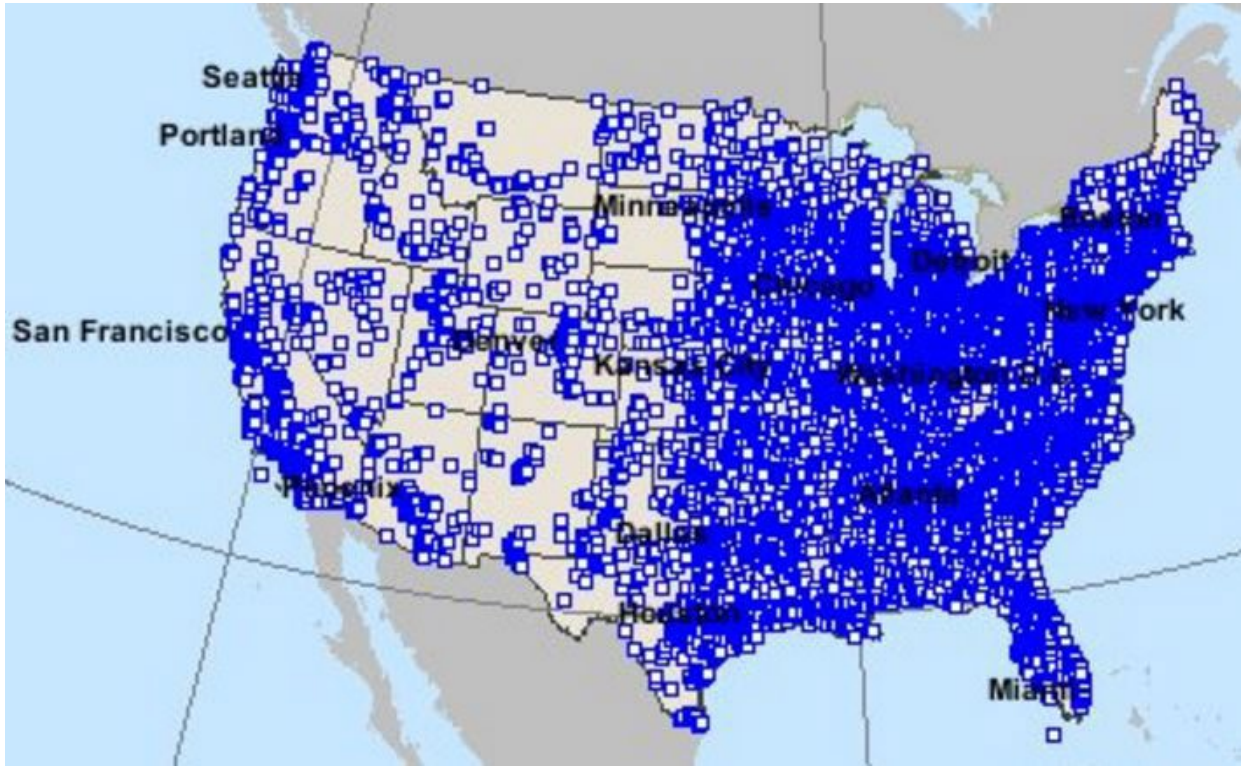
The Effects of Increased Pollution on COVID-19 Cases and Deaths

Claudia Persico, American University, IZA, and NBER
Kathryn R. Johnson, American University

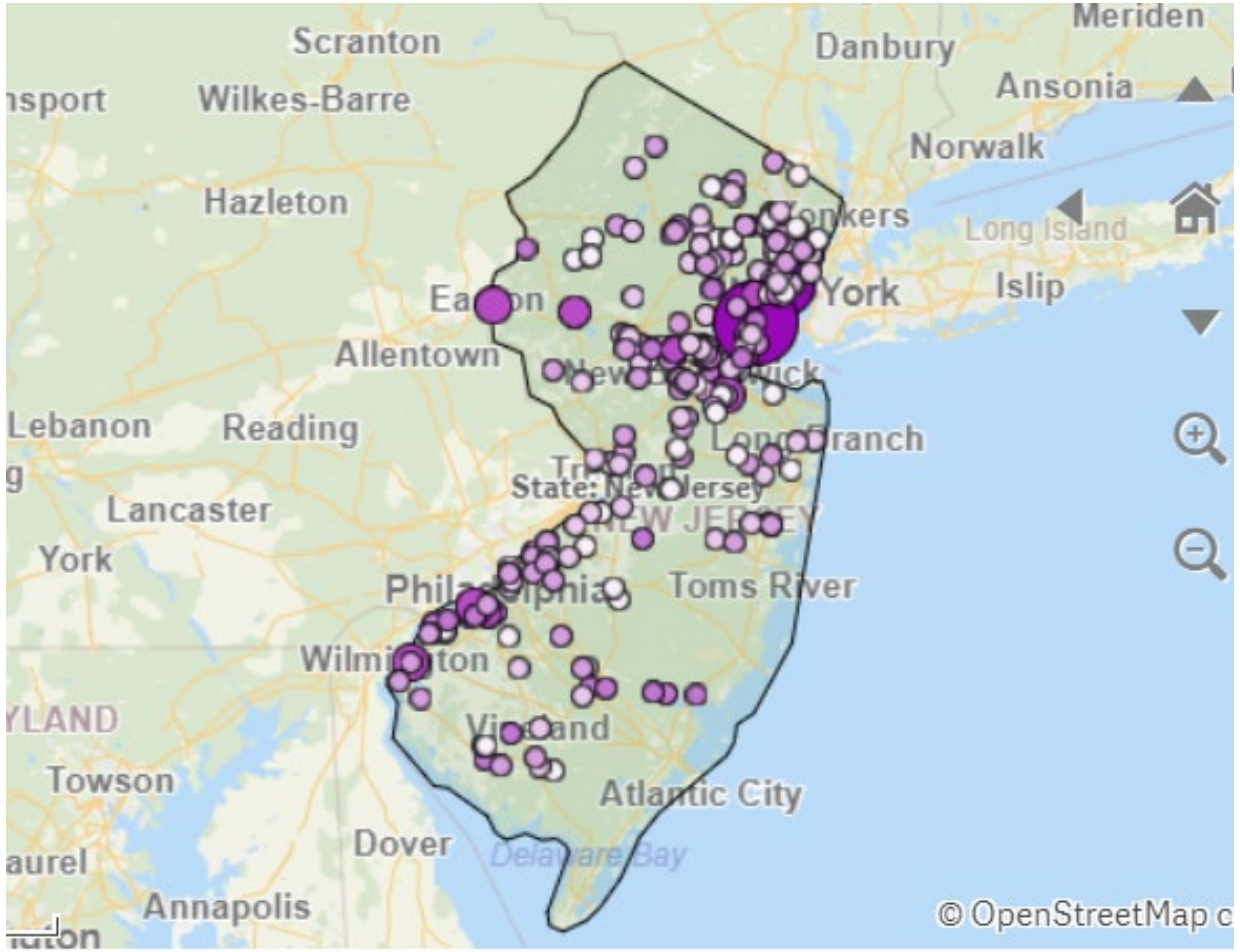
New Jersey Clean Air Council
April 12, 2022

Toxic Release Inventory Sites

- Toxic Release Inventory (TRI) sites are industrial and federal facilities that release pollution.
- 2/3 of Americans live within 3 miles of a TRI site (200 million people)
- >60 million people live within 1 mile of a TRI site



TRI Sites in New Jersey



March 26, 2020

THE HILL

EPA suspends enforcement of environmental laws amid coronavirus

BY REBECCA BEITSCH - 03/26/20 05:48 PM EDT

957 COMMENTS

304,435 SHARES

The Environmental Protection Agency (EPA) issued a sweeping suspension of its enforcement of environmental laws Thursday, telling companies they would not need to meet environmental standards during the coronavirus outbreak.

Just In...

Mississippi mayor reverses, will allow drive-in church with windows up
STATE WATCH — 26S AGO

DOJ watchdog to inspect federal prisons after hundreds diagnosed with coronavirus
HEALTHCARE — 10M 51S AGO

Missouri may start to reopen in coming weeks
STATE WATCH — 26M 11S AGO

Pennsylvania state senate votes to override governor's stay-at-home order
STATE WATCH — 1H 2M AGO

Most Popular

1. **Trump threatens to adjourn both...**
   7,278 SHARES
2. **Hamptons bicyclist files police...**
   2,063 SHARES
3. **House Democrats propose $2,000...**
   627 SHARES
4. **Pennsylvania state senate votes to...**
   599 SHARES

Background on the Policy Change

- The EPA issued a memo on March 26th that stated that it intends to exercise enforcement discretion not to pursue violations of "routine compliance monitoring, integrity testing, sampling, laboratory analysis, training, reporting, and certification" because the pandemic "may" constrain the ability of companies to perform these obligations.
  - In particular, the EPA stated that it does "not expect to seek penalties … in situations where the EPA agrees that COVID-19 was the cause of the noncompliance" (EPA 2020).
- The EPA issued the nonenforcement policy after the American Petroleum Institute (API) wrote to the EPA on March 23, 2020 (*State of New York v. EPA* 2020).
  - The API, which represents more than 600 oil and gas companies across the U.S., cited "physical challenges" that would impinge compliance with "on-site testing/monitoring/reporting requirements."
- These monitoring and reporting requirements are used across a huge swath of federal air water and waste laws and regulations to demonstrate industry compliance.

Pollution during the Pandemic

- Some recent research suggests that some kinds of pollution decreased on average during the pandemic (Cicala et al., 2020), other studies find that pollution actually increased in some areas and overall (Bekbulat et al., 2020; NOAA, 2020; Schade, 2020).
  - Cicala and colleagues (2020) estimate that CO2 and PM2.5 emissions were projected to decline over this time period via estimates of electricity consumption and distance traveled, but they also find substantial heterogeneity in their estimates and do not make use of pollution monitor data from 2020.
  - Bekbulat and colleagues (2020) find that PM2.5 concentrations are higher than expected across the United States based on long term seasonal trends.
  - Schade (2020) finds the pollution has increased in some parts of Texas, such as Houston, which has many TRI sites.
  - The NOAA (2020) reported that atmospheric carbon dioxide reached the highest monthly reading ever recorded in May 2020.
- The largest emitters of pollution are electricity generation, industry and agriculture, jointly accounting for more than 58% of the total pollution emissions in the U.S. (EPA 2020).

Pollution and Respiratory Health

There were two primary reasons to be concerned about the impact pollution might have on COVID-19 outcomes.

1. There is evidence that pollution can aggravate respiratory disease generally.
   - Pollution harms the immune system, leaving people more vulnerable to airborne diseases. (Beatty and Shimshack 2011; Miyashita et al. 2020).
   - Air pollution has been linked to respiratory illness in children. (Jans, Johansson, and Nilsson, 2014; Beaty and Shimshack, 2011).
   - There is also growing evidence that days of high air pollution can cause deaths (Anderson, 2019; Schwartz Bind and Koutrakis 2017; Deryugina et al. 2019).
2. There was evidence that pollution could worsen COVID-19 outcomes specifically.
   - For example, there is evidence that pollution can increase inflammatory cytokines, which had been implicated in deaths from COVID-19 infections (Tay et al 2020).
   - Isphording and Pestel (2020) find days of increased pollution in German counties lead to increases in cases and deaths.

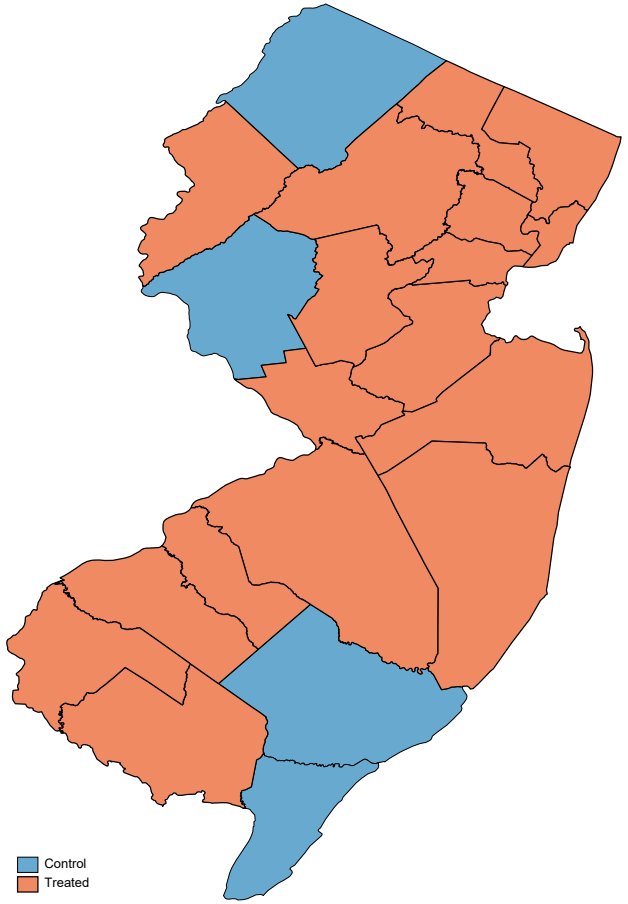
Data

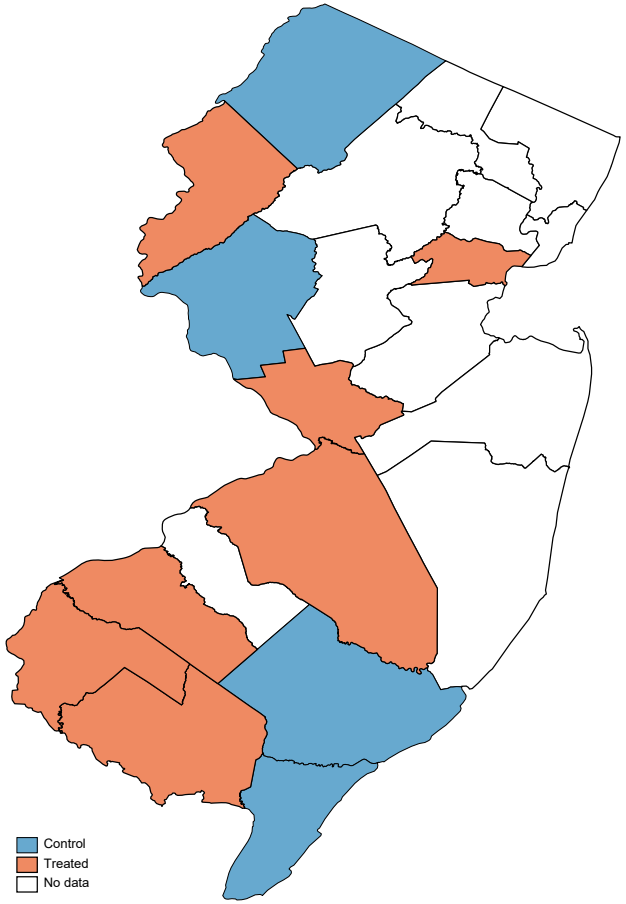
- We use daily, county-level data from Johns Hopkins University Center for Systems Science and Engineering Coronavirus Resource Center on COVID-19 outcomes.
  - We supplement these data with New York Times data and New York City Department of Health data from before March 22, 2020.
- We match this to data from the Environmental Protection agency on (1) daily air pollution from the Air Quality System (AQS) and (2) TRI sites from the 2018 TRI Basic data files.
- We use NOAA data on daily temperature and precipitation.
- We use 5 daily social distancing measures from Unacast and SafeGraph (i.e., the percent change in distance traveled, percent change in visits to nonessential venues, change in the rate of encounters, the percentage of people who are at work, the percentage of people who are neither at home nor at work).
- We also control for stay at home orders, reopenings, the days since the first COVID-19 death, cumulative cases, daily tests administered by state, day of the week, and month fixed effects.

Research Design

- We employ a within-county difference in differences design to estimate whether counties with 6 or more TRI sites:
  1. Experienced increased pollution because of the rollback of environmental regulations and
  2. See increases in COVID-19 deaths and cases, compared to counties that had fewer TRI sites (before versus after the rollback on March 26th).
- To address concerns about the timing of the policy coinciding with the worsening of the pandemic, we limit the sample to counties that:
  1. Had no COVID-19 deaths in the period before the rollback in all of our analyses
  2. Had at least 1 TRI site to address concerns about the possible selection of TRI sites into counties
  3. Have between 10,000 and 1.64 million people
  4. Control group counties have 250 or more persons per square mile
- Limiting the sample in this way ensures that the increase in pollution must have preceded the first COVID death in a county, and that no counties were suffering from a severe outbreak at the time of the pollution increase.

Treatment and Control Counties in New Jersey





Descriptive Statistics

	(1) Characteristics of Counties in the U.S. in 2018 with 1 or More TRI sites	(2) Characteristics of Counties with 6 or More TRI sites	(3) Characteristics of Counties with 1 to 5 TRI sites	(4) Characteristics of Counties with 1 to 5 TRI sites, Limited to Population Density of >250
Total Population	95,769	160,736	39,194	86,136
	[143,050]	[186,315]	[34,600]	[58,831]
Population Density	343.2	574.9	141.7	619.7
	[681.6]	[847.5]	[396.6]	[957.9]
Percent Essential Workers	0.551	0.553	0.544	0.524
	[0.059]	[0.0566]	[0.0691]	[0.0730]
Percent White	0.838	0.827	0.848	0.853
	[0.148]	[0.140]	[0.154]	[0.135]
Percent Black	0.090	0.098	0.0834	0.070
	[0.136]	[0.129]	[0.143]	[0.101]
Percent Hispanic	0.089	0.095	0.084	0.084
	[0.125]	[0.119]	[0.130]	[0.126]
Percent With Less Than a High	0.208	0.198	0.217	0.189
School Degree	[0.092]	[0.0783]	[0.102]	[0.0831]
Percent Poverty	0.110	0.103	0.115	0.0961
	[0.046]	[0.0409]	[0.0498]	[0.0402]
Median Income	52,206	55,217	49,584	57,905
	[12,535]	[12,827]	[11,666]	[16,493]
Unemployment Rate	0.033	0.034	0.03277	0.03189
	[0.011]	[0.0099]	[0.01164]	[0.00974]
Percent Over 65	0.170	0.167	0.180	0.192
	[0.0452]	[0.0420]	[0.0559]	[0.0649]
Percent Change in Daily Distance	-0.165	-0.177	-0.155	-0.214
Traveled	[0.0899]	[0.0827]	[0.0945]	0.112
Total TRI Sites	8.498	15	2.835	3.485
	[10.36]	[12.24]	[1.331]	[1.399]
Total Confirmed Cases	753.7	1,330	252.1	512.1
	[1,687]	[2,286]	[487.9]	[637.0]
Total Confirmed Cases in the	6.150	10.87	2.043	5.786
Pre-rollback Period	[17.84]	[24.50]	[6.055]	[11.20]
Total Deaths	21.60	38.22	7.116	18.29
	[72.46]	[101.8]	[18.97]	[36.40]
Number of Counties	1,463	681	782	103

Steps of Analysis

Our analysis proceeds in two steps:

First, we determine whether the announced policy has any impact on pollution levels in counties with large numbers of TRI sites.

Second, we determine whether those treated counties experienced increased levels of COVID cases and deaths after the announcement.

First, Does the Rollback Increase Pollution?

(1) $Pollution_{it} = \beta_1 TreatedPost_{it} + Post_t + X_{it} + \sigma_i + \varphi_t + \varepsilon_{it}$

$Pollution_{it}$ is the daily amount of PM2.5 (or ozone) pollution in ug/m3 (or ppm) in county i in time t.

$TreatedPost_{it}$ is a binary indicator for being in a county in the top third of the distribution in terms of the number of TRI sites (with 6 or more TRI sites) after the rollback of environmental enforcement.

$Post_t$ is a binary variable for being in the period after the EPA's rollback of civil enforcement.

X_{it} is a vector of daily county-level variables (i.e., whether there is a stay at home order on that day, state re-openings, and average temperature and precipitation).

σ_i are county fixed effects.

φ_t are day of the week fixed effects.

Then, what effect does the rollback have on COVID cases and deaths (through pollution)

(2) $Y_{it} = \beta_1 TreatedPost_{it} + Post_t + X_{it} + \sigma_i + \varphi_t + \varepsilon_{it}$

Y_{it} is the log of the number of daily deaths (or confirmed cases) in county *i* in time *t* using the inverse hyperbolic sine transformation to account for zeros.

$TreatedPost_{it}$ is a binary indicator for being in a county in the top third of the distribution in terms of the number of TRI sites (with 6 or more TRI sites) after the rollback of environmental enforcement.

$Post_t$ is a binary variable for being in the period after the EPA's rollback of civil enforcement

X_{it} is a vector of daily county-level variables (i.e., daily average temperature and precipitation, whether there is a stay at home order, state re-openings, whether a mask mandate is in place, days since the first death from COVID-19, the number of confirmed cases, daily total tests administered by state, and 5 daily social distancing measures).

σ_i are county fixed effects.

φ_t are day of the week and month fixed effects.

Findings

- Counties with high numbers of TRI sites experienced and 11.8% increase in pollution after the EPA announcement

- This policy-induced increase in pollution is associated with:
  - 53% increase in COVID-19 cases and
  - 10.6% increase in COVID-19 deaths.

Step 1: The impact of the policy on pollution

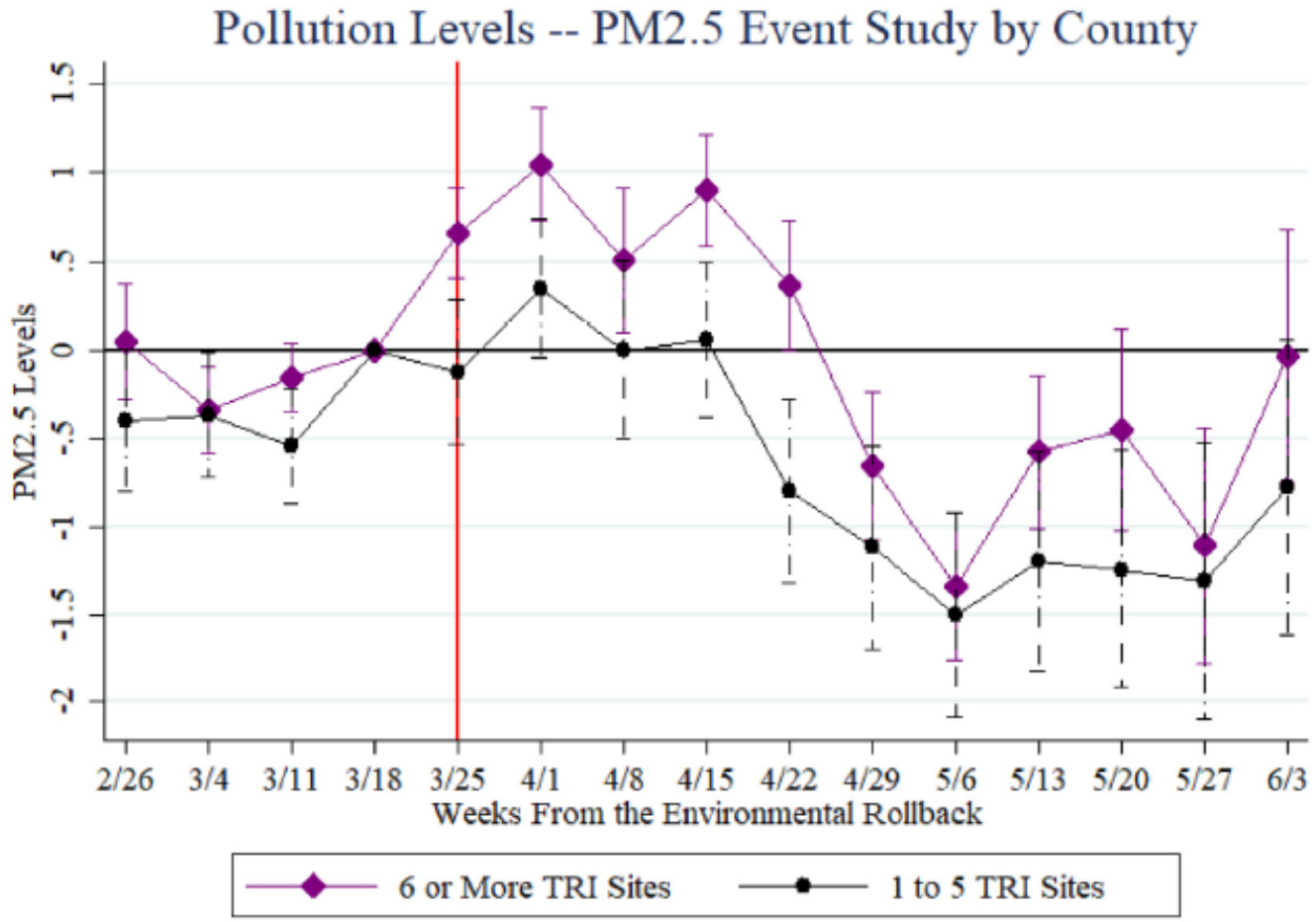
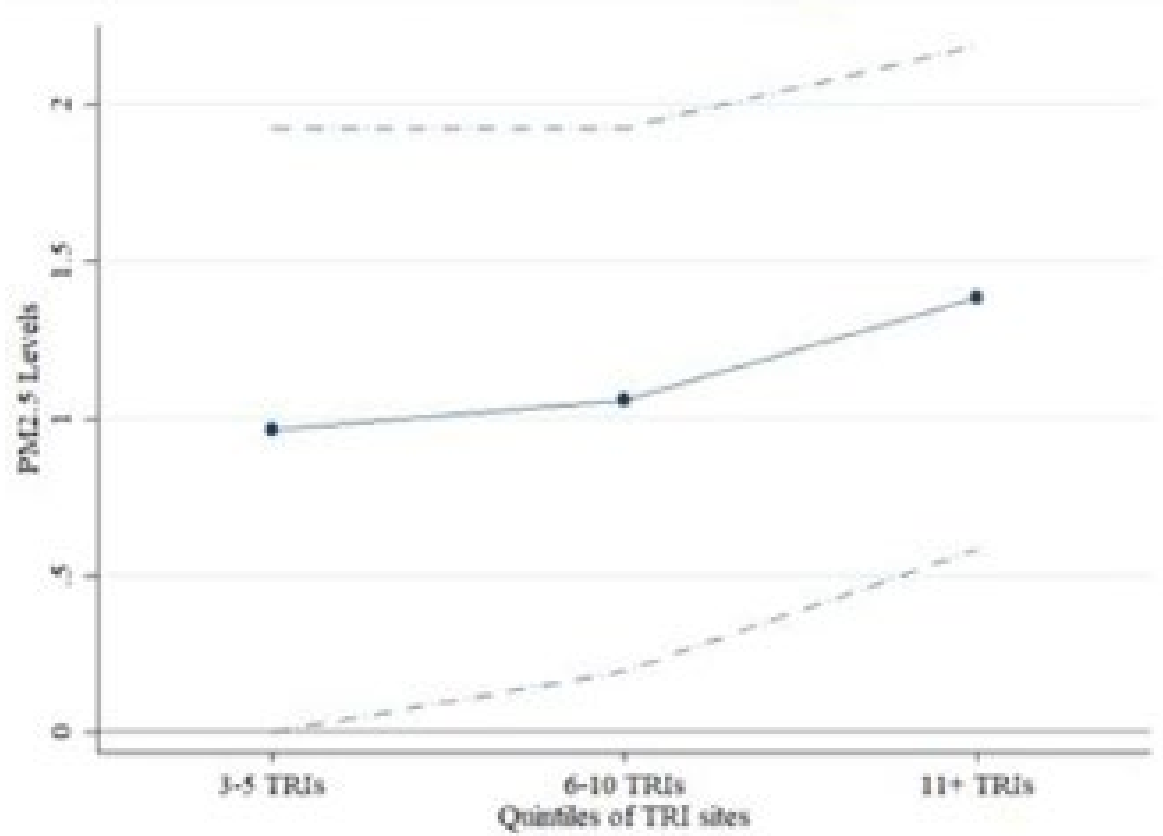


Table 2: Difference in Differences Results for Being in County with 6 or more TRI sites on Pollution Levels After the EPA's Rollback of Enforcement Compared with Placebo Years

	(1) Daily Mean PM2.5 Concentration	(2) Daily Mean Ozone Concentration	(3) Daily Mean PM10 Concentration
	Panel A: 2020 (Treatment Year)		
Treated County Post Rollback (March 26, 2020)	0.7782***	0.0021***	1.5419*
	(0.2350)	(0.0004)	(0.9307)
	Panel B: 2019 (Placebo Year)		
Treated County Post March 26, 2019	−0.3249*	0.0017***	0.5188
	(0.1964)	(0.0002)	(0.5920)
	Panel C: 2018 (Placebo Year)		
Treated County Post March 26, 2018	0.2602	−0.0008***	−0.8180
	(0.1654)	(0.0003)	(0.7210)
	Panel D: 2017 (Placebo Year)		
Treated County Post March 26, 2017	−0.0185	−0.0005	−0.8370
	(0.2378)	(0.0003)	(0.7523)
Mean of Dependent Variable	6.618	0.040	16.198
Observations	105673	109739	35239

Results seem to be driven by counties with large numbers of TRI sites



Step 2: What is the impact of the policy on Covid Deaths?

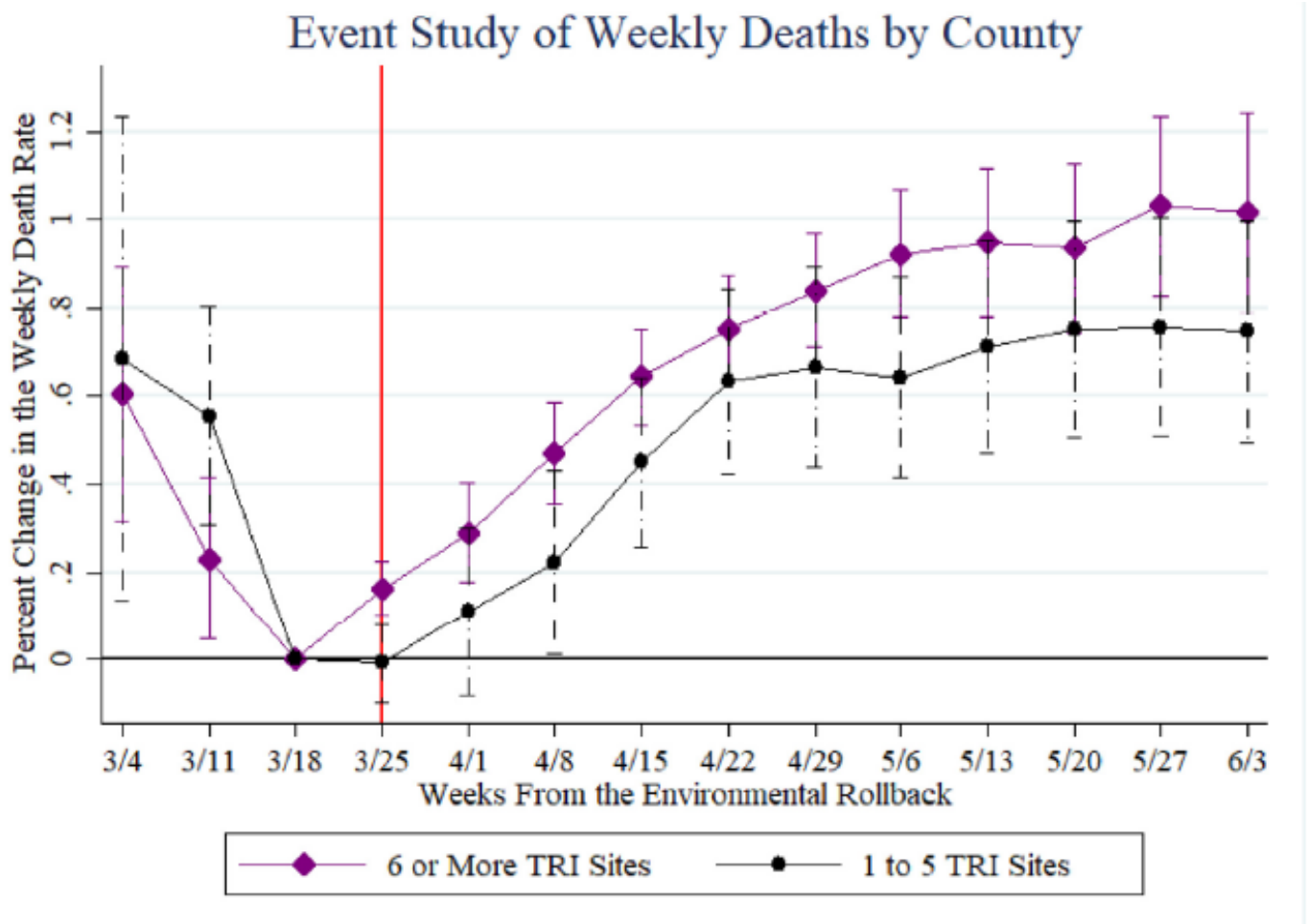


Table 3: The Effects of Pollution on Deaths and Cases

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log COVID-19 Deaths	Log COVID-19 Deaths	Log COVID-19 Deaths	Log COVID-19 Deaths	Log Confirmed COVID-19 Cases	Log Confirmed COVID-19 Cases	Log Confirmed COVID-19 Cases	Log Confirmed COVID-19 Cases
Treated Counties After the Rollback	0.1331***	0.1533***	0.1055***	0.1410***	0.6856***	0.7078***	0.5296***	0.2308**
	(0.0160)	(0.0168)	(0.0272)	(0.0348)	(0.0450)	(0.0479)	(0.0962)	(0.0989)
With State Fixed Effects and controls	X				X			
With County Fixed Effects and daily controls		X	X	X		X	X	X
With County-Specific Linear Time Trends				X				X
Limited to Counties with Population Density >250 in the Control Group			X	X			X	X
Limited to Populations between 10K and 1.64 million	X	X	X	X	X	X	X	X
Mean of the Dependent Variable	0.194	0.194	0.194	0.194	1.148	1.148	1.148	1.148
County-Day Observations	137716	137815	84126	84126	137716	137815	84126	84126

Table 4: Results for Weekly COVID-19 Death and Cases in the Same Week and Allowing for a Delay

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log Weekly COVID-19 Deaths (same week)	Log Weekly COVID-19 Deaths 1 Week Later	Log Weekly COVID-19 Deaths 2 Weeks Later	Log Weekly COVID-19 Deaths 3 Weeks Later	Log Weekly COVID-19 Cases (same week)	Log Weekly COVID-19 Cases 1 Week Later	Log Weekly COVID-19 Cases 2 Weeks Later	Log Weekly COVID-19 Cases 3 Weeks Later
Treated Counties After the Rollback	0.3218***	0.2573***	0.2302**	0.1445*	0.5886***	0.5464***	0.4862***	0.5326***
	(0.0834)	(0.0898)	(0.0895)	(0.0821)	(0.1464)	(0.1242)	(0.1124)	(0.1037)
Whole Sample with 1 or More TRIs, using County and Month Fixed Effects	X	X	X	X	X	X	X	X
County-Week Observations	12975	12267	11555	10833	12975	12983	12825	12129

Conclusion

- Pollution increased immediately after the announcement of a rollback of enforcement of environmental laws.
- This policy induced increase in pollution resulted in an increase in COVID-19 cases and deaths.
- These results emphasize the importance of continuing enforcement of environmental regulations for the protection of health.
- Additionally, these results are in line with a growing literature emphasizing the damage air pollution can do to respiratory health.

Thank You

Persico, C., & Johnson, K. R. 2021. The Effects of Increased Pollution on COVID-19 Cases and Deaths. *Journal of Environmental Economics and Management 107* 102431.