Day 5: Practical Exercise

New Climate Economy Training Course

World Resources Institute

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Motivation

During the course, we have studied several topics regarding

- Poverty
- Inequality
- Impact evaluation

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On this final lecture, we are going to put into practice some of these topics replicating the results of an empirical paper focused on environmental policies and inequality. Specifically:

"Does Enviromental Policy Affect Income Inequality? Evidence from the Clean Air Act", AEA Papers and Proccedings, 2019 by Akshaya Jha, Peter H. Matthews and Nicholas Z. Muller.

Jha, Matthews and Muller (2019)

- The paper quantifies the impact of an environmental policy on income inequality → *Clean Air Act (CAA)*[1].

- Evidence on the CAA effects is inconclusive → multiple channels through which the CAA affects firms and workers.

  - Exposure to local air pollution decreases labor productivity and increases absenteeism → Reductions in pollution due to CAA might boost wages or employment opportunities.

  - Firms must take costly actions in order to comply with stricter environmental regulations → firing employees, reductions in wages, etc.

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[1]https://www.boem.gov/air-quality-act-1967-or-clean-air-act-caa

Jha, Matthews and Muller (2019)

The authors use panel variation in the stringency of environmental regulation generated by the National Ambient Air Quality Standards (NAAQS).

- Annual county-level limits on the allowable concentrations of various air pollutants $\Rightarrow$ Particulate matter $(PM_{2.5})$ and tropospheric ozone (O_3).

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- Annual county-level limits on the allowable concentrations of various air pollutants $\Rightarrow$ Particulate matter ($PM_{2.5}$) and tropospheric ozone (O_3).
- The sample period considered is $2005 - 2015$.
- Focus on two policy changes:
  1. 2006 $PM_{2.5}$ NAAQS (implemented in 2009).
  2. 2008 NAAQS for O_3 (implemented in 2012).

Data

Authors use publicly available date from several sources:

- CASES 2018 $\rightarrow$ Estimates of the annual concentration levels of fine particulates: $PM_{2.5}$ and O_3.

- Income Revenue Service (SOI) $\rightarrow$ annual data on the average gross adjusted income in each zip code.

Data

- United States Enviromental Protection Agency (USEPA 2016, 2018) $\rightarrow$ Annual county-level designations with each of the NAAQS.

- Consumer Price Index (CPI).

- Centers for Disease Control and Prevention $\rightarrow$ Annual county-level mortality rate by age group: Monetary cost of premature mortality risk due to exposure to $PM_{2.5}$ and O_3.[2]

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[2]We will not consider this topic in our analysis.

Empirical Strategy

The matched difference-in-difference you should estimate is the following:[3]

$$log(Y_{i,t}) \quad = \quad \alpha_i + \gamma_t + \beta NA_{i,t} + \theta PREVNA_{i,t} + \varepsilon_{i,t}$$

- $Y_{i,t}$: Outcome of interest in county i in year t.
- α_i: County fixed effects.
- γ_t: Year fixed effects.
- $NA_{i,t}$: Indicator that assumes a value of one if and only if county i is out of attainment with the relevant NAAQS standard in year t.
- $PREVNA_{i,t}$: Indicator that assumes a value of one if and only if county i is out of attainment with the previous NAAQS standard for the same pollutant in year t.
- $\varepsilon_{i,t}$: Error term.

[3]Standard errors are clustered by county group.

Empirical Strategy

Authors considered annual county-level average and dispersion as measured by the Gini coefficient, the $90/50$ ratio and the $90/10$ of three outcome variables:

- Household income

- $PM_{2.5}$ and O_3 concentration levels

- Pollution adjusted household income

Matching Procedure

The matching estimator used in this study was originally proposed by Heckman, Ichimura, and Todd (1997).

In sum:

Based on the 2005 concentration levels of $PM_{2.5}$ the authors matched each county that was ever out of attainment with the relevant standard between 2005 and 2015 to ten counties that were always in attainment with this standard during 2005 and 2015.[4]

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[4]Check Appendix D from Jha, Matthews, and Muller (2019).

Results

To interpret the results as causal, authors relies on the assumption:

Counties that will eventually shift into non-attainment with the relevant standard have the same average trend in outcomes over time as counties that are always in attainment:

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<p style="text-align:center;color:red;">Common trends assumption!</p>

Results

TABLE 1—THE EFFECT OF NAAQS NON-ATTAINMENT ON POLLUTION AND INCOME

Dependent variable	Pollution standard	log of Gini coefficient (1)	log of mean (2)	log of 90/50 (3)	log of 90/10 (4)
Ozone	Ozone (2008)	−0.016 (0.020)	0.007 (0.004)	0.030 (0.023)	0.001 (0.020)
$PM_{2.5}$	$PM_{2.5}$ (2006)	−0.067 (0.014)	−0.023 (0.008)	−0.129 (0.021)	−0.082 (0.015)
Market income	Ozone (2008)	0.055 (0.006)	0.030 (0.010)	0.075 (0.019)	0.040 (0.015)
	$PM_{2.5}$ (2006)	0.044 (0.011)	0.010 (0.016)	0.002 (0.028)	0.002 (0.019)
Pollution-adjusted income	Ozone (2008)	0.171 (0.010)	0.033 (0.010)	0.100 (0.021)	0.079 (0.017)
	$PM_{2.5}$ (2006)	0.192 (0.020)	0.067 (0.019)	0.084 (0.028)	0.080 (0.021)

Note: Standard errors clustered by county group are in parentheses.

Results

In sum:

- Non-attainment with either 2008 O_3 NAAQS or 2006 $PM_{2.5}$ NAAQS results in substantial increases in income inequality.
  - These two standards affect the distribution of income through costly actions taken by firms.
  - Compliance of these binding standards require that (polluting) firms allocate additional resources $\Rightarrow$ decrease wages or reduce number of employees (impact on low-productivity or low-wage earners).

Exercises

Now you are asked to solve three exercises focused on the paper we just reviewed:

1. Compute summary statistics at the state level
   - Use market income, $PM_{2.5}$ and O_3 to compute several inequality indicators at the state level.[5]
2. Replicate main results of the paper $\Rightarrow$ Negative effect on the $PM_{2.5}$ log gini from a policy changed introduced in 2006 (row 2, column 1).
   - Also replicate the common-trends assumption figure presented on the online appendix of the paper.

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[5]In the paper, these statistics are computed at the county-level. However, running those programs is computationally demanding and unnecessary for our purposes.

References

Heckman, James J, Hidehiko Ichimura, and Petra E Todd (1997).
"Matching as an econometric evaluation estimator: Evidence from
evaluating a job training programme". In: *The review of economic studies*
64.4, pp. 605–654.

Jha, Akshaya, Peter H Matthews, and Nicholas Z Muller (2019). "Does
Environmental Policy Affect Income Inequality? Evidence from the Clean
Air Act". In: *AEA Papers and Proceedings* 109, pp. 271–276.

THANK YOU!