



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

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Background and Motivation

- Analysis of monitoring and enforcement (M & E) issues traditionally neglected by environmental economics
- Debate focused on optimal regulation
- Assumed perfect compliance by sources





Background and Motivation

- M & E costly, but resources limited
- Example: environmental management and pollution control budget in 2005 only PHP 187 M or USD 3.46 M
- If ineffective = no regulation





How effective is M & E in the Philippines?

- This paper reports initial results of an analysis of impact of inspections and legal enforcement on conventional water pollution discharges of beverage and pulp & paper firms around Laguna de Bay from 1997-2004.





Outline

- What determines compliance? A whistle-stop tour of theory and evidence
- Regulatory context in Laguna de Bay
- Data and initial results
- Tentative conclusions and agenda for future work





What Determines Compliance? Theoretical Perspective

- Large theoretical literature building on *Becker (1968)*
- Basic framework: cost of compliance vs. expected penalties





What Determines Compliance? Theoretical Perspective

- Becker (1968) – cost-benefit under risk

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

- where C_i , compliance cost; $\pi.P.$, expected penalties





What Determines Compliance? Theoretical Perspective

- For non-binary choice:
- Marginal cost of abatement vs. marginal saving (expected penalties avoided)
- Shavell (1992): ‘Marginal deterrence’ - expected penalties must rise with level of harm





What Determines Compliance? Theoretical Perspective

- What if firms can contest enforcement actions?
- Expected penalties become endogenous
- Kambhu (1989): increased M & E may trigger intensified contestation > decrease compliance





What Determines Compliance? Theoretical Perspective

- Harrington (1988): firms may still want to comply even if compliance cost greater than expected penalties
- dynamic targeting model under restricted penalties
- G_1 and G_2
- Where, $p_1 < p_2$, $F_1 < F_2$, c =compliance cost, u =probability of being transferred to G_1





What Determines Compliance? Theoretical Perspective

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

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





What Determines Compliance? Theoretical Perspective

- Private enforcement:
- Citizen complaints brought to regulatory agency
- Legal action against polluters (citizen suits)
- Legal action against regulators
- Public disclosure > capital and product markets





What Determines Compliance? Theoretical Perspective

- Naynerski and Tietenberg (1992): citizen suits under random monitoring but incomplete public enforcement > increase compliance
- Heyes (2000): counterproductive when there is 'regulatory dealing'
- Tietenberg (1996): reduce incidence of bribery





What Determines Compliance? Evidence from Developing Countries

- Sparse empirical work for developing countries (e.g. *Dasgupta, Laplante, Mamingi and Wang, 2001; Wang and Wheeler, 2005; Cafferla, Morzuch and Stranlund, 2005; etc.*)
- Results: clear deterrent effects of inspections, citizen complaints for China studies





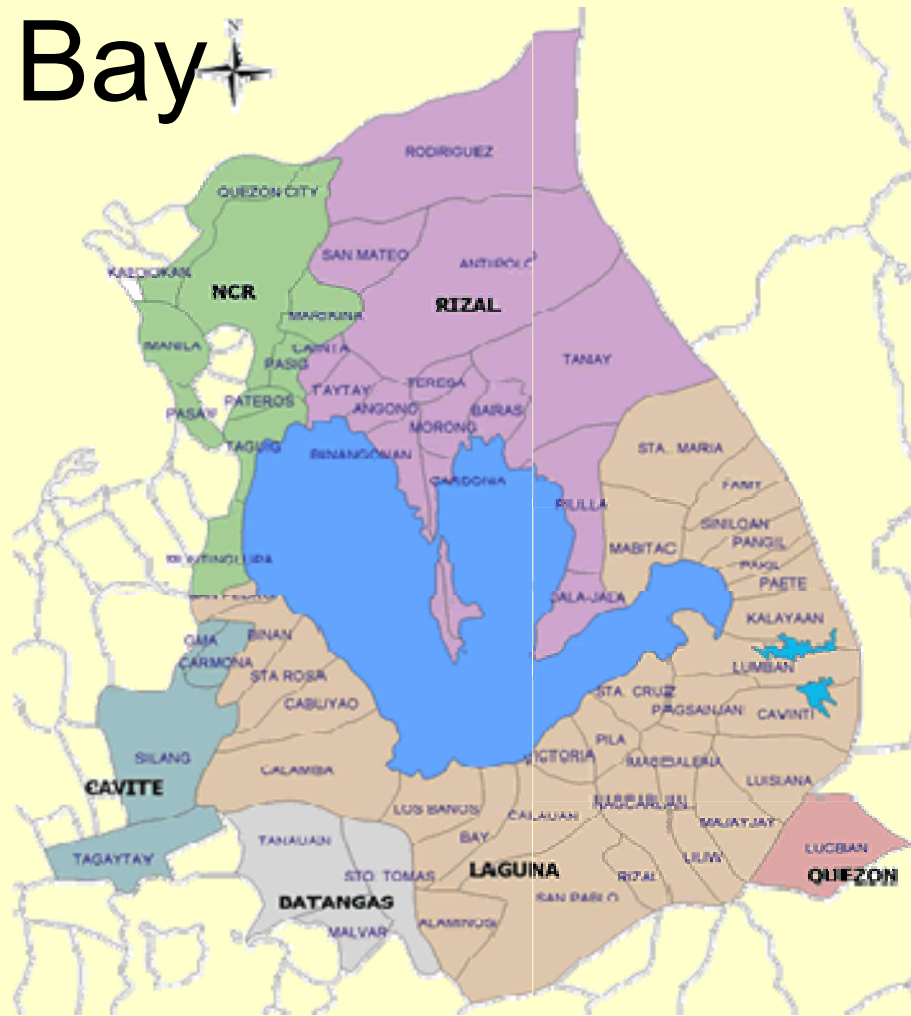
What Determines Compliance? Summary

- Cost of compliance: economies of scale, type of production process
- Expected penalties: probability of detection, level of public and private enforcement, size of penalties





The Case of Laguna de Bay



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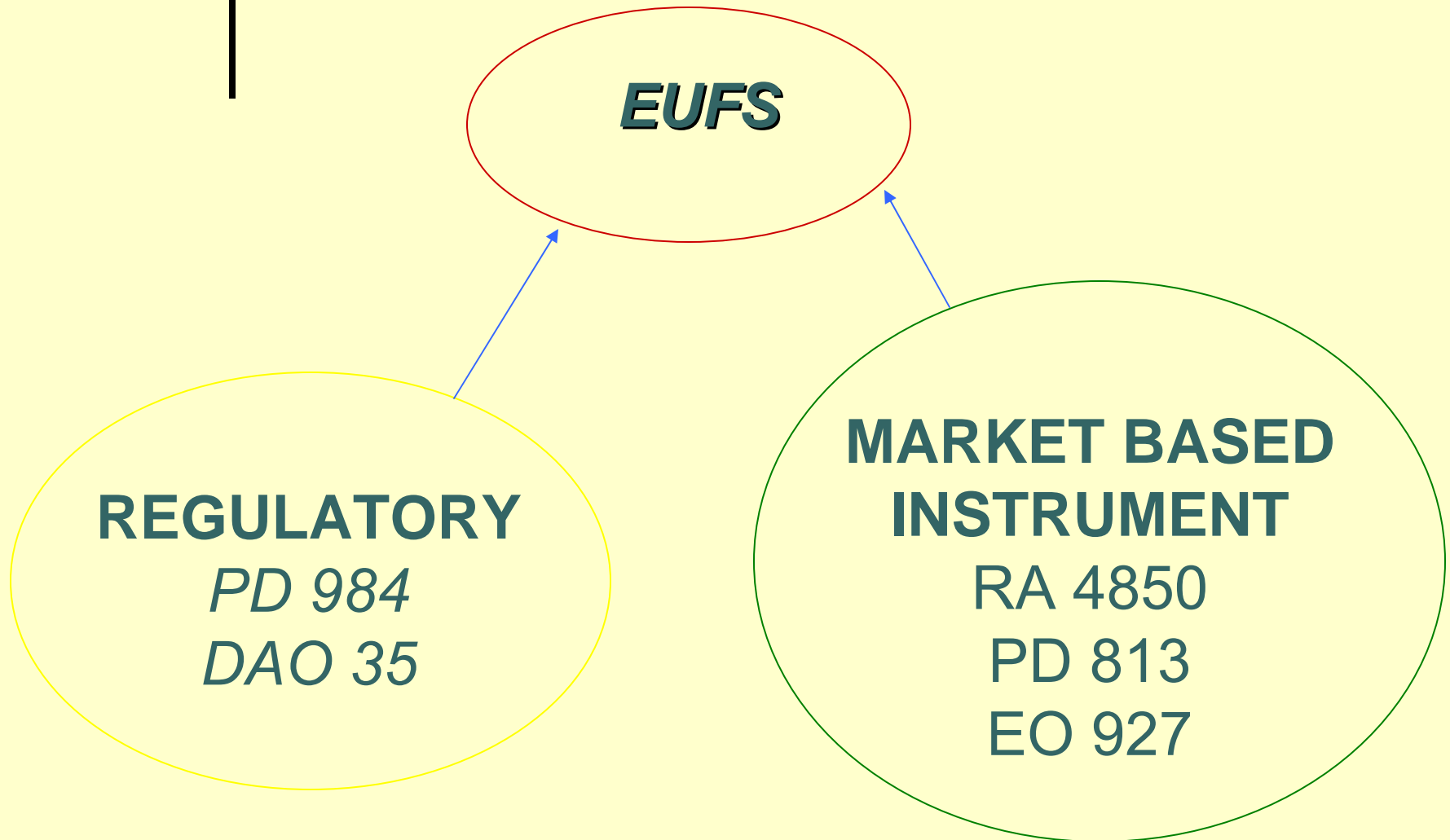
The Case of Laguna de Bay

- 74,000 tons of BOD₅ enter the lake yearly
- LLDA strives to maintain Class C status
- National effluent standards for Class C freshwater bodies
- Concentration-based standards





EUFS: LLDA MODEL





USER FEE STRUCTURE

$$\text{EUF} = \text{FIXED FEE} + \text{VARIABLE FEE}^*$$

$$*\text{VARIABLE FEE} = \text{LOADING}^{**} \times \text{Rate}$$

$$**\text{LOADING} = Q \times \text{BOD}_5 \times \text{days/yr} \times 0.001$$





Fixed Fee - cost of compliance monitoring, analysis, etc.

**- based on vol. rate of
discharge**

Conventional

$Q \leq 30$ cu.m/d	- P 6,800
$31 \geq Q \leq 150$ cu.m/d	- P12,000
$Q > 150$ cu.m/d	- P18,000

Heavy Metals

$Q \leq 150$ cu.m/d	- P12,000
$Q > 150$ cu.m/d	- P18,000





Variable Fee - based on BOD_5 loading;
- covers firms with discharges w/in prescribed standards & those w/c exceed standards

$BOD_5 \leq 50$ mg/L

$BOD_5 \geq 50$ mg/L

Variable Rate

- P 5.00/kg

- P 30.00/kg

Pollution case shall be filed against firms discharging wastewater exceeding BOD_5 & other regulated parameters.





LAGUNA LAKE DEVELOPMENT AUTHORITY SELF MONITORING REPORT

FREQUENCY OF ANALYSIS & SUBMISSION

<i>Flow Rate</i>	<i>Parameter</i>	<i>Freq. of Analysis</i>	<i>Submission</i>
0-150 m³/d	BOD, Conventional	Once every Quarter	Semi-Annually
>150 m³/d	BOD, Conventional	Once every Month	Quarterly
0 - ∞ m³/d	W/ Heavy Metals	Once every Month	Quarterly



LAGUNA LAKE DEVELOPMENT AUTHORITY COMPLIANCE MONITORING

Compliance Monitoring Schedule

<i>Effluent Flow Rate</i>	<i>Type Of Waste</i>	<i>Frequency/yr</i>
0-30 m ³ /d	Conventional	At least 1
31-150 m ³ /d	Conventional	At least 2
0-150 m ³ /d	Heavy Metals	At least 2
>150 m ³ /d	Conv'l., HM	At least 4

Frequent monitoring for firms with pollution case





Data

- Beverages
- 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





Data

- Unbalanced panel dataset for 16 firms
- 5 out of 14 registered pulp and paper firms
- 11 out of 29 registered beverage firms
- Average of 40/96 monthly observations for 8 years
- Not clear if missing data is random or systematic





Data

- 600 monthly observations for analysis
- 1994-2003 – 2 firms misreported 4x, 7 firms misreported 1x,





Model Specification

$$P_{it} = \alpha + \beta_1 \text{EMPLOY}_{it} + \beta_2 \text{LINS}_{it} + \beta_3 \text{LENFORCE}_{it} + \beta_4 \text{LDISMISS}_{it} + \beta_5 \text{COST}_{it} + \beta_6 \text{ISIC}_i + \beta_7 \text{ENFIN}_{it} + V_{it} \quad (12)$$

Estimation: GLS random effects





Descriptives

Variable	Mean	Standard deviation
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





Independent variables	Dependent variable	
	BOD	TSS
EMPLOY _{it}	.9657088** (0.000)	2.908893** (0.000)
LINSP _{it}	-11.15982 (0.758)	114.8797 (0.274)
LENFORCE _{it}	-96.24929 (0.261)	-158.9859 (0.482)
LDISMISS _{it}	-62.25658 (0.541)	-63.72782 (0.541)
COST _{it}	.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 _{it}	359.309* (0.054)	1015.617** (0.003)
CONSTANT	103.7408 (0.531)	-399.1247** (0.018)
No. of observations	606	607
Overall R ²	.3933	.4378





Initial Results

- Weaker deterrent influence of inspections vs. enforcement, deterrence continues even after dismissal of pollution case
- Inspection triggers more abatement resources for BOD at expense of TSS





Future Work

- Improved specification and estimation
- Acquisition of larger dataset
- Probe accuracy of self-report
- Determinants of non-compliance duration and truth-telling





Thank You! 😊



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