Greenstone (2002) "The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures"

Hulai Zhang

Env.Climate

September 26, 2023

Outline

Introduction

- Anecdotal evidence shows environmental regulations place costs on firms
  - Manufacturing plants spend almost $30 billion a year to comply with environmental regulations
- Empirical research fails to get negative industrial activity effects by environmental regulations
  - Some suggests that environmental regulations do not harm regulated rms or their workers and may even benet them

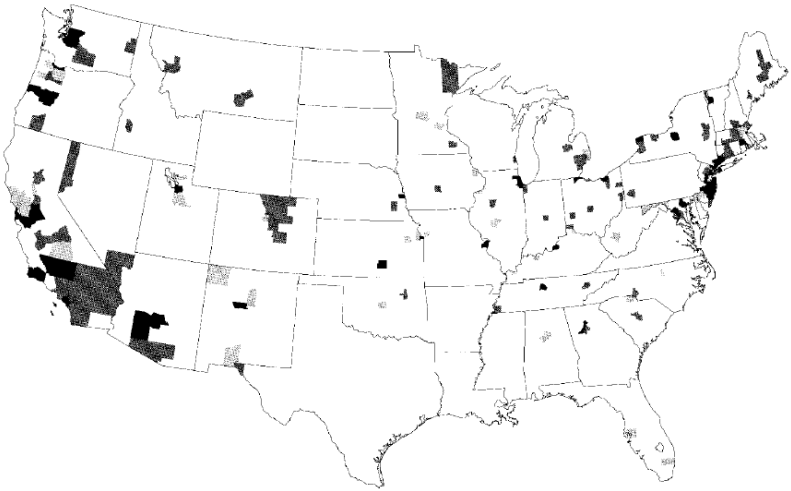
$\Rightarrow$ This paper documents negative impact on industrial activity by environmental regulations using comprehensive data

The 1970 CAAAs

- The 1970 CAAAs establish separate federal air quality standards for CO, O_3, SO_2 and TSPs.
  - All counties are assigned a nonattainment or attainment status for each pollutant
  - Nonattainment counties have more stringent regulations on polluters
  - Attainment counties have less restrictions on polluters
- Polluters are defined by industry emissions (EPA's estimates)
  - Industries that account for 7% emissions over total of that pollutant

  $\Rightarrow$ 12 industries are designated as emitters of ≥ 1 pollutant

The 1970 CAAAs: Nonattainment Designation of CO



Data

Censuses of Manufactures, 1967–1987

- Five surveys in four periods 1967, 1972, 1977, 1982 and 1987
- Plant level panel data
- Plant employment, capital stock, total shipments, location and industry

Code of Federal Regulations, 1967–1987

- County level nonattainment/attainment status for each period

Nonattainment/attainment status

	Nonattainment Period t (1)	Attainment Period $t-1$ and Nonattainment Period t (2)	Nonattainment Period $t-1$ and Attainment Period t (3)
	A. Carbon Monoxide (CO)		
1967–72	0	0	0
1972–77	81	81	0
1977–82	144	90	27
1982–87	137	15	22
	B. Ozone (O_3)		
1967–72	0	0	0
1972–77	32	32	0
1977–82	626	595	1
1982–87	560	104	170
	C. Sulfur Dioxide (SO_2)		
1967–72	0	0	0
1972–77	34	34	0
1977–82	87	75	22
1982–87	60	7	34
	D. Total Suspended Particulates (TSPs)		
1967–72	0	0	0
1972–77	296	296	0
1977–82	235	108	169
1982–87	176	24	83

Identification strategy

$$
\begin{aligned}
\%\Delta E_{pt} =& \frac{E_{pt} - E_{pt-5}}{\left(E_{pt} + E_{pt-5}\right)/2} \\
=& \beta_1 \mathbf{X}_{pt-5} + \beta_{2t} \text{ ind }_i + \beta_{3t} \text{ nonattain }_{ct-5} \\
&+ \beta_4 1(\text{ emit CO} = 1 \& \text{ nonattain CO} = 1)_{cit-5} \\
&+ \beta_5 1(\text{ emit } O_3 = 1 \& \text{ nonattain } O_3 = 1)_{cit-5} \\
&+ \beta_6 1(\text{ emit } SO_2 = 1 \& \text{ nonattain } SO_2 = 1)_{cit-5} \\
&+ \beta_7 1(\text{ emit TSPs } = 1 \& \text{ nonattain TSPs } = 1)_{cit-5} + \alpha_p + \gamma_{ct} + \Delta u_{pt}
\end{aligned}
$$

- Assumptions
  1. $\Delta u_{pt} | X \perp$ Nonattainment Status$_{ct}$
  2. $\Delta u_{pt} | X \perp$ Emitter$_{it}$

Identification strategy

- β_{2t} ind $_i$: industry×period fixed effects
  - Federal wide industry specific shocks
- α_p: plant fixed effects
  - Plant specifics that correlate with nonatainment status
- γ_{ct}: county×period fixed effects
  - Shocks to all plants within a county-period

Total employment

	(1)	(2)	(3)	(4)
CO regulation effect (β_4)	−.084	−.075	−.086	−.163
	(.032)	(.031)	(.030)	(.045)
O_3 regulation effect (β_5)	.001	.022	−.011	−.049
	(.011)	(.010)	(.010)	(.015)
SO_2 regulation effect (β_6)	−.004	−.016	.003	.001
	(.029)	(.028)	(.029)	(.036)
TSPs regulation effect (β_7)	−.024	−.010	−.020	−.024
	(.014)	(.013)	(.013)	(.024)
R^2	.109	.119	.144	.504
Industry by period fixed effects	yes	yes	yes	yes
Nonattainment by period fixed effects	yes	yes	no	no
County fixed effects	no	yes	no	no
County by period fixed effects	no	no	yes	yes
Plant fixed effects	no	no	no	yes

Capital stock and shipments

	(1)	(2)	(3)	(4)
	A. Capital Stock (N=1,607,332)			
CO regulation effect (β_4)	−.047	−.047	−.097	−.092
	(.043)	(.042)	(.043)	(.062)
O_3 regulation effect (β_5)	−.009	.016	−.001	−.041
	(.022)	(.021)	(.021)	(.029)
SO_2 regulation effect (β_6)	−.024	−.048	−.057	−.063
	(.047)	(.049)	(.055)	(.048)
TSPs regulation effect (β_7)	.026	.042	.010	−.043
	(.027)	(.025)	(.024)	(.039)
R^2	.074	.109	.155	.462
	B. Shipments (N=1,737,753)			
CO regulation effect (β_4)	−.058	−.036	−.072	−.146
	(.029)	(.029)	(.029)	(.046)
O_3 regulation effect (β_5)	.022	.048	.019	−.032
	(.018)	(.018)	(.016)	(.024)
SO_2 regulation effect (β_6)	−.007	−.026	−.027	−.010
	(.033)	(.030)	(.030)	(.039)
TSPs regulation effect (β_7)	−.014	−.002	−.010	−.032
	(.019)	(.018)	(.018)	(.034)
R^2	.127	.142	.185	.516
Industry by period fixed effects	yes	yes	yes	yes
Nonattainment by period fixed effects	yes	yes	no	no
County fixed effects	no	yes	no	no
County by period fixed effects	no	no	yes	yes
Plant fixed effects	no	no	no	yes

Heterogeneity in regulation effects

Industry Name (SIC Code)	CO Regulation Effects (1)	O_3 Regulation Effects (2)	SO_2 Regulation Effects (3)	TSPs Regulation Effects (4)
Lumber and wood (24)				−.006
				(.034)
Pulp and paper (2611–31)	−.080	−.110	−.105	.006
	(.077)	(.056)	(.074)	(.064)
Iron and steel (3312–13,	−.177	−.104	.038	−.012
3321–25)	(.061)	(.068)	(.059)	(.050)
Printing (2711–89)		−.072		
		(.027)		
Organic chemicals		.071		
(2961–69)		(.151)		
Rubber and plastic (30)		−.093		
		(.046)		
Fabricated metals (34)		−.013		
		(.026)		
Motor vehicles (371)		−.026		
		(.057)		
Inorganic chemicals			−.089	
(2812–19)			(.113)	
Petroleum refining (2911)	−.133	.172	−.180	
	(.092)	(.101)	(.109)	
Stone, clay, and glass (32)		−.072	.039	−.063
		(.039)	(.062)	(.039)
Nonferrous metals (333–34)	−.169		−.063	
	(.163)		(.147)	
χ^2 statistic of equality	1.03	11.67	5.82	1.57
	(.79)	(.17)	(.32)	(.67)

H_0: The environmental regulation effects are equal across industries.

Robustness checks

	Base Specification (0)	Dynamic Model (1)	Limit Sample to "Stayers" (2)	4.5% Emission Rule (3)
	A. Total Employment			
CO regulation effect (β_4)	−.086	−.094	−.059	−.097
	(.030)	(.028)	(.023)	(.028)
O_3 regulation effect (β_5)	−.011	−.007	−.019	−.016
	(.010)	(.010)	(.008)	(.010)
SO_2 regulation effect (β_6)	.003	.005	.010	.006
	(.029)	(.027)	(.021)	(.028)
TSPs regulation effect (β_7)	−.020	−.013	−.022	−.013
	(.013)	(.014)	(.011)	(.013)

Total employment: magnitude

	Estimated Regulation-Induced Change, 1972–77 to 1982–87		Change 1972–77 to 1982–87	Mean of 1972–77 and 1982–87 Levels	Ratio of Col. 1 to Col. 3	Ratio of Col. 1 to Col. 4
	Mean (1)	95% Confidence Interval (2)	(3)	(4)	(5)	(6)
	A. Total Employment					
CO emitters	−119,100	[−54,600, −183,500]	−296,502	892,312	.402	−.133
O_3 emitters	−423,400	[−169,400, −677,400]	−169,000	5,496,651	2.505	−.077
SO_2 emitters	800	[57,400, −55,800]	−359,821	1,537,994	−.002	.001
TSPs emitters	−50,200	[48,200, −148,500]	−374,081	1,884,883	.134	−.027
All manufacturers	−591,900	[−118,400, −1,065,200]	−250,183	17,215,016	2.366	−.034

Conclusion

- Environmental regulations restrict industrial activity
  - Nonattainment counties lost 590,000 jobs, $37 billion in capital stock, and $75 billion of output in polluting industries.
- The regulation effects are evident across polluting industries
- Future research
  - Causality
  - Industrial activity being cut or reallocated?

References

Greenstone, M. (2002). The impacts of environmental regulations on industrial activity: Evidence from the 1970 and 1977 clean air act amendments and the census of manufactures. *Journal of political economy 110*(6), 1175–1219.