The Effectiveness of Mandatory Regulation v.s. Voluntary Program in Hazardous Waste Abatement: Emperical Evidences from National Partnership for Environmental Priority Program

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Introduction

- Voluntary programs are gaining popularity as an alternative, or complementary instrument, to traditional mandatory approach, in promoting pollution abatement.
- Almost 100 voluntary programs have appeared since EPA initiated its first voluntary program "33/55" in 1991.
- At the beginning, voluntary programs were welcomed for simplicity and flexibility, and potentially lower cost in achieving the same environmental goal(Anna Alberini and Kathleen Segerson,2001).
- More rigorous analyses reveal mixed results regarding the effectiveness of voluntary programs, compared to mandatory regulation(Brouhle *et al* 2009, Robert Innes and Abdoul G.Sam, 2008).

Introduction

- Voluntary programs can be categorized into binding and non-binding. In the U.S, the latter one is more prevalent. To avoid strategic reactions from firms, non-binding voluntary programs do not usually promise regulation exemption.
- Early theoretical literatures usually "create" the exemption incentives for firms in formulating the optimization problem.
- Non-binding voluntary programs without regulation exemption confront participants the same legislation threat as non-participants. Possible benefits for participants are limited to technical assistance and public recognition offered by various voluntary programs.
- Of the nearly 100 voluntary programs initiated by EPA, up to 95% belong to the non-binding class, including the National Partnership for Environmental Priority Program(NPEP).

NPEP

- Launched by EPA in 2002, NPEP is a national voluntary partnership program that reduces potentially hazardous chemicals from products and wastes, which might otherwise be released into the environment.
- As a part of EPAs National Waste Minimization Program and Resource Conservation Challenge, NPEP encourages public and private organization to form voluntary partnerships with EPA to reduce or eliminate any of the 34 hazardous wastes (including bioaccumulative, Priority Chemicals and etc.).
- Two benefits (No regulation exemption):
  1. recognition and awards: participants may receive enrollment plaque, achievement awards, have the right to use NPEP logo; EPA may publish some of the success stories on its website.
  2. access to technical information, technical resources and worker training, offered by EPA.

NPEP cont'd

- Until October, 2008, NPEP cumulatively contribute the reduction of more than 9.2 million pounds of potentially hazardous chemicals.
- In the 2008 fiscal year alone, NPEP partners reduced or recycled more than 5.6 million pounds of priority chemicals (Source: EPA, NPEP Accomplishment Report, 2007-2008)
- Somehow, NPEP is discontinued in the September, 2011.
- The overall impacts of the NPEP program remain an interesting and untouched area that calls for rigorous investigations. It is possible (or not?) that the participants can achieve the same abatement level even without NPEP.

Mandatory Regulation on Hazardous Waste

- The Resource Conservation and Recovery Act (RCRA), which is passed in 1976 and amended in 1984, acts as the first major law that provides the guidelines for hazardous waste generation and management.
- It establishes the minimum standards of hazardous waste. Besides RCRA, there are some other statutes addressing specific hazardous waste, such as Compensation and Liability Act (also called Superfund), the Clean Air Act and the Clean Water Act.

Mandatory Regulation on Hazardous Waste cont'd

- Each state has the authority to make additional hazardous waste regulations as long as the regulations made by state are as stringent as RCRA. Thus, the regulations regarding hazardous waste vary from state to state.
- Until now, more than forty states have instituted the strict liability and almost thirty states allow punitive damages against recalcitrant responsible parties.
- The heterogeneity of mandatory regulations among states provides a good opportunity to estimate the interaction effects of mandatory regulations, if could be differentiated quantitative across states, and the voluntary program.

Hypotheses

- Hypotheses are formulated according to previous theoretical and emperical studies, for the purpose of consistent and comparison. We also consider some factors that we think might be influential in facilities' participation/abatement decisions.
  - *Hypothesis 1*: A facility is more likely to participate in the NPEP and increase pollution abatement if it faces strict liability and more mandatory inspection actions
  - *Hypothesis 2*: A facility is more likely to participate in the NPEP and increase pollution abatement if it locates in the area where has higher population density, more educated population, richer neighborhood, or lower minority percentage.
  - *Hypothesis 3*: A facility is more likely to participate in the NPEP and increase pollution abatement if it has more employees or higher annual revenues.
- One firm may operate multiple facilities, assume firms make independent decisions on whether one facility would participant.

Hypothesis 1

- Previous studies find that the more stringent the mandatory regulation is, the more likely the facilities choose to participant in voluntary programs(J.Videras and A.Alberini, 2000).
- Specifically, facilities locate in the states with strict liability rule and more inspections, are more likely to participate in NPEP, as studied in our context.
- Similarly, facilities face more stringent regulations abate more pollution.

Hypothesis 2 and 3

- Demographic circumstance may also cause different participation or abatement behaviors from facilities. To some extent, demographic profile reflects potential community pressure on the decisions of facilities (Brouhle *et al* 2009).
- Studies consistently find that larger firms are more likely to participant voluntary programs than small firms(Jonathan C. Borck and Cary Coglianese, 2009).

Empirical Model

- Based on Brouhle, Griffiths and Wolverton(2008), assume firms would join only if voluntary program brings higher benefits. We first model firms' participation behavior, as a binary choice, and then estimate the respective impacts of voluntary program and mandatory regulation on pollution abatement.
- Assume firm i's net benefit from participation is:

$$B_i^* = W_i\alpha_i + \eta_i$$

where α_i is the parameter vector, W_i is a vector of explaining variables, η_i is the error term. Since B_i^* is unobserved, we approximate with firms' participating decision, which is denoted as Γ_i such that:

$$\Gamma_i = 1 \textit{ if } B_i^* > 0;$$

$$\Gamma_i = 0 \textit{ otherwise}.$$

Empirical Model cont'd

- Then, we can use probit model to estimate the probability of participation with $P(\Gamma_i) = \phi(W'\alpha)$.
- For the emission equation, we model the abatement amount ΔE_i as:

$$\Delta E_i = X_i\beta_i + \varepsilon_i$$

  where ΔE_i is the difference of firm i's abatement amount before and after our selected reference year.
- We address the endogeneity issue (James J.Heckman, 1979) by correcting selection bias using the treatment model.

Data

- The data come from several sources. The list of NPEP partners combined with their locations and participation informations are provided by EPA(Thanks to Newman Smith for support). The emission and management data come from EPA's Toxic Release Inventory (TRI) and Enforcement and Compliance History Online (ECHO). We consider only profit-driven private firms.
- Meanwhile, we only utilize facilities' participation decisions in 2008, the detailed inspection data are available from 2006 to 2010; also, in 2008, more facilities participated in NPEP than any other single year (For NPEP, once you decided to join in, you stay in the program, until the program discontinues).

Data

- We collect information for 189 firms, over five years. Of the 189 firms, 59 firms participant NPEP in 2008, the rest NEVER participant in NPEP. In our data, participants account for 22% of total NPEP members. Also, the selected firms locate in 17 states where NPEP members are more concentrated. We do not include firms who participant other than 2008, and firms from other less concentrated states. Firms participant in NPEP in 32 states.
- According to North American Industrial Classification System (NAICS) codes, participants belong to 31 different industries. As for non-participants sample, we select from the same 17 states and 31 industries. We obtain facilities information, like the annual revenue and the number of employees, from Manta (www.manta.com). We collect the specific mandatory regulation information from the Department of Environmental and Natural Resource website.

Location of NPEP Members

Figure 1. Location of NPEP Members

Resource:EPA,NPEP Accomplishment Report 2007 and 2008.

Dependent variables

- In the participation equation, the dependent variable is a binary variable, which equals to 1 if the facility chose to participate and 0 otherwise.
- In the emission equation, the dependent variable is the difference between the average toxic chemicals or metals release in 2006-2007 and that in 2009-2010.

Independent variables

- Demographic variables: the percentage of minority, education, population density in a three miles radius around the facilities and proportion of household with more than 50,000 annual income.
- Facilities characteristics: annual revenue, the number of the employees of the facilities, annual hazardous waste release, and industry categorical dummy based on NAICS codes.
- Mandatory regulation variables: dummy variable indicate whether the facility is under strict liability, average inspection, dummy variable for violation.

Variables	Definition
Participation	Equals to 1 if facilities choose to participating in NPEP, or 0 otherwise
Release Abatement	The log of difference of average release in 2006-2007 and that in 2009-2010
Minority	The log of minority percentage in a three miles radius around the facilities
Population density	The log of population density in a three miles radius around the facilities
Educated people percentage	The log of percentage of people who achieve the high school or beyond diploma in three miles radius around the facilities
Wealthy household percentage	The log of percentage of household whose annual income are more than 50,000 dollars in three miles radius around the facilities
Annual Revenue (AR)	The ordinal variable represents the annual revenue of facilities. AR=1, if $AR \leq$ 1 million; AR=2, if 1 million $< AR \leq$ 5million; AR=3, if 5million $< AR \leq$ 20million; AR=4, if 20million $< AR \leq$ 50million; AR=5, if 50million $< AR \leq$ 100million; AR=6,if100million $< AR \leq$ 500million;AR=7 if $AR \geq$ 500million.
Employee (E)	The ordinal variable represents the total employees of the facility. E=1, if $E < 100$; E=2, if $100 \leq E < 250$; E=3,if $250 \leq E < 500$;E=4,if $500 \leq E < 1000$; E=5, if $E \geq 1000$.
Average release	The log of average release in 2006-2007, including on-site and off-site release reported by TRI in given years.
Average management	The log of average off-site transferring reported by TRI in given years.
Industry categorical Dummy	The dummy variable define industry category based on NAICS codes.
Liability	The dummy variable indicates if the facility is under strict liability.
Main	The dummy variable that equals to 1 if the PC emission account for 10% of the total release
Average inspection	The average inspection from CAA, CWA, RCRA in a given year (frequency: daily)
Average inspection	The average inspection from CAA, CWA, RCRA in a given year (frequency: daily)
Violation	The dummy variable equal to 1 if facilities violate the mandatory regulation in a given year.

Table 1. Definition of Variables

	ML Estimation		ML With Robust Errors	
Participation Equation	Estimate	Std. Err.	Estimate	Std. Err.
Ln education	0.5520	1.8334	0.3905	1.8090
Ln minority	0.9040***	0.2713	0.9255***	0.2742
Ln population density	-0.3479	0.2327	-0.4269*	0.2539
Annual revenue	0.3310**	0.1450	0.3015*	0.1579
Employees	-0.2799	0.2130	-0.2507	0.2097
Ln affluent	-0.2458	0.8229	0.2147	0.8197
Liability	2.0416***	0.6448	2.1929***	0.6866
Main	1.8814***	0.5557	1.9017***	0.5420
AveInspection	-0.1748**	0.0795	-0.1512*	0.0897
Aveinspection ×violation	0.2242***	0.0720	0.2121***	0.0781
Ln average release	0.3798***	0.1010	0.3402**	0.1666
Ln average management			0.0386	0.1437
Cons	-10.0766	7.4166	-8.9484	7.5809
Log likelihood	-28.5874		-28.5087	

Table 2. Regression Result, Participation equation

*Industry specific dummies are not presented

	ML Estimation		ML With Robust Errors	
Emissions Equation	Estimate	Std. Err.	Estimate	Std. Err.
Ln education	-0.5770	1.0606	-0.5770	0.7261
Ln minority	-0.4138 **	0.2052	-0.4138***	0.1549
Ln population Density	0.2686	0.1879	0.2686	0.1638
Annual revenue	0.5940	0.1068	0.0594	0.0736
Employees	0.0296	0.1136	0.0296	0.0755
Ln affluent	0.3229	0.4903	0.3229	0.3097
Average inspection	0.0740	0.0644	0.0740	0.0445
Main	-0.5167	0.3295	-0.5167*	0.2410
Liability	-0.5721	0.4660	-0.5721	0.5079
AveInspection × violation	0.0438	0.0595	0.0438	0.0381
Participation	1.0988***	0.3446	1.0988**	0.4797
Cons	0.5751	4.2663	0.5751	2.9825
Log Likelihood	-135.3099		-135.3099	

Table 3. Regression Result, Emission equation

Result: Hypothesis 1

- Facilities under more inspections, or with more previous release, tend to violate the mandatory regulation before participating.
- Strict liability significantly (at 1% level) increases the probability to participant in the NPEP.
- This finding indicates that although NPEP is non-binding and promises no regulation exemption, the stringent mandatory regulation still has the effect to promote facilities to participate in, which support many theoretical literatures that more strict legislation threat can create more possibility for facilities to participate.
- Facilities' participation into NPEP significantly promote the abatement of hazardous wastes, from the results of emission equation.

Result: Hypothesis 2

- Facilities are more likely to participant in the NPEP if they were located in areas with more minority (1% significant level), less population density (10% significant level); the eduction and the percentage of affluent household variable are not significant.
- Demographic variables are not significant in the emission equation, except that facilities located in areas more minority are more unlikely to reduce abatement.

Result: Hypothesis 3

- The number of employees does not significantly influence facility' participation decision; however, higher annual revenue increases the probability of participating NPEP(5% significant level).
- In the emission equation, these two facility's characteristic variables are not significant.