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The Impact of Sanctions and Inspections on Firms' Environmental Compliance Decisions[1]

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Abstract

Firms' compliance decisions are expected to be strongly influenced by the expected fine for non-compliance with environmental regulations. In this paper we measure the effect of the probability of inspection and the size of the fine – jointly and separately – on the compliance decisions made by textile firms in Flanders. The results confirm the deterrence effect of increasing inspections, but they do not support a similar finding for monetary sanctions. The low levels of the sanctions that courts levy and the rapidly increasing marginal abatement costs imply that firms' compliance decisions are not positively affected by the imposed penalties. However, we do find that it might be welfare enhancing to occasionally scan a selection of firms or sectors more deeply since the number of detected violations raises significantly as a consequence.

Keywords: Monitoring and enforcement; environmental regulations; textile sector

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I. INTRODUCTION

In the context of environmental regulation as well as other policy areas, it is important to strategically choose the monitoring and enforcement policy in order to put the legislation in effect. Environmental rules will have little or no impact on environmental quality without an adequate inspection and sanctioning strategy in place. The compliance decisions made by firms are often thought to be strongly influenced by the expected fine for non-compliance (Becker, 1968)[2]. This expected sanction is, in essence, determined by the probability of inspection and by the size of the fine. In this paper we measure the effect of these two variables – jointly and separately – on the compliance decisions made by textile firms in Flanders. These estimations allow us to approximate the benefits of increasing each parameter and compare them with the associated costs.

The design and composition of the monitoring and enforcement policy is of great importance to policy makers, not only because it determines the impact of the environmental legislation, but also because substantial expenditures are associated with it. As a case in point, Cohen (1987) showed the marginal cost of the prevention of oil spills in the US consists for more than 25 % of enforcement costs.

Previous empirical research which estimates both compliance and inspection decisions include, among others, the work by Gray and Deily (1996). The authors use data on individual steel plants to study the relationship between regulator's enforcement of air pollution regulations and firms' compliance decisions in the United States. They find the expected interactions between the decisions: at the plant level, greater enforcement leads to greater compliance, while greater compliance leads to less enforcement. The analysis did not include information on fines but it did include data on inspections, letters, phone

[2] For an extensive overview of the research following and extending Becker's work, we refer to Cohen (2000) and Polinksy and Shavell (2000).

calls, and enforcement orders. The enforcement pressure variable used depended on the total number of these actions.

Nadeau (1997) used survival analysis to model the EPA's effectiveness at reducing the duration of plant-level non-compliance. Nadeau considered the separate effects of monitoring actions (inspections) and enforcement actions (orders and penalties) on the length of the non-compliance period of pulp and paper plants. He found that both instruments reduce the time in violation, though the enforcement actions seem to have a stronger effect.

Finally, Earnhart (2004; 2006) analyze the regulatory factors (i.e. inspections and enforcement actions) that shape the level of performance at individual polluting facilities. The enforcement actions[3] imposed by the US EPA and the Kansas Department of Health and Environment are aggregated into one count variable. No monetary measure of enforcement was included in the analysis because the scarcity of fines imposed in the sample. The evidence provided by the estimations about the amount of deterrence generated by actual interventions is mixed. While federal and state enforcement actions against large municipal wastewater treatment plants in Kansas significantly improve environmental performance, federal and state inspections at specific facilities are similarly ineffective at improving performance.

The focus of this contribution is different from much of the earlier empirical work since the impact of monitoring and enforcement on firms' compliance decisions is investigated in more detail. More specifically, the estimation takes the monetary consequences (fines and settlements) for violating firms into account. The results confirm the deterrence effect of increasing inspections, but they do not support a similar finding for monetary sanctions.

[3] The enforcement actions include the following types: (1) consent order or agreement, (2) corrective action, (3) remediation requirement, and (4) administrative, civil, or criminal fine. The data were collected using the EPA's Docket database (now called ECHO database).

The low levels of the sanctions that courts levy and the rapidly increasing marginal abatement costs imply that textile firms' compliance decisions are not positively affected by the imposed penalties. However, we do find that it might be welfare enhancing to occasionally scan a selection of firms or sectors more deeply since the number of detected violations raises significantly as a consequence.

Section II describes the empirical model that will be estimated. The dataset and the variables used are presented in section III. Section IV gives the estimation results for three different specifications of the model and in section V we discuss these results.

II. EMPIRICAL MODEL

This section presents the empirical model to be estimated as well as the method that is used. The goal of the estimation is to examine the effect of monitoring and enforcement on firms' compliance decisions while taking into account the inspection agency's audit decisions.

It is commonly known that data on noncompliance with laws and regulations are systematically biased. Typically, the data only include detected violations, which are not representative of all violations. This problem of incomplete detection can seriously complicate statistical analysis. In order to analyze the compliance decision of Flemish textile firms, we use a bivariate probit model with partial observability. Poirier (1980) has discussed the estimation and identification issues of this model when the observed binary outcome of the model does not reflect the binary choice of a single decision-maker, but rather the joint unobserved binary choices of two decision-makers (i.e. firm and inspection agency). Meng and Schmidt (1985) extended the model and discussed five cases which range from full observability to partial observability in the sense of Poirier (1980).

Feinstein (1990) has renamed this method 'detection controlled estimation' and has presented a case study of the US Occupational Safety and Health Administration's safety regulation. Helland (1998) has applied this method to the enforcement of pollution control laws and has investigated the compliance and self-reporting decisions of pulp and paper companies with respect to water pollution regulation.

Each period firm *i* decides whether to comply with environmental regulations or not. A site will comply if the benefits of compliance exceed the costs of complying. When the net benefits of compliance are positive, the latent variable V_{1it} is expected to be positive. The probability that a firm *i* is compliant at time *t* can then be modeled using this latent variable:

$$V_{1it} = x_{1it}\beta_1 + \varepsilon_{1it}$$

$$Y_{1it} = \begin{cases} 1(compliance) & if\, V_{1it} \geq 0 \\ 0(in\, violation) & if\, V_{1it} < 0 \end{cases}$$

where Y_{1it} is the observed binary variable, β_1 is a vector of the coefficients to be estimated and x_{1it} is a vector including several monitoring and enforcement variables and plant characteristics, which are discussed in section III.

In each period the environmental inspection agency also decides to inspect a number of sites. The probability that the agency inspects firm *i* at time *t* is determined by:

$$V_{2it} = x_{2it}\beta_2 + \varepsilon_{2it}$$

$$Y_{2it} = \begin{cases} 1(inspected) & if\, V_{2it} \geq 0 \\ 0(not\, inspected) & if\, V_{2it} < 0 \end{cases}$$

where Y_{2it} is the observed binary variable, β_2 is a vector of the coefficients to be estimated, V_{2it} is a latent variable reflecting the difference between the benefits and costs of inspecting site *i* and the vector x_{2it} includes several monitoring and enforcement variables and plant characteristics, which are also discussed in section III.

Let $F(\cdot)$ be the probability that $Y_{1it}=1$ and $G(\cdot)$ be the probability that $Y_{2it}=1$. If link functions[4] are monotonic and Gaussian, the likelihood of inspecting a compliant firm in period *t* is (Helland, 1998):

$$L_{Y_{1it}=1,Y_{2it}=1}=\sum_{Y_{1it}=1,Y_{2it}=1}\log\left[F\left(x_{1t}\beta_1\right)G\left(x_{2t}\beta_2\right)\right]$$

The likelihood of observing a detected violation is

$$L_{Y_{1it}=0,Y_{2it}=1}=\sum_{Y_{1it}=0,Y_{2it}=1}\log\left[\left(1-F\left(x_{1t}\beta_1\right)\right)G\left(x_{2t}\beta_2\right)\right]$$

The likelihood of not inspecting a compliant firm equals

$$L_{Y_{1it}=1,Y_{2it}=0}=\sum_{Y_{1it}=1,Y_{2it}=0}\log\left[F\left(x_{1t}\beta_1\right)\left(1-G\left(x_{2t}\beta_2\right)\right)\right]$$

The likelihood of not inspecting a violator equals

$$L_{Y_{1it}=0,Y_{2it}=0}=\sum_{Y_{1it}=0,Y_{2it}=0}\log\left[\left(1-F\left(x_{1t}\beta_1\right)\right)\left(1-G\left(x_{2t}\beta_2\right)\right)\right]$$

The problem for the researcher is that the last two categories are observationally equivalent. In both cases no inspection is observed and no information on the firm's compliance status is available. However, the methodology developed by Poirier (1980) and Meng and Schmidt (1985) allows a consistent estimation of the factors influencing inspections and violations (see also Greene, 2002).

III. DATA AND VARIABLES

This section describes the dataset that is used and defines the explanatory variables. We investigate what factors can potentially influence compliance and inspection decisions.

[4] The link function relates the random distribution of the measured variable of the experiment (the distribution function) with the systematic (non-random) portion of the experiment (the linear predictor). (Dobson, 2002).

3.1 Data

In 2002 the Flemish environmental inspection agency (AMI) performed a complete environmental audit of forty-one textile improvement and carpet production companies (NACE-codes 17.3 and 17.51) within the framework of the internal project P216. The database collected by AMI contains information about 1800 inspections completed between 1991 and 2003. Per inspection we have information on its characteristics (type, cause, and timing) and on its results (violations and enforcement actions). In Rousseau (2007) and Billiet and Rousseau (2005) three types of inspections – routine, reactive, and project-related – are distinguished and the targeting approach of the inspection agency is analyzed for each category.

In order to investigate the compliance decisions of the firms, we now add data on the water related emissions by each firm, which were collected by the Flemish Environmental Agency (VMM). The dataset contains yearly (1994 – 2003) information on several key indicators such as daily BOD[5] load and the daily effluent load at the sites.

Figure 1 shows the number of inspections performed per year and the compliance status of the firms during these audits. The peak in 2002 is due to the project P216. On average 150 site visits took place, or each firm was inspected 3.75 times per year. Looking at the compliance status of the firms during these inspections, we find that over the years at least 30 % (1994) and at most 66 % (1999) of the firms were compliant. Over the complete database, we found that 47 % of the firms were found to be compliant during an inspection. The violations that were detected include both administrative shortcomings (e.g. missing documents such as maintenance reports or fire safety reports, incomplete or missing exploitation licenses, and the inaccessibility of measuring points) as well as

[5] BOD or Biological Oxygen Demand represents the amount of oxygen (mg/l waste water) that certain bacteria use, during five days at 20°C, in order to oxidise organic carbon to carbonic acid.

emission related violations (e.g. breaches of emission standards for one or more water pollutants, air pollution, smoke or bad smell, and oil spills).

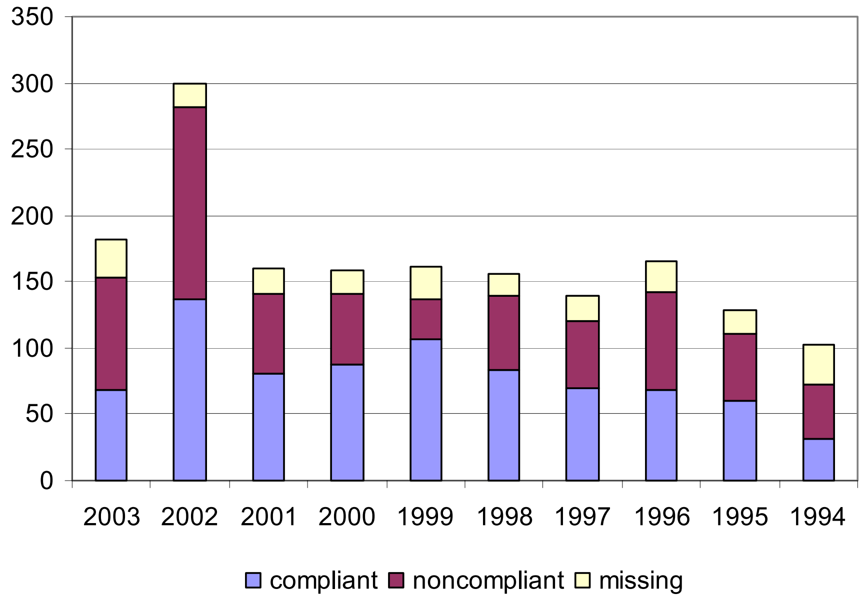

Figure 1: Number of inspections per year and compliance status (Rousseau, 2007)

We also investigate the enforcement actions taken after or during an inspection which found a firm in violation. The environmental agency can issue advices, warnings or notices of violations.[6] An advice is given to recommend the firm to make sure that the present situation of compliance with regulations continues in the future.[7] A warning, on the other hand, is provided to instruct the firm to end the present situation of non-compliance and abide with all appropriate laws, decrees, and permits. A notice of violation (NOV)[8] formally documents a violation. This document can be used as evidence in a court of law and a copy is send to the Public Prosecutor. Moreover, the agency can

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

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

[8] Internal regulations of AMI state that the civil servants do not always have to issue a notice of violation when violations are discovered. They can evaluate the situation and use their professional competences to decide on the firm's level of precaution. However, a warning will always be sent to a violating firm.

also use administrative sanctions, such as making a motivated proposal to the administration in power to suspend or withdraw the firm's environmental permit. The latter sanctioning instrument does not occur in our sample.

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

Table 1: Enforcement actions (Rousseau, 2007)

Noncompliant during inspection	Enforcement action taken		Information on follow-up[9]		Legal consequence		Average monetary penalty
709	NOV	140	Info	69	Court of Appeal	2	7165 Euro
					First instance	15	2869 Euro
					Settlement	16	260 Euro
					Dismissal	36	0
			No info	71			
	Warning	38					0
	Advice	21					0
	No action	510					0

In Table 1, we analyze what happens after an inspection that found a firm in violation and focus, more specifically, on the monetary penalties imposed. As mentioned above, in

[9] We process here the information received by AMI on the follow-up on NOVs by the Prosecutor's Office.

the majority (72 %) of the cases no enforcement action was taken. We concentrate on the notices of violations that are issued, since a copy of those is always sent to the Public Prosecutor in order to start criminal prosecution. These violations can potentially lead to monetary penalties.

In our sample, only 25 percent of the cases (17 out of 69) are actually brought to trial. In 23 percent of the cases (16 out of 69) a settlement is negotiated and the remaining cases (52%) are dismissed without further consequences. Looking at the average monetary penalty, we see that the average settlement amount is 260 Euro, the average fine at the first instance is 2869 Euro and the average fine at the Court of Appeal is 7165 Euro.

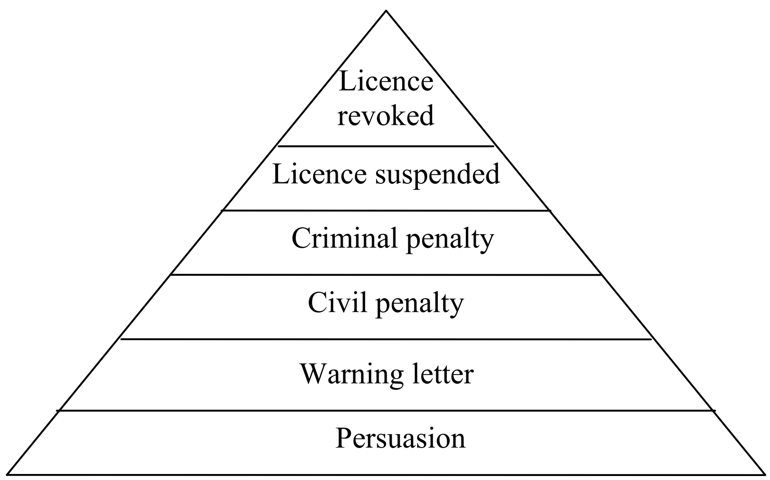

Figure 2 : Ayres and Braithwaite's enforcement pyramid

The monetary penalty for violating environmental regulations in Flanders is apparently limited. The expected monetary sanction, combining fines and settlements, after a violation is detected equals only 176 Euro. There must therefore be other motivations for firms to comply with environmental policies. Typically, the environmental agency starts with more lax instruments only to move up to harsher ones and thus it proceeds through the different stages of an enforcement pyramid (Ayres and Braithwaite, 1995) until it has secured an offender's compliance (see figure 2). This threat of harsher punishment (e.g.

firm closure) can be sufficient to make firms comply. Other possible reasons for firms' compliance include, among other things, risk aversion, the presence of social norms, the presence of other environmental regulations and dynamic interactions between firms and inspection agency.

3.2 Explanatory variables

We now discuss the different factors that determine firms' compliance and the environmental agency's inspection decisions. We use quarterly data and summarize the different variables in table 2 at the end of this section.

3.2.1 Probability of compliance

The probability of compliance will depend on variables determining the expected costs and benefits of a violation and other firm characteristics. The specification of the compliance equation is given by

$$Compliance_{it} = f\begin{pmatrix} INSPQ, COMP, NOV, COMPLAINT, MONSAN / SANCTION, EXPSAN \\ IMPROVE, CAPACITY, SURFACE, BOD, RETURN, AGE, Y2002 \end{pmatrix}$$

Firstly firms' compliance decisions depend on several monitoring and enforcement variables such as the predicted number of inspections and their history of past violations. The probability of future inspections is approximated by the variables INSPQ1 and INSPQ2, which indicate whether or not a firm was visited by the agency one (two) quarter(s) ago. In order to predict a firm's compliance status, we also include the observed compliance status one, two, three and four quarters ago (COMP1, COMP2, COMP3 and COMP4). If a firm was found to be compliant in the previous quarter (COMP1=1), we can expect the firm to be still following the rules this period. Therefore we expect a positive coefficient for the variables COMP. Firms that were in violation and received a notice of violation less than a year ago (NOV) can either still be in violation or they can have rectified the situation. The expected sign of the variable NOV can thus not be predicted. If a complaint concerning a firm is received by the environmental inspection agency, we can suspect that that firm has a higher probability of being found in violation when inspected. The variable COMPLAINT counts the number of complaints that were received of the firm in the previous year and its coefficient is expected to be negative. Based on the economics of crime (Becker, 1968), we expect firms that had to pay a monetary sanction in the recent past to be more compliant in the present. The 0/1-variable MONSAN equals one if the firm had to pay a monetary sanction less than two years ago. The variable SANCTION is continuous and specifies the level of the monetary sanction that the firm had to pay in the previous two years. Again we expect that firms that were recently subject to a monetary sanction will be more likely to follow the rules. We also define the variable EXPSAN as the product of INSPQ1 and SANCTION. This variable is thus a proxy for the expected monetary sanction for each firm based on its past violations.

Another set of factors determining firm's compliance are plant characteristics. The firms in our sample belong to two subsectors of the textile industry, textile improvement and carpet production, and we expect to see a difference between the two firm types. The average composition of the wastewater discharged by the two sectors indicates that, overall, carpet production tends to be dirtier than textile improvement (Jacobs et al., 1998). Thus the coefficient of the variable IMPROVE (i.e. a dummy for the cleaner sector) can be expected to be positive. The size of the firm is another important factor and is measured by the variable CAPACITY. Larger firms potentially produce more pollution. However, they are also better informed and have more resources to spend on abatement. The influence of firm size on its compliance status is, therefore, ambiguous. Further, it will also be important whether the firms discharge in the sewer system or in surface waters[10]. Firms discharging in surface waters might be more careful, in which case we expect a positive sign for the variable SURFACE. Firms that emit higher levels of pollutants might be more likely to exceed environmental regulations. We use the daily load of BOD as a proxy for the size of the pollution caused by the firm and expect its coefficient to be negative. We also look at the influence of the financial situation of the firm through the firm's gross rate of return (RETURN). Firms with more financial resources presumably spend more on information gathering and emission abatement. This implies a positive coefficient for RETURN. We also include the age of the plants (AGE) as a determinant of compliance behavior. We can also expect more detected violations during the execution of project P216 in the year 2002, since the project implied a thorough scanning of textile firms. We expect, therefore, a negative sign for the dummy variable Y2002.

3.2.2 Probability of inspection

The inspection agency selects the firms it inspects based on several characteristics. The specification of the inspection decision is

$$Inspection_{it} = f\begin{pmatrix} INSPQ, COMP, NOV, COMPLAINT, MONSAN, \\ IMPROVE, SURFACE, BOD, QFLOW, Y2002 \end{pmatrix}$$

These determinants can be divided into two categories: i) monitoring and enforcement variables and ii) plant characteristics. These are subsequently discussed in more detail.

A first set of monitoring variables (INSPQ1 and INSPQ2) represent whether the firm was inspected one (two) quarters ago. INPSQ will probably pick up firm characteristics that are not included in the analysis but that influence the likelihood of being examined by AMI. Examples of these unobservable plant characteristics are the social norms of the

[10] In our sample half of the firms discharge in surface waters while the other half discharge in the sewer system.

managers, the environmental awareness of the plant's neighbors, and the skills of the workers. Also, however, if the plant was inspected often before, this could be because it is known to be a bad performer. The practice of inspecting firms most likely to violate a regulation is often referred to as targeting. A significant and positive coefficient for the variable INSPQ might thus be proof of targeting. Empirical evidence (e.g. Eckert (2004), Gray and Deily (1996), Nadeau (1997) and Rousseau (2007)) has already shown that environmental inspection agency often target firms based on their compliance history. Thus we expect a negative coefficient for the variable COMP and a positive one for the variables NOV, MONSAN and SANCTION. Furthermore we expect that firms with many complaints in the past year (COMPLAINT) will be more frequently inspected. This prediction is based on the agency's internal regulations, which state that complaints must be followed by a site visit within three months.

Next we discuss the firm characteristics that were included in the analysis. We can expect a negative sign for the variable IMPROVE that relates to the less dirty firms, since increasing compliance of the dirtier firms will have a higher impact on the environmental quality. Moreover, the environmental agency can find it beneficial to target firms that discharge in surface waters, since the effluent disposed in sewers is carried to water treatment plants for additional treatment while those disposed in surface water are not. As a result, we expect a positive sign for the variable SURFACE. This expectation is reinforced by the yearly report of AMI in which we read that the agency has the intention to inspect firms that discharge in surface water more frequently (AMI 2005, p.70). This report also states that inspections are determined by the waste load that is discharged. This leads us to expect a positive sign for the variables BOD and QFLOW (daily waste load).

We can also expect more frequent inspections during the project's execution in the year 2002, since P216 implied a thorough scanning of the textile firms. We expect, therefore, a positive sign for the dummy variable Y2002.

Table 2: Variable definitions

Variable name	***Unit***	***Definition***
Dependent variables		
COMP	0/1	=1 if firm observed in compliance during inspection at time t
INSPQ	0/1	=1 if firm inspected at time t
Independent variables		
INSPQ1/2	0/1	= 1 if firm inspected one/two quarters ago
COMP1/2/3/4	0/1	= 1 if firm observed in compliance 1/2/3/4 quarters ago
NOV		= number of NOV in previous year
COMPLAINT		= number of complaints received in previous year
MONSAN	0/1	= 1 if firm had to pay monetary sanction in past two years
SANCTION	Euro	= amount of monetary sanctions paid in past two years
EXPSAN	Euro	= expected fine (INSPQ x SANCTION)
IMPROVE	0/1	= 1 if independent textile improvement firm
CAPACITY	Ton/day	= firm's capacity for pre-treatment and dyeing
SURFACE	0/1	= 1 if firm discharges in surface water
QFLOW	m^3	= daily load of waste water
BOD	Kg O2	= daily load of BOD5
RETURN		= net return on firm's total assets
AGE	In years	= age of firm
Y2002	0/1	= 1 if year 2002

IV. ESTIMATION RESULTS

The estimation results using a bivariate probit model with partial observability are presented in table 3 for three specifications for the compliance and inspection decisions[11]. The specifications differ with respect to the way the monetary sanction is included:

specification (1): includes the dummy variable MONSAN

specification (2): uses the continuous variable SANCTION

and specification (3): includes the variable SANCTION and the variable EXPSAN.

[11] The correlation coefficients of all variables are (well) below $|0.35|$ except for the variables COMP1, COMP2, COMP3 and COMP4 which are correlated and the variables EXPSAN and SANCTION which have a correlation coefficient of 0.90.

Table 3: Estimation results: Coefficients (p-value)

	Specification (1) # obs = 964 Log lik. = -958.7		Specification (2) # obs = 964 Log lik. = -959.1		Specification (3) # obs = 964 Log lik. = -958.8	
	Insp	Comp	Insp	Comp	Insp	Comp
INSPQ1	**-0.1878** (0.0570)	-0.0972 (0.2872)	**-0.1853** (0.0614)	-0.1023 (0.2610)	**-0.1866** (0.0375)	-0.0901 (0.3232)
INSPQ2	-0.0465 (0.5902)	**0.1897** (0.0306)	-0.0463 (0.5921)	**0.1847** (0.0344)	-0.0491 (0.5551)	**0.1813** (0.0372)
IMPROVE	-0.0771 (0.4161)	0.0024 (0.9779)	-0.0848 (0.3694)	0.0081 (0.9265)	-0.0877 (0.2903)	0.0081 (0.9267)
CAPACITY	-	0.0001 (0.9464)	-	0.0002 (0.8780)	-	0.0002 (0.8856)
COMP1	-0.0188 (0.8852)	**0.7232** (0.0000)	-0.0084 (0.9489)	**0.7185** (0.0000)	-	**0.7126** (0.0000)
COMP2	0.0132 (0.9222)	-0.0951 (0.4333)	0.0138 (0.9195)	-0.1021 (0.4042)	-	-0.0914 (0.4226)
COMP3	-0.1128 (0.4064)	**0.2305** (0.0814)	-0.1104 (0.4151)	**0.2257** (0.0884)	-	0.1742 (0.1475)
COMP4	0.0974 (0.4024)	0.0709 (0.5487)	0.1011 (0.3854)	0.0694 (0.5552)	-	0.1081 (0.2987)
NOV	**0.2389** (0.0218)	-0.0737 (0.4103)	**0.2519** (0.0145)	-0.0913 (0.3029)	**0.2541** (0.0101)	-0.0918 (0.2996)
COMPLAINT	**0.1644** (0.0003)	**-0.0979** (0.0002)	**0.1673** (0.0002)	**-0.1004** (0.0001)	**0.1666** (0.0002)	**-0.0998** (0.0001)
MONSAN	0.2025 (0.1846)	**-0.2552** (0.0616)	**-**	-	**-**	-
SANCTION	-	-	0.00007 (0.2907)	**-0.000072** (0.0977)	0.000059 (0.3843)	0.02455 (0.8259)
EXPSAN	**-**	-	**-**	-	-	**-0.0001** (0.3018)
SURFACE	**-0.2535** (0.0266)	0.0427 (0.6894)	**-0.2534** (0.0266)	0.0448 (0.6744)	**-0.2537** (0.0227)	0.0428 (0.6873)
BOD	-0.000005 (0.9727)	0.00008 (0.5455)	-0.00002 (0.8747)	0.000099 (0.4290)	-0.00002 (0.8725)	0.0001 (0.4159)
QFLOW	**0.00028** (0.0007)	-	**0.00028** (0.0007)	-	**0.00028** (0.0005)	-
RETURN	-	-0.0049 (0.4497)	-	-0.0049 (0.4421)	-	-0.0053 (0.4107)
AGE	-	**0.0058** (0.0014)	**-**	**0.0058** (0.0016)	**-**	**0.0057** (0.0016)
Y2002	**0.7131** (0.0000)	**-0.5901** (0.0000)	**0.7018** (0.0000)	**-0.5735** (0.0000)	**0.7019** (0.0000)	**-0.5741** (0.0000)

The results suggest that firms are more likely to be inspected if they were not inspected during the previous quarter, if they received a NOV in the previous year, if a high number of complaints were submitted during the previous year, if they discharge their effluent in the sewer system, if their daily waste load is higher, or in the year 2002. Further we find that we are more likely to observe compliant behavior with firms that were found to be compliant in the previous quarter, that were inspected two quarters ago, that received no or only few complaints in the previous year, that did not pay a monetary sanction during the previous two years, that are older, or in years other than 2002.

V. DISCUSSION

In this section we first make some general observations concerning the estimated results. Next we concentrate specifically on the monitoring and enforcement variables.

5.1 General observations

The significant results for the variables COMP1 and COMP3 indicate that a firm that was compliant during the last period is more likely to be compliant in the current period. The firms' compliance status seems to be persistent over time. This result is obvious for abatement decisions that involve investments in technologies or infrastructure, but it is not evident if violations consist of sporadic incidents.

The significant results for the variable COMPLAINT show the importance of involving neighborhoods in the monitoring process. Complaints submitted by citizens to the environmental agency provide a reliable signal of an increased probability of finding the firm in violation with environmental regulations. The inspection agency has picked up on this and it visits firms with complaints more frequently.

Contrary to the official inspection policy, firms that discharge their waste water in surface water are inspected less frequently than sites that are connected to the sewer system. However, the positive coefficient for QFLOW indicates that the policy of inspecting firms with a higher waste load is indeed being implemented by the environmental inspection agency.

Finally it seems that older firms are more likely to be compliant than more recently established plants. The longer firms are active, the more information they are likely to have about their production processes, the technological possibilities and their compliance status. Moreover, these firms will have a more established relationship with the environmental inspection agency. This might lead to faster solutions to detected problems since the policy in Flanders is essentially a problem-solving one rather than a penalizing one (Rousseau, 2007).

5.2 Impact of different monitoring and enforcement actions

First we discuss the impact of inspections and monetary sanctions on compliance decisions by firms. Next we compare the costs and benefits associated with regulatory projects such P216 “Integrated Control of Textile Improvement Firms”.

Impact of inspections

Looking at the impact of inspections, we see that firms have a lower probability to be inspected if they were inspected in the previous quarter. Also we find that firms that were inspected two quarters ago have a significant higher probability of being observed complying environmental regulations. The time lag between inspections and compliance can be explained by looking at the agency’s procedures. Typically when a firm was found in violation, a notice of violation is issued and this notice is always accompanied by a compliance order. Such a compliance order will give the violator at least three months (one quarter) time to correct the situation and conform to the regulations. The time lag observed in our results might therefore be caused by the time given to firms to obey the rules.

Impact of monetary sanctions

If we look at the impact of monetary sanctions (MONSAN, SANCTION and EXPSAN), we find some surprising results. Apparently firms that had to pay a monetary sanction during the previous two years are more likely to be violators, when inspected, than firms that did not have to pay a fine or settlement. This group of firms does not seem to be deterred by the monetary sanctions and continue to violate environmental regulations. One reason for this behavior can be found in figure 2, which represents the marginal abatement cost curve for textile firms in Flanders. It is clear that the abatement costs for textile firms are often much higher than the fine that might be imposed (maximum 7165 Euro, see table 1). The low expected sanction (i.e. 176 Euro) does not provide all firms with sufficient incentives to abate their emissions and obey regulations. The results might also indicate that the firms' ex-ante and the ex-post estimations of the monetary sanctions differ. Firms that did not have to pay a fine in the recent past are less able to correctly anticipate the expected level of the sanction and might overestimate the expected fine. Firms that were fined recently, however, have a more accurate impression of the true expected sanction, which might be lower than initially projected.

The low sanctions are not dictated by the associated legislations and the discretion of judges in imposing sanctions is substantial in Flanders. The Labor Safety Law (ARAB 1946), the Environmental Permit Decree (Milieuvergunningsdecreet 1985) and the Manure Decree (Meststoffendecreet 1991) allow sanctions up to 500000 Euro. More recent legislation includes even higher maximum fines: for example, a fine up to 50 million Euros is possible within the Waste Decree (Afvalstoffendecreet 1981, as amended in 1994) and the Soil Clean-up Decree (Bodemsaneringsdecreet 1995) (Billiet and

Rousseau, 2003). Thus there are no legal inhibitions why the level of fines imposed for environmental offenses might not be higher.

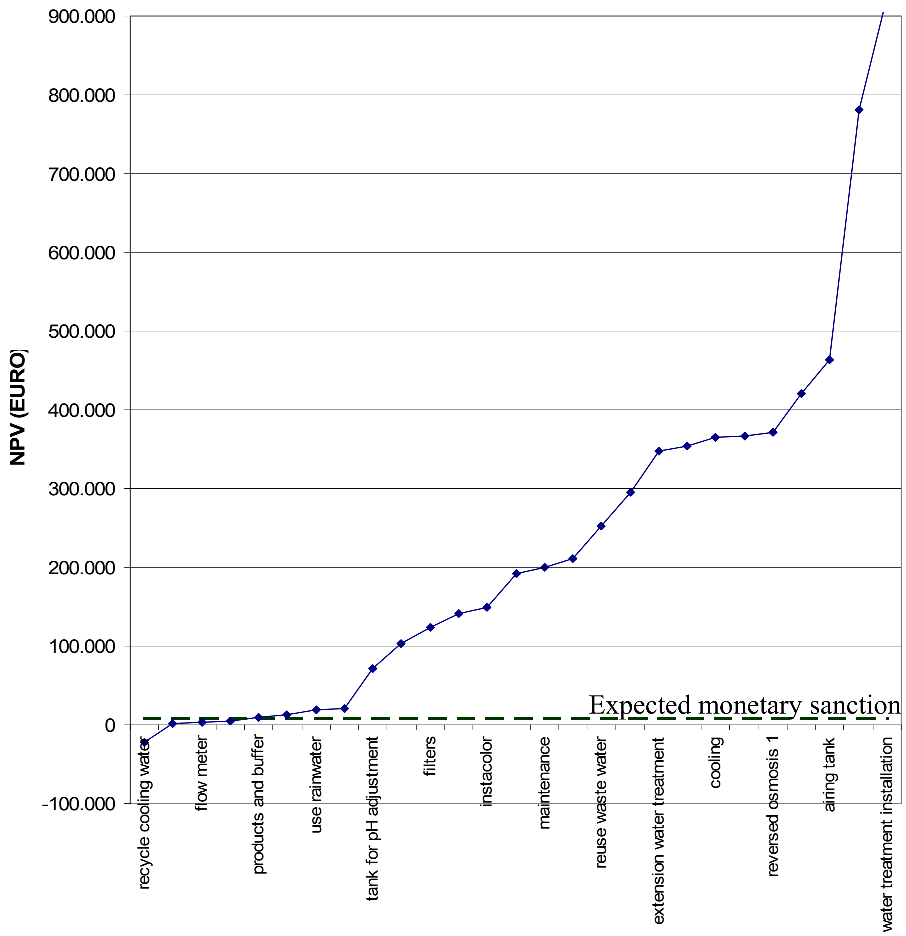

Figure 3: Marginal abatement cost curve

Source: Survey of Flemish textile firms (2000)

The results with respect to the monetary sanctions suggest that marginal increases in the fine levels are probably useless. The estimated model, however, does not allow us to comment on non-marginal changes in the sanctions imposed. Substantially higher penalties might increase compliance as suggested by economic models of crime (Becker, 1968).

Costs and benefits of regulatory projects

Each year the Flemish environmental inspection agency plans a number of regulatory projects. These projects typically focus on one problem firm, sector or technology. We can now use the data collected to evaluate the usefulness of regulatory projects such as P216. We can examine whether these projects are likely to be welfare enhancing. Several aspects need to be considered. Firstly, the costs associated with the regulatory project include the additional inspections that are needed. In 2002 the environmental inspection agency performed 150 extra inspections compared to the yearly average in our sample. Moreover, these inspections took more time than average: an inspection executed as part of the P216 project took on average 122 minutes, while other inspections took on average 77 minutes. These averages include the time needed to get to the site and back to the office as well as the actual time spent on the firms' premises. Also more samples of the firms' wastewater streams were taken and needed to be analyzed. In the yearly report 2003 (AMI, 2003) we find that 233 samples were taken in the course of the project. Since the inspection agency is restricted by its available budget, the opportunity costs of using resources on the regulatory project rather than on other monitoring tasks need to be taken into account. The more frequent and more detailed audits also imply that both the inspection agency and the firm have additional administrative costs, such as writing reports, accompanying inspectors on site, searching for reports and information, or making phone calls (Rousseau and Proost, 2005).

Table 4: Impact on number of detected violations

	Yearly average 1994-2003 (excluding 2002)	**2002**
Administrative violations	19.44	44 (+126%)
Emission related violations	36.11	60 (+66%)
Number of warnings	4.13	18 (+336%)
Number of Notices of Violation	8.38	12 (+43%)

Inspections performed as part of the project P216 seem to be more thorough and are, therefore, more likely to find the firm in violation with one or more elements of environmental regulations. In 2002 significantly more serious violations (i.e. violations mentioned in a NOV) were detected than in other years. Table 4 shows that the raise in administrative violations was more prominent than the increase in emission related violations. This increase in detected violations was furthermore associated with a raise in administrative costs for both government and firms (Rousseau and Proost, 2005).

The increased monitoring and enforcement efforts enhance deterrence in the sector under scrutiny as well as stimulate progress in the environmental problems associated with that sector. In the yearly report 2003 we see that 46 of the 99 specific warnings that were issued during the project were taken to heart by the firms by the end of 2003. The remediation of these environmental violations is bound to lead to an improvement of the environment. It is, however, impossible to put monetary values on the enhanced deterrence and the environmental improvements for this illustration.

In table 5 we summarize the different costs and benefits of implementing regulatory projects. Since there are no data available to provide a reliable estimate of the benefits associated with the regulatory project, we focus on the cost side. Using data from the yearly report 2003 (AMI, 2003) of the environmental inspection agency, we are able to estimate the monetary costs of the project. We assume that 48 percent (see table 1) of the notices of violations originated from the project, i.e. 22 NOVs (AMI, 2003), are followed by a sanction, which can be either a fine or a settlement. Table 6 shows that the monetary costs for the regulatory project P216 are approximately 300000 Euro. Taking into account that the total population of the provinces East and West Flanders amounts to 2.5 million, this implies that as long as the willingness-to-pay for the benefits associated with the project exceeds 12.1 cents per inhabitant the project will be welfare improving.

Table 5: Costs and benefits of implementing regulatory projects

Costs		Benefits	
More inspections Longer inspections	150 extra inspections 122 minutes per extra inspection	More detected administrative violations	24.56 violations
More samples to analyze	233 samples + Approx. 375 € per analysis*	More detected emission related inspections	23.89 violations
More administrative costs associated with inspections	Per audit*: 2.5 man-days for government 1 man-day for firm	More general deterrence	
More administrative costs due to increase in warnings and NOV	Per criminal fine*: 70 man-days for government 39 man-days for firms	Increased environmental quality	
Opportunity costs (fixed budget)			

* Estimates taken from Rousseau and Proost (2005)

Table 6: Monetary costs of the regulatory project

	Number	**Unit cost**	**Total (euro)**
More inspections	150 inspections	64 € per inspection	9600
More samples to analyze	233 samples	375 € per sample	87375
More administrative costs			
for firms (inspections)	1 man-day x 150 insp.	120 € per man-day	18000
for firms (prosecution)	39 man-days x 10 pros.	120 € per man-day	46800
for government (prosecution)	70 man-days x 10 pros.	200 € per man-day	140000
TOTAL			**301775**

Source: AMI (2003); Rousseau and Proost (2005) and own calculations

Depending on the seriousness of the environmental problem of the sector under investigation, a targeting approach to inspection seems to be worth its while. Regulatory projects can be welfare enhancing since thorough audits are able to uncover several administrative and emission related violations that are overlooked by routine inspections.

VI. Conclusion and Policy Recommendations

In line with previous empirical and theoretical research, the estimation results indicate that increasing the number of inspections will lead to more observed compliance. However, the findings do not confirm the deterrence effect of monetary sanctions. Despite very high legal ceilings, monetary sanctions for environmental violations are so low in Flanders that they are not able to convince firms to comply. On the contrary, the fact that a firm has paid a monetary sanction in the recent past can act as an indicator of violating behavior by textile firms. However, the environmental inspection agency does not seem to target firms based on previously imposed monetary sanctions.

These results lead us to suggest that substantial increases in the monetary sanctions will be necessary to provide sufficient incentives for firms to comply with environmental regulations. The costs of investing in abatement technologies are, after all, much higher for textile firms than the current fines that are imposed by the courts.

Further we found that the apparent state of compliance of firms can be deceptive since more thorough audits can lead to substantial increases in observed violations. Administrative violations seem to be pervasive. Examples of these are missing fire and maintenance reports, incomplete registers of toxic substances, belated submission of yearly emission reports, or incorrect environmental licenses. The more profound inspections, however, also uncovered several emissions related violations. This targeted approach to inspections has therefore a significant effect on the environmental impact of the selected firms on the ecosystem.

In conclusion, the impact of inspections and sanctions on firms' compliance decisions is significantly different. For this reason it is important that the regulator investigates the precise circumstances in the policy region and the industrial sector before deciding how to allocate resources to improve monitoring and enforcement of environmental regulations.

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