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Environmental Performance Rating and Disclosure

An Empirical Investigation of China's Green Watch Program

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Abstract

Environmental performance rating and disclosure has emerged as an alternative or complementary approach to conventional pollution regulation, especially in developing countries. However, little systematic research has been conducted on the effectiveness of this emerging policy instrument. This paper investigates the impact of a Chinese performance rating and disclosure program, Green Watch, which has been operating for 10 years. To assess the impact of Green Watch, the authors use panel data on pollution emissions from rated and unrated firms, before and after implementation of the program. Controlling for the characteristics of firms and locations, time trend, and initial level of environmental performance, the analysis finds that firms covered by Green Watch improve their environmental performance more than non-covered firms. Bad performers improve more than good performers, and moderately non-compliant firms improve more than firms that are significantly out of compliance. The reasons for these different responses seem to be that the strengths of incentives that the disclosure program provides to the polluters at different levels of compliance are different and the abatement costs of achieving desired levels of ratings are different for different firms.

This paper—a product of the Environment and Energy Team, Development Research Group—is part of a larger effort in the department to understand and improve environmental governance in developing countries.. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hwang1@worldbank.org.

Environmental Performance Rating and Disclosure: An Empirical Investigation of China's Green Watch Program

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Key words: environmental performance rating, public disclosure, developing country, China, Green Watch, program evaluation

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1. Introduction

Environmental performance rating and disclosure (PRD) has emerged as a substitute or complement for traditional pollution regulation, especially in developing countries [6][28][31]. Indonesia's PROPER (Program for Pollution Control, Evaluation and Rating), initiated in June 1995, was the first PRD program in developing countries. Because of its perceived overall success, as measured by reduced emissions at a lower regulatory cost, many countries have established similar programs for a variety of industry sectors and pollutants in diverse economic, institutional and cultural settings. These programs include the Philippines' EcoWatch, India's Green Rating Project, China's Green Watch, Vietnam's Green Bamboo, Ghana's EPRD, and Ukraine's PRIDE. PRD programs are particularly attractive for developing countries because institutional weaknesses hinder conventional monitoring and enforcement of environmental laws, regulations, and standards [8], and because PRD programs have lower regulatory costs [6].

The literature on the effectiveness of PRD programs is very limited and falls into two groups. The first compares the environmental performance ratings of firms before and after a program is implemented, and ascribes any ratings improvements to the program [1]. However, this approach may be confounded by time-varying factors such as technology improvements. The second group compares polluting emissions from rated and unrated firms, and credits performance improvements by rated firms to the program. However, this approach may be confounded by selection bias (e.g., firms with better environmental performance may be more likely to be rated).

It is rare to have pollution data for both rated and unrated firms before and after implementation of a PRD program. Garcia et al. [10][11] assess the effectiveness of Indonesia's PROPER using measured pollution from rated and unrated firms, both ex ante and ex post. Their

2007 study suggests that PROPER has reduced emissions intensity, with a particularly rapid and strong impact on firms that have poor initial compliance records. Their 2009 study finds a strong reactive response during the first six months of disclosure, followed by a more moderate, but still significant, longer-run response as management adjusts to the new regime.

This study extends PRD assessment to China, using panel data on pollution from rated and unrated firms, before and after implementation of the Green Watch program. Our work offers two main contributions to the literature. First, we exploit the panel structure of the data to control for confounding factors such as time-variant technology improvement and selection bias between rated and unrated firms. Second, we go beyond a single measure of environmental performance to consider the impact of ratings disclosure on several measures, including emissions intensity and effluent concentrations for a variety of air and water pollutants.

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature, focusing on the role of PRD programs in developing countries. Section 3 describes China's Green Watch program, while Section 4 describes our survey instrument and provides descriptive statistics for major variables. Section 5 presents our estimation model and results, and Section 6 summarizes and concludes the paper.

2. Previous research

The literature on pollution control policies includes extensive work on command-and-control, market-based and information-based instruments [6]]. Command-and-control instruments are often inefficient and ineffective in developing countries, because firms may fail to report adequately, regulators may lack the technical and administrative capacity for effective monitoring and enforcement, and judicial systems may be weak and/or corrupt. These same

weaknesses limit regulators' ability to employ market-based instruments, which also work less effectively in countries where market failures are common and legal and institutional supports for formal market activities are weak.

Information-based instruments can be effective in developing countries where strong regulatory institutions and/or well-developed markets are absent, but where enough information can be reliably obtained to provide credible performance ratings. In practice, diverse information programs have served as complements to command-and-control and market-based instruments [21]. Information programs reduce the information asymmetry between polluters and environmental stakeholders (consumers, communities, NGOs, investors), empowering these stakeholders to pressure polluters for improved environmental performance [5][17][26]. When implemented correctly, information instruments promote better interaction and dialogue among firms, stakeholders and regulators [10].

Information instruments also leverage markets in significant ways. An extensive empirical literature suggests that disclosure of firms' bad environmental performance reduces their stock prices both in developed countries [8][14][19][23],[24] and developing countries such as Argentina, Chile, Mexico, and the Philippines [7]. Jackson [16] and Boyle and Kiel [4] review the impacts of disclosure on housing prices in the US, which are found to be lower near Superfund sites [22][29], hazardous waste sites [30], non-hazardous landfills [25], nuclear radiation sources [9], and polluting manufacturing plants [11]. Housing prices also respond to publicized environmental contamination incidents [19][20].

Information instruments have diverse forms, including reports of measured pollution, environmental accident reports, and environmental performance ratings. In the US, for example, the Toxics Release Inventory (TRI) discloses toxic chemical releases and waste management

activities by significant toxic polluters and federal facilities. In developing countries, however, weak regulatory institutions may have difficulty in implementing such emissions inventories. In addition, despite an emerging literature on stakeholders' role in improving firms' environmental performance [2][3][27][33], concerns remain about the public's ability to understand and utilize complex emissions reports. For example, Bui and Mayer [5] find that the release of TRI's highly-detailed information on facilities' toxic emissions has virtually no effect on housing prices in neighboring areas, even when the release of such information is unexpected. The dual problems of emissions inventories in developing countries – technical feasibility and public understanding – have led to a preference for programs that condense complex information into environmental performance ratings that are disclosed to the public.

Research on the effectiveness of performance rating and disclosure (PRD) programs suggests that that have a significant, positive impact on regulatory compliance [1][6][10][11][32]. Dasgupta et al. [6] summarize the changes in compliance rates for several PRD programs in Asia. During the first and second years after inception, compliance rates among covered firms increased from 37% to 61% in Indonesia, 8% to 58% in the Philippines, 10% to 24% in Vietnam, 75% to 85% in Zhenjiang, China and 23% to 62% in Hohhot, China.

Several empirical studies also find that PRD programs have improved firms' environmental performance in Indonesia [1][10][11] and China [32]. However, data constraints generally limit these studies to comparisons of environmental ratings before and after program implementation, or comparisons of compliance status between rated and unrated firms. Unfortunately, intertemporal rating comparisons are subject to confounding effects from time-varying factors such as technology change, while cross-sectional comparisons can be subject to significant selection bias.

3. China's Green Watch Program

Despite long-standing efforts to control pollution with traditional regulatory instruments, China continues to have severe pollution problems. This has led China's State Environmental Protection Administration (SEPA) to test the effectiveness of environmental performance rating and disclosure in a program supported by the World Bank. In 1999, SEPA launched its Green Watch program in Zhenjiang City, Jiangsu Province and Hohhot City, Inner Mongolia Autonomous District. Zhenjiang implemented a relatively complex rating system, as shown in Figure 1, while Hohhot used a simpler rating system that was suited to its lower level of economic and institutional development (Wang et al., 2004). As shown in Figure 1, Green Watch in Jiangsu rates firms' environmental performance from best to worst in five colors – green for superior performance; blue for full compliance; yellow for meeting major compliance standards but violating some minor requirements; red for violating important standards; and black for more extreme non-compliance.

Green Watch ratings provide incentives for firms to improve their environmental performance in a comprehensive way. The primary benchmarks for ratings are China's emission and discharge standards that specify effluent concentration limits. Firms violating any of these standards are rated red, and firms violating standards in more than 60% of inspections are rated black. The secondary benchmarks are China's load-based emission and discharge standards. Firms that satisfy the primary benchmarks but violate the secondary standards are rated yellow. The ratings system also incorporates other performance indicators, including hazardous waste disposal practices, solid waste recycling, pollution accidents, public complaints, internal management requirements, China cleaner production certificates, ISO 14000 certificates,

administrative penalties, and other citations for illegal activity. For each indicator, the system specifies a link to ratings that is clear, unambiguous and publicly available.

The first Green Watch ratings were disclosed through the media in 1999. The program was extended from Zhenjiang to all of Jiangsu Province in 2001, and to eight other provinces during 2003-2005. Nationwide implementation of Green Watch has been promoted since 2005. Overall, the available evidence suggests a positive impact for the program. Table 1 shows that in Zhenjiang, the percentage of firms with positive ratings (green, blue and yellow) increased from 75% in 1999 to 85% in 2000. The most significant changes were in the extremely-noncompliant black group, whose percentage dropped from 11% in 1999 to 2% in 2000, and a major shift from the partially-compliant yellow group (44% to 22%) to the fully-compliant blue group (27% to 61%).

Evidence for the Green Watch program in Jiangsu Province indicates both increasing participation by firms and improvement in their compliance rates. As shown in Table 1, the number of rated firms increased more than tenfold, from 1,059 in 2001 to 11,215 in 2006; and the percentage of firms with positive ratings (green, blue, and yellow) increased from 83% in 2001 to 90% in 2006. Furthermore, Table 1 suggests that Green Watch ratings provide a strong improvement incentive for noncompliant (red and black) firms, with stronger effects on firms with red ratings (moderate noncompliance) than those with black ratings (extreme noncompliance).

4. Data

This study utilizes a pollution dataset for both rated and unrated firms during the period 1996-2001 in four cities of Jiangsu province (Huaian, Wuxi, Yangzhou, and Zhenjiang). Following the success of the pilot program in Zhenjiang, Huaian, Wuxi and Yangzhou adopted

the same program in 2001. Table 2 provides information on socioeconomic and environmental conditions in the four cities, as well as polluting emissions in 2001. Wuxi has the largest population as well as the highest GDP per capita, while Huaian is the poorest. Wuxi and Yangzhou have the lowest readings for air quality, measured by SO2 (sulfur dioxide) and NO2 (nitrogen dioxide), and water quality measured by TSS (total suspended solids) and regulatory compliance percentage.

The dataset includes detailed information on the firms' characteristics, pollution, and environmental performance ratings. We obtained this information from the municipal environmental protection bureaus of the four cities. Their pollution monitoring, inspection and environmental information systems are well-developed and well-managed, primarily because of their long-standing experience with pollution registration requirements and China's pollution charge system.[2] Table 3 shows that 36.7% of the firms in the sample were rated by Green Watch. The majority of rated firms were assigned blue (60.38%) and yellow (22.37%); only a few earned the best (green) rating (2.96 %) or the worst (black - 2.96%). The distributions are similar across cities, with the majority of firms rated blue and yellow, and very few green and black.

5. Multivariate analysis

Our pollution data are sufficiently detailed to permit assessment of Green Watch for both water and air pollution, measured by intensity and effluent concentration. Pollution intensity is total emissions divided by the gross value of output. We use total suspended solids (TSS), chemical oxygen demand (COD) and generated waste water to measure water pollution, and sulfur dioxide (SO2), waste gas, and dust and smoke to measure air pollution.

[2] For discussion of firm-level pollution data in China, see Wang and Wheeler (2006).

The dependent variables in our multivariate analyses are changes in pollution intensity and concentration for different pollutants. Let pollution intensity be specified as $Y_{i,t}$ for firm *i* in year *t*. The dependent variable for the intensity equation is the first difference, $Y_{i,t} - Y_{i,t-1}$. The reduced-form fixed effects model for $Y_{i,t} - Y_{i,t-1}$ is

$$(1)\ Y_{it}-Y_{it-1} = \beta_0 + \boldsymbol{\alpha_1}\ \mathbf{F_{it}} + \boldsymbol{\alpha_2}\ \mathbf{C_{it}} + \boldsymbol{\alpha_3}\ \mathbf{R_{it}} + \beta_1\ t + \mu_{it} + \varepsilon_{it.}$$

where $\mathbf{F_{it}}$ and $\mathbf{C_{it}}$ are vectors of characteristics of the firm and the city; $\mathbf{R_{it}}$ is a vector that incorporates both rating status (rated or unrated) and color-category assignments for rated firms; t is a time trend; μ_i represents unobserved firm effects; and ε_{it} is a random error term. Endogeneity is not a serious problem in this case, because ratings released in year t are based on multi-dimensional performance observations during year *t – 1*.

If sample firms were randomly assigned to rated and unrated groups, we would not expect a statistical difference in intergroup pollution at *t* -1, before the first Green Watch disclosure in period *t*. Assessing prior randomness is complicated in this case by the distributions of pollution intensity and effluent concentration. Both are highly skewed, with skewness coefficients ranging from 3 to 9. In this case, the traditional student t test for equality of pre-rating group means is not appropriate. We employ the nonparametric Wilcoxon-Mann-Whitney test for equal means and the K-sample test for equal medians. Our results, reported in Table 4, show that significant differences in means and medians are common in the sample. In Zhenjiang, where Green Watch began in 1999, we find significant differences in mean and/or median pollution intensities for waste water, COD and dust and smoke, and significant differences in mean and/or median effluent concentrations for TSS, COD and dust and smoke. Table 4 reports similar findings for

the other three sample cities (Huaian, Wuxi and Yangzhou), where the first public disclosure of ratings occurred in early 2001.[3]

In light of these results, it is appropriate to introduce controls for pre-program pollution in our estimating equation:

$$(2)\ Y_{it}-Y_{it-1} = \beta_0 + \boldsymbol{\alpha_1}\,\mathbf{F_{it}} + \boldsymbol{\alpha_2}\,\mathbf{C_{it}} + \boldsymbol{\alpha_3}\,\mathbf{R_{it}} + \beta_1\, t + \beta_2\, Y_{it-1} + \mu_{it} + \varepsilon_{it}$$

To determine the appropriate estimator, we employ Breusch and Pagan Lagrangian multiplier (BPLM) tests for random effects. We reject the null hypothesis in favor of the random effects model for air pollution intensities, and for air and water effluent concentrations. We assume that ε_{it} is correlated across firms within a city but uncorrelated across firms in different cities.

Table 5/6 and 7/8 present estimation results for changes in pollution intensity and effluent concentration, respectively. In Tables 5 and 7, we test whether a firm reduces pollution simply because it is rated. A priori, it is possible that self-scrutiny by a rated firm results in better environmental management and reduced pollution, even if the firm's rating is good. Our results for the regression variable PRD are consistent with this hypothesis: PRD rating has a negative impact on pollution for all equations in Tables 5 and 7, and a statistically significant impact on TSS and SO2 for pollution intensity, and dust and smoke for effluent concentration.

Tables 6 and 8 provide more insight, by identifying specific color ratings for firms. Here we find very strong results for water pollution intensity (TSS and COD) and dust-and-smoke intensity in Table 6, with highly-significant reductions for poorly-rated firms that are much larger than reductions for firms with better ratings. Intensities generally decline more among

[3] We also conducted the equal mean and median tests for each of the three cities. The results are qualitatively similar.

rated firms for the other pollutants as well, but without the striking differential for poorly-rated firms. The same general pattern holds in Table 8, with generally-declining effluent concentrations across all rated firms and the largest impacts among poorly-rated firms. Although some concentration results are highly significant, the overall significance level is somewhat lower than for pollution intensities. Across both tables, red-rated firms exhibit stronger responses than black-rated firms.

6. Summary and conclusions

This study has employed a new panel data set to test the impact of environmental performance rating and disclosure (PRD) on polluting firms in China. The data include ex ante and ex post pollution measures for both rated and unrated firms, enabling us to control for confounding factors such as time-variant technology improvement and selection bias. Our results strongly suggest that Green Watch has significantly reduced pollution from rated firms, with particularly strong impacts on firms with poor ratings. Among poorly-rated red and black firms, the impact is generally greater on red-rated firms that are closer to compliance with regulations. The reasons for these responses can be that the incentive for improvement that the Green Watch generates is stronger for firms with poor ratings than those with good ratings, and that the abatement costs for the red-rated firms to achieve compliance are lower than those black rated firms, even though the pressure for improvement can be stronger with the black-rated firms than the red-rated firms.

This research also adds some insights to the growing comparative literature on PRD's. After studying PRD experiences in Indonesia (PROPER) and the Philippines (EcoWatch), Dasgupta et al. [6] argue that PRD programs are most effective in moving moderately non-compliant firms

into compliance with regulations, but may provide insufficient incentives to induce significant improvements by the worst performers or firms with good ratings. However, our results for Green Watch indicate significant impacts for firms with good (green and blue) ratings. The stronger result for our four cities in Jiangsu Province may stem from two additional benefits for green-rated firms: (a) Enterprises awarded green in a particular year can be given priority consideration in the selection of enterprises with the best economic and social performance records; and (b) an enterprise that has won green for three consecutive years is given preferential status by provincial environmental regulators. The Jiangsu experience suggests that stronger results can be produced by PRD programs that target highly-rated firms for benefits beyond reputational improvement.

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Table 1. Firms' Environmental Performance Ratings by the Green Watch Program in Jiangsu Province, China (% Representation in Parentheses)

	Year	Green	Blue	Yellow	Red	Black	Total
Pilot program in Zhenjiang City	1999	3	25	40	13	10	91
		(3.30)	(27.47)	(43.96)	(14.29)	(10.99)	
	2000	2	58	21	12	2	95
		(2.10)	(61.05)	(22.11)	(12.63)	(2.10)	
Province-wide program	2001	77	512	288	141	41	1059
		(7.27)	(48.35)	(27.20)	(13.31)	(3.87)	
	2002	182	1196	655	398	77	2508
		(7.26)	(47.69)	(26.12)	(15.87)	(3.07)	
	2003	267	1545	789	367	106	3074
		(8.69)	(50.26)	(25.67)	(11.94)	(3.44)	
	2004	329	2659	1467	525	114	5094
		(6.46)	(52.20)	(28.80)	(10.31)	(2.24)	
	2005	530	4016	2614	702	143	8005
		(6.62)	(50.17)	(32.65)	(8.77)	(1.79)	
	2006	702	5414	3944	1000	155	11215
		(6.26)	(48.27)	(35.17)	(8.92)	(1.38)	

Sources: Pilot program in Zhenjiang: Wang et al. (2004). Province-wide program: the Legislative Affairs Office of the China State Council (2007) (available at http://www.chinalaw.gov.cn/article/dfxx/dffzxx/js/200706/20070600021431.shtml; last assessed on May 19, 2009).

Table 2. City Comparisons for Industiral Pollution and Socioeconomic and Environmental Conditions, 2001

	Huaian	Wuxi	Yangzhou	Zhenjiang
Socioeconomic conditions				
GDP per capita (Yuan)	14,359	37,700	21,311	18,852
Economic growth rate (%)	11.05	12.20	7.30	11.10
Unemployment rate (%)	3.84	3.62	3.60	2.30
Population (1,000)	558	2,131	1,097	628
Environmental conditions				
TSS: Total suspend solids (mg /m3)	0.158	0.144	0.237	0.105
SO2: sulfur dioxide (mg /m3)	0.037	0.056	0.023	0.024
NO2: nitrogen dioxide (mg /m3)	0.027	0.034	0.035	0.038
% of drinking water meeting standards	93.00	97.96	98.80	96.43
% of surface water meeting standards	83.00	91.67	62.00	88.89
Noise (dB(A))	55.80	56.90	53.20	55.50
Total industrial pollution emissions				
Waste water (10,000 tons)	1,674	14,010	3,774	4,544
COD: chemical oxygen demand (tons)	1,708	N.A.	6,787	25,200
Waste gas (100 million m^3)	129	471	461	1,895
Smoke (tons)	11,063	8,611	5,385	47,421
SO2 (tons)	8,863	21,492	35,765	96,377
Solid waste (10,000 tons)	1	8	N.A.	265

Sources: Municipal governments of the four cities.

Table 3. Distributions of Sample Firms During 1997-2001

Total number of rated (R) and nonrated (NR) firms by city and year						
Year	Status	Huaian	Wuxi	Yangzhou	Zhenjiang	Total
1997 [a]	Unrated	42	33	64	89	228
1998 [a]	Unrated	46	26	71	81	224
1999 [a]	Unrated	46	32	76	12	166
	Rated				57	57
2000	Unrated	54	43	68	13	178
	Rated				78	78
2001	Unrated	16	1	13	131	161
	Rated	39	69	59	91	258
1997-2001	Unrated	204	135	292	326	957
	Rated	39	69	59	226	393
	Total	243	204	351	552	1350
Distribution of rated firms by rating colors*						
	Green	Blue	Yellow	Red	Black	Rated
ZhenJiang (1999)	1 (1.75)	34 (59.65)	17 (29.82)	4 (7.02)	1 (1.75)	57
Zhenjiang (2000)	2 (2.56)	48 (61.54)	19 (24.36)	8 (10.26)	1 (1.28)	78
Huai'an (2001)	2 (5.13)	29 (74.36)	4 (10.26)	3 (7.69)	1 (2.56)	39
Wuxi (2001)	15 (21.74)	20 (28.99)	20 (28.99)	8 (10.59)	6 (8.70)	69
Yangzhou (2001)	2 (3.39)	52 (88.14)	5 (8.47)	0 (0.00)	0 (0.00)	59
Zhenjiang (2001)	2 (2.20)	60 (65.93)	20 (21.98)	7 (7.69)	2 (2.20)	91
All cities (1998-2001)	24 (6.11)	243 (61.83)	85 (21.63)	30 (7.63)	11 (2.80)	393

***** Figures in parentheses represent the percent of firms by rating colors.

[a] Green Watch began in Zhenjiang in 1999, and in the other three cities in 2001. Thus, no firms were rated in 1997 and 1998, and only some firms in Zhenjiang were rated in 1999 and 2000.

Table 4. Pollution Intensities and Effluent Concentrations for Unrated Firms and Firms Rated for the First Time

	Pollution Intensity						Effluent Concentration			
	Water	TSS	COD	SO2	Dust/Smoke	Gas	TSS	COD	SO2	Dust/Smoke
Zhenjiang launched its pilot Green Watch Program in 1999										
Unrated	50.06	68.05	63.44	0.58	0.38	6.38	115.44	170.43	183.52	199.82
	(103.13)	(190.49)	(177.37)	(1.70)	(0.81)	(13.39)	(51.90)	(97.95)	(343.55)	(166.58)
Rated	6.93	26.71	23.82	0.04	0.01	2.30	93.54	179.51	413.45	485.60
	(19.94)	(63.85)	(67.41)	(0.11)	(0.06)	(5.68)	(79.60)	(227.12)	(522.20)	(709.19)
Equal mean test	3.64*	0.13	0.82	0.42	3.21*	0.52	3.77**	1.30	0.73	0.67
Equal median test	5.14**	0.15	2.73*	0.17	0.48	0.10	6.71***	3.25*	1.99	2.58*
Three cities (Huaian, Wuxi and Yangzhou) launched Green Watch programs in 2001										
Unrated	76.74	8.79	1.89	0.16	0.11	24.17	95.83	278.24	967.66	253.96
	(245.71)	(28.67)	(6.67)	(0.49)	(0.31)	(102.11)	(56.86)	(304.49)	(999.83)	(218.00)
Rated	143.92	30.34	119.72	0.13	0.06	28.81	120.27	229.84	1284.55	295.01
	(492.41)	(94.04)	(556.27)	(0.68)	(0.28)	(148.89)	(335.57)	(650.73)	(2476.77)	(784.40)
Equal mean test	2.93**	0.06	6.83***	1.67	1.25	2.42	5.06**	8.71***	0.01	0.22
Equal median test	7.54***	1.23	2.58*	0.05	0.83	1.52	7.02***	10.57***	0.14	0.23

Table 5. Estimation Results for Pollution Intensity Increases: Rated vs. Unrated Firms

		Water Pollution		Air Pollution		
	Waste Water	TSS	COD	SO2	Waste Gas	Dust & Smoke
PRD	-41.62	-15.47**	-18.23	-0.05	-11.06	-0.02
	(29.35)	(7.82)	(21.85)	(0.06)	(12.96)	(0.03)
Lagged pollution intensity	-0.56*	-0.94***	-1.01***	-1.00***	-0.75***	-0.80***
	(0.31)	(0.15)	(0.17)	0.00	(0.27)	(0.16)
City dummies (base = Wuxi)						
Huanan	-277.03***	-11.29***	-25.94	-0.02	-6.27*	0.03***
	(26.99)	(3.79)	(23.11)	(0.01)	(3.24)	(0.01)
Yangzhou	-259.84***	-6.37	-24.28	-0.09***	-14.56*	-0.02***
	(24.50)	(8.66)	(42.11)	(0.02)	(7.48)	(0.01)
Zhengjiang	-287.32***	0.07	-6.66	-0.07***	-11.41*	0.00
	(36.43)	(5.31)	(37.96)	(0.01)	(6.51)	(0.01)
Firm size (base = small)						
Large	16.31**	-14.18	-29.13	-0.07***	-6.53***	-0.02
	(7.20)	(10.29)	(37.82)	(0.02)	(1.50)	(0.02)
Medium	30.02	-14.73**	-22.42	-0.02	-0.01	-0.01
	(30.30)	(6.01)	(25.97)	(0.03)	(6.48)	(0.02)
Ownership structure (base = private)						
State-owned	-114.86**	14.66*	23.14	(0.03)	(9.15)	(0.02)
	(52.68)	(8.27)	(19.18)	(0.09)	(6.44)	(0.05)
Collectively-owned	-113.49*	12.91***	1.66	-0.06	-16.09**	-0.02
	(61.29)	(3.53)	(19.67)	(0.08)	(6.73)	(0.05)
HK, Macao, & Taiwan investor	-169.5	46.81***	-10.71	-0.04	-13.75*	-0.04
	(158.32)	(17.24)	(19.96)	(0.08)	(7.60)	(0.04)
Foreign investor	-17.23	9.4	-2.85	-0.06	-21.77***	0.01
	(46.86)	(12.93)	(5.59)	(0.07)	(8.24)	(0.05)
Companies with limited shares	-113.59*	23.82*	51.00	(0.06)	-17.30***	(0.03)
	(62.37)	(13.86)	(45.32)	(0.07)	(6.11)	(0.04)
Others	-110.31***	7.27	2.67	(0.08)	-19.37**	(0.04)
	(33.46)	(7.43)	(7.98)	(0.07)	(9.22)	(0.04)
Firm age (years)	0.36*	-0.21**	-0.12**	0.00	(0.08)	0.00
	(0.21)	(0.10)	(0.05)	0.00	(0.13)	0.00
Industry (base = mining)						
Food & beverages	41.43	18.64	17.37	-0.26***	4.98	-0.32***
	(84.23)	(16.99)	(10.80)	(0.03)	(7.14)	(0.07)
Textiles and leather	-57.54	11.97	25.70*	-0.19**	3.85	-0.30***

	(48.65)	(9.28)	(14.86)	(0.08)	(3.96)	(0.06)
Pulp & paper	-39.94	47.03**	95.62	-0.26***	3.27	-0.33***
	(69.45)	(19.59)	(72.80)	(0.04)	(3.70)	(0.07)
Chemicals	-18.07	27.17	86.95**	-0.15**	8.61*	-0.26***
	(55.47)	(18.02)	(43.88)	(0.07)	(4.93)	(0.07)
Medical	-28.76	7.18	46.21**	-0.28***	2.59	-0.33***
	(50.67)	(8.67)	(18.42)	(0.02)	(3.73)	(0.06)
Fiber, rubber &	-33.66	19.83	9.34	-0.26***	20	-0.33***
plastic	(65.93)	(26.68)	(15.45)	(0.04)	(12.85)	(0.07)
Smelting	(52.41)	4.56	11.52	-0.29***	0.81	-0.33***
	(66.49)	(12.51)	(14.89)	(0.03)	(5.51)	(0.07)
Machinery	(100.65)	11.87	12.53**	-0.28***	0.50	-0.33***
manufacture	(89.26)	(11.87)	(6.02)	(0.02)	(1.63)	(0.06)
Utilities	145.69*	5.53	13.66	-0.12***	33.50	-0.27***
	(74.49)	(16.52)	(39.68)	(0.03)	(35.80)	(0.08)
Transportation	(58.63)	20.67*	(2.78)	-0.30***	(1.72)	-0.32***
	(67.32)	(11.46)	(8.49)	(0.06)	(3.95)	(0.08)
Others	-24.54	9.74	12.69	-0.24***	1.12	-0.31***
	(25.03)	(16.18)	(8.75)	(0.04)	(3.19)	(0.06)
Time trend	13.04	1.67	2.46	0.00	3.28	0.00
	(8.84)	(2.50)	(6.27)	(0.02)	(4.18)	(0.01)
Constant	377.03***	(0.18)	2.11	0.43***	18.97***	0.36***
	-107.85	-20.45	-34.02	-0.08	-6.75	-0.07
No. of obs	1320	1128	1296	1158	1229	1104
within R^2	0.15	0.61	0.73	0.99	0.49	0.82
between R^2	0.16	0.52	0.84	0.97	0.33	0.61
overall R^2	0.14	0.39	0.77	0.99	0.33	0.62
Breusch and Pagan Lagrangian Multiplier test for random effects						
Test statistics: $\chi^2(1)$	0.04	0.19	0.05	75.13***	5.27**	21.68***

Numbers in parentheses are standard errors of the estimated coefficients. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Table 6. Estimation Results for Pollution Intensity Increases: Five-Color Ratings

	Waste Water	Water		Air		
		TSS	COD	SO2	Waste Gas	Dust/Smoke
Rating dummies (base = not rated)						
Green	-46.24	-4.37	-0.51	-0.05**	-6.06**	0.01
	(53.17)	(6.63)	(4.01)	(0.02)	(2.45)	(0.01)
Blue	-12.35	-9.18***	-5.1	-0.03**	-4.26	0.00
	(8.56)	(2.39)	(4.58)	(0.02)	(6.20)	(0.01)
Yellow	-16.32	-13.69*	-30.51	-0.04*	-5.84	-0.03**
	(18.19)	(7.32)	(23.78)	(0.02)	(3.88)	(0.01)
Red	24.03	-35.14***	-44.40***	-0.05**	-5.48*	-0.03*
	(30.88)	(5.76)	(10.95)	(0.02)	(2.87)	(0.01)
Black	-11.4	-19.72***	-25.06***	-0.15	-5.3	-0.16*
	(32.89)	(2.67)	(8.34)	(0.12)	(5.81)	(0.09)
Lagged pollution	-0.56*	-0.94***	-1.00***	-1.00***	-0.75***	-0.80***
intensity	(0.31)	(0.15)	(0.16)	0.00	(0.27)	(0.16)
City dummies (base = Wuxi)						
Huanan	-270.10***	-11.20***	-27.55	-0.02*	-5.79**	0.02**
	(23.91)	(3.13)	(22.27)	(0.01)	(2.32)	(0.01)
Yangzhou	-251.97***	-6.64	-26.67	-0.10***	-14.27**	-0.03***
	(23.46)	(7.87)	(40.37)	(0.02)	(6.37)	(0.01)
Zhengjiang	-275.58***	-0.24	-6.82	-0.07***	-12.54*	0.00
	(30.74)	(4.41)	(33.79)	(0.01)	(7.21)	(0.00)
Firm size (base = small)						
Large	13.66**	-15.44	-30.23	-0.07***	-8.09***	-0.02*
	(6.36)	(11.08)	(39.11)	(0.02)	(2.57)	(0.01)
Medium	24.35	-16.17**	-23.81	-0.03	-2.02	-0.01
	(30.51)	(7.55)	(29.53)	(0.02)	(4.53)	(0.01)
Ownership structure (base = private)						
State-owned	-113.99**	15.31*	23.5	-0.03	-8.77	-0.02
	(47.38)	(9.17)	(20.86)	(0.09)	(7.29)	(0.05)
Collectively owned	-106.28**	14.33***	2.7	-0.06	-15.24**	-0.02
	(47.70)	(3.97)	(17.08)	(0.09)	(6.85)	(0.05)
HK, Macao &	-146.61	48.76***	-8.14	-0.04	-10.38*	-0.04
Taiwan investor	(178.46)	(17.67)	(27.85)	(0.07)	(5.78)	(0.04)
Foreign investor	19.3	11.12	-0.84	-0.06	-19.02***	0.01
	(56.03)	(11.37)	(7.19)	(0.07)	(6.22)	(0.05)
Companies with	-99.66**	25.36*	52.34	-0.05	-16.26**	-0.03
limited shares	(48.54)	(14.97)	(50.35)	(0.07)	(6.31)	(0.04)
Others	-92.33***	11.51*	10.45	-0.07	-17.10**	-0.03

	(29.16)	(6.84)	(16.47)	(0.06)	(7.77)	(0.04)
Firm age (years)	0.32***	-0.21**	-0.07	0	-0.1	0
	(0.11)	(0.10)	(0.06)	0.00	(0.14)	0.00
Industry (base = mining)						
Food & beverages	50.26	19.02	16.87*	-0.26***	3.8	-0.31***
	(89.18)	(16.31)	(9.34)	(0.03)	(5.06)	(0.08)
Textiles and						
leather	-64	13.86*	27.70*	-0.19**	3.33	-0.29***
	(49.92)	(7.39)	(14.67)	(0.09)	(2.74)	(0.07)
Pulp & paper	-45.68	47.79**	94.92	-0.27***	2.27	-0.33***
	(77.88)	(20.04)	(69.00)	(0.04)	(2.70)	(0.07)
Chemicals	-25.34	27.33	85.24*	-0.15**	7.33*	-0.26***
	(62.05)	(18.48)	(46.95)	(0.07)	(4.23)	(0.07)
Medical	-32.38	8.39	47.90***	-0.28***	-0.05	-0.33***
	(49.98)	(8.36)	(17.31)	(0.02)	(2.53)	(0.07)
Fiber, rubber &	-38.3	19.67	5.93	-0.26***	18.71	-0.32***
plastic	(65.87)	(26.08)	(20.49)	(0.04)	13.91)	(0.07)
Smelting	-49.93	4.12	10.07	-0.29***	0.03	-0.33***
	(62.06)	(11.75)	(14.23)	(0.03)	(4.38)	(0.07)
Machinery	-102.24	11.2	9.34***	-0.29***	-0.87	-0.32***
manufacture	(87.87)	(12.63)	(3.44)	(0.02)	(1.05)	(0.06)
Utilities	154.48*	4.44	10.57	-0.12***	31.06	-0.27***
	(90.40)	(16.83)	(36.76)	(0.04)	32.86)	(0.08)
Transportation	-42.63	23.17***	-0.19	-0.29***	3.27	-0.32***
	(60.82)	(6.49)	(10.26)	(0.04)	(2.84)	(0.07)
Others	-22.62	10.17	13.15*	-0.24***	0.85	-0.30***
	(32.06)	(15.22)	(7.11)	(0.03)	(2.27)	(0.06)
Time trend	12.82	1.67	2.52	0.00	3.28	0.00
	(8.56)	(2.52)	(6.32)	(0.02)	(4.22)	(0.01)
Constant	404.84***	4.3	10.24	0.45***	30.09***	0.37***
	(114.78)	(25.46)	(48.67)	(0.09)	(9.50)	(0.09)
No. of obs	1320 (4)	1128 (4)	1296(4)	1158 (4)	1229 (4)	1104 (4)
within R^2	0.15	0.61	0.73	0.99	0.49	0.82
Between R^2	0.16	0.52	0.84	0.97	0.33	0.61
overall R^2	0.14	0.39	0.77	0.99	0.33	0.62
Breusch and Pagan Lagrangian Multiplier test for random effects						
Test statistics: $\chi^2(1)$	0.06	0.14	0.05	71.64***	5.17**	23.77***

Numbers in parentheses are standard errors of the estimated coefficients. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Table 7. Estimation Results for Pollution Concentration Increase: Rated vs. Unrated firms

	Water		Air	
	TSS	COD	SO2	Dust/Smoke
PRD	-21.76	-31.45	-32.72**	-29.94**
	(17.67)	(28.59)	(14.69)	(14.63)
Lagged pollution intensity	-0.50*	-0.57***	-1.02***	-1.00***
	(0.28)	(0.03)	(0.00)	(0.00)
City dummies (base = Wuxi)				
Huanan	-44.52	-32.72***	-136.48*	-133.30*
	(37.69)	(8.98)	(78.80)	(72.49)
Yangzhou	10.99	-85.95**	-3	-29.81
	(29.41)	(36.22)	(21.63)	(29.67)
Zhengjiang	9.11	-50.03*	-40.24	-44.08
	(37.23)	(25.89)	(32.61)	(28.44)
Firm size (base = small)				
Large	46.17	-11.1	91.68	89.42
	(30.65)	(25.74)	(115.56)	(105.23)
Medium	31.62**	38.21	68.88**	74.29***
	(16.11)	(36.70)	(33.95)	(23.99)
Ownership structure (base = private)				
State-owned	-7.97	-48.77**	2.79	-10.12
	(31.43)	(22.30)	(81.34)	(99.86)
Collectively-owned	-24.28	-81.77	-75.84***	-78.17
	(31.73)	(50.92)	(29.33)	(51.18)
HK, Macao & Taiwan investor	-71.65**	-123.66***	-150.52	-146.23
	(35.61)	(40.66)	(95.66)	(90.76)
Foreign investor	-23.82	-78.31**	-70.96	-74.38
	(41.25)	(35.54)	(48.88)	(52.14)
Companies with limited shares	-30.64	-68.33	-104.19***	-87.09**
	(23.55)	(48.15)	(40.15)	(43.20)
Others	-46.89**	-103.96**	-33.63	-31.56
	(18.73)	(47.75)	(55.95)	(69.48)
Firm age (years)	0.17	0.7	0.43	0.38
	(0.42)	(0.87)	(0.64)	(0.68)
Industry (base = mining)				
Food & beverages	31.87	-100.11*	70.79	3.7
	(27.39)	(51.64)	(47.65)	(26.30)
Textiles and leather	14.72*	-71.75	18.11	-25.07
	(8.15)	(60.39)	(22.11)	(23.43)
Pulp, paper & print	41.38*	-48.51	53.41*	6.48

	(23.19)	(30.64)	(31.95)	(43.91)
Chemicals	68.33***	-24.58	155.20***	96.44***
	(22.19)	(60.20)	(37.76)	(35.55)
Medical	272.51	79.85	681.55*	571.31*
	(190.54)	(108.69)	(364.86)	(345.14)
Fiber, rubber & plastic	28.79	-54.47*	41.76	-18.84
	(28.23)	(28.32)	(73.15)	(17.63)
Smelting	15.55	-28.35*	41.75	-21.98
	(21.69)	(15.67)	(32.05)	(30.01)
Machinery manufacture	6.16	-54.18	-26.72	-59.85
	(12.24)	(47.44)	(21.91)	(41.71)
Utilities	20.87**	2.2	0.62	-46.04
	(10.09)	(63.66)	(48.36)	(70.90)
Transportation	144.51*	95.16***	439.38***	379.11***
	(84.83)	(10.56)	(94.84)	(58.23)
Others	40.96***	-10.94	29.16	-20.65
	(15.68)	(44.81)	(70.07)	(38.23)
Time	3.84	6.78	3.14	1.20
	(8.03)	(7.90)	(18.50)	(17.48)
Constant	-3.13	129.43**	70.99	130.67
	(73.45)	(51.03)	(124.84)	(103.53)
No. of obs	967	914	659	664
within R^2	0.53	0.01	0.14	0.96
between R^2	0.11	0.76	0.98	0.95
overall R^2	0.24	0.57	0.96	0.96
Breusch and Pagan Lagrangian Multiplier test for random effects				
Test statistics: $\chi^2(1)$	9.05***	8.91***	8.61**	8.52***

Numbers in parentheses are standard errors of the estimated coefficients. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

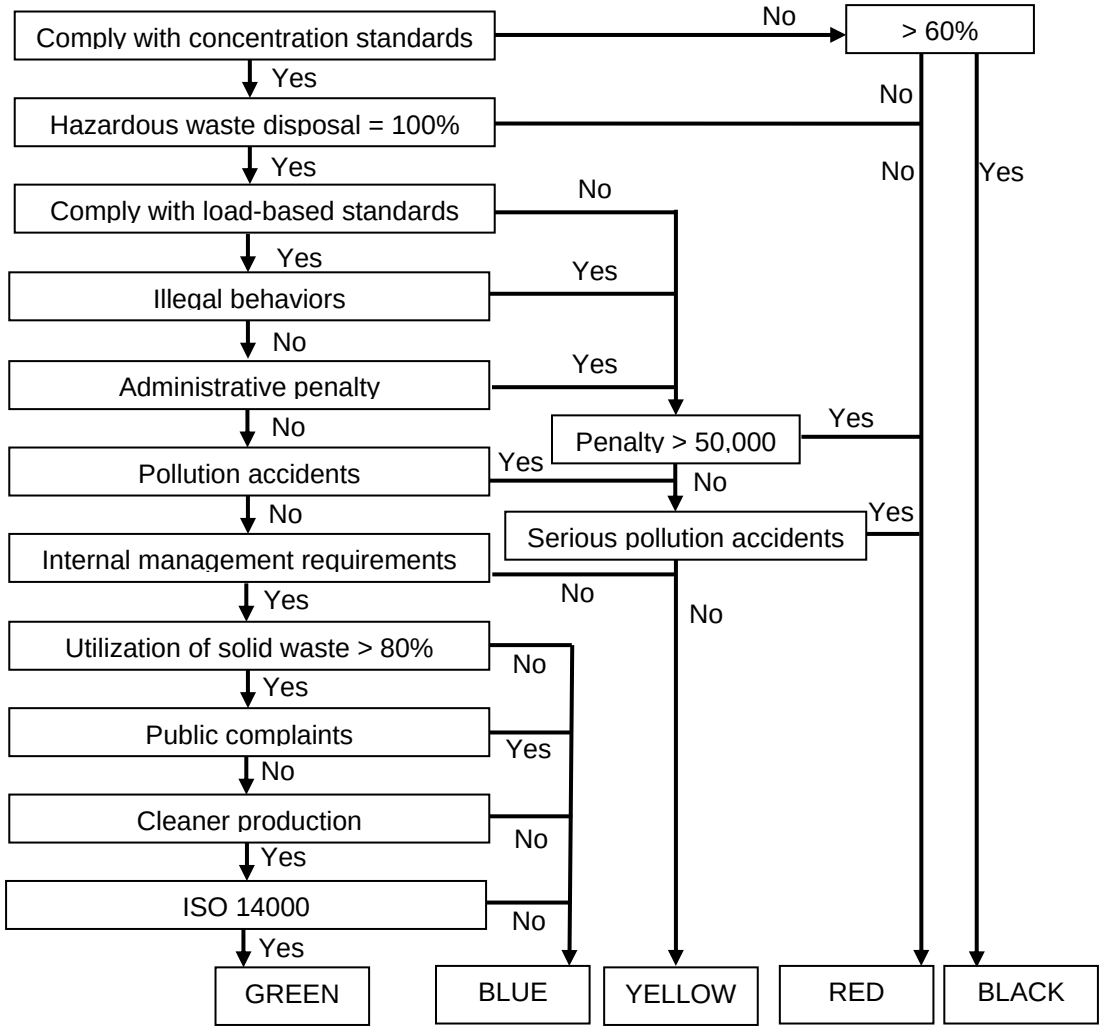
Table 8. Estimation Results for Pollution Concentration Increase: Five-Color Ratings

	Water pollution		Air pollution	
	TSS	COD	SO2	Dust/Smoke
Rating dummies (base = not rated)				
Green	-38.95	-55.95***	-46.42	-40.46
	(25.97)	(9.49)	(70.40)	(75.08)
Blue	-7.09	-3.83	-12.14	-7.70
	(18.04)	(19.48)	(23.17)	(23.33)
Yellow	-41.46	-63.43	-54.54***	-53.79***
	(26.54)	(39.15)	(12.15)	(10.35)
Red	-68.47**	-77.8	-101.34*	-100.56
	(34.07)	(59.15)	(59.88)	(62.64)
Black	9.02	-109.21**	33.02	23.29
	(11.58)	(48.53)	(28.47)	(19.68)
Lagged pollution intensity	-0.50*	-0.57***	-1.01***	-1.00***
	(0.28)	(0.03)	(0.00)	(0.00)
City dummies (base = Wuxi)				
Huanan	-47.82	-40.70***	-137.09*	-134.01*
	(38.77)	(8.29)	(79.30)	(73.40)
Yangzhou	8.14	-93.54***	-4.91	-31.37
	(30.45)	(35.12)	(24.20)	(31.73)
Zhengjiang	8.39	-54.57**	-39.73	-43.68
	(37.45)	(24.41)	(33.35)	(29.12)
Firm size (base = small)				
Large	47.88	-9.47	92.21	90.07
	(29.90)	(24.87)	(116.47)	(105.35)
Medium	31.91**	37.46	69.04**	74.09***
	(15.63)	(37.44)	(34.67)	(24.31)
Ownership structure (base = private)				
State-owned	-7.00	-45.87**	4.27	-7.18
	(32.37)	(19.54)	(84.70)	(102.78)
Collectively-owned	-21.71	-77.1	-73.43**	-74.79
	(31.05)	(47.51)	(32.93)	(52.46)
HK, Macao & Taiwan investor	-65.87*	-116.33***	-140.2	-135.37
	(35.41)	(37.48)	(96.19)	(90.21)
Foreign investor	-17.34	-67.09**	-59.55	-59.53
	(38.43)	(32.29)	(46.26)	(51.74)
Companies with limited shares	-28.13	-62.52	-101.31**	-83.70*

	(23.66)	(48.72)	(41.87)	(45.07)
Others	-42.68**	-88.13**	-30.49	-26.83
	(21.08)	(43.05)	(65.66)	(79.01)
Firm age (years)	0.2	0.71	0.46	0.42
	(0.46)	(0.95)	(0.67)	(0.70)
Industry (base = mining)				
Food & beverages	33.51	-100.96*	70.56	1.46
	(30.03)	(55.52)	(49.40)	(26.47)
Textiles and leather	18.65**	-67.9	22.38	-22.09
	(8.78)	(61.76)	(18.45)	(17.09)
Pulp & paper	50.24*	-44.35	69.28*	20.58
	(27.29)	(31.55)	(36.85)	(49.40)
Chemicals	72.18***	-27.88	160.67***	100.26***
	(24.02)	(60.28)	(36.49)	(31.95)
Medical	279.24	79.76	686.83*	573.04*
	(194.64)	(111.22)	(366.71)	(346.37)
Fiber, rubber & plastic	29.2	-59.85*	40.74	-22.71
	(28.77)	(32.48)	(74.32)	(17.33)
Smelting	18.62	-30.11*	46.8	-20.37
	(23.73)	(17.80)	(34.14)	(29.70)
Machinery manufacture	7.39	-60.81	-24.94	-61.55
	(12.60)	(50.83)	(19.93)	(41.75)
Utility	21.58**	-4.32	0.34	-49.59
	(9.66)	(68.11)	(47.24)	(71.06)
Transportation	147.44*	93.82***	442.96***	380.16***
	(86.75)	(11.30)	(95.04)	(57.75)
Others	46.08***	-11.19	36.24	-16.45
	(17.25)	(47.13)	(71.49)	(39.33)
Time trend	3.5	5.87	2.79	0.95
	(8.26)	(7.28)	(18.68)	(17.70)
Constant	-6.66	134.60***	65.27	126.36
	(70.41)	(46.86)	(122.78)	(99.61)
No. of obs (clusters)	967 (3)	914 (4)	659 (4)	664 (4)
within R^2	0.53	0.01	0.14	0.96
between R^2	0.12	0.77	0.98	0.95
overall R^2	0.24	0.57	0.96	0.96
Breusch and Pagan Lagrangian Multiplier test for random effects				
Test statistics: $\chi^2(1)$	9.05***	8.91***	8.61**	8.52***

Numbers in parentheses are standard errors of the estimated coefficients. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Figure 1. Rating Criteria of the Green Watch Program in Jiangsu



Source: Revised based on Figure 1 in Wang et al. (2004).