Public Pressure and Heterogeneous Effects of Voluntary Pollution Abatement

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Motivation

Voluntary pollution abatement programs (VPAs) are widely used complement for the mandatory regulations:

- Flexible: lack quantitative targets, sanctions and punishment.
- Do not require legislative action.
- No direct benefit.

Research Questions

- How do VPAs create an incentive for firms to participate?
- What factors determine the effectiveness of VPAs in reducing pollution?

Literature

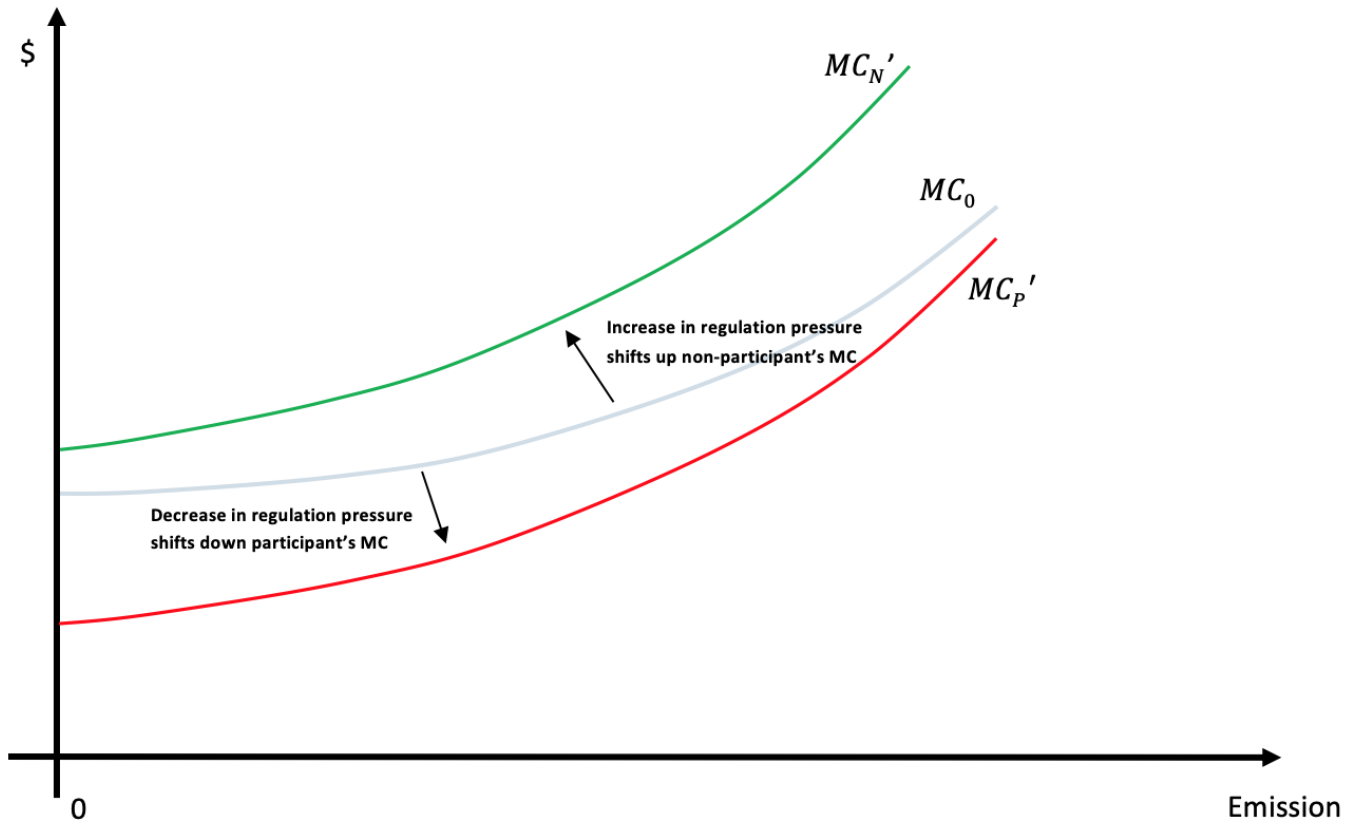
- VPAs are effective. (Khanna and Damon, 1999; Bi and Khanna, 2012; Innes and Sam, 2008).
- VPAs are not effective. (Welch et al., 2000; Gamper-Rabindran, 2006; Vidovic and Khanna, 2007; Brouhle et al., 2009; Carrion-Flores et al., 2013; Vidovic and Khanna, 2012; Vidovic et al., 2019)
- VPAs participants increase emissions compared to non-participants. (King and Lenox, 2000; Gamper-Rabindran and Finger, 2013)

Three Factors Affecting Firm's Emission Behavior:

- Firm characteristics related to abatement cost
  - Example: Managerial skill, size, energy type, equipment, ownership...
- Emission cost from mandatory regulation pressure
  - Source: government intervention/regulation
  - Example: environmental taxes, expected inspections and violation penalties.
- Emission cost from public pressure
  - Source: Coasian bargaining in corporation-society conflicts (Heal, 2005)
  - Example: "green" consumers boycott, loss in stock market, negative media coverage, local communities protests and lawsuits...

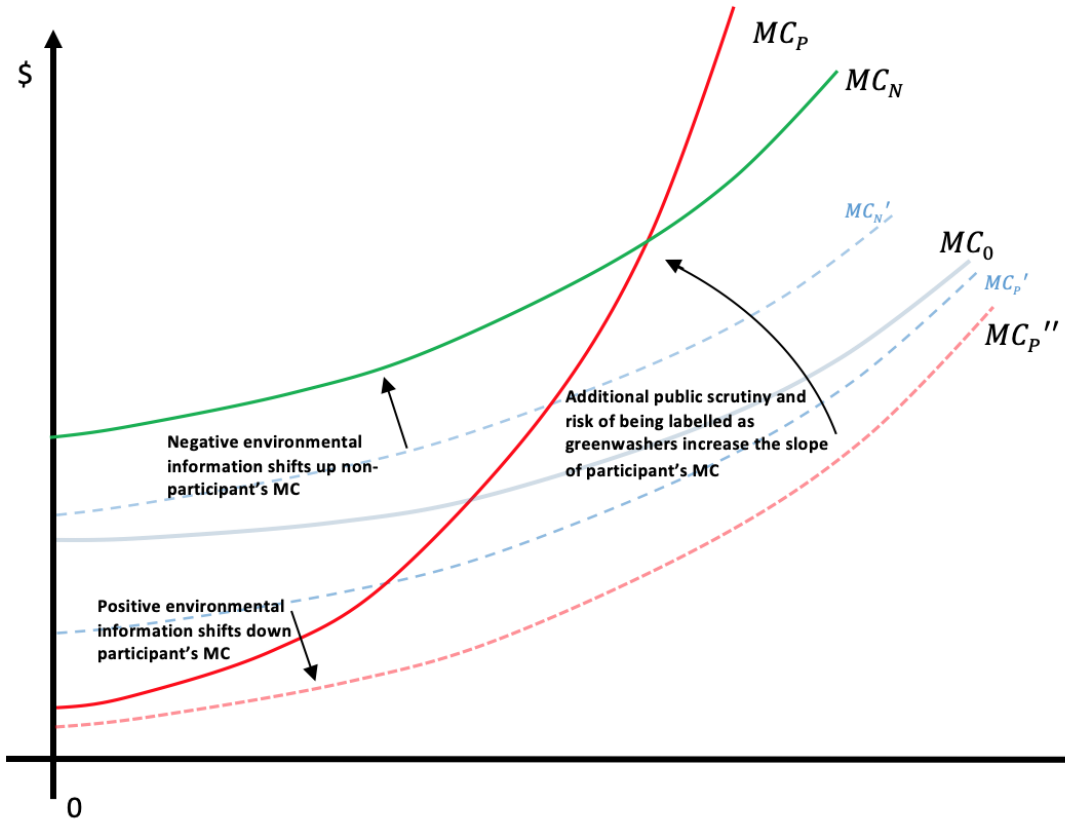
Regulation Pressure

VPA shifts regulation resources from participants to non-participants (Gamper-Rabindran, 2006; Innes and Sam, 2008; Li and Khanna, 2018).



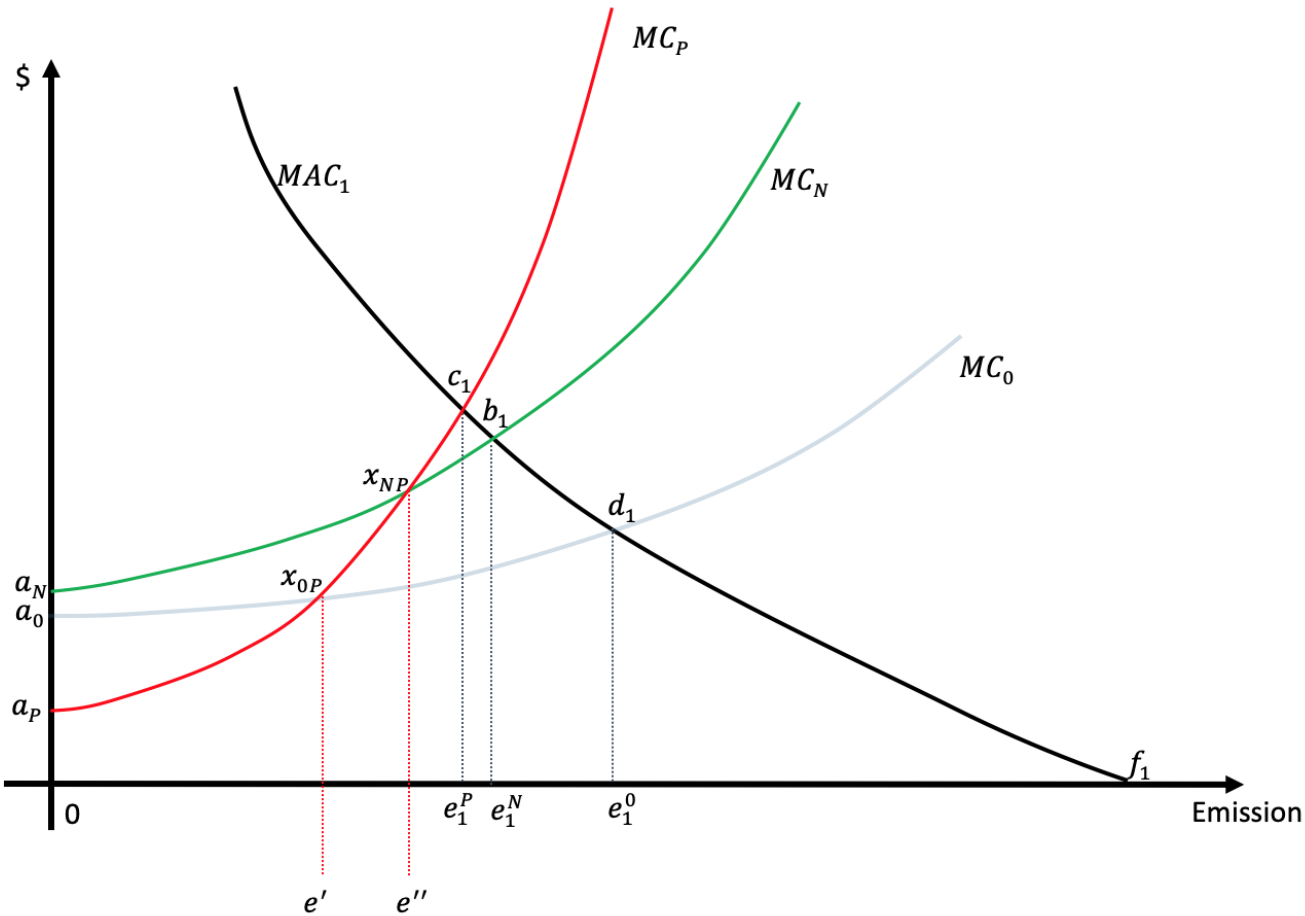
Public Pressure

- VPA participation as positive news lowers public pressure, and *vice versa* (Aerts et al., 2008).
- VPA participation brings public scrutiny and the associated risk of being labeled greenwashers (Lyon and Maxwell, 2011; Kim and Lyon, 2011).



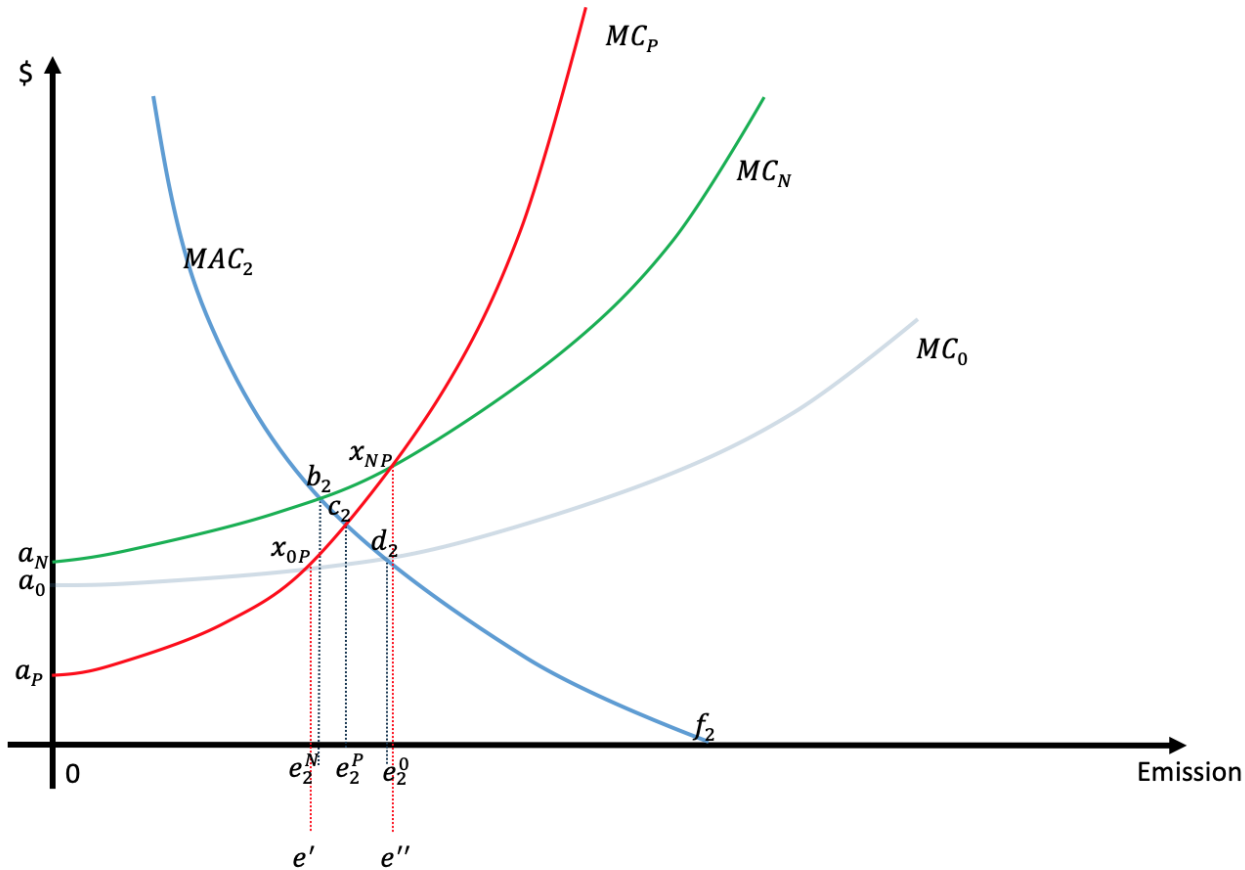
3 Types of Firms: High Pollution Firms

1. MAC intersects MC_P and MC_N on the right of x_{NP};
2. Always reduce emissions, participants $(d_1 \rightarrow c_1)$ reduce more than non-participants $(d_1 \rightarrow b_1)$;
3. More polluting firms have smaller participation incentive $(Area(a_N a_P x_{NP}) - Area(x_{NP} b_1 c_1)$; $Area(x_{NP} b_1 c_1) \uparrow)$



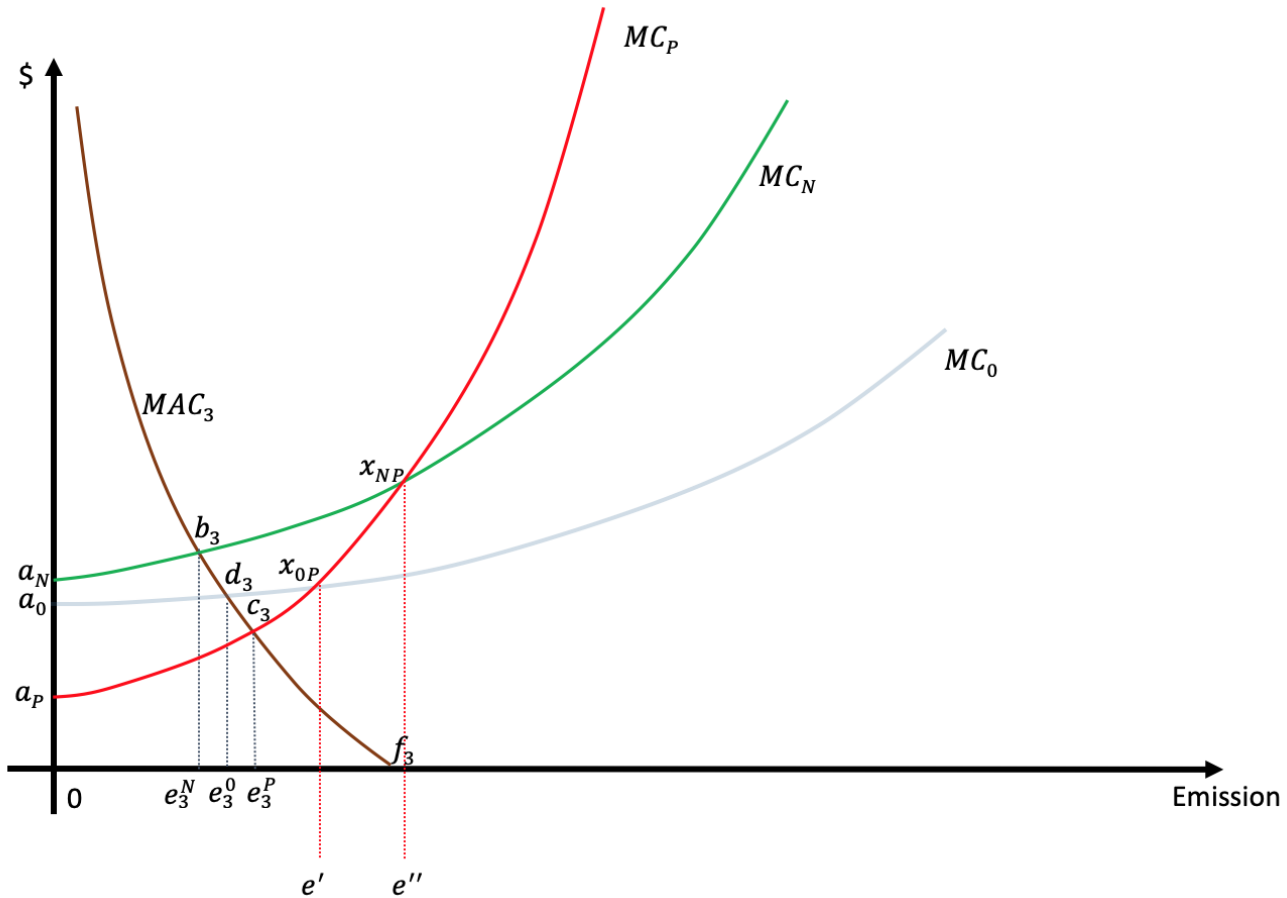
3 Types of Firms: Medium Pollution Firms

1. MAC intersects MC_P between x_{NP} and x_{OP};
2. Always reduce emissions, participants $(d_2 \to c_2)$ reduce less than non-participants $(d_2 \to b_2)$;
3. More polluting firms have greater participation incentive $(Area(a_n a_p c_2 b_2) \uparrow)$



3 Types of Firms: Low Pollution Firms

1. MAC intercepts MC_P on the left of x_{OP};
2. Non-participants reduce emissions ($d_3 \to c_3$), participants increase emissions ($d_3 \to b_3$);
3. More polluting firms have greater participation incentive ($Area(a_n a_p c_3 b_3) \uparrow$)



Testable Hypothesis

Hypothesis 1. If the lagged emission level $e_{t-1} \leq e''$, then a marginal increase in e_{t-1} increases the probability of participation. If the lagged emission level $e_{t-1} > e''$, a marginal increase in e_{t-1} decreases the probability of participation.

Hypothesis 2. If the lagged emission level $e_{t-1} \leq e''$, then a participant reduces emissions by a smaller magnitude than non-participant (and is a free-rider). If the lagged emission level $e_{t-1} > e''$, then a participant reduces pollution by a larger amount than non-participant.

Data

We use the EPA 33/50 program (1991-1995) data set from Zhou et al. (2020).

The goal of EPA 33/50 program was to reduce total emissions of 17 toxic chemicals by 33% by 1992 and by 50% by 1995, compared to the 1988 baseline.

There are 8,670 plants from 1988 to 1996.

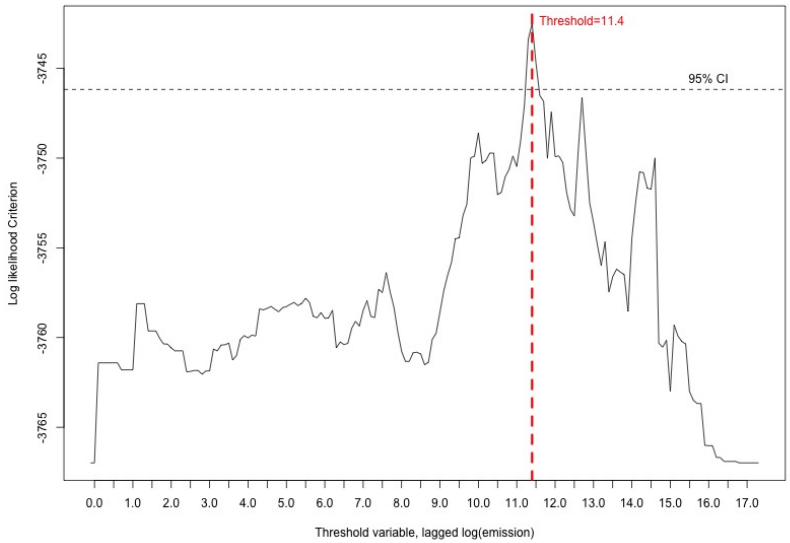
We consider two samples: the whole sample, and a 1991 sub-sample (with all non-participants and only first year (1991) participants).

Empirical Model

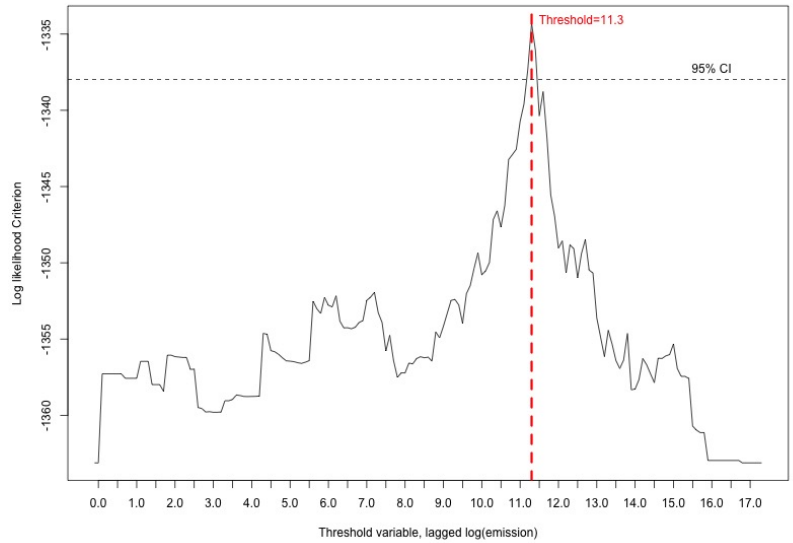
Two-stage regression to solve the endogeneity from self-selection in participation.

- First stage probit model estimates participation incentives
- Identify e'' by grid search that maximizes likelihood of probit model (Hansen, 1999, 2000).
- Second stage dynamic panel model estimates the participation effect (instrumented by first stage estimates) using Arellano and Bond (1991) GMM.
- Allow heterogeneous participation effect on either side of the threshold e''.

Empirical Results: First Stage



(a) MLE criterion of threshold parameter, 33/50 program participation incentive in 1991-1995



(b) MLE criterion of threshold parameter, 33/50 program participation incentive in 1991

Figure 1: Threshold estimation and 95% confidence interval

Empirical Results: Second Stage

Table 1: Main analysis: 1991-1996 participation effect (benchmark results)

	Dependent variable: log(33/50 emissions), first difference					
	Full Sample	Full Sample		1991 Sub-Sample	1991 Sub-Sample	
		Before threshold	After threshold		Before threshold	After threshold
Participation Status	-0.556^{***}	-0.183^{***}	-0.956^{***}	-0.287^{***}	0.758^{***}	-0.806^{***}
	(0.053)	(0.062)	(0.104)	(0.072)	(0.190)	(0.109)
Control Variables	Y	Y		Y	Y	
Industry Specific Time Trends	Y	Y		Y	Y	
State Specific Time Trends	Y	Y		Y	Y	
Threshold log emission	-	11.4		-	11.3	
Over-identification test (Hansen J Statistics P Value)	0.2794	0.3242		0.2105	0.2729	
Weak identification test (Cragg-Donald Wald F Statistics)	69.611	70.083		49.133	47.385	

Note: *p<0.1; **p<0.05; ***p<0.01
Covariates: lag log(33/50 emissions), HAP/TRI Ratio, LCV Score, county nonattainment status, county income per capita.
All covariates are in first differences.
IV's are first stage estimated participation probability and the third-year lag of log 33/50 emissions.

Result Interpretation

$$
\begin{aligned}
e^P_{ijt}/e_{ij,t-1} &= e^N_{ijt}/e_{ij,t-1} \times exp\Big(\gamma_1 \mathbb{1}_{e_{ij,t-1} \leq e''} + \gamma_2 \mathbb{1}_{e_{ij,t-1} > e''}\Big), \\
e^P_{ijt} &= e^N_{ijt} \times exp\Big(\gamma_1 \mathbb{1}_{e_{ij,t-1} \leq e''} + \gamma_2 \mathbb{1}_{e_{ij,t-1} > e''}\Big).
\end{aligned} \tag{1}
$$

Participation effect estimated by the full sample:

- Below the threshold: -16.7%
- Above the threshold: -61.6%

Participation effect estimated by the 1991 Sub-Sample:

- Below the threshold: +113.4%
- Above the threshold: -55.3%

Conclusion

- We develop a theoretical model illustrating a firm's incentives to participate in VPAs and outline the firm's emission decisions.
- The scrutiny of participating firms' environmental outcomes by the public is the key factor in determining whether VPAs participants free-ride the program or not.
- Public pressure can be effectively leveraged to complement traditional regulation and keep firms from free-riding in voluntary pollution abatement programs.

Questions, Comments and Suggestions

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