



Inspections, Enforcement and Water Pollution Discharges in  
Laguna de Bay, Philippines

Lourdes O. Montenegro  
Department of Economics, University of San Carlos

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# **Inspections, Enforcement and Water Pollution Discharges in Laguna de Bay, Philippines**

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## **Abstract**

Monitoring and enforcement is crucial to bringing about compliance to pollution control laws; its feasibility and effectiveness is an important consideration in the design of environmental regulations. For developing countries like the Philippines, where regulatory agencies routinely face severe budgetary constraints, understanding monitoring and enforcement issues take on added urgency. This paper reports the initial results of an analysis of the impact of inspections and legal enforcement on water pollution discharges of beverage and pulp and paper firms in the vicinity of Laguna de Bay, Philippines using a firm-level panel dataset covering the period 1997-2004. It was found that compliance cost, firm size and the presence of pulping processes is significantly and positively associated with higher levels of biological oxygen demand (BOD) and total suspended solids (TSS) in the firm's discharges. However, the monitoring and enforcement actions of the regulator appear to only weakly deter pollution discharges.

## **1. Introduction**

Much of environmental economics has traditionally turned a blind eye to the central importance of understanding monitoring, enforcement and compliance issues. In a survey of the field, Cropper and Oates (1992 p. 695) had pointed out that the bulk of the economic analysis of environmental regulation simply assumed that polluters followed whatever rules were put in place. This analytical neglect leads to an inflated view of the efficacy of environmental regulations (specifically, pollution control laws) and consequently, may lead to inappropriate policy recommendations. The reality is that compliance of agents is not assured; resources need to be spent on the monitoring of their environmental behavior and the enforcement of rules when violations are found.

Fortunately, there is now increasing recognition of the significance of such issues within environmental economics. This is evidenced by a rapidly growing literature that attempts both a positive analysis of regulator and firm/agent behavior as well as the normative analysis of optimal monitoring and penalty levels. Most of the growth in this literature, however, has been concentrated on theoretical efforts to extend and enrich the static model developed by Becker (1968) and adapting the theoretical frameworks of derivative works in the law and economics tradition so as to fit the pollution control context.<sup>1</sup>

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<sup>1</sup> I use the term pollution control to exclude the separate but large literature on monitoring and enforcement in fisheries.

However, the empirical literature has largely lagged behind. There remain, for example, relatively few studies that empirically investigate firm-level responses to monitoring and enforcement actions. Much cited examples of analyses in this vein include the work by Magat and Viscusi (1990) which empirically measured the impact of Environmental Protection Agency (EPA) inspections on the emissions of the pulp and paper industry in the U.S. as well as that by Laplante and Rilstone (1996) which does the same for the pulp and paper industry in Quebec, Canada. Both have shown that monitoring actions (e.g. inspections) had deterrent effect on firms. Laplante and Rilstone (1996), in particular, had also shown that the mere threat of an inspection had a strong negative impact on pollution emissions. Nadeau (1997) extended such analysis to find that monitoring reduces the duration of non-compliance as well. While these three studies empirically model firm-level responses to monitoring and enforcement actions, they do not explicitly set about to test and link with the rich variety of theoretical models available. Their results however can be described as consistent with the implications of static Becker-type models—monitoring and enforcement action increases the expected penalty and hence leads to increased compliance. Helland (1998), marked a new development in this area by explicitly testing hypotheses that can be drawn out from the dynamic targeting model of compliance developed by Harrington (see for example Russell, Harrington and Vaughan, 1986). Eckert (2004) empirically investigated the role of warnings as an enforcement tool by using compliance data of petroleum storage sites in Manitoba, Canada and obtained results consistent with the implications of the Harrington model. All these studies mentioned, however, are exclusively based on regulatory experiences in developed countries, the U.S. and Canada in particular.

While resources available for monitoring and enforcement are generally limited, the limitation is much more pronounced in developing countries where severe fiscal and socio-political constraints often characterize efforts of regulatory agencies. A case in point would be the Philippines, an archipelagic biodiversity hotspot whose national government currently faces a debt equivalent to 78 % of its 2003 Gross Domestic Product and where a third of national government expenditures are already taken up by interest payments alone (De Dios et.al., 2004; p. 1). This implies that resources for many other categories of public expenditure, including the monitoring and enforcement of pollution control are severely constrained. In the 2005 national government budget, only about Php 187 million or USD 3.46 million was allocated for environmental management and pollution control (DENR-EMB, 2005).

Given the severe fiscal constraints faced by developing country agencies, it is therefore especially crucial to understand the impact and effectiveness of regulators' monitoring and enforcement actions on reducing emissions. Empirical work on this issue in a developing country context has only recently emerged and is still very limited. An early study on determinants of firm compliance in developing countries by Pargal and Wheeler (1996) has focused on the role of 'informal regulation' or on how community pressures affect the environmental performance of firms. As such, they have not investigated the role of regulators' actions *per se*. On the other hand, the study by Hettige et al. (1996) has examined the contribution of formal regulatory pressure on levels of pollution abatement by firms in South and Southeast Asia. However, the concept of formal regulatory pressure (measured through a constructed index) that was used in the study was not unbundled into either monitoring or enforcement actions. The study by

Dasgupta et al. (2000) on the determinants of compliance among firms in Mexico looked at the kind of environmental management policies adopted by firms as the main explanatory variable but has also examined the impact of inspections on the adoption of environmental management practices. Both studies have used cross-section data in contrast to the panel datasets used by North American studies and was therefore limited by the range of analysis that was feasible. Hence in this context, the subsequent work by Dasgupta et al. (2001) with a panel dataset for industries in Zhenjiang, China marked a new development by extending the framework used by Laplante and Rilstone (1997) to include citizens' complaints (equivalent to the 'informal regulation' mentioned earlier) and pollution prices. They were able to demonstrate that in the Chinese context, complaints as well as inspections had a statistically significant negative impact on emissions, although for the later, this impact was lower than those obtained in North American studies. Wang and Wheeler (2005; p. 175) pointed out that the Chinese regulatory set-up differs markedly from that in the U.S. and Canada partly because legal contestation of compliance rulings is not allowed. I argue that this absence of 'contested enforcement' may make the Chinese case unique not only in contrast with developed countries but with many other developing countries as well. This may partly limit the wider applicability of insights gained from the Chinese regulatory experience. Unlike in the Chinese case, enforcement actions of Philippine environmental laws are highly contestable and it is not uncommon for firms to negotiate lower fines or succeed to have their pollution cases dismissed. As a result, increased intensity of monitoring and enforcement may also paradoxically increase pollution discharges.

In this paper, I report on the initial results of an analysis of the impact of inspections and legal enforcement on conventional water pollution discharges of beverage and pulp and paper firms in the vicinity of Laguna de Bay, Philippines using a firm-level dataset covering the years 1997-2004. My research objectives are two-fold: (a) to describe the regulatory framework and monitoring and enforcement regime in the Laguna de Bay area and (b) to empirically analyze the firm-level impact of these monitoring and enforcement actions on conventional water pollution discharges.

The paper proceeds as follows. In Section 2, I outline the basic economic theory of monitoring and enforcement of pollution control and discuss how this is modified by the inclusion of contested enforcement, dynamics and multi-period interactions, and informal pressure. I then proceed to discuss the various testable hypotheses deriving from this body of theory in relation to the determinants of firm compliance as well as how these have been supported by empirical analysis in developing countries. In Section 3, I describe the regulatory context in Laguna de Bay, Philippines as well as the existing monitoring and enforcement regime. In Section 4, I describe the dataset, discuss its issues and present the empirical model and estimation results. Conclusions and plans for further research are outlined in Section 5.

## 2. The Economics of Monitoring, Enforcement and Compliance to Pollution Control Laws

Cohen (1999; p. 46) decomposes the economics literature on monitoring and enforcement as made up of ‘positive’ and ‘normative’ theories. He characterizes positive theories as comprising that which sought to explain the behavior of the agents involved, either the regulated parties and/or the regulator (government agencies that monitor and enforce environmental regulation). He contrasts this with normative theories which deal with the optimal level of monitoring and enforcement. Since the difference is often not clear cut with insights and implications going both ways, I do not make the distinction in the discussion that follows.

### *The Basic Static Framework*

The basic model for monitoring, enforcement and compliance to pollution control laws evolved from Becker’s classic analysis of the economics of crime and punishment. Following the analysis by Becker (1968) on the “supply of offenses,” the agent’s decision to comply or not to comply is modeled as a cost-benefit decision made under conditions of risk. That is the polluter decides to comply or not based on the consideration of the cost of compliance and its benefits—the avoidance of an expected level of penalties. Heyes (1998; p. 51-53) sets up this simple model as:

$$C_i \leq \pi P, \quad (1)$$

where under conditions of random monitoring, a profit-maximizing and risk-neutral firm will comply if the cost of compliance,  $C_i$ , is cheaper relative to the expected penalty it faces. This expected penalty is determined by the probability of getting caught,  $\pi$ , and the size of the penalty,  $P$  (Ibid., p. 51). This basic framework can be extended to examine the compliance rates across the industry as a whole with  $C$  set-up as a cumulative distribution function,  $\gamma$ , taking on values of zero to one and the first equation can be re-stated as (Ibid., p. 52):

$$\gamma \leq F(\pi P). \quad (2)$$

Furthermore an agency increases compliance by increasing  $\pi$  and  $P$  but full compliance can only be secured if  $\pi P$  is greater than the highest  $C$  (Heyes, 1998; p. 52). Reality, however, is such that there are budgetary, legislative, and other constraints that limit the size of expected penalties (Ibid., p. 52).

So far, the framework outlined has modeled compliance as a binary choice. Whether it is or is not, of course, will depend on the regulation in place. If the legal requirement, for example, is simply the installation of a particular pollution abatement technology, then the binary choice framework would be descriptively realistic. But in many cases, firms are faced with various legally-defined environmental standards which allow them to choose the extent of their compliance or non-compliance. As Heyes (1998; p. 52) pointed out, most compliance decisions are continuous in character. A firm, for example, may be required not to exceed a specified concentration of the pollutant it discharges or specified volume of effluent for a specific time period. The compliance decision can now be modeled as

$$c'(e_i^*) = -P'(e_i^* - S) \quad (3)$$

where the firm equates the marginal cost of abatement,  $c'(e_i^*)$ , with its marginal saving in terms of expected penalties avoided,  $-P'(e_i^* - S)$  (Ibid., p. 52). This now introduces the possibility for what has been termed ‘marginal deterrence.’ Shavell (1992) notes that agents who have already decided to violate (or commit a harmful act) will have reason to commit a less harmful act if expected penalties rise with the level of harm (or degree of non-compliance). In determining the size of the violation, to quote Heyes (1998; p. 52): “*it is not the size of the penalties that matters, but rather the ‘speed’ with which they increase with the degree of violation.*” Monitoring and enforcement regimes with this property induce marginal deterrence.

As previously mentioned, the theoretical literature on monitoring and enforcement as applied to environmental regulations as well as to other issues such as crime, tax enforcement etc. is relatively well-developed. The basic static framework has been extended to portray more realism by incorporating the possibility of error-prone monitoring (‘noisy’ monitoring), restricted penalties or the bankruptcy constraint, inspectability and many other variations on the theme. In the discussion that follows, I will outline briefly extensions to the static framework that are of greatest relevance to understanding firm compliance and environmental performance in Laguna de Bay, Philippines. I begin with a discussion of the basic model of contested enforcement, followed by the introduction of dynamics and targeted (non-random) monitoring and proceed to a brief sketch of the implications of informal pressure via information disclosure.

### *Contested Enforcement*

An important but, in most cases, unreasonable assumption behind the basic model just outlined is that enforcement action by the regulator is not legally challenged or contested by the regulated agent/firm. This suggests, for example, that the penalties or legal punishment meted out by the regulator is simply accepted as final. It is more likely though that the requirements for due process found in many legal systems allow regulated agents much leeway to contest or challenge enforcement actions. The main consequence of this is that expected penalties are no longer exogenous to the firms’ decision-making process.

Kambhu (1989) develops a theoretical model to analyze the consequences of firm action to evade penalties for non-compliance. In the Kambhu model, firms are able to invest in an amount  $h$  to avoid or reduce the effective penalty. This  $h$  could include spending on efforts to hide non-compliance and litigation to challenge penalties (the hiring of good lawyers, for example). If the level of abatement of the firm,  $a$ , is less than the standard,  $s$  and the firm is legally required to pay a fine,  $f$ , then  $\beta$  represents the part of the fine that is upheld (or that remains after the firm’s challenge) and is a function of the regulator’s enforcement effort,  $m$ , and  $h$ . This is written as

$$\beta = \beta(m, h), \quad 0 \leq \beta \leq 1 \quad (4)$$

where  $\partial\beta/\partial m > 0$ ,  $\partial\beta/\partial h < 0$ ,  $\partial^2\beta/\partial m^2 < 0$  and  $\partial^2\beta/\partial h^2 > 0$  (Kambhu, 1989; p. 105). If the firm argues that its non-compliance is less than what the regulator says and succeeds, then the expected penalty becomes  $f\beta(m, h)\cdot(s - a)$  which is lesser than  $f(s - a)$  or what would have prevailed without contestation. The firms' total cost function is

$$W(a, h) = c(a) + f\beta(m, h)\cdot(s - a) \quad \text{if } a \leq s \quad (5)$$

$$W(a, h) = c(a) + h \quad \text{if } a > s \quad (6)$$

where  $c(a)$  or the cost of compliance is a positively increasingly function of abatement (Ibid.; p. 106). The interior solution to the firm's problem has the properties

$$\partial c/\partial a = f\beta(m, h), \quad (7)$$

and

$$f\cdot(s - a)\partial\beta/\partial h = 1 \quad (8)$$

A formal analysis of Eq. 7 and 8 yields the proposition that if: a) the fine and the enforcement resources are held constant; b) the level of abatement that solves Eq. 7 and 8 is less than the regulatory standard; and c) at the regulatory standard the firm spends a positive amount on  $h$ , then an increase in the stringency of the standard will lead to lower abatement (Kambhu, 1989; p. 107). That is, a higher standard will lead the firm to intensify its challenge to enforcement which in turn reduces the effective fine and causes a decrease in the firm's compliance (Ibid.; p. 107). This leads Kambhu (1989; p. 107) to suggest that there may be logic to the regulator's tolerance of some degree of non-compliance to the legal requirement.

What is of special interest for this paper is the result obtained by Kambhu showing that for higher enforcement effort to cause compliance to increase, the sufficient condition

$$\frac{\partial^2\beta}{\partial m\partial h} \geq 0 \quad (9)$$

must be satisfied. Eq. 9 suggests that an increase in compliance from increased enforcement is by no means assured; the increase in enforcement effort has to overpower the increase in the firm's evasive effort. Note, however, that Kambhu's definition of enforcement effort,  $m$ , encompasses both enforcement *and* monitoring. So an increase in monitoring and enforcement which raises the expected penalty by raising the probability that the penalty is imposed may only serve to trigger intensified contestation and not necessarily increased compliance (whilst the basic Becker-type model would suggest an unambiguous increase).

### *Compliance under Dynamic Targeting*

Unlike in the basic model, regulators and polluters interact repeatedly across multiple time periods. This repeated interaction may result in an outcome that run counter to the predictions of the basic model (as implied by Eq.1). Harrington (1988; p. 32) adapts the dynamic 'state-dependent' enforcement model used in the tax compliance literature to explain what he observed to be relatively high compliance rates among U.S. pollution

sources amidst lax enforcement (the ‘Harrington paradox’). He relaxes a key assumption (shared by the basic static framework and earlier ‘state-dependent’ enforcement models) that penalties can be set as high as possible to induce compliance. He argues that it is more likely for penalties to be restricted in a real regulatory setting. The regulatory agencies often have limited enforcement budgets and the fines they can impose are also often limited by law. If penalties are restricted, compliance costs would most likely often exceed expected penalties for violations and the static framework would predict very low compliance rates. Harrington demonstrates that the introduction of dynamics changes this result and leads to incentives for the firm to comply even if its compliance cost exceeds its expected penalty for a violation.

When repeated interactions are allowed for it becomes much more reasonable to view the monitoring process as non-random, with the regulator deciding on the frequency of inspections and level of enforcement on the basis of the firm’s past performance. This practice is also referred to as ‘targeting.’ Harrington (1988) sets-up a dynamic repeated game model where the regulator assigns firms into two different ‘states’ or groups:  $G_1$  and  $G_2$ , depending on the firm’s performance. It is the case that  $p_1 < p_2$  and  $F_1 < F_2$ . That is, the probability of inspection,  $p_i$ , and the level of the fine,  $F_i$ , is higher in  $G_2$  than in  $G_1$ . If the firm is found to be in violation in  $G_1$  it will be moved to  $G_2$  and if it is found to be in compliance in  $G_2$  it is given the chance to be transferred back to  $G_1$ . Let  $c$  represent the cost of compliance and  $u$  represent the probability that a firm will be returned to  $G_1$  if found to be complying in  $G_2$ . Harrington (1988; p. 35) then summarizes the firm’s payoff matrices in both groups as:

The firm’s payoff depends on the action it takes at a particular state and time (Ibid., p. 35). The firm is modeled as facing a Markov decision problem and chooses a policy, which is a sequence of decisions on whether to comply or not, that minimizes its expected cost over time (Ibid., p. 36). The firm can pursue one of four policies: a)  $f_{00}$  or comply in both groups; b)  $f_{01}$  or comply in group 1 and violate in group 2; c)  $f_{10}$  or violate in group 1 and comply in group 2; d)  $f_{11}$  or violate in both groups (Harrington, 1988; p.36). The policy that is optimal for the firm will depend on its compliance cost. It is the case, however, that the policy of  $f_{01}$ , complying in group 1 and violating in group 2, is never optimal because  $f_{00}$  is the dominant policy when  $c < p_2F_2$  and  $f_{11}$  when  $c \geq p_2F_2$  (Ibid., p. 38). Hence, the firm is left with three choices. If it is a low compliance cost firm, it will comply in both groups. If it is an intermediate cost firm, it will violate in group 1 and comply in group 2. If it is a high cost firm it will violate in both groups.

#### *Private Enforcement: Informal Pressure via Information Disclosure*

Thus far, the theoretical models of monitoring and enforcement have only examined the interaction between regulator and polluter. The analytical focus has been on public enforcement. Recently, however, the perceived success of information disclosure as an instrument for pollution control, such as those shown by experiences with the Toxic Release Inventory (TRI) in the United States and the PROPER PROKASIH program in Indonesia (U.S. EPA, 2001; U.S. EPA, 2004; Pargal and Wheeler, 1996), has highlighted the role of private citizens. Armed with the knowledge about the environmental performance of firms, private citizens can influence enforcement through several channels. Heyes (2000; p. 18) identifies these channels as: a) voting or political behavior,

b) behavior in capital and product markets and c) private litigation (Heyes, 2000; p. 18). Unlike other areas of inquiry in the environmental compliance literature, ‘private’ enforcement has attracted exceptionally little theoretical work and lags behind empirical efforts.

The conventional view as represented by Naysnerski and Tietenberg (1992; p. 43) argues that more private enforcement results in more compliance because it raises the probability of detection and prosecution of violations. In this sense, the encouragement of private enforcement through information disclosure is seen as complementary to public enforcement. However, there may be instances where the regulator paradoxically lets known violators off without penalty in order to increase compliance; private enforcement in this case may only serve to lower overall compliance (Heyes, 2000; p. 20).

### *Factors Affecting Compliance: Hypotheses and Evidence for Developing Countries*

From the previous discussion, one can draw key hypotheses about the different factors that affect firm compliance. These factors can be broadly categorized under two headings: compliance cost and expected penalties.

Compliance cost. To comply with environmental regulations, firms have to expend resources. For water pollution, in particular, discharges/effluent quality is stochastic; ensuring compliance with a standard usually means ensuring that accidentally high discharges or pollutant concentrations occur with less probability by undertaking more pollution abatement (Gray and Shadbegian, 2000; p. 7). This would require, *inter alia*, the investment in pollution abatement equipment (e.g. wastewater treatment facilities) as well as the hiring and training of personnel to operate them. Similar to that of abatement cost, the marginal cost of compliance is thought of as increasing with increasing efforts to achieve perfect compliance (Ibid., p. 7). Both the basic static framework and the dynamic models discussed assign a key role to compliance cost in the firms’ decision to comply. Other things being equal, the higher the compliance cost, the less likely it is for the firm to comply. It has been suggested (Hettige et al., 1996, p. 1899; Helland, 1998, p. 145) that firms experience economies of scale in pollution abatement, with larger output/sales volume firms finding it less costly to comply. In a study on pollution abatement among South and Southeast Asian firms, Hettige et al. (1996; p. 1899) found that larger firms (measured with employment as proxy) undertook more abatement (or BOD removal rates). At the same time, however, higher production may also imply higher volumes of effluent discharges which increase the cost of reducing BOD levels to meet the standard (Helland, 1998; p. 145). A common proxy, therefore, for capturing the height of the compliance cost function is the ratio of daily effluent discharges over the annual sales of the firm or plant (Ibid., p. 145).

Expected penalties. When firms violate, they do not face a certain and deterministic penalty. Instead, they face the *probability* of a penalty. This is because there is a chance that their violation will not be detected or if detected, there is a chance that the penalty will not be imposed. Again, both the basic static framework and dynamic models predict that the higher the expected penalties, the more likely it is for the firm to comply. In turn, several factors affect the level of expected penalties faced by firms. An increased probability of detection and punishment through more frequent monitoring and enforcement actions would increase the level of expected penalties. The negative impact,

for instance, of inspections on pollution discharges have been empirically supported in both developed and developing country settings (see for example Dasgupta et al., 2001; Laplante and Rilstone, 1996). On the other hand, an increase in enforcement actions is also expected to result in decreased discharges or more compliance. This effect, however, may be dampened by the ability of firms to contest enforcement. There is also the possibility that decreased enforcement may improve compliance in situations where the regulator practices ‘regulatory dealing’ (such as that described by Heyes and Rickman, 2001). The impact of regulators’ enforcement actions on firm compliance (or on pollution discharges) has been less empirically analyzed than inspections, for both developed and developing country cases.

The presence of informal pressure from communities and capital markets has the effect of increasing expected penalties by increasing the probability of detection as well as the losses to the firm for non-compliance. There has been empirical support for this hypothesis in developing country studies (see for example, Dasgupta et al., 2001; Pargal and Wheeler, 1996). The introduction of dynamics and multi-period interactions between regulator and firm, on the other hand, adds a longer term dimension to the firm’s payoff from complying. It does not change the direction of enforcement impact on compliance; it simply reinforces it.

### **3. Environment and Regulation in Laguna de Bay, Philippines**

#### *The Lake and Surrounding Regions*

The Philippines, an archipelago of 7,107 islands and more than 80 million people, is estimated to have about 211 lakes<sup>2</sup>. The 900 km<sup>2</sup> Laguna de Bay is the largest in the country and is also the second largest freshwater lake in Southeast Asia. The lake occupies an important part of national myth and folklore as well as provides economically vital ecosystem services. It is located on the island of Luzon and straddles two of the country’s most industrialized regions: Metro Manila and Southern Tagalog.

Metro Manila (or the National Capital Region) is the Philippine’s largest urban area and center of commerce and government. It is one of Asia’s mega-cities with its household population at more than 2 million or about 10 million people living within a 636 km<sup>2</sup> land area (Philippines Statistical Yearbook, 2000). Southern Tagalog, on the other hand, is the country’s largest region in terms of land area and has a population of 2.4 million households or almost 11 million people. Together, the two regions account for close to half of the country’s 2003 gross domestic product, with Metro Manila alone accounting for a third of national production.<sup>3</sup> It is estimated that there are currently more than fifteen industrial estates with more than 3,000 facilities, 10,000 small to large stand-alone manufacturing enterprises and more than 11 million inhabitants surrounding the vicinity of the lake who directly or indirectly use it in a variety of often conflicting

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<sup>2</sup> [http://www.ilda.gov.ph/inland\\_water\\_group.htm](http://www.ilda.gov.ph/inland_water_group.htm)

<sup>3</sup> <http://www.nscb.gov.ph/grdp/2003/2003conlev.asp>

ways. The lake is primarily used for aquaculture and open-fishing and was estimated to have yielded an average of 14,000 metric tons annually from 1997-2000. It is also used: a) as a transport route among lakeshore communities; b) for Metro Manila's floodwater control; c) for power generation through a pump storage hydroelectric plant; d) as a year-round source of irrigation; e) as recreation spot for lakeshore residents and local tourists; and f) as a domestic, industrial and agriculture waste sink.<sup>4</sup>

There are 21 river tributaries that drain into Laguna de Bay but it has only one outlet where its water flows out into the heavily polluted Pasig River and out into Manila Bay. Since 1963, the lake has shrunk by 59 km<sup>2</sup> and is estimated to be losing about 3 million cubic meters a year.<sup>5</sup> Given its location in the most industrialized and populous area in the Philippines, Laguna de Bay's water quality is bound to deteriorate further without pollution control mechanisms. It is estimated that some 74,300 tons per year of biological oxygen demand (BOD-5) enter the lake annually. Domestic wastes are the largest source of conventional pollution in the lake, accounting for more than half while industry comes in second with a contribution of almost 20 per cent. Discharges of toxic and hazardous wastes into the lake are also increasing. The daily discharge, for example, of toxic phenolic substances into the lake is projected to reach 49.5 metric tons in 2010.<sup>6</sup>

#### *Regulatory Context for Pollution Control in Laguna de Bay*

The regulation and control of pollution in Laguna de Bay is under the responsibility of the Laguna Lake Development Authority (LLDA), a quasi-governmental body with corporate powers which operates under the administrative supervision of the Philippines' Department of Environment and Natural Resources (DENR). The LLDA was established by law in 1966 through Republic Act 4850. RA 4850 broadly mandates the LLDA with the management of development activities in the lake basin. This was later amended in the 70s through Presidential Decree 813 which extended the responsibility of LLDA to include environmental management and jurisdiction over the surface waters of the lake basin. This gave it authority to issue permits and clearances for activities that use or affect the lake's waters. In 1983, the issuance of Executive Order 927 further strengthened and clarified LLDA's responsibility over pollution control in Laguna de Bay by granting it the power, *inter alia*: a) to collect fees for the use (broadly defined) of the lake's waters and its tributaries (Section 3); b) to issue, renew, deny, revoke, modify or suspend permits for the purpose of preventing or abating pollution (Section 4.d and 4.f); and c) to "*authorize its representatives to enter (at) all reasonable times any property of the public dominion and private property devoted to industrial, manufacturing, processing or commercial use without doing damage, for the purpose of inspecting and investigating conditions relating to pollution or possible or imminent pollution*" (Section 4.h).

Aside from laws defining the regulatory authority of the LLDA, aspects of the regulatory framework for water pollution in the lake was also defined by several national

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<sup>4</sup> [http://www.llda.gov.ph/existing\\_lake\\_uses.htm](http://www.llda.gov.ph/existing_lake_uses.htm)

<sup>5</sup> [http://www.llda.gov.ph/scientific\\_facts.htm](http://www.llda.gov.ph/scientific_facts.htm)

<sup>6</sup> [http://www.llda.gov.ph/masterplan.htm#1.5.2.1\\_Overview](http://www.llda.gov.ph/masterplan.htm#1.5.2.1_Overview)

legislations, key among which are Presidential Decree 984 (PD 984) or the Pollution Control Law of 1976, DENR-Department Administrative Order No. 34 (DAO 34-90), and DAO 35-90 or the Revised Effluent Regulations of 1990. PD 984 provides for the establishment of effluent, stream, ambient and emission standards (Section 6.i), sets penalties for violations (Section 9) and requires polluters to secure permits (Section 6.g). DAO 34-90 categorizes bodies of water according to beneficial uses while DAO 35-90 specifies water quality criteria and effluent standards to be met by each category. Table 1 below summarizes the different classifications for fresh surface waters by decreasing order of water quality.

The LLDA strives to maintain Laguna de Bay as Class C fresh surface water. Table 2 enumerates selected standards for effluents from domestic sewage and industrial wastewater applicable to Class C waters.

If the discharger does not undertake daily monitoring of its effluent quality, then the numerical values listed in Table 2 represent maximum values that are not to be exceeded for even once in a year (Section 5, DAO 35-90). If the discharger undertakes daily monitoring, the standards in Table 3 represent 90<sup>th</sup> percentile values (Section 5, DAO 35-90). Note that Philippine effluent standards are concentration-based measures. They *do not* specify the maximum volume of pollutants to be discharged but the concentration of the pollutants *in* the discharge. This is in contrast, for instance, with the case of the pulp and paper industry in Canada where the effluent standards for BOD and TSS are set in kilograms per ton of production (Laplante and Rilstone, 1996; p. 23). Concentration-based standards are thought to provide incentives for dilution; instead of undertaking real abatement, firms may attempt to meet the standard by using more water to dilute its effluent discharges. If firms have their own private water source, it may be difficult for the regulator to monitor and detect this.

#### *Laguna de Bay Environmental User Fee System*

In January 1997, LLDA introduced the Environmental User Fee System (EUFS) which aimed to reduce the biological oxygen demand (BOD)<sup>7</sup> discharges into the lake by charging industrial and commercial enterprises a pollution fee (US-EPA, 2004). This economic incentive instrument is built on top of the essentially command and control framework set-up under PD 984. During its first-year of implementation it focused on what was identified as the top polluting industries in the area: beverages, food processing, pulp and paper, textiles as well as pig farms/slaughterhouses. In 1998, the EUFS covered all industries with wastewater, subdivisions and commercial establishments. From 222 firms or establishments in 1997, the system now includes 1,080 registered firms. Under this system, firms are required to obtain a discharge permit which is to be renewed annually. Firms are to meet certain requirements and conditions for the approval, continued validity and renewal of the discharge permits. These include, *inter alia*: a) payment of the environmental user fee; b) compliance to effluent standards specified in DAO 35-90 and partially listed in Table 2; c) submission of self-monitoring reports; and d) provision of a flow measuring device. The LLDA also requires firms to have an

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<sup>7</sup> Any mention of biological oxygen demand in this paper refers to the 5-day 20 degrees Celsius measure.

accredited pollution control officer who must be a full-time employee of the firm. These officers are required to annually attend pollution control seminars conducted by LLDA, DENR and other government agencies and non-government organizations.<sup>8</sup> As of June 2004, there were already 959 firms with accredited pollution control officers.<sup>9</sup>

The environmental user fee which firms must pay for their wastewater discharges is akin to a pollution charge or tax, although it isn't labeled as such because the LLDA (or the DENR for that matter) does not have the authority to collect taxes. This user fee is a two-part tariff. It is made up of a fixed fee to cover the cost of compliance monitoring, analysis and operational expenditures of the LLDA. The amount of this fixed fee is dependent on the volume of the firm's rate of discharge (measured in cubic meters per day) as well as on whether the firm's discharge contains conventional pollutants only or includes heavy metals. The variable fee is computed according to the following formula:

$$\text{Variable Fee} = (\text{Loading}) (\text{Rate}) \quad (10)$$

$$\text{Loading} = (Q) (\text{BOD-5}) (\text{days/yr}) (0.001) \quad (11)$$

where Loading is measured in kilograms, Q is the daily volume of discharge, BOD-5 is the BOD concentration in mg/L and days/yr is the number of days per year that the firm is discharging wastewater. If the firm's wastewater BOD concentration is less than 50 mg/L, then the firm only pays a rate of PHP 5 per kilogram (or £ .05/kg.)<sup>10</sup>. If the firm's BOD concentration is greater than 50 mg/L, then the firm pays PHP 30 per kilogram (or £ .30/kg.). As listed in Table 2, a BOD concentration of 50 mg/L is the effluent standard applicable to Class C waters like Laguna de Bay. Since the computation of the fee is partly based on the volume of discharge wastewater, it may make an attempt to dilute more easily detectable and hence partly mitigate the perverse incentive arising from the concentration standard.

Revenues from the environmental user fees are put in an environmental fund which the LLDA administers. These fee revenues are used to recover the costs of administering the system (monitoring, data management etc.), provide subsidies for clean technology investments and obtain capital market loans to pay for construction of treatment plants for domestic waste (EPA, 2004). Table 4 shows the amount of environmental user fees the authority has collected annually from 1997-2003 as well as the number of firms in the EUF system in each year.

#### *LLDA Monitoring and Enforcement Practices*

Majority of the various water quality regulations in the Philippines are not enforced (or sporadically enforced) for various reasons including budgetary constraints (World Bank, p. 21). These laws and regulations, however, are relatively well-monitored and enforced in the Laguna de Bay area (Ibid., p. 21). The LLDA uses revenues from the

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<sup>8</sup> Engr. Caesar Natividad, LLDA Pollution Control Division Head, personal phone interview, 15 March 2005

<sup>9</sup> Ibid.

<sup>10</sup> At an exchange rate of £ 1 = PHP 100

EUFS to partially finance its operations; monitoring and enforcement activities are crucial components for the functioning of the EUFS.

Compliance monitoring in Laguna de Bay is two-pronged: self-monitoring by firms and unannounced inspection visits by LLDA. Firms are required to submit self-monitoring reports (SMRs) as a requirement for the issuance and renewal of discharge permits (DPs). The LLDA specifies varying frequencies of effluent analysis and SMR submission for firms of varying daily effluent flow rates. Firms whose flow rates are 150 cubic meters per day or less and who discharge only conventional pollutants are required to submit less often than those with higher flow rates and heavy metals in their discharges.

The SMR is an 8-page long document which if completely filled up would include information on the following: a) basic firm characteristics and production data; b) wastewater treatment operation and cost; c) effluent flow rate and pollutant concentrations (influent and effluent); d) employment and energy use; and e) wastewater treatment system and sludge management. However, in the earlier phases of the EUFS's implementation, the LLDA has not strictly implemented this requirement.<sup>11</sup>

The LLDA also conducts unannounced site inspections where they collect effluent samples for analysis. They have announced that in 2001 alone, they have conducted more than 2,500 individual site inspections. They have well-defined protocols relating to the deployment of inspectors and assign these inspectors in such a way that they do not conduct two consecutive visits to the same firm.<sup>12</sup> Firms whose discharge permits are due for renewal are prioritized for inspection and the sampling results are used as basis for the processing of the permit.<sup>13</sup> LLDA's monitoring strategy is targeted and non-random. Firms with higher effluent flow rates and with heavy metals in their discharges are targeted for more frequent inspections.

If from the analysis of inspection samples, the LLDA finds the firm in violation of effluent standards, they can take various enforcement actions of differing levels of severity. The four key legal enforcement actions, listed according to increasing severity include: 1) issuance of a notice of violation (NOV); 2) issuance of a NOV *ex-parte*; and 3) issuance of a 'cease and desist' order (CDO); 4) issuance of a CDO *ex-parte*. A notice of violation is akin to a warning. The firm is sent a letter prior to such an issuance informing them that a violation has been found. The firm may contest this by showing evidence that they have not exceeded the standard or that they are now in compliance.<sup>14</sup> When a NOV is issued *ex-parte*, the LLDA presents evidence of the violation without necessarily informing the firm or requiring the presence of the firm when the evidence is being presented to begin administrative proceedings (or pollution case) against the said

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<sup>11</sup> Engr. Rowena Pagdingalan, LLDA Pollution Control Officer, personal phone interview, 14 March 2005

<sup>12</sup> Engr. Caesar Natividad, LLDA Pollution Control Division Head, personal phone interview, 15 March 2005

<sup>13</sup> Ibid.

<sup>14</sup> Atty. Edna Pana, personal interview, 9 May 2005

firm.<sup>15</sup> A CDO can also be issued *ex-parte* when despite an NOV, the firm's discharge continues to violate effluent standards. An *ex-parte* CDO may also be issued immediately without a prior NOV if the LLDA believes the violation to be grave (e.g. pollutant concentrations substantially above the standard). A CDO essentially compels the firm to stop its operations. Table 5 summarizes the number of enforcement actions that the authority has taken from 1996-2002.

Firms who are found in violation of standards are liable to pay fines for each day of violation and, if they exceed the maximum BOD concentration, then they are also liable to pay a higher variable rate for the environmental user fee. Also, firms facing an administrative proceeding (pollution case) for a violation are subjected to more frequent monitoring.

#### *Information Disclosure: The Industrial Ecowatch Project*

In 1995, the DENR launched the Industrial Ecowatch Project, an information disclosure program that was meant to encourage pollution reduction by putting firms under reputational pressure through the publication of environmental ratings (U.S. EPA, 2004; p. 45). Before this project was legally extended nationwide through Department Administrative Order 26 Series of 2003 (DAO 26-03), it was pilot-tested among industries in the jurisdiction of the LLDA and the DENR-National Capital Region (Ibid. p.45). The DENR primarily rated firms according to their extent of compliance with environmental regulations (e.g. air and water pollution standards). Similar to Indonesia's PROPER, the ratings were represented by different colors which are summarized in Table 8.

The first ratings were made in April 1997. However, before they were made public, these were confidentially disclosed first to the rated firms to give them the opportunity to make improvements. As it was the first rating period, no firms were awarded gold or green. Based on the initial confidential disclosure only four firms made it to blue and by the time the public announcement was made in April 1998, 22 firms have already achieved blue status (U.S. EPA, 2004). The first public announcement only involved disclosure of the list of blue status firms. It was during the second announcement in November 1998 that the red and black status firms were publicly identified.<sup>16</sup> The red and black status firms that were publicly disclosed were those involved in textiles (3 firms), food manufacturing (7 firms), hog raisers (3 firms), ink (1 firm), and paper manufacturing (1 firm).<sup>17</sup>

Very few firms relative to the total number under the jurisdiction of LLDA and DENR-National Capital Region were included in the Industrial Ecowatch information disclosure scheme. Despite having been cited as a success (see for example U.S. EPA, 2004; p. 46), the implementation of the scheme was short-lived with no public disclosures made after 1998. The LLDA has not been using the scheme since then, for various reasons, including manpower constraints; however, from 2004-2005 it began

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<sup>15</sup> Ibid.

<sup>16</sup> [http://www.worldbank.org/NIPR/pub\\_info.htm](http://www.worldbank.org/NIPR/pub_info.htm)

<sup>17</sup> <http://www.worldbank.org/NIPR/ecowatch/ecov2rate.htm>

designing a similar disclosure scheme through a project funded by the World Bank and the Dutch government.<sup>18</sup>

#### 4. Data, Model and Initial Results

##### *The Beverage and Pulp & Paper Industries*

There are a variety of industries or economic activities in the Laguna de Bay area that are currently being regulated by the LLDA. These include, *inter alia*: food manufacturing, textiles, beverages, pulp and paper, piggeries/poultry/livestock, semiconductor and electronics, metals and automotives, chemicals and pharmaceuticals, minerals and non-metals, rubber and tanneries, plastics/film/foam, dumpsites, and energy manufacturing. The econometric analysis, in this paper, of the impact of monitoring and enforcement actions focuses on two industries in Laguna de Bay, Philippines: beverages and pulp & paper. Firms in these two industries have the highest annual discharges of BOD, with pulp and paper coming out top and beverages a close second.

From the perspective of direct usefulness to policy, it makes sense to focus the analysis on the most polluting industries. These two industries have also been part of the LLDA's EUFS since its launch in 1997. As a result, records on their BOD discharges and monitoring and enforcement history are available from the LLDA since 1997. This allows for the analysis of a longer time series needed to exploit the advantages of panel data.

##### *The Dataset*

The analysis was conducted using an unbalanced panel dataset for 16 manufacturing firms in the beverage and pulp and paper industry within the Laguna de Bay region. The observations covered the years 1997-2004. The dataset was constructed from the quarterly self-monitoring reports submitted by firms to the LLDA as part of the conditions of their discharge permit and from inspections and enforcement records provided by the authority.

There are 14 pulp and paper firms and 29 beverage firms who are registered with the LLDA. The LLDA had available SMR documents for five out of the fourteen pulp and paper firms while such documents were available for only 11 out of 29 registered beverage firms. One key issue with the data, therefore, is the extent to which the 16 sample firms are representative of the two industries in the Laguna de Bay area. The pulp and paper firms for which the authority no longer kept SMRs in their files were those that had already closed due to labor problems or those that had converted from wet to dry processes and were no longer discharging.<sup>19</sup> Of the 29 registered beverage firms, only 14

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<sup>18</sup> Mrs. Alice Bongco, Coordinator-LLDA-SLDBE project, personal communication, 26 October 2004

<sup>19</sup> Engr. Rowena Pagdingalan, LLDA Pollution Control Officer, personal phone interview, 14 March 2005

were part of the EUFS and of this only 11 regularly submitted SMRs. The environmental behavior of excluded firms may differ markedly from the sample (especially for pulp and paper). Firms in financial trouble and who are likely to go bankrupt if caught for violations do not face the full effect of expected penalties (Gray and Shadbegian, 2000; p. 5). These may also be the kind of firms who are liquidity constrained and find it more expensive to invest in pollution control because they would have to borrow from the capital market to do so (Helland, 1998; p 146). Since compliance decisions are largely based on comparisons of compliance cost and expected penalties, these may be the kind of firms who are highly predisposed to non-compliance. On the other hand, firms who convert from wet to dry processes may be the kind of firms who find it the least costly to shift production technologies to minimize pollution. They may represent firms who are likely to be over compliant. Without additional information (which are currently unavailable for this paper), this possibility cannot be ruled out. Hence, conclusions drawn from the analysis may only be interpreted as applicable to the class of firms for which the LLDA have records.

While the SMRs submitted by firms represented one quarter, monthly pollution loads may be derived from the information reported, along with employment and the cost of water treatment. If firms submitted SMRs for each quarter, there would be 96 monthly observations of pollution loads for the 8-year period. However, since the self-reporting requirement was not strictly implemented and firms with less discharge volumes and no heavy metals in their effluents were only required to report twice a year, there were on average only 40 monthly observations per firm. This is compounded by missing data arising from incomplete reporting. And, it is not clear whether missing observations arising from incomplete SMRs are random or systematically missing and hence it would not be possible to fill in the blanks through univariate autoregressions. This still left, however, approximately 600 monthly observations out of a potential of more than 1,000 available for the analysis (even after factoring in the less frequent reportorial requirements for certain firms).

The LLDA does not make their own estimates and keep monthly records of pollution loads and wastewater discharges for each firm.<sup>20</sup> The main sources of such data are the SMRs submitted by the firms. The SMRs contain firm self-reports on the concentration of pollutants and volume of wastewater discharge. Hence, another key issue with the data would be the accuracy of firm self-reports. This issue arises from the possibility of firms misreporting pollutant concentrations either by simply putting in the 'wrong' figure or by manipulating its discharge through dilution. The LLDA believes that it can easily detect attempts to dilute since it would be red flagged by inexplicable increases in wastewater volumes.<sup>21</sup> Assuming that dilution is minimal, the remaining issue would be with the accuracy of self-reported pollutant concentrations (or effluent quality).

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<sup>20</sup> They do, however, estimate annual wastewater discharge volumes and BOD loads based on their own inspection results and firm self-reports.

<sup>21</sup> Engr. Rowena Pagdingalan, LLDA Pollution Control Officer, personal phone interview, 14 March 2005

While not necessarily a measure of accuracy, one may try to analyze the consistency of firm self-reports with those of the regulator to see if there is widespread misreporting. The variable of interest in this paper is the monthly BOD load/discharge (measured in kilograms). This variable was measured as the reported concentration multiplied by the reported effluent flow rates (or volume of wastewater discharge). Since the LLDA does not keep records of their own estimates of the firms effluent flow rates, it is not possible to conduct a paired difference of means test (as done, for example, by Laplante and Rilstone, 1996) to compare self-reported monthly BOD loads with those of LLDA's (as they don't have their own monthly estimates). However, one can examine the consistency of self-reported BOD concentrations (in mg/L) with those determined from inspections. For the period 1997-2004, I have investigated the number of times the firms in the sample were observed to be 'misreporting'; the number of times, that is, that they only self-reported BOD concentrations compliant with standards while an LLDA inspection for that same month yielded a non-compliant value. For the period 1997-2004, only two firms had misreported four times, seven firms misreported once, and the rest had no observed misreporting either because they were not caught violating or that there were no available months to compare. These results seem to suggest that while there are instances of inconsistency, there is not enough evidence to conclude that the self-reported data is completely inconsistent. It must be kept in mind, however, that pollution discharges are essentially stochastic and variable. A plant's effluent fluctuates seasonally and is bound to exceed a simple concentration standard at some point in time. Hence, the issue of accuracy (and even simple consistency) is difficult to resolve.

#### *Empirical Model and Estimation Results*

One of the main objectives of this paper was to measure empirically the impact of LLDA's monitoring and enforcement actions on the monthly self-reported conventional pollution discharges of beverage and pulp & paper firms in the Laguna de Bay. The analysis that is presented is to be considered as highly exploratory in nature and the starting point of a larger and more thorough empirical work. I estimate a single-equation model of the general form:

$$\begin{aligned} P_{it} = & \alpha + \beta_1 \text{EMPLOY}_{it} + \beta_2 \text{LINS}_{it} + \beta_3 \text{LENFORCE}_{it} \\ & + \beta_4 \text{LDISMISS}_{it} + \beta_5 \text{COST}_{it} \\ & + \beta_6 \text{ISIC}_i + \beta_7 \text{ENFINS}_{it} + v_{it} \end{aligned} \quad (12)$$

where  $i = 1, 2, 3, \dots, N$  stands for firms;  $t = 1, 2, 3, \dots, T$ ;  $P_{it}$  represents a measure of monthly conventional pollution discharge;  $\text{EMPLOY}_{it}$  is a proxy for the level of monthly production;  $\text{LINS}_{it}$  is a lagged inspection dummy variable;  $\text{LENFORCE}_{it}$  is a lagged dummy variable for an enforcement action;  $\text{DISMISS}_{it}$  is a lagged dummy variable representing a contested and failed enforcement action;  $\text{COST}_{it}$  represents the monthly compliance cost;  $\text{ISIC}_i$  is a set of dummy variables which capture the different kinds of products and the technologies used by the firms in the sample; and finally,  $\text{ENFINS}_{it}$  is a measure of the intensity of enforcement actions faced by the firm.

Since the compliance decision of firms in the Laguna de Bay region is not binary, the dependent variable used is a continuous variable representing levels of pollution discharges. Concentration measures were not used since it is not known to what extent

dilution is practiced by firms and from a policy perspective, it is the total discharges that find its way into Laguna de Bay that is an important determinant of the maintenance of its water quality. Regressions were performed on two different measures of  $P_{it}$  : self-reported Biological Oxygen Demand (BOD) discharges in kilograms per month, and self-reported Total Suspended Solids (TSS) discharges in kilograms per month.

$EMPLOY_{it}$  on the other hand is the no. of production workers hired by the firm during the month and captures the level of production activity for the firm during the month. Since higher production would entail greater use of water and consequently, higher volumes of wastewater discharges, it is expected that there is a positive relationship between this variable and the conventional pollution discharges.

One key problem with the analysis of the impact of inspections and enforcement on compliance and discharges is that of endogeneity. As discussed previously, regulating agencies usually target high polluting firms with more frequent monitoring and enforcement actions. There are two ways in which this problem has been dealt with in the literature: the use of lagged variables or the use of instrumental variables. The data available for this paper did not make the instrumental variable technique feasible and hence the simpler method of using lagged versions were used instead.  $LINSP_{it}$  is a dummy variable coded as 1 if a particular firm experienced an LLDA inspection during the previous month and 0 if otherwise.  $LENFORCE_{it}$  is a dummy variable coded as 1 if a particular firm experienced an LLDA enforcement action during the previous month and 0 if otherwise. The use of lagged inspection and lagged enforcement variables were made necessary because current inspections and enforcement is endogenous. These enforcement actions included issuance of NOVs, *ex-parte* orders, notices of public hearing and orders to pay fines.  $DISMISS_{it}$  is a dummy variable coded as 1 if a particular firm had any pollution case dismissed during the previous month and 0 if otherwise. I have found that the use of longer lags for inspections, enforcement and dismissals did not improve the fit of the model and involved a large loss of degrees of freedom.

$COST_{it}$  is the firm's cost of water treatment for the month which includes expenditures on personnel, chemicals, facility maintenance, energy use and others.  $ISIC_i$  is a non-time varying vector of dummy variables (minus one) which represents the different sub-type of firms in the beverage and pulp & paper industries as categorized according to the United Nations International Standard Industrial Classification (ISIC) rev. 3 version. ISIC codes beginning with 15 represent the manufacture of food products and beverages, while those starting in 21 represent the manufacture of paper and paper products. ISIC 2101 represents firms manufacturing pulp, paper and paperboard and is especially to be noted as the dummy variable which indicates the presence or absence of a pulping process. Production involving pulping processes is known to generate large amounts of water pollution and it is therefore expected that these kinds of firms generate higher monthly BOD and TSS discharges.  $ENFINS_{it}$  is the variable that measures the intensity of enforcement faced by the firm and is measured as the ratio of sum of past enforcement actions over the sum of past inspections experienced by a firm at a point in time.

The estimation was done using generalized least squares (GLS) and the following were assumed: (1) the firm-specific effects are random and (2) the two error terms are uncorrelated and well-behaved. The first assumption was supported by a Hausman

specification test which rejected systematic differences between fixed-effects and random-effects coefficients. The results of this Hausman test, however, are valid only under the assumption that the estimated equation was correctly specified. Descriptive statistics for values of dependent and independent variables among sample firms are presented in Table 10.

For the regression on BOD, lagged inspection and enforcement variables have turned up with expected negative signs, both of which are not statistically significant. The coefficient for inspections, however, appears to be more insignificant and lesser in magnitude than that for enforcement actions. This suggests that the volume of pollution discharges of the class of firms in the sample do not respond as strongly to the regulator's actions. Interestingly, the coefficient of the lagged inspection variable was positive for TSS and more significant, both statistically and in terms of its magnitude, than the corresponding effect on BOD. Since, the environmental user fee is assessed based only on BOD, it may be that an inspection simply triggers an increase of abatement resources for BOD at the expense of TSS reduction. The lagged dismissal variable has turned up a negative but insignificant result on both BOD and TSS discharges. This suggests that the effect on the firm of having experienced a pollution case is stronger than the dismissal of the case itself; this suggests that the deterrent impact of the pollution case continues even after the case is dismissed.

The regression on both TSS and BOD turned up an expected positive and highly significant coefficient for ISIC2101 which represented firms using pulping processes. This result indicates that firms with these processes are likely to be most highly polluting in terms of BOD and TSS discharges and non-compliant with environmental regulations. Firms coded ISIC1553 who manufacture malt and malt liquors such as beer, ale and stout appear to be the most highly polluting in terms of TSS. The variable on the cost of wastewater treatment which was used to proxy compliance turned up a highly significant and expectedly positive result. However, this variable may only be indicative of a two-way relationship as higher discharges for the month would also necessitate higher treatment expenditures for firms. Data on sales value for the firms was unobtainable within the period for this research and hence, it was not possible to use the more theoretically correct proxy of the height of the compliance cost function (which was measured as a ratio with daily wastewater discharge volumes and the annual sales value). Interestingly enough, the variable on enforcement intensity (cumulative enforcement over cumulative inspections) had turned up a positive and significant result for both BOD and TSS. It is possible to obtain this effect with the presence of contested enforcement, as higher enforcement actions would only lead to increasing use of evasive tactics by firms. However, there is also the possibility that again, this variable is plagued by the problem of endogeneity.

## **5. Conclusions and Agenda for Further Research**

The experiences of water pollution regulation in Laguna de Bay, Philippines is noteworthy in that it has been a test bed for various regulatory instruments that have been

legislated nationally in the country. Economic incentive instruments and public disclosure programs have been first implemented in the area by the LLDA. The institutional evolution of the LLDA, in itself, has been an example of how experimental policies can be tried out within the confines and constraints of an essentially traditional command and control legal foundation. It is also unique in that, its monitoring and enforcement regime is relatively well-developed and implemented compared to those in other regions of the archipelago. Since its regulatory framework is often being set-up as a model for other regions in the country and even for other countries in the developing world, it is especially interesting and crucial to understand how, for example, its monitoring and enforcement practices have affected the environmental behavior of the firms in its jurisdiction. It was with this goal in mind that the research for this paper was undertaken. The initial results suggest that the monitoring and enforcement actions of the LLDA only have a very weak deterrent effect on the firm's conventional pollution discharges.

Admittedly, much work remains to be done to explore the relationship between monitoring and enforcement actions and pollution discharges. An immediate agenda for further investigation is to re-specify the empirical model to better account for endogeneity as well as to examine the impact of inspections and enforcement on the firm's abatement over and above the specified concentration standard.

The acquisition of a larger dataset possibly covering all industries in the region may yield stronger results and more valuable insights. This would also enable the investigation of exciting and interesting issues in monitoring and enforcement such as those on: (a) the determinants of truth-telling in firm self-reports, (b) a more in-depth exploration of the vagaries of contested enforcement in developing countries, and (c) the separate measurement of impacts on production processes and end-of-pipe abatement. These are important and most possibly productive agenda for future research.

**Table 1. Firm's payoff matrices for the enforcement game**

	Group 1		Group 2	
	Comply Violate	Violate	Comply	
No inspection	$c$	0	$c$	0
Inspection	$c$	$F_1$ $\rightarrow G_2$	$c$	$F_2$
	$P(\rightarrow G_1) = u$			

Source: Harrington (1988; p. 35)

**Table 2. Fresh surface water classification by beneficial use**

Classification	Beneficial Use
Class AA: Public Water Supply	<ul style="list-style-type: none"><li>▪ Require disinfection to meet National Standards for Drinking Water (NSDW)</li><li>▪ Require complete treatment to meet NSDW</li></ul>
Class A: Public Water Supply	<ul style="list-style-type: none"><li>▪ Primary contact recreation (e.g. bathing, swimming etc.)</li></ul>
Class B: Recreational Water	<ul style="list-style-type: none"><li>▪ Fishery, aquaculture, manufacturing processes after treatment, boating</li><li>▪ Irrigation, industrial cooling, and etc.</li></ul>
Class C	
Class D	

*Source: DAO 34-9; World Bank, 2003*

**Table 3. Class C effluent standards for selected conventional pollutants**

Parameter	Effluent Standard
pH (alkalinity or acidity)	▪ 6.0-9.0 pH range
Chemical Oxygen Demand (COD)	▪ 100 mg/L
Biological Oxygen Demand (5-day 20 degrees Celsius)	▪ 50 mg/L
Total Suspended Solids (TSS)	▪ 70 mg/L
Total Dissolved Solids (TDS)	▪ 1,000 mg/L
Oil and Grease	▪ 5.0 mg/L
Total Coliforms	▪ 5,000 MPN/100 ml

*Source: DAO 35-90*

**Table 4. Environmental user fee collection (1997-2003)**

Year	User Fees Collected (in million PHP)	No. of Firms in the EUF system	Average amount of fees collected per firm (in thousand PHP)
1997	6.7	222	30
1998	14.8	255	58
1999	12.9	429	29
2000	13.3	628	21
2001	11.9	738	16
2002	21.4	914	23
2003	13.4	1080	12

*Source: LLDA Pollution Control Division*

**Table 5. Frequency of SMR submission**

Flow Rate	Discharge Characteristics	Frequency of Analysis	Frequency of Submission
0-150 m <sup>3</sup> /day	BOD, Conventional	Quarterly	Semi-annually
>150 m <sup>3</sup> /day	BOD, Conventional	Monthly	Quarterly
0-∞ m <sup>3</sup> /day	with Heavy Metals	Monthly	Quarterly

*Source: Engr. Caesar Natividad, LLDA Pollution Control Division*

**Table 6. Frequency of monitoring**

Effluent Flow Rate	Discharge Characteristics	Target Annual Inspection Frequency
0-30 m <sup>3</sup> /day	Conventional pollutants only	At least 1
31-150 m <sup>3</sup> /day	Conventional pollutants only	At least 2
0-150 m <sup>3</sup> /day	Heavy metals only	At least 2
>150 m <sup>3</sup> /day	Conventional pollutants & heavy metals	At least 4

*Source: Engr. Caesar Natividad, LLDA Pollution Control Division*

**Table 7. Number of enforcement actions (1996-2002)**

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Enforcement Action	1996	1997	1998	1999	2000	2001	2002
Notice of Violation	27	30	31	18	14	4	17
Ex-parte Order	41	146	88	95	138	91	156
Cease and Desist Order	401	546	596	574	993	604	349

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*Source: www.llda.gov.ph*

**Table 8. Industrial Ecowatch Project rating scheme**

Rating	Compliance Level	Performance Indicators
Gold	<ul style="list-style-type: none"> <li>▪ Efforts beyond legal requirement</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rated green in previous periods for all media; uses clean technology; practices energy and water efficiency and conservation; has a community environmental outreach program</li> </ul>
Green	<ul style="list-style-type: none"> <li>▪ Effort level sufficient to comply</li> </ul>	<ul style="list-style-type: none"> <li>▪ Rated blue in previous period; effluents/emissions consistently lower than standards by 20 %; has well-functioning monitoring equipment and undertakes continuous monitoring; discharge points accessible to inspection</li> </ul>
Blue	<ul style="list-style-type: none"> <li>▪ Effort level sufficient to comply</li> </ul>	<ul style="list-style-type: none"> <li>▪ Effluent consistently within standards during rating year; submitted SMRs are complete and accurate; wastewater treatment facilities are well-maintained</li> <li>▪ Violation of standards despite presence of wastewater treatment facilities and pollution control equipment</li> </ul>
Red	<ul style="list-style-type: none"> <li>▪ Effort not sufficient for compliance</li> </ul>	<ul style="list-style-type: none"> <li>▪ Under a ‘cease and desist’ order; willful manipulation of discharges through dilution; direct discharge of untreated air emissions and wastewater; obstruction of inspection activities; facing public complaints but make no effort to address it during rating period</li> </ul>
Black	<ul style="list-style-type: none"> <li>▪ No effort to comply</li> </ul>	

*Source: Adapted with modifications from DAO 26-03 Procedural Manual*

**Table 9. Wastewater volumes and BOD discharges for beverages and pulp & paper**

Industry	Average daily volume of wastewater discharge per firm from 1999-2003 (in cubic meters/day)	Average annual BOD discharges per firm from 1997-2003 (in kilograms/year)
Pulp & Paper	1,825	72,205
Beverages	780	10,814

*Source: LLDA Pollution Control Division*

**Table 10. Selected descriptive statistics for the sample (monthly data for 16 firms)**

<b>Variable</b>	<b>Mean</b>	<b>Standard deviation</b>
BOD	346.4689	487.0935
TSS	740.2801	1283.169
Inspections	.1640212	.3705399
Enforcement	.031746	.1754393
Dismissals	.0145503	.119823
Compliance cost	180015.5	280254.6
Production employment	259.1678	232.4157
Enforcement intensity	.2158204	.2099741

**Table 11. Estimation results**

Independent variables	Dependent variable	
	BOD	TSS
EMPLOY <sub>it</sub>	.9657088** (0.000)	2.908893** (0.000)
LINSP <sub>it</sub>	-11.15982 (0.758)	114.8797 (0.274)
LENFORCE <sub>it</sub>	-96.24929 (0.261)	-158.9859 (0.482)
LDISMISS <sub>it</sub>	-62.25658 (0.541)	-63.72782 (0.541)
COST <sub>it</sub>	.0004167** (0.000)	.00108** (0.000)
ISIC1543	-235.2915 (0.563)	-19.22606 (0.947)
ISIC1520	-237.692 (0.369)	-422.869** (0.036)
ISIC1553	-386.406 (0.331)	737.5392** (0.010)
ISIC1551	-138.2547 (0.727)	-78.74598 (0.773)
ISIC2101	807.2659** (0.001)	643.3661** (0.028)
ISIC2109	-403.6297* (0.099)	-517.3043** (0.016)
ENFINS <sub>it</sub>	359.309* (0.054)	1015.617** (0.003)
CONSTANT	103.7408 (0.531)	-399.1247** (0.018)
No. of observations	606	607
Overall R <sup>2</sup>	.3933	.4378

*Note: Numbers in parenthesis represent corresponding P-values. Coefficients with an asterisk are significant and those with two asterisks are highly significant.*



**Figure 1. Laguna de Bay and surrounding cities and municipalities**  
Source: LLDA

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