

# **Corporate Environmental Behavior and the Effectiveness of Government Interventions**

## **PROCEEDINGS OF NEW GRANTEES IN CORPORATE ENVIRONMENTAL BEHAVIOR**

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# Pollution Prevention: The Role of Environmental Management and Information

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University of Illinois and Michigan State University

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## Pollution Prevention (P2)

- Promises several advantages over end-of-pipe controls
  - Focuses on multi-media pollution control
  - Prevents trace emissions/bio-accumulative pollutants
  - Requires greater integration between environmental and business decisions; encourages innovation and cost-effectiveness
- Waste reduction at source implies increased efficiency in production
  - Potentially higher profits and a win-win strategy
  - Differentiated products that respond to environmentally conscious consumers
  - Reduced environmental risks to shareholders
  - Improvement in corporate reputation

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# Approaches for Pollution Prevention

- Regulatory agencies encouraging P2
  - Voluntary programs, technical assistance and training
  - Environmental Leadership Programs/Adoption of Environmental Management Systems
  - Information collection and disclosure through the Toxics Release Inventory
    - Requires reporting on toxic releases and adoption of 8 types of P2 activities
- Firms are
  - Participating in stewardship programs
  - Adopting Environmental Management Systems (EMSs): Total Quality Environmental Management (TQEM)
    - Seeking continuous progress in reducing waste and improving product quality
    - Undertaking internal environmental audits, employee training and involvement
    - Making process and product modifications to increase efficiency and reduce waste

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# Motivation for this Research

- What is motivating some firms to adopt EMSs/TQEM and P2?
  - Which types of firms are more likely to adopt?
- Do EMSs encourage P2 and which types of P2
  - Visibility of EMSs may provide stakeholder benefits to firms even in absence of P2
  - Some P2 is costly; less observable by public
  - Adoption rates of TQEM high (50%) but of P2 low (25-33%)
- Is P2 effective in improving environmental performance of firms?
- Does pollution prevention really pay?
  - Which types of P2 in particular and for what types of firms?

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## Theoretical Issues Addressed

- Can market pressures (consumer preference for green products) motivate P2 as a strategy to differentiate products and achieve social optimality?
- Are supplementary regulations needed (minimum quality standards, taxes/subsidies) and their implications for social welfare, firm profits and prices
- Incentives for P2, EMS adoption and social optimality of market based pressures when all consumers cannot observe P2 but can observe a firm's EMS

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## Empirical Analysis

- Motivations for P2: Role of TQEM and information provision about toxic releases
- Impact of P2 adoption on environmental performance
- Impact of P2 on economic performance of firms
  - Event study analysis of impact of P2 and EMS adoption on stock market reactions to toxicity weighted TRI
  - Impact of P2 on expected future profitability of firm, price earnings ratios and market shares

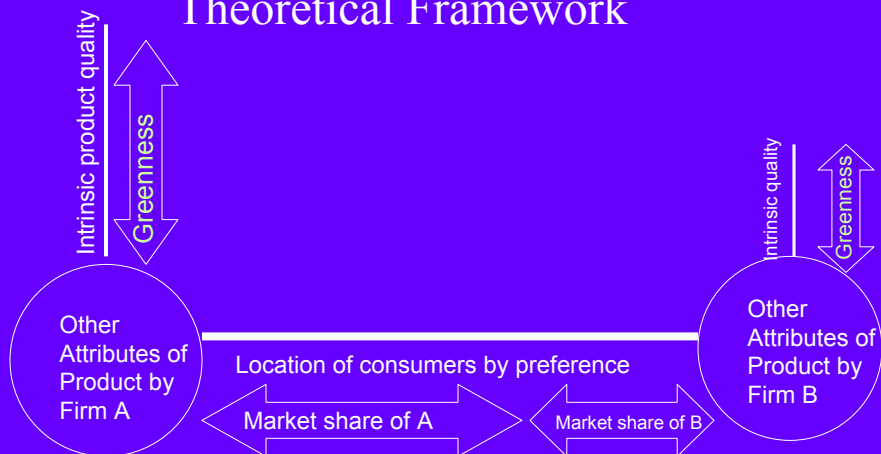
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## Theoretical Framework

- Assumptions
  - Product attributes:
    - Greenness
    - Reliability
    - Others: style, design, convenience
  - All consumers care about greenness to same degree; differ in preferences for other attributes
  - Consumers willing to internalize the externality to some extent
  - Greenness measured by emissions intensity (P2)
  - Consumers can observe extent of P2
  - Rival firms in an industry seek to differentiate their products
  - Increasing greenness of product by a firm imposes fixed costs that increase with greenness
    - can lead rivals to match greenness or lower prices

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## Theoretical Framework



Reliability and other attributes of brands pre-defined

Firms choose greenness and product prices to maximize profits

Consumers choose the product that maximizes their benefits net of prices

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## Specific Questions Investigated

- Whether firms with a higher intrinsic quality are more/less likely to choose more P2
- Incentives for P2 due to
  - Impact of increased consumer awareness about environmental attributes of products
  - Cost sharing of P2 by regulators
- Impact of P2 on market shares, prices and profits
- Whether consumer preferences are sufficient to achieve socially optimal level of P2 by all firms
- Implications of minimum quality standards, taxes/subsidies for P2, firm profits and social welfare.

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## Initial Findings

- When consumers observe and care about product greenness
  - Firm with higher intrinsic quality does more P2, charges a higher price and has a greater market share than rival firm
  - Even if consumers fully internalize the environmental externalities, market pressures will not lead to an optimal provision of the environmental attribute
    - Need to supplement market pressures with regulatory intervention
  - Impact of a minimum quality standard on social welfare is ambiguous
    - Higher quality firm may overcomply with standard but would do less P2 than in absence of standard

### Work in Progress

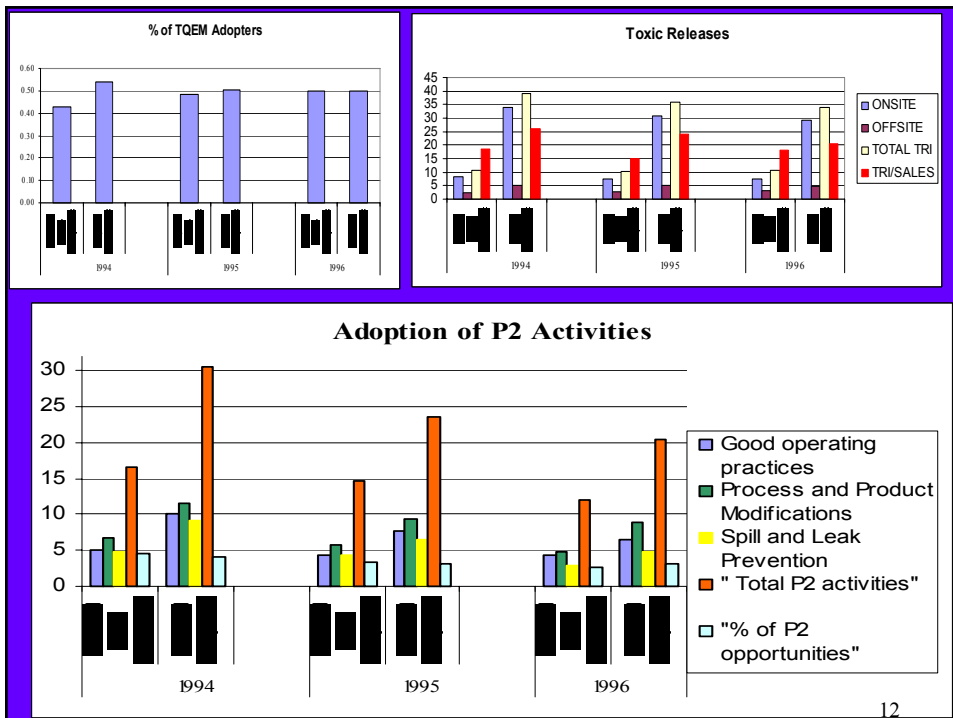
- Implications of product quality taxes/subsidies and cost sharing policies for P2, firm profits and social welfare
- Implications for P2 and social welfare when only some consumers observe product greenness but all care about it and firms adopt an EMS to indicate product quality

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## Sources of Data for Empirical Analysis

- Adoption of TQEM: IRRC surveys 1994-96
  - 228 parent company level observations each year
  - 3500 observations at the facility level each year
- Toxic Releases and P2 activities: TRI
  - Types of P2 activities: Good operating practices; Spill and Leak Prevention; Process and Product Modification
  - On-site Releases, Off-site Transfers, Hazardous Air Pollutants
- Superfund sites, inspections and civil penalties: IDEAS data
- Financial Performance: Research Insight Data
- Environmental Pressure Indicators: Census and other sources
- Sample of Firms: S&P 500 firms that report to TRI and<sup>11</sup> completed IRRC survey 1994-96



## Motivations for TQEM

### Probit Analysis using Panel Data Methods

Explanatory Variables	Effect
Market Pressures: Final Good	+
Market Share	+
Asset/Sales	+
Regulatory Pressure: NPL sites	+
Volume of HAP	+
Civil Penalties	
Frequency of Inspections	
Information Provision: Off-site Transfers	+
On-site Transfers	
Firm Characteristics: Size	+
R&D expenditures	+
Older Assets	+

+: Significant positive effect; Others Insignificant effect

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## Motivations for P2

Explanatory Variables	Good Operating practices	Spill and Leak Prevention	Process/Product Modification	Off-site Transfers/Sales
TQEM		+		-
Market Pressures: Final Good		-	+	
Market Share		-	+	
Regulatory Pressure: NPL sites	-	-	+	
Volume of HAP	+		+	-
Civil Penalties				-
Frequency of Inspections	+			
Info. Provision: Off-site Transfers past		-		+
On-site Transfers past	-	-	-	
Number of TRI Records	+	+	+	
Firm Characteristics: Size	-	-	-	
R&D expenditures	+		+	
Older Assets	+			
Sales/Asset	+	+	+	
Facilities in Non attainment Counties			+	
Facilities in States with high compliance expenditure	+			14

## Impact of TQEM on Process/Product Modification Activities Varies Across Firm Types

- Firms in the Top Quartile of R&D expenditures:
  - Larger R&D expenditure more likely to lead to more P2
  - TQEM has an insignificant impact on P2
- Firms in the lower 3 quartiles of R&D expenditures
  - Larger R&D expenditures less likely to lead to more P2
  - TQEM has a positive impact on P2
- Firms in the top 3 quartiles of market share
  - Firms with larger market share more likely to do P2
  - TQEM has a positive significant impact on P2

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## Event Study Analysis: Stock Market Reactions to Toxic Release Information

### Hypothesis to be Tested:

- **H1:** There is a significant negative association between the quantity of pollutants released and a firm's abnormal stock returns.
- **H2:** The toxicity level of the releases is negatively associated with the stock market returns.
- **H3:** Higher P2 activities exhibit a positive association with stock market returns
- **H4:** A firm's degree of readiness to improve its environmental performance, signaled by its adoption of an EMS, and its stock market returns are positively associated.

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## Other Work in Progress

- Analysis of effects of TQEM and other practices (such as corporate reporting) on P2
- Facility level analysis of impact of P2 and source of information/assistance on P2 on Toxic Release performance and on criteria pollutants
- Impact of P2 on financial performance of firms

# The Effect of Self-Policing on Hazardous Waste Compliance

Sarah L. Stafford

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EPA's Corporate Environmental Behavior Workshop April 27, 2004

Research Supported by STAR Grant R831036

## Objectives

- Determine whether self-policing policies have affected compliance with hazardous waste regulations.
  - Understand the extent to which companies use self-policing.
  - Develop compliance model that incorporates self-policing.
- Provide feedback on the effectiveness of self-policing policies.

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## Self-Policing

- Self-Policing: a situation in which a regulated entity notifies authorities that it has violated a regulation or law.
  - Not necessarily the same as self-reporting.
- Federal “Audit Policy” encourages self-policing by reducing or eliminating penalties for self-disclosed violations.
- State self-policing policies and environmental audit privilege and immunity laws also encourage self-policing.

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## Theoretical Framework

- A self-policing policy without a change in inspection targeting or fines cannot increase compliance.
  - Can increase environmental protection by requiring remediation.
  - Should only effect inadvertent, not willful, violations.
- If a self-policing policy is combined with a redistribution of enforcement it can increase compliance.
  - Can affect willful violations as well as inadvertent.

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## Empirical Analysis

- Ideal analysis would consider effect of self-policing policies on auditing, self-policing, and compliance.
  - Comprehensive data not available.
- First, look for changes in compliance behavior after imposition of federal and state policies.
- Based on results, conduct more focused analysis.

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## Initial Analysis

- Use panel data on inspections and detected violations before and after imposition of federal and state policies.
  - Probability of inspection, and thus probability of detection, is not exogenous.
  - Use censored bivariate probit with errors clustered by facility.
- Data for 9,500 hazardous waste facilities from 1992 to 2001.
  - No newly regulated facilities, one-time generators, small quantity generators, or federal facilities.

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## Initial Results

- Federal policy accompanied by change in targeting, but no significant change in overall level of violations.
- State policies appear to have had a more significant effect:
  - States with audit privilege only: lower probability of inspections and violations.
  - States with audit privilege and immunity: higher probability of inspection, lower probability of violation.
  - States with self-policing: lower probability of inspections and violations.

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## Questions Still to be Answered

- Is the change in targeting due to self-policing policies or merely coincident?
- Can the change in violations be attributed to self-policing or are there other causes?

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## Follow-up Analysis

- Use data on 2001 self-disclosures to examine impact of self-disclosure on probability of an inspection.
  - Challenges:
    - How accurate is the data on self-disclosures?
    - Are there enough self-disclosures to make estimates?
- Find data on audit adoption to determine whether increased auditing could be responsible for decreased violations.
  - Possible sources?

# **Comparative Plant-level Analysis of Three Voluntary Programs**

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April 27, 2004



## **Status of Voluntary Programs for Environmental Protection**

- 00's in Germany, Netherlands: national government, industry associations
- 000's in Japan: local agencies, firms
- in U.S. 'public voluntary programs' or 'government lead challenges' popular
- 54 EPA programs in 1999, up from 28 in 1996
- U.S. climate policy dominated by voluntary efforts: EPA, DOE, DOA



## Potential Advantages of Voluntary Programs

- Increased flexibility for government and industry
- Reduced confrontation
- Reduced transaction costs, litigation, etc.
- Pilot test new approaches, especially in absence of legal basis for mandatory program



## Are Voluntary Programs Really Effective?

- Concerns expressed that programs do not push firms beyond baseline performance
- Without regulatory or price signals few incentives to develop/use new technologies
- Shifts emphasis from 'worst' polluters to those willing to act voluntarily



## Two Types of Voluntary Programs

- Focusing on particular technologies, e.g., Green Lights
- Focusing on environmental performance, e.g., 33/50, Climate Wise, 1605b



## Goal of Research

Expand understanding of environmental effectiveness as well as efficiency of voluntary programs

- Current information is often too aggregate, without clear baseline
- Pollution prevention and GHG reduction are growing areas of policy interest



## Principal Contributions of Research

- Shift focus from firm-level to plant-level analysis, thereby controlling for changes in output, other key factors
- Improve modeling of participation, emission reductions: focus on differences between participants and non-participants
- Expand breadth of academic-style studies beyond 33/50 to include GHG reduction programs
- Validate/improve data quality



## Plant-level Data

- Unlike most previous studies which rely on firm-level information, focus is on plant-level data
- Available on confidential basis from US Census (LRD, QFR)
- Need to link Census data with public information: 33/50, Climate Wise, 1605b
- Builds on researchers' previous experience with Census Bureau data



## Methodology

**Problem:** firms self-select to join programs. Thus participation is not random

**Method 1:** Ignore problem

**Method 2:** Condition selection on observable data, e.g., size, profits, etc

**Method 3:** Condition selection on unobservable data (analyze residuals) (Heckman & Hotz)



## Early Progress

- STAR grant awarded Fall, 2003
- Initial focus on literature review, assembling publicly available data, formal approval from Census (Predominant Purpose Statement)
- Currently on second round of PPS reviews
- Optimistic about near-term approval



## Expected Research Results

- Key characteristics of program participants vs non-participants
- Environmental performance of participants vs non-participants
- Factors influencing performance including size, profitability, industry, firm type, early/late joiner, etc
- Inter-program comparisons
- Effect of program participation on performance in other areas



# Oregon Business Decisions for Environmental Performance

U.S. EPA Funded Project on Corporate Environmental Behavior and Effectiveness of Government Intervention

5/17/2004

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University

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## Project Team

- **David Ervin, PI/PD, Portland State U.**
- **Madhu Khanna, PI, U. Illinois at Champaign-Urbana**
- **Patricia Koss, PI, Portland State U.**
- **Junjie Wu, PI, Oregon State U.**
- **Cody Jones, GRA, Portland State U.**

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## Project Objectives

1. Identify and measure the major elements of environmental performance, e.g., toxic waste compliance, solid waste recycling and water use efficiency, for Oregon firms.
2. Collect primary data on the set of environmental practices used by a random sample of Oregon firms.

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## Project Objectives cont'd

3. Collect data on firm, industry, regulatory, and 'voluntary' environmental program factors hypothesized to influence the environmental performance.
4. Test the influences of firm, industry, regulatory conditions, simultaneously with voluntary program factors, on the adoption of environmental practices.

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## Project Objectives cont'd

5. Test the influences of firm, industry, regulatory, and voluntary program factors on firms' environmental performance.
6. Infer the 'voluntary' program features (e.g., practices and incentives) and other conditions that significantly improve firm environmental performance.

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## Hypotheses

1. The decision to adopt a particular environmental practice is related to characteristics of the firm, industry, and regulatory environment, as well as voluntary program incentives.
2. The environmental performance induced by a particular environmental practice is also related to specific firm, industry, and regulatory characteristics and program incentives.

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## Hypotheses cont'd

- The effects of the firm, industry, and regulatory characteristics and program incentives vary across environmental performance elements, e.g., toxic releases and solid waste recycling.
- The effects of the firm, industry, and regulatory characteristics and program incentives on environmental performance vary across sectors, e.g., building construction, agriculture.

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## Major Activities

- Review potential environmental programs available to Oregon industries
- Conduct industry focus groups to identify practices and performance measures
- Select stratified sample of firms
- Implement survey with Washington State University survey research center
- Conduct multivariate analyses to test hypotheses

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## Approach/Methods

- **2-stage model to analyze, simultaneously, the determinants of program participation and environmental performance.**
- **1<sup>st</sup> stage -- firm's choice of environmental plan (or combination of practices)**
- **2<sup>nd</sup> stage -- explanation of environmental performance as influenced by firm, industry, regulatory and program factors**

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## Approach/Methods

- **Polychotomous-choice selectivity model to address self selection bias and interaction between practices**
- **Stratified random sample to assure sufficient number of participating and non-participating firms**

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## Planned Schedule

- **Environmental program review 1-5/04**
- **Industry Focus groups 6-9/04**
- **Survey instrument design 6-9/04**
- **Sample selection 8-9/04**
- **Survey enumeration 10/04- 3/05**
- **Data cleaning 4/05-6/05**
- **Analysis 7/05-12/05**
- **Writing and outreach 1/06-9/06**

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## Progress – Environmental Program Review

- **Many environmental programs are available to Oregon firms.**
- **Participation may be affected by business composition -- 97.6% of Oregon firms are classified as small.**
- **Most programs allow firms to choose best environmental practices.**

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## Progress – Environmental Program Review

- A preliminary finding is that certain practices appear to be common across programs and industries
  - Supply chain management
  - Employee behavior modification
  - Environmental personnel
  - Training – employees, contractors, vendors

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## Progress – Environmental Program Review

Selected EPA Cross-Sector Programs	Incentives			Statistics
	"Green" Label/Public Recognition	Enforcement Discretion/Regulatory Relief	Tech. Assistance	Oregon Participation
Climate Leaders			✓	2
Energy STAR/Climate Wise/Green Lights	✓			109
National Environmental Performance Track	✓	✓	✓	4
WasteWi\$e	✓		✓	10

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# Progress – Environmental Program Review

Selected International Programs	Incentives			Statistics
	"Green" Label/Public Recognition	Enforcement Discretion/Regulatory Relief	Tech. Assistance	
CERES Endorser Program	✓			2
Forest Stewardship Council Certification	✓			62
ISO 14001 Certification	✓			NA
Responsible Care/RC 14001 Certification	✓			3

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# Progress – Environmental Program Review

Selected National/State/Local Programs	Incentives			Statistics
	"Green" Label/Public Recognition	Enforcement Discretion/Regulatory Relief	Tech. Assistance	
Food Alliance (National)	✓			32
LEED Green Building Certification (National)	✓		✓	73
Eco-Logical Business Program for Auto Shops (Oregon)	✓		✓	45
The Oregon Natural Step Network (Oregon)	✓		✓	127
Eco-Logical Business Program for Landscapers (Regional)	✓		✓	NA
G/Rated Green Building Program (Regional)			✓	50

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