A Study of Chinese Government's Policies in Industrial Pollution Mitigation

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Abstract

China's rapid economic growth poses serious concerns over environmental degradation, especially in the context of higher pollution levels resulting from unprecedented industrial activity. It is commonly held that government policies are effective in the form of investment in pollution control and the imposition of a discharge fee on industrial units for the purpose of safety of environmental quality. In this study, we find that government policies do not prove to be successful in controlling air pollution in comparison to water pollution. Furthermore, air pollution is increasing, while water pollution is following a stable, decreasing curve. Hence, some reforms need to be implemented in government policies, particularly those concerning the effectiveness of investment in environmental protection and improving managerial skills in industry.

Key words: industrial air and water pollution   government discharge fee   government investment expenditure

JEL code: H50, Q52, Q53, Q58

I. Introduction

The dynamic tension between the quest for higher economic growth and the responsible maintenance of environment quality has fueled many lively debates around the globe. Some experts argue that the decision-makers in industry need to factor in sustainable environmental measures as every bit as important as the bottom line, while some other

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scholars have started to wonder whether it is the production techniques or government policy that should be applied to pollution control. It is an axiom that if economic growth runs parallel to a healthy environment, an upward spiral is the prospect for such a utopia.

Since the 1980s, the Chinese government has instituted environmental protection laws, regulations and standards on air/water and solid waste contaminations similar to those of developed countries; but they have yet to function effectively owing to a certain hesitancy on the part of administrative authorities, lack of funding, and inadequate monitoring. This is perhaps understandable, given the vast scale of the exercise. In the past three decades, China has devoted much attention to developing and strengthening environmental institutions and regulatory frameworks, largely by establishing command and control regulations, and waste treatment and disposal technologies for reducing industrial pollution.

China's industrial growth has been extremely rapid during this period of economic reform, with the output of the nation's 10 million industrial enterprises in the 1990s increasing by more than 15 percent annually. Industry is also China's largest productive sector, accounting for 47 percent of its gross domestic product and employing 17 percent of the country's total labor force. Unfortunately, environmental degradation has accompanied this rapid growth. In many urban areas, atmospheric concentrations of pollutants such as suspended particulates and sulfur dioxide routinely exceed World Health Organization safety standards by very wide margins. As a result, hundreds of thousands of people are suffering from pollution-related respiratory disease each year. There is no doubt that Chinese industry is a primary suspect, with many polluting industrial enterprises located in densely populated metropolitan areas. The Chinese Annual Environmental Statistics Reports of year 2001-2004, published by the State Environmental Protection Administration of China (SEPA), shows an increase of 12.6 percent in the national total wastewater emission from 2001 to 2004, whereas industrial wastewater emission accounted for an average of 46.4 percent of the national total. In the same period, the national waste gas emission increased at the rate of 6.4 percent while industrial waste gas (SO_2, smoke, dust) emission contributed on average 86 percent of the national total.

Since 2003, with China's economy growing steadily, the demand for raw materials has risen in direct proportion, placing enormous pressures on the environment. According to Zhang (2004), the intensity of environment pollutants per GDP of China, e.g. SO_2, NO_x waste gases etc., is 8 to 9 times higher than those of developed countries or taking in the same way as a result of per 1 percent GDP growth. Hence, these figures indicate a higher-than-acceptable wastage of resources.

According to empirical evidence, when a country's per capita GDP enters the range of US$1,000-3,000, its environmental pollution becomes a source of conflict with its future economic development. In order for China to maintain its current environmental level up to

2020, when GDP growth is expected to double, an 80-85 percent reduction in the current level of pollution will be needed. Past failures of abatement policies have been blamed on the traditional environmental protection system and a general lack of infrastructure for pollution control. Although there were some recent government statements indicating that waste water management plants have been installed in some areas, resulting in a 40 percent improvement, water pollution throughout China remains serious and draws criticism from abroad.

Industrial pollution is looming as the largest single menace to people's health and prosperity, and no province can escape its menacing cloud. The industries still operating under tradition-bound structures are burdening the population with foul and harmful air. Coking, fuel and tobacco industries are the main contributors polluting the air with SO_2, CO_2 and NO_x. Paper, textiles and fertilizers/pesticides industries are certainly contributing to river and drinking water pollution. Hence, the polluted water is very difficult to treat and recycle, and while this remains the case, crops and plantations are at risk.

In view of the relevance of industrial production and its effect on the environment, we aim to explain the effectiveness of Chinese government policies on water and air pollution.

The paper is organized as follows: in section II, we present a brief overview of the literature on the subject; in section III we describe the data and methodological framework of our research; section IV gives the interpretation of the empirical results and pollution intensity graphs; and section V concludes our study along with some policy recommendations.

II. Literature Review

China's economic growth has been extremely rapid in the past two decades, with an average annual growth rate of about 10 percent in the last two decades. Subsequently, environmental problems are threatening China's sustainable future. Pollution damage is estimated to be costing around US$54 billion annually – close to 8 percent of Chinese GDP (World Bank, 1997). Policy makers in China are facing a tradeoff between continuing economic growth and environmental protection.

1. A Brief Review on China's Environmental Protection Movement

When the People's Republic of China was founded in 1949, environmental issues were quite low on the agenda and remained so until the early 1970s. In 1972, water pollution in Dalian Bay and the Guanting Reservoir began to send alarming signals to the authorities in Beijing. Consequently, the government launched a campaign for comprehensive utilization of three industrial wastes (gas, water, and solids) to reduce the risks of pollution. Then, environmental protection was introduced into the Chinese Constitution of 1978 when the government launched the reform and opening up policy. Additionally, China has imposed a pollution levy on industrial polluters since 1979, and environmental protection was incorporated into the country's Sixth Five-Year Plan (1981-1985). This was defined as a strategic target in China's modernization at the Second National Conference on Environmental Protection in 1983.

During the 1980s, environmental protection in China gradually began to receive significant attention from the government. The Environmental Protection Law was enacted in 1979, which introduced several principles of environmental protection and various policy guidelines which included the principle that the polluter must be responsible for pollution treatment; an environmental impact assessment system (in the absence of public involvement procedures); the polluter discharge fee system and the "Three Simultaneity System."[1] In 1988, the National Environmental Protection Agency was entered into State Council proceedings. In addition, the government began to include nature conservation in environmental protection measures through the China Conservation Strategy of 1986.

Although the institutional aspects of environmental policy have improved, positive results have been limited so far due to scarcity of funds and appropriate technology for such large-scale efforts. Several domestic measures have been formulated, including the regulations of the State Council on Integrating Industrial Pollution Prevention and Control with Technological Renovation in 1983[2]. In addition, the government has sought financial and technical assistance from developed nations. Since the late 1980s, China has adopted a positive stance on environmental diplomacy in an effort to maintain good international relations. For instance, in 1991, in preparation for the Earth Summit of 1992, the Chinese government hosted the Ministerial Conference of the Environment and Development. This conference adopted the Beijing Declaration, which demanded that new and additional financing and technology be transferred from developed countries to developing countries. China's Ninth Five-Year Plan (1996-2000) and the Long-term Program for 2010 has taken sustainable development as critical for the future. China has adopted environmental protection and sustainable development as its fundamental national policy to meet the challenge of developing policies that will protect the environment without reining in

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[1] The Three Simultaneity System is exclusive to China, and means that for all newly built, rebuilt, or expanded projects or projects undergoing technological transformation, facilities for preventing pollution or other public hazards should be designed, constructed, or put into operation simultaneously with the main project.

[2] For further reading on China's efforts to reduce air pollution, see Bohm *et al.*, (1998).

modernization and economic development.

2. Review of Some Earlier Studies

The environmental Kuznets curve (EKC) hypothesis asserts that pollution follows an inverted-U path with respect to economic growth. Grossman and Krueger (1995) note that the downward sloping portion of the EKC could arise "because as countries develop, they cease to produce certain pollution intensive goods and begin instead to import these from other countries with less restrictive environmental protection laws". Meanwhile Porter (1995) claims that tight environmental regulations may enhance competitiveness rather than hinder it.

Smita and Cohen (1997) have done research into the effectiveness of stricter environmental regulation on innovation, and they found that more stringent environmental regulations spur environmental innovation (as measured by the number of green patent applications); however, there is no evidence that these new patents increase industry profits.

Anastasios and Zeeuw (1999) have developed a model, in which firms can invest in machines where newer machines are more productive and "cleaner" but also more expensive than older machines, indicating that downsizing and modernization of firms subject to environmental policy will increase average output growth and lead to higher marginal decrease in pollution emissions and lower marginal decrease in profits. Hence, the study indicated the increase in productivity of the capital stock along with a relatively less impact on profits and more emission reductions, when the stricter environmental policy induces modernization of the capital stock.

Yuan and Wu (1999), in a Chinese environmental study, found that environmental pollution would decrease in the case of a rise in import volume and government investment expenditure directed toward environment protection, because an increase in imports shows that in this case the country is producing less output domestically thus leads to decrease in environment pollution (which is in conformity with environmental Kuznets curve hypothesis). Furthermore the study implies that the increase in imports proves to be more effective in reduction of environment pollution compared to an increase in government expenditure.

Wang (2002) analyzed the impact of pollution regulation by the government on abatement expenditures, for one thousand large and medium Chinese industrial polluters. He found that the plant-level expenditures on end-pipe wastewater treatment are strongly responsive to the pollution charges, while the other command-and-control regulatory approaches were not found to have systematic and significant impacts on abatement expenditures.

Shen (2003) found that the formal regulations based on the industrial model have not proved cost-effective toward reducing industrial and other pollution, nor have command-and-control and media-specific waste control strategies been as successful as anticipated. Despite this, some economists have stated that current waste and pollutant control technologies have been developed in industrial nations around the world and they are technically possible to greatly reduce waste release and pollutant emissions from the major pollution generators, but they are costly and non-productive.

Yun (2003) analyzed the enterprises' compliance behavior in dealing with the Pollution Charge System (PCS), finding that no matter what the existing fee level is compared to the optimal fee level, the enterprises respond to it in an economic way. However, most of their compliance behavior and the local Environmental Protection Bureaus' (EPBs) enforcement behavior lower both the incentive functions that the existing fee level could have offered and the overall effectiveness of the PCS. Thus there is a need for reforms within PCS itself (e.g., removing subsidy and raising fee rate), and institutional reforms within the EPBs.

Zhang (2004) stated that environmental pollution from the industrial sector carries important characteristics responsible for degradation in environmental quality, such as the location of the industrial zones that have not been properly planned, and inefficient usage of resources in both large and small scale industries.

Li and Fu (2004), using the CGE model in their research, found that implementation of the tax on different levels of industrial production in a range based on pollution emission intensity by different industries respectively would succeed in reducing pollution, as well as reducing the corporate tax burden.

Wang and Wheeler (2005), using data from 3000 Chinese factories, estimated an econometric model of endogenous enforcement in which factories' levy rates and emissions are jointly determined by the interaction of local and national enforcement factors, abatement costs, and regulator-manager negotiations that are sensitive to plant characteristics. By arguing that the existence of regional diversity that reflects local conditions, they found that despite central pressure for uniformity in enforcement, pollution control through financial incentives has a much greater impact on production processes than on end-of-pipe abatement.

In this paper, our focus is to explore the impact of government policies (government discharge fee and investment expenditures on pollution control). Government discharge fee is defined as some levy or tax imposed on the industrial sector, with the producers liable to pay a certain amount based on output volume. In the formal regulatory system, the levy is based on standards that are supposed to be applied uniformly across China. Government expenditure in the air and water sectors is considered to be an important policy measure for environment protection and is explained as the investment made in establishing, operating, and maintaining anti- pollutant projects and subsidies given to the producers to motivate them to control the pollution. In this paper, we analyze the impact of the government discharge fee and investment expenditure on air and water pollution mitigation. Other studies have explored only the effect of the government discharge fee. Furthermore, to find the effect of government policies on environmental pollution control, we have divided total pollution into two categories (air and water), a separation that has not been done by most of the studies reviewed above.

III. Data, Construction of Variables and Methodology

The explanation for the notation of variables' name and their construction is given as below:

(1) WO represents water pollution. To construct this variable, we have taken total industrial wastewater discharge (million tons), for the years included in our sample.

(2) AO represents air pollution. To construct the variable, we have taken the aggregate sum of industrial SO_2 discharge (million tons), industrial smoke discharge (million tons), and industrial dust discharge (million tons), on annual basis.

(3) GEC represents government investment expenditure on environment protection, which contains the government annual investment expenditure (million yuan).

(4) GDF represents government discharge fee, which was collected by the government from the industries on annual basis (total levy; million yuan).

(5) PDAO represents production of air pollutant products. To construct the variable of annual production of air pollutant products, we have chosen three industries namely: production of fuel industry (PDFU), coking industry (PDCO) and tobacco industry (PDTO). We have taken aggregate sum of all these three industries production to make the "PDAO" variable (PDAO = PDFU+PDCO+PDTO). All the quantities have been taken in million tons on annual basis.

(6) PDWO represents production of water pollutant products. We have chosen three industries namely: production of paper industry (PDPA), textile industry (PDTX), and pesticides and fertilizers industry (PDPFE) to construct the variable of annual production of water pollutant products. We have taken aggregate sum of all these three industries production to make the "PDWO" variable (PDWO = PDPA+PDTX+PDPFE). All the quantities have been taken in million tons on annual basis.

(7) GRAO represents output growth of air pollutant products in percentage form.

(8) GRWO represents output growth of water pollutant products in percentage form.

For estimation purpose, we have specified two equations in our model as described below:

$$\ln WO = \alpha + \beta \ln GEC + \gamma \ln GDF + \theta GRWO + \varepsilon \quad (1)$$

$$\ln AO = \alpha + \beta \ln GEC + \gamma \ln GDF + \theta GRAO + \varepsilon \quad (2)$$

where: ε is the random error term.

Data for the variables included in the analysis have been provided from Table 1-3 given below. For the period 1988-2003 annual data have been taken from the State Environmental Protection Administration of China (SEPA), National Bureau of Statistics of China and World Bank statistical database. The computation for annual percentage change in the air pollution (AO), water pollution (WO), production of air pollutant items (PDAO), and production of water pollutant items (PDWO) etc. has also been included in the tables.

Table 1. Annual Statistics for Chinese Government Investment expenditure on Environment Protection (GEC) and Discharge Fee (GDF), 1988-2003

(Million yuan)

Year	GEC	GDF
1988	7410	1618.1
1989	7230	1666.3
1990	7070	1751.6
1991	11110	2001.4
1992	11830	2394.5
1993	14490	2680.1
1994	17270	3097.6
1995	19400[e]	3578.3
1996	4240	4096
1997	11640	4543
1998	12380	4900
1999	15250	5545
2000	23940	5796
2001	17450	6220
2002	18840	6740
2003	22180	7310

Sources: Statistical database of the State Environmental Protection Administration of China (*http://www.sepa.gov.cn/*), National Bureau of Statistics of China (*www.stats.gov.cn/english*) and World Bank statistical database (*www.worldbank.org*).

Note: e = estimated value.

Table 2. Annual Statistics of China's Air Pollution (Sum of Industrial SO_2, Dust and Smoke Discharge), 1988-2003

(Million Tons)

Year	AO	Annual percentage change (%) of AO	PDFU	PDCO	PDTO	PDAO	GRAO (%)	Annual percentage change (%) of PDAO
1988	11.26	/	137.05	61.08	30.96	229.09	0.037	/
1989	8.40	-25.40	137.64	66.24	31.95	235.83	0.029	2.94
1990	19.45	131.56	138.31	73.28	32.98	244.57	0.037	3.71
1993	28.38	3.62	145.42	93.20	33.76	272.38	0.069	6.90
1999	35.89	-12.25	160.00	120.74	33.40	314.14	-0.027	-2.68
2000	36.58	1.92	163.00	121.84	33.97	318.81	0.015	1.49
2001	33.98	-7.10	163.96	131.31	34.02	329.29	0.033	3.29
2002	33.07	-2.68	167.00	142.80	34.67	344.47	0.046	4.61
2003	36.59	10.63	171.18	156.36	35.36	362.90	0.053	5.35

Sources: Same as Table 1.

Table 3. Annual Statistics of China's Water Pollution (Industrial Waste Water Discharge), 1988-2003

(Million Tons)

Year	WO	Annual percentage change (%) of WO	PDPA	PDPFE	PDTX	PDWO	GRWO (%)	Annual percentage change (%) of PDWO
1988	24888.93	/	12.70	17.58	4.71	34.99	0.070	/
1989	23335.23	-6.24	13.33	18.23	4.82	36.38	0.040	3.98
1990	22982.46	-1.51	13.72	19.03	4.68	37.43	0.029	2.87
1993	20625.12	-6.15	19.14	19.82	5.11	44.07	0.022	2.25
1999	19730.00	-1.60	21.59	33.14	5.74	60.47	0.053	5.34
2000	19420.00	-1.57	24.87	32.47	6.64	63.98	0.058	5.81
2001	20070.00	3.35	37.77	34.62	7.69	80.08	0.252	25.17
2002	20720.00	3.24	46.67	38.84	8.60	94.11	0.175	17.51
2003	21240.00	2.51	58.34	45.44	9.63	11.34	0.205	20.51

Sources: Same as Table 1.

IV. Empirical Results

1. The Impact of Government Policies on Water and Air Pollution

In equation (1) and (2), all the variables have been taken in natural logarithm form besides the GRWO and GRAO. In the Table 4, the results of OLS estimation for equation (1) and (2)

Table 4. The OLS Estimation Parameters for Water and Air Pollution

Variables	Water Pollution (WO)	Air Pollution (AO)
C	26.72271 (0.744274)	1.821154 (4.472029)
LnGEC	-0.048344* (0.036736)	0.134170 (0.253740)
LnGDF	-0.083448*** (0.029898)	0.557812** (0.230772)
GRWO	0.214219 (0.173307)	
GRAO		-3.949705 (3.024737)
Adjusted R^2	0.618104	0.609877

Notes: ***Significant at the 1 percent level; **Significant at the 3 percent level; *Significant approximately at the 10 percent level. Figures in parenthesis are standard errors. Results are estimated by "E-views" software.

are presented. The results for lnGEC are describing that holding other explanatory variables constant there is significant reduction in water pollution as a result of government investment on pollution mitigation. The results for lnGDF show that holding other explanatory variables constant there is significant decrease in water pollution as a result of implementation of government discharge fee policies on water pollutant products. The results for GRWO describe that holding other explanatory variables constant the output growth of water pollutant products does not have significant impact on water pollution. Meanwhile, the results for lnGEC and GRAO describe that the investment expenditure policies of the government and output growth of air pollutant products do not have significant impact on air pollution. The results of GDF shows that government discharge fee policies (lnGDF) have not been successful in reducing the air pollution; in fact, it is increasing significantly.

2. Industrial Water and Air Pollution Intensities

For computing industrial water and air pollution intensities we have used the following formula:

(1) Industrial Air Pollution Intensity = Air Pollution (AO) / Total Production of Air Pollutant Items (PDAO).

(2) Industrial Water Pollution Intensity = Water Pollution (WO) / Total Production of Water Pollutant Items (PDWO).

Figure 1 shows the trend for industrial air pollution from 1988 to 2003. It is clear that air pollution intensity fluctuates, but follows an increasing trend overall. A possible explanation is that it has been much harder for the government to detect the less tangible sources of air pollution compared to water pollution. Therefore, even with the implementation of the

Figure 1. Industrial Air Pollution Intensity (AO/PDAO)

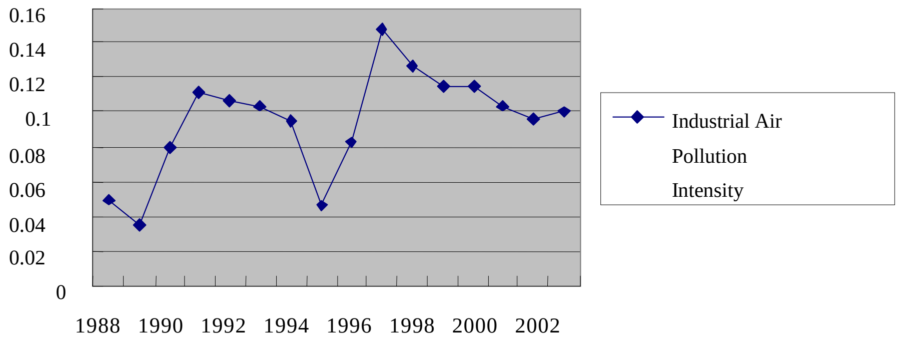
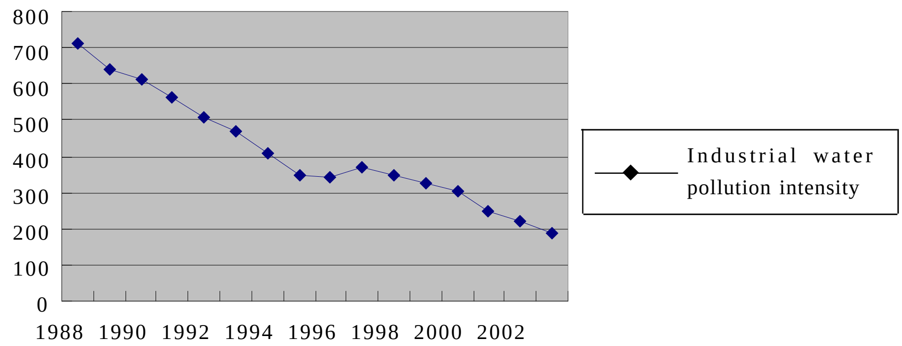


Figure 2. Industrial Water Pollution Intensity (WO/PDWO)



government discharge fee and investment expenditure policies, air pollution is increasing. The air pollution intensity trend line is showing the bigger proportional increase in AO compare to PDAO (refer to column 3 and 9 of Table 2).

The industrial water pollution intensity trend from 1988 to 2003 has been presented in Figure 2. We can see that the water pollution intensity follows a stable decreasing trend from start to the end, which shows that in water pollution mitigation, government discharge fee and investment expenditure policies have produced the desired results (also confirmed by a significant parameter coefficient in estimation results). Therefore these policies have been successful in encouraging producers to manage the wastewater of their production plants properly. This supports our findings factored on OLS estimation results. It is evident from the trend line of water intensity that WO is decreasing or maintaining its average level compared to PDWO that follows on average an increasing trend (refer to column 3 and 9 of Table 3).

V. Conclusion and Recommendations

In the context of openness for international trade and huge inflow of FDI, China has generated a production economy, giving rise to big concerns over environmental degradation. The empirical results that we estimated show that the Chinese government discharge fee and investment expenditure policies for controlling the air pollution have not been successful; meanwhile the government discharge fee policies remained influential in successful reduction of the water pollution, although there is much room for improvement.

we suggest that the Chinese government should focus on efficient allocation and utilization of pollution mitigation funds, as well as improve the management and monitoring mechanism of the institutions concerned. We can see from the results that the air pollution increase has not been well controlled by the policies, suggesting that inefficient implementation of the "Three Simultaneity System" could be the possible reason for that. Besides, campaigns, mass communication and inter-relationship among government, civil society, and NGOs on environmental pollution mitigation should be well established and supported with the government funds in the long term so that awareness can be created among the public and industry. Hence, the allocation of pollution mitigation funds and practical implementation of the policies should go hand-in-hand to achieve the desired goals.

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