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*An Empirical Study of Environmental R&D:  
What Encourages Facilities to be  
Environmentally Innovative?*

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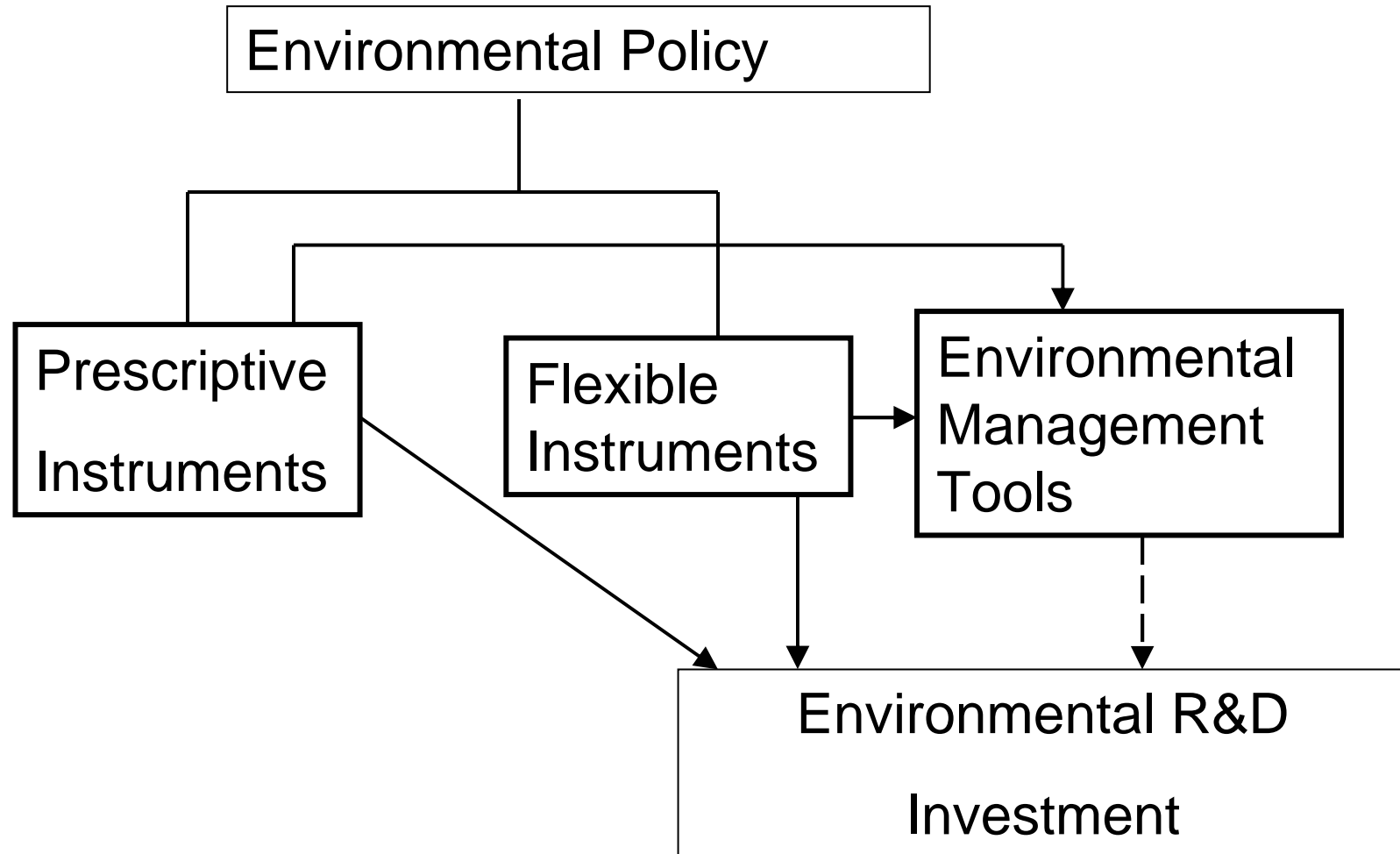
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# Environmental R&D

- We examine R&D activities devoted to environmental purpose (environmental R&D) as the source of environmental innovation.
- What promotes environmental R&D?
  1. Environmental Policy Strength
  2. Environmental Policy Instruments
  3. Environmental Management Tools

# What promotes environmental R&D?

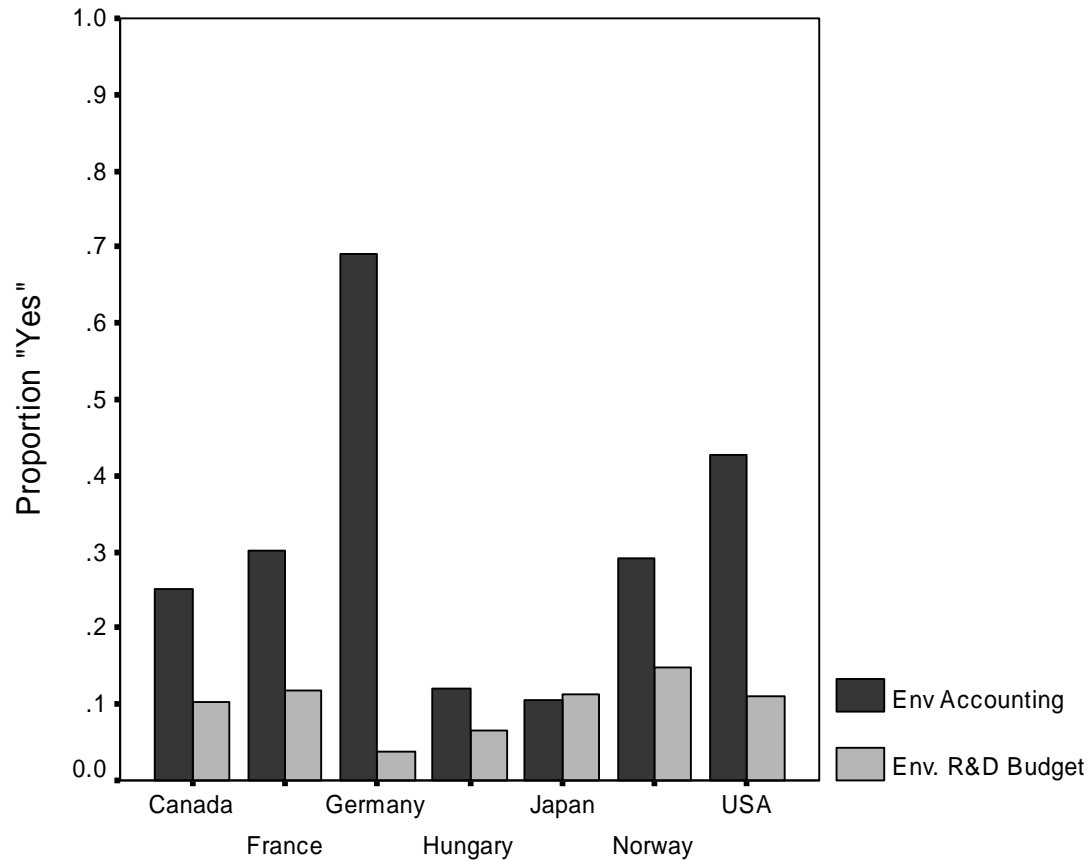


# Three main hypotheses

- Hypothesis 1: Policy stringency encourages investment in environmental R&D;
- Hypothesis 2: Flexible environmental policy instruments promote environmental R&D to a greater extent than prescriptive instruments; and,
- Hypothesis 3: The adoption of environmental management tools promotes environmental R&D.

# Environmental Accounting System

- Env. Accounting Systems helps firms to identify their environmental impacts and associated financial implications.



# Econometric Models: Bivariate probit model with a endogenous dummy

- Two Decisions: Env. R&D and Env. Accounting System
- Explanatory Variables:
  1. Environmental Policy Strength
  2. Environmental Policy Instruments
  3. General Management Practices

# Estimation Results: Policy Stringency

	Env. R&D
Variables	Coefficients (Z-Value)
Stringent Env. Policy	0.215*(1.75)
Inspection Frequency	0.00234(0.37)

- Stringent environmental policy stimulates Environmental R&D

# Policy Instruments

	Env. R&D
Variables	Coefficients (Z-Value)
Technology-based Standards	0.174(1.23)
Performance-based Standards	-0.117(-0.66)
Input (energy) Taxes	0.257(1.55)
Emission or Effluent Taxes	-0.215(-1.38)
Technical Assistance	0.078(0.70)

- Instrument choice does not affect Env. R&D in a direct way

# Effects of Environmental Accounting System

	Env. R&D
Variable	Coefficients (Z-Value)
Env. Accounting	1.575***(5.58)

- The adoption of an Environmental Accounting System promotes Environmental R&D Activities
- Endogeneity between Env. R&D and Env. Accounting
- Flexible Policy Instruments promote Env. R&D

# Other Results

- Economies of scope between general management practices and Env. Accounting
- Being listed on a stock exchange also affects Env. Accounting
- Other factors are not significant influence on Env. R&D

# Summary

- Stringent Environmental Policy induces Environmental R&D.
- Environmental Accounting System matters a great deal to Environmental R&D.
- Instrument Choice has an important indirect influence on Environmental R&D, via the effect on the Environmental Accounting Systems.

# Conclusion

- Well designed environmental policy can induce environmental innovation by stimulating investment in Environmental R&D
- Further research is needed to examine the output of innovation such as patents or productivity

*End-of-Pipe or Cleaner Production? An  
Empirical Comparison of Environmental  
Innovation Decisions Across OECD Countries*

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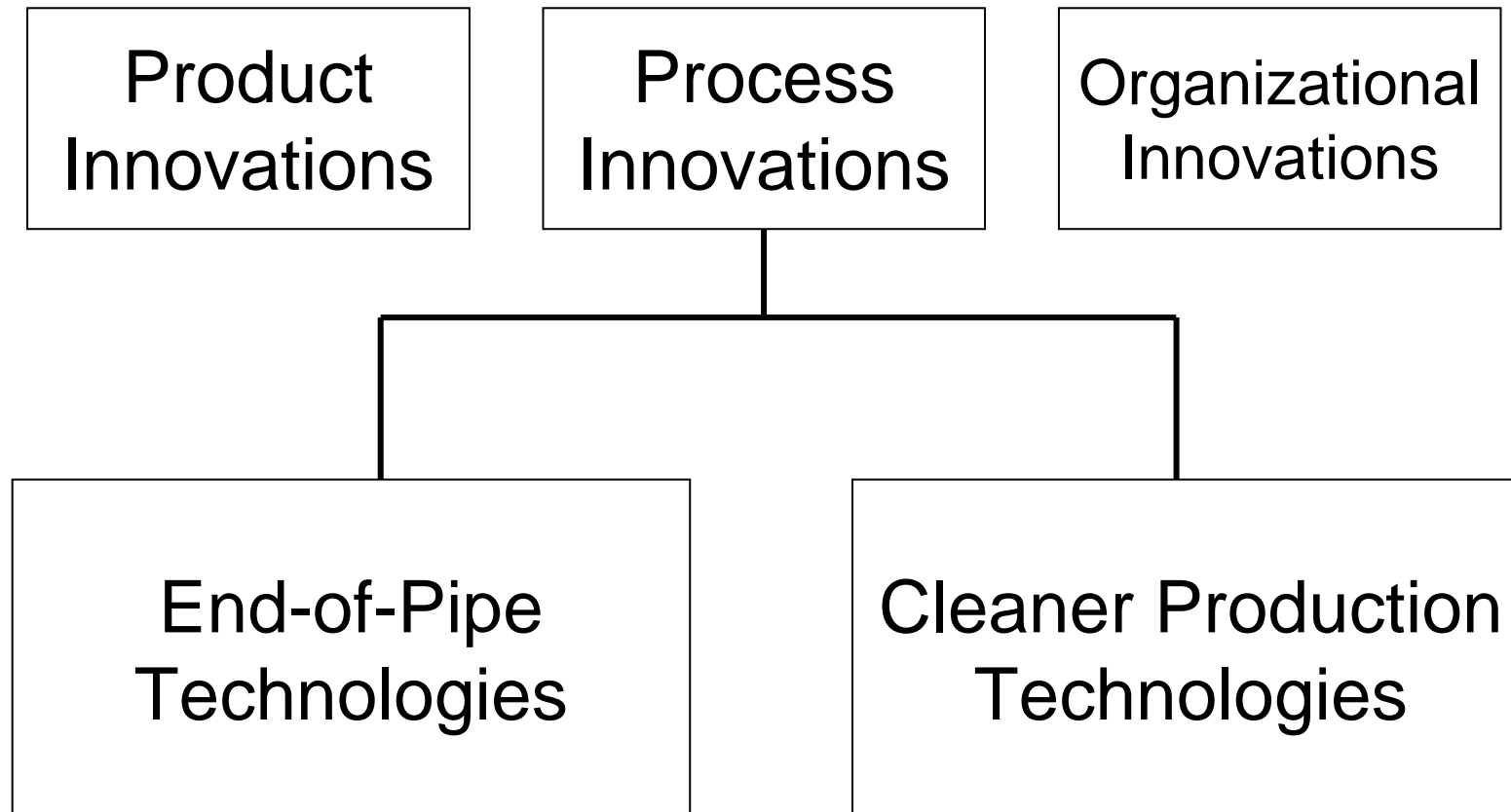
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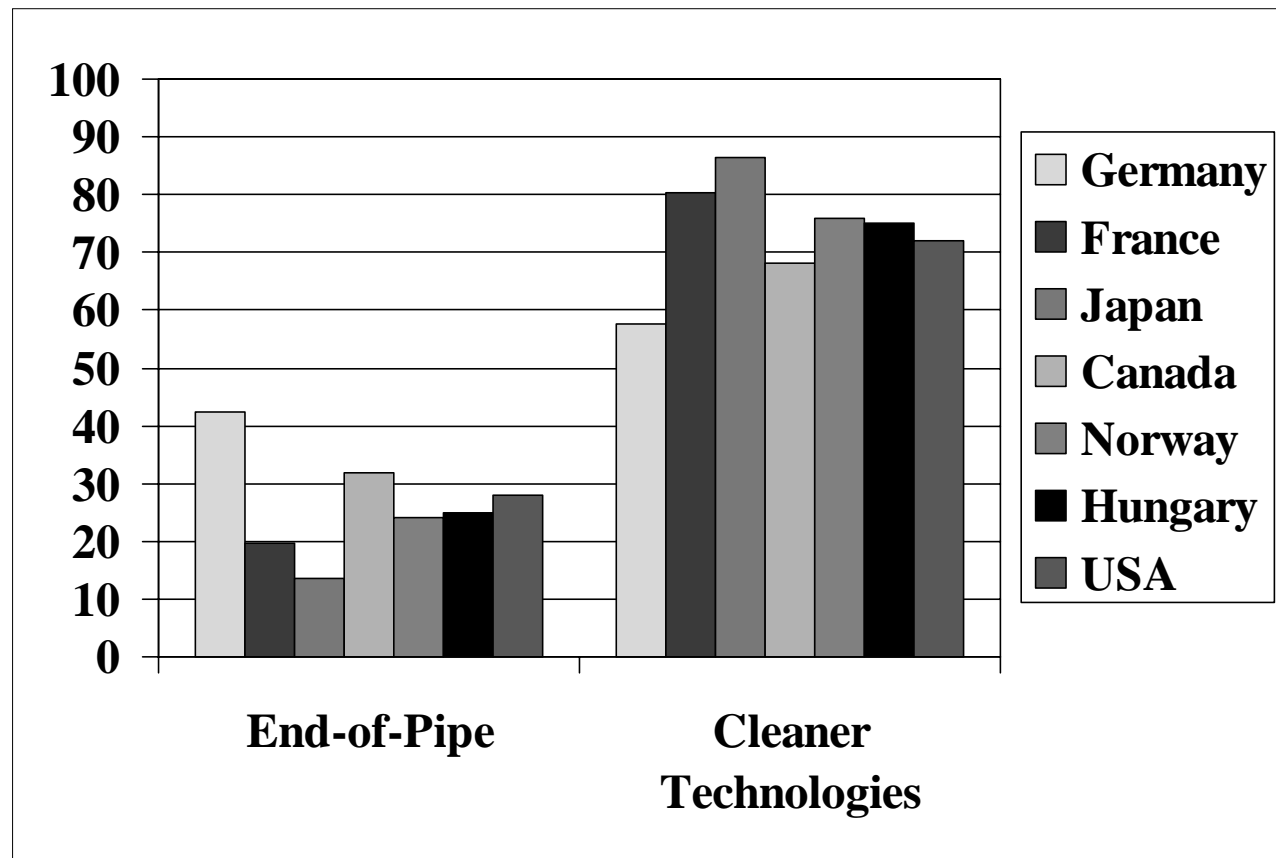
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# Types of Environmental Innovations



## Choice of Environmental Technologies in Different OECD Countries



Source: OECD database.

# Econometric Analysis: A Multinomial Logit Model

Dependent variable:

Choice of abatement technology (end-of-pipe, cleaner technology, no new technology)

Five sets of independent variables:

- Environmental policy instruments
- Motivations for environmental activities
- Pressure groups and stakeholders
- (Environmental) management tools
- Facility characteristics

## Results of the Econometric Analysis

	End-of-pipe	Cleaner Production
	Environmental Policy	
Policy Stringency	1.43 (2.15)*	1.22 (1.27)
Regulatory Measures	1.34 (2.11)*	1.14 (1.12)
Market Instruments	1.30 (1.86)	1.06 (0.47)
Information	0.82 (-1.13)	0.80 (-1.48)
Voluntary Measures	0.90 (-0.52)	1.02 (0.12)
Subsidies	1.08 (0.46)	1.15 (0.97)

Number of observations: 3699.  $\chi^2(78) = 1267.71$ . Pseudo  $R^2 = 0.178$ . The base category is “no abatement technology”. Z-statistics are given in parentheses; \* and \*\* denote significance at the 5% and 1% level, respectively. Relative Risk Ratios for the corresponding variables are reported instead of coefficients.

- The strictness of environmental policy and regulatory measures are more important for the introduction of end-of-pipe technologies
- No significant impacts of market-based instruments

	End-of-pipe	Cleaner Production
	Pressure Groups	
Internal Forces	1.43 (2.60)**	1.52 (3.57)**
Unions	0.65 (-1.92)	0.84 (-0.88)
Green orgs	1.01 (0.09)	0.96 (-0.32)
	Motivations	
Image	1.03 (0.18)	1.10 (0.84)
Incidents	1.47 (2.85)**	1.37 (2.88)**
Cost Savings	1.23 (1.63)	1.62 (4.53)**

- Cost savings are only relevant for cleaner technologies
- Among the influences of pressure groups only internal stakeholders promote both types of environmental innovation
- Environmental incidents spur the realization of both environmental technologies

	End-of-pipe	Cleaner Production
	Management Tools	
Health and Safety System	1.29 (1.98)*	1.44 (3.49)**
Process or Job Control System	1.13 (0.85)	1.33 (2.35)*
Written Environmental Policy	1.45 (2.42)*	1.52 (3.31)**
Internal Audits	1.26 (1.53)	1.58 (3.72)**
Environmental Accounting and Reports	2.00 (4.05)**	1.71 (3.52)**
	1.28 (1.56)	1.52 (2.98)**

- (Environmental) management tools (especially process or job control systems, internal environmental audits and environmental reports) seem to be particularly important for the introduction of cleaner technologies

	End-of-pipe	Cleaner Production
	Facility Characteristics	
Competition	0.91 (-0.79)	1.02 (0.15)
Impacts	1.78 (4.34) **	1.40 (2.95) **
Officer	2.11 (4.86) **	1.63 (4.07) **
R&D	1.31 (1.03)	1.75 (2.47) *
Size	1.00 (-0.27)	1.00 (-1.95) *
Turnover	1.07 (0.51)	1.02 (0.23)

- R&D promotes cleaner technologies but is not significant for end-of-pipe
- The existence of a person explicitly responsible for environmental concerns triggers environmental innovation
- Environmental impacts spur the realization of both environmental technologies

# Policy Recommendations

- The strictness of environmental policy but not the choice of the policy instrument matters
- Support of the introduction of (environmental) management tools is useful because these tools improve the information basis for cleaner technologies
- Widening the cost gap between the two types of technologies, for instance, by additionally charging for the use of waste and energy is useful to support cleaner technologies