



Intermediary report – January 2003

**LAW & ECONOMICS AND THE ENFORCEMENT OF
ENVIRONMENTAL LAW
CP-11**

KUL - RUG

SPSD II



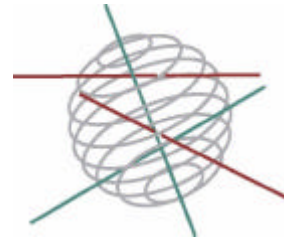
PART 1

SUSTAINABLE PRODUCTION AND CONSUMPTION PATTERNS

-  GENERAL ISSUES
-  AGRO-FOOD
-  ENERGY
-  TRANSPORT

This research project is realised within the framework of the Scientific support plan for a sustainable development policy (SPSD II)

Part I “Sustainable production and consumption patterns”



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Intermediate scientific report

1. Project title

Law & Economics and the enforcement of environmental law

CP/01/111 and CP/02/112

2. Introduction

2.1 Context and summary

The project relates to monitoring and enforcement of environmental law. Enforcement consists of both the imposition of sanctions and the execution of imposed sanctions (sanction execution).

We concentrate on modelling the instruments and strategies of monitoring and enforcement. Including these considerations into policy-making is vitally important. An unwisely chosen monitoring and enforcement policy can affect the efficiency of the entire legislative policy. Moreover it can lead to unnecessary expenditures for the firms and enforcers involved.

On an international level economic and 'law and economic' research is increasing speedily. Especially on a theoretical level more and more publications appear. However, empirical research seems to be lagging behind. The underlying reason for this slower pace is the difficulty of obtaining useful data. Governmental institutions are hesitant in disclosing their enforcement policy and decisions are often made informally. This leads to the virtual impossibility of obtaining data on monitoring and enforcement. A recent overview of the literature can be found in Cohen (2000).

In Belgium economic and 'law and economic' research concerning the costs of monitoring and enforcement for the different agents is virtually non-existent.

The project team has acquired relevant know-how while working on the SPSP I – project '*Law & Economics and the choice of environmental policy instruments*' (1997-2001). In this SPSP I – project we work with the notion of 'regulatory chains'. Regulatory chains consist of three stages, namely the rule making, the implementation and the enforcement stage. In a regulatory chain we combine a normative instrument (e.g. emission tax) with different possible sanctioning instruments (e.g. fines). Juridical cards are made in which we identify the properties and structure of both normative and sanctioning instruments. Several available instruments have been analysed and modelled in a case study. This case study considers water pollution by the textile improvement sector along the Leie. For more information see: Rousseau and Proost (2001), Billiet (2000), Rousseau (1999) and Billiet, Rousseau and Proost (2002).

We would like to point out that both teams only worked partially on the project in 2002. The economic team had one full-time researcher during four months and the legal team had one researcher working ten percent during the whole of 2002.

2.2 Objectives

We investigate the instruments and strategies of environmental law enforcement using an interdisciplinary ‘Law & Economics’ approach. More specifically the objectives are:

- a. the in-depth exploration of the SPSD I – model developed during the project ‘*Law & Economics and the choice of environmental policy instruments*’
- b. the fine-tuning of the study of costs and strategies of environmental law enforcement. This fine-tuning will be both empirical and theoretical
- c. synthesis of the acquired knowledge about monitoring and enforcement

The in-depth exploration of the SPSD I – model consists of including new instruments in the analysis. We include tradable permits, monitoring and sanction execution instruments.

2.3 Expected outcomes

We expect the following outcomes of this project:

- overview of the literature on dynamic modelling of monitoring and enforcement aspects
- report on the inspection function discussing the factors that influence the monitoring decision of the environmental inspection agency
- report on the penalty function discussing the factors that influence the enforcement of environmental violations
- overview of the legal and ‘law and economic’ literature on tradable permits
- database of inspection data

3. Detailed description of the scientific methodology

3.1 In-depth exploration of the SPSD I – model by including new instruments

The economic conceptual model that was developed during the SPSD I-program, stresses sanction instruments in the enforcement stage: fines, firm closure or annulment of permits... Next to sanction instruments there also exist monitoring instruments (e.g. right of entrance, right of taking samples...) and sanction execution instruments (e.g. compulsory measures). This project will refine the modelling of the enforcement stage by adding monitoring and sanction execution instruments. This is especially useful for the project since it is generally acknowledged that most of the enforcement files are solved during the monitoring stage. Moreover, sanction execution involves a new enforcement stage that is barely studied before. Finally we also want to extend the model, including the monitoring and enforcement stage, by analysing tradable permits.

The juridical team formulates cards that represent the different cost aspects typical for the structure of the monitoring and sanction execution instruments. The cards are formulated after a detailed analysis of the legislative practice and the relevant juridical context. A typical profile of the instrument is drawn. Mapping the cost aspects characteristically is done for both the normative stage as the application stage. Using the cards the economic team, in collaboration

with the juridical team, valorises the different cost elements. The monetary valuation of the cost elements of instruments is used as an input in a numerical model and consequently the cost linked with the instrument is estimated.

Moreover, we want to apply the methodology developed in the SPSD I- project to an instrument with which we do not have any previous legislative experience in our country. We selected tradable permits. Firstly, we analyse the European proposal for a directive for tradable permits (31 October 2001, DOC 501PC0581), as this proposal aims to come into force very soon (implementation by the member states per 31 December 2003), and add information from existing foreign experiences with tradable permits. Secondly, building on the knowledge acquired by modelling other, better known instruments, we also formulate a card indicating the cost elements characteristic for the structure of the instrument. The cost elements are selected not only for the normative stage but also for the application stage. We dissect the matching organisation of monitoring, sanctions and sanction execution and try to define the different possible regulatory chains, taking into account the needs for information transmission. The economic team will also include tradable permits into the numerical model.

3.2 Empirical exploration of the monitoring and enforcement of environmental law

Estimating the inspection function

We want to investigate which firms are monitored and which firms have a greater probability of being inspected. Therefore we formulate a partial equilibrium model. According to economic theory the decision to inspect depends on previous convictions, the size of the firm, the sector...

To perform a correct regression analysis, a substantial amount of data are necessary. We will obtain these through the collaboration with the administrations responsible for environmental monitoring.

The methodology will be based on foreign studies that estimate comparable functions. These include, among others, Dion et al. (1996); Gray and Deily (1996); Helland (1998); Helland (1998) and Olson (1999).

Estimating the sanction function

We also want to investigate which sanctions firms face that are found to be noncompliant. Moreover we will analyse on what elements these sanctions depend. During the SPSD I - project we already collected data about this topic but only for cases that were effectively tried and where there was given notice of appeal. This obviously leads to a certain bias of the data. It would be very interesting to obtain data on cases where a friendly settlement was negotiated or that were dismissed. We will extend our analysis by analysing the motivation behind actual sanctions imposed by the Council of State. Our methodology is based on foreign studies that estimate comparable functions. Examples of such studies are Cohen (1987) and Oljaca et al. (1998).

3.3 Theoretical exploration of environmental law enforcement

First we make an overview of the literature. Next we incorporate the time dimension into a model. This means that we will model several different periods. The conduct of agents will differ if it is known that they will have to interact again the next period. Therefore we can take the history of the different agents into account, e.g. previous convictions. Agents can also obtain a certain reputation, e.g. the environmental inspection agency can have the reputation of severely punishing certain crimes. Firms found in violation can now be forced to regularise the situation. This influences the emissions in the next period. It is theoretically possible to have monitoring and enforcement depend on the past behaviour.

We choose a certain methodology based on the overview of the literature. We will focus on studying how the incorporation of multiple periods influences the behaviour of different agents. The range of options is extended and therefore the agent's conduct as well. Interactions between the different agents as well as between the different periods is taken into account. Further we also look at the influence of the dynamic model on the costs of monitoring and enforcement. In a last step we will also apply the model numerically. Then we will be able to calculate the full extend of the social costs.

3.4 Synthesis of the accumulated knowledge concerning monitoring and enforcement

We will make a synthesis of all knowledge about monitoring and enforcement acquired during the SPSD I - project "Law & Economics of the Choice of Environmental Policy Instruments" and the SPSD II - project "Law & Economics and the Enforcement of Environmental Law".

4. Detailed description of the intermediary results, preliminary conclusions and recommendations

Both the legal and the economic team have been working on several tasks during the past year¹. Firstly we started the work on the database. We discussed the data we require for the models and investigated several possible ways to obtain these. Secondly we made an initial overview of the literature concerning empirical monitoring and enforcement studies. We focussed our research on the estimation of inspection and penalty functions. Thirdly we performed an initial analysis of the level of penal fines levied by the Court of Appeal in Gent. We estimated a simple penalty function. Finally, we made an analysis of the available monitoring and enforcement instruments in the Belgian legal context. We focussed on administrative sanctions since the administrations dealing with these cases remain roughly the same, while this is not the case with penal sanctions.

Next we will discuss these intermediate results more thoroughly.

¹ Please remember that both teams only worked partially on the project in 2002. The economic team had one full-time researcher during four months and the legal team had one researcher working ten percent during the whole of 2002.

4.1 Database of inspection data

Before we could start collecting data, we first needed to define what we wanted to investigate. Firstly we want to know by which factors the decision to inspect firms is influenced. These factors can consist of firm characteristics, environment characteristics, political factors.... Secondly we also want to study which sanctions violating firms face. The choice of a particular sanction will probably depend on several factors; such as the type of violation, firm characteristics... Finally we also want to investigate the influence of inspections and sanctions on the firms' compliance decision with respect to environmental regulation.

It is interesting to notice that we want to study the monitoring and enforcement policy that takes place in reality. It will be quite interesting to compare this with the policy that is legally prescribed. Think, for instance, about the SEVESO II – cooperation agreement in which it is stated that firms involved should be audited at least once a year. Moreover, there is also the Recommendation 2001/331/EG of 4 April 2001 of the European Parliament and the Council concerning minimum criteria for environmental inspections in member states. It requires, for instance, the member states to inspect IPPC-institutions at least once a year. Further there are also the yearly environmental inspection plans drawn up by the environmental inspection (AMI).

In order to perform correct regression analyses (inspection function and penalty function) we need data. After discussions with the environmental inspection of Brussels (BIM) and Flanders (AMI) it was agreed upon that we could use data obtained through an internal project of the AMI. This project aims at an integrated check-up of textile improvement firms. The initial end date of the project was December 2002 but it has been postponed.

4.2 Literature overview of empirical monitoring and enforcement studies

When looking at the empirical literature concerning monitoring and enforcement, one cannot fail to notice the small number of papers written on the subject. The main reason for this lack of empirical data is the difficulty of obtaining sufficient data. Only one sector apparently does not experience these difficulties: the pulp and paper industry. Almost half of the existing papers use data from the American, Canadian or Swedish pulp and paper industry.

Before describing the results, a word of caution should be added. One must take care drawing strong policy implications for this kind of empirical studies. Each empirical study is necessarily limited by the scope of the data and the choice made by the regulatory agencies. Moreover, few studies have attempted to characterise the social costs and benefits of monitoring and enforcement.

First we discuss the dependent variables that are used in the different studies. Second we analyse the independent variables that can be found.

Dependent variables

We begin by analysing what exactly is examined in the existing literature. We distinguish three categories: sanctions, inspections and violations.

Dependent variable (sanctions)	Reference
Actual paid fine after consent order	Oljaca, Keeler and Dorfman (1998); Helland (2001)
Number of administrative orders, legal steps and sanctions directed against a firm	Nadeau (1997)
Choice between imposing a penalty or issuing a compliance order?	Kleit, Pierce and Hill (1998)
Size of (administrative) fines levied	Kleit, Pierce and Hill (1998); Cohen (1987); Earnhart (1997)
Size of clean-up costs	Earnhart (1997)
Court trial or settlement?	Helland (2001)
Probability EPA wins court trial	Helland (2001)
Size of profit in court trial	Helland (2001)

Dependent variable (inspections)	Reference
Number of inspections in a certain industry	Olson (1999)
Number of enforcement activities directed to a firm	Nadeau (1997); Gray and Deily (1996); Deily and Gray (1991)
Is a firm inspected or not (0/1 variable)	Laplante and Rilstone (1996); Helland (1998a); Helland (1998b); Dion, Lanoie and Laplante (1996)
Which type of inspection is performed (0/1/2 hierarchical variable)	Helland (1998b)

Dependent variable (violations)	Reference
Aggregate number of firms in industry found in violation in year t	Olson (1999)
Absolute amount of effluent emissions	Magat and Viscusi (1990); Laplante and Rilstone (1996); Lanoie, Thomas and Fearnley (1998); Helland (1998b); Foulon, Lanoie and Laplante (1999)
Is the amount of emissions below the acceptable level or not? Violation or not (0/1 variable)	Magat and Viscusi (1990); Laplante and Rilstone (1996); Helland (1998a); Gray and Deily (1996); Foulon, Lanoie and Laplante (1999)

Abatement investments in firms	Lanoie, Thomas and Fearnley (1998)
Output of firm	Lanoie, Thomas and Fearnley (1998)
Emission standard	Lanoie, Thomas and Fearnley (1998)
Self-reporting of violation (0/1 variable)	Helland (1998a)
Size of oil spill	Cohen (1987)

Firstly we find that a large part of the studies look at the probability of a violation for a firm or industry. Secondly we find that often the same researchers are doing the studies. Thirdly there is not much variation in the industry that is examined. Often the study considers the pulp and paper industry. Finally we also noticed that often several equations were estimated simultaneously.

Independent variables

The value of the previously discussed dependent variables depends on a number of factors. These factors can be specific to the firm, industry, environment, politics... We now consider which of these factors prove relevant in the literature. More details of the overview of these independent variables can be found in 6.3 *Detailed results*.

The independent variables can be subdivided into three categories. These are:

1. data obtainable with the administration
e.g. time of inspection, name of firm, type of violation (water, air...), cause of violation, actions taken...
2. economic data on the firm (via *balanscentrale*)
e.g. size of firm, employment, age, industry code, gross revenue...
3. socio-demographic data on firm's environment (via NIS)
e.g. employment in surrounding community, population density...

4.3 Estimation of the level of penal fines levied by the Court of Appeal in Gent

The importance of monitoring and enforcement for the effectiveness of environmental regulation is obvious. Without a proper monitoring and enforcement policy environmental legislation remains an empty chest. The study of the level of penal fines is a first step in the analysis of which sanctions violators of environmental regulations encounter. Our main objective is to find out which factors determine the type and the stringency of the sanctions.

In this study we aim to answer four questions. Firstly, is it plausible to work with a fixed fine independent of the size of the violation when modelling enforcement issues? Secondly, does the compliance history of the violator influence the level of the fine? Thirdly, how do firm

characteristics influence the fines that are levied? And finally, are there differences in sanctioning over the different regions?

Determinants of the fine level

Cohen (1987) and Polinsky and Shavell (1992) show that the optimal penalty of environmental crimes theoretically depends on the environmental damage caused, clean-up costs, enforcement costs and inspection frequency. We assume that the inspection frequency is constant. We will not elaborate on this.

In general we can distinguish four groups of determinants in the literature that influence penalties: environmental, legal, firm and political factors.

Environmental factors consist of, among others, the size of the damage, the size of the violation and the environment in which the discharge took place. In a legal setting the size of the violation is often measured in terms of the damage caused to environment or public health. Moreover it is important the violator should not experience any financial benefit from trespassing the law. The size of the violation is often difficult to measure. Therefore one often encounters a classification of crimes according to seriousness.

Among the legal factors that influence the penalty level we find, among others, the intent of the violator, the compliance history, the type of legislation that was violated and the offences and penalties specified in that legislation. Moreover, violators who broke the law on purpose will face higher penalties than those who just suffered from an accident.

Firm characteristics have received little attention in the theoretical literature. However, in the empirical literature (see literature overview in 4.2) several characteristics appeared relevant; such as the location of the firm, the size of the firm or the sector.

Political factors include, among others, the program of ruling political parties or the form of government in the country under consideration. Studies that take these factors into account are, for example, Kleit et al. (1998), Helland (2001) and Earnhart (1997). We will not consider these factors.

Background to the case study

Our empirical exercise uses the jurisprudence of the Court of Appeal in Gent for the period 1990-2000 concerning (a) discharges permits (Law of surface water 1971) and (b) environmental permits (the discharge permit was included in the environmental permit due to the decree on environmental permits 1985). In most cases charges were also filed for other violations. If these additional charges concerned violations of environmental regulations, they were included in the analysis. This is the reason why we also include data on the labour safety law (ARAB 1946 ; includes a.o. an environmental permit) and the manure decree 1991. Sentences determined in the previously described regulation can be found in *6.3 Detailed results*.

The data only include prosecutions of persons. The Law 1999 Legal responsibility of Legal Bodies was only relevant towards the end of the research period, as it came into force on 2 July 1999. We include 38 cases.

Description of variables and data

The variable we estimate is the level of the fine pronounced following an environmental violation. We discuss the fine of the first instance as well as that of the appeal. We already take the correction factor ('opdecimenen') into account since that is the amount with which the convicted party is confronted.

As was mentioned previously when we discuss the determinants of the fine level we distinguish three groups² of factors that determine the sanctioning of environmental crimes: environmental, legal and firm characteristics. For an overview and definition of these variables see *6.3 Detailed results*.

The environmental characteristics are represented by the variable DUUR. Through the variable DUUR we measure the duration of the violation. Some criminal offences (such as the absence of an appropriate permit) could last a long time while others (such as an accidental point discharge) were non-recurrent.

The legal influences we take into account are the costs for the Public Prosecutor (OMAAN) or the costs of an appeal procedure (OMBER). Moreover we take the type of violated legislation into consideration. We distinguish four types of legislation: law on labour safety (ARAB), Decree on environmental permits (MVD), Law on surface waters (WOW) and the Manure Decree (MEST). The variables count the number of violations of one type of legislation. Further we also measure the influence of the compliance history through the variable STRAFREG. This 0/1-variable shows whether the accused already had a criminal record or not. We also include the variable HGSDUM. HGSDUM indicates whether next to the fine there was also a prison sentence pronounced. Finally we also include the variable NEG that counts the number of aggravating circumstances mentioned against the defendant. They measure the intent of the wrongdoer.

Moreover we also include the sector in which the defendant works in the analysis. We distinguish eight sectors: agriculture (LAND), concrete industry (BETON), building industry (BOUW), dancings (DANCING), food industry (VOEDING), sand extraction (ZAND), scrap yards (SCHROOT) and furniture industry (MEUBEL). Further we also observe when the case first started. This is summarized in the variable VOOR94 that represents whether the verdict in first instance was pronounced before or after 1994. We use this variable to search for a time trend in our data. Next we include the location of the court of law of the first instance. We wanted to use this variable to search for differences over the different regions. However, these variables were never significant in our analysis and they caused problems with heteroskedasticity. That is why we did not include these variables in our final analysis.

We performed two estimations: one for the verdict in first instance and one for the verdict in appeal. The selection of the independent variables was slightly different in both cases. A description of the selected variables can be found in *6.3 Detailed results*.

² Remember that we choose not to consider political factors.

Expected results

We now discuss briefly the expected signs of the different variables. A summary can be found in *6.3 Detailed results*.

According to existing models, e.g. Polinsky and Shavell (1992), the optimal fine is higher if the enforcement costs are higher. Therefore we expect the variables OMAAN and OMBER to show a positive sign.

Next we can expect that a violator with a criminal record will be more heavily punished (Polinsky and Rubinfeld, 1991). Therefore we expect the variable STRAFREG to have a positive sign. We can also assume that the variable NEG will show a positive sign. It is logical to punish the deliberate violator more stringent than the accidental violator.

When we look at the duration of the violation, we can assume that longer violations (which are usually more serious) will be punished more severely. We therefore expect the coefficient connected to DUUR to be positive.

Next we investigate how the simultaneous punishment with a prison sentence, influences the level of the fine. Since executing a prison sentence is more expensive to society than levying a fine, we assume that a prison sentence will only be used if the fine is already at its legal maximum. Therefore we assume that the sign of HGSDUM is positive.

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

Looking at the variables that represent the violated legislation, we take the maximum allowable sentences (see *6.3 Detailed results*) into account. We find that penalties pronounced for violating the Law on surface waters (WOW) cannot be higher than 5000 BEF while those pronounced for violating the Decree on environmental permits (MVD) can amount to 100000 BEF. Therefore we expect a positive sign for MVD, MEST and ARAB. About the sector and time variables we cannot make any predictions.

Estimation method

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

$$Y = b_0 + b X + \mathbf{e} \quad (1)$$

with Y the dependent variable, b_0 the constant, X the vector of independent variables, b the regression coefficients and \mathbf{e} the error term. The variable we include in our two models can found in *6.3 Detailed results*.

We cannot estimate a semilog or loglinear specification since our dependent and most of the independent variables contain zeroes (see descriptive statistics in *6.3 Detailed results*). We used the statistical program SPSS for our estimations.

Discussion of the results

As mentioned before we estimate two separate models: the penalty function for the first instance and that for the appeal. We discuss in turn the results for both models.

First instance

Firstly we notice that the assumption of normality of the error terms is not rejected by the standard tests. Secondly it became immediately clear that we experienced problems with heteroskedasticity. We used the Breusch-Pagan test³ to test this. We could solve this problem by a careful selection of the independent variables and by rejecting two outliers

The results of this modified estimation can be found in Table 1. It is clear that, for a cross-section model, we obtain a high R²-value. Our model explains 66% of the variances of the fines pronounced by the courts of first instance. We now discuss the three groups of determinants we distinguished: environmental, legal and firm factors.

	Non standardized coefficients	Standard error	Standardized coefficients	t-statistic	Sign.
(Constant)	-41.802	50.841		-0.822	0.417
OMAAAN	0.0003604	0.001	0.031	0.289	0.774
STRAFREG***	408.603	92.963	0.550	4.395	0.000
LAND	43.810	43.945	0.129	0.997	0.326
BETON**	-344.143	166.078	-0.331	-2.072	0.046
BOUW**	-252.089	102.417	-0.411	-2.461	0.019
DANCING*	173.040	85.751	0.233	2.018	0.052
VOEDING	-56.936	50.943	-0.150	-1.118	0.272
ZAND**	-243.212	114.779	-0.234	-2.119	0.041
ARAB**	179.781	70.365	0.335	2.555	0.015
MVD***	75.036	19.281	0.499	3.892	0.000
WOW	36.706	26.230	0.180	1.399	0.171
DUUR*	1.659	0.956	0.344	1.736	0.092
MEST	67.414	75.954	0.110	0.888	0.381
HGSDUM*	89.476	45.787	0.277	1.954	0.059
VOOR94	-16.748	39.122	-0.052	-0.428	0.671
NEG	-4.338	15.841	-0.033	-0.274	0.786
R ² = 0.661 Adj. R ² = 0.502 F-stat = 4.151 N = 51 Dependent Variable: BOETEKL * = significant on the 10% level ** = significant on the 5% level *** = significant on the 1% level					

Table 1: Results for the court in first instance

³ For an description of this test we refer to Verbeek (2000).

The influence of environmental factors on the level of the fine was measured through the duration of the violation (DUUR). This variable DUUR appeared significant (10 % level) and positive. This matches our expectations. The longer a violation continues, the higher the fine will be. If the time in violation increases with a month, the fine will increase with approximately 1700 BEF (or €42).

The legal influences included in the analysis are the costs for the Public Prosecutor of going to court in the first instance (OMAAN). This variable is not significant in our analysis. Moreover we also take the type of violated legislation into account (ARAB, MVD, WOW and MEST). Here we distinguish differences in the sanctioning of law on labour safety (ARAB – significant on 5% level) and the decree of environmental permits (MVD – significant on 1% level) compared with other legislation. In both instances the fine will be higher if these particular laws are violated.

Furthermore we also measure the influence of the defendant's compliance history through the variable STRAFREG. This variable is significant on the 1% level and positive. The presence of a criminal record increases the fine with approximately 400000 BEF (or €10000). The variable HGSDUM indicates whether there was, next to the fine, also a prison sentence pronounced. This variable is also significant in our model (10% level). The sign of HGSDUM is positive. We can explain this result as follows: a prison sentence is costly to society and will only be imposed when the fine for the case is already maximal. The variable representing the number of aggravating circumstances mentioned during trial (NEG) was not significant in our analysis.

Firm factors include the sector in which the defendant works and the timing of the case (VOOR94). Four sector dummies turned out to be significant: that of the concrete industry (BETON), the building industry (BOUW), dancings (DANCING) and sand extraction (ZAND). Dancings appears to be punished more stringently. However we have to qualify this results since in our sample there is only one dancing included. This result certainly does not represent the Flemish sanctioning policy. Further the accused, who were working in the concrete or building industry were punished less stringently. The variable VOOR94 was not significant.

Court of Appeal

We again notice that the assumption of normality of the standard errors was not rejected. Again we experienced heteroskedasticity. We analyzed it via the Breusch-Pagan test. We could solve the problem by an appropriate selection of independent variables and the rejection of one outlier.

The results of the estimation can be found in Table 2. The R^2 -value of this estimation is very high. We could explain more than 96 percent of the variance in the dependent variable. A very important explanatory variable is without a doubt the fine that was imposed in first instance (AANBOEKL). The size of this fine is directly related to one pronounced in appeal. Further we discuss three groups of determinants of the sanctioning of environmental crimes: environmental, legal and firm factors.

The influence of environmental factors in the level of the fine is measured through and the duration of the violation (DUUR). Again the variable DUUR was significant (on the 10 % level) and positive. A long-term violator, who appeals to the verdict, will most likely be punished even more severely. The longer the duration of the violation is, the higher will be the fine.

Among the legal influence we include we find the costs for the Public Prosecutor of going the trial in the Court of Appeal (OMBER). This variable is now significant and positive. The coefficient is, however, small and the influence of these costs on the size of the penalty is therefore limited. Moreover, we take the legislation that was violated into account (ARAB, MVD, WOW and MEST). In this model the coefficient of the decree of environmental permits of 1985 (MVD) is significant (on the 1% level). The fine after an appeal will be higher if this type of legislation is violated. This can be explained by looking at the maximum allowable sentence (see 6.3 Detailed results). Next we also measure the influence of the defendant's compliance history through the variable STRAFREG. This variable turns out to be significant on the 1% level and positive. The Court of Appeal will increase the fine imposed in the first instance with approximately 240000 BEF (of €6000) if the accused has a criminal record. The variable NEG representing the number of aggravating circumstances was again not significant.

	Non standardized coefficients	Standard error	Standardized coefficients	t-statistic	Sign.
(Constant)**	-84.341	40.027		-2.107	0.043
AANBOEKL***	0.429	0.020	0.771	21.526	0.000
OMBER***	0.02680	0.009	0.117	2.870	0.007
LAND*	62.817	31.640	0.086	1.985	0.055
VOEDING	28.697	36.981	0.037	0.776	0.443
BETON	-228.385	164.747	-0.102	-1.386	0.175
ZAND	72.386	89.396	0.032	0.810	0.424
BOUW*	-152.681	77.829	-0.096	-1.962	0.058
DANCING***	868.117	61.022	0.545	14.226	0.000
SCHROOT	-113.401	92.200	-0.051	-1.230	0.227
MEUBEL	21.270	50.515	0.016	0.421	0.676
NEG	14.456	10.924	0.050	1.323	0.195
STRAFREG***	241.855	65.370	0.152	3.700	0.001
ARAB	34.505	51.940	0.030	0.664	0.511
MVD**	28.968	13.464	0.091	2.151	0.039
WOW	6.275	18.949	0.014	0.331	0.743
MEST	-22.691	56.600	-0.017	-0.401	0.691
DUUR*	2.504	1.238	0.179	2.022	0.051
R ² = 0.962 Adj. R ² = 0.943 F-stat. = 50.655 N = 52 Dependent variable: BOETEKL in appeal * = significant on the 10% level ** = significant on the 5% level *** = significant on the 1% level					

Table 2: Results for the Court of Appeal

The sector dummies represented the firm characteristics. Three dummies turned out to be significant: that of agriculture (LAND), the building industry (BOUW) and dancings (DANCING). Dancings and agricultural firms appeared to be more heavily punished. However, recall that we only have one dancing in our sample. The results will therefore not be

representative for the Flemish sanctioning policy. Next we also found that violators from the building sector received smaller penalties than other sectors.

Conclusion

In this model we study four questions. Firstly, is it a plausible research assumption to work with a fixed fine independent of the size of the violation? We find that this is not the case. In our sample the fine does depend on the seriousness of the violation. Secondly, does the defendant's compliance history influence the level of the fine? Our results show that violators in possession of a criminal record have a significantly higher probability of receiving a higher penalty. Thirdly we asked how the firm characteristics influence the fines that are imposed. Depending on the sector, other penalties seem to be pronounced. Finally, we want to know whether there are differences in fining behaviour according to the different regions? In this study we did not find any differences. Reasons for this result could be that the sample size is relatively small and the aforementioned problems with heteroskedasticity.

4.4 Definition and description of monitoring and enforcement instruments

Framework and background

We aim to develop a model closely related to reality. This will give the model a high predicting value. The law team should therefore provide up-to-date professional information to the economic team.

Within this perspective we wrote, as a basis for the dynamic modelling (task D2), an overview of the legally formalised instruments that are at the law enforcers' disposal for the different stages of the administrative enforcement process: monitoring, sanctioning and sanction execution. The objective of the document is to create a basis of the interdisciplinary dialogue for the implementation of task D2. This document should contribute to a more realistic selection of the successive options (time periods) modelled within the dynamic model. Moreover, it would provide an overview of the monitoring and sanctioning instruments used for refining the SPSD I – model.

Methodological aspects

While executing the SPSD I – project it became clear that the Belgian legislators have neglected the administrative monitoring and enforcement instruments. The instruments used have scarcely evolved since 1946 (year of the first environmental law), have only limited effectiveness in a functional way and are, at least some of them, not in accordance with compulsory human right treaties (European treaty November 4th 1950 for the protection of human rights and fundamental freedoms; International treaty December 19th 1966 concerning civil and political rights) (Billiet, Rousseau and Proost (2002)). Since it is useless to model such faulty instruments, we will work with the assumption of a rational legislator: a legislator who designs effective, legal-technically correct and cost efficient instruments. Using this principle, with the current Belgian legislation as starting point, and using comparative and other legal research (mostly research of legal cases and literature), we have already formulated within the SPSD I – project cards with the typical profile

of some administrative sanctions. The same assumption of the rational legislator and a similar legal method have led to the following overview of monitoring, sanctioning and sanction execution instruments. The instruments that are already present in the current legislation but that are significantly improved are marked with *. The instruments that are new vis-à-vis the current legislation are marked with ***. Moreover we also performed a first rough estimation of the time required to implement these instruments.

Results

Overview of monitoring instruments

Since 1946 environmental legislation grants certain special rights to monitoring agents. Those rights must help to gather useful information with respect to the compliance with the environmental regulation. Moreover it is traditionally so that everyone is obliged to cooperate with the supervisors and not to prevent the monitoring. The monitoring rights that are crucial to obtain information concerning the monitoring and enforcement process are the following.

- *Entrance right.* On the basis of an entrance right a supervisor can at all times, taking with him all necessary material, enter every space, excluding living spaces.
- *Right to inspect and copy business data.* A supervisor can demand to inspect all business documents and other business information carriers (a.o. electronic devices). He can without cost obtain a copy. When copying is impossible, he can keep or take along the information carriers, after giving a written notice, for as long as is necessary for the completion of his task.
- *Right to inspect goods*.* A supervisor can investigate or let investigate goods. He can, among others, try them or let them be tried, take samples or let others take samples and measure them or let others measure them. Therefore he can open or let open packaging. If the investigation cannot be performed in site, he can take goods along, after giving a written notice, for as long as is necessary for the completion of his goal.
- *Right to inspection transportation vehicles*.* A supervisor can inspect transportation vehicles and their load. With respect to the execution of these inspections he can request the driver of a vehicle or the captain of a ship to halt his transportation vehicle and bring it to a specified place.
- *Expert assistance.* When exercising its monitoring rights a supervisor can be assisted by experts.

Overview of sanctioning instruments

- *Warning notice.* The warning notice is an informal instrument. It is nothing more than an urgent request to stop the offence, to undo its consequences completely or partially and to avoid any repetition of the offence. The warning notice seems to be extremely efficient in practice: the majority of the detected offences are ended by booking and warning. Since the warning notice is not a sanction legally, its use is not subject to any formal procedure. The warning notice is not only effective but also cheap. The year reports of

the Flemish department of environmental inspection indicate that in most cases a sanction is only imposed if the warning notice has no effect.

- *Regularization order**. The regularization order is a sanction with which the competent administrative institution orders the violator to, within a time limit, take measures to end the offence, to undo its consequences completely or partially and to avoid any repetition of the offence. The time limit takes into account the time that is required, within reasonable bounds, to implement the measures taken. The regularization order can be implemented with damages. It can be implemented with the obligation to formulate and execute a regularization plan and / or a closing down plan.
- *Cessation order*. The cessation order is a sanction with which the competent administrative institution orders the violator to immediately and permanently terminate the use of a good, activities or operations that constitute an offence. The cessation order can be implemented with damages
- *Administrative coercion **. Administrative coercion is a sanction in which the competent administrative institution acts itself to end an offence, to undo its consequences completely or partially and to avoid any repetition of the offence. Administrative coercion can, among others, be the sealing of buildings, grounds and everything which is in or on there and the taking away of goods, in order to store them until returning them to their owners or to dispose of them through destruction or otherwise. The violator is liable for the costs associated with the implementation of administrative coercion unless they are reasonably thought to be partially or completely irrelevant. Unless the urgency of the matter prohibits it, there is always a time period determined during which the violator and other persons entitled to the use of the goods subject to the sanction can prevent the administrative coercion by taking the appropriate measures themselves.
- *Suspension and withdrawal of a permit*. Both these sanctions imply the existence of an authorization (permit, recognition, other). An authorization can be suspended or withdrawn after violation of regulations relevant for its use (regulatory prescriptions and prescription included in the authorization itself). The suspension and withdrawal can involve the whole or part of the authorization. The suspension is temporarily, the withdrawal is permanent. The suspension is imposed when it is reasonable to expect a return to compliance. The withdrawal is imposed in cases that are categorized as hopeless and is meant to protect the future. The implementation period of a suspension is determined by the time that is reasonably required to take measures to end the offence, to undo its consequence partly or completely and to avoid any repetition of the offence. The implementation period of a withdrawal takes into account the time that is reasonably required to close down the organizations and/or activities in question. A suspension can be imposed together with the obligation to design and implement a regularization plan and/or closing down plan. A withdrawal can be imposed under damages.
- *Administrative fine**. The administrative fine is a sanction in which the competent institution imposes an unconditional obligation on the violator to pay a certain amount of money. We make a distinction between two types: the alternative and the exclusive administrative fine. The alternative type is an alternative for penal pursuit, the exclusive type concerns violations that are no penal offences.

- *Administrative deprivation of benefits****. The deprivation of benefits is a sanction in which the competent authority orders the violator to pay a sum of money equivalent to the benefits that he derived from the offence. In our legislative setting, deprivation of benefits can only be imposed together with an administrative fine.
- *Administrative transaction****. The administrative transaction is an instrument for violations that are no penal offences. The competent authority proposes to the violator to pay a sum of money and, eventually, to take measures to end the violation, to undo its consequences completely or partially and to avoid any repetition of the violation and / or to abandon goods whose possession is against the law. When the violator doesn't accept the proposal, the violation is communicated to the authority competent for administrative fining. This instrument aims at relatively unimportant environmental crimes; the transaction sums are adapted to this (e.g. maximum 1.000 to 1.500 euro per violation).

Overview of sanction execution instruments

- *Administrative damages****. Administrative damages can be stipulated in a decision imposing a regularization order, a cessation order, or the withdrawal of an authorization. The damages support the timely and complete execution of the obligations contained in those sanctions. They can only be stipulated when the person to whom the sanction is given, holds the power to execute the obligations contained in the sanction. The competent authority shapes the damages as a sum to pay at once, or a sum per time unit or per offence. The damages are due when the obligations contained in the sanction are not timely or completely executed as ordered.
- *Regularization plan**. A regularization plan is a help to take away the cause of an offence in the situations where it is linked to unadapted or illegal installations. The obligation to formulate and execute a regularization plan can be stipulated in decisions imposing a regularization order or the suspension of an authorization. A regularization plan at the minimum holds the following data: the causes of the offence, the means to end the offence and to prevent its repetition, the concrete measures that guarantee the compliance with the violated legal prescriptions and whom the violator will take, and the delays in which those measures can and will be taken.
- *Closing down plan****. A closing down plan is a help for the temporally or definitive closing down of an installation or activity in a safe and legal way in those cases where such closing down has technical aspects that are delicate, complex or potentially problematic in environmental respect.

Rough estimation of the time required for the application of enforcement instruments

Monitoring instruments	Preparation	Implementation	Execution aspects
Entrance right	+	+++ to +++++	0
Inspection and copying business documents	+	+ to +++++	0 to +++
Right to inspect goods a.o. sampling	+	+ to +++	0 to +++++
Right to inspect	0	+ to +++	0 to +++++

transportation			
Expert assistance	+	+ to +++	+ to +++++

Sanctioning- and sanction execution- i.	Preparation	Implementation	Execution aspects
Regularization order			
as such	+++	+++	+++
with damages	++++	++++	+++++
with regularization plan	+++	+++++	+++++
with closing down plan	+++	+++++	+++++
with damages and plan	++++	+++++	+++++
Cessation order			
as such	+	+++	+++
with damages	+	+++	+++++
Administrative coercion	+++	+++	+++++
Suspension			
as such	+++	+++	++++
with regularization plan	+++	+++++	+++++
with closing down plan	+++	+++++	+++++
Withdrawal			
as such	+	+++++	+++++
with damages	+++	+++++	+++++
with closing down plan	+++	+++++	+++++
with damages and plan	++++	+++++	+++++
Administrative fine (A)			
as such	+	+++	+ to +++
with deprivation of advantages	+++	++++	+ to +++++
Administrative fine (B)			
as such	+	+++	+ to +++
with deprivation of advantages	+++	++++	+ to +++++
Transaction	+	+	+

Discussion results

The aforementioned overviews provide a basis for the interdisciplinary dialogue concerning the development of the dynamical model (Task D2). It is clear that every sanction can provide information on the considerations that were taken into account when deciding on the type and level of the sanction. Analyzing the existing case history (cases brought for the Council of State,

the highest administrative law college and, if possible, others) can obviously yield useful information.

5. Future prospects and future planning

A first priority will be the formulation of cards for tradable permits by the legal scholars. Based on the knowledge collected during the modelling of other, better-known, instruments, we will write down the cost aspects that are typical for tradable permits. These cost aspects do not only consider the regulatory phase but also the implementation and enforcement (monitoring, sanctioning and sanction-execution) phase. Cooperation with the economic team will ensure the estimation of these cost aspects. This monetary valuation of the cost aspects of the instruments will be used as input in a numerical model with which we estimate the social cost of the instrument. The numerical model was developed during the SPSD I – model ‘Law & Economics and the choice of environmental policy instruments’. We will finish these tasks in 2003.

A second priority is the collection of data to build a database of monitoring and enforcement data for Flanders. The Flemish environmental inspection agency (AMI) will help us collect these data.

Once collected, the database will be used to estimate an inspection function. We want to investigate which firms have a higher chance to be inspected. We will work in a partial equilibrium framework. Economic theory has found that the inspection decision depends on the firm’s past compliance history, complaints, the size of the firm, the sector... This analysis should provide insight into the current enforcement policy.

Further we would also like to obtain information about which sanctions are levied against firms in violation. We will refine and extend the analysis of the level of penal fines that were issued by the Court of Appeal of Gent. Moreover we will look at different sanctions, such as, compliance orders, annulment of permits, transactions or settlements.

We will also theoretically extend the model to incorporate more than one period. The behaviour of the agents will differ if they know they will have to cooperate again later. This model will provide the necessary theoretical foundations for the previously described analysis of the penalty and inspection function. We will investigate how a multi-period model influences the inspection agency and the enforcer. The legal team will follow-up on the work of the economic model by the CES-team, especially with respect to the reality value of the model. They will supervise closely the ‘translation’ and the use of enforcement instruments into the model.

6. Annexes

6.1 References

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6.3 Detailed results

Details of survey of empirical studies concerning monitoring and enforcement

Size of the (administrative) fine levied depends on...	Study
<ul style="list-style-type: none"> - number of previous enforcement actions issued by OWR against respondent - number of excursions committed by respondent - permit dummy - failed to submit DMRS dummy - allowed permit to expire dummy - illegally discharged a substance dummy - region dummies - district represented by at least one member of the house natural resources committee dummy - district represented by at least one member of the senate environmental quality committee dummy - district represented by at least one member of the house 	Kleit, Pierce and Hill (1998)

<ul style="list-style-type: none"> - appropriations committee - district represented by at least one member of the senate - revenue and fiscal affairs committee 	
<ul style="list-style-type: none"> - price - vessel size - variance - compliance inspections - observed oil transfers - patrol ports - spill size - vessel size - enforcement - fraction cleaned up - time dummy - inland waterway dummy - beach dummy - crude oil dummy - gasoline dummy - distillate fuel oil dummy - diesel oil dummy - residual fuel oil dummy - personnel error dummy - improper maintenance dummy - equipment failure dummy - intentional discharge dummy - natural cause dummy - seasonal dummy 	Cohen (1987)
<ul style="list-style-type: none"> - damaged resource - primary cause of emission - secondary cause of emission - economic group of the responsible party - region (dummies) - measured caused damage (dead commercial fish and destroyed agricultural crop) - type of pollution - fish killed or not (0/1) 	Earnhart (1997)

Inspection decision (0/1) depends on...	Study
<ul style="list-style-type: none"> - type of production dummy - lagged pollution - current inspections - previous inspections - regional dummy - daily productive capacity 	Laplante and Rilstone (1996)
<ul style="list-style-type: none"> - economic profit of mill - difference between plant's shutdown point and current price of its product - level of pollution in surrounding community - per capita income of surrounding community 	Helland (1998a)

<ul style="list-style-type: none"> - number of quarters since plant has been inspected - number of significant violations last year - dummy if plant failed to file DMR - portion of EPA's budget spent on water pollution control - number of manufacturers - violation rate at company's other mills - rate of self-reported violations at company's other mills - gross rate of return by firm - dummy if plant independently operated - cost of compliance - total number of employees - inspections that detect violations - inspections that do not detect violations - level of self reporting by other mills - gross rate of return by firm 	
<ul style="list-style-type: none"> - quarter of the year - mill's history of past inspections - past history of violations - amount of EPA's budget spent on water/number of manufacturers - number of manufacturers - average weekly pay of state employees - dummy if state has formally delegated authority for enforcing CWA - budget variable - average salary of state employees - stringency of last inspection - % of county labour force employed at plant - delegation dummy - per capita income - daily mill output - pollution level one year ago - product type - plant's history of past inspections - region dummy 	Helland (1998b)
<ul style="list-style-type: none"> - unemployment rate in local market - number employees in plant/total employment within a circumference of 100km of plant - number of years of production by plant - number of months within previous 12 months in which plant complied with TSS standards - number of months within previous 12 months in which plant complied with BOD standards - total number of inspections per year in region of plant excluding inspections at plant - regional dummies - trend - annual dummies - average annual household income - presence of organochlorides - population of city if plant's discharges are upstream the city - ratio of the flow of effluent over flow of river - environmental pressure on river 	Dion, Lanoie and Laplante (1996)

Violation depends on...	Study
<ul style="list-style-type: none"> - inspection in particular period (0/1) - dummy region - dummy SIC code - number of tons produced daily at plant - dummy time 	Magat and Viscusi (1990)
<ul style="list-style-type: none"> - type of production dummy - lagged pollution - current inspections - previous inspections - regional dummy - daily productive capacity 	Laplante and Rilstone (1996)
<ul style="list-style-type: none"> - total effluent charge per day/annual sales of plant (proxy for cost of compliance) - daily output of mill - plant's history of past violations - product type - age of plant - compliance rate at firm's other plants - gross rate of return by firm - dummy if plant independently operated 	Helland (1998a)
<ul style="list-style-type: none"> - total enforcement actions for plant (predicted) - dummy if enforcement action in plan past 2 years - predicted number of inspections - dummy if plant was inspected past 2 years - cost per ton of capacity to bring plant into full compliance - predicted probability that plan will close during contraction - plant capacity - firm's total capacity - % of firm's work force in steel division - firm's gross rate of return - dummy if firm owns single steel plant - average compliance rate of firm's other plants in previous year/ all past years 	Gray and Deily (1996)
<ul style="list-style-type: none"> - number of appearances on list as 'out of compliance' - number of appearances on list as 'of concern' - dummy if subject to new BC regulation - number of prosecutions faced by firm in given year - total amount of fines imposed on a plant in a give year - production - dummy for river basin - region dummy - dummy if mechanical process 	Foulon, Lanoie and Laplante (1999)

Details on the study of the fine level in the Court of Appeal in Gent

The size of the penalties in the regulation under consideration can be found in the following table.

	Imprisonment	Penalty
ARAB 1946 (sedert 1974) <i>Labour safety</i>	8 days – 1 month	50 – 50.000 BEF ⁴
Wet 1971 Oppervlaktewateren <i>Surface water</i>	8 days – 6 month	26 – 5.000 BEF
Milieuvergunningdecreet 1985 <i>Environmental permits</i>	8 days – 1 year	100 – 100.000 BEF
Mestdecreet 1991 <i>Manure</i>	8 days – 2 months or 8 days – 6 months or 8 days – 1 year	100 – 50.000 BEF or 100 – 75.000 BEF or 100 – 100.000 BEF

This table gives the definitions and descriptions of the variables used.

Variable	Definition
Dependent variable	
BOETEKL	Fine pronounced in the first instance or in appeal
Independent variables	
OMAAN	Costs of the Public Prosecutor for cases in the first instance
OMBER	Costs of the Public Prosecutor for cases in appeal
STRAFREG (0/1)	Defendant has a criminal record or not
LAND, BETON, BOUW, DANCING, VOEDING, ZAND, SCHROOT, MEUBEL (0/1)	Sector in which the defendant works: agriculture, concrete industry, building industry, dancing, food industry, sand extraction, scrap yard, furniture industry
ARAB (0/1)	Charge within the scope of law on labour safety (ARAB)
MVD (0/1)	Charge within the scope of decree on environmental permits
WOW (0/1)	Charge within the scope of law on surface water
MEST (0/1)	Charge within the scope of the manure decree
DUUR	Duration of the violation (in months)
HGSDUM (0/1)	= 1 if there was a prison sentence complementary to the fine
VOOR94 (0/1)	= 1 if the case appeared in first instance before 1994
NEG	Number of aggravating circumstances mentioned
AANBOEKL	Fine pronounced in first instance

⁴ The conversion rate for BEF in Euro is 40.3399 BEF = 1 Euro.

This table gives the descriptive statistics for the variables of the 'first instance' model.

	Minimum	Maximum	Average	Std. Deviation
BOETEKL	0	4 000	203.793	551.653
BOETE	0	4 000 000	203 792.453	551 652.913
HGSDUM	0	1	0.283	0.455
OMAAAN	0	88 956	2 812.283	12 481.263
VOOR94	0	1	0.283	0.455
LAND	0	1	0.226	0.423
BETON	0	1	0.019	0.137
BOUW	0	1	0.057	0.233
DANCING	0	1	0.038	0.192
VOEDING	0	1	0.189	0.395
ZAND	0	1	0.019	0.137
NEG	0	4	1.547	1.084
STRAFREG	0	1	0.038	0.192
ARAB	0	1	0.075	0.267
MVD	0	5	1.283	0.968
WOW	0	3	0.359	0.710
MEST	0	1	0.057	0.233
DUUR	0.03	159	15.868	29.710
Number of observations N	53			

This table gives the descriptive statistics for the variables of the 'appeal' model.

	Minimum	Maximum	Average	Std. Deviation
BOETEKL	0	1 800	220.453	325.308
BOETE	0	1 800 000	220 452.830	325 307.832
AANBOEKL	0	4 000	203.793	551.653
OMBER	0	3 917	1 996.774	1 345.904
LAND	0	1	0.226	0.423
VOEDING	0	1	0.189	0.395
BETON	0	1	0.019	0.137
ZAND	0	1	0.019	0.137
BOUW	0	1	0.057	0.233
DANCING	0	1	0.038	0.192
SCHROOT	0	1	0.019	0.137
MEUBEL	0	1	0.057	0.233
NEG	0	4	1.547	1.084
STRAFREG	0	1	0.038	0.192
ARAB	0	1	0.075	0.267
MVD	0	5	1.283	0.968
WOW	0	3	0.359	0.710
MEST	0	1	0.057	0.233
DUUR	0.03	159	15.869	29.710
Number of observations N	53			

This table gives the expected signs of the different variables.

	Boete in eerste aanleg	Boete in beroep
OMAAN	+	nvt
OMBER	Nvt	+
STRAFREG (0/1)	+	+
LAND, BETON, BOUW, DANCING, VOEDING, ZAND, SCHROOT, MEUBEL (0/1)	?	?
ARAB (0/1)	+	+
MVD (0/1)	+	+
WOW (0/1)	?	?
MEST (0/1)	+	+
DUUR	+	+
HGSDUM (0/1)	?	nvt
VOOR94 (0/1)	?	nvt
NEG	+	+
AANBOEKL	nvt	+