Private Property Rights and Pollution in Emerging Market Economies

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Abstract

I use cross-country panel data to show that strengthening of private property rights protection lowers pollution emission intensity. The finding is robust to the inclusion of many controls and use of different independent variables. This paper provides preliminary empirical evidence for property rights theory of environmental goods, and suggests that completely specifying property rights is an important approach to response to environmental degradation.

Keywords: Private Property Rights, Pollution, Emerging Market, CO_2 Emission

1. Introduction

In economics literature, environmental pollution is usually explained by market failure caused by externalities. For open-access resources, no one can exclude others from using them, and in this circumstance, the private marginal costs of exploiting these resources are lower than social marginal costs, while private marginal earnings are higher than social marginal earnings. This induces the situation as Aristotle described "*that which is common to the greatest number has the least care bestowed on it*", which is called *tragedy of the commons* by Hardin (1968).

There are typically two solutions offered for avoiding the tragedy, regulating entry and use of environmental goods (by the government) and specifying property rights (privatize the commons). Regulation can base on either command-and-control or market mechanisms, and the later encompasses *Pigou* taxes and trading systems[1]. Supporters of specifying property rights

[1]Regulations are getting increasingly relying on property-rights-based market mecha-

argue that environmental pollution and resource overexploit are consequences of inadequate specification of property rights in environmental goods. Governments usually mismanage publicly owned natural resources because public resource managers do not bear all the costs of their management decisions for the reason that they are not personally invested in the resources (Anderson and Leal, 1991), and they are short-sighted relative to private resource owner. In contrast, private owners manage their resources more carefully to maximize their interests, and they have lower discount rates and longer time horizons than public resource managers, and thus lead to longer-term investments or conservation[2]. Completely specified property rights also allows one to prevent unauthorized emissions from neighborhood by means of lawsuit. Moreover, specifying property rights helps internalize externalities (Coase, 1960). So complete privatization might be the way to solve the tragedy.

Property rights theory on environmental goods implies that strengthening of private property rights (PPR) protection may ease pollution or resource overexploitation, but few research investigates this relationship empirically. In this paper, I estimate the relationship using data of emerging market economies, showing that strengthening of PPR protection lowers pollution intensity in these economies, and the result is robust.

2. Data and Empirical Framework

Emerging markets[3] are defined as nations with social or business activity in the process of rapid growth and industrialization. Rapid industrialization induces rapid growth of non-agriculture sectors, such as manufacturing and service sectors. Pollution and resource overexploitation are receiving more critiques in these countries simultaneously. Institutions, including private property rights protection and the integrity of legal system, are improved at the same time. **They are candidates of high income countries but may encounter bottlenecks of environmental degradation. That's why this paper focus on these emerging market economies.**

nisms, such as European Union Emission Trading Scheme (EU ETS) and tradable SO2 emission quotas used in the United States.

[2]See Cole (2000) for more comprehensive discussion.

[3]There are 24 economies listed by the International Monetary Fund (IMF), including Argentina, Brazil, Bulgaria, Chile, China, Estonia, Hungary, India, Indonesia, Latvia, Lithuania, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Romania, Russia, South Africa, Thailand, Turkey, Ukraine and Venezuela.

Pollution is the introduction of contaminants into the natural environment that cause adverse change. Overall pollution severity is hard to measure accurately as pollution takes various forms, including chemical substances or energy, and poses various forms of damage to human beings and the ecology. WDI (World Development Indicators, World Bank Group) database provides cross-country CO_2 emissions and other greenhouse gas (HFC, PFC, SF6 and others) emissions data as CO_2 equivalent. Data on other greenhouse gas only covers a few years discontinuously. **But noting that generally these forms of pollution yield at the same time in industrial production, it is rational to use CO_2 emission as a swap index of overall pollution**. Precisely, CO_2 emissions per 2000 US$ of GDP is used as pollution intensity index in the following empirical analysis. To further test the robustness of the empirical results, I also consider the effect of PPR protection on **water pollution**.

Property right is a bundle of rights that are relevant for the use of resources, including access, withdrawal, management, exclusion and alienation. These elements of rights can be separately assigned to different individuals as well as being viewed as a cumulative scale moving from the minimal right of access through possessing full ownership rights (Ostrom, 2000). Ideally, property rights can be divided into four categories: private, common, state and open access. Real-world property regimes inevitably combine features from various ownership categories (see Feeny et al. 1996 and Cole 2000, for example). Confusions rise up even for scholars of legal and economics. But generally, definition and enforceability of private property rights both should be considered when measuring the intensity of PPR protection. Area 2 *Legal System and Property Rights* in EFW dataset[4] is chosen as the index of PPR protection in the following empirical analysis. There are nine sub-index including *judicial independence, impartial courts, protection of property rights, military interference in rule of law and politics, integrity of the legal system, legal enforcement of contracts, regulatory restrictions on the sale of real property, reliability of police and business costs of crime*, so **it is a comprehensive indicator of private property rights protection covering both the definition and enforceability of PPR**.

[4]The Economic Freedom Dataset dataset is published in *Economic Freedom of the World: 2012 Annual Report*, authored by James D. Gwartney, Joshua C. Hall, and Robert Lawson, available at http://www.freetheworld.com/release.html.

I use country-level panel data[5] from WDI database and EFW dataset to estimate the following equation to see the effect of private property rights protection on pollution intensity:

$$\log(CO2)_{it} = \beta_0 + \beta_1 \log(PPR)_{it} + \beta_2 X_{it} + \varepsilon_{it} \tag{1}$$

and

$$\log(BOD)_{it} = \beta_0 + \beta_1 \log(PPR)_{it} + \beta_2 X_{it} + \varepsilon_{it} \tag{2}$$

where i and t denote the individual and time period, respectively. The meaning and source of variables are as follows:

- Dependent Variable:
  - log(CO2), log of CO_2 emissions per 2000 US$ of GDP, indicating pollution intensity, WDI;
  - log(BOD), log of organic water pollutant (BOD) emissions measured in two dimensions: kg of BOD emissions per 2000 US$ of GDP and kg of BOD emissions per day per worker[6].
- Independent Variable: log(PPR), log of private property rights protection index, Area 2 *Legal System and Property Rights* in EFW dataset;
- Controlling Variables: X_{it} includes
  - log(NAVA), log of value added by non-agricultural sectors as percentage of GDP, representing economic structure. WDI,
  - log(IVA), log of value added by industrial sectors as percentage of GDP, representing economic structure. WDI,

[5]Restricted by data availability, variables range from the year of 2000 to 2009, covering 24 emerging economies.

[6]Emissions of organic water pollutants are measured by biochemical oxygen demand, which refers to the amount of oxygen that bacteria in water will consume in breaking down waste. This is a standard water-treatment test for the presence of organic pollutants. The data were updated by the World Bank's Development Research Group using the same methodology as the 1998 study by Hemamala Hettige, Muthukumara Mani, and David Wheeler, "Industrial Pollution in Economic Development: Kuznets Revisited" (available at www.worldbank.org/nipr).

- log(Topen), log of trade openness index, the sum of exports and imports of goods and services measured as a share of gross domestic product[7], WDI;
- log(PPR)*log(Topen), the interactive term of PPR and trade openness.

- ε_{it} is random error term.

3. Empirical Results

3.1. Effect of PPR protection on CO_2 Emissions

I first estimated the effect of PPR protection on CO2 emissions. After F test and Hausman test, random-effect panel data model is chosen. Regression results are summarized in Table 1.

Column (I) reports basic estimation of Eq. (1) that using log(NAVA) as control variable. There is a negative and statistically significant relationship between the PPR protection index and CO_2 emissions intensity, with an estimated coefficient of -0.2132, that is, strengthening of private property rights lowers pollution intensity.

To determine the robustness of this main effect, I then conducted five robust estimation and the results are presented in Column (II) to (VI). The specification used in Column (II) adds the trade openness index. The estimated coefficient on the private property rights is -0.2095, slightly lower than in Column (I). Trade openness has no significant impact on CO_2 emission intensity.

Pollution haven effect may induce pollution intensive industries to be shifted to developing countries where environmental regulations are weak, other by means of direct investment or outsourcing activities of firms from high income countries. So Column (III) adds interactive term between PPR protection and trade openness to test this effect. The estimated coefficient of PPR protection is -0.3149 (-0.3470 multiplied by means of log(Topen)

[7]Some studies find that environmental regulations in developed countries may push pollution intensive industries to developing countries where environmental regulations are weak, see Cole et al. (2010) and Dean et al. (2009) for example. This pollution haven effect will induce firms in industrialized countries import more pollution intensive goods from developing countries

plus 1.1591), much larger than that in Column (I) and (II), showing a negative and statistically significant impact on CO_2 emission intensity. Trade openness becomes significant after the inclusion of interactive term, with an estimated coefficient of 0.0345 (-0.3470 multiplied by mean of log(PPR) then plus 0.5996). It provides some support for *Pollution Haven Hypothesis*, but this finding is NOT robust (as showed in the following estimations).

Column (IV) to column (VI) use log(IVA) as control variable instead of log(NAVA). PPR protection remains statistically significant and has a negative impact on CO_2 emission intensity, while economic structure measured by value added by industrial sectors is not significant. The estimated coefficient of PPR protection is also much larger when interactive term is included (with the value of -0.4848, -0.4813 multiplied by means of log(Topen) then plus 1.5597). Again, trade openness is not significant without inclusion of the interactive term, it becomes significant after the inclusion of the term with an estimated coefficient of -0.0171 (-0.4813 multiplied by mean of log(PPR) then plus 0.7666).

Table 1: Effect of PPR protection on CO_2 Emissions

	Random Effect					
log(CO2)	I	II	III	IV	V	VI
Intercept	14.8880***	14.9098***	11.6069***	0.7183*	0.7199*	-2.1978***
	(1.6824)	(1.6856)	(1.8659)	(0.4246)	(0.4257)	(0.7531)
log(PPR)	-0.2132***	-0.2095***	1.1591***	-0.3570***	-0.3578***	1.5597***
	(0.0513)	(0.0516)	(0.3720)	(0.0567)	(0.0572)	(0.4189)
log(NAVA)	-3.1542***	-3.2097***	-2.9500***			
	(0.3770)	(0.3808)	(0.3770)			
log(IVA)				0.0482	0.0564	0.0193
				(0.1143)	(0.1371)	0.1315
log(Topen)		0.0524	0.5996***		-0.0068	0.7666***
		(0.0452)	(0.1539)		(0.0617)	(0.1778)
log(PPR)*log(Topen)			-0.3470***			-0.4813***
			(0.0935)			(0.1042)
R-Squared	0.35	0.35	0.38	0.15	0.15	0.22
F-statistic	61.62	41.31	36.17	19.94	13.26	16.22
N of Obs.	237	237	237	237	237	237

Note: Standard errors in parenthesis, *, **, and *** are 10, 5,and 1% significance levels.

In short, the estimation results show that PPR protection has a significant negative impact on CO_2 emission intensity, providing some preliminary empirical evidence for property rights theory of environmental goods. Its impact is larger when trade openness is considered in estimation. Economic structure measured by weight of non-agricultural sectors has a significant

negative impact on CO_2 emission intensity, but that measured by industrial sector has no significant impact. The impact of trade openness is uncertain.

3.2. Effect of PPR protection on BOD Emissions

To further check the robustness of the main finding, I conducted many estimation on Eq. (2) using organic water pollutant (BOD hereinafter) emission intensity as dependent variable instead. Because of serious data missing, it is not effective to conduct panel regression, so pooled estimation is chosen. The empirical results are summarized in Table 2.

In Column (I) to (III), kilograms of BOD emissions per 2005 US$ of GDP is used as BOD emission intensity index. PPR protection has significant negative impact on BOD emission intensity when trade openness and the interactive term are included, with the estimated coefficients of -1.2720 (Column II) and -1.1971 (Column III, calculated as -1.8347 multiplied by mean of log(Topen) then plus 6.5964) respectively. The results also provide some support for *Pollution Haven Hypothesis*, with the estimated coefficients of 0.6158 (Column II) and 0.8223 (Column III, calculated as -1.8347 multiplied by mean of log(PPR) then plus 3.81) respectively.

In Column (IV) to (VI), kilograms of BOD emissions per day per worker is used as BOD emission intensity index. PPR protection also has significant negative impact on BOD emission intensity. But impact of economic structure (measured by weight of non-agricultural sectors) is reversed. Another notable result is that pollution haven effect disappeared here.

Table 2: Effect of PPR protection on BOD Emissions (Pooled Estimation)

	Kg per 2005 US$ of GDP			Kg per day per worker		
log(BOD)	I	II	III	IV	V	VI
Intercept	19.8818***	12.8009**	-3.8290	-9.3335***	-7.8956***	-10.0526***
	(6.1228)	(5.5735)	(6.6714)	(1.5918)	(1.5262)	(1.9242)
log(PPR)	-0.4986	-1.2720***	6.5964***	-0.4263***	-0.2692***	0.7514
	(0.3321)	(0.3244)	(1.9772)	(0.0863)	(0.0888)	(0.5703)
log(NAVA)	-5.8274	-4.5770***	-3.9169***	1.8279***	1.5740***	1.6596***
	(1.4295)	(1.2874)	(1.2215)	(0.3717)	(0.3525)	(0.3523)
log(Topen)		0.6158***	3.8100***		-0.1251***	0.2892
		(0.1079)	(0.7995)		(0.0296)	0.2306
log(PPR)*log(Topen)			-1.8347***			-0.2380*
			(0.4555)			(0.1314)
R-Squared	0.27	0.43	0.50	0.20	0.31	0.33
F-statistic	22.07	29.54	29.12	14.89	17.33	14.08
N of Obs.	120	120	120	120	120	120

Note: Standard errors in parenthesis, *, **, and *** are 10, 5,and 1% significance levels.

In summary, the results show that for emerging market economies: (1) **CO_2 and BOD emission intensity decrease as PPR protection is strengthened. This result provides preliminary support for property right theory on environmental goods**; (2) Economic structure measured by value added by non-agricultural sector has significant negative impact on CO2 emission intensity and BOD emission intensity measured in "per constant $ of GDP" scale; (3) the results only provide very limited support for pollution haven hypothesis.

4. Conclusion

Although private property rights play an important role in environmental issues, but to my knowledge, this is the first paper to investigate the relationship empirically using cross-country data. The empirical results show that strengthening of private property protection lowers pollution intensity in emerging market economies. This paper provides preliminary empirical evidence for property rights theory of environmental goods, and suggests to policy-makers that completely specifying property rights might be an important approach to response to environmental degradation.

Anderson, T.L., Leal, D.R., 1991. Free market environmentalism. Pacific Research Institute for Public Policy San Francisco, CA.

Coase, R.H., 1960. The problem of social cost. Journal of Law and Economics 3, 1–44.

Cole, D.H., 2000. New forms of private property: Property rights in environmental goods, in: Brouckaert, B., Geest, G.D. (Eds.), Encylopedia of Law and Economics. Edward Elgar: Cheltenham. volume II of *The History and Methodology of Law and Economics*, pp. 274–314.

Cole, M.A., Elliott, R.J., Okubo, T., 2010. Trade, environmental regulations and industrial mobility: An industry-level study of japan. Ecological Economics 69, 1995–2002.

Dean, J.M., Lovely, M.E., Wang, H., 2009. Are foreign investors attracted to weak environmental regulations? evaluating the evidence from china. Journal of Development Economics 90, 1–13.

Feeny, D., Hanna, S., McEvoy, A.F., 1996. Questioning the assumptions of the "tragedy of the commons" model of fisheries. Land Economics , 187–205.

Hardin, G., 1968. The tragedy of the commons. Science 162, 1243–1248.

Ostrom, E., 2000. Private and common property rights, in: Brouckaert, B., Geest, G.D. (Eds.), Encylopedia of Law and Economics. Edward Elgar: Cheltenham. volume II of *The History and Methodology of Law and Economics*, pp. 332–379.