

Air Quality, Human Capital Formation and the Long-term Effects of Environmental Inequality at Birth

2018 AEA Annual Meeting

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January 6, 2018

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Motivation I

- ▶ Pollution exposure is not distributed equally across the population
 - ▶ Poor and non-white children are exposed to higher levels of pollution than rich, white children
- ▶ Intergenerational income mobility is low in the United States
 - ▶ Chetty et al. [2014]: Children born in the bottom income quintile have a 7.6% chance of being in the top quintile as adults, vs. to a 36.5% chance for children born in the top quintile
- ▶ These two facts may be connected, if pollution exposure at birth has long term economic consequences

Motivation II

- ▶ Retrospectively, total benefits of the Clean Air Act of 1970 and the Clean Air Act Amendments of 1990 greatly outweigh total costs – EPA (1997) and EPA (2015)
- ▶ However, these cost-benefit analyses have excluded costs/benefits associated with long term effects of pollution exposure
- ▶ Credible causal estimates of these long term effects can improve future cost-benefit analysis by reducing bias due to excluded long term costs/benefits

What do we know?

Short & long term effects of pollution exposure:

- ▶ Reduces birthweight & increases infant mortality: Currie and Walker [2011], Chay and Greenstone [2003a]
- ▶ Decreases performance on school exams, in the long run (Bharadwaj et al. [2014]) and contemporaneously (Lavy et al. [2014], Marcotte [2017])
- ▶ Increases crime (Herrnstadt and Muehlegger [2015], Reyes [2014])
- ▶ Decreases wages in the long run (Isen et al. [2016]) and contemporaneously (Chang et al. [2014])

Surveys of the state of the art: Currie [2011], Currie et al. [2013] and Almond et al. [2017]

What's Missing?

Open Questions:

- ▶ What's the mechanism for long term wage effects?
 - ▶ Clifford et al. [2016]: epidemiological evidence that pollution affects brain development
 - ▶ Could affect cognitive, non-cognitive skills
- ▶ What role does later life pollution exposure play? (Almond et al. [2017]: the “missing middle”)

My results

- ▶ I confirm long term wage effects for an older cohort (born around 1970)
- ▶ For a younger cohort, I examine how exposure at birth affects intermediate determinants of adult economic well-being: college attendance, high school completion and incarceration
 - ▶ Additionally, I show how exposure in adolescence affects these outcomes

Data

I construct a linked dataset for two cohorts of interest: 16–24 year olds, born between 1987–1997, and older adults born between 1969–1976

- ▶ Responses from the 2005–2015 American Community Survey (ACS)
- ▶ The SSA Numerical Identification File (Numident)
- ▶ For younger cohort: Universe of IRS Form 1040 filings (2000–2014)
- ▶ Exposure at birth to TSP measured from EPA monitor data
- ▶ Exposure during adolescence to PM_{2.5} for younger cohort measured using satellite data from the Atmospheric Composition Analysis Group (ACAG)

Empirical Strategy

Strategy: use nonattainment IV similar to Chay and Greenstone [2003b], Isen et al. [2016]

- ▶ Capitalize on sharp declines in emissions associated with nonattainment status designations
 - ▶ For older cohort, use nonattainment of 1971 TSP standards (replicating Isen et al. [2016])
 - ▶ For younger cohort, use nonattainment of NO₂ standards, designated in 1991
- ▶ For younger cohort: allow for adolescent pollution exposure to have a separate effect on intermediate outcomes

Empirical Strategy

For an individual i born in county c in year t who responds to the ACS in year s , estimate IV regressions of the form:

$$TSP_{i,c,t} = \nu_c + \mu_t + \psi_s + \delta_1 Nonattainment_{c,t} + \theta X_{i,c,t} + \epsilon_{i,c,t}$$

$$Y_{i,c,t} = \eta_c + \lambda_t + \pi_s + \beta_1 \widehat{TSP}_{i,c,t} + \gamma X_{i,c,t} + e_{i,c,t}$$

- ▶ $X_{i,c,t}$ contains: age, sex, race, county population, personal income and personal income per capita growth rate in 1969/1980 interacted with quadratic trends, weather controls and month of birth fixed effects (both cohorts)
- ▶ For younger cohort, $X_{i,c,t}$ also includes county of residence in adolescence fixed effects, parents' AGI in adolescence, and average PM2.5 exposure during adolescence

Identifying Assumptions

- ▶ First stage is a difference-in-difference regression, so key identifying assumption is parallel trends
- ▶ Can examine the validity of this in an event study framework by estimating the following regression:

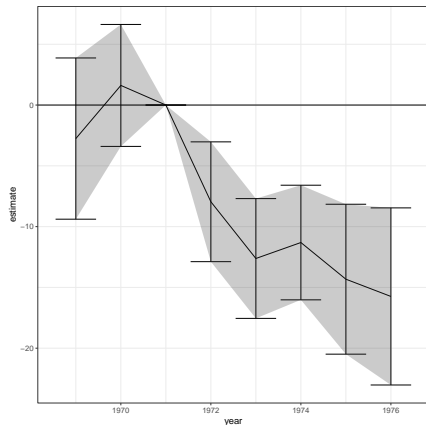
$$TSP_{i,c,t} = \alpha_c + \alpha_t + \alpha_s + \sum_{j=T_-}^{T_+} \delta_j Non_c \times I(t = j) + \theta X_{i,c,t} + \epsilon_{i,c,t}$$

where T_- , T_+ are 1969-1976 or 1987-1997, and δ_{1971} , δ_{1991} are normalized to 0

- ▶ If $\delta_j = 0$ for $j < 1991$ or $j < 1971$, this is evidence ID assumption holds

Nonattainment & TSP Exposure: Older Cohort

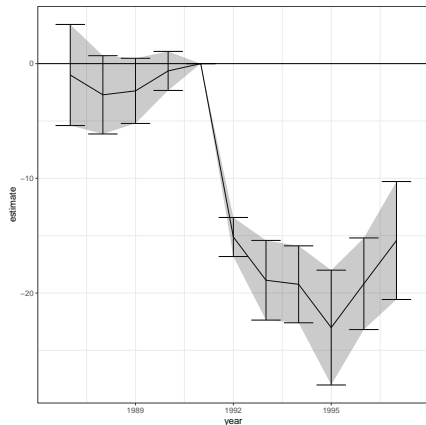
Figure: Effect of 1971 TSP Nonattainment on TSP Exposure In Utero, Event Study Framework



Source: ACS and EPA data

Nonattainment & TSP Exposure: Younger Cohort

Figure: Effect of NO₂ Nonattainment Designations on TSP Exposure In Utero, Event Study Framework



Source: IRS 1040, ACS, EPA and ACAG satellite data

Results

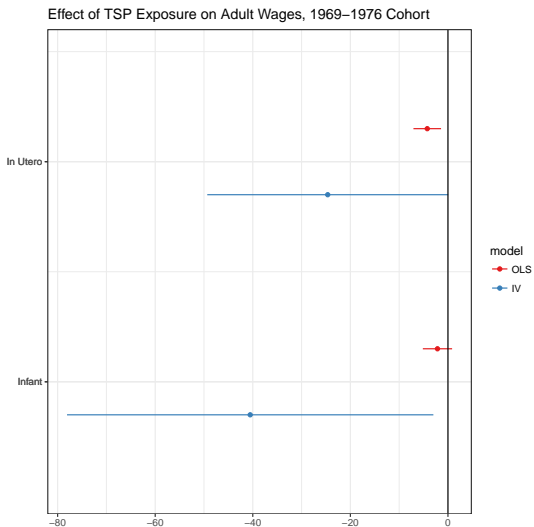
Results for older cohort:

- ▶ Effect of pollution exposure on real wages

Three sets of results for younger cohort:

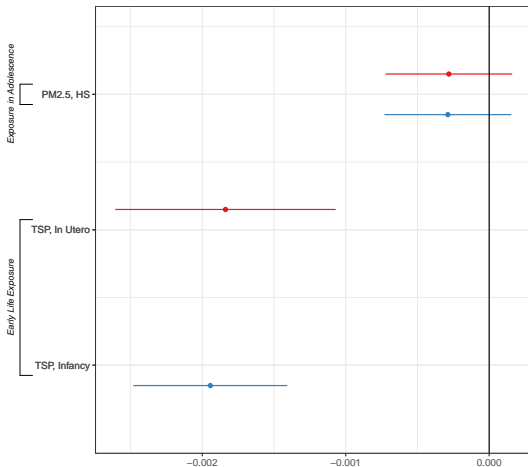
- ▶ Effect of pollution exposure on college attendance (cognitive skills channel)
 - ▶ Dep. Var: attending college. Sample: ages 19-22
- ▶ Effect of pollution exposure on high school (HS) non-completion (non-cognitive skills channel)
 - ▶ Dep. Var: less than HS diploma & not attending HS. Sample: ages 16-24
- ▶ Effect of pollution exposure on incarceration (non-cognitive skills channel)
 - ▶ Dep. Var: In Correctional Facility GQ at ACS response. Sample: ages 16-24

Older Cohort (Replicating Isen et al. [2016])



Source: 2005–2015 ACS and EPA Monitor Data

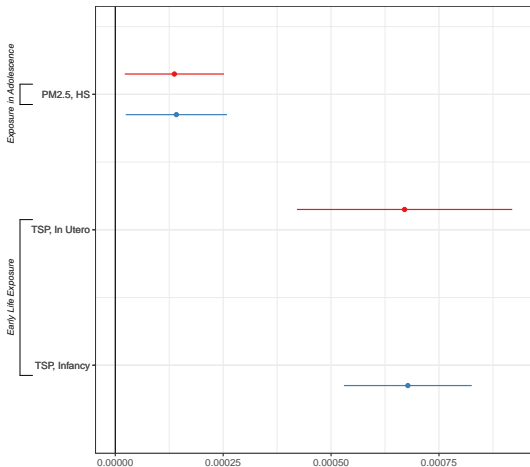
Effect of Pollution Exposure at Birth on College Attendance



Source: 2000–2014 IRS 1040s, 2005–2015 ACS, EPA and ACAG satellite data

HS Non-completion

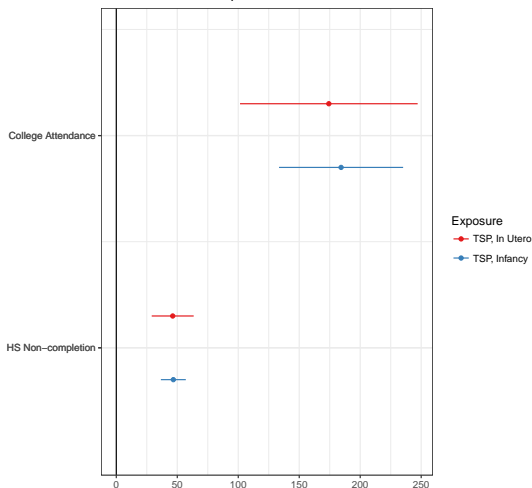
Effect of Pollution Exposure at Birth on High School Non-completion



Source: 2000–2014 IRS 1040s, 2005–2015 ACS, EPA and ACAG satellite data

Implied Wage Effects

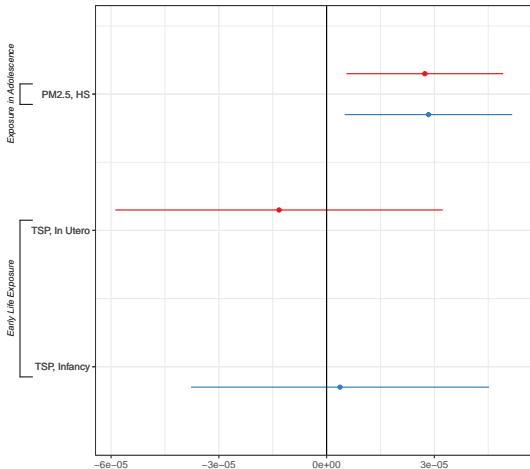
Implied Wage Effects of a 10..g/m3
Decrease in TSP Exposure at Birth



Source: 2000–2014 IRS 1040s, 2005–2015 ACS, EPA and ACAG satellite data

Incarceration

Effect of Pollution Exposure at Birth on Incarceration

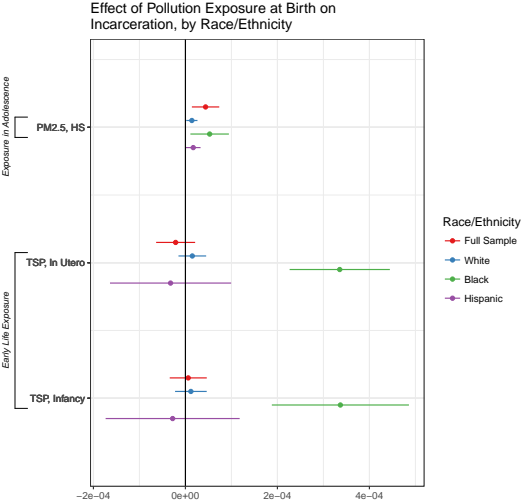


Source: 2000–2014 IRS 1040s, 2005–2015 ACS, EPA and ACAG satellite data

Environmental Justice

- ▶ EJ lit: disadvantaged communities are exposed to higher levels of pollution
- ▶ Are disadvantaged communities also more affected by this pollution exposure?
 - ▶ Material deprivation could result in more acute effects for disadvantaged communities
 - ▶ Related: Morello-Frosch and Shenassa [2006]: "double jeopardy"
 - ▶ Other structural disadvantages (i.e. racial bias in policing) could also result in disproportionate effects for disadvantaged communities
- ▶ To examine this, I stratify the sample by race/ethnicity

Environmental Justice: Incarceration



Source: 2000–2014 IRS 1040s, 2005–2015 ACS, EPA and ACAG satellite data

Implied Wage Effects

- ▶ Translating incarceration effects into implied wage effects is difficult
 - ▶ No consensus in the literature (e.g. recent work on Ban-the-Box)
- ▶ However: if the incarceration wage effect is the same size as the college wage premium:
 - ▶ TSP in utero effect for Blacks implies a wage effect of \$53
 - ▶ vs. a full sample wage effect implied by the college attendance result of \$174, and a High school dropout wage effect of \$46

Conclusion

- ▶ Pollution Exposure at birth has economically important effects later in life. An increase in TSP exposure:
 - ▶ Decreases wages in adulthood
 - ▶ Decreases college attendance
 - ▶ Increases high school completion and incarceration (for blacks)
- ▶ Follow up research
 - ▶ Other Pollutants?
 - ▶ Lead NAAQS Nonattainment designations have similar effect on incarceration, HS non-completion
 - ▶ Intergenerational Effects?
 - ▶ 1970 CAA affects family dissolution (divorce), suggesting potential intergenerational effects (in progress)

Conclusion

Thanks!

Contact Information

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