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Incomplete Enforcement of Pollution Regulation: Bargaining Power of Chinese Factories

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Abstract. Only a limited number of papers have empirically examined the determinants of the monitoring and enforcement activities performed by the environmental regulator. Moreover, most of these studies have taken place in the context of developed countries. In this paper, we empirically examine the determinants of the enforcement of pollution charges in China. More precisely, we seek to identify the characteristics which may give firms more or less bargaining power with local environmental authorities pertaining to the enforcement (collection) of pollution charges. Firms from the private sector appear to have less bargaining power than state-owned enterprises. Firms facing an adverse financial situation also appear to have more bargaining power. Finally, we also show that the higher the social impact of a firm's emissions (as measured by the presence of complaints), the smaller the bargaining power of the firms with local environmental authorities.

Key words: bargaining power, enforcement

JEL classification: D78, Q28

1. Introduction

A large amount of theoretical research has been conducted on the incomplete enforcement of environmental regulation, and how regulators and firms respond to optimal enforcement and compliance strategies. However, on the empirical side, only a handful of empirical studies have been undertaken, almost exclusively in the context of developed countries.[1]

A small number of papers have empirically examined the determinants of the monitoring and enforcement activities performed by the environmental regulator. Dion et al. (1998) have examined the determinants of environmental inspections (monitoring) in the pulp and paper industry in Canada, and found that local conditions (such as employment conditions, and local environmental damages) explain variations in monitoring intensity across plants: the lower the unemployment rate in a region, and the higher the potential of damages from a firm's emissions, the higher the probability of inspections. Deily and Gray (1991), and Gray and Deily (1996) have similarly analyzed the determinants of inspections and enforcement activities in the steel industry in the United States. In particular, Gray and Deily (1996) found that larger firms in the steel industry as well as firms with higher gross profit rates faced less enforcement actions from the United States Environmental Protection Agency.

In this paper, we empirically examine the determinants of the enforcement of water pollution charges in China.[2] China's pollution levy system is one of the most extensive in the world. According to this system, central government sets up the level and structure of the pollution levy but local (municipal) environmental authorities are responsible for collecting the levies from industrial facilities. This effectively leaves in the hands of the local regulators the responsibility of establishing how much of the calculated levies to collect from each facility. As may be expected, Wang and Wheeler (1996) have observed that the collection of the fees by local authorities diverges from the legal system established by the central government. In particular, the level of completeness in levy collection varies markedly across polluting firms: some firms pay 100% of the pollution charges they should be paying, while others pay a much smaller percentage. Using database of plants located all across China, Dasgupta et al. (1997) and Wang and Wheeler (2000) have shown that the actual collection of pollution levies is sensitive to differences in economic development and environmental quality: air and water pollution levies are higher in areas which are heavily polluted. While this result supports the normative theory of regulation where it is assumed that the regulator seeks to maximize social welfare (Posner 1974), these papers do not seek to explain how the characteristics of individual firms may impact their relative bargaining power with local authorities.

In this paper, we seek to analyze the determinants of the relative bargaining power that firms may have in their relation with local environmental authorities pertaining to the enforcement of pollution levy. We show that firms from the private sector appear to have less bargaining power than state-owned enterprises. We also show, contrary to Gray and Deily (1996), that firms facing an adverse financial situation have more bargaining power and are more likely to pay *less* pollution levies than what they should be paying (less enforcement). Finally, we also show that the higher the social impact of a firm's emissions (as measured by the presence and number of complaints), the smaller the bargaining power of the firms with local environmental authorities.

The paper is organized as follows. The next section presents a short description of Zhenjiang municipality where the analysis takes place, and of the pollution levy system in China. The analytical and statistical models are presented in Section 3, while results are presented in Section 4. We briefly conclude in Section 5.

2. Policy Context

2.1. CHINA'S POLLUTION LEVY[3]

China's pollution levy is one of the few economic instruments with a long, documented history of application in a developing country. In sheer magnitude, the current Chinese system may be without peer in the world. The Chinese environmental protection law specifies that "in cases where the discharge of pollutants exceeds the limit set by the state, a compensation fee shall be charged according to the quantities and concentration of the pollutants released." In 1982, after three years of experimentation, China's State Council began nationwide implementation of pollution levies. Since then billions of yuan (US$1 = 8.2 yuan) have been collected each year from hundreds of thousands of industrial polluters for air pollution, water pollution, solid waste, and noise. In 1996, the system was implemented in almost all counties and cities. Four billion yuan were then collected from about half a million industrial firms. Numbers are increasing each year as the number of firms included in the program increases.

There are some unique features to the levy system in China. For wastewater, the system first calculates a pollution levy only on those pollutants that do not comply with regulatory effluent standards. Then, among these calculated levies (for each pollutant that does not comply with the standard), the firm must pay the charge only on the pollutant which violates the standard by most.[4] The levy collected is used to finance environmental institutional development, the administration of the program, and to subsidize firms' pollution control projects. When a firm invests in pollution abatement, a maximum of 80% of the levy paid by the firm can be used to subsidize the investment project proposed by the firm.

In China, the effective implementation of environmental laws and regulations, including the implementation of the pollution levy, is in large part the responsibilities of local, especially municipal, governments. Article 16 of Chapter 3 of the Environmental Protection Law (EPL) indeed states that "the local people's governments at various levels shall be responsible for the environmental quality of areas under their jurisdiction and shall take measures to improve the quality of the environment." As a result, Environmental Protection Bureaus (EPB) have been created at all levels of local governments, from provinces to counties. These EPBs are thus responsible for the implementation of the pollution levy system.

2.2. ZHENJIANG MUNICIPALITY

Zhenjiang, with a population of approximately 3 million people, is an industrial city located on the South Bank of the Yangtze River. It is directly under the leadership of the Jiangsu provincial government. Zhenjiang's industrial growth has been extremely rapid during the period of China's economic reform. Over the course of the last decade, Zhenjiang's industrial output increased at an average rate of 9% annually. The industrial sector is the most important economic sector of Zhenjiang employing a large percentage of the total labor force, and the industrial base is large and diversified. State owned enterprises do not dominate Zhenjiang industry as private investments have considerably increased in the last decade. Given its importance, the rapid growth of the industrial sector has contributed significantly to improving living standards. However, as a result of this rapid expansion, environmental quality – both air and water ambient quality – has significantly deteriorated.

Zhenjiang Environmental Protection Bureau (ZEPB) is at the apex of decision-making and interagency coordination on environmental policies in Zhenjiang. The activities include the collection of pollution levies and non-compliance fees, the monitoring of air and water ambient quality, and the monitoring and inspection of industrial facilities. The monitoring and inspection of industrial facilities in Zhenjiang (and in all other EPBs in China), follow a precise procedure. Apart from regular inspection activities, complaints made by citizens regarding environmental incidents may give rise to field inspections.[5] If the polluter is found at fault, various administrative penalties or warnings may then be imposed. These may also include the need for the polluter to install treatment facilities. In extreme cases, the plant may be ordered to cease and relocate its operations.

Like in other areas of China, even though Zhenjiang EPB is legally responsible for enforcing environmental regulations, it has limited resources and power to fully enforce the policies. As a result, many polluters can effectively avoid paying charges, fines or other penalties. While Zhenjiang EPB is in a position to assess and determine the pollution levy that must be paid by each individual polluter, in fact, it lacks all necessary power to collect the entire levy it has assessed. In practice, local authorities must negotiate with polluters.[6] Hence, the effective payment made by the polluter is the result of a negotiation and bargaining process with the EPB. It is this negotiation process that we seek to model below.

3. Model

3.1. ANALYTICAL FRAMEWORK

Two groups of factors may determine the level of completeness of the enforcement of a nationwide policy. A first group of determinants pertains to local socio-economic and environmental conditions. Indeed, the national policy may or may not reflect the optimal level of pollution control in a local area. In such circumstances, local governments may want to adjust the national policy to reflect those local conditions. This creates a phenomenon of endogenous enforcement of a national policy.[7]

The second group of determinants of the level of enforcement is associated with the polluters themselves. Indeed, in most circumstances, local regulators will have to negotiate with polluters. In the case of the pollution charge system, regulators will have to negotiate on the amount of charges that polluters effectively pay for their emissions. To the extent that the negotiated payment is less than what the firm should be paying (according to the legislation), this causes incomplete enforcement of the regulation.

There exist formal bargaining models in the environmental regulation literature (see Amacher and Malik (1996, 1998), Frisvold and Caswell (1994), Spulber (1989), Porter (1988), and Ricketts and Peacock (1986)). These models have essentially examined the welfare implications of bargaining, and have not necessarily focused on firms' characteristics as a determinant of the outcome of the bargaining process. In the current analysis, we seek to test empirically the determinants of the outcome of this bargaining process. In this bargaining process, it is assumed that the authority seeks to maximize its collection rate as this is the legal mandate of the local authority. Moreover, 20% of the collected levy can be used by the local authorities themselves. On the other hand, it is assumed that an industrial facility seeks to minimize its total cost, inclusive of the total levy paid, net of the refund it may be able to receive for investment in pollution abatement activities.

Define the completeness of pollution levy enforcement in China (noted EL_{ij}) as the ratio of the pollution charges actually collected from a polluter i in a region j (L^c_{ij}) to the charges that should be collected according to the national standards (L^s_{ij}):

$$EL_{ij} = L^c_{ij}/L^s_{ij}. \tag{1}$$

It is important to note that the denominator of equation (1) is not itself a negotiated amount but is calculated according to a precise levy formula prescribed by the central government. To this extent, EL_{ij} represents a good measure of the extent of enforcement of the pollution levy in China.

Following the above discussion, the degree of enforcement of the national pollution levy system is expected to be a function of local government's enforcement adjustment of the national policy, and the relative bargaining power of an individual firm. We note $EL_{ij} = f(R_j, P_{ij})$ where R_j is a vector of local variables which determine the nature of the local adjustment of a national policy in region j, and P_{ij} is a vector of variables which determine a polluter's relative bargaining power vis-à-vis the local enforcement agencies. R_j may include variables such as local income, education level, environmental condition as well as local industrial development. In China, we expect the following firm specific variables to impact the relative bargaining power of the firm:

- *Plant ownership*. It is understood that plants with government ownership (which may, for example, be local departments of industry) can more easily get protection and access to public decision-makers, as the distinction between regulators, firm owners, and firm managers looses some of its clarity. We thus expect a privately owned plant to have less power to bargain with a municipal EPB and elicit a lower payment than other types of firms, namely state-owned enterprises. We thus expect EL_{ij} to be higher for privately owned firms;

- *Employment*. Firms which employ more workers should have stronger power to negotiate with the EPB for levy payment. Indeed, large industrial facilities providing high levels of employment may have higher political and social powers given the government concerns' with unemployment. We thus expect EL_{ij} to be lower the larger the plant is (in terms of number of employees);[8]
- *Pollution discharge*. A large polluter may or may not have stronger power in negotiation. Therefore, the effect of the scale of pollution discharge is an empirical issue. Moreover, pollution discharge itself may be a function of the levy collection. In this paper, pollution discharge is treated as an endogenous variable;
- *Industrial sector*. This effect remains an empirical issue;
- *Profitability*. It is expected that the relative power and effort to negotiate with an enforcement agency for less levy payment should be stronger if a company has a lower level of profitability. In other words, the more profitable is a firm, the more it can afford to pay the pollution levy (without its financial status being threatened), and the smaller its capacity to negotiate and evade payment of the full amount of the calculated pollution levy;[9]
- *Pollution control effort*. A company with demonstrates significant effort to abate or reduce pollution should be more likely to succeed in bargaining with the environmental enforcement agency;
- *Negative image*. A firm with a negative environmental image (as measured for example by the number of environmental incidents or citizen complaints) should have less bargaining power than another firm with a positive environmental image;
- *Levy refund*. As indicated previously, a polluter in China is entitled to get some refund of the levy it has paid if it can demonstrate that the refund will be used for its pollution control activities. It is expected that a firm which is successful in getting a refund in previous years may reasonably expect to get a similar refund in the current year, and may therefore exert less effort to bargain for lower levy payment; it is however important to note that the refund is not obtained automatically on a yearly basis. Indeed, before being allowed to submit a request for the refund, plants must first need to get approvals of their pollution control investment projects.
- *Number of inspections*. As for the pollution discharge variable, we expect the number of inspections at any given facility to be itself endogenous to the pollution levy, and it will thus be treated that way.

3.2. ECONOMETRIC MODELING

Since in this paper we are focusing our research effort strictly in one municipality (Zhenjiang), the vector of variables R_j is treated as a constant vector in the function $EL_{ij} = f(R_j, P_{ij})$. Therefore, variance in EL_{ij} is expected to be determined only by P_{ij}. Given that both the number of inspections and the level of discharges are treated as endogenous variables, the system of equations we seek to estimate is as follows:

$$\begin{aligned} Insp_{it} = {} & c + a_1 Time + a_2 Lcinsp_{i,t-1} + \\ & a_3 Lcc_{i,t-1} + a_4 PO_{i,t-1} + b_i + v_{it} \end{aligned} \tag{2}$$

$$PO_{it} = c + X_{it}\beta + Z_i\gamma + \delta_1 Insp_{it} + \delta_2 PO_{i,t-1} + d_{i+m_{it}} \tag{3}$$

$$EL_{it} = c + X_{it}\phi_1 + Z_i\phi_2 + R_{it}\phi_3 + PO_{it}\phi_4 + Insp_{it}\phi_5 + \alpha_i + u_{it}. \tag{4}$$

Where

$i = 1, 2, 3, \ldots, N$	stands for firm;
$t = 1, 2, 3, \ldots, T$	stands for time;
Insp	is the number of inspections;
Lcinsp	is the cumulative number of inspections up to time $t - 1$;
Lcc	is the cumulative number of complaints up to time $t - 1$;
PO	is the level of discharges relative to the standard;
X	is a matrix of time-varying variables which consists of: *Emp* (number of employees); *State* (dummy variable to indicate state owned enterprise); *Coll* (dummy variable to indicate collectively owned enterprise); *Fjv* (dummy variable to indicate joint venture);
Z	is the matrix of dummies for sectors such as textile, petrol, tobacco, construction, food, beverage, metal, paper, and chemical;
EL	is the ratio of water levy actually paid to water levy that should be paid;
R	is the matrix of time-varying variables which consists of: *Profem* (profit per number of employees); *Lref* (lag refund/lag levy paid); *Ratwtop* (pollution control operation cost/total operating cost);[10] *Cmpaccon* (complaints or accidents or conflicts with local communities);
b_i, d_i, α_i	are firm specific effects in the first, second, and third equation;
v_{it}, m_{it}, u_{it}	are the usual error terms.

The following assumptions are made in estimation:

- the firm specific effects are random;
- the three error terms are uncorrelated and well behaved;
- the lagged pollution variable is uncorrelated with the errors term in the first and second equations;

- all the right-hand side variables in the first equation are doubly exogenous; that is, uncorrelated with the firm specific effects as well as with the error term;
- inspection is an endogenous variable in the three equations;
- pollution is an endogenous variable in the second and third equation;
- levy payment ratio (ratio of water levy actually paid to water levy assessed by the authorities) is an endogenous variable in the third equation along with inspection and pollution.

The exogeneity/endogeneity distinction of variables has been made on a priori ground as in many simultaneous/recursive equations models. It is worth noting that the exogeneity of variables most likely holds for the dummy variables of the model (dummies for sectors and dummies for the nature of the enterprise) as the latter variables can be considered given; that is, they are determined outside the system. Similarly, the lagged variables of the model are predetermined variables. We acknowledge, however, the possibility for the exogenous time varying variables (Profemp, Ratwtop and Cmpaccon) to be endogenous. In any event, this is not a major problem since we use enough instruments in our generalized method of moments (GMM) to take care of this eventuality. Inspection, pollution and levy payment ratio are the endogenous variables of the model.

As can be seen, the system of equations (2, 3, and 4) is recursive and dynamic. Since the model is recursive, we can estimate it equation by equation.[11] Here, however, we are interested in the third equation. To eliminate the individual effects we transform equation (4) into the following:

$$\begin{aligned}\Omega^{-1/2}EL_{it} \;=\; & \Omega^{-1/2}c + \Omega^{-1/2}X_{it}\phi_1 + \Omega^{-1/2}Z_i\phi_2 + \Omega^{-1/2}R_{it}\phi_3 + \\ & \Omega^{-1/2}PO_{it}\phi_4 + \Omega^{-1/2}Insp_{it}\phi_5 + \Omega^{-1/2}e_{it}\end{aligned} \tag{5}$$

where variables are defined as above, and e_{it} is the new error term, defined as the sum of the firm random specific effects (α_i) and the regular error term (u_{it}). The matrix omega is the appropriate matrix to eliminate the individual effects. It is constructed as follows:[12]

$$\Omega^{-1/2} = Q_v + P_v\theta \tag{6}$$

with

$$P_V = I_N \otimes l_T l_T'/T \tag{7}$$

$$Q_V = I_N - P_V \tag{8}$$

and

$$\theta^2 = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_\alpha^2}. \tag{9}$$

Table I. Water discharge characteristics in 1997

Average discharges (kg/year)	
TSS (total suspended solids)	47,861 (530)
COD (chemical oxygen demand)	48,591 (626)
Average concentration (mg/l)	
TSS (total suspended solids)	99 (503)
COD (chemical oxygen demand)	280 (507)
Proportion of firms paying levy	45%

For any integer m, let l_m be an m $x1$ vector of ones. The idempotent matrix Q_V transforms the original variables into deviations from individual means, and P_V transforms original variables into a vector of individual means.

4. Data and Estimation Results

4.1. DATASET

In order to perform this analysis, a primary dataset was recently collected with detailed information on several hundreds industrial plants in Zhenjiang, covering the period 1993 to 1997. In 1997, the total number of plants included in our sample is 640. Of these, 26% are state owned enterprises, the majority being collectively-owned enterprises. Most of the plants in the dataset are medium and small enterprises, with only 4% of the enterprises being large. These large plants, however, account for approximately one third of the total value of output of the enterprises in the dataset. A further breakdown indicates that the timber processing, the food processing and the petroleum processing industries represent the largest number of sectors in our dataset with 17.2%, 15.6% and 10.2% of the plants, respectively.

Table I describes the water pollution discharges of the firms in 1997. In brackets is the number of firms on which the entry has been computed (since the information was not always available for all the firms in the dataset). Note that a large proportion of the firms in the dataset have paid water levies, and therefore, was not complying with at least one regulatory standard.

In 1997, the 640 enterprises were the object of 5,287 inspections, most of them (99.4%) performed by the Zhenjiang Environmental Protection Bureau. These enterprises were also the object of 78 water related complaints.

Table II provides means, coefficient of variation, the number of plants, the time span, and the total number of observations for selected variables. Some remarks are useful before commenting the statistics of interest. First, the panel data nature of the exercise combined with the small time series observations per plant (1993–1997) indicate that total variation and cross-section variation are more useful than time series variation. Second, the panel data of interest is unbalanced to the extent that some plants do not contain information for the full period. Third, the coefficient of variation instead of the standard variation has been used as a measure of dispersion to compare variables with different means and different units of measurement.

Noteworthy are the mean values of the levy payment ratio, the ratio of total profit to employment, the ratio of total operation cost of water pollution abatement to total production cost, the level of discharges of total suspended solids and of chemical oxygen demand with respect to the own standard, and the number of inspections. The levy payment ratio variable indicates that on average during the period of investigation water levy paid was slightly less than the water levy charged. The ratio of total profit to total employment was on average negative indicating that most plants incur losses. This average is most likely affected by outliers. On average, total operation cost of water pollution abatement was a very small proportion of total production cost. The behavior of discharges of total suspended solids was different from the behavior of discharges of chemical oxygen demand. Indeed, on average while the discharges of the former were below the standard, discharges of chemical oxygen demand were above the standard. On average, a plant received on average 8 inspections a year during the period of investigation.

Observe that the coefficient of variation varies greatly. It goes from 29.78% (*EL*) to 6,053.77% (*Profemp*). The typical variation is between 100% and 1000%. There seems to be a great difference in variations between discharges using total suspended solids (3,852.16%) and those for chemical oxygen demand (306.16%). Care should thus be exercised when interpreting results using variables with greater variability since the variables might contain some outliers.

4.2. ESTIMATION RESULTS

Given the presence of endogenous variables in the equation of interest, the generalized method of moments (GMM) is an appropriate method of estimation to obtain under some conditions consistent and efficient estimates. Thus, the GMM is applied to equation (5). The instruments we use here are[13]

$$(Q_V X,\ Q_V R,\ P_V X,\ P_V R,\ P_V Z) \qquad (10)$$

where the variables are defined as above. Note, however, that in equation (10), the matrix X also contains the time variable as well as the constant term c.

Table II. Statistics for selected variables (panel and cross-section data for the period 1993–1997)

Variable Name	Mean	CV in %	# plants	Time period	# observ.
EL (water levy paid/	0.957	29.78	734	1–5	1953
water levy charged)	0.958	19.84			
Emp	395.41	136.34	734	1–5	1953
(total employment)	326.13	138.82			
State	0.323	144.89	735	1–5	1955
	0.2667	161.65			
Coll	0.596	89.38	735	1–5	1955
	0.649	71.80			
Fjv	0.071	360.56	735	1–5	1955
	0.071	354.92			
Textile	0.018	672.73	735	1–5	1955
	0.016	649.18			
Chemical	0.022	665.16	731	1–5	1955
	0.023	640.35			
Profemp	–0.106	6053.77*	579	1–5	1947
(profitability)	–0.191	3514.55			
Lref	0.450	348.22	352	1–4	743
	0.426	270.42			
Ratwtop	0.002	432.26	727	1–5	1936
(pollution control effort)	0.002	441.38			
Cmpaccon	0.184	209.73	734	1–5	1953
(social impact)	0.154	190.32			
Lcc (Cumulative number of	0.177	362.147	580	1–4	1219
complaints up to time $t-1$)	0.146	349.32			
Bentss	0.067	3852.16	570	1–5	1349
(TSS violation)	–0.082	2610.91*			
Bencod	1.592	306.16	562	1–5	1397
(COD violation)	1.331	236.14			
Insp	7.760	127.20	734	1–5	1953
(number of inspections)	6.739	122.42			
Lcinsp	14.398	159.12	580	1–4	1219
	10.920	177.04			

Note: State: 1 = a plant is a state-owned enterprise; 0 = otherwise; Coll: 1 = a plant is a collectively-owned enterprise; 0 = otherwise; Fjv: 1 = a plant is a joint venture; 0 = otherwise; Textile:1 = textile industry; 0 = otherwise; Chemical: 1 = chemical industry; 0 = otherwise; Cmpaccon: 1 = with environmental accidents, environmental conflicts or citizen complaints on its pollution; 0 = otherwise; Columns (2) and (3): top figures are derived from panel data (cross section and time series) and bottom figures are related to cross section data (between variation: means of plants for the available years). CV: coefficient of variation. It is calculated as the ratio of the standard deviation to the mean. (*) indicates the absolute value. Column (5) provides information on time span: i.e., 1–4 means the minimum number of years is 1 and the maximum number of years is 4; that is, some plants have only one year of observations and others more than one year of observations. # observ.: total number of observations (cross section combined with time series).

In terms of model selection, we adopt the Hendry's general to specific (top – down) methodology. That is, we submit the original general model to a battery of tests to derive a parsimonious model (see Maddala 1992, pp. 494–496). The parsimonious model derived from equation (5) contains the following explanatory variables: 'State', 'Coll', 'Fjv', 'Textile', 'Chemical', 'Profemp', 'Lref', 'Ratwtop', 'Cmpaccom', 'Bentss or Bencod', and 'Insp'.

Results of estimation of the parsimonious model derived from equation (5) are presented in Table III.[14] The results of Table III are consistent with expectations except that two different pollutants give two different signs. The default ownership variable in the model is private ownership, which should have a positive relationship with the ratio of levy payment because three other forms of ownership – state-owned, collectively owned and joint ventures, all have negative effects.[15] This thus indicates that privately owned enterprises (voluntarily or not) have less bargaining power with respect to the payment of the pollution levy.

Profitability has a positive relationship with the levy payment ratio just as expected but the relationship is not significant. Pollution abatement effort has a significant, negative relationship with the levy payment ratio. This negative relationship indicates that a company which has spent more on pollution abatement (which may be an indication of goodwill or greater awareness of environmental and pollution issues) will more easily get waived of paying for the levy charged. Precisely, a 1% increase in pollution control brings about a 0.01% decrease in the levy payment ratio.[16]

A firm which has suffered environmental accidents, conflicts with residents on environmental issues or is the object of citizen complaints is more likely to pay for the full pollution charge. A firm which has received a refund from the levy funds in the previous year appears more willing to pay for the levy charged in the current year. A 1% increase in discharges of total suspended solids relative to its standard brings about a decrease of the order of 0.007% in the levy payment ratio. On the contrary, a 1% increase in discharges of chemical oxygen demand with respect to its standard gives rise to a 0.04% increase in the levy payment ratio. As explained previously, both results are consistent with expectations regarding the uncertain impact of pollution discharges on the bargaining power of the firm. Finally, a 1% increase in the number of inspections brings about a 0.04% decrease in the levy payment ratio.[17] This result is of interest. In a previous paper, Dasgupta et al. (2001) have shown that inspections reduce pollution discharges of industrial establishments in China. However, results here indicate that a greater level of inspections is associated with a reduction in the levy payment ratio. While more inspections may improve the environmental performance of the plants, more inspections also appear to indicate that the plant is less willing to pay for a pollution charged.

Table III. GMM results for equation (5) – dependent variable: EL

Independent variables	Parameters Model 1 (TSS)	Parameters Model 2 (COD)
State	–0.0607**	–0.0729**
	(0.013)	(0.013)
Coll	–0.0843***	–0.1195***
	(0.000)	(0.000)
Fjv	–0.0421*	–0.0581
	(0.094)	(0.136)
Textile	0.2423***	0.1586***
	(0.000)	(0.007)
Chemical	0.1159**	0.1321***
	(0.016)	(0.000)
Profemp	0.0003	0.0000
(profitability)	(0.119)	(0.869)
Lref	0.0059***	0.0067***
(refund)	(0.001)	(0.001)
Ratwtop	–3.8832*	–5.5717***
(pollution control effort)	(0.057)	(0.003)
Cmpaccon	0.0504**	0.0725**
(social impact)	(0.023)	(0.012)
Bentss	–0.0094*	
(TSS violation)	(0.099)	
Bencod		0.0202*
(COD violation)		(0.093)
Insp	–0.0007	–0.0033**
(number of inspections)	(0.283)	(0.050)
Test overid. rest.	14.0825	13.1836
	(0.295)	(0.356)
# observations	382	378

Note: (...) are p-values. Standard errors are robust standard errors. Test overid. rest. is the test for the validity of over-identifying restrictions. (***), (**), and (*) mean significant at the 1%, 5%, and 10% level, respectively.

5. Summary and Conclusion

There are two issues associated with the implementation of a national environmental policy at the local level such as the pollution levy system in China: endogeneity of enforcement and incomplete enforcement. With a primary database collected in Zhenjiang, China, this paper has analyzed the issue of incomplete enforcement, which is caused by the relative bargaining power of the industrial establishments. Unlike previous papers which have mainly focused on the impact of socio-economic and environmental conditions, in this paper we have examined more precisely the impact of firms' characteristics (such as financial status, pollution control effort, social impact of pollution emission, magnitude of emission violation, as well as refund of levy paid and number of inspection received on the amount of levy paid relative to the amount that should have been paid if the national system had been strictly applied. With a stronger bargaining power in the hands of the industrial sector, we expect the degree of enforcement to be lower.

The empirical results are consistent with prior expectations. Firms which are privately owned have less bargaining power in levy payment. A bad financial situation entails a higher relative bargaining power and a bigger effort to bargain for less levy payment. A plant which spent more on pollution control is more likely to get waived, the some portion of the levy payment. The higher the social impact of pollution emissions of a plant, the less is the bargaining power in levy payment. A plant which had more levy refund before is less likely to spend strong effort to bargain for less levy payment. Finally, the number of inspections received has a significant, negative correlation with the ratio of levy payment. However, conflicting results are found in the magnitude of emission violation between two different pollutants: total suspended solids and chemical oxygen demand. Although the signs of the correlation are empirical issues, the reason for this divergence is not known.

Empirical work of the nature performed here which seeks to analyze and comprehend the actual implementation of environmental policies still remains a rarity in the literature. This is especially the case for developing countries where very little is known on implementation issues. Yet designing environmental policies and legislation while ignoring how these will be implemented may in all likelihood lead to the adoption of policies which may appear effective, perhaps even cost efficient in design, but lead to only minimal results in practice. We hope this paper provide a further understanding of the determinants of the implementation of environmental policies in China.

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The findings, interpretations, and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the World Bank, its Executive Directors, or the countries they represent.

Notes

1. See Garvie and Keeler (1994), and references therein. See Cohen (1998) for a literature review.
2. The pollution charge system in China is most often referred to as pollution ‘levy’. We thus adopt this terminology in this paper.
3. For a comprehensive overview of environmental legislation and institutions in China, see Mei (1995) and Sinkule and Ortolano (1995). For a detailed discussion of the pollution levy system itself, see Wang and Wheeler (1996), and Dasgupta et al. (2001).
4. After 1993, the government started charging for wastewater discharges (flow) whether the effluent met regulatory concentration standards or not.
5. All Chinese citizens have a right to file complaints on pollution matters, and these have to be filed and dealt with in a very precise manner. Zhenjiang EPB is entitled to bring cases to court on behalf of the public.
6. For more discussions on environmental enforcement issues in China, see Wang (2001).
7. In the environmental regulation literature, this phenomenon has been empirically analyzed in Dion et al. (1998), Deily and Gray (1991), Gray and Deily (1996), Pargal and Wheeler (1996), and Wang and Wheeler (2000).
8. This hypothesis is consistent with Dion et al. (1998) who found that the likelihood of enforcement of the environmental regulation by means of fines and penalties is lower the more important the plant is in the local labor market.
9. This hypothesis is consistent with Deily and Gray (1991) who found that the extent of EPA’s environmental monitoring activities in the steel industry in the United States was inversely related to the financial status of the industrial facilities.
10. Chinese enterprises are required to submit to the local governments detailed information on their activities including information such as: total profit, output, material input, water use, energy use, pollution discharges, total investment, investment in pollution abatement facilities, total operating expenditures, operating expenditures associated with pollution abatement, etc. Plants submit this information based on their accounting books which are guided by accounting manuals issued by the Chinese government. Of course, there can be biases in the cost accounting practices. However, we have no means of testing the extent and determinants of the nature of these biases. To the extent that the biases are not systematically correlated with variables used in the current analysis, we do not expect our results to be affected.
11. See Lahiri and Schmidt (1978) for further details.
12. See, for example, Ahn and Schmidt (1995) for details.
13. See Ahn and Schmidt (1995) for a thorough discussion on instruments.
14. Although the results from equations (2) and (3) are not really of interest here, they are nevertheless reported in Appendix 1 and 2. These results are indicative rather than definitive.
15. Firm ownership in China can be classified as state-owned, collectively owned, joint ventures, and private (domestic private and foreign private). The private dummy is omitted in the model. Since all three variables (State, Coll, and Fjv) have significant negative signs, it can therefore be said that private companies have less bargaining power.

16. All responses are elasticities. Each elasticity is the coefficient of the variable of interest times the mean of the variable and divided by the mean of EL.
17. This conclusion is somewhat tentative to the extent that in one of the models, inspection with a negative sign has no significant impact on the levy payment ratio.

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Appendix 1. Random Effects and Within Estimates from Inspection Equation (2)

Variables	Random effects	Within effects	Variables	Random effects	Within effects
Time	–1.923***	1.184***	Time	–1.566***	1.399***
	(0.000)	(0.005)		(0.000)	(0.002)
Lcinsp	0.295***	–0.066**	Lcinsp	0.296***	–0.048
	(0.000)	(0.043)		(0.000)	(0.134)
Lcc	–0.031	1.808**	Lcc	0.578	1.558
	(0.951)	(0.046)		(0.147)	(0.530)
Bentss(-1)	0.231***	0.357**	Bencod(-1)	0.058	0.083
	(0.000)	(0.049)		(0.290)	(0.563)
C	12.843		C	11.340***	
	(0.000)			(0.000)	
Adj. R^2	0.543	0.754	Adj. R^2	0.577	0.723
χ^2_4	175.88***		χ^2_4	154.35***	
	(0.000)			(0.000)	
# Plants	400	400	# plants	433	433
% observations	787	787	# observations	847	847

Note: For variables definition, see Table I. χ^2_4 is the Hausman test which tests for random effects vs fixed effects. (...) are *p*-values. (***), (**), (*) mean significant at the 1%, 5% and 10% level, respectively.

Appendix 2. GMM estimation of transformed Equation 3 (pollution equation)

Bentss		Bencod	
Emp	–0.0001 (0.269)	Emp	0.029* (0.070)
State	–0.787*** (0.000)	State	–36.698** (0.046)
Coll	–0.435*** (0.007)	Coll	–20.654** (0.030)
Petrol	–0.494*** (0.001)	Petrol	–9.677* (0.084)
Coal	–0.628 (0.141)	Coal	–4.923 (0.510)
Construction	0.351 (0.166)	Construction	94.978 (0.624)
Paper	–0.237 (0.611)	Paper	–24.938 (0.624)
Chemical	–0.009 (0.320)	Chemical	–0.470 (0.964)
Insp	–0.010 (0.320)	Insp	2.961*** (0.008)
Bentss(-1)	0.851*** (0.000)	Bencod(-1)	0.761*** (0.000)
Adj. R^2	0.338	Adj. R^2	0.845
# observations	757	# observations	1219

Note: Some variables are defined as in Table I. Coal: 1 if coal industry and 0 otherwise; Construction: 1 if construction industry and 0 otherwise; Petrol: 1 if petrol industry and 0 otherwise; Paper: 1 if paper industry and 0 otherwise; (...) are *p*-values; (***), (**), (*) mean significant at the 1%, 5% and 10% level, respectively.