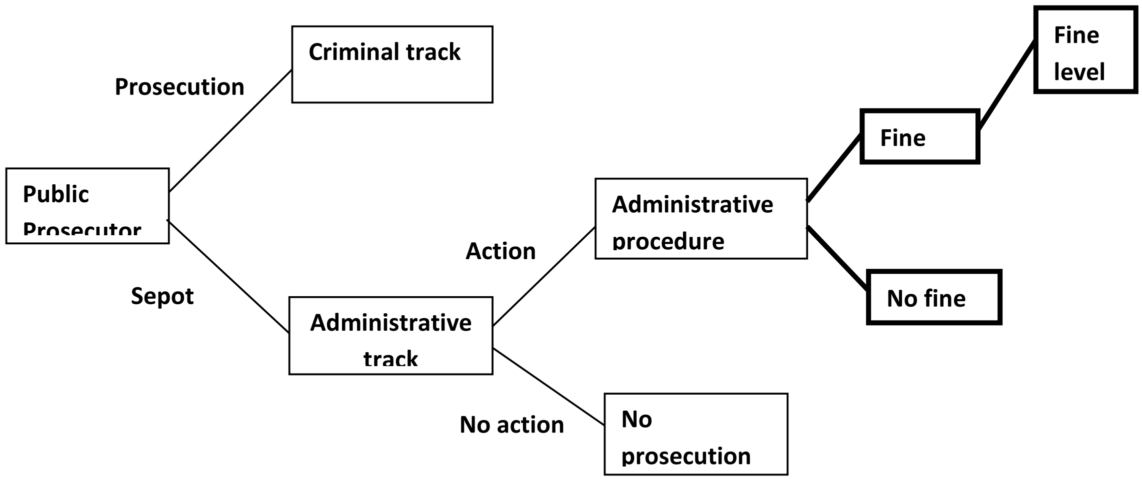

Figure 1 Overview of the administrative track, we focus on the last two decisions of the decision tree.

According to Billiet (2008), the decision maker in the administrative track is required to take into account the interests of all parties involved when imposing punitive sanctions. Therefore, careful attention should be paid to the trade-off between mitigation of environmental costs and minimization of other social costs involved for society. This trade-off is reflected in certain legal principles, such as the ‘proportionality principle’ and the ‘economy principle’. The former principle indicates that fines imposed should be proportional to the seriousness of the infringement that occurred, while the latter principle encourages the agency to impose cost-effective sanctions. Billiet (2008) indicates that the following variables may influence the level of the fine: Aggravating circumstances are e.g. the extent of the nuisance as a consequence of the environmental violation and repeated environmental infractions. Mitigating circumstances are a.o. efforts made to diminish the consequences of infractions for society, as well as a positive compliance history. She also cites other motives that can influence the fine: the culpability of the offender and ability to pay or related social motives sometimes also play a role. In general, she concludes that the administrative sanctioning procedure is rather simple and that decision makers have large discretionary powers. At the same time, she warns that the legal equality principle may be jeopardized by inconsistency between the bounds for the fine in the administrative and in the criminal penalization track.

3 Empirical analysis

In the empirical part of this article, we estimate the fine function. Our goal is to identify determinants of fining decisions in the administrative track. Thanks to extensive data gathering efforts within the 'environmental lawforce'[2] research project, we dispose of data from sanctions that were administered at the Brussels Institute of Environmental Policy (BIM) for the region of Brussels in the period 2004 – 2006. In our dataset, in the administrative track there are 1172 accusations against 653 defendants in total, which originate from 624 sanctioning procedures. The reason for this discrepancy is that there may be multiple defendants grouped into one sanctioning procedure, and that a defendant could be facing different accusations. Since we focus on cases per defendant, we dispose of 653 data points from the sanctioning decision process. We execute the regression with the sanction per defendant as the dependent variable because this is the level at which the sanctions are imposed. As mentioned before, the sanctioning procedures of the administrative track originate from the fact that the public prosecutor decides not to prosecute or not to take any action within a certain period. After starting up an administrative penalization procedure, the BIM decision makers decide on whether to impose a fine and on its amount. We take all cases into account: the ones where a sanction was actually imposed and the ones where no sanction was implemented. We also address cases for both natural and legal bodies. We focus, however, on the sanctions imposed by the BIM and we do not take the 'appeal' cases of the Environmental College into account, in order to avoid sample bias.

We give some descriptive statistics on the type of defendants and the fines that they receive in Table I. A first observation is that most defendants are legal bodies, i.e. firms. This holds for the 'first instance' penalty procedures of the BIM, as well as for 'appeal' procedures at the Environmental College. We also see that on average administrative fines are higher for legal bodies than for natural bodies, and higher for 'appeal' cases than for 'first instance' cases. The latter observation is probably due to sample bias: defendants that receive higher fines are more inclined to file for second hearing of the case. The maximal fines, in contrast, are lower in 'appeal' than at 'first instance'.

[2] More information can be found at http://www.environmental-lawforce.be and in Billiet et al. (2009)

Decision type	Natural body	Legal body
BIM Decision	183 (28,60 %)	457 (71,40 %)
Appeal Decision	3 (11,10 %)	24 (88,90 %)
Total	186 (27,89 %)	481 (72,11 %)
Average fine BIM	672€	4 477€
Maximal fine BIM	2 280€	102 915€
Average fine appeal	1 121€	11 276€
Maximal fine appeal	1 500€	82 293€

Table I Overview of legal and natural bodies in the administrative track with their average and maximal fines (Billiet et al., 2009)

3.1 Methodology and dependent variables

We implement the empirical analysis using a two step approach, which is called the Heckman estimation procedure (Heckman, 1979). We used the statistical software package LIMDEP to do the estimations. In the first step, we estimate a probit model using the maximum likelihood method to assess the impact of our set of explanatory variables on the probability of imposing a fine. Mathematically, the equation we estimate can be denoted as:

$$P\left(FINE=1|\,X\right)=\Phi\left(\hat{\beta}_0+X\hat{\beta}+e\right).$$

The symbol X represents the set of explanatory variables or covariates, the symbol $\hat{\beta}$ is the notation for the set of estimated coefficients (with $\hat{\beta}_0$ as the constant term), Φ indicates that we use a standard normal cumulative distribution function and *e* is an error term which is assumed to be normally distributed. The symbol $P(.)$ is the conditional probability operator which assigns a value of 1 to FINE if the estimated probability is larger than 0.5 and a value of 0 if the probability is lower than 0.5. The dependent variable in this equation is given by FINE, which is a dummy variable that takes a value of 1 if a fine is imposed on the defendant and is equal to 0 if the defendant is acquitted.

In the second step, we have a closer look at the determinants of the level of the fine for the cases where a sanction is imposed. The dependent variable is LNAMOUNT, which is logarithmic transformation of the level of the fine. We estimate an augmented linear model by two stage least squares. We put an additional term into the model, the 'inverse mills ratio', to account for possible sample bias introduced by selection of the dependent variable at value 0.[3] Mathematically, the model we estimate is given by:

$$LNAMOUNT = \hat{\beta}_0 + X\hat{\beta} + \widehat{\sigma_{12}}\lambda + u\,.$$

The symbol X again indicates the set of covariates, $\hat{\beta}$ are the estimated coefficients and u the error term. The symbol λ indicates the inverse mills ratio which has $\widehat{\sigma_{12}}$, the estimated covariance of the error terms of the probit and of the selection model, *e* and *u* respectively, as its coefficient. We need to make the assumption that the error terms in the regression models of the first and second step are jointly normally distributed for this procedure to be valid. The distribution of the level of the fines is strongly skewed to the right, with many relatively small fine amounts being imposed at a high frequency and large amounts implemented at a low frequency. However, by taking the logarithmic transformation we make sure that its distribution is more approximate to a normal distribution. In addition, the central limit theorem applies, because we dispose of around 600 observations.

3.2 Independent variables

In this section, we define the explanatory variables that we include in our regression. Given the large scope of the database at our disposal, we include an extensive range of control variables. We include a set of defendant characteristics, a set of violation characteristics, a set of variables indicating the environmental impact and a set of legal characteristics. According to Rousseau (2007), these are the categories for which control variables should be included in the context of estimation of fine levels.

[3] An alternative which also addresses the truncated property of the dependent variable would be to estimate a one step tobit model. However, then we would restrict the explanatory variables to have the same coefficients in both steps of the estimation. We find this inappropriate for our application; because we consider that the decision whether to impose a sanction and the decision on its magnitude are independent. This can be confirmed in our application by use of a likelihood ratio test.

With respect to the defendant characteristics, we include dummy variables that indicate the defendant's type. The dummy variable LEGBOD is 1 if the defendant is a legal body and 0 if he is a natural body. We also include the defendant's compliance history as an explanatory variable. The variable HISTORY is equal to 1 when the defendant has previously committed environmental offences and in case the defendant had already been convicted for the same offence. Finally, we include a dummy variable to indicate whether the defendant was an AIRPLANE company. We do this because violations of the noise emission standard at Brussels National Airport by airplane companies constitute a share of about 20% of the procedures that are administered at the BIM. These cases have particular characteristics because they always lead to a sanction and the fines that are imposed are high in comparison to the other cases. In Table II, you can see that the average fine without airplane cases is 833€, while the total average (including airplane cases) is equal to 3628€. So the airplane dummy must be included in the analysis to control for this effect. It could also be an explanation for the lower acquittal rate for legal bodies than for natural bodies, as discussed in the previous paragraph.

Fine Amount	**BIM**		
	Total	Without airplanes	Only airplanes
Minimum	62,50	62,50	625,00
Average	3 628,00	883,00	10.244,50
Maximum	102.915,00	7.363,00	102.915,00

Table II Descriptive statistics of sanction amounts with strong bias caused by airplane related cases (Billiet et al., 2009)

With respect to violation characteristics, we define dummies that take a value of 1 if at least one of the offences committed by a defendant caused CONTINUOUS or CHRONIC (i.e. repeated pollution without being continuous) environmental consequences. Temporary offences are considered as the reference group and consist of cases in which the defendant only committed offences which have consequences for the environment that die out. Furthermore, we indicate the type of contamination caused using dummies for illegal WASTE disposal (possibly leading to release of dangerous substances), for NOISE nuisance, for ODOR/AIR pollution, for SOIL/GROUNDWATER contamination and for SURFACE WATER contamination. As illustrated in table III, the majority of cases are related to WASTE or NOISE nuisance.

Contamination	BIM	
	Number	%
Waste	386	34,87 %
Noise	379	34,24 %
No information	187	16,89 %
No contamination	95	8,58 %
Air	72	6,50 %

Table III Overview of contamination types in the database (Billiet et al., 2009)

Additionally, we indicate whether the formal motivation of decisions reported a POSITIVE ACTION to be undertaken by the defendant, such as clean-up, mitigation of damages, etc. The dummy COMMUNITY impact is set equal to 1 in case the offender committed violations which had a negative effect on public health, on health of a third party or on his property. If the violator committed offences that negatively affected natural resources, without having an impact on the surrounding community we indicate this by setting the dummy variable NATURE equal to 1. However, we do not include the latter variable in the empirical analysis, due to lack of occurrences and only focus on the COMMUNITY variable. As illustrated in table IV, in the great majority of cases the community impact is due to affection of public health or of third party health. These effects are mentioned in about 40% of all accusations. Infringements of third party property and damage to natural resources, in contrast, are almost never mentioned. This seems to be a consequence of the fact that we analyze the district of Brussels, which is an urban area.

Type of damage	BIM	
	Number	%
Third party health damage / effect on public health	432	39,03 %

Damage to fauna, flora or vulnerable areas	3	0,27 %
Damage to third party property	0	0,00 %

Table IV Overview of type of damage caused in the database (Billiet et al., 2009)

Finally, there are dummy variables to indicate the cause of violation (HUMAN BEHAVIOR, TRANSPORT, TECHNICAL CAUSE and INCIDENT) and the way the offence was detected (COMPLAINT or BIM INSPECTION). The impact of the violation on the environment is represented by the type of pollution as indicated by the variables defined above. We do not include separate variables for the extent of environmental degradation, because we do not have information on it and in addition there is nothing known about the initial state of the environment.

In the category of legal characteristics, we include a dummy ACTIVE SEPOT to detect whether there is a difference between the cases where the public prosecutor explicitly states that he will not prosecute, i.e. the equivalent of an active sepot, and the cases where he does not take any action, i.e. a passive sepot. Next, we define the variable WARNING which takes a value of 1 if warnings were issued by the enforcement administration for this offence before they issued a notice of violation, thereby initiating a sanctioning procedure. Related to this, we define the variable proof of FAULT, which is equal to one if a formal proof of fault statement was issued before initiating the penalization procedure. We also indicate whether the violation was an infraction against MULTIPLE regulations. Finally, we add dummies for the year in which the sanctioning procedure was concluded, which we define as Y05 and Y06. The reference year is 2004. This way, we can detect possible time shifts in the enforcement strategy of the BIM. This could be due to a shift in political regime, a change in the administration’s enforcement strategy, a different decision maker that decides on the sanctions, etc.

3.3 Expected results

We now turn to formulating expectations for the explanatory variables in our regression. We expect that the variable LEGBOD has a positive effect on the amount of the fine imposed and on the probability of imposing a fine. The reasoning for the former effect is that legal bodies in general have more financial resources at their disposal, so a higher fine would be required to achieve the same deterrence effect on a legal and on a natural body. For an explanation of the latter effect, it suffices to draw up some descriptive statistics. Around 38% of all defendants in our dataset do not receive a penalty. If we differentiate the acquittal rate into a rate for legal bodies and one for natural bodies, we see that the chances of being acquitted are very different: the acquittal rate for firms is much lower (around 30%) than the rate for normal persons (around 50%). For the variable HISTORY, we expect a positive effect on the amount of the fine. This expectation is based on the concept of penalty leverage (Harrington, 1988), but lacks empirical confirmation up to now. The effect on the decision whether to impose a fine, however, is less obvious. It seems unlikely that compliance history is a an important component of the decision whether to impose a sanction, given that enforcers can also take compliance history into account in their decision whether to issue a warning or whether to start a sanctioning procedure. Finally, based on the descriptive analysis of the data, we expect that the variable AIRPLANE enters positively in both equations. From Table II, it is clear that offences including airplane companies lead to fines more frequently and on average also to higher fines.

Next, we address expectations concerning the characteristics of the violation. Firstly, violations of a CONTINUOUS or of a CHRONIC type may lead to stricter enforcement because of their longer time duration. However, the temporal dimension of an offence is not directly related to the environmental damages that they entail. A common type of offence, which is not complying with the duty to file for an appropriate environmental permit, is of the continuous duration kind, but does not produce a lot of direct environmental damages. An alternative explanation for the positive expectation could be the fact that a long duration of an offence shows that the defendant has had a long time span to regularize the offending situation. The fact that this has not been done shows his negative intentions. For temporal offences, the causes may be rather unintentional, such as an accident or a temporary failure. Secondly, it is likely that efforts being made by the defendant to mitigate environmental damages are associated with a lower fine probability and with lower fines. So the variable POSITIVE ACTION is expected to enter both estimations with a negative coefficient. Thirdly, the COMMUNITY impact of a violation positively affects the valuation of environmental harm. Polinsky & Shavell (1994) state that harm-based liability rules are generally speaking superior to gain-based liability. This should lead to more stringent sanctions and to a higher probability of incurring a fine if the offence has a significant impact on the community. Fourthly, with respect to the variables that indicate the cause of the accident, the way we interpret the variables is of crucial importance. In the data gathering process, we interpreted TECHNICAL CAUSE as a problem of technical kind. Therefore, this variable may indicate that no direct fault was made and therefore no one can entirely be held responsible for the offence. In this view, we expect that the estimated coefficients for TECHNICAL CAUSE have a negative sign, while HUMAN BEHAVIOR may enter the equation with a positive sign. The variable INCIDENT is mainly used for cases which have resulted in more severe damages (e.g. fires). Consequently, we can expect that more stringent fines will be imposed. Finally, we expect that an offence that was discovered following from a COMPLAINT has a high probability of leading to a fine, due to the fact that the effects of the violation automatically have a negative impact on society (because someone complained about them). An alternative reasoning could be that in case of a complaint the consequences of the offence are more visible than for offences which have been discovered by an inspection. However, this leads to the same conclusion that the incentives for imposing (high) fines are larger. Therefore, we expect that COMPLAINT enters both equations with a positive coefficient. For the other control variables that we included, such as detection following after a BIM INSPECTION or indicating the type of contamination, it is not immediately clear which sign we can expect in our estimation.

With respect to legal characteristics, we expect that penalties are more stringent if the defendant neglected WARNINGS by the enforcement agency previous to him issuing a notice of violation. The reason for this is that issuing (one or more) WARNINGS gives the offender an opportunity to regularize a situation for which he is in violation, but it turns out that this opportunity has not been seized because he received a notice of violation after all. So the variable signals the negative intent of this offender and this is why we expect a negative sign for the estimated coefficient. Because of a similar reasoning, the variable FAULT provides a signal of the negative intentions of the offender and we also expect to find a negative coefficient. Finally, we expect that the probability of imposing a stringent sanction increases if the violation was an infringement against MULTIPLE regulations.

3.4 Discussion of results

3.4.1 First step: Estimation of fine probability

We now turn to a discussion of the estimated coefficients. Before estimating the equations, we check for problems of multi-collinearity. We decide to leave out the variables NOISE and TRANSPORT, because they are both very much correlated with the AIRPLANE dummy and also with the variable

COMMUNITY in case of NOISE nuisance. This would lead to a problem of high standard errors and low significance levels for these variables which would jeopardize interpretation of the coefficients. We start by giving an overview of the results of the first step of our regression, namely the estimation of the probability that a fine is imposed, in table V. In general, the validity of the estimated model is satisfactory.[4]

Binomial Probit Model with PROB(FINE) as the dependent variable				
#Observations	653			
Log Likelihood	-287			
Variable	Coëfficiënt	Std. Error	Marginal Effect	Expectation
Constant**	**-0,68****	**0,32**	**/**	**/**
LEGBOD**	**0,32****	**0,14**	**0,11**	**+**
AIRPLANE***	**2,07*****	**0,50**	**0,42**	**+**
HISTORY	0,26	0,20	/	/
CONTINUOUS	0,29	0,19	/	+
CHRONIC	0,29	0,31	/	+
COMMUNITY***	**1,10*****	**0,25**	**0,32**	**+**
(HAZARDOUS) WASTE**	**0,33****	**0,15**	**0,11**	**/**
ODOR/AIR	0,07	0,22	/	/
SOIL/GROUNDWATER	0,06	0,30	/	/
SURFACE WATER	0,04	0,29	/	/
COMPLAINT	0,16	0,21	/	+
BIM INSPECTION*	**-0,31***	**0,16**	**-0,11**	**/**
POSITIVE ACTION***	**-1,12**	**0,13**	**-0,38**	**-**
FAULT				
HUMAN BEHAVIOR***	**0,63*****	**0,24**	**0,23**	**+**
TECHNICAL CAUSE***	**-0,82*****	**0,28**	**-0,31**	**-**
INCIDENT	-0,11	0,45	/	+
ACTIVE SEPOT	-0,22	0,14	/	/
MULTIPLE***	**0,58*****	**0,18**	**0,18**	**+**
WARNING	-0,22	0,14	/	+
FAULT**	**0,31****	**0,15**	**0,10**	**+**

[4] We find a share of around 75% correct predictions which is not so far from the 80% reported by Kleit et al. (1998).

Y05	0,10	0,15	/	/
Y06	0,17	0,16	/	/
Pseudo-R^2 value	0,34			
% Correct Predictions	80%			
% Correct actual 1s	86%	% Correct actual 0s	70%	

Table V Output of the regression of the sanction probability on the explanatory variables (a * indicates that the variable is significant at a 10% level, a ** that it is significant at a 5% level and a * that it is significant at a 1% level)**

In this table, the marginal effect is the expected effect on the dependent variable of increasing an explanatory variable with 1 unit when we set the other explanatory variables at their average level. We first address the estimated coefficients which are in accordance to our expectations. LEGAL BODIES have a higher probability of being sanctioned than NATURAL BODIES. The variable is statistically significant at a 5% significance level.[5] The marginal effect of being a legal body is an increase of the sanction probability of 11%. The AIRPLANE dummy has a strong positive effect on the probability of imposing a fine. This observation is in correspondence with the descriptive statistics given in table II (see supra). So in case of the AIRPLANE dummy, an airplane offence has a 42% higher chance of being sanctioned than a 'non-airplane' case. A second observation that comes out is that a violation with COMMUNITY impact has a 32% higher chance of being sanctioned than other violations. Furthermore, we found that a defendant which undertakes POSITIVE ACTIONS in order to mitigate environmental damages has a probability of being sanctioned which is 38% smaller than other defendants. Next, we find that violations resulting from HUMAN BEHAVIOR have a 23% higher probability of being penalized, whereas this probability decreases by 31% for offences due to TECHNICAL CAUSE. Also in accordance to our expectations, we find that offenders who violated MULTIPLE regulations have a significantly higher probability of being sanctioned. Their sanction probability increases by 18%. Finally, we find that the probability of being fined increases if a proof of FAULT document has been issued previous to initiating the penalization procedure.

We also find that some coefficients are significant, while we did not expect any effect. It seems that offenders who committed offences related to HAZARDOUS WASTE and illegal WASTE disposal face more stringent enforcement than offences which result in other types of contamination. We find that

[5] This means that the variable has a positive effect on the fine probability with 95% certainty.

(HAZARDOUS) WASTE related offences have a 33% higher probability of leading to a sanction than the other categories. For the variable COMPLAINT we do not find a significant effect on the sanctioning probability, whereas we had expected a positive coefficient. This is probably because we control for the community impact of an offence through another explanatory variable. We also find that violations that were discovered through BIM INSPECTIONS have an 11% smaller sanction probability than the violations that were discovered in other ways. The reason for this effect is not obvious. The estimated coefficient, however, is only significant at a significance level of 10%, not at a 5% or at a 1% significance level. This makes the negative estimation of the coefficient less convincing. The effect could be related to the fact that BIM INSPECTIONS are routine inspections whereas the reference group is a rather heterogeneous group of other violation detection ways, among which complaints and also the airplane related cases, which are more likely to be sanctioned. We come back to the issue of interpretation of the variables BIM INSPECTION and COMPLAINT in section 3.4.3. It turns out that the variable INCIDENT has no significant effect. This could be due to the low frequency of this variable in our dataset. We did not find a positive effect of WARNINGS being issued on fine probability. In contrast, the estimated coefficient is negative, though not significant. A possible rationale for a negative coefficient could be that the offences that cause serious environmental damages lead to a sanctioning procedure immediately, whereas less damaging offences first incur warnings before being penalized. Finally, there are some additional variables that we would have expected to have an effect in our equation, but that turn out to be insignificant. We did not find any effect of the offence duration on the probability of imposing a sanction, although the estimated coefficients are indeed positive.

3.4.2 Second step: Estimation of the fine level

We now turn to the results of the second step of our regression, namely the estimation of the (logarithmically transformed) fine LNAMOUNT that the BIM imposes on the defendant. The results are given in Table VI. Here also, the validity of the model is satisfactory. We obtain an adjusted R^2 value of around 75%, which is an indication for the share of the variability of the dependent variable, in our case the fine that can be explained by our model. So our model performs well in comparison to earlier related analyses.[6]

Sample Selection Model with LNAMOUNT as the dependent variable			
#Observations	399		
Variable	Coefficient (in %)	Standard Error	Expectation
CONSTANT* **	**4,04*** **	**0,49**	**/**
LEGBOD **	**0,36** **	**0,14**	**+**
AIRPLANE* **	**2,56*** **	**0,38**	**+**
HISTORY* **	**0,64*** **	**0,14**	**+**
CONTINUOUS* **	**1,43*** **	**0,14**	**+**
CHRONIC* **	**0,90*** **	**0,18**	**+**
COMMUNITY	0,43	0,27	+
(HAZARDOUS) WASTE* **	**0,49*** **	**0,15**	**/**
ODOR/AIR	0,19	0,18	/
SOIL/GROUNDWATER	-0,19	0,26	/
SURFACE WATER	0,37	0,26	/
COMPLAINT	-0,01	0,18	+
BIM INSPECTION	-0,23	0,15	/
POSITIVE ACTION* **	**-0,68*** **	**0,20**	**-**
HUMAN BEHAVIOR	-0,20	0,26	+
TECHNICAL CAUSE **	**-0,56** **	**0,27**	**-**
INCIDENT	0,21	0,38	+
MULTIPLE* **	**0,76*** **	**0,13**	**+**
WARNING	-0,13	0,13	+
FAULT **	**0,51** **	**0,14**	**+**
Y05	0,11	0,13	/
Y06	0,09	0,14	/
Lambda* **	**1,21*** **	**0,32**	**/**

[6] Ringquist (1998), for instance, reports adjusted R^2 values of 36% and of 34% in regressions with the log of the average fine as the dependent variable. Atlas (2001) obtains values of around 20% in a regression with the log of the fine as dependent variable. Oljaca et al. (1998) report an adjusted R^2 of 50% in a regression with the logarithm of the paid fine as the dependent. Note, however, that one should be cautious in comparing models with different dependent variables on the basis of R^2 values.

Adj. R^2	0,73

Table VI Output of the regression of the logarithmically transformed fine amount on the explanatory variables (a * indicates that the variable is significant at a 10% level, a ** that it is significant at a 5% level and a * that it is significant at a 1% level)**

In table VI, the coefficient shown can be interpreted as the approximate percentage change of the fine when changing the value of one of the dummy explanatory variables because the dependent variable has been logarithmically transformed. This percentage change should be interpreted as the estimated effect on the fine before the decision whether to impose a sanction is made. However, in the second stage estimation we are primarily interested in the marginal effects of the explanatory variables on the fine imposed, conditional on being in the group of cases being penalized. So we focus on the factors that make the fine level shift up or downwards, holding the effects of the explanatory variables on the decision to penalize fixed. Therefore, in order to obtain the direct marginal effect of the explanatory variables on the level of the fine, we need to correct the estimated coefficients for sample selection effects. In fact, each marginal effect can be decomposed into two parts: there is a direct effect of the variable on the fine, which is given as the coefficient in table VI, and there is an indirect sample selection effect, i.e. the effect of the explanatory variable on the probability of being in the group that incurs a fine. The fact that the coefficient on the inverse mills ratio is significantly positive shows that the sample selection effect is indeed present in our regression. We calculate the marginal effects for a subset of explanatory variables. The results are given in table VII.

Variable	Marginal Effect	Standard Error	Expectation
LEGBOD	0,16	0,17	+
AIRPLANE**	**1,32****	**0,58**	**+**
HISTORY**	**0,48****	**0,19**	**+**
CONTINUOUS***	**1,26*****	**0,19**	**+**
CHRONIC***	**0,72*****	**0,26**	**+**
WASTE	0,29	0,19	/
POSITIVE ACTION	-0,01	0,28	-
HUMAN BEHAVIOR*	**-0,58***	**0,32**	**/**
TECHNICAL CAUSE	-0,06	0,34	/
MULTIPLE**	**0,41****	**0,19**	**+**
FAULT*	**0,32***	**0,18**	**+**

Table VII Marginal effects of selected explanatory variables on the logarithmically transformed fine amounts

As you can see in Table VII, after calculation of the marginal effect the variable LEGBOD does not have a significant impact on the level of the fine. So it turns out that the positive coefficient that we estimated in Table VI can be attributed to sample selection, i.e. legal bodies have a higher probability of being penalized, but there is no significant evidence that they also receive higher fines. In contrast, the marginal effect of the variables AIRPLANE, HISTORY and the temporal variables CONTINUOUS and CHRONIC is highly significant. This means that there is an indication in our model that these explanatory variables are taken into account for deciding on the level of the fine. We estimate that the amount of the fine increases with 274% for AIRPLANE cases, which can be obtained by the calculation: $274\% = 100\% \times \left[\exp\left(1,32\right) - 1\right]$. In a related way, we can calculate that fines increase by about 62% in case of a negative compliance HISTORY, by 253% if the offence lead to CONTINUOUS damages and by 105% in case of a violation with CHRONIC damages. For offences related to WASTE contamination, we find no significant marginal effect on the amount of the fine, although there is still some indication of a positive sign on the coefficient. Surprisingly, taking a POSITIVE ACTION does not seem to have any effect on the level of the fine after the decision to sanction is made. So for defendants undertaking such an action only leads to a beneficial effect in terms of increasing the acquittal probability, but it does not have an effect on the fine amount. The same argument applies for violations that can be attributed to a TECHNICAL CAUSE: they have a higher acquittal probability, but do not lead to different fine amounts. For infringements which are caused by HUMAN BEHAVIOR, we observed that they have a lower acquittal rate. However, here we find a significantly negative marginal effect on the level of the fine of about -79%. So these violations seem to lead to sanctions more often, but, on average, to lower ones. We also find a positive marginal effect of about 51% on the fine level in case of a violation of MULTIPLE regulations. Again, this is the effect on the expected level of the fine, conditional on being penalized. Finally, the marginal effect for the variable FAULT is significantly positive at the 10% level. Thus, both the probability of imposing a fine and its level can be expected to be higher if a proof of FAULT was issued before initiation of the sanctioning procedure.

The explanatory variables that we excluded from Table VII do not have a significant coefficient or marginal effect. So it seems that violations with an impact on the COMMUNITY do not incur higher fines than others. In addition, the way of detecting an offence (through a COMPLAINT, a BIM INSPECTION or another way) does not have an effect on the fine. Also, the variables INCIDENT and

WARNING do not have a significant effect on the fine level, as was the case for these variables in the estimation of the probability of incurring a sanction.

3.4.3 An extension: Estimation of the fine probability excluding airplane cases

We now come back to the issue of interpreting the estimated coefficients for the variables BIM INSPECTION and COMPLAINT. We found that violations being discovered through BIM INSPECTIONS have a significantly lower probability of being penalized in a sanctioning procedure than other offences. This observation at first seems odd, but we hypothesized that it might be due to the fact the estimated coefficient picks up the inclusion of AIRPLANE related cases into the reference category. Therefore we re-estimate the first step of our regression, the probit model with the probability of imposing a SANCTION as the dependent variable, while leaving out the AIRPLANE cases. Some results are given below in table VIII.

Binomial Probit Model with PROB(FINE) as the dependent variable				
#Observations	534			
Variable	Coëfficiënt	Standard Error	Marginal Effect	Expectation
WARNING*	**-0,23***	**0,14**	**0,09**	**+**
CONTINUOUS*	**0,38***	**0,20**	**0,16**	**+**
CHRONIC	0,39	0,32	/	+
COMPLAINT	0,28	0,21	/	+
BIM INSPECTION	-0,24	0,16	/	/
TRANSPORT CAUSE**	**0,90****	**0,38**	**0,31**	**/**

Table VIII Estimated coefficients in a regression where the probability of a FINE is the dependent variable and where the AIRPLANE cases are left out (a * indicates that the variable is significant at 10% level, ** that it is significant at 5% level and * that it is significant at 1% level)**

We still find a negative coefficient for the variable BIM INSPECTION, but the coefficient is not significant any more at a 10% significance level. The estimated coefficient on the variable COMPLAINT is positive, but it is again not significant. Looking at the correlation between this variable and COMMUNITY, we find that both have a correlation coefficient of 64%. So both variables actually measure more or less the same characteristic of an offence and it is therefore logical that the

COMPLAINT variable does not have a significant effect on sanction probability. The coefficient does become significantly positive if we leave out the control variable for COMMUNITY impact. We also find that the variable which indicates that the cause of a violation is TRANSPORT related has a significantly positive effect on the probability of imposing a sanction. Furthermore, we see that the negative coefficient for WARNING and the positive coefficient for CONTINUOUS damages are significant in Table VIII. Note that the results of the regression for the level of the fine are very similar as those including the airplane cases.

Finally, for the cases where defendants are natural bodies, we dispose of information on whether the defendant was acting in the context of professional or non-professional activities. So we can re-estimate the model in which we only use cases for natural bodies and in which we include the variable PROFESSIONAL to test whether we find a significant difference between a professional and a non-professional defendant. We could expect that the acquittal rate is lower for professionals, because they are required to know to which regulations they ought to obey, whereas a non-professional could invoke being ignorant about certain regulations. Indeed, we find that being a PROFESSIONAL has a positive effect on sanctioning probability. The estimated coefficient is 0,81 and is significant at a 1% significance level. The marginal effect of PROFESSIONAL on the probability of imposing a fine is 30%. We do not find a significant effect for this variable in a regression with the level of the fine as the dependent variable.

4 Conclusion

As a general conclusion, we can say that our empirical analysis has revealed many interesting relationships in the administrative enforcement track. For all of these relationships, we have found plausible explanations. So this analysis can serve to increase confidence in an administrative enforcement track. It is clear that penalties are not imposed in this track in an arbitrary way. As a policy implication, this observation should encourage the use of administrative procedures as a supplementary enforcement track, which in certain cases could be a more cost-effective and a more efficient way of achieving the same level of deterrence.

More specifically, we observed that the probability of being ‘acquitted’ (i.e. not being punished) in a penalization procedure is positively affected when the defendant has taken actions in order to mitigate damages and when the offence can be attributed to a technical cause. In addition, there was also some evidence that acquittals occur more often when previous warnings have been issued for this offence. At first, this seems odd, but it is probably due to the fact that more serious offences get sanctioned immediately without receiving previous warnings. The probability of acquittal was negatively affected in the following cases: when the defendant is a legal body, when the defendant committed the offence during professional activities, when damages caused by the offence had a community impact, when the violation was caused by human behavior or related to transport, when the infringement was a violation of multiple regulations, when a proof of fault document has been issued before sanctioning the defendant, when the defendant was an airplane company and when the contamination caused was related to (hazardous) waste. In addition, there was also some evidence for a lower acquittal rate in case the violation resulted in damages of a longer duration. For all these effects plausible explanations exist.

With respect to the decision on the level of the fine, we assume that it is made after the decision whether or not to penalize the defendant has been taken. The most important determinants for higher fines, conditional on being fined, are: a negative compliance history, a longer duration of damages, an offender of multiple regulations, the issuance of proof of fault previous to the punishment procedure and again the airplane cases. We also found that a violation due to human behavior leads to lower fines.

As a possible extension of this analysis, it would be interesting to do a similar exercise for different regions. This would make it possible to make a comparison between enforcement practices for several places, which could enable us to detect political determinants for enforcement strategies. It is likely that some adjustments will need to be made such as for the airplane companies, which is an issue typical for the district of Brussels. In a similar way, the analysis could also be done over different time periods to detect temporal shifts in enforcement strategies. This again could be related to political characteristics of enforcement. We are planning to do a similar empirical analysis for the criminal enforcement track for environmental offences in Flanders. This will enable us to make a comparative analysis for both tracks and get a comprehensive view of enforcement practices for environmental violations in Belgium.

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