Evaluating Voluntary Programs in the United States+

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Voluntary Climate Programs: Climate Wise

- Established 1993; continued until 2000. Focus on non-utility industrial sector.
- Required baseline emission estimate (but not inventory).
- Required to identify mitigation actions, goal for 2000.
- Report activities via 1605(b).
- Gained technical assistance; annual workshop.

Voluntary Climate Programs: 1605(b)

- Established under EPACT 1992; began 1994.
- Required reporting of emission reductions, with flexibility over
  - Whether entity or project
  - Reference year or hypothetical reference
  - Absolute or intensity reductions
- Open to any individual or business; dominated by electric power industry
- Important benefits (EIA, 2002):
  - Teach corporations how to estimate emissions and mitigation options
  - Sharing experience concerning mitigation activities
  - Evidence for evaluating other voluntary programs
  - Illuminate accounting issues related to future emission regulation

Participation in Programs (raw / not linked to LRD)

Join year	1605(b)	ClimateWise
1994	43	8
1995	105	37
1996	37	179
1997	26	138
1998	17	106
1999	61	89
2000	35	144
2001	59	
Subtotal	383	671

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Key Challenges

- Measuring outcome
  - Need data on emission outcomes before and after policy, for both participants and non-participants.
- Addressing selection
  - Participants and non-participants may not look the same and/or participation may depend on various characteristics unrelated to the program but correlated with outcome.

Proposed Solutions

- Use Census data on energy use (expenditures on fuel and electricity) to proxy for emissions. Available for both participants and non-participants; requires working at Census Bureau to access confidential data and link to participation information.
- Address selection through two alternative models.

Selection Problem and Solutions

$$Y_{i,t} = f\left(X_{i,t}\right) + g\left(X_{i,t}\right) D_{i,t} + u_{i,t}$$

- Y is emissions / energy use; D is participation; X are covariates (location, industry, size).
- $g(X_{i,t})$ measures program effect on outcome.
- Potential problems
  1. μ correlated with D.
  2. miss-specification of f and g.
- Solutions
  - Structural model of selection and correlation with μ (Heckman-Hotz). *Requires excluded variable predicting selection and not outcome.*
  - Propensity score matching.

Heckman-Hotz

- Consider joint estimation of selection model and outcome model:

$$D_{i,t}^{*} = \delta \cdot Z_{i,t} + v_{i,t}$$
$$Y_{i,t} = f\left(X_{i,t}\right) + g\left(X_{i,t}\right) D_{i,t} + u_{i,t}$$

- Here, $(u_{i,t}, v_{i,t})$ are jointly normal, $Z_{i,t}$ includes at least one additional variable than $X_{i,t}$, and $D_{i,t}^{*}$ is a continuous latent variable, with $D_{i,t} = 1$ when $D_{i,t}^{*} > 0$.
- Estimate selection model using probit; insert additional regressor in outcome model, $E[u_{i,t} \mid v_{i,t}] = \lambda(D_{i,t}, Z_{i,t})$

Problems with Heckman-Hotz

Table 1: EPA Climate Wise program, effect of program on logged cost of electricity after 2 years, Heckman-Hotz approach

Cohort	w/o correction	with correction	sample	participants
1994	0.06 (0.02)*	0.60 (0.09)*	19627	809
1995	0.04 (0.04)	-0.16 (0.14)	34880	335
1996	0.02 (0.03)	0.36 (0.21)	31253	656
1997	-0.02 (0.03)	-0.29 (0.18)	17534	835
1998	0.01 (0.02)	-0.75 (0.16)*	30693	1063
1999	0.05 (0.12)	-1.42 (0.71)*	33971	96

- Program effects on energy costs are ±100%.
- *Excluded variables (membership in advocacy organization & distance to EPA regional office) are not effective at predicting participation.*

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Propensity Score Matching

- Estimate participation model and predict propensity to join for each plant in each year.
- Consider each participating plant; find non-participating plant with closest propensity value (nearest neighbor) in the join year.
- Sample without replacement.
- Estimate separate selection model for each horizon (1, 2, and 3 years) where program effects are computed.

Participation Model

$$\text{probability of joining in year } t \text{ (assuming plant } i \text{ has not yet joined)} = h(t)\exp\left(\begin{array}{l}\beta_{size}\ln TVS_{i,t-1}+\beta_{elec}\ln EE_{i,t-1}+\beta_{fuels}\ln CF_{i,t-1}\\ +[\text{all quadratic combinations of size, elec, fuels}]\\ +\beta_{growth}\left(\ln TVS_{i,t+h}-\ln TVS_{i,t-1}\right)\\ +\sum_{\text{industries } j}\beta_j 1(M_i=j)+\sum_{\text{region } k}\beta_k 1(G_i=k)\end{array}\right)$$

- Cox proportional hazard model of probability of plant *i* choosing to join in year *t*.
- includes lagged total value of shipments (TVS), electricity expenditures (EE), cost of fuels (CF), plus linear and quadratic terms, interactions
- future growth rate in shipments (*h* = 1-, 2-, or 3- year lead vs. 1 year lag).
- includes census region *G* (9 values) and industry *M* (2-digit) dummy variables.

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Model of Program Effects Using Pairwise Matched Participants / Controls

$$\Delta Y_s = \frac{\sum_{i,t}\left(Y_{\text{participant } i,t+s} - Y_{\text{participant } i,t-1}\right) - \left(Y_{\text{control } i,t+s} - Y_{\text{control } i,t-1}\right)}{\sum_{i,t} 1\left(\begin{array}{c}\text{participant } i \text{ joined in } t \\ \text{and observed in } t+s \text{ and } t-1\end{array}\right)}$$

- $Y_{d,i,t}$ is the relevant variable (total value of shipments, fuel and electricity expenditure) in pair i at time t.
- ΔY_s is the average program effect after s years relative to the year before the joinyear (for output, fuel and electricity expenditures)

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Propensity Score Results (median estimates with all controls)

Effect of program participation on energy expenditures (fractional change)

	1605(b)		ClimateWise	
	Fuel	Electricity	Fuel	Electricity
1-year effect	0.02	-0.04*	-0.01	0.00
	(0.03)	(0.02)	(0.03)	(0.01)
2-year effect	0.03	-0.03	0.03	0.02
	(0.03)	(0.02)	(0.03)	(0.02)
3-year effect	-0.05	-0.05*	-0.01	-0.01
	(0.06)	(0.03)	(0.03)	(0.02)

- Effects are no more than 5% with most general specification. Zero for ClimateWise.
- Other specifications lead to a wider range of median estimates from –8% to +5% (positive effect is transitory)

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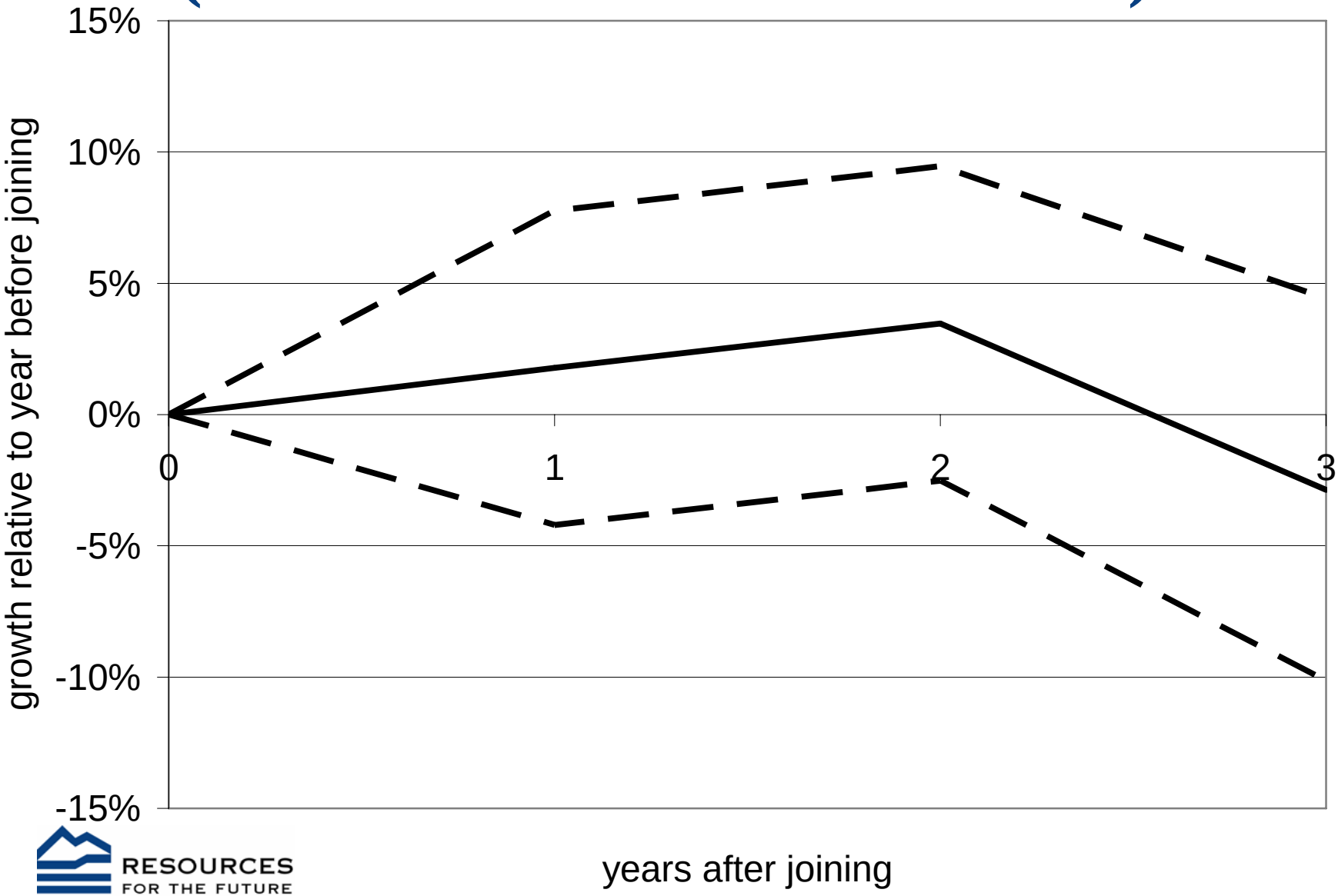
1605(b) Effect on Fuel (with 95% confidence interval)



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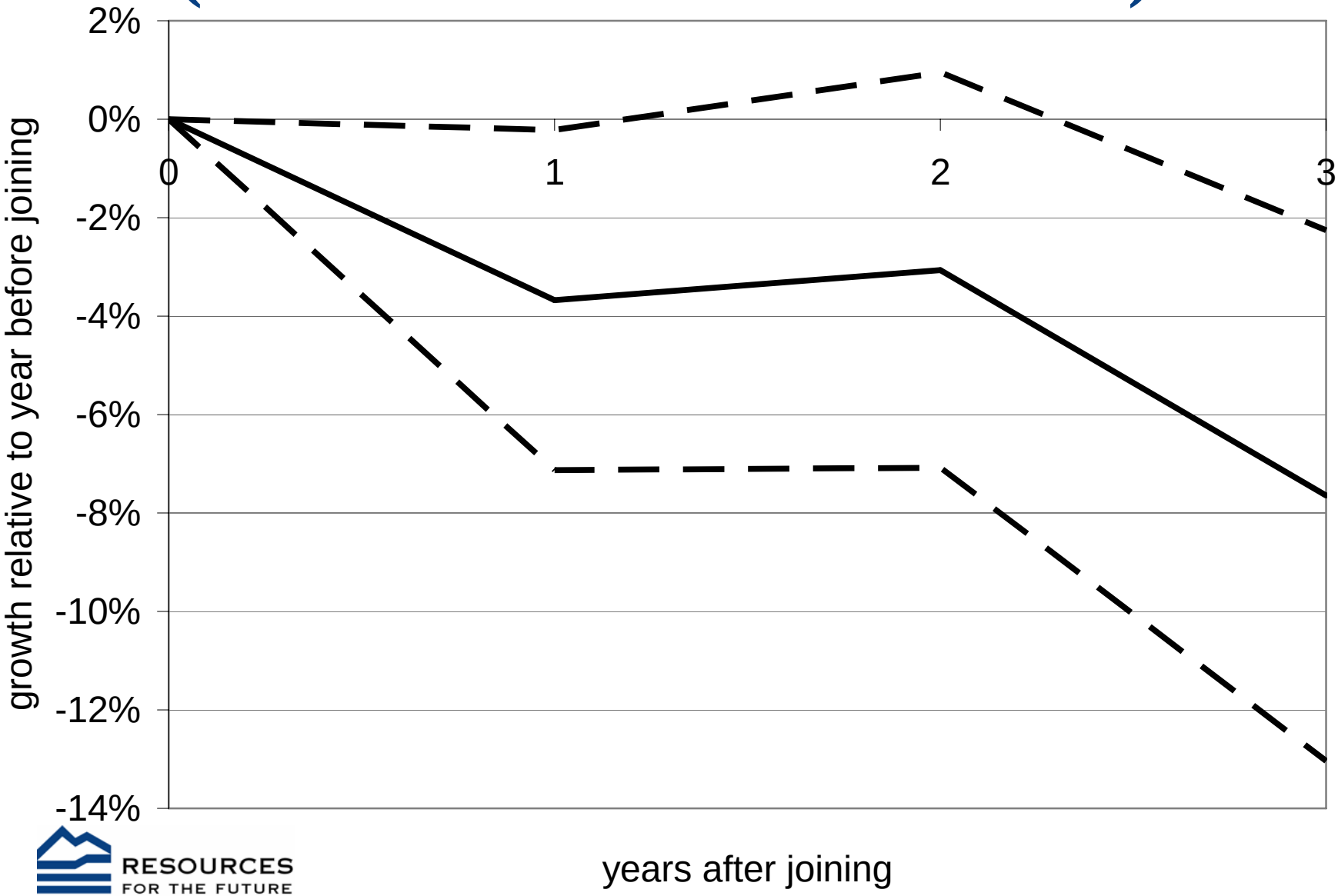
1605(b) Effect on Electricity (with 95% confidence interval)



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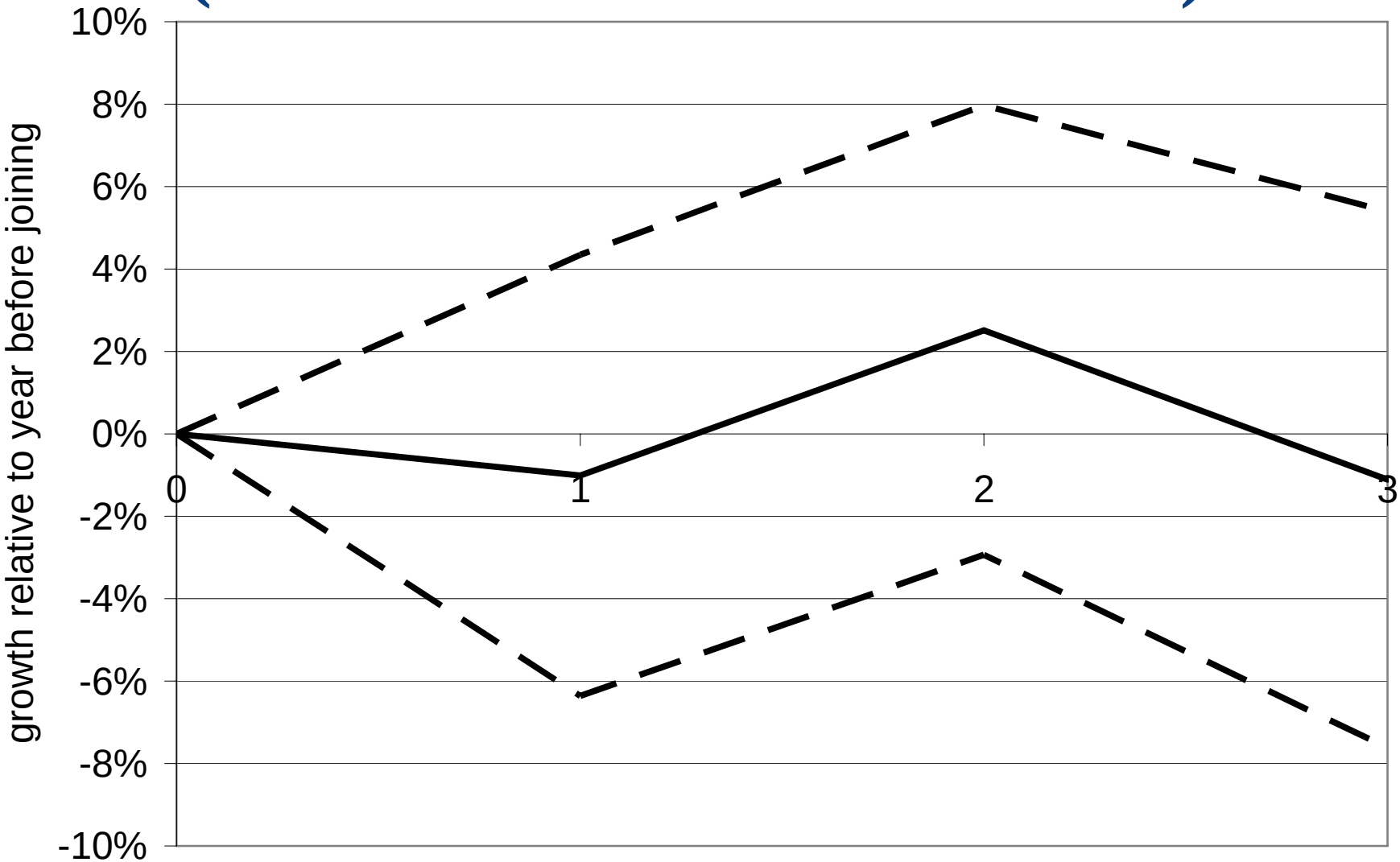
ClimateWise Effect on Fuel (with 95% confidence interval)



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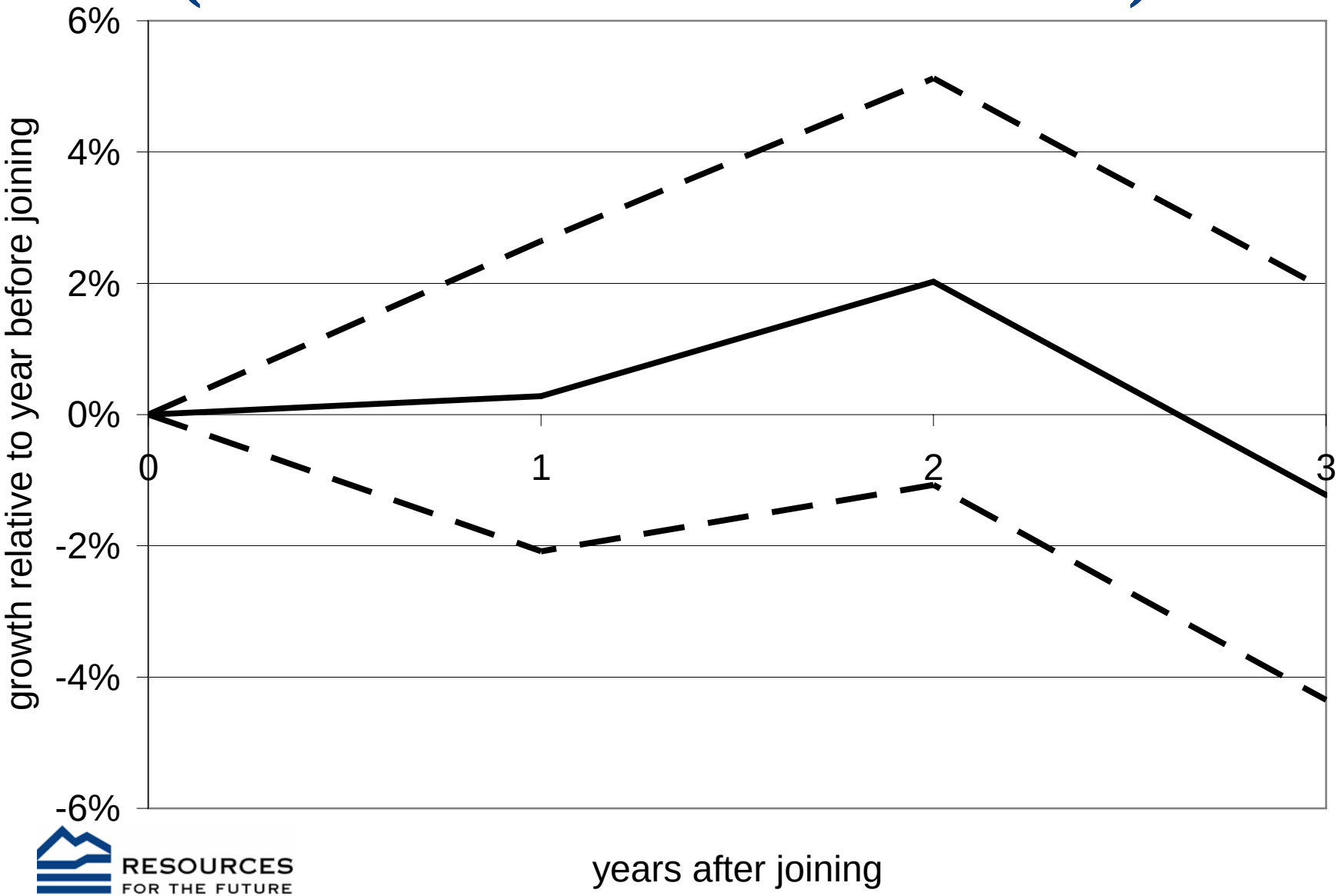
ClimateWise Effect on Electricity (with 95% confidence interval)



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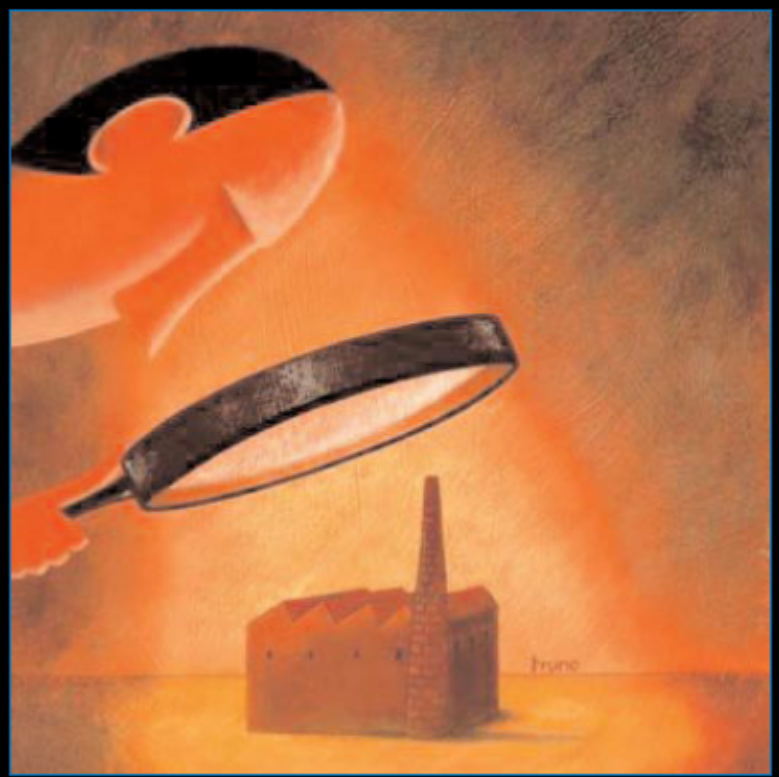
Reality Check

The Nature and Performance of Voluntary Environmental Programs in the United States, Europe, and Japan



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What are “voluntary programs”? Why do we care?

- Types of programs
  - Unilateral agreements
  - Public voluntary programs
  - Negotiated agreements
- Varied and expanding use
  - 87 EPA programs, 1.6% operating budget
  - Dozens more in states, other federal agencies
  - Hundreds of VP/VAs in Europe
  - Thousands in Japan
- BUT, do voluntary programs deliver significant environmental gains relative to a realistic baseline, i.e., do they change behavior?
  - If so, how large are the gains?
  - Do results differ for toxics vs energy programs?
  - What else affects program impact?

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Motivation

- Business
  - Get ‘hands on’ experience
  - Enhance reputation with customers, government, investors, communities, etc.
  - Benefit from government-provided technical assistance.
  - Help shape future requirements; improve relationship with regulators
- Government
  - Get ‘hands on’ experience in the absence of regulatory mandate
  - Experiment with more holistic approaches vs traditional regulation
  - Build public support for future action
  - Build bridges to industry, e.g., via technical assistance
- Environmental groups (mixed reaction)
  - Some applaud VP’s as means to build support in public, industry
  - Some fear regulatory capture, distraction from real work of environmental protection, shift in focus from worst polluters to more progressive firms

Table 1-1: Selected Characteristics of Case Studies

Program	Author(s)	Years of Operation	Energy, CO2 (GHGs), or Toxics	Industry or Household	Program Type
33/50 (US)	Khanna	1991-1996	Toxics	Industry	Public Voluntary Program
Japanese Keidanren	Wakabayashi and Sugiyama	1997-	CO2	Industry	Negotiated agreement
UK Climate Change Agreements	Glachant and Muizon	2001-	CO2	Industry	Negotiated agreement
Danish Energy Efficiency Agreements	Krarup and Millock	1996-	CO2	Industry	Negotiated agreement
German Cement Industry	Bohringer and Frondel	1995	CO2	Industry	Unilateral agreement
Climate Wise (US)	Morgenstern, Pizer and Shih	1993-2000	GHGs	Industry	Public Voluntary Program
California Demand Side Management	Sanstad	Early-mid 1990s	Energy	Household	Public Voluntary Program

33/50 Program

- Followed development of TRI
- Focus on measurable reductions (33%, 50%) for 17 TRI chemicals in major industries (1991)
- Actual reductions clearly exceeded goals
- Sophisticated studies find program reduced emissions, controlling for self-selection, especially for larger firms
- Partly attributable to fear of regulations
- Some evidence suggests no/negative gains beyond Montreal Protocol substances

Keidanren Voluntary Action Plan

- Involves large firms representing 80% of industrial, electric emissions (almost half of Japan's total emissions) (1997)
- Targets negotiated for sectors, not firms
- So far, emissions below target levels
- Reductions attributed to industry, gov't cooperation, fear of regulation, firms' social awareness
- Questions about BAU estimates, stringency of goals
- Is program really voluntary?

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UK Climate Change Agreements

- CCAs part of tax ($9-18/ton of CO_2), and emissions trading policies (2001)
- Intensity or fixed targets negotiated with gov't
- Covering 12,000 sites = 44% UK emissions
- 80% rebates of levy for meeting CCA goals
- Goals exceeded (based on observed permit prices), although stringency in question
- Overall, authors find that CCAs make small contribution

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Denmark's Energy Efficiency Agreements

- VAs part of policy package involving CO_2 taxes ($18/ton) on industry (1996)
- Negotiated agreements based on audits, adoption of energy efficiency measures. No quantitative targets
- 100% tax rebates for participants
- Audit eventually dropped
- Using data from 60 firms, authors find some reductions in early years, although quite modest reductions overall

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German Cement Industry

- Unilateral commitment by major sectors (not firms) for 20% cuts below 1987 levels by 2005; case focuses on cement industry (1995)
- By 2000 most goals met; target raised to 28% reduction
- Trend regression used to establish baseline using historical data
- Actual emissions same as forecast BAU (+/- 5%)
- Authors recommend firm specific targets; negotiated instead of unilaterally set

Climate Wise

- EPA program involving negotiated agreements with 600+ firms (1993)
- Emissions based program; TA, other incentives offered for joining
- Comparisons with matched set of non-participants used to determine what would have happened anyway
- Authors find modest differences in fuel (-) and electricity (+) use in early years; no significant differences later on

Residential DSM in California

- Utilities started providing free technical information to single family houses in 1970s
- Two of three evaluations indicate savings ‘that would not have occurred without programs’
- One study finds changed maintenance and other practices more important than use of new equipment
- Some evidence that provision of information by authoritative source is key

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Table 9-1: Quantitative comparison of the effect of voluntary programs on behavior

	Quantity measured	Estimated Effect	Scope	Baseline	Comment
33/50 Program	Aggregate toxic releases	28%	Participating chemicals facilities	Non-participants with self-selection model	Effect reversed when ODS excluded.
UK Climate Agreements	GHG emissions	9%	Participating industries	Negotiated forecast	Baseline criticized; considerable over-achievement.
Danish Energy Efficiency Agreements	Energy Use	4-8%	Participating facilities	Non-participants	Estimate based on 60 participants.
German Cement Industry GWP Declaration	Energy per unit of cement	0	German cement industry	Econometric forecast using historic performance	Baseline error band is +/- 5%. 2005 target achieved by 2000.
Japanese Keidanren	CO_2 emissions	5%	Participating industries	Keidanren forecast of 2010 BAU	Basis of BAU estimate unclear.
Climate Wise	Fossil energy expenditures	3%	Participating facilities	Matched non-participants	Electricity expenditures estimated to rise 6%. Margin of error is +/- 5% and both effects vanish after 1-2 years.
California Demand Side Management	Natural gas & electricity demand	2-4%	Participating households	Non-participants	Covers three programs; some evaluations more carefully matched non-participants / controlled for self-selection

Conclusions

- Hard to reject conclusion of 5% reduction for energy programs, +/- 5%. Thus, evidence that VPs do change behavior, but not suitable for major reductions
- Significant differences exist between energy and toxics, although clear limitation on toxics as well
- Incentives have modest impact on reductions achieved among participants, potentially larger impact on level of participation
- Efforts to increase program breadth (i.e., many participants) may yield greater environmental gain than efforts to increase depth (big cuts in emissions for individual firms) (broad vs deep)
- More attention needed on baselines for evaluation, including both forecasts and control group approaches
- Subtle changes in social attitudes and corporate practices may be significant but are difficult to measure