HAS THE CENTRALIZED ENVIRONMENTAL GOVERNANCE REGIME WORKED IN CHINA?

Wanxin Li, Jintao Xu, Hui He

Abstract

Scholars have suggested that in China centralized environmental policymaking may be decoupled from idiosyncratic local implementation, and thus have questioned the outcomes. This paper fills a gap in the literature on China's environmental governance by assessing the effects of the centralized regime on outcomes and diagnosing institutional deficiencies along the following three dimensions: structure, penetration to multiple actors in society, and persistence in efforts taken. Analyses of panel data from the years 1998 to 2005 find the structure of the environmental governance regime associated with both reduced pollution discharge and enhanced pollution treatment, as measured by COD and SO_2. However, the measures imposed from the top had limited penetration to polluting industry and had limited effects on pollution control. The good news is that bottom-up efforts taken by the public and industry have largely enhanced pollution treatment, although not associated with reduced pollution discharge. Thus, China faces the challenge to reduce pollution from the source but not to rely on end-of-pipe treatment. It calls for the centralized environmental governance regime to strengthen its penetration to polluters by rigorous enforcement and empowering the public with adequate informational, administrative, and legal means.

INTRODUCTION

China, as a country that has been experiencing both rapid economic growth and tremendous environmental damage, faces pressure to clean up its environment not only from the international community but also from inside the country itself. Over the past 30 years or more, China has established a comprehensive governance system for protecting the environment (Ferris & Zhang, 2003; Jahiel, 1998; Qu, 1991). However, scholars and official reports by the OECD and the World Bank still attribute the severe pollution in China largely to a lack of governmental capacity for strategic planning and the failure to implement environmental laws and policies (Economy, 2004; Jahiel, 1997; Lieberthal, 1997; Ma & Ortolano, 2000; OECD, 2007; Richerzhagen & Scholz, 2008; Sinkule & Ortolano, 1995; The World Bank, 2001; Zhu & Ru, 2008; Zhu & Lam, 2009). The Chinese central government has also realized the problems and tried to raise the standards of local governments by pursuing the Urban Environmental Quality Examination System (UEQES) (Economy, 2007) and Green GDP (Li & Lang, 2010; Qiu, 2007; Zheng & Chen, 2007). Although local governments respond to commands from above, there is good

reason to doubt they have made substantive impacts on environmental outcomes on the ground.

Schofer and Hironaka (2005) asked a similar question: does the top-down, internationally-sponsored environmentalism produce the desired result at a nation-state level. Acknowledging the decoupling of policy and outcome (Ayre & Callway, 2005; Bardach, 1977; Davies & Mazurek, 1997; Meyer, Frank, Hironaka, Schofer, & Tuma, 1997), they did not examine the conformity to any specific international convention by nation-states. Rather, they suggested a theoretical model of broader institutional effects. That is, when an international treaty is imposed from above, pro-environmental structures including organizations, cultural models, and discourses (structure) may emerge and diffuse influence across the social system (penetration). As a result, national governments may enact new policies and laws, businesses may develop new corporate standards, and public attitudes and values towards the environment may be transformed (author paraphrased the Figure 1 of Schofer and Hironaka 2005). As the changes last over time (persistence), many environmental outcomes, not only limited to the environmental issue targeted by the international treaty, can be observed (Schofer & Hironaka, 2005).

Within the Chinese context, featured by a centralized environmental policy-making and a sub-national policy implementation (Jahiel, 1998; Li, 2006; Ma & Ortolano, 2000), scholars have studied separately the legal system (Ferris & Zhang, 2003), administrative system (World Bank Group, 2009), industrial environmental behaviors (Studer, Tsang, Welford, & Hills, 2008; Wang & Jin, 2002), or rising public environmental awareness (Yang & Calhoun, 2007). However, the research community has not yet answered the question, under the pressures from the centralized environmental governance regime, whether institutional structures and efforts taken by key actors in the 31 regions of China are associated with observable environmental outcomes?

This paper extends the institutional analysis to better address the structure, penetration, and persistence of the centralized environmental governance regime in China. Empirical evidence is brought to bear on the central question: do the pressures from the central government reduce environmental degradation in the country? The rest of the paper develops as the follows. Section 2 reviews existing

research on the effects of environmental governance on outcomes. Section 3 presents an analytical framework for the paper followed by a measurement strategy for structure, penetration, and persistence of the environmental governance regime in China. Empirical findings and discussion conclude the paper.

EFFECTS OF ENVIRONMENTAL GOVERNANCE ON OUTCOMES

Li (2006) defined environmental governance as government agencies, industry, civil society, and transnational organizations (actors) working through formal (structures) and informal institutions (penetration) to manage and conserve environmental and natural resources, control pollution, and resolve environmental conflicts (efforts). Environmental outcomes are a function of the will and determination of the actors, capacity and penetration of the structures, and persistence of the efforts (Wanxin Li, 2006). Local environmental problems as well as the fear for climate change and associated consequences have boosted a stronger political commitment in environmental protection from governments. In September 2007, in light of water pollution in Tai Lake, the former party secretary of Jiangsu province declared in public that he would sacrifice GDP growth for better environmental quality. That means the municipal governments in Jiangsu may have to refuse some polluting industries that seek to locate in their jurisdictions, even though these industries might bring jobs and revenue. Industry still works under the premise of searching for profitability. But business opportunities are opening up for first movers who invest in new energy and cleaner production technologies (Gunningham & Rees, 1997; King & Lenox, 2002; Maynard & Shortle, 2001; Porter & van der Linde, 1995; Wheeler, 2000). Environmental movements in developed countries since the 1970s have played a critical role and now have emerged in developing countries including China (Dunlap & Mertig, 1992; Mertig & Dunlap, 2001; Mertig & Dunlap, 1995; Yang & Calhoun, 2007). Thus, government, industry, and the public are willing to engage in constructing cleaner and low carbon societies.

Past empirical studies have examined effects of government efforts on pollution in China. Using 2002 environmental statistical data, Li and Zusman (2006) evaluated the effects of the capacity of local environmental protection bureaus (EPBs) on pollution discharge. They found, EPBs with more and better

qualified staff—though not necessarily greater financial resources—enforce regulations more rigorously. However, these efforts do not necessarily imply cleaner air or water. Regions with industries that have a greater capacity to abate pollution tend to pollute more, offsetting the potentially beneficial effects of stronger regulatory enforcement (Li & Zusman, 2006). Their findings echo results arrived at in other research that command and control environmental policies in China have largely fallen short of its promises (Economy, 2004; Ma & Ortolano, 2000; Tao & Mah, 2009; Zhu & Ru, 2008). It takes more than innovative regulations and more capable EPBs to narrow the gap between regulatory promise and progress on the ground. Thus, informal institutions, penetration of the environmental regime to multiple actors in society and persistence of their efforts, deserve attention.

Private enforcement is an important informal institution in environmental governance, supplementing the administrative apparatus and top-down efforts by government. Publicly traded firms were found to be punished by investors in the stock markets for negative news reports on their environmental performance (Dasgupta, Laplante, & Mamingi, 2001; Mamingi, Dasgupta, Laplante, & Hong, 2008). Or, simply making pollution information publicly available would induce pollution reduction by participant firms because of concern about their reputation (Afsah, Blackman, & Ratunanda, 2000; Graham, 2002; Khanna & Damon, 1999; Khanna, Quimio, & Bojilova, 1998; Konar & Cohen, 1997, , 2001; Tietenberg & Wheeler, 1998). Residents of neighborhoods where industrial firms are located may monitor their pollution and complain to the government (O'Rourke & Macey, 2003). EPBs in China take into consideration public complaints and allocate their scarce enforcement resources accordingly (Dasgupta & Wheeler, 1997).

When government and the public push for better industrial environmental performance and financial markets pull in the same direction, industry is provided with incentives to clean up, especially for enterprises that are financially viable, targeting a global market, or aiming to benefit from being a first mover (Esty & Winston, 2009; Porter & van der Linde, 1995). Of course, efforts by industry take various forms. They can voluntarily certify with ISO 14000 or adopt environmental management systems

(Berthelot & Coulmont, 2004; Marcus & Willig, 1997; Wever, 1996). They can also adopt cleaner production practices (Day, 2005; Duan, 2001). However, the root rests in investments in cleaner technology and pollution control and abatement facilities (OECD, 2007).

Although scholars have analyzed behavioral implications of individual societal actors for pollution, an overall assessment of the effectiveness of a centralized environmental governance regime has yet to be done. Schofer and Hironaka (2005) made great strides in building a model of the broader institutional effects of the global regime on environmental outcomes. Using the model, they assessed the effects of the structure, penetration, and persistence of the world environmental regime and found they were associated with reduced CO_2 and CFC emissions. Similarly, China is a country in which the central government imposes laws and policies on the local level. Since the 1972 United Nations Conference on the Human Environment (UNCHE) first provided impetus for introducing environmental management in China, the Chinese central government has gradually adopted legal, institutional, and administrative measures to advance environmental interests. Have the efforts made any impact on environmental outcomes? This question is especially relevant because numerous accounts have reported that Chinese local governments generally place development before the environment and their practices become decoupled from central mandates (Economy, 2004; Tilt, 2007; Tong, 2007). By investigating the structure, penetration, and persistence of the Chinese environmental governance regime, the paper will connect the institutions to environmental outcomes.

RESEARCH STRATEGY

The main empirical question is: Does the centralized environmental governance regime with idiosyncratic local implementation generate desirable environmental outcomes in China? To pursue this question, the paper examines trends in discharge and treatment of major air and water pollutants using fixed effect model for panel data analysis to determine whether the environmental governance regime is associated with reduced degradation. The econometric model is the following:

$y_{it} = \beta_0 + X_{it}\beta + \alpha_i + u_{it}$, ($i$ takes a value between 1 and 31; and t takes a value from 1998 to 2005)

where y_{it} is the dependent variable, chemical oxygen demand (COD, a major water pollutant) or sulfur dioxide (SO_2, a major air pollutant) discharged (measured in tons) or treated (percentage of industrial wastewater discharge meeting standards, and percentage of municipal wastewater treated, and percentage of SO_2 treated) in year t and i^{th} region.

X_{it} is the structure, penetration, and persistence of environmental governance in year t and i^{th} region. We will explain the construction of X_{it} in the following paragraphs.

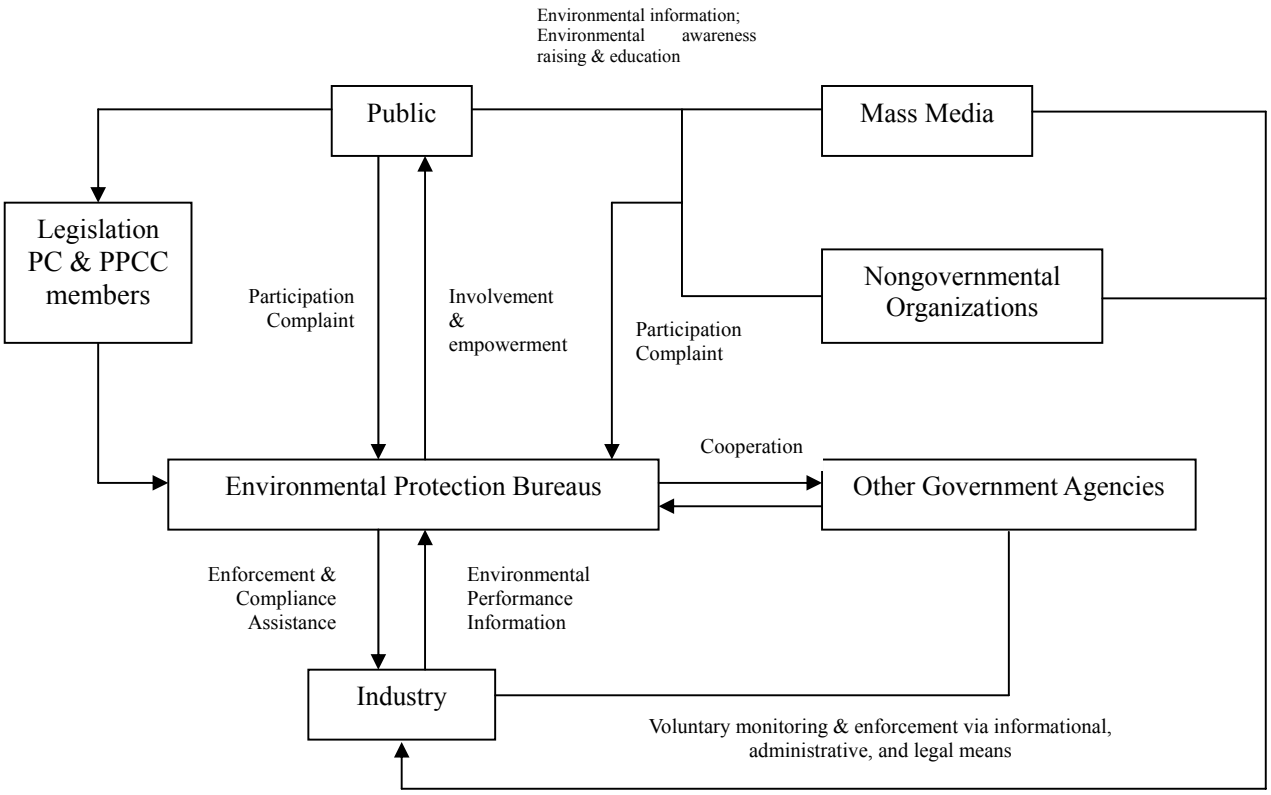
α_i is unobservable effects in the i^{th} region, such as natural endowment, historical traditions, intergovernmental relations, culture, etc.

u_{it} is the error term.

Having described the model and variables, we now explain the construction of X_{it}. Figure 1 illustrates the key players in the Chinese environmental governance regime, their actions and possible relationships. We will explain what variables are relevant for structure, penetration, and persistence of the regime followed by adopting a factor analysis method to classify those variables into the three categories for further regression analysis.

(Figure 1 is about here)

Figure 1. Mapping key players, their actions and possible relationships in a centralized environmental governance regime in China



Environmental protection agencies are important government establishments. Their status and the resources at their disposal have changed dramatically over time. At the central level, the Environmental Protection Bureau, a unit with a staff of 20, was set up in 1974 under the State Council. In 1982, three years after the promulgation of the Environmental Protection Law (for trial implementation), the State Council set up the Ministry of Urban and Rural Construction and Environmental Protection, incorporating the Environmental Protection Bureau within its structure. Subsequent reorganizations in 1984 and 1988 elevated the status of the environmental bureau to a separate office. Its staff size doubled from 60 to 120 persons, and it had dual subordination: to the Ministry of Construction and, at the same time, to the State Council's Environmental Protection Commission, which was an important forum for coordinating environmental management among different ministries. In 1990, the Bureau was separated from the Ministry of Construction and renamed the National Environmental Protection Agency (NEPA). In the

meantime, its staff more than doubled, from 120 to 320. In 1998, NEPA was renamed the State Environmental Protection Administration (SEPA). It was upgraded to a ministerial rank this time but not given a permanent seat in the State Council. In 2008, SEPA was restructured and renamed the Ministry of Environmental Protection (MEP), a full cabinet member of the State Council. Besides changes in status, the number of administrative organs has also changed over time. There were 31 provincial, 1,458 prefectural, and 6,030 city/county EPBs in 1998, and 31, 2,019 and 7,655 in 2005, respectively. The total number of EPB employees across the country increased from 105,932 in 1998 to 166,774 in 2005. Thus, we expect the number of environmental agencies and their employees are relevant for the structure of environmental governance and their change over time may have an impact on both pollution discharge and treatment.

Besides the administrative bodies, the People's Congress (PC) and the People's Political Consultation Committee (PPCC) have been charged with the duty to voice public concerns and to propose solutions. Members of the PC and PPCC submit proposals requesting the government to advance environmental interests. Even though the total numbers of proposals put forward by the PC members or members of the PPCC only increased modestly from 9,637 in 1998 to 12,343 in 2005, we expect the highly formalized representative system is relevant for the structure of environmental governance and may influence both pollution discharge and treatment.

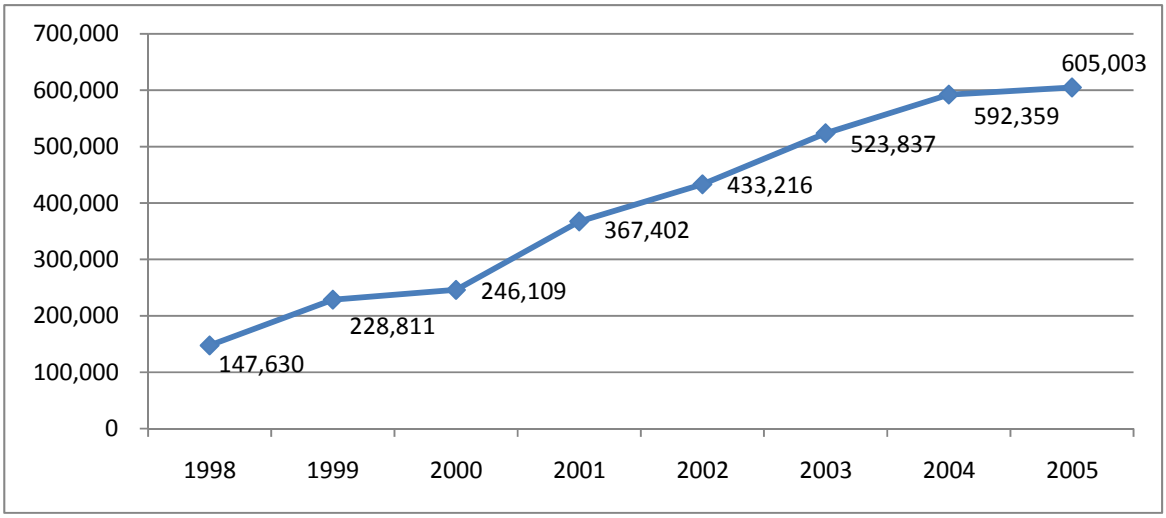
The environmental agencies are charged with monitoring pollution, enforcing environmental regulations and policies, providing technical assistance to the regulated, dealing with public environmental complaints, and conducting public environmental awareness raising and education programs. The basis for EPBs to take the above actions to bring the business sector and the public on board is gathering and processing environmental information for compliance and enforcement as well as for public consumption. Thus, we expect the capacity of EPBs to collect and process environmental information is relevant for penetration.

With environmental information made public by EPBs or from other sources, citizens can visit or

send letters to the government offices if they detect something wrong with their local environment. From 1998 to 2005, there has been a four-fold increase in number of public complaints on environmental issues in the forms of complaint letters or personal visits to EPBs (Figure 2). The increased public environmental awareness and concern are also reflected by the increased mass media coverage. For example, the People's Daily, which is representative of view point of the Chinese central government, published altogether 2,131 news articles on environmental issues from 1978 to 2008, with the most recent ten years had 1,133 reports, exceeding the cumulative total of the first twenty-one years (998 reports) (Xu, 2009). Thus, public letter and visit complaints on environmental issues reflect the penetration of the environmental regime and the public may take endured efforts to voice their environmental concerns. Thus we expect the number of their letters and visits is relevant for penetration and/or persistence.

(Figure 2 is about here)

Figure 2. Increasing public letter and visit complaints on environmental issues 1998-2005



Data source: Chinese Environmental Yearbooks.

With pollution data, EPBs can take enforcement actions to punish polluting firms and provide financial assistance for abating and controlling pollution. Since 1981, pollution levies/pollution discharge fees have been a major environmental policy tool for stimulating pollution prevention and control. Article 28 of the 1989 Environmental Protection Law stipulated that polluters pay a fee for a single pollutant

discharge that exceeds national standards even though the enterprise might have several other polluting discharges over the national standards. This is the largest amount of pollutant discharged by the polluter. The funds collected were pooled together with government funding to create a special fund for encouraging polluting industry to treat pollution. Thus, we expect both the pollution levy and special fund for environmental protection are relevant for penetration.

Table 1. Sources of funding for pollution treatment 1998-2005 (10,000 yuan)

Year	Total Investment in Pollution Treatment Projects	Government Budgetary Funds	Special Funds for Environmental Protection	Percentage of Public Funds
2005	4,581,900	77,800	206,001	6.2%
2004	3,081,100	137,100	111,313	8.1%
2003	2,218,000	187,521	123,800	14.0%
2002	1,883,663	419,555	67,893	25.9%
2001	1,745,280	363,457	83,245	25.6%
2000	2,393,791	621,841	67,051	28.8%
1999	1,527,307	73,770	50,235	8.1%
1998	1,220,461	106,410	44,940	12.4%

Source: Author compilation based on information from the *Environmental Yearbooks of China* 1999-2006

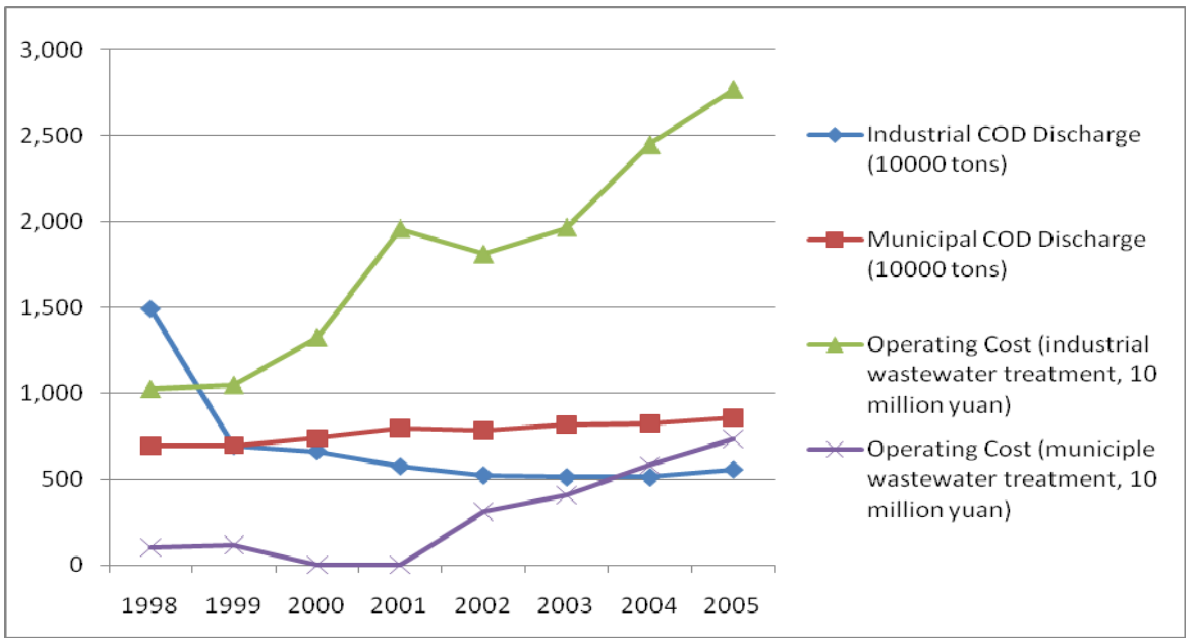
Besides pollution discharge fees, the Chinese environmental regulations and policies have resulted in increasing investments in pollution treatment projects (Table 1). The system of "Three Synchronisations" (also called "three simultaneous steps") introduced by the 1989 Environmental Protection Law requires that (1) the design, (2) the construction; and (3) the operation of a new industrial enterprise (or an existing factory expanding or changing its operations) be synchronised with the design, construction, and operation of an appropriate (end-of-pipe) pollution treatment facility. Moreover, an environmental impact assessment report is required before a facility is issued a construction permit by a competent economic development authority.

Consequently, the operating costs of treatment facilities for industrial wastewater and waste gas increased from 10.27 and 6.2 billion yuan in 1998 to 27.67 and 26.7 billion yuan in 2005, respectively. While the COD discharge from industrial sources dropped from 14.95 in 1998 to 5.55 million tons in

2005, COD discharge from municipal sources increased from 6.95 to 8.59 million tons during the same time period associated with the rapid urbanization in China. In 1998, the Ministry of Construction ordered all cities with a population size over 500,000 to build at least one municipal wastewater treatment plant (World Resources Institute, 1998). As a result, the operating costs of municipal wastewater treatment plants increased from 1.05 billion in 1998 to 7.37 billion yuan in 2005 (Figure 3).There is no doubt more waste gas facilities have been built and operated, but SO_2 emissions from industrial sources have increased steadily from 15.95 in 1998 to 21.68 million tons in 2005 (Figure 4). Even though pollution control efforts do not always positively correlate with pollution reduction, we expect the pollution abatement and control facilities as well as their operating costs, and environmental professionals employed by industry are relevant for penetration and/or persistence.

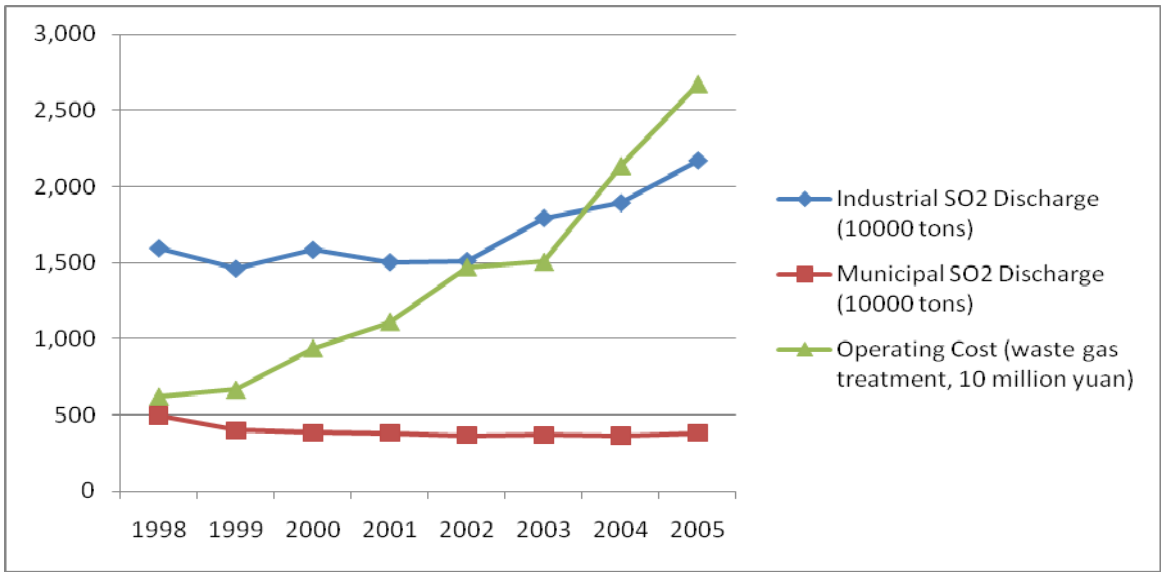
(Figure 3 is about here)

Figure 3. COD discharge and treatment 1998-2005



(Figure 4 is about here)

Figure 4. SO_2 discharge and treatment 1998-2005



Having identified conceptually the composition of structure, penetration, and persistence of the environmental governance regime, we define and measure relevant variables then apply a factor analysis method to group them into three categories for both quantitative confirmation and setting a basis for further analysis. The results of the factor analysis are reported in Table 3. Based on the factor loadings and logical correlations of selected variables, Table 2 lists the definition and measurement methods of the variables grouped under the three dimensions characterizing China's environmental regime, structure, penetration, and persistence.

(Table 2 is about here)

Table 2. Variable composition of structure, penetration, and persistence of China's environmental governance regime

Dimension	Variable	Definition	Measurement
Structure	envorg	Formal environmental protection administrative organs	Total number of EPBs in a province
	envpop	Work force hired by the formal environmental protection administrative organs	Total number of EPB employees in a province
	pubindirect	Public participation in environmental protection via their representatives	Number of environmental proposals by PC and PPCC members in a province
Penetration	signal	Capability of EPBs to collect environmental information	Percentage of cells filled in China Environment Yearbook on resource consumption, criteria pollutant discharge and pollution treatment in a province
	investenv3	Special funds for environmental protection	Total annual investment in pollution abatement and control made by the special funds for environmental protection in a province
	result8	Pollution levy paid by polluting firms	Total annual pollution discharge fee collected in a province
Persistence	pubdirect	Public direct participation in environmental protection	Number of public letter and visit complaints on environmental issues in a province
	facility3	Operating costs of air pollution treatment facilities	Total operating costs of industrial wastewater treatment facilities in a province
	facility 6	Operating costs of industrial wastewater treatment facilities	Total operating costs of air pollution treatment facilities in a province
	facility 11	Operating costs of municipal wastewater treatment facilities	Total operating costs of municipal wastewater treatment facilities in a province
	indenv1	Number of environmental professionals employed by industry	Total number of environmental professionals employed by industry in a province

As Table 3 indicates, factor 1 represents the dimension of persistence, factor 2 penetration and factor 3 structure. Because there are 76 observations without relevant information on the operating costs of municipal wastewater treatment facilities, we were concerned that including this variable would make too few observations to derive meaningful analysis in the next steps. Thus we decided to drop the variable (facility11) in the regression analysis. Since all the selected variables are in the same valence and existing theoretical or empirical work does not suggest their relative importance, we allow the variables to carry equal weights in calculating the index scores for structure, penetration, and persistence:

Structure = (envorg + envpop + pubindirect)/3;

Penetration = (signal + investenv3 + result8)/3;

Persistence1 = (pubdirect + indenv1 + facility3)/3; (for wastewater)

Persistence2 = (pubdirect + indenv1 + facility6)/3. (for waste gas)

(Table 3 is about here)

Table 3. Factor analysis results for grouping variables into structure, penetration and persistence

Variable	Factor1	Factor2	Factor3	Uniqueness
envorg	0.6641	0.5069	-0.124	0.2867
envpop	0.6865	0.3797	0.3345	0.2726
pubindirect	0.6443	0.1645	-0.2137	0.5122
investenv3	0.5274	0.2001	0.4103	0.5135
signal	0.3883	-0.3052	0.315	0.6568
result8	0.7354	0.0065	0.0637	0.4551
pubdirect	0.7868	-0.3929	-0.2242	0.1764
facility3	0.896	-0.1704	-0.1513	0.1453
facility6	0.896	-0.1275	0.2838	0.1003
facility11	0.7345	-0.4175	0.0129	0.286
indenv1	0.8615	0.2177	-0.4028	0.0482

The study of the impact of institution on economic or social behavior usually involves an endogeneity problem (Acemoglu, Johnson, & Robinson, 2001). In the case of environmental protection, the institutional set up and efforts taken may themselves be a result of pollution. To address the endogeneity of the environmental governance regime, we take one year lagged form of the three regime dimensions, which is obviously unaffected by later pollution discharge and treatment. It passed the endogeneity test based on residuals (Wooldridge, 2009).

The following five variables that measure the discharge and treatment of major water and air pollutants are included in the analysis as dependent variables: annual total discharge of COD; annual total

discharge of SO_2; annual average percentage of industrial wastewater discharge meeting standards; annual average percentage of municipal wastewater treated; and annual average percentage of SO_2 treated. In addition, economic activities measured by GDP and population size necessarily place large burdens on the natural environment. We assume that unobserved effects for each region such as natural endowment, historical traditions, and culture are time independent but related to the explanatory variables. Thus, we employ the fixed effect models for analyzing the effects of environmental governance regime on pollution discharge and treatment as the following:

Model 1-2: Pollution discharge vs. structure, penetration, and persistence of the environmental governance regime

$$\ln discharge_{it} = \alpha_0 + \alpha_1 \ln structure_{i(t-1)} + \alpha_2 \ln penetration_{i(t-1)} + \alpha_3 \ln persistence_{i(t-1)} + \alpha_4 \ln GDP_{it} + \alpha_5 \ln pop_{it} + \alpha_6 time + \varepsilon_{it}$$

Model 3-5: Pollution treatment vs. structure, penetration, and persistence of the environmental governance regime

$$\ln treatment_{it} = \beta_0 + \beta_1 \ln structure_{i(t-1)} + \beta_2 \ln penetration_{i(t-1)} + \beta_3 \ln persistence_{i(t-1)} + \beta_4 \ln GDP_{it} + \beta_5 \ln pop_{it} + \beta_6 time + \omega_{it}$$

The data are drawn from the Environmental Statistical Yearbooks and Statistical Yearbooks 1999-2006. The fixed effect model with autocorrelation corrected model can ensure the error terms are uncorrelated among the data points and thus the ordinary least squares method is adequate. We expect the accumulation of regional environmental governance structure together with its penetration and the persistence to generate desirable environmental outcomes across the country.

FINDINGS AND DISCUSSIONS

The regression results are reported in Table 4. The regression models can account for 15 to 61 percent of the variations in the discharge and treatment of COD and SO_2 in China. The structure of China's environmental governance regime could statistically significantly reduce COD discharge but not SO_2. The

penetration and persistence of the environmental governance regime did not have any statistically significant effect on COD or SO_2 discharge. As expected, the economic growth and local population created burdens on the environment and the local population statistically significantly increased COD discharge but its effect on SO_2 discharge was neither large nor significant.

Table 4. The effect of China's environmental governance regime on pollution discharge and treatment, 1998-2005

	Discharge		Treatment		
	COD	SO_2	Industrial Wastewater	Municipal Wastewater	SO_2
Structure (lagged)	-0.634	0.047	0.127	0.433	0.453
	(2.81)**	(0.26)	(1.06)	(1.06)	(0.84)
Penetration (lagged)	0.059	0.078	0.005	-0.275	-0.079
	(0.93)	(1.59)	(0.14)	(2.38)*	(0.54)
Persistence (lagged)	0.017	0.063	0.003	0.379	0.251
	(0.28)	(1.07)	(0.10)	(3.37)**	(1.43)
Local GDP	0.081	0.047	0.068	0.855	0.010
	(0.73)	(0.49)	(1.14)	(4.19)**	(0.04)
Local Population	2.288	-0.053	-0.541	-1.269	1.050
	(2.96)**	(0.09)	(1.31)	(0.90)	(0.59)
Constant	-13.856	1.318	2.165	-10.499	-15.287
	(2.25)*	(0.28)	(0.66)	(0.94)	(1.08)
Observations	102	102	102	102	102
Number of id	23	23	23	23	23
R-squared	0.18	0.25	0.15	0.61	0.15
Absolute value of t statistics in parentheses					
* significant at 5%; ** significant at 1%					

In terms of pollution treatment, the structure of the environmental governance regime resulted in enhanced treatment of industrial wastewater, municipal wastewater and SO_2, even though the effects were not statistically significant. The penetration of the regime had almost zero effect on industrial wastewater treatment. But strangely, it even had a negative impact on treating municipal wastewater and SO_2. The

persistence of the regime had almost zero effect on industrial wastewater treatment but could greatly improve treatment of municipal wastewater and SO_2. Especially, its effect on municipal wastewater treatment was statistically significant. The GDP growth resulted in better pollution treatment but its effect was statistically significant only for municipal wastewater. Local population exerted a negative impact on the water system but a positive impact on the treatment of SO_2, although not statistically significant.

The research decomposed the channels of influence of the centralized environmental governance regime into three dimensions and examined their effects on the 31 regions on China. The findings revealed the positive effects of the governance structure on both reducing discharge and enhancing treatment of major water and air pollutants. The structure is measured by the number of environmental agencies, number of employees working within, and environmental proposals put forward by the representatives of the public via official venues. Its positive effects across the board proved it is worthwhile to set up the basic institutional infrastructure for protecting the environment.

However, the activities carried out by the EPBs including environmental monitoring, taking enforcement actions, and providing funding and assistance to the polluting firms, were not able to penetrate to the regulated community to change their behaviors and thus have not reduced the discharge or enhanced the treatment of the major water and air pollutants. The results reinforce observations by other researchers. Environmental monitoring has been sacrificed by a lack of adequate equipment and a shortage of manpower (Li & Zusman, 2006; World Bank Group, 2009). The pollution discharge fees were so low that it was economically rational for polluters to pollute rather than to treat pollution. According to one account, the operating cost of wastewater treatment in one highly polluting industry is around 1.2-1.8 RMB/ton. The fixed investment in wastewater treatment facility is 100 million RMB for the 150ton/day alkali-recycling equipment used in the paper and pulp industry. But the maximum fine on wastewater discharge is 100,000 RMB, and hence it is a rational choice to pay the fine rather than treat the pollution (Yang & Ge, 2006). In addition to this, EPBs gradually came to rely on pollution discharge fees to fund to meet their administrative and salary needs. Consequently, the original regulatory goal was not met. The

State Council therefore enacted the 2003 Ordinances on Collecting and Managing Pollution Discharge Fees to enhance the deterrent effect of this policy instrument and to deal with the problem of goal displacement ("State Council Ordinance No. 369 on Collecting and Managing Pollution Discharge Fees Paiwufei zhengshou shiyong guanli tiaoli " 2003). Although local EPBs are still responsible for collecting pollution discharge fees, the power to allocate the funds has been turned over to finance bureaus at or above the county level. In addition, these funds are earmarked for environmental protection usages. The separation of pollution discharge fee collection from appropriation has the potential to correct misaligned interests. Moreover, a discharge fee is assessed on any pollution discharge, regardless of whether it exceeds national standards or how large it is in comparison with other discharges. And the rate of pollution discharge fee is indexed to the discharge amount, with a higher rate assessed for amounts that exceed national standards. Despite these changes, it is still cheaper for polluters to pay for pollution discharges instead of taking pollution prevention and treatment measures. In light of this, it is no surprise that the regime has largely failed to penetrate to polluters and induce them to reduce pollution from the source.

Fortunately, even though the penetration to polluting industry and results of the top-down environmental governance regime were limited, the persistent efforts taken by the public and industry for protecting the environment from bottom-up have largely improved pollution treatment even though it has not had much effect on reducing pollution discharge. The finding justified making environmental information publicly available and encouraging industry to take measures to prevent and control pollution. With the increasing number of public letters and visits and putting more pollution abatement and control facilities in operation, the period between the year 1998 and 2005 has already witnessed increased pollution treatment. It gives a reason for us to be optimistic about the future of China's environment because more favorable policies have been promulgated for mobilizing public participation in environmental issues. For example, the State Council issued the Open Government Information Decree and Measures of Environmental Information Disclosure (Trial) in 2007. Moreover,

economic incentives have been given for polluters to adopt pollution control technology. For example, electricity generated by power plants with desulfurization facilities will enjoy a favorable tariff rate of RMB 0.0015 Yuan higher than that produced by power plants without desulphurization facilities (State Council & Ministry of Environmental Protection, 2007). We expect with those policies, more persistent environmentally friendly efforts will emerge from bottom-up and produce favorable environmental results in the future.

RECOMMENDATIONS

As a side product of industrial processes and human consumption, pollution discharge has largely increased with GDP growth. Even though the structure of the Chinese environmental governance regime significantly reduced discharge of COD and SO_2, neither the environmental monitoring and enforcement by government, nor citizen private enforcement, nor the end-of-pipe pollution control facilities have resulted in reduction in pollution discharge. The analysis indicates alternative policies have to be invented to reach the numerous producers and consumers to encourage them to reduce pollution from the source. The traditional approach of relying on the administrative measures by environmental agencies supplemented by public complaining about pollution is not effective for transforming the production and consumption processes. Liu and Diamond (2008) argued for "investment in environmentally friendly enterprises, reform of land ownership, tax on polluting enterprises, and eco-compensation (payments to those protecting environmentally sensitive areas) to green insurance (insurance companies cover the cost of environmental damage and push for better environmental protection) (Liu & Diamond, 2008, p. 38). Those measures can potentially penetrate to and provide incentives for industry as well as individuals to take initiatives to cut down resource utilization and to upgrade technology and thus reduce pollution in the production or consumption processes.

For dealing with the pollution that has been generated, the effects of the structure of the Chinese environmental governance regime were insignificant and that of penetration were mixed. Liu and Diamond proposed to establish a new, high-level, authoritative national organization that coordinates all

relevant ministries and agencies for economic development and environmental protection that could reduce conflicts among them (Liu & Diamond, 2008), p. 37). Maybe not only at a high-level, but also applying the same idea to every level of local governments, the EPBs will be in a better position to deal with polluters that were previously protected by economic agencies. Building strong local institutions is important for achieving good results on environmental protection and natural resources management (Andersson & Gibson, 2007; Li & Chan, 2009; Ostrom, 2005). Moreover, since the industry running the pollution control and abatement facilities and the public voicing their environmental concerns have already resulted in improved pollution treatment, it is recommended that government capitalize on past successes by further empowering the public with adequate informational, administrative, and legal means. In the future, with a strong centralized environmental governance regime, which is able to penetrate to multiple actors in society and induce their endured efforts to protect the environment, the industrialization and urbanization in China can be brought on an environmentally friendly path.

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APPENDIX 1. Summary of key variables

Variable	Obs	Mean	Std. Dev.	Min	Max	Unit
pd1	248	22.27	21.05 3	0.1	147.50	10,000ton
pd2	248	25.09	16.2 5	0.05	88.94	10,000ton
pt1	195	0.74	0.22	0.14	1.00	%
pt2	195	0.27	0.18	0.01	0.87	%
pt3	195	0.29	0.2 2	0.03	0.96	%
envorg	198	641.38	338.2 3	54.00	1615	unit
envpop	225	5532.3 1	4918.9 2	137.00	40077	person
pubdirect	248	14976.81	15638.56	26.00	81411	piece
pubindirect	183	343.26	246.90	4.00	980	piece
signal	248	0.8 4	0.11	0.53	0.94	%
result8	242	24610.86	23802.54	141.90	181130.20	10,000Yuan
investenv3	239	3152.3 1	4810.56	0	44314.60	10,000Yuan
facility3	248	57862.05	62482.91	19.00	343652.10	10,000Yuan
facility6	246	45193.12	45347.90	4.00	249794.30	10,000Yuan
facility11	172	9139.90	16670.14	0	115896.20	10,000Yuan
indenv1	248	5477.00	4841.89	0	20273	person