China's provincial industrial pollution: the role of technical efficiency, pollution levy, and pollution quantity control

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Online Appendix

Table A1. *Value of key parameters in calculating levy for non-compliant firms*

Water	Pollutant	T_i^W	R_{i1}^W	R_{2i}^W	$\bar{C}_i^W$ (mg/liter) by industry		
		(ton)	$(¥/ton)$	$(¥/ton)$	Pulp paper	Textile	Beverage
	COD	20,000	0.18	0.05	350	180	100
	BOD	30,000	0.18	0.05	70	60	30
	TSS	800,000	0.03	0.01	100	100	70
Air	Pollutant	R_i^A	$\bar{C}_i^A$				
		$(yuan/kg)$	(mg/m^3)				
	SO_2	0.04	0.06				
	TSP	0.02	300				

Note: COD (chemical oxygen demand), BOD (biochemical oxygen demand), and TSS (total solid suspend) are three common water pollutants; while SO_2 (sulfur dioxide) and TSP (total suspend particulate) are two common air pollutants.

Table A2. *China pollution control instruments*

Command-control Instruments	Economic Incentives	Voluntary Instruments	Public Disclosure
Pollution discharge limit, based on allowable pollutant concentration	Pollution Levy	Environmental labeling system	Clean-up campaigns
Mass-based controls on total provincial discharge	Pollution Report and Discharge permit system[6]	Cleaner Production	Assessment of Urban Envi. Quality (AUEQ)[8]
Environmental Impact Assessment (EIA) [1]	Non-Compliance Fine	Environmental model cities	Envi. Awareness Campaigns
Three Synchronization Policy (TSP) [2]	Sewage tariff regulation	Envi. responsibility system[7]	Air Quality Index Disclosure
Limited Time Treatment (LTT) [3]	Sulfur emission fee	ISO 14000 system	
Centralized Pollution Control (CPC) [4]	Emission trading (experimental)		
Two compliance policy[5]	Subsidies for energy-saving products		
Environmental compensation fee	Credit Restrcitions to heavy polluters		

[1] EIA was first introduced in Clause 6 of the 1979 Provisional Environmental Protection Law and was formally required to carry out by an administrative order from National Environment Projection Commission in 1981. All new firms or new production projects are required to complete an EIA depending to the nature and size of the proposed project/firm.

[2] The TSP requires that the design, construction, and operation of a new production facility be synchronized with the design, construction, and operation of appropriate waste treatment facilities. A new production facility or a production line cannot be put into operation without a certification of the TSP issued by from SEPA. Jing and Mckibbin (2002) argues that this policy instrument may not contribute to environmental protection as firms may shut down the waste treatment facilities after granted the certification.

[3] The LTT policy orders a limited time for non-compliant, heavy polluting firms to treat their pollution to meet the standard and come into compliance. If the requirement is not met, the firm will be ordered to temporarily halt its production, or face shut-down or relocation.

[4] Cnetralized Pollution Control provides economies of scale and is cost effective and, thus, is greatly encouraged (Jiang and McKibbin, 2002).

[5] Two Compliance Policy requires firms in compliance with both discharge standards and ambient standards. This instrument suggests the emphasis shift from pollutant concentration-based control to pollutant mass-based control.

[6] Pollution Report and Discharge Permit System requires individual firms report their pollution discharge to local environmental authorities and the authorities then issue pollution discharge permit to each firm. No market has emerged to trade the discharge permit in China.

[7] The government leaders at the different levels sign an environmental protection control contract to raise their environmental awareness.

[8] AUEQ is conducted annually and the results are assessible to the public through different channels including media. The aim is to impose public pressure on local government to improve environmental quality and to raise environmental awareness among the public.

Table A3. *Summary statistics of dependent and independent variables*

Variables	mean	standard deviation	Min.	Max.
Pollution intensity (ton per million output value)				
COD intensity	4.23	6.17	0.03	77.66
SO_2 intensity	10.21	14.18	0.23	183.53
Production input prices				
Annual wage (¥1,000)	8.71	7.29	1.75	49.17
Price index of capital investment	1.03	0.12	0.76	1.31
Effective levy for water pollutant (¥/kilogram)	0.23	0.24	0.01	1.38
Effective levy for air pollutants (¥/kilogram)	0.12	0.18	0.00	1.13
Annual number of patents granted (1,000)	7.35	14.53	0.09	128.00
Percent of pop. aged 15 and up have at least tertiary education	19.65	10.20	6.50	60.20
Share of gross output value contributed by				
state-owned enterprises (SOE)	0.50	0.17	0.14	0.91
collectively owned enterprises (COE)	0.10	0.08	0.00	0.41
foreign investment	0.07	0.07	0.00	0.29
privately owned enterprises	0.15	0.06	0.01	0.35
Other	0.18	0.15	0.00	0.55
Openness to trade: (import + export) / GDP	0.35	0.72	0.03	12.80
Gross industry output value (¥1,000,000,000)	188.23	270.68	3.71	2084.88
GDP per capita (¥1,000)	2.38	2.78	0.08	19.81

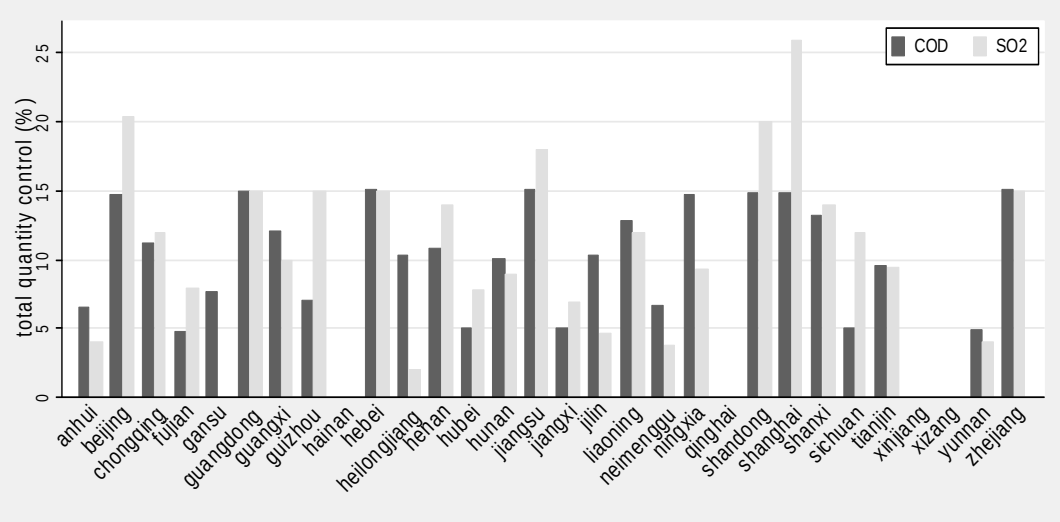

Figure A1. *Total quantity control target for each province*

References

Jiang, T. and W.J. McKibbin (2002), 'Assessment of China's pollution levy system: an equilibrium pollution approach', *Environment and Development Economics* **7**(01): 75-105.