Does More Environmental Innovation Lead to More Voluntary Pollution Reduction Program Participation?

Shicong Xu

Department of Agricultural, Environmental, and Development Economics

Ohio State University

Email: xu.1738@osu.edu

and

Abdoul Sam

Department of Agricultural, Environmental, and Development Economics

Ohio State University

Email: sam.7@osu.edu

Selected Poster for presentation at the 2017 Agricultural & Applied Economics Association Annual Meeting, Chicago, Illinois, July 30th – August 1st.

Does More Environmental Innovation Lead to More Voluntary Pollution Reduction Program Participation?

Shicong Xu and Abdoul G. Sam
Department of Agricultural, Environment, and Development Economics

INTRODUCTION

Voluntary pollution prevention (P2) has become an integral part of US environmental policy, along with the traditional legislative approach to directly regulate emissions, and market-oriented instruments such as tradable permits.

In addition to government-sponsored voluntary P2 programs, many businesses and industries are taking unilateral steps to proactively improve their environmental performance by adopting the ISO14001 standard and related systems that enable them to find and disrupt wasteful and inefficient tasks in the production process.

The costs of meeting voluntary P2 commitments can be quite high and may require firms to invest a significant amount of financial resources in the development of cleaner technologies (environmental patents).

OBJECTIVE

The purpose of this research is to test whether firms that invest more in environmental innovation are more likely to invest in P2 activities.

MODEL

We construct a reduced form equation to test our main hypothesis:

$$P2_{i,t} = aP2_{i,t-1} + bEP_{i,t} + cE_{i,t} + dE_{i,t+1} + R_{i,t-1} + R_{i,t-2} + X_{it} + f\lambda_t + gd_i + \epsilon_{i,t}$$

- $P2_{i,t}$: Number of P2 programs firm i participates in at time t
- $EP_{i,t}$: Count of environmental patent applications by firm i at time t
- $E_{i,t}$: *amount of CAA regulated chemical emissions by firm i at time t*
- $R_{i,t-(1,2)}$: Number of regulations experience by firm i in the past two years. This is measured by inspections, violations, and enforcement actions
- X_{it}: Firm level control – sales, capital intensity, workers, advertising intensity
- λ_t: Time dummy
- d_i: Industry dummy
- Herfindahl index and industry level P2 spillover are also included

METHODS

The relationship between innovation and P2 activities is likely to be bi-directional. Therefore, the identification of the causality of environmental patents on P2 participation is the biggest challenge in this analysis. We use a system GMM to estimate the causal impact. We instrument the endogenous variable, environment patents, by using non-environment patents and lagged environmental patents.

DATA

Patent information was retrieved from the United States Patent and Trademark Office (USPTO). Emission and P2 participation data were obtained from the EPA's Toxic Release Inventory (TRI) database. Enforcement and inspection data was obtained from the EPA's Enforcement and Compliance History Online (ECHO). Fidata were retrieved from the Standard & Poor's Compustat database.

VARIABLE DESCRIPTION

Variable Name	Mean	Std. Dev.
P2	5.85	14.98
Env Patents (Broad)	16.36	36.79
Env Patents (Narrow)	10.82	24.66
NonEnv Patents	77.29	244.53
Emissions (in pounds)	944262.7	2520209
Air Emissions (in pounds)	691212.7	2028314
Advertising Intensity (advertise expense/sales)	.034	.045
Capital Intensity (capital expense/sales)	1.05	.565
Number of Workers (in 1,000)	35.94	58.60
Sales (in millions)	11115.68	28792.68
Inspections	18.05	37.21
Enforcement Actions	0.918	2.40
Violations	2.31	3.65
Yearly P2 Control	1147.222	854.38
SIC P2 Control	147.88	185.27
HHI	.18	.15

RESULTS and MODEL SPECIFICATION

The Table on the right shows the regression results from our system GMM estimation.

1. Model 1 is our baseline patent specification: all patents in the classification of air pollution control, water pollution, solid waste disposal, recycling, alternative energy, and solid waste prevention.
2. Model 2 used narrowed definition of environmental patent instead of the baseline broad definition of environmental patents. The narrow definition of environmental patents follows the patent classification by Brunnermeier and Cohen (2003), which only includes patents that are associated with air pollution control, water pollution, and solid waste disposal.
3. Model 3 includes yearly P2 spillover as an additional control.
4. Model 4 includes yearly industry P2 spillover as an additional control.
5. Model 5 uses only air pollution release instead of all CAA (air, water, land) release because 70% of all waste is from air emissions on average.
6. Model 6 replicates model 5 with the narrow definition of patents.

Table 1	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
$P2_{t-1}$	.7063***	.6723***	.72054***	.70316***	.6523***	.64392***
	(.0366)	(.0360)	(.0365)	(.0362)	(.0341)	(.0338)
Env Patents	.0182*	.0394***	.02122**	.02388**	.01833*	.04347***
	(.0101)	(.01386)	(.01025)	(.0101)	(.0099)	(.01377)
Emission	2.06e-06***	2.2e-06***	1.8e-06***	2.3e-06***	2.9e-06***	2.5e-06***
	(5.2e-07)	(5.2e-07)	(5.1e-07)	(5.2e-07)	(5.99e-07)	(5.9e-07)
$Emission_{t-2}$	-1.4e-06**	-1.4e-06**	-1.4e-06**	-1.59e-06***	-1.4e-06*	-1.3e-06*
	(6.05e-07)	(6.1e-07)	(6.1e-07)	(6.01e-07)	(7.5e-07)	(7.5e-07)
Advertising	.0007	20.9408	8.6517	-4.1084	25.7277*	15.329
	(.0007)	(15.7780)	(15.7816)	(17.202)	(15.605)	(15.157)
Cap Intensity	1.3055	1.4950	-.1590	.5985	1.5496*	-.69748
	(.9488)	(.9130)	(.96803)	(.9456)	(.9111)	(.93133)
Worker	.0074	-.000026	-.00259	.01121	.0098	-.00737
	(.0148)	(.01491)	(.01470)	(.01483)	(.0145)	(.01443)
Sale	-.0001**	-.00008**	-.000057	-.00011***	-.00011***	-.00006*
	(.000043)	(.00004)	(.00004)	(. 00004)	(.00004)	(.00004)
$Inspection_{t-1}$	.04287	.04402	.04030	.03128	.04105	.04469
	(.0531)	(.05219)	(.0537)	(.05257)	(.05196)	(.0517)
$Inspection_{t-2}$	.0775	.07146	.08053	.06398	.09284*	.09311*
	(.0544)	(.05369)	(.0552)	(.05393)	(.05328)	(.05338)
$Enforcement_{t-1}$	-.1847	-.17961	-.1129	-.1854	-.16490	-.06593
	(.2253)	(.2217)	(.2293)	(.2223)	(.22005)	(.22150)
$Enforcement_{t-2}$	-.4040*	-.4075*	-.3605	-.3974*	-.35138	-.32545
	(.2235)	(.2202)	(.2258)	(.2205)	(.21834)	(.21869)
$OutComp_{t-1}$	-.1177	-.1356	-.16259	-.13597	-.17968	-.24868
	(.1714)	(.16760)	(.17285)	(.16919)	(.1677)	(.1663)
$OutComp_{t-2}$	.1632	.14018	.1149	.11348	.05138	-.02490
	(.1685)	(.1652)	(.16899)	(.1665)	(.16439)	(.16276)
HHI	-.2389	-.2329	-1.1912	6.0981*	-2.0110	-2.9746
	(2.6283)	(2.5368)	(2.6507)	(3.1267)	(2.5345)	(2.563)
Yearly P2			.00617***			
			(.00057)			
Yearly Industry P2				.01044***		
				(.0032)		
Sargan P Value	0.8240	0.3106	0.7952	0.5119	0.6952	0.1978

***p<0.01, **p<.05, *p<0.1

CONCLUSIONS

This is the first empirical study, to our knowledge, that investigates the effect of environmental patents on P2 participation. We have found that more technologically innovative firms participate in more P2 programs. The lagged dependent variable is highly significant indicating that the decision to adopt P2 is dynamic. Our results also show that the expectation of tightening environmental regulations and higher emissions are both significant factors for P2 participation.

THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

250 Agricultural Administration Building
2120 Fyffe Road, Columbus, OH 43210