Evidence of a Filtered Approach to Environmental Monitoring

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ABSTRACT

This contribution focuses on the formulation of optimal inspection strategies and distinguishes between a targeting approach and a filtered approach to monitoring. Using a case study for the Flemish textile industry, we investigate the costs and benefits associated with specific monitoring and enforcement campaigns. The results show the beneficial role such campaigns can play in an effective and efficient monitoring policy. Thus we provide empirical evidence of the advantages associated with the filtered monitoring approach and show that filtering is an interesting complement to targeting.

Keywords: Environmental regulation; Monitoring and enforcement; Policy design; Filtered approach

JEL Codes: K32 Environmental law; K42 Illegal behaviour and the enforcement of law

1. INTRODUCTION

It is commonly known that the act of designing and publishing regulatory rules is insufficient in order to ensure compliance with these rules. Law enforcement thus has an important value to add to the legislative process. We can distinguish two different aspects implied by law enforcement: monitoring and sanctioning. Monitoring consists of overseeing compliance with regulations and sanctioning concerns situations where, as a result of monitoring, a violation has been detected and where the appropriate actions are taken. In reality, violations of environmental regulations are a common occurrence and effective compliance practices in a particular region can differ substantially from the actual text of the legislation. This incomplete compliance can be the result of a deliberate strategy by the regulator in order to adapt legislation to local circumstances or it can be an unintended fact due to ambiguity in the legislative text or due to the scarcity of available resources.

In order to efficiently use government funds, it is important to carefully consider the amount of resources allocated to the enforcement process associated with environmental regulation. The direct costs of monitoring and enforcement should be balanced with their deterrence effect on the pollution level targeted by the regulation (specific deterrence) as well as their impact on compliance with other regulations (general deterrence). The well-thought-out formulation of inspection strategies can be framed within the general European trend towards more systematic, clearly planned and coordinated monitoring and enforcement. This trend was confirmed by 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. For this reason, we focus on optimising the monitoring strategy in this contribution and, more specifically, the inspection strategy implemented by the environmental inspection agency when enforcing regulation aimed at firms. After developing the appropriate theoretical framework, we investigate in more detail the inspection strategy of the Flemish environmental inspection agency (also called 'Afdeling Milieu-Inspectie' or 'AMI' in the remainder of the text). In particular we study the possible role of enforcement projects in an optimal inspection policy using data on one specific campaign – i.e. the P216-project *Integrated control of textile improvement companies*. Even though the case might be considered small and benefit estimates are only indicative, it nevertheless yields interesting results on the design of monitoring strategies. We show that efficiency gains can not only be attained from the careful selection of firms to routinely inspect ('targeting'), but also from the judicious use of standard and thorough inspections ('filtering'). Thus, the filtered approach can be an interesting complement to the targeting approach in the development of inspection policy.

First we develop a theoretical framework to discuss the importance of selecting and implementing an optimal monitoring strategy (section 2). Next, in section 3, we discuss the relevant background to the specific enforcement campaigns executed in Flanders (Belgium) (3.1), the project P216 *Integrated control of textile improvement companies* (3.2) and the dataset (3.3). Further, in section 4, we describe the costs and benefits associated with the P216 project and estimate their monetary impact when possible. Finally, we conclude.

2. Theoretical framework

Previously, a number of law and economic studies have already commented on optimal enforcement strategies. A recent overview of the law and economics of environmental crime

can be found in Faure and Visser (2004). The probability of detection and the structure of the fine were investigated by, among others, Polinsky and Shavell (1979, 1992), Cohen (1987), Rasmusen (1995) and Garoupa (2001). These studies conclude that the optimal fine is determined in essence by the damage that was caused, the probability of detection and the cost of imposing the fine. However, it is less evident to derive the optimal probability of detection or the optimal inspection frequency. Its level depends, among other things, on the fixed and variable monitoring costs, the available budget, the damage caused, the firms' reactions and the legally allowed and actually imposed sanctions.

The alternatives open to the environmental inspection agency are constrained by the resources at its disposal and hence it is virtually impossible to monitor all firms on a frequent basis. A logical response to this scarcity of resources is searching for possibilities to improve on random inspections and use the available funds more effectively. Next we discuss two possible approaches to the more careful design of monitoring strategies: *targeting* and *filtering*.

Firstly, the agency can opt to implement a focused inspection policy which is also called *targeting*. Thus, the environmental agency will inspect those firms that are suspected to be in violation based on past behaviour. Such a targeted policy approach will induce more compliance than a random auditing approach. One of the first to investigate this targeting strategy in a theoretical model is Harrington (1988). Harrington shows how an enforcement agency can increase deterrence by dividing firms into two or three groups depending on their compliance status in the previous periods. The enforcement pressure on the group of 'good' firms will be significantly less than that on the group of 'bad' firms with past detected violations. This differentiated monitoring and enforcement approach motivates companies in the 'bad' group to comply with the environmental regulations so as to move to the 'good' group. Thus the agency's monitoring and enforcement strategy has additional leverage compared to a static approach and more deterrence can be achieved with the same amount of available resources. An important observation here is that the targeting approach is used to determine which firms will be inspected, however, it does not determine the type of inspection (standard versus thorough inspection) that will be performed. Indeed, only one type of inspection visit is implicitly taken into account. More recently, Lando and Shavell (2004) have also commented on the advantage of focusing law enforcement effort in a model where firms' compliance decisions are discrete (i.e. firms are either fully compliant or non-compliant and partial compliance is not possible). Consequently, several empirical papers[1] have studied the interactions between past violations and the structure of inspection strategy in search of evidence that this targeting approach is indeed used in practice. Harrington's model has successively been translated as targeting on het basis of the predicted compliance status of firms (Gray and Deily 1996; Laplante and Rilstone 1996), the company's compliance status in the previous quarter (Stafford 2002; Billiet and Rousseau 2005; Rousseau 2007) and the number of warnings imposed on the firm in the past (Eckert 2004).

Besides this targeting approach to designing an environmental inspection policy, it is also possible to use a *filtering* approach: thorough audits will only be executed after the firms have somehow been screened using signals. Note that the gain from the filtered approach arises both from careful selection of the firms to be inspected and from explicitly allowing two types of inspections: standard, partial, inspections and thorough, more complete, ones. The standard inspections do not have to include a site visit, but can also be based on a study of publicly available or previously gathered information (i.e. signals). In a recent study,

[1] For an overview of empirical studies of the enforcement of environmental policy see Cohen (2000).

Malik (2007) distinguishes emission related signals from other signals concerning the firms' compliance status. This last group of additional signals is in essence collected to be able to comment on the degree of intent associated with the violation. Furthermore, inspecting company administration, equipment and installations can be a less expensive way to determine the firms' compliance status compared to measuring actual emission levels. Malik (2007), however, does not specify which of these two types of signals should be collected first. Heyes (2002), on the other hand, specifically studies the role of a filtered approach to environmental inspection policy: he models the outcome of routine inspections as a signal of the possibility that the visited firm is in violation. Once this signal exceeds a certain threshold, the firm will be inspected more systematically. Using these signals in order to filter which firms qualify for comprehensive audits again ensures that the inspection agency can use its resources more effectively. We can define these signals in several ways such as, among other things, the outcome of routine inspections, the number of complaints received, the environmental classification of the firms or yearly turnover figures. In contrast to the targeting approach, the filtered approach to inspections has, to our knowledge, not yet been empirically studied. A first attempt to fill this gap is made in the current contribution by studying the environmental inspection strategy in Flanders (Belgium)[2].

3. Background to the case study

First we discuss into more detail the inspection strategy of the Flemish environmental inspection agency and more specifically the role of enforcement campaigns (3.1). Next we focus on one particular campaign, i.e. project P216 *Integrated control of textile improvement companies* (3.2). Finally, some important characteristics of the dataset are highlighted (3.3).

3.1 Enforcement campaigns

The Flemish environmental inspection agency ('Afdeling Milieu-Inspectie') divides its monitoring efforts into three categories: it distinguishes routine and reactive inspections as well as campaign related inspections (AMI 2006). Routine inspections form the backbone of the agency's inspection activities. AMI (2006) states explicitly that the main purpose of routine inspections is to provide a positive probability of inspection that is not related to complaints or campaigns. Reactive inspections, on the other hand, are answers to complaints, calamities, questions from the public prosecutor, parliamentary questions, and the evaluation of temporary licenses. Finally, campaign related inspections are determined by the agency's headquarters in Brussels and focus on sectors, on problem companies or on a specific pollutant or medium.

As shown by Billiet and Rousseau (2005) and Rousseau (2007), the selection of specific firms for routine inspections by the environmental inspection agency in the textile sector is a clear application of the targeting approach. Firms within the textile sector are selected on the basis of past compliance behaviour and the firm's capacity. With respect to the reactive inspections performed in the textile sector, it is more difficult to talk about targeting since these inspections are by definition reactions to questions, previous enforcement actions or complaints. In a way, however, one could say that the Flemish environmental inspection

[2] Belgium as a federal state consists of three regions: Flanders, Wallonia and Brussels Capital.

agency targets firms for which it receives complaints since these are always inspected within three months after the complaint was made (Billiet and Rousseau 2005; Rousseau 2007).

The specific enforcement campaigns, on the other hand, apply the filtering approach to inspections so as to increase deterrence by explicitly using both standard and thorough inspections. The agency uses a reasoning closely related to the one specified by Heyes (2002): based on certain characteristics ('signals') concerning the seriousness of the environmental problem in a particular sector, the agency plans thorough audits of specific (sub)sectors or firms. The yearly report (AMI 2006) defines specific enforcement campaigns as those inspection activities that are executed in a planned and coordinated manner. They are subdivided in enforcement projects, actions, studies and follow up of past campaigns. Firstly, projects are non-recurring and innovative initiatives which are both well defined in time and in content. The firms or sectors that are selected are potentially responsible for serious environmental damages and risks. Secondly, actions involve coordinated tasks in a specific sector and are aimed at performing the agency's monitoring objective. This contrasts with projects which are aimed at enlarging the agency's internal knowledge base and which are generally more original. Thirdly, enforcement studies are used when it is desirable to support the agency inspection practice with academic research. Clearly this last category is not of interest when we are discussing the filtering approach. In the remainder of the text, we therefore focus on enforcement projects and actions and exclude enforcement studies. When planning the enforcement campaigns, the inspection agency aims to deal with industry sectors with high environmental relevance, a balanced distribution of files over the different regional offices and a uniform strategy for the Flemish region as a whole. European directives such as the IPPC directive[3] and the Seveso II directive[4] often offer a useful guideline for the selection of sectors by providing relevant firm classifications that can be used in the filtering approach.

Using the environmental inspection programs (EIP) of the Flemish environmental inspection agency we can obtain a general idea of the number and the type of specific enforcement campaigns planned each year by the agency (see table 1). In its environmental inspection programs, the Flemish agency tries to map all its inspection activities as well as the necessary funds and personnel associated with these activities. By using the data from table 1, we can calculate that the environmental inspection agency plans on average forty-one enforcement campaigns per year; consisting of nine projects, seventeen actions, five studies and the follow-up of ten past campaigns on average. Moreover, sizable funds are extracted for covering laboratory costs and additional research costs imposed by specialized laboratories or experts: on average an amount of 594000 euro per year is reported.

[3] The IPPC directive 96/91/EG of 24 September 1996 concerning Integrated Pollution Prevention and Control focuses on an integrated and preventive approach to pollution.

[4] The Seveso II directive 96/82/EG of 9 December 1996 deals with the prevention of serious accidents concerning hazardous substances as well as limiting the consequence of such accidents for public health and the environment. It was extended by directive 2003/105/EC and applies to some thousands of industrial establishments where dangerous substances are present in quantities exceeding the thresholds in the directive.

Table 1: Overview of monitoring and enforcement campaigns (AMI reports 2001-2006)[5]

	2006	2005	2004	2003	2002	2001
Projects	12	11	8	8	8	7
Actions	22	15	25	15	10	13
Studies / research[6]	4	3	5	7	8	4
Past campaigns	7	11	6	11	12	12
Total number of campaigns	45	40	44	41	38	36
Research costs / specific enforcement studies[7]	473.994	542.880	462.015	391.548	545.786	437.096
Lab costs specific cases	209.996	93.834	36.199	186.038	103.761	78.455
Total resources specific enforcement (in €)	683.990	636.714	498.214	577.586	649.546	515.551

3.2 Description of project P216

During the year 2002 and the beginning of 2003 the Flemish environmental inspection agency executed the enforcement project P216 *Integrated control of textile improvement firms*. Using a filtering approach, the sector was selected from annex I to the European IPPC directive containing IPPC sectors. As mentioned in the yearly report of the Flemish environmental inspection agency (AMI 2002), the motivation for the integrated control of particular sectors can be found in the wish to implement the IPPC directive. The specific choice for the textile improvement sector is motivated by the observation that the sector has traditionally been viewed as having the potential of causing serious environmental damages due to the problems associated with wastewater discharges, storage and use of hazardous substances, large heating boilers, extensive groundwater collection, the storage and removal of waste products and noise (AMI 2002).

The textile improvement sector contains 'plants for the pre-treatment (operations such as washing, bleaching and mercerisation) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tonnes per day'. Within the project, the agency opted to inspect these firms that belong to the categories 41.4 and 41.6 in Vlarem 1.[8] Installations with a capacity exceeding 10 tonnes per day are IPPC plants and fall under the separate category 41.10 in Vlarem 1. Overall, forty-one firms were checked: twenty-one plants in West Flanders, eighteen in East Flanders and two in Limburg (AMI 2002 and AMI 2003). An additional

[5] Despite the fact that the Flemish environmental inspection agency started formulating EIPs from 1996 onwards (AMI 2006), they were only included in the agency's yearly report only from 2001 onwards.
[6] This category was called 'research' in EIP 2001 until EIP 2004 and was called 'enforcement studies' in EIP 2005 and EIP 2006.
[7] This category includes resources for additional studies by specialized labs and experts. It was called 'research costs' in EIP 2001 until EIP 2004 and 'overview of specific enforcement studies' in EIP 2005 and EIP 2006.
[8] Appendix 1 'An alphabetical list of establishments considered to be a nuisance' to the Order of the Flemish Government of 6 February 1991 concerning environmental licenses.

observation, which aggravated the strength of the 'signal' send by these firms, is the impact of the sector on the Flemish water pollution problem: the textile sector is after all the fourth largest industrial source of COD[9], total nitrogen and heavy metals discharges in Flanders.[10]

The integrated audits performed within the project P216 implied taking several wastewater samples and performing a variety of measurements. The project's main focus was monitoring firms' discharges of wastewater, but to a lesser extent it also included inspecting waste products, soil, groundwater use and discharges to air. During the execution of an integrated audit attention was given to, among other things, the status of the environmental license, wastewater discharges, emissions from heating installations, odour problems, storage of hazardous substances, waste management, groundwater extraction and noise. [11]

3.3 Description of the dataset

During the project *Law & Economics and the environmental law enforcement*[12] and in cooperation with the Flemish environmental inspection agency information was gathered concerning approximately 1800 inspections performed between 1991 and August 2003. In this case study we only take the audits executed between 1994 and 2003 into account since the data before 1994 are not entirely reliable[13]. The dataset contains information on a number of characteristics of each audit (type of inspection, its cause and the timing) as well as on the associated consequences (number of detected violations, enforcement actions and sanctions).

An extensive description and analysis of these data can be found in Billiet and Rousseau (2005) and Rousseau (2007). Here we briefly mention a number of relevant observations. Summarising over the complete dataset, on average each year 165 inspections were performed, or each firm in the sample was visited on average four times per year. With respect to the compliance status, during at least 42 percent (in 1994) and at most 77 percent (in 1999) of the inspections no violation of the environmental regulation was detected.[14] Overall, in 55 percent of the visits firms were reported to be compliant and thus one or more violations were detected for 45 percent of the inspections. These violations include administrative failures (e.g. missing documents such as maintenance report or fire reports, incomplete or missing environmental licenses and the inaccessibility of the measuring points) as well as emission related infractions (e.g. exceeding the discharge limits on one or more pollutants, air pollution and oil spills).

The average monetary fine reported by Billiet and Rousseau (2005) and Rousseau (2007) is very modest: after a violation of the environmental regulation was detected during an

[9] Chemical oxygen demand (COD) is defined as the amount of oxygen needed per liter wastewater to completely break down the organic elements through oxidation (MIRA-T 2006).
[10] MIRA-T 2007 Indicatorrapport, p.28.
[11] Yearly report AMI 2003, p.50-51.
[12] This was an interdisciplinary research project (2002 – 2004) financed by Federal Research Center with cooperation between the Center of Economic Studies of the K.U.Leuven (S. Proost, S. Rousseau & C.M. Billiet) and the Center of Environment Law of Ghent University (L. Lavrysen & C.M. Billiet).
[13] The Flemish environmental inspection agency was founded in 1991 and, in its own words, the agency was only fully functional in 1993. One of the effects of this starting-up phase is that many of the inspection reports are missing in the files and this makes the quality of the data concerning inspections before 1994 questionable.
[14] Here we exclude missing data. The percentages are calculated for the inspections for which we know the outcome.

inspection[15], the firm faced an expected monetary fine of 181 euro, taking settlements as well as criminal fines into account[16]. Using data reported in Rousseau (2007), the expected monetary fine for the textile firms in our sample was calculated as follows:

Probability of notice of violation after detection of the violation x
[*probability of settlement* x *average settlement amount*
+ *probability case to court of first instance* x *average criminal fine first instance*
+ *probability case to court of appeal* x *average criminal fine in appeal*]

= 0.20 x [0.23 x 260 + 0.22 x 2869 + 0.03 x 7165] = 181 euro.

The deterrence effect of this low expected fine is not likely to be the main reason for the textile firms' compliance with environmental regulations. Thus there must be other factors affecting their compliance decisions. One possible alternative is the concept of the enforcement pyramid introduced by Ayres and Braithwaite (1995)[17]. According to this model, violators are initially dealt with by soft enforcement instruments (such as advices and warnings) and only if those measures do not have the desired effect more stringent instruments are used. This way the enforcing authorities climb up the pyramid until the firm returns to compliance. The threat of more severe punishments, such as the suspension and withdrawal of the environmental license, can be a sufficient incentive for firms to encourage them to regularize their compliance status. For Flanders in 2003, the environmental inspection agency reports that 45 compulsory measures (i.e. orders to terminate (part of) the firm's activity) and 26 proposals to the qualified authority to withdraw or suspend a firm's license (including one textile firm) were used (AMI 2003). These administrative sanctions, combined with the occurrence of criminal sanctions which can also include mandatory measures, make the threat of harsher punishment credible for Flanders. Other alternative explanations that have been brought forward to explain high environmental compliance rates by firms are, among other things, risk aversion, the presence of other firm related legislation, the presence of social norms and the dynamic interaction between firms and inspection agencies.[18]

4. Case study of a filtered inspection strategy: project P216

In this section we first (4.1) give a description of the costs and benefits associated with the enforcement project P216 *Integrated control of textile improvement firms*. Next (4.2) the costs associated with the project are estimated and expressed in monetary terms. This allows us to comment on the welfare impact of this specific project and of filtered inspection strategies in general.

First, however, we discuss the benchmark to which we compare the impact of the filtering approach. As found by Billiet and Rousseau (2005) and Rousseau (2007), the Flemish environmental inspection agency applies the targeting approach for selecting firms for routine

[15] This probability is estimated using data from Rousseau (2007) and is low since in many instances more than one inspection was needed to formally document a violation. Also, many of the inspections in the dataset stated known violations in the inspection reports. Of course, these known violations will not to lead to the start of new sanctioning procedure since one was already started before.
[16] It is noteworthy that in none of the cases in our dataset an administrative sanction was imposed by the Flemish environmental inspection agency.
[17] See also Ogus and Abbot (2002).
[18] For a recent overview of these topics see Cohen (1999) and Rousseau and Billiet (2008).

(and reactive) inspections within the textile improvement industry. Thus, if the project P216 would not have taken place, we assume that the 'normal' monitoring strategy, i.e. targeting, would have been implemented. This implies that we compare the effects of filtering (through thorough project related inspections) combined with targeting (through standard routine and reactive inspections) to the effects of only using targeting in 2002 and part of 2003. The benchmark is then determined by taking the average from 1994 to 2001 of variables such as the number of inspections performed, the duration of inspections, the number of detected violations and the number of warnings and notices of violation issued. Therefore, if the benefits associated with the implementation of the enforcement project are likely to exceed the costs, then we have an indication that the filtering is socially beneficial to use as a complement to the targeting approach.

4.1 Description of costs and benefits

As shown in the previous section, the Flemish environmental inspection agency organises several enforcement campaigns each year. We can now use the information concerning project P216 *Integrated control of textile improvement firms* to discuss the likely impact and benefits of the filtered approach to monitoring firms for environmental compliance. Using the case study, we are able to investigate whether enforcement campaigns – and more specifically project P216 – may be beneficial for society and thus whether they can play a significant role in the design of an optimally planned inspection strategy. For this reason, several elements need to be considered with respect to the costs associated with such a project. A first type of costs associated with enforcement projects are the additional inspections needed to thoroughly audit the selected companies. In order to implement P216 the inspection agency performed 148 extra site visits in the textile improvement sector in 2002 and 2003[19] compared to the average over the previous years (see table 2). The sector under consideration was not only inspected more frequently, but these inspections also took more time than usual: audits within the scope of project P216 lasted approximately 122 minutes while the duration of other inspections was 77 minutes on average. The reported durations of these inspections include the time to drive to and from the firm as well as the actual time on site. Furthermore, it is clear that more samples of the wastewater streams will need to be taken for closer analysis of the firms' emission status. AMI (2003) states that as a result of the P216 project 233 samples were obtained and these samples obviously needed to be chemically analysed.

Since the environmental inspection agency is constrained by the amount of available resources, it is important to incorporate the opportunity costs of using these limited funds for the specific campaign under consideration. After all, these funds can no longer be used for other monitoring and enforcement actions. The more frequent and more meticulous inspections within the frame of an enforcement project also imply that the agency and the firms are confronted with higher administrative costs; for instance writing inspection reports, accompanying inspectors on site, searching for information and documents or sending letters.[20]

The inspection visits performed as a result of an enforcement campaign are more comprehensive and thorough and are therefore more likely than standard inspections to detect

[19] The data collection ended in august 2003. Thus the comparison for 2003 has to be corrected for this since we only observe eight months for that year.
[20] For more details on these costs see Billiet et al. (2002) and Rousseau and Proost (2005).

an infraction of one or more aspects of the environmental regulation in place. Indeed, we see in table 2 that significantly more violations were reported in 2002 and 2003. Table 2 shows that the number of administrative violations between January 2002 and August 2003 increased with 58.3 compared to the average in the previous years. This is a rise by more than 200 percent. Moreover the number of emission related violations also increased considerably in the same period going from 61.5 to 90 detected infractions. This implies a growth of almost 50 percent.

Table 2: Impact on the number of inspections and detected violations

		Number	Yearly average 1994-2001	Increase compared to average
Number of inspection visits	2002	235	146	+ 89
	2003	156	146 (x 8/12 = 97)	+ 59
Administrative violations	2002	44	16.6	+ 27.4
	2003	42	16.6 (x 8/12 = 11.1)	+ 30.9
Emission related violations	2002	60	36.9	+ 23.1
	2003	30	36.9 (x 8/12 = 24.6)	+ 5.4
Number of warnings	2002	18	3.6	+ 14.4
	2003	8	3.6 (x 8/12 = 2.4)	+ 5.6
Number of notices of violation	2002	12	8.1	+ 3.9
	2003	10	8.1 (x 8/12 = 5.4)	+ 4.6

As a case in point, AMI (2003) comments on the type of violations that were detected during the integrated audits of forty-one textile companies included in project P216:

- *License*: Ignoring one or two exceptions, the permitted classes coincided with the activities that were actually present. However, more problems were reported concerning the permitted amounts.
- *Wastewater*: The agency detected fully illegal discharges with two firms. At half of the textile companies breaches of one or more discharge limits were identified through the analysis of the samples taken. Also, approximately half of the firms did not meet all requirements concerning self monitoring of their wastewater.
- *Groundwater*: Ten companies extracted more groundwater than permitted.
- *Air*: Only twenty-four firms complied with the requirements with respect to self monitoring of heating installations. Nine firms did not perform any monitoring at all and eight firms did not obey the requested frequency. For thirteen firms the exploitation of a textile improvement installation resulted into complaints about bad smells.
- *Waste*: Seven firms did not keep a register of waste products at all and the registers of six other firms had data missing.
- *Storage of hazardous substances*: Five plants lacked the necessary permits for the storage of hazardous substances and considerably more plants faced difficulties complying with permit requirements.
- *Other*: Twenty-five companies did not have a report documenting adequate consultation of the fire departments concerning fire prevention and fighting.

Furthermore, as is calculated in more detail in the next section, the growth in the number of violations that was identified leads to a considerable increase in the administrative cost burden for firms, environmental inspection agency, public prosecutor offices and to lesser extent court magistrates.

We now turn to the benefits associated with filtered monitoring. The increase in enforcement activity within a particular industry typically results in an intensification of the deterrence effect for the industry under scrutiny and this provides a stimulus to deal more effectively with sectoral environmental problems. At the end of 2003 AMI (2003) reports that 46 out of 99 warnings[21] were already taken into account by the textile firms. Regulating these shortcomings cannot fail to lead to an improvement of the quality of the environment. However, it is virtually impossible to express these benefits of increased deterrence and environmental progress in monetary terms. Nonetheless, some general reference points for the willingness-to-pay for water quality improvements in Flanders are provided. However, the next section focuses mainly on estimating the costs associated with the project P216. After all, costs are generally more easily measured than environmental benefits since usually costs are already expressed in monetary terms. Moreover, more data concerning costs are readily available and the preferences of individuals and society with respect to costs are less subjective.[22]

In table 3 we summarise the categories of costs and benefits associated with managing and implementing enforcement projects as an application of the filtered approach to the design of monitoring policies.

Table 3: Costs and benefits associated with an enforcement project

Costs	Benefits
▪ More inspections ▪ Longer inspections ▪ More samples to analyse ▪ More administrative costs related to inspections ▪ More administrative costs by increase warnings and notices of violations ▪ Opportunity costs (fixed budget)	▪ More administrative violations detected ▪ More emission related violations detected ▪ More general deterrence ▪ Environmental improvement

4.2 Some estimates

Primarily, we now focus on the cost side related to the project, since a reliable estimate of the benefits is out of our reach. Using AMI (2003), Billiet et al. (2002) and Rousseau and Proost (2005), we are able to provide a rudimentary estimate of the monetary costs connected to the enforcement project *Integrated control of textile improvement firms*. We assume that 10 of the 22 notices of violations[23] that resulted from the project lead to a monetary penalty which

[21] During the P216 project 38 firms received a warning letter to encourage them to correct the identified shortcomings. These warning letters contained 99 specific warnings (AMI 2003).
[22] See, for instance, Proost and Rousseau (2007) or Callan and Thomas (2000).
[23] See AMI (2003), p.53. In Flanders, each notice of violation is send to the public prosecutor's office and then the prosecutor decides about the next step in the sanctioning process such as dismissal, settlement or a criminal court trial. We assume that 48% of 22 notices of violation are followed by a monetary sanction: that is 23% of

is either a settlement or a criminal fine. Note that this fraction of imposed monetary sanctions is high compared to the Flemish average that is estimated to be around 25% and 30% (Vander Beken and Balcaen 2007). Filtering by the inspection agency thus affects the working of the criminal sanctioning track and this reinforces the efficacy of the agency's enforcement campaigns. The calculations in table 4 show that the costs associated with project P216 are approximately 300000 euro.

Taking into account that the total population of the provinces East and West Flanders consists of 2.5 million individuals, or around 1 million households, the project is welfare improving as long as the willingness-to-pay for the benefits of the program – i.e. increased deterrence and environmental quality improvements – exceed 30 eurocent per household. Even if the actual costs are twice the estimated costs, the project will still be welfare enhancing as long as the willingness-to-pay is more than 60 eurocent per household. Even though we are unable to estimate the exact benefits associated with the project, we are able to give some reference points. In the study by Brouwer et al (2007), we find that approximately 53% of Flemish inhabitants are prepared to pay for an improvement of the water quality of the Schelde basin[24]. Moreover, the median willingness-to-pay for water quality improvements in the stream Schelde amounts to 19 Euro per year per household. Also in a study for the river Dender in Flanders (Liekens and De Nocker 2008), the willingness-to-pay for a water quality improvement from 'average' to 'good' was estimated to be 20 Euro per year per household.

Table 4: Monetary costs of enforcement projects

	Number	**Estimate unit cost**	**Total (euro)**
More inspections	150 inspections	64 € per inspection[25]	9600
More analyses of samples	233 samples	375 € per sample*	87375
More administrative costs			
- for firms (inspections)	1 man-day* x 150 inspections	120 € per man-day[26]	18000
- for firms (sanctions)	39 man-day* x 10 sanctions	120 € per man-day	46800
- for government (sanctions)	70 man-day* x 10 sanctions	200 € per man-day[27]	140000
TOTAL			**301775**

** Estimates based on Billiet et al. (2002) and Rousseau and Proost (2005).*

the cases can expect a settlement, 22% a criminal fine in first instance and 3% a fine in appeal (Billiet and Rousseau 2005). These percentages are estimated by looking at the outcome for 69 notices of violations for violations by textile firms in Flanders.

[24] Almost all (39 of 41) of the textile firms in our dataset are situated in this basin.

[25] The (administrative) cost of one inspection is calculated as the average of research costs and operation costs over all inspections in 2003; i.e. 746920 euro divided by 11605 inspections (AMI 2003). Here we do not include the wages of the enforcers since they are fixed for the short term.

[26] Estimate based on average gross wage of 3000 euro per month and 25 working days per month.

[27] Estimate based on average gross wage of 5000 euro per month and 25 working days per month.

The limited magnitude of the estimated costs associated with the enforcement project P216 compared the estimated willingness-to-pay of Flemish inhabitants for water quality improvements imply that this project has to potential to be socially beneficial. This then points to the desirability of combining a filtered approach with a targeting approach in the design of an effective and efficient monitoring policy.

5. Conclusions

Theoretical and empirical research has already shown that targeting inspections can considerably increase the efficient employment of scarce monitoring resources compared to random inspections. Next to this targeting approach to monitoring, recent theoretical models have also identified a constructive role of a filtered approach in the design of an optimal inspection strategy. The two stages promoted by the filtered approach, i.e. the selection of firms for thorough audits based on certain signals, lead to a more efficient use of the limited funds available to the inspection agency. This claim has, however, not been empirically tested before and therefore we investigate whether the enforcement campaigns executed by the Flemish environmental inspection agency are likely to be welfare improving. The welfare improvement that is estimated as a result of the case study for the textile improvement sector clearly supports the use of a filtered inspection policy in practice. Thus, the filtered approach based on the deliberate use of both standard and thorough inspections is an interesting complement to the better documented targeting approach.

Furthermore, enforcement campaigns are advantageous since the comprehensive audits identify several administrative and emission related violations which are not likely to be detected during routine inspections. The notable increase in the number of detected violations and the subsequent sanctions give the selected firms a clear signal of regulatory attention and this might prove beneficial for overall environmental quality. Depending on the magnitude of the environmental problem in the industry under scrutiny, both targeting and filtering have their role to play in the development of an optimal monitoring policy and have the potential to increase the social benefits associated with environmental monitoring and enforcement practices.

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