Abate or Abscond?

The Response of Polluting Plants to Environmental Regulation

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The Impact of Environmental Regulation

An illustrative example:

Table: Comparing Plants Avg in Regulated and Unregulated Counties

	Sales	Emp	Emissions (lbs)	Hazard
Unregulated	$22,861,348	127	431,416	116
Regulated	$8,259,664	51	223,447	146

Polluting plants: SIC 2851 (Paint and Varnish) in Ohio

- Emissions are non-targeted pollutants
- Regulated polluters are smaller and pollute less
- Regulated polluters emit more toxic pollutants

Preview of Results

- Pollution regulation is effective against non-targeted pollutants
- There is little impact on plant location decisions
- The least productive plants close in response to regulation
- Remaining plants reduce output and cut employment

Literature Review

- Voluminous literature on the impact of environmental regulations
- Jaffe *et al*; Earnhart and Shadbegian/Gray examine the impact of regulation on pollution
- More recent work by Greenstone; List
- Morgenstern, Pizer and Shih carefully calculate employment effects, estimate output effects

Data Sources

- Monitor Data
  - Summary statistics from annual ambient concentrations
- Attainment Status
  - Taken from the Green Book
- County Characteristics
  - Population, eduction, income, race at the county level among many others
  - Irregular intervals interpolated to create panel
  - All results robust to interpolation technique from Fernandez and Montuenga-Gomez (2003)

Establishment Level Data

Plant level characteristics from the National Establishment Time Series

- Sales, employees, credit rating, location details, 8-digit SIC industry
- Export status
- Detailed information on firm structure

Plant level pollution from the EPA's RSEI and TRI data sets.

- Pounds of emissions of all toxic chemicals
- Hazard Score: quantity of emissions weighted by the toxicity of each chemical
- Risk Score: Hazard score weighted by the exposed population

The data cover 12,000 plants over 12 years in 2550 counties and 441 SIC4 digit industries

Importance of Chemical Heterogeneity

Chemical	Hazard Score	Use
Propylene	0.6	Plastics
Hydrochloric Acid	90	Industrial Applications
Sodium Fluoroacetate	25,000	Pesticide

- Approximately 580 chemicals on the list
- Huge variance in toxicity
- Using pounds weights chemicals equally, poor proxy for damage

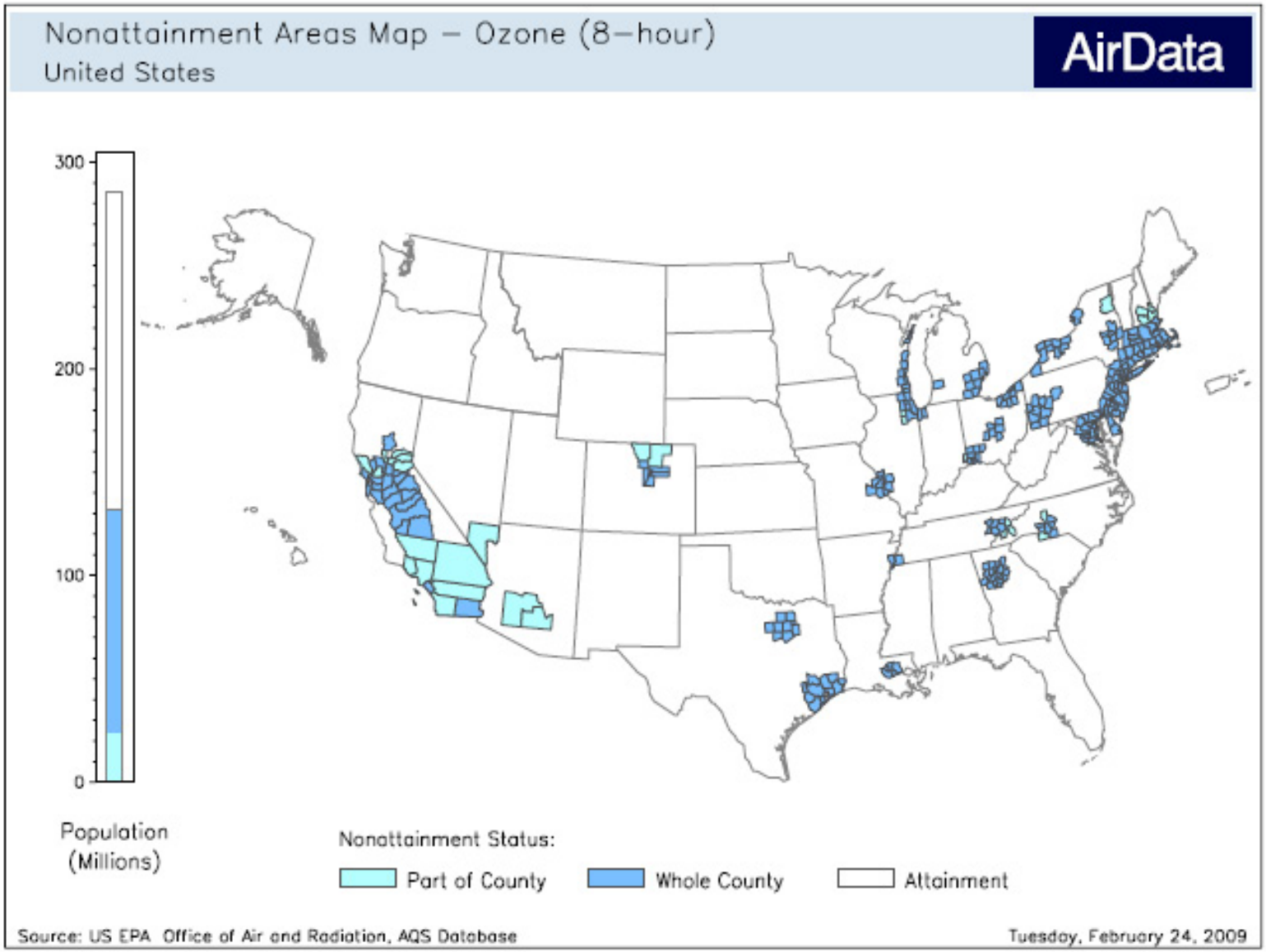
Importance of Chemical Heterogeneity (cont.)

Tradename	Monsey-Bakor	Hunt Wesson Foods
City	Rock Hill	Memphis
Year	SC	TN
Sales	$4,912,500	$79,175,000
Emp	30	250
Pounds	**345**	**2,558,781**
Hazard	**345,000,000**	**195,640**
Main Emission	Asbestos	Amonia
SIC	2952	2076
Industry	Asphalt Felts and Coatings	Vegetable Oil Mills

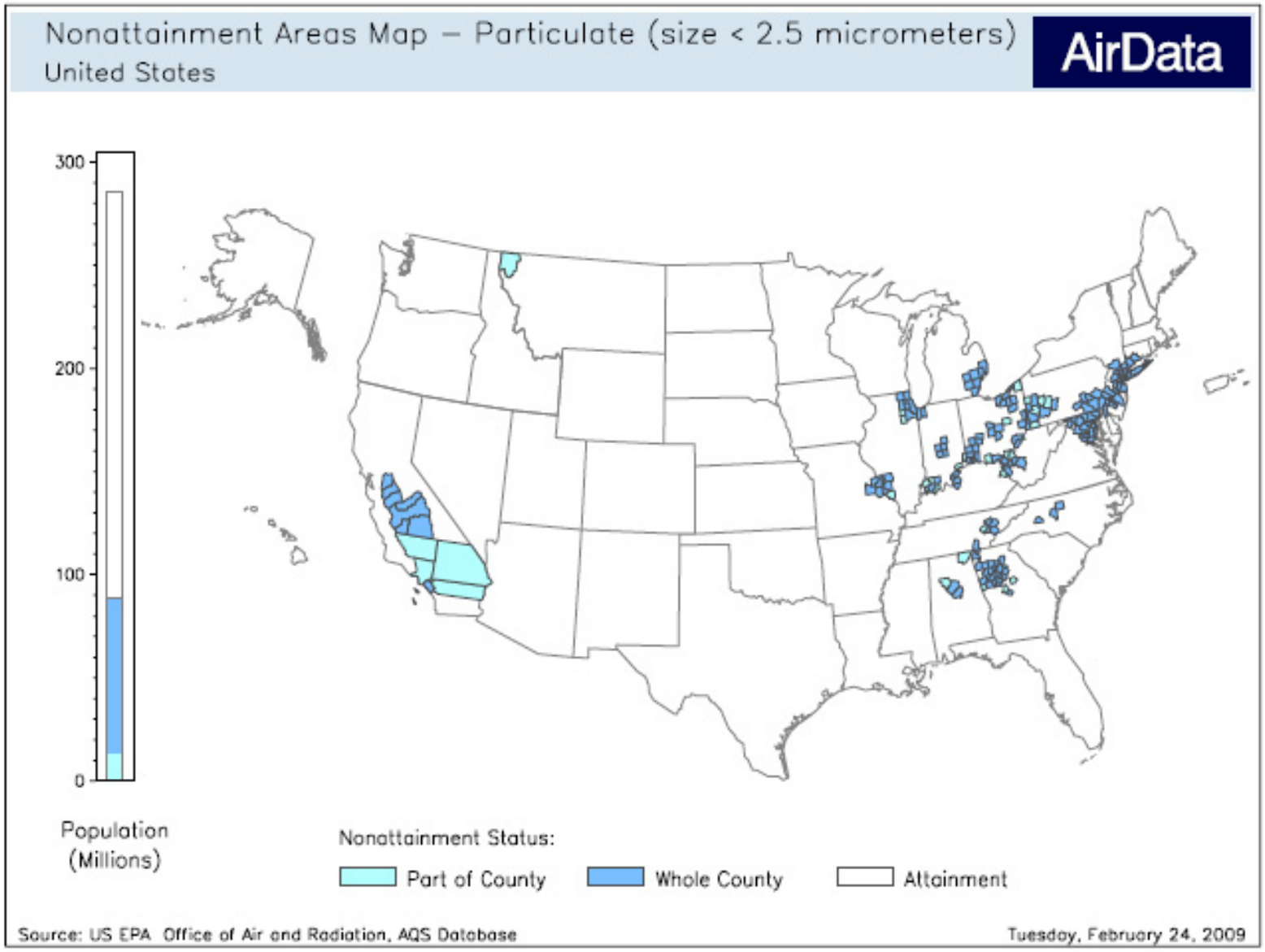
EPA Non-Attainment Status

- EPA designates high pollution counties as non-attainment if ambient levels are above standard
- 6 criteria air pollutants are regulated
  - CO, PM-10, SO_2, NO_2, Lead, Ozone
- Non-Attainment counties face strict environmental regulations
  - New sources subject to review, must use best available abatement technology
  - Existing sources required to upgrade to to best practical abatement technology
  - Counties that remain above standards face reduced federal funding

Non-Attainment Counties for Ground Level Ozone



Non-Attainment Counties for PM 2.5



Methodology

- Compare plant openings, closings, characteristics and emissions between attainment and non-attainment counties
- Conduct a series of difference-in-difference regressions with attainment status being the variable of interest
  - An indicator variable if a county is ever in non-attainment status
  - An indicator variable if a county is currently in non-attainment status
  - The interaction of those two indicators is the diff-in-diff estimator
- Truncated regressions include plant/county characteristics, industry and year fixed effects

Plant Location Impacts of Regulation (Extensive Margin)

- Least productive plants exit immediately after the designation
  - Exiting plants are around 14% less productive than survivors in same industry
- After three years exit returns to the pre-regulation level
- Entry remains constant despite regulation
  - Plant location is planned far in advance
  - Regulated counties are more attractive places to locate

Exiting Plants' Characteristics

Table: Exiting Plants in Non-Attainment Counties

	Survive	Exit
Sales	$27,874,980	$21,451,210
Emp	265.8	215.7
Productivity	1,119.0	1,057.9
Export	36.2 %	19.3 %

- Exiting plants are smaller in terms of sales and employees
- Surviving plants are somewhat more productive
- Exporters are much less likely to be forced to exit
- In attainment counties there are no significant differences

The impact of attainment status on output

Dep Var	Log Sales	Log Sales	Log Sales	Log Sales
Status	-0.0588***	-0.0574***	-0.0978***	-0.0832***
	(-6.37)	(-6.20)	(-10.09)	(-8.91)
Relocations				-0.273***
				(-28.87)
Exporter				0.273***
				(34.75)
Public				0.602***
				(70.30)
New				-0.476***
				(-34.30)
r^2		0.000372	0.00977	0.0811
N	104,732	104,732	104,732	104,732
Fixed Effects		SIC6	SIC6, Year	SIC6, Year

- Plants are responding at the intensive margin

The impact of attainment status on employment

Dep Var	Emp	Emp	Emp	Emp
Status	-6.360	-6.229	-7.712	-3.166
	(-1.27)	(-1.24)	(-1.46)	(-0.60)
Relocation				-4.012
				(-0.76)
Export				23.27***
				(5.29)
Public				187.1***
				(38.96)
New				-93.09***
				(-11.97)
r^2	0.00000	0.0000149	0.000139	0.0163
N	104732	104732	104732	104732
Fixed Effects		SIC6	SIC6, Year	SIC6, Year

- Plants are not dropping employment

The Output and Employment Impacts of Regulation

- Remaining plants reduce output in response to regulation
  - After controlling for plant characteristics output drops 10%
- Employment drops for two reasons:
  - The least productive firms exit
  - More productive plants cut output
  - Total reduction is around 6 people per plant (not sig)
- Exporters see a slightly smaller decrease in output
- The highest 10% of the productivity distribution actually see an increase
- Suggests industry specific skill (θ) is relatively high

Matching Procedure

- Use matching estimators to select similar counties
- Match counties entering non-attainment with counties that are never regulated
- Matching variables:

  County characteristics: Population, density, education, income,

  Pollution characteristics: Summary stats of emissions, 3 year weighted averages

Plant Location Decisions

Table: The number of plant openings by county type

Year Year	Openings Attainment	Openings Matched Non-Attainment
t-2	74.4%	25.6%
t-1	72.3%	27.7%
t	73.6%	26.4%
t+1	74.7%	25.3%
t+2	74.8%	25.2%
t+3	72.6%	27.4%
t+4	78.8%	21.2%
t+5	75.1%	24.9%

- Match counties on observable characteristics
- Openings are constant are fairly constant after designation

Conclusions and Future Research

- Environmental regulations work and delivery ancillary benefits
- Plants respond primarily along the intensive margin
- Regulation leads to small job loss in regulated industries
- Weak/no evidence of the pollution haven effect which has implications for the race to the bottom
- Possible causality issues for the Porter Hypothesis
- Extensions:
  - Expand Use of Matching estimators
  - Regression discontinuity