Climate Change and Labor Market Dropouts: Evidence from the Half Century

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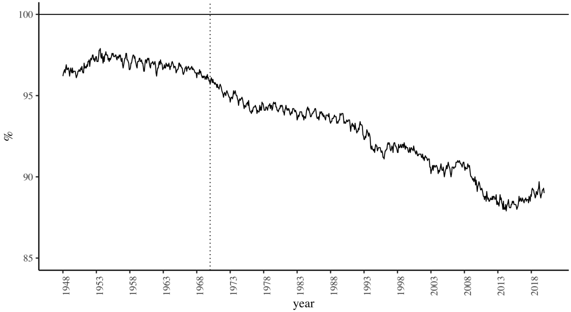
Background: Global rise in males' labor market dropouts

Since the late 1960s, **labor market participation rate (LFPR)** of prime-aged men across **almost all rich countries** have started decreasing.

→ It peaked in 1968 at OECD countries. Ths U.S. is a leading alarming case. (96.5% (1950) → 89.1%(2019))

Figure: LFPR (males aged 25-54; U.S.)

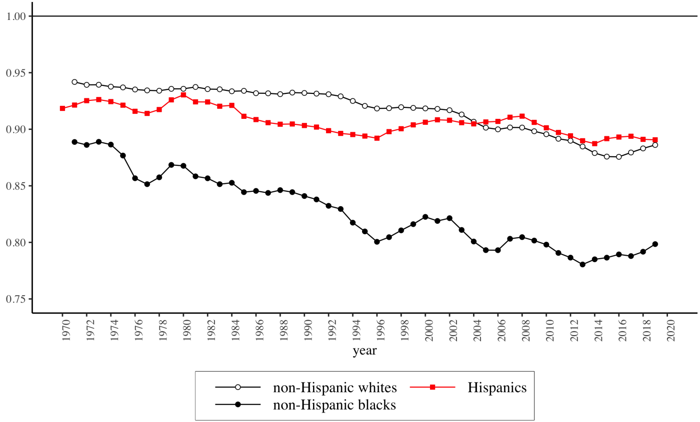


Note: OECD employment database and BLS.

Trend by race and ethnicity (U.S.)

Blacks exhibit a lowest level and experienced **the sharpest drop in LFPR**. (1970: 88% → 2019: 80%) Attachment of Hispanics is relatively stable.

Figure: LFPRs by race and ethnicity (males aged 25-54; 1970-2019)



Source: CPS

Why care for declining males' labor supply?

The impact is massive because prime-aged males have traditionally been main income-earners.

- First-order source of **rising income inequality**
- Dropouts may lead to *lower* **happiness** (Krueger [2017]), even **morbidity and mortality**. (Sullivan and Von Wachter [2009])
- **Higher dependency ratio** threatens the social security system under population aging.
- Fewer working males plausibly lead to *lower* **partnership and fertility rate**. (Autor et al. [2019])
    - ✓ In the U.S., a marriage rate and the fertility rate has been consistently declining after the peak of 1972 and 1957, respectively.

Why is males' labor supply declining?

Unsurprisingly, the literature admits that a single driver cannot explain all.

- **Labor demand drivers**: computerization (1990-); robots (2004-); (Acemoglu and Restrepo [2020]); China shock (2001-) (Autor et al. [2014]) and offshoring (1990-)
- **Labor supply drivers**: disability insurance (Parsons [1980]); health (Krueger [2017]); computer game technology (Aguiar et al. [2021])

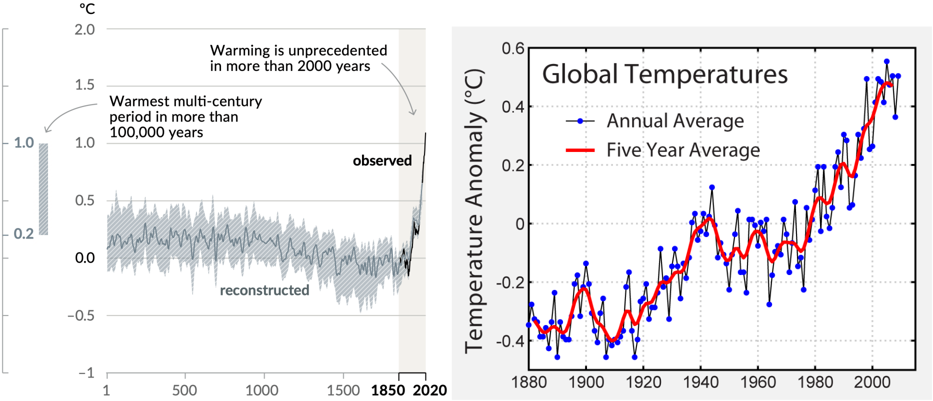
None spans **long enough** to reconcile the half-century worldwide phenomenon.

(→ Another **global** and **secular** trend should be a fundamental culprit.)

Global warming

Since the late 1960s, the world has experienced an unprecedented rise in temperature for the 2 millennia. (preceding the decline of males' LFPR)

Figure: Global trend of temperature (left: 2 millennia; right: 1880-2020)



Source: IPCC, 2021: Summary for Policymakers. In: Climate Change 2021.

Question 1: Does climate change induce dropouts?

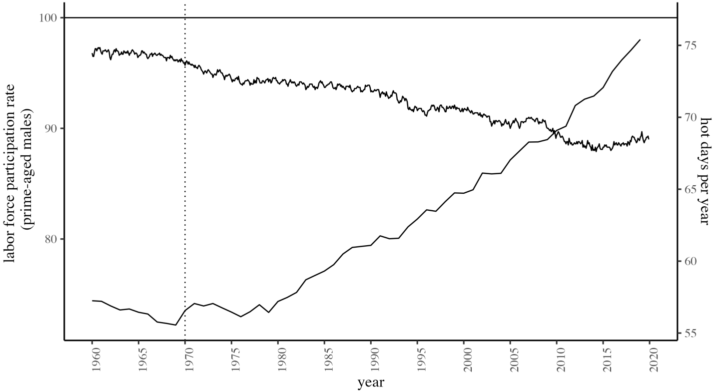
Did climate change induce the labor market dropouts of prime-aged males?

- A far larger proportion of males work *outdoor* than females.
  (e.g. agriculture, forestry, construction, mining, Uber Eats driver)
- Outdoor workers have larger exposure to climate change.
  ($\rightarrow$ cost of work steadily increases)
- Outdoor workers are **essential workers**; measurable outcomes (e.g. harvesting; lumbering) are monitored and little room for moral hazard once hired.($\rightarrow$ higher incentives to drop out)
- Less educated males have **fewer outside options in indoor jobs**.
  Low-skilled indoor jobs are more intensive in ICT and communication.
  (e.g. office clerk; call center operator; waiter)

See the USA: Climate change and Male dropouts

The onset of warming and rising male dropouts **roughly coincided** around 1970. Average hot days per year for an average American increased by 25.4 days in 5 decades.

Figure: Hot days (mean >70F) and prime-aged male LFPRs (1960-2019, USA)



Source: LFPR from BLS. The hot days are 20 year moving-average.

Spread of air conditioners

In parallel to global warming, residential air conditioners (AC) rapidly spread since the 1960s. The relative cost of working outside vs. dropouts surged in this period.

- AC cools down the temperature by lowering the humidity. (→ bring comfortability)
- AC adoption in hot areas is faster than a cold area. (Biddle [2008]) (→ the relative cost expanded even more quickly in hot areas.)
- Intriguingly, initially hot areas (e.g. Southeast, West, Southwest) received the largest effect of climate change. (shown below)

Question 2

How much did climate change explain the racial (and ethnic) gap of male LFPR trend?

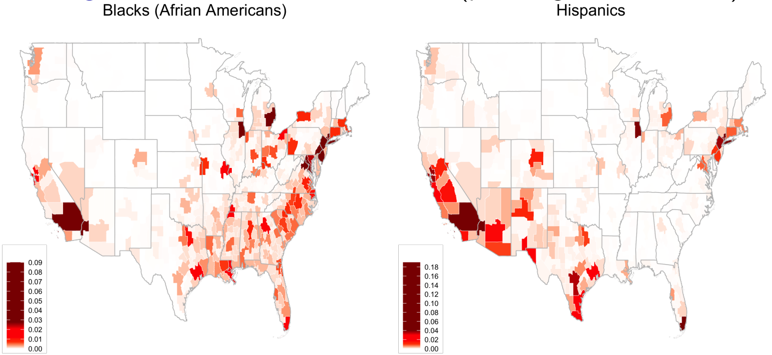
- Blacks agglomerate in the **hottest and most humid** area (South and Southeast; Alabama, Georgia, Mississippi).
- Hispanics agglomerate in the **hottest and least humid** area (West and Southwest; California, Nevada, Arizona).

→ The difference of discomfort, especially in the summer, may account for the racial (and ethnic) gap of LFPR trend relative to whites.

Map: Geographic distribution of minorities

Historically, blacks agglomerate near the Mexican gulf and Atlantic ocean from the Colonial age. Hispanics agglomerate near the Mexican border from immigration since 1970s.

Figure: Minorities share across CZs (prime-aged males, 1970)



Source: Population Census, 1970.

Empirical Strategy

Use a differential change in hot days across regional labor markets as a **"natural" experiment**, controlling for humidity.

- From meteorological daily big data, I document a dramatically rich variation of climate change across regions and years; in fact, some regions experienced cooling.
- Long-run variation of climate change is driven by topography, not significantly shaped by regional economic activities.
- At least, an individual chooses labor supply, taking the climate **as given**.
- Compliers of the treatment (i.e.; less-educated) plausibly have less mobility. (Kennan and Walker [2011])

Data

I assemble a panel of climates (long-run trend of daily weathers) and male LFPRs across Commuting Zones (CZs) during the post-war decades in the U.S. mainland.

- **Variation of analysis** 722 CZs $\times$ years (1970, 80, 90, 2000, 2010, 2019)
- **Climate change**
  - ✓ **daily** temperature and precipitation data from 2,000-3,000 stations from GHCN-daily from National Climatic Data Center (NCDC).
  - ✓ compute # of "hot days" under daily mean temperature over 70F (21.1C); "cold days" under 35F (1.7C). Using a decadal average as a climate.
- **LFPR of males** CZ-level: Census (1970-2000, by decades), and ACS (2010-2012, 2017-2019)

Literature

The paper builds on the literature on the impact of extreme weather (or climate change) and the cause of declining male LFPR.

1. **Weather shocks**
   1. **Mortality** Barreca et al. [2016]; Deschenes and Moretti [2009]
   2. **Production** Deschênes and Greenstone [2007](agriculture); Somanathan et al. [2021] (manufacturing); Dell et al. [2012] (GDP)
   3. **Time allocation** Graff Zivin and Neidell [2014]
2. **Declining LFPR of males**
   1. Krueger [2017] (morbidity); Autor and Duggan [2003]; Parsons [1980] (disability); Aguiar et al. [2021] (gaming technology)
   2. Autor et al. [2014] (trade); Acemoglu and Restrepo [2020] (robots); Autor and Dorn [2013] (computerization)

Model: Working outdoors or Exit

- Consider a basic labor supply model where a market wage $(w(s))$ for skill s and non-labor income NLI is given.
- A person with a skill $s \in [0,1]$ under hot days hd and cold days cd keeps working outdoors if $U^{work} > U^{drop}$ s.t.

$$U^{work} = w(s) - c(hd, cd) - \underbrace{\epsilon}_{\text{unobservable cost}} \quad ; \quad U^{drop} = NLI.$$

- Then, the LFPR is computed by summing up ϵ s.t.

$$LFPR = \int_0^{\Delta} f(\epsilon) d\epsilon$$

- Note that LFPR is strictly increasing in $\Delta \equiv U^{work} - U^{drop}$

Propositions

- Recall the net benefit of working outdoors is

$$\Delta \equiv U^{work} - U^{drop} = w(s) - (NLI + c_{out}(hd, cd) + \epsilon)$$

- A person is more likely to drop out if one of the 3 effects is salient.
  - ✓ **Climate effect:** hd or cd is larger
  - ✓ **Income effect**: NLI is high. (family income or public welfare)
  - ✓ **Substitution effect**: $w'(s)$ is low (adverse labor demand shock)

Why NOT go to indoor jobs?

- Now, add indoor jobs:

$$\begin{cases} U_{in}^{work}(s) = w_{in}(s) - c_{in} - \epsilon & \text{(indoor)} \\ U_{out}^{work}(s) = w_{out}(s) - c_{out}(hd, cd) - \epsilon & \text{(outdoor)} \end{cases}$$

- Assume inside jobs are skill intensive $(w'_{in}(s) > w'_{out}(s))$.
- When $hd \uparrow$, outdoor workers will switch to indoor jobs if

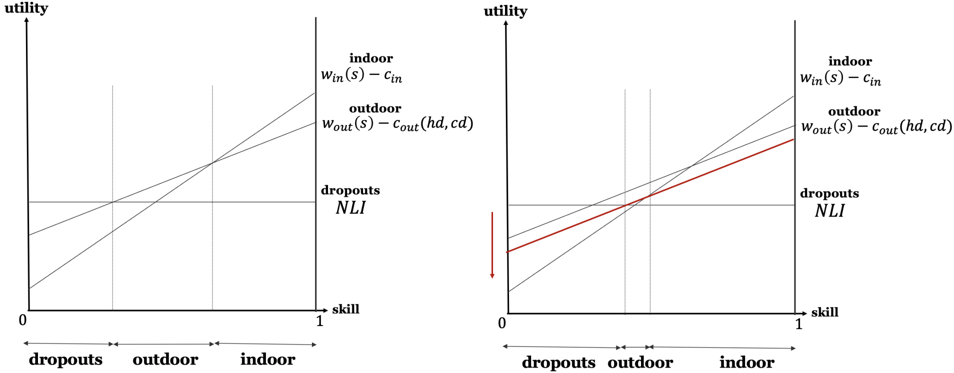
$$w_{in}(s) - w_{out}(s) > c_{out}(hd, cd) - c_{in}$$

  holds; .[1] Under some regularity, only skilled workers (large s) switch.
- When $hd \uparrow$, cost-benefit analysis of less-educated men (low s) is: $U^{drop} > U_{out}^{work}(s) > U_{in}^{work}(s)$.

Propositions: Occupation sorting

As climate gets severer, **a dropout rate** and a share of working indoors *increases* while **a share of working outdoors** *decreases*.

Figure: Dropout or working indoors ($\epsilon = 0$)



Why is dropping out feasible?

$U^{drop} = NLI$ has to be higher than the subsistence level.

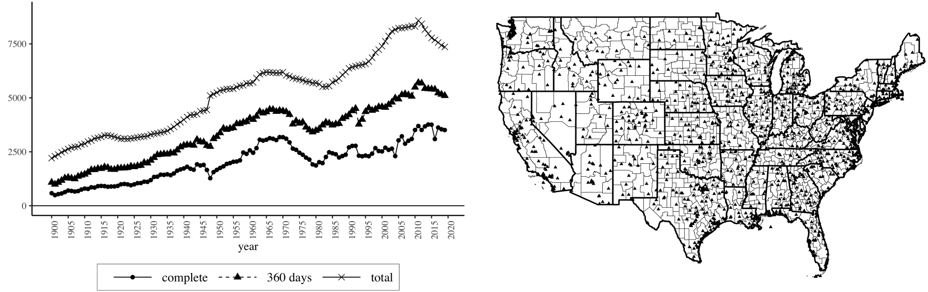
- Intrafamily transfer from parents (Binder and Bound [2019]) or spouses
- Welfare benefit as a "subsidy for dropping out"
  - ✓ Rise of disability insurance benefit (Parsons [1980])
  - ✓ Poverty measures (e.g. social security income; medicaid; food stamp)
- Cohabiting with parents saves housing rent; houses typically has a spare room in the U.S. (e.g. empty kids room)

($\rightarrow$ These fall-back options appear to be only substantial for **developed economies in the post war period**.)

Daily weather big data

The daily weather (max/min temperature and precipitation) comes from stations, recorded by GHCN-Daily. I take an inverse-distance weighted average of records of **3 closest stations from CZ population centroids**.

Figure: stations recording temperature (1900-2019); distribution (2019)



Source: GHCN-Daily from NOAA (National Oceanic and Atmospheric Administration).

Construct a temperature

I compute a daily temperature T_d as

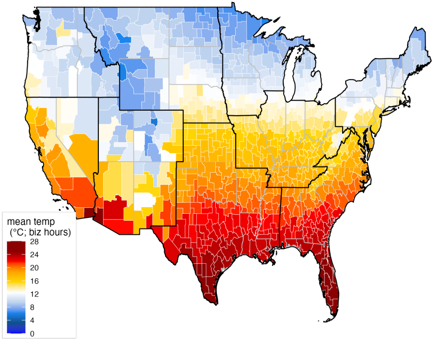
$$T_d = \omega T_{max} + (1 - \omega) T_{min}.$$

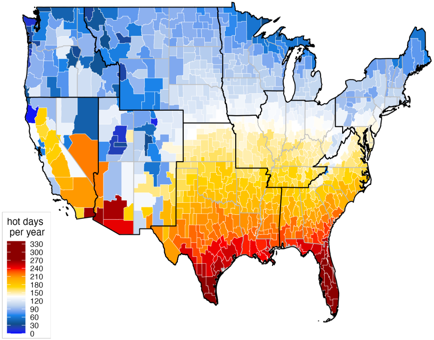
1. Mean temperature: $\omega = 0.5$ (convention of literature)
2. **Business hour temperature:** $\omega = 0.75$ (business hours (8AM-6PM; including commuting).
   - ✓ Assuming linear temperature cycle between T_{max} and T_{min}.

Annual temperature (level)

Significant heterogeneity of baseline temperature across regional labor markets. **South, Southeast, West area is hotter.**

Figure: Baseline temperature across CZs (2010-19; level (left); hot days (right))





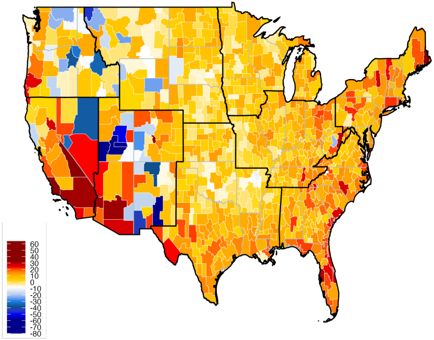
Source: Computed from GHCN-daily.

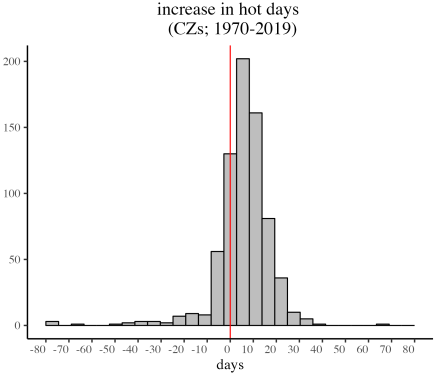
Annual temperature (change)

Initially hot Southeast, West, Southwest areas have been increasingly getting hotter. Some regions experienced cooling.

($\rightarrow$ Different shocks from automation, ICT or China shocks!)

Figure: Change of # of hot days (mean >70F) across CZs (1960-70 to 2010-19)



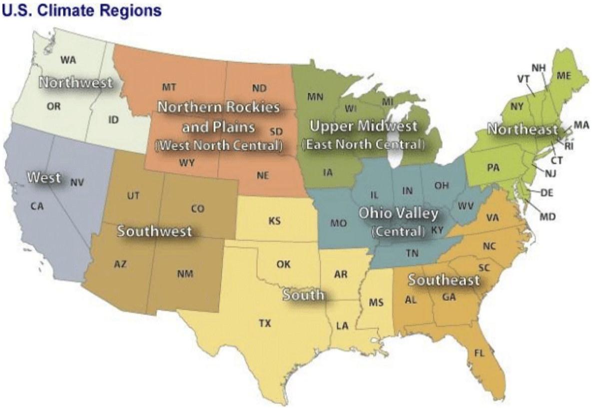


Source: Computed from GHCN-daily.

Definition: Climate region

The U.S. includes 9 climate regions from tropical one to deserts.

Table: Annual hot days by climate regions (1970-2019)

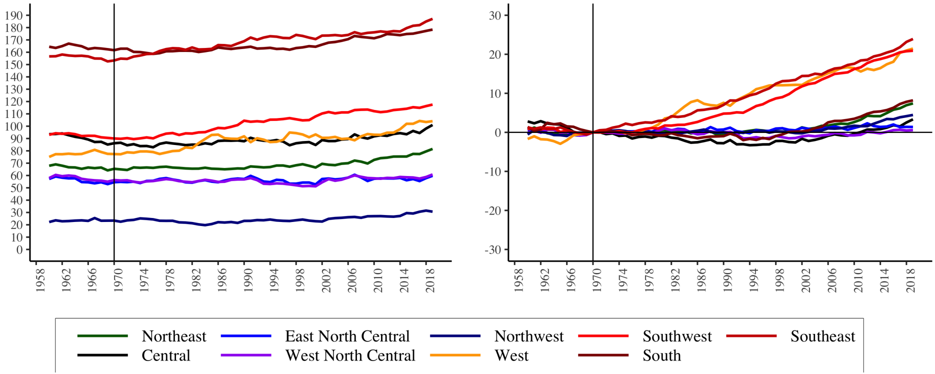


Source: National Centers for Environmental Information (NCEI); NOAA

Climate change by climate region

When climate is measured by hot days, hot regions are increasingly getting hotter.

Table: Annual hot days across climate regions (1970-2019)



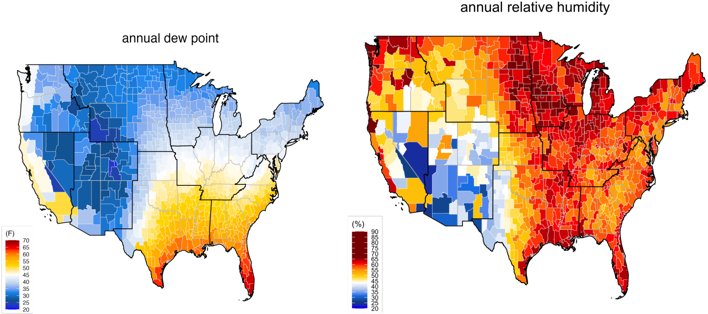
Source: Computed from GHCN-daily.

Humidity

Humidity is *lower* in the **west area** close to mountains and *higher* in the **east area** near the Mexican gulf.

- **Daily relative humidity** is computed from a dew point and mean temperature through a standard meteorological formula.

Figure: Humidity across CZs (2019)

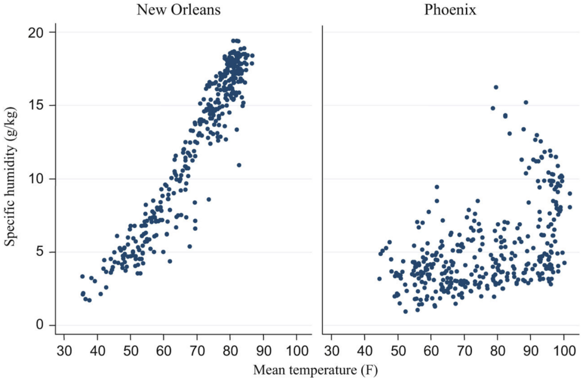


Source: Computed from Global Summary of the Day (GSoD).

Examples: Outlier cities

New Orleans in Louisiana is *much more humid* than Phenix in Arizona with comparable temperature. (→ **discomfort in summer** is much different.)

Figure: Distribution of mean daily temperature and humidity (2002 only)

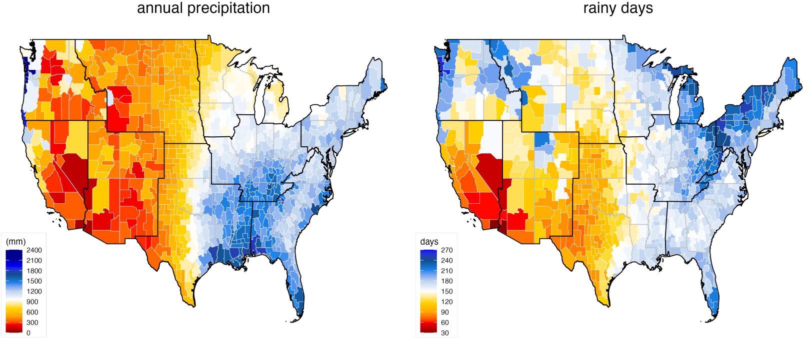


Source: Barreca (2012); Humidity is a specific humidity (g/kg).

Precipitation

Humidity is heavily shaped by precipitation. **East region** has larger annual precipitation and rainy days due to the U.S. geography. **West region** near desserts (especially, California) suffers from droughts and even forest fires.

Figure: Precipitation across CZs (average in 2000-2019)



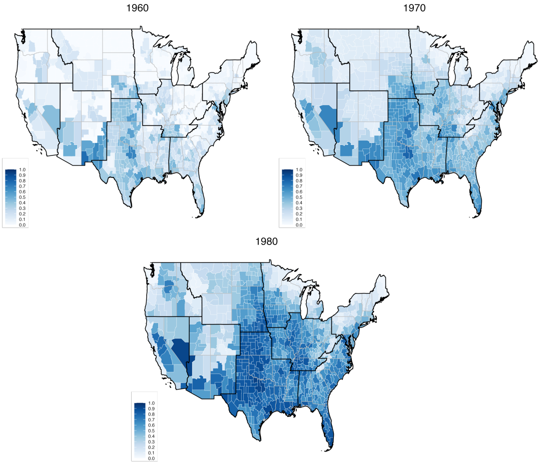
Source: Computed from GHCN-daily.

Spread of Air conditioner

Hotter regions experience faster adoption rates of ACs. (Biddle [2008])

(→ a gap of relative cost increasingly expands in hotter areas.)

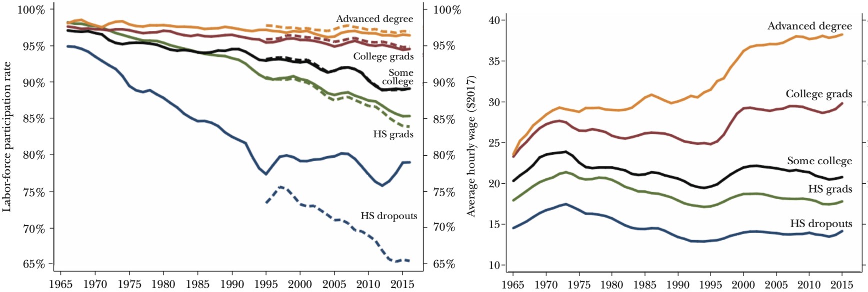
Figure: Fraction of households with residential ACs (1960-1980)



Stylized fact: LFPR trend by education (US)

The dropout is stark for **the less-educated**. (→Many literature studies the substitution effect from adverse labor demand shocks)

Figure: LFPR by education attainment (males aged 25-54)

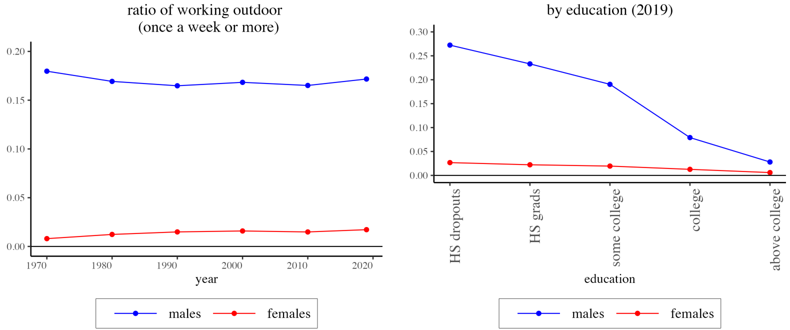


Note: BLS, NBER. (Source: Binder and Bound [2019])

The proxy of working outdoors

Using Work Context survey from ONET, I construct an indicator where **a person regularly works outdoor (cf. at least once a week)** for 873 occupations. 95% of outdoor workers are males (mostly less-educated).

Figure: The ratio of outdoor workers (left: 1970-2019; right: by education (2019)))

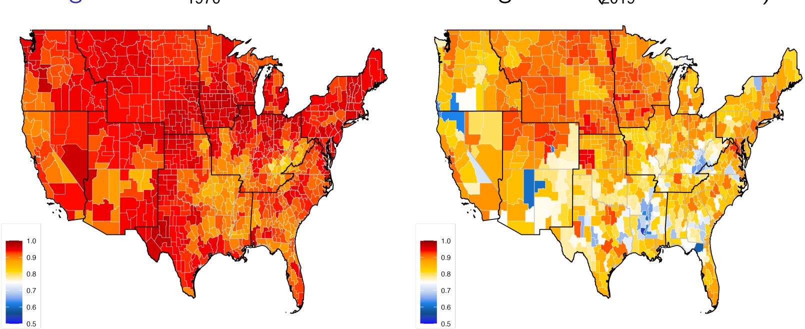


Note: ACS 2017-2019, and *ONET*.

LFPR of prime-aged males

Male LFPR significantly dropped, especially in the South and Southeast region.

Figure: LFPR of males across Commuting Zones (1970 vs. 2019)

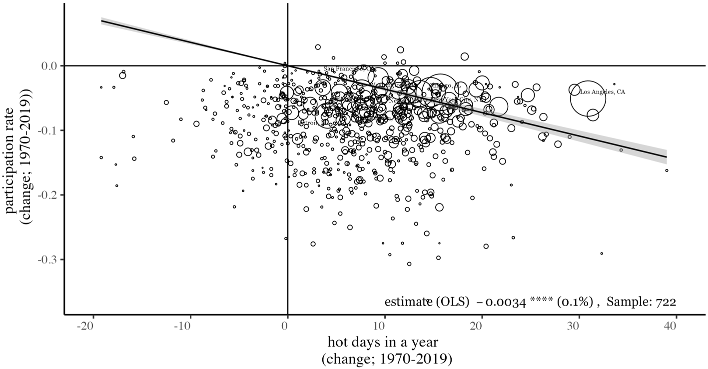


Note: Bold line is a climate zone from NOAA.

Bubble plots: CZ-level

A naive first-difference model shows that 10 more hot days reduces LFPR by 0.3%. ($p < 0.1\%$).

Figure: Exposure to hot days and male LFPRs during 1970-2019 (across CZs)



Note: *Weighted by a prime-aged population in 1970, captured by the size of each bubble.*

Empirical model Regional covariates

I estimate the model by the panel data regression at CZ l and year t:

$$LFPR_{l,t} = \underbrace{\beta^h hd + \beta^c cd}_{\text{effect of climate change}} + \underbrace{\mathbf{X}_{l,t}}_{\text{covariates}} + \underbrace{\delta_l + \delta_t}_{\text{location and year FE}} + \epsilon_{l,t}$$

30 regional covariates along the 5 categories:

- **Climate**: precipitation, days with no rains, air conditioner adoption
- **Demography**: age, race, immigrants and veterans; education
- **Family structure**: share of never-married; divorced (separated); children
- **Health**: ratio of disability (only 1970-)
- **NLI**: personal or family NLI; ratio of farm; rented house
- **Welfare income**: recipient ratio and mean level of welfare income (only 1970-)

Labor demand shocks

To incorporate labor demand shocks to induce substitution effects, I construct a shift-share Bartik shocks for employments and wages of prime-aged workers. (See Goldsmith-Pinkham et al. [2020] for a background)

$$B_{l,d} = \sum_k \underbrace{s_{l,k,d_0}}_{\text{locational } l \text{ industry } k \text{emp. share}} \underbrace{g_{k,d}}_{\text{national industry } k \text{ growth rate}}$$

Construct a list of alternatives, but the estimates are largely unchanged.

- prime-aged males employment
- Exclude self-employment
- Non-college educated workers
- Separately include outside and inside workers

Baseline result (males; 1970-2019)

After controlling for all covariates, **10 more hot days reduces LFPR by 0.2%** ($p < 1\%$) during 1970-2019.

Table: *Climate impact on male LFPRs (across CZs)*

	LFPR (prime-aged males)			
treatment period	1960-2019			
	(1)	(2)	(3)	(4)
10 hot days	-0.003 ***	-0.003 ***	-0.002 ***	-0.002 ***
10 cold days	-0.003	-0.003	-0.002	-0.002
precipitation	○	○	○	○
air conditioner	○	○	○	○
demographics	○	○	○	○
health	×	○	○	○
family	×	×	○	○
NLI	×	×	○	○
welfare	×	×	×	○
czone and year fixed effects	Yes	Yes	Yes	Yes
Observations	4,332	4,332	4,332	4,332

Note: $*** : p < 1\%$; $** : p < 5\%$;$* : p < 10\%$. *Weighted by a prime-aged male population each year. SE is clustered by states.*

Baseline result (females; 1970-2019)

Under the SAME specifications for females, the effects are **close to zero and mostly insignificant**. ($\rightarrow$ Outdoor workers are predominantly males.)

Table: Climate impact on **female** LFPRs (across CZs)

	LFPR (prime-aged females)			
treatment period	**1960-2019**			
	(1)	(2)	(3)	(4)
10 hot days	-0.001	-0.002	-0.00	-0.00
10 cold days	-0.001	-0.001	-0.002	-0.002
precipitation	○	○	○	○
air conditioner	○	○	○	○
demographics	○	○	○	○
health	✕	○	○	○
family	✕	✕	○	○
NLI	✕	✕	○	○
welfare	✕	✕	✕	○
:zone and year fixed effects	Yes	Yes	Yes	Yes
Observations	4,332	4,332	4,332	4,332

Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Weighted by a prime-aged female population each year. SE is clustered by states.*

By education: Less-educated reacted more?

Consistently with the model, the effect is **larger** for less-educated. The relationship is unobserved in females.

Table: Effects by education

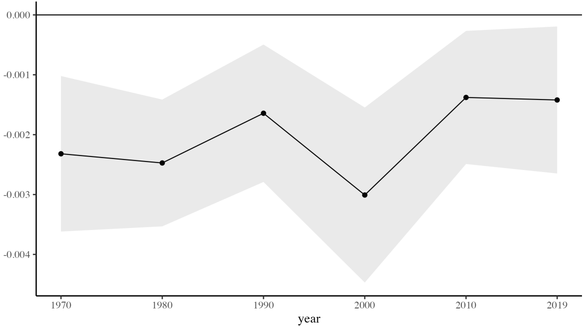
		dependent variable: participation ratio	
		(1)	(2)
		males	females
10 hot days ×	HS dropouts	-0.005 ***	0.005
	HS graduates	-0.006 ****	-0.002
	some college	-0.003 **	-0.005 **
	college graduates	0.004	0.006
	above college	0.0003	0.003
full controls		Yes	Yes
czone * year fixed effects		Yes	Yes
Observations		4,332	4,332

Note: *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged male population.*

Effects by periods or areas

The climate effect is fairly stable across years. Perhaps, surprisingly, the effect of hot days is **almost uniform** across the areas of different levels of hot days.

Table: Dynamic effects



Note: *Full-controlled and FEs in year×CZs. Weighted by a prime-aged male population each year. SEs are clustered by states.*

Alternative stories

1. **Composition effect by mobility of workers**

- outside workers left warming areas to avoid labor discomfort.
  - ✓ Compliers of the treatment have plausibly less mobility. (Kennan and Walker [2011]) Even if it's high, my estimates are lower bound.
- early-retirees before 54 moved to high-warming areas to prefer heat as residential amenity.
  - ✓ Excluding the movers in recent 5 years strengthens the estimates.

1. **Product market channel**

- Climate change hurt agriculture thus, suppress incomes at farms.
  - ✓ agriculture employment accounts for less than 5% of U.S. prime-aged population.
    - Controlling for a ratio of farm employment does not affect the estimate.
    - The estimate is flexible to spread of residential air conditioner. (below)

How large is the effect?

Interacting the estimate with prime-aged population during 1970-2019, 10 more hot days (at biz hours) **generate 200,000 male dropouts. (caveat: including in-and-outs)**

- During 1970-2019, climate change (23.5 hot days (at biz hours) have produced 480,000 male dropouts.
- Climate change alone explains **approximately 10%** of prime-aged male dropouts during 1970-2019.
- Linearly extrapolating the climate trend to 2030, at least 280,000 males will drop out.

In-and-out?: flexible work style

Climate change *reduces* **weeks during a year**, choosing a seasonal part-year job. (c.f. the rise of in-and-out work style; Coglianese [2018])

Table: Climate impact on work style (limited to employees)

	dep. variable		
	weeks in a year	usual hours in a week	total hours in a year
	(1)	(2)	(3)
10 hot days	**-0.038 ****	**0.094 ***	0.002
Observations	4,332	4,332	4,332

Note: $*** : p < 1\%$; $** : p < 5\%$;$* : p < 10\%$. *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged male population. SEs are clustered by states.*

In-and-out?: being your boss

Climate change *reduces* **males' normal employment rate** and *raises* **self-employment rate (e.g. gig workers; working at home)**, plausibly due to flexible work schedules in response to climate shocks.

Table: Climate impact on labor force attachment

	dep. variable (denominator: prime-aged males)		
	not self-employment rate	self-employment rate	self-employment rate (at home)
	(1)	(2)	(2')
10 hot days	-0.003 **	0.002 ***	0.001 **
Observations	4,332	4,332	4,332

Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged population each year. SEs are clustered by states.*

(1) Do outdoor workplace receives more effect?

Expectedly, exposure to outdoors *accelerates* the response. (especially, with a roof) Within indoor workplaces, air conditioners *flip* the impact.

Table: Climate effects by outdoor environments

		dependent variable: participation ratio				
		(1)	(2)	(3)	(4)	(5)
hot days ×	pre-period share of outdoor	-0.002 ***				
	outdoor with cover		-0.003 ****			
	open vehicle			-0.002 **		
	indoor (non-controled)				-0.003 **	
	indoor (controled)					0.002 ***
	hot days	-0.002 **	-0.001	-0.002 ***	-0.004 ****	-0.002 **
	Observations	4,332	4,332	4,332	4,332	4,332

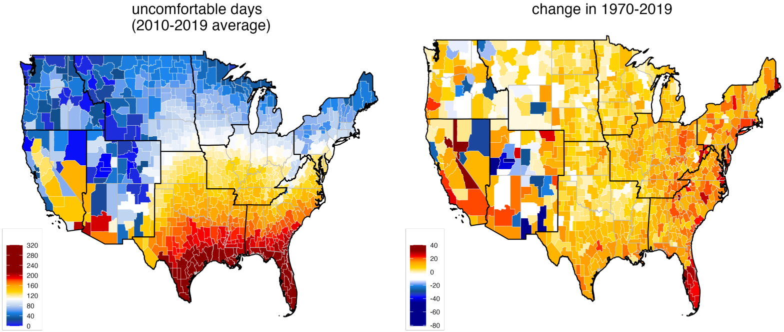
Note: *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged male population. SEs are clustered by states.*

(2) Do workers avoid discomfort?

DI is a function of temperature and relative humidity. Uncomfortable days have DI > 75. (A majority of people feels uncomfortable)

- The West or Southwest regions are comparably hot, but less uncomfortable compared to the Southeast or South.

Figure: Discomfort index across CZs



Source: Computed from GHCN-daily.

Discomfortable vs. hot days

Discomfort index, narrowing to business hours or non-rainy days gives larger and more robust estimates.

Table: Estimates from other climate proxies

	dep. variable: participation ratio (prime-aged males)			
scope of climates	business hours	all hours	business hours on no rainy days	
treatment period	1960-2019	1960-2019	1960-2019	1946-2019
	Panel A: temperature only			
	(1)	(2)	(3)	(5)
10 hot days	**-0.002 *****	**-0.002 ***	**-0.004 ******	**-0.003 *****
10 cold days	-0.002	-0.002	-0.005 *	-0.003
	Panel B: uncomfortable index			
	(1)	(2)	(3)	(5)
10 discomfort days	**-0.003 *****	**-0.002 ***	**-0.005 ******	**-0.004 ******
10 cold days	-0.002	-0.002	-0.006 **	-0.003
Observations	4,332	4,332	4,332	5,054

Note: $****: p < 0.1\%$;$***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged male population. SEs are clustered by states.*

(3) Role of *residential* air conditioner?

By contrast to business air conditioner, **spread of residential air conditioner** (1970-2000) augments the dropouts in response to climate change as well as family income, welfare income, marital status, a ratio of farm.

Table: Results from other climate proxies

		dep. variable LFPR (denominator: prime-aged males)				
		(1)	(2)	(3)	(4)	(5)
	10 hot days	-0.002 ***	0.008 **	-0.001	-0.002 ***	-0.01 *
interacted with	air conditioner	-0.001 *				
	log(family income)		-0.001 ***			
	marriage			-0.002 **		
	farm				-0.005 *	
	welfare income					-0.039 ***
		only 1970-2000				
	Observations	2,888	4,332	4,332	4,332	4,332

Note: $****: p < 0.1\%; ***: p < 1\%; **: p < 5\%; *: p < 10\%$. *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged male population. SEs are clustered by states.*

(4) Outside to inside?

Climate change *decreases* the share of **outdoor salaried worker** and **unemployment**. Excluding the shift to self-employments, this accounts for the rise of dropouts.

Table: Outdoor vs. indoor vs. dropouts

	dep. variable: Ratio of (denominator: prime-aged males)				
	working outdoors			not working	
	working for salary	self-employer	total	unemployment	dropouts
	(1)	(2)	(3)	(7)	(8)
10 hot days	**-0.002 *** **	**0.001 *** **	-0.001	**-0.001 ***	**0.002 *** **
Observations	4,332	4,332	4,332	4,332	4,332
	working indoors				
	working for salary	self-employer	total		
	(4)	(5)	(6)		
10 hot days	-0.001	**0.001 ** **	-0.000		
Observations	4,332	4,332	4,332		

Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged male population. SEs are clustered by states.*

(5) How to exit: go to prisons, not schools?

Non-employment rate in the institution (e.g. chiefly prison) significantly *increases* in contrast to academic enrollment. (e.g. go to community college)

Table:

	dep. variable (denominator: prime-aged males)		
	non-working (institition)	non-working (disability)	student
	(1)	(2)	(3)
10 hot days	**0.001 ***	0.001	**-0.001 *****
Observations	4,332	4,332	4,332

Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Full-controlled and FEs in year×CZs. Weighted by a 1970 prime-aged male population. SEs are clustered by states.*

Why are dropouts among blacks severest?

Decompose the climate response into elasticity vs. climate exposure.

1. **Is labor supply elasticity of climate change larger for blacks?**
   - ✓ Given the outdoor working, the response to heat is higher for blacks? (e.g. Obesity?)
2. **Is climate exposure larger for blacks?**
   1. The share of working outdoor is larger for blacks?
   2. The number of hot days is larger for blacks?

1. LS elasticity larger for blacks?

So far, no evidence is confirmed for 1. ($\rightarrow$ I suspect that the climate exposure is dominant.)

- Regress DIDID: β^B is close to 0 and insignificant.

$$LFPR_{l,d} = \beta^h hd_{l,d} + \beta^h hd_{l,d} \times Outdoor_{l,d-10} + \beta^B hd_{l,d} \times Outdoor_{l,d-10} \times ratio^{Black}_{l,d} + \cdots$$

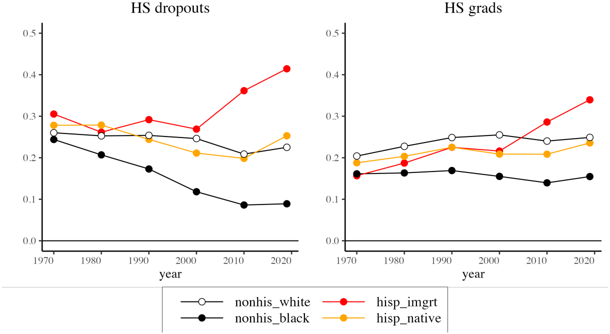
- Replacing to hispanics, the coefficient shows significantly positive. ($\rightarrow$ Hispanics appears to be resilient to heat shocks.)

2-(a) The share of working outdoor is larger for blacks?

Opposite. **Blacks are less likely to work outdoors** than whites or hispanics even after education is controlled.

(→ The remaining is the difference of hot days.)

Figure: The share of prime-aged outdoor workers by race (prime-aged males; 1970-2019)



Source: Census, ACS and ONET.

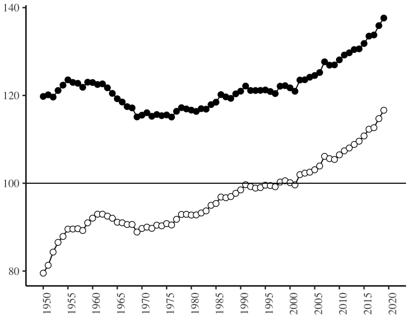
2-(b) Is climate exposure larger for blacks?

Yes, a gap of 18 hod days for 5 decades. A simple envelope calculation:

-0.2% for 10 days in a decade $\times$ Δ18 days exposure $\times$ 5 decades = -1.8%.

$\rightarrow$ This accounts for **30% of black-white gap of LFPR trends during 1970-2019**. (LFPR gap widened from 5% to 11%)

Figure: Hot days experienced by average blacks and whites (1950-2019)



Summary

Throughout the human history, males have enjoyed comparative advantage in working outdoors. The paper suggests that **modern climate change hurt their advantage**.

- Climate change drives the decline of male LFPRs.
- Geographic variation of climate change may be responsible for dispersion of racial (black vs. white) LFPR trends.
- **Policy implication**: subsidy or OSHA regulation for **deployment of air conditioners** at indoor workplaces. This would prevent further dropouts.

For comments

Thank you for listening. Please feel free to send me a feedback to my email:

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