Can Access to Health Care Mitigate the Effects of Temperature on Mortality?

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Heterogeneity in Environmental Health Damages

Studies have shown causal effects of environment on health

- Air pollution Currie and Neidell (2005), Schlenker and Walker (2015)
- Water pollution Ebenstein (2012), Alsan and Goldin (forthcoming)
- Weather Deschenes and Greenstone (2011), Barreca et al. (2016)

Damages are heterogeneous across populations

Banzhaf, Ma and Timmins (2019)

- Larger health effects of air pollution for blacks vs. whites

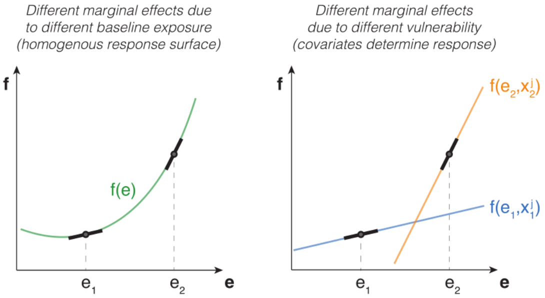
  Chay and Greenstone (2003b); Currie and Walker (2011)
- Mortality effects of CO are 10x larger in Mexico vs. US

  Arceo, Hanna and Oliva (2016)
- Mortality effects of temperature are larger for poor populations Carleton et al. (2019)

What Drives Heterogeneity in Damages?

Hsiang, Oliva and Walker (2019) note heterogeneity arises from:

1. Different levels of baseline exposure across populations combined with a non-linear damage function.
2. Different damage functions across populations.
   - Damage functions may differ for many reasons (e.g., differences in health stock or defensive investments).



Source: Hsiang, Oliva and Walker (2019)

Our Study

Environmental shocks

- Cold and hot ambient temperature exposure
  - Temperature shocks are repeated over time, occur at any geographic scale, and are conditionally random. Deschenes and Greenstone (2011), Barreca et al. (2016), Heutel et al. (2019)
  - Different mechanisms underly the health effects of cold vs. hot temperature. Deschenes and Moretti (2009), White (2017)

Access to health care

- Establishment of community health centers (CHCs) in the 1960s-1970s
  - **Bailey and Goodman-Bacon (2015) – henceforth "BG"**
    - Use a DiD design and find that CHC access significantly reduces general mortality rates.

Background: Community Health Centers

- CHC program initiated in 1965 as part of President Johnson's War on Poverty.
- Early CHCs (established 1965-1974) were in high poverty urban areas, and funded by the OEO during the "great administrative confusion".
  - BG show timing of CHC establishment was essentially random, and uncorrelated with other War on Poverty programs.
- CHCs provided direct provision of primary care services for low-income individuals.
  - Often employed multiple clinics locations or mobile units.

Effect of CHCs

$$\text{AMR}_{cym} = \gamma \text{CHC}_{cy}^{t\geq 0} + \beta \text{X}_{cym} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy}$$

- AMR_{cym} is the Adjusted Mortality Rate per 100,000 population in county c, year y, and month m.
- $\text{CHC}_{cy}^{t\geq 0}$ is an indicator for the presence of a CHC.
  - Sometimes a vector of indicators for time relative to treatment ($t = -1$ omitted).
- $\text{X}_{cym}, \delta_{sy}, \delta_{cm}, \delta_{uy}, \delta_{ym}$ are county-level time-varying covariates and fixed effects.
  - Can replace these with more parsimonious county and time fixed effects for similar results.

Data Info

Effect of CHCs and Temperature

$$\text{AMR}_{cym} = \gamma \text{CHC}_{cy}^{t\geq 0} + \pi g(\text{Temp}_{cmy}) + \beta \text{X}_{cmy} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy}$$

$g(\text{Temp}_{cmy})$ is a nonlinear function of *daily* mean temperatures.

- Bins: each bin is the number of days in a given range (e.g., Deschenes and Greenstone, 2011)
  - e.g., $\text{Temp}^{>80}$ is the number of days above 80°F
  - Estimate effect of one extra day in bin j relative to a day in the omitted bin (40-80 degrees, or 60-70 degrees)

- Polynomial: polynomials constructed at the daily level, then summed over months (e.g., Carleton et al., 2019)
  - Estimate effect of one extra day at temperature t relative to a day at 65 degrees

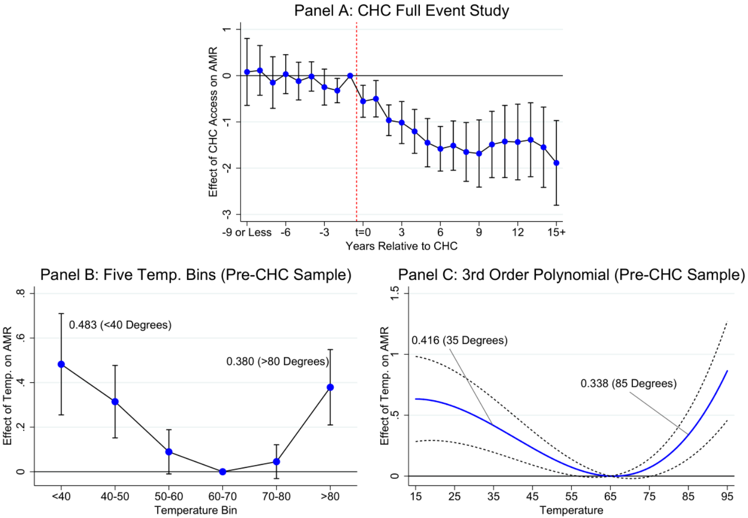
Effect of CHCs and Temp: Results

	(1)	(2)	(3)	(4)	(5)
$CHC^{t\geq0}$	-1.136***		-1.146***		
	(0.307)		(0.307)		
$CHC^{t\leq-2}$				-0.0976	-0.102
				(0.168)	(0.168)
$CHC^{0\leq t\leq4}$				-0.836***	-0.850***
				(0.157)	(0.158)
$CHC^{5\leq t\leq9}$				-1.554***	-1.566***
				(0.271)	(0.270)
$CHC^{t\geq10}$				-1.562***	-1.578***
				(0.390)	(0.390)
$Temp^{<40}$		0.116***	0.116***		0.116***
		(0.0159)	(0.0158)		(0.0158)
$Temp^{\geq80}$		0.182***	0.183***		0.183***
		(0.0187)	(0.0187)		(0.0187)
N	1,094,760	1,094,760	1,094,760	1,094,760	1,094,760

Notes: Estimates from each column are from a single regression. The covariates and fixed effects described above are included in all specifications. Standard errors in parentheses are two-way clustered at the county and year-month levels. *, **, *** indicate significance at the 10%, 5%, and 1% levels.

Summary Statistics

Effects of CHCs and Temp: Flexible Specifications



Interaction Model – Naive Approach

$$\text{AMR}_{cmy} = \phi(\text{CHC}_{cy}^{t\geq 0} \times g(\text{Temp}_{cmy})) + \gamma\text{CHC}_{cy}^{t\geq 0} + \pi g(\text{Temp}_{cmy}) + \beta\text{X}_{cmy} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy}$$

Naive approach: simply add the interaction effect (ϕ) to the replication model. This model assumes:

1. No cross-sectional differences in the temperature-mortality relationship between treated and untreated counties.

2. No trends in the temperature-mortality relationship unrelated to CHC establishment.

Interaction Model – Preferred Approach

$$\text{AMR}_{cmy} = \phi(\text{CHC}_{cy}^{t\geq 0} \times g(\text{Temp}_{cmy})) + \gamma\text{CHC}_{cy}^{t\geq 0} + \pi g(\text{Temp}_{cmy})$$
$$+ \theta(g(\text{Temp}_{cmy}) \times \text{Treated}_c) + g(\text{Temp}_{cmy}) \times \delta_y + \kappa(g(\text{Temp}_{cmy}) \times \text{AC}_{sy})$$
$$+ \beta\text{X}_{cmy} + \delta_{sy} + \delta_{cm} + \delta_{uy} + \delta_{ym} + \varepsilon_{cmy}$$

- $g(\text{Temp}_{cmy}) \times \text{Treated}_c$ allows for time-invariant differences in the temp-mortality relationship across treated and untreated counties.
  - Analogous to a treatment group indicator or county fixed effects in a standard DiD design
- $g(\text{Temp}_{cmy}) \times \delta_y$ allows the temp-mortality relationship to vary over time in a manner common across all counties.
  - Analogous to time fixed effects in a standard DiD design
- $g(\text{Temp}_{cmy}) \times \text{AC}_{sy}$ allows for temperature effects to vary across air conditioning penetration rates Barreca et al. (2016)

Interaction Results

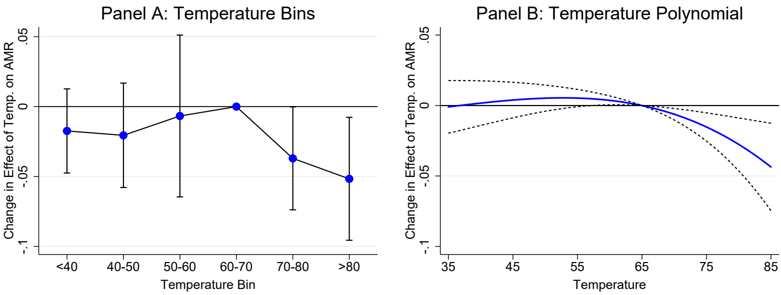
	(1)	(2)	(3)	(4)	(5)
$CHC^{t\geq 0} \times Temp^{<40}$	-0.00294	-0.00346	-0.00336	-0.00324	-0.0221**
	(0.0114)	(0.0115)	(0.0151)	(0.0155)	(0.0101)
$CHC^{t\geq 0} \times Temp^{\geq 80}$	-0.0484**	-0.0518**	-0.0499*	-0.0603**	-0.0314**
	(0.0201)	(0.0197)	(0.0273)	(0.0288)	(0.0131)
Temp $\times$ Treated	X	X		X	X
Temp $\times$ δ_y	X	X	X		X
Temp $\times$ AC		X			
Temp $\times$ δ_c			X		
Temp $\times$ δ_{sy}				X	
δ_{cy}					X

Notes: For reference, the baseline estimates for CHC counties in the pre-CHC period (1959-1965) for the effect of a <40 and >80 day are 0.241 (s.e.=0.081) and 0.339 (s.e.=0.070), respectively. Standard errors are two-way clustered at the county and year-month levels. *, **, *** indicate significance at the 10%, 5%, and 1% levels.

- The estimate of -0.0484 in Column 2 (preferred specification) implies that CHC access mitigates the relationship between hot temperatures and mortality by 14.2%.

Summary Statistics

Interaction Results: Bin and Polynomial Specifications



- Bin specification: implies mitigation of 13.6% for >80°F days.
- Polynomial specification: implies mitigation of 13.0% for 85°F days.

Why the difference between heat and cold?

Different mechanisms underlie heat vs. cold-related mortality

Deschenes and Moretti (2009), Gasparrini et al. (2015), White (2017)

- Heat-induced deaths more concentrated in disease categories prevented by CHC access.
  - CHCs mostly prevented cardio/cerebrovascular deaths; these deaths account for 50% of cold-related mortality and 71% of heat-related mortality.
- Heat-induced deaths are immediate (i.e., day of or day after); cold-induced deaths are delayed (up to 3 weeks later).
  - Highlights different mechanisms underlying these relationships
  - Suggests that cold-induced deaths might be more responsive to *medical treatment*, where heat-induced deaths are more responsive to *preventative care* (like CHCs).
- **Supplementary analysis:** We use Southern hospital desegregation as a source of variation in access to *medical/hospital treatment*
  - Desegregation significantly mitigated the cold-mortality relationship.

Conclusions – What Do We Learn?

1. Access to health care *can* mitigate environmental damages
    - Differential access to health care can explain heterogeneity in environmental damages

2. Expanding access to health care – especially primary care – has potential as an adaptive tool for climate change

3. The setting matters
    - The type of care must be highly relevant to ailments triggered by the environmental shock
        - E.g., improving access to care as an adaptive tool for climate change will only be effective if the mode of care is well-targeted

Thank You!

Data

Sample: County by Year and Month, 1959-1988

Mortality – **National Vital Statistics System**

- Outcome: Adjusted Mortality Rate per 100,000 population.

Weather – **PRISM and Schlenker and Roberts (2009)**

- Gridded (2.5×2.5 mile) daily temperature and precipitation data aggregated to counties. Daily data is used to construct monthly counts of days within six temperature bins <40 to >80.

Community Health Centers – **Bailey & Goodman-Bacon (2015)**

- The county and implementation year of all CHCs established 1965-1975, as well as all covariates used in Bailey and Goodman-Bacon (2015)

Population – **SEER and US Census**

- Data from SEER and the US Census (1950 and 1960). Missing years are linearly interpolated.

Air Conditioning – **US Census**

- AC data available in 1960, 1970 and 1980 US Census. Missing years are linearly interpolated.

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CHC Summary Statistics

	CHC Counties				Non-CHC Counties			
	1959-1965		All Years		1959-1965		All Years	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
AMR	81.26	(11.16)	70.97	(13.25)	76.61	(17.44)	67.15	(17.42)
Temperature (°F)	55.26	(16.89)	55.37	(16.8)	54.29	(17.61)	54.29	(17.49)
Num. Days $<$40	6.56	(10.24)	6.42	(10.1)	7.41	(10.67)	7.29	(10.54)
Num. Days 40-50	4.53	(5.84)	4.55	(5.85)	4.52	(5.63)	4.60	(5.69)
Num. Days 50-60	5.54	(6.61)	5.7	(6.67)	4.9	(5.68)	5.06	(5.76)
Num. Days 60-70	6.15	(6.94)	6.18	(6.97)	5.86	(6.54)	5.91	(6.59)
Num. Days 70-80	5.83	(8.18)	5.67	(8.10)	6.07	(8.26)	5.82	(8.16)
Num. Days $>$80	1.83	(5.51)	1.91	(5.65)	1.69	(5.11)	1.76	(5.28)
AC	0.13	(0.07)	0.36	(0.26)	0.14	(0.07)	0.39	(0.28)
Num. Counties	114				2,927			

Notes: All summary statistics are weighted by the county's 1960 population. Temperature is measured as the mean daily temperature.

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