Climate Change and the Demise of Marriage of the Millennials

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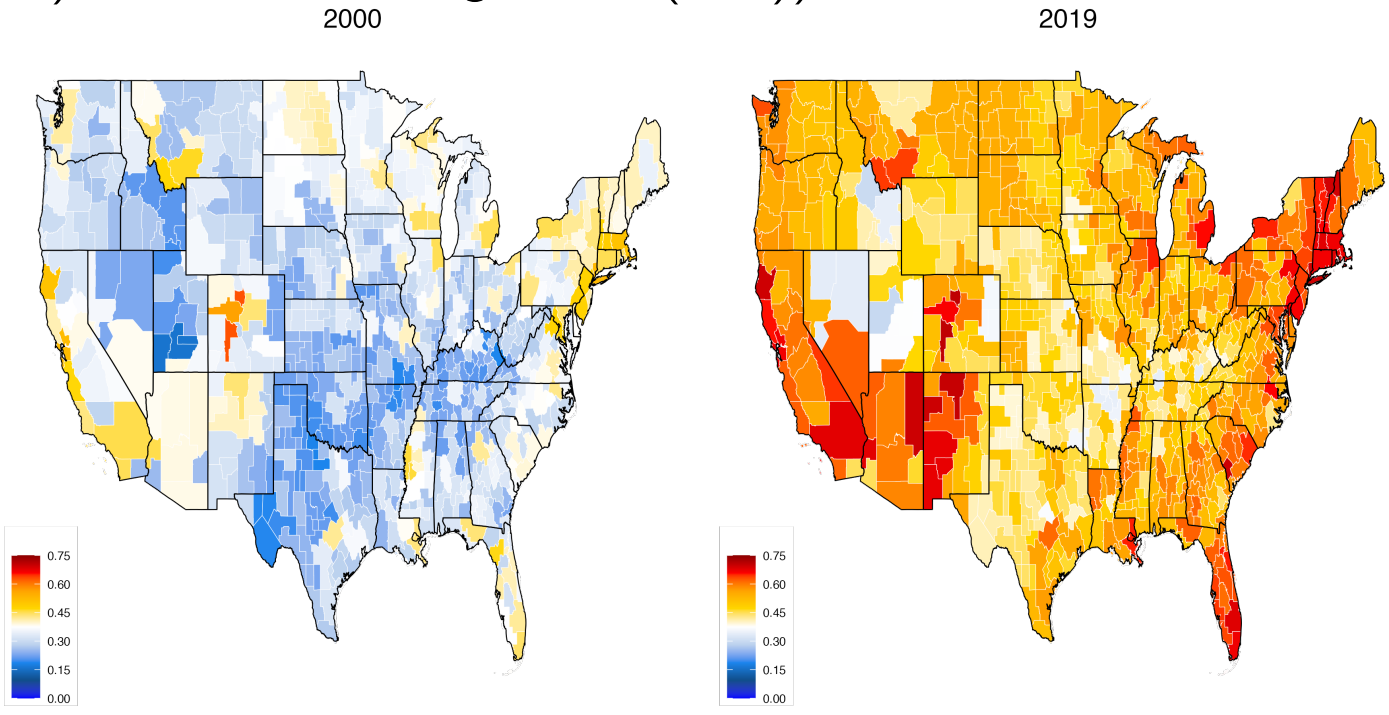
Background: Declining marriage rate of the Millennials

Since 1970s, a marriage rate has been declining across rich countries, most severely for the Millennial generation and after (born in 1980-).

- **Alarming**: population aging & shrinking; unstable environment for children; threat on social security

Figure: A never-married ratio (25-34 aged males; 2000 (Gen. X) vs. 2019 (Millennials), U.S. Commuting Zones (CZs))

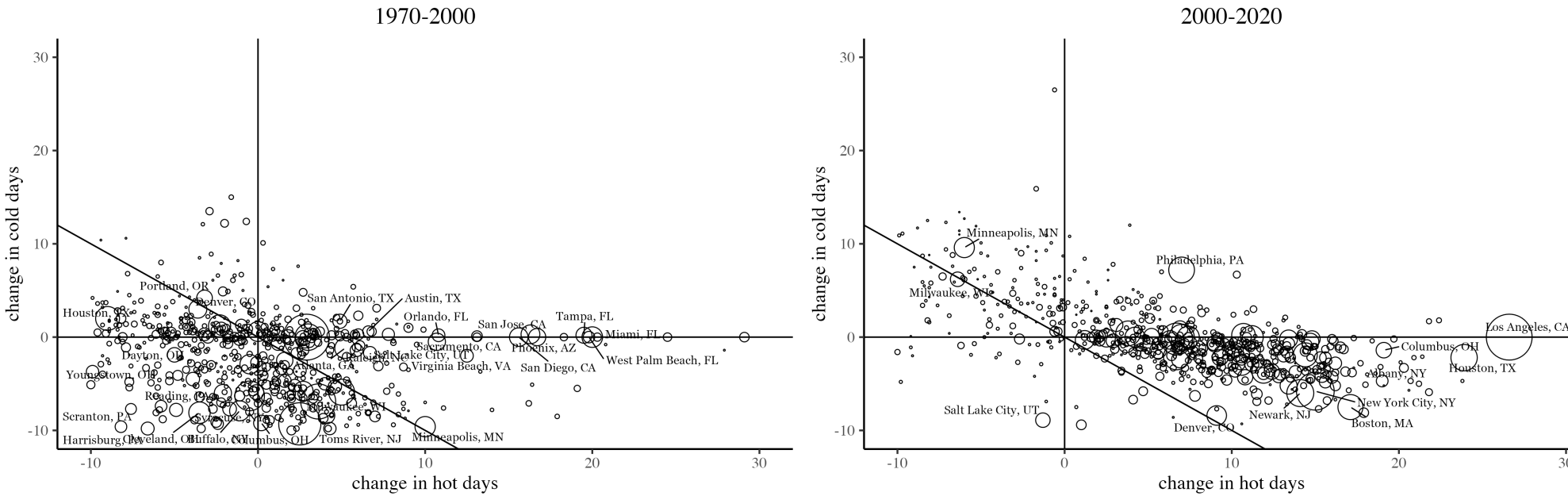


Note: Census and American Community Survey.

Climate change at the dawn of the Millennium

The warming has started around 1970, and the 21st century underwent the largest recorded increase in hot days (>75F). The Millennials are the first generation coming of age in the new century, receiving the severest warming in the formative age (18-34).

Figure: Change of hot and cold days across CZs in the U.S. (1970-2000 vs. 2000-2019)



Note: Computed from GHCN-Daily. The hot days are 20 year moving-average (right).

Question: Did climate change fuel declining marriage rate?

The paper tests a hypothesis that climate change *suppressed* marriage rate, especially of the Millennials.

1. Due to technology revolution and globalization, an **increasing share of non-colleged males work outdoors.** (e.g., agriculture, construction, mining, package delivery)

2. Due to global warming, working outdoors bring more discomfort (e.g. sweating).
   - ✓ In the long run, worsens mental health. The rise of crimes (Ranson [2014]), suicides (Burke et al. [2018]), negative tweets (Baylis [2020]) on hot days)

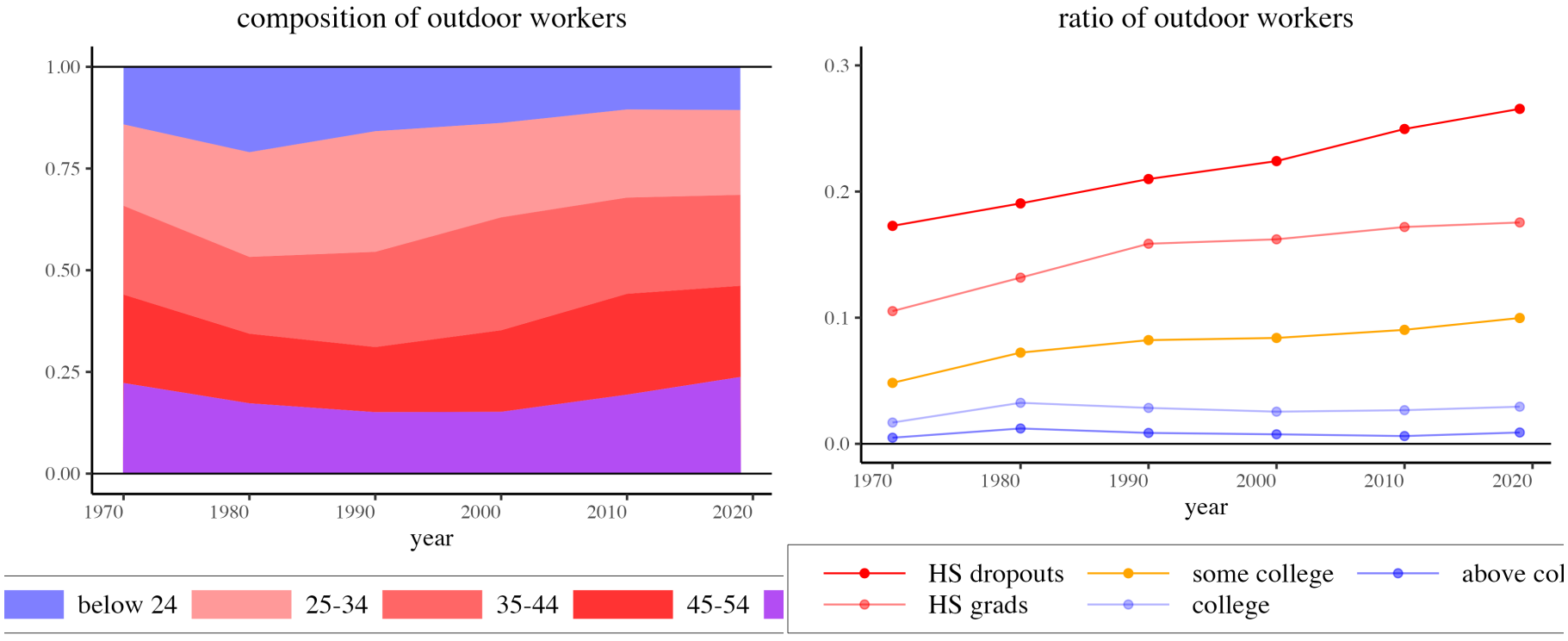
3. Due to higher cost of working outdoors, **the Millennial non-colleged males shifted to indoor sectors with lower salary.** (including unemployments and dropouts at home)

   $\Longrightarrow$ **Their marriage market value declined.**

More non-colleged males worked outdoors

Historically, 95-98% of outdoor workers have been males. Increasingly ratio of non-colleged males work outdoor regularly.

Figure: The composition and ratio of working outdoor by gender and education

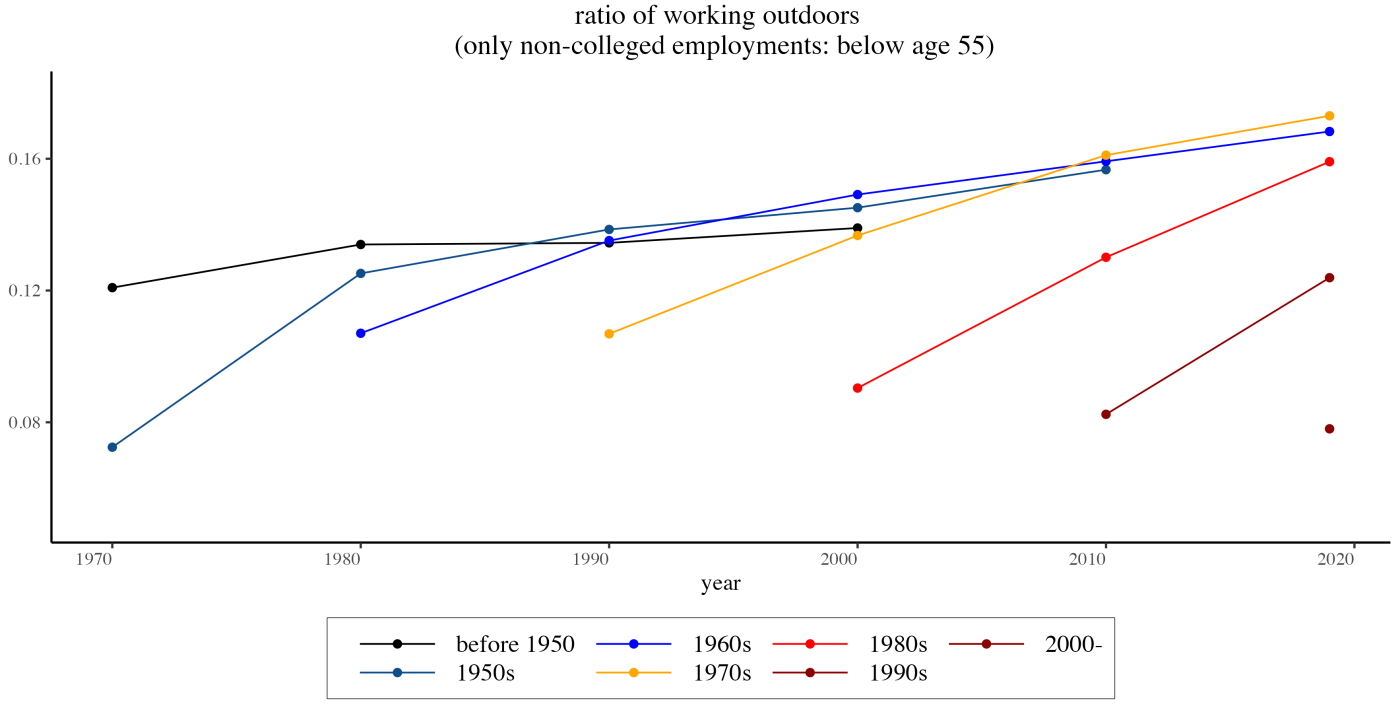


Note: Census, ACS, and Work Context survey at ONET. I construct an indicator where a person regularly works outdoor (cf. at least once a week) for 873 occupations. Ratio of outdoor workers is a ratio out of employment.

Millennial non-colleged males avoided working outdoors

Non-colleged males in the younger cohort are **becoming detached from work outdoors**.

Figure: Trend: the ratio of working outdoor by age (**out of employments**)



Note: Census, ACS, and Work Context survey at ONET. I construct an indicator where a person regularly works outdoor (cf. at least once a week) for 873 occupations.

Empirical Strategy

Use a differential change in hot (or cold) days across regional labor markets as a **"natural" experiment** in the U.S. mainland.

- **Variation of analysis** 722 CZs $\times$ years (1970, 80, 90, 2000, 2010, 2019)
  - ✓ CZ most likely captures both temperature of workplaces and commuting routes (instead of counties).
  - ✓ Not only marriage rates, but labor market proxies (e.g., occupation and wages) and demographics are computable from micro data.
- From daily (partially hourly) weather big data, I document a dramatically rich variation of climate change across CZs.
- Climate change is governed by meteorology and geography.

Data

I assemble a panel of climates (long-run trend of daily weathers) and never-married rates across CZs during a half century.

- **Climate change**
  - ✓ **daily (and partly hourly)** temperature and precipitation from 2,000-3,000 stations from National Climatic Data Center (NCDC).
  - ✓ compute # of "hot days" under daily mean temperature over 75F (23.6C); "cold days" under 35F (1.7C). Using a decadal average as a climate.
- **Never-married rate**
  - ✓ IPUMS micro data from Census (1970-2000, by decades), and American Community Survey (2010-2012, 2017-2019)

Preview of preliminary findings

- Occupational exposure to 10 more hot days (>75F (23.6 C)) or cold days (<35F (1.6C)) in a decadal baseline **increased** never-married rates**.**
- Both hot and cold days **decreased** the ratio of salaried outdoor workers, **increased** unemployed and dropouts of young males (aged 18-34).

- Across occupations, the ratio of salaried working outdoors for males is **negatively linked** with never-married rates.
- (conjecture) Climate change **shrank** the gender wage gap by occupation sorting.

Literature: declining marriage rate

The paper adds to the marriage literature via a lens of an outdoor labor market, exposed to the climate change.

- Labor demand shocks and marriage rate
  - ✓ Free trade shocks (Autor et al. [2019])
  - ✓ Declining labor force participation for males (Binder and Bound [2019]; Krueger [2017])
- Educational attainment of females (Chiappori et al. [2009])
- Rising disability and morbidity (e.g. opioid; alcohol) (Parsons [1980]; Case and Deaton [2017])

Empirical model: isolate climate effects

I estimate a DID-style model by the panel data regression at CZ l and decade t (1970,1980,1990,2000,2010,2019):

$$SingleRate_{l,t} = \sum_{z \in \{hot,cold\}} \left(\beta^z day^z_{l,t} \times \underbrace{r_{l,t_0}}_{\text{initial outdoor intensity}} \right) + \underbrace{\mathbf{X}_{l,t^{-1}}}_{\text{covariates}} + \underbrace{\mathbf{B}_{l,t}}_{\text{labor demand shocks}} + \underbrace{\delta_{s,t} + \delta_l}_{\text{state}\times\text{year FE and czone FE}} + \underbrace{\epsilon_{l,t}}_{\text{clustered by czones}}$$

- Now, climate is interacted with **an initial (1960) outdoor emp. share**.
- Regional covariates $\mathbf{X}_{l,t^{-1}}$ at start-of-decade t^{-1} includes:
  - ✓ **Other climate proxies**: precipitation and snow
  - ✓ **Demography**: age, education, race and ethnicity, veterans, birth of state
  - ✓ **Health**: disability **Wealth**: personal NLI, rented house

1. Climate change raised Never-married rates

Both hot and cold days **raised a single rate** for females (and almost equivalently, males, too).

Table: *Never-married rates (aged 25-34* **females***; across CZs)*

	dep. variable: never-married rate (p.p.)			
	females (age 25-34)			
	(1)	(2)	(3)	(4)
10 hot days	0.765 ***	0.373 **		
	(0.214)	(0.175)		
10 cold days	0.929 ***	0.360		
	(0.312)	(0.346)		
10 hot days × ratio(outdoor)			4.47 ***	2.27 **
			(1.25)	(0.896)
10 cold days × ratio(outdoor)			10.9 ***	6.35 ***
			(1.81)	(1.63)
start-of-decade covariates	Yes	Yes	Yes	Yes
czone FEs	Yes	Yes	Yes	Yes
year FEs	Yes		Yes	
state × year FEs		Yes	Yes	Yes
errors clustered by	states	czones	states	czones
Observations	4,332	4,332	4,332	4,332

Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Weighted by regional female population in 1960.*

2. Climate change reduced salaried outdoor workers

Both hot and cold days **reduced salaried outdoor emp. rate** and **raised self-employed emp. rate**. ($\rightarrow$ Salaried workers have **less flexibility** of time and location than the self-employed.)

Table: *Emp. rate of outdoor workers (aged 25-34* **males***; across CZs)*

	dep. variable: outdoor worker ratio of population (p.p.)			
	males (age 25-34)			
	(1)	(2)	(3)	(4)
	salaried	self-employed	salaried	self-employed
10 hot days	-0.175	**0.190** ***		
	(0.125)	**(0.049)**		
10 cold days	-0.010	-0.084		
	(0.210)	(0.110)		
10 hot days × ratio(outdoor)			**-1.76** ***	**1.75** ***
			(0.632)	**(0.364)**
10 cold days × ratio(outdoor)			**-2.81** ***	**3.36** ***
			(0.966)	**(0.601)**
start-of-decade covariates	Yes	Yes	Yes	Yes
czone + state × year FEs	Yes	Yes	Yes	Yes
errors clustered by	czones	czones	czones	czones
Observations	4,332	4,332	4,332	4,332

Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Weighted by regional male population in 1960.*

I construct an indicator where a person regularly works outdoor (cf. at least once a week) for 873 occupations.

3. Climate change generated Non-workers

Both hot and cold days **raised unemployed and dropout rate**.

Table: *Market attachments (aged 25-34* **males***; across CZs)*

	dep. variable: Labor force participation rate (p.p.) (males, aged 25-34)				
	LFPR	**emp rate (non-self)**	**emp rate (self)**	**unemp rate**	**drop rate**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
10 hot days × ratio(outdoor)	**-1.60 *****	**-5.52 *****	**2.46 *****	**1.46 *****	**1.47 *****
	(0.59)	**(0.93)**	**(0.50)**	**(0.44)**	**(0.49)**
10 cold days × ratio(outdoor)	**-2.05 ****	**-8.73 *****	**4.77 *****	**1.92 ****	0.95
	(0.81)	**(1.52)**	**(0.88)**	**(0.74)**	(0.68)
start-of-decade covariates	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
czone + state × year FEs	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
errors clustered by	**czones**	**czones**	**czones**	**czones**	**czones**
Observations	**4,332**	**4,332**	**4,332**	**4,332**	**4,332**

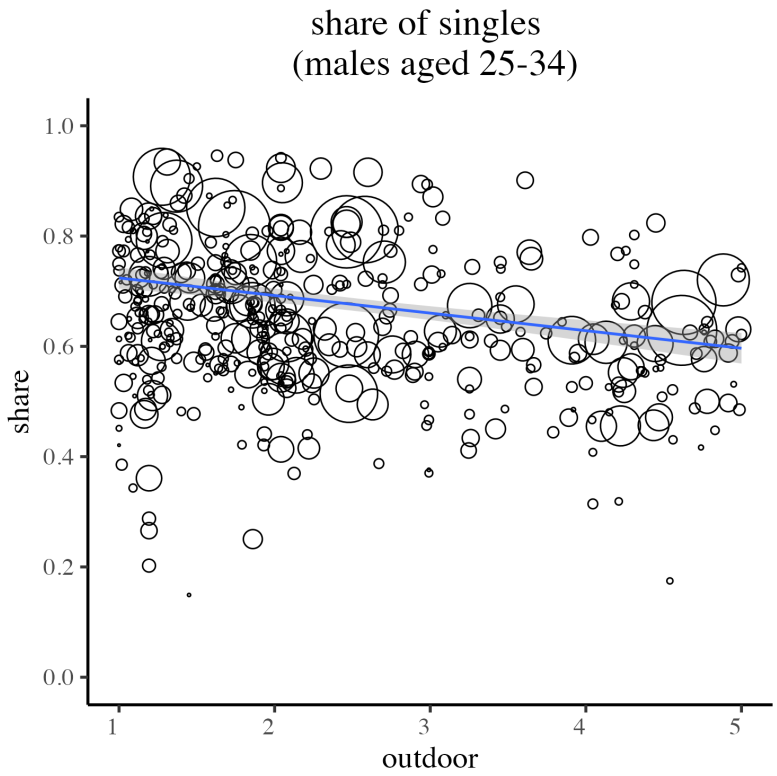
Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Weighted by a prime-aged male population.*

4. Salaried outdoor workers are typically more married?

Working in salaried (or self-employed) outdoor jobs is negatively (or positively) associated with a never-married rate.

Table: *Exposure to outdoor and single rates (aged 25-34; across occupations in 1970-2019)*

	dep. variable: never-married rate (p.p.) (aged 25-34)	
outdoor proxy	extensive margin	intensive margin
	(1)	(2)
outdoor	-0.101 ***	-0.028 ***
	(0.007)	(0.002)
outdoor × ratio(self-employed)	0.282 ***	0.116 ***
	(0.047)	(0.015)
ratio(self-employed)	-0.243 ***	-0.453 ***
	(0.035)	(0.058)
start-of-decade covariates	Yes	Yes
year FEs	Yes	Yes
Observations	2,100	2,100

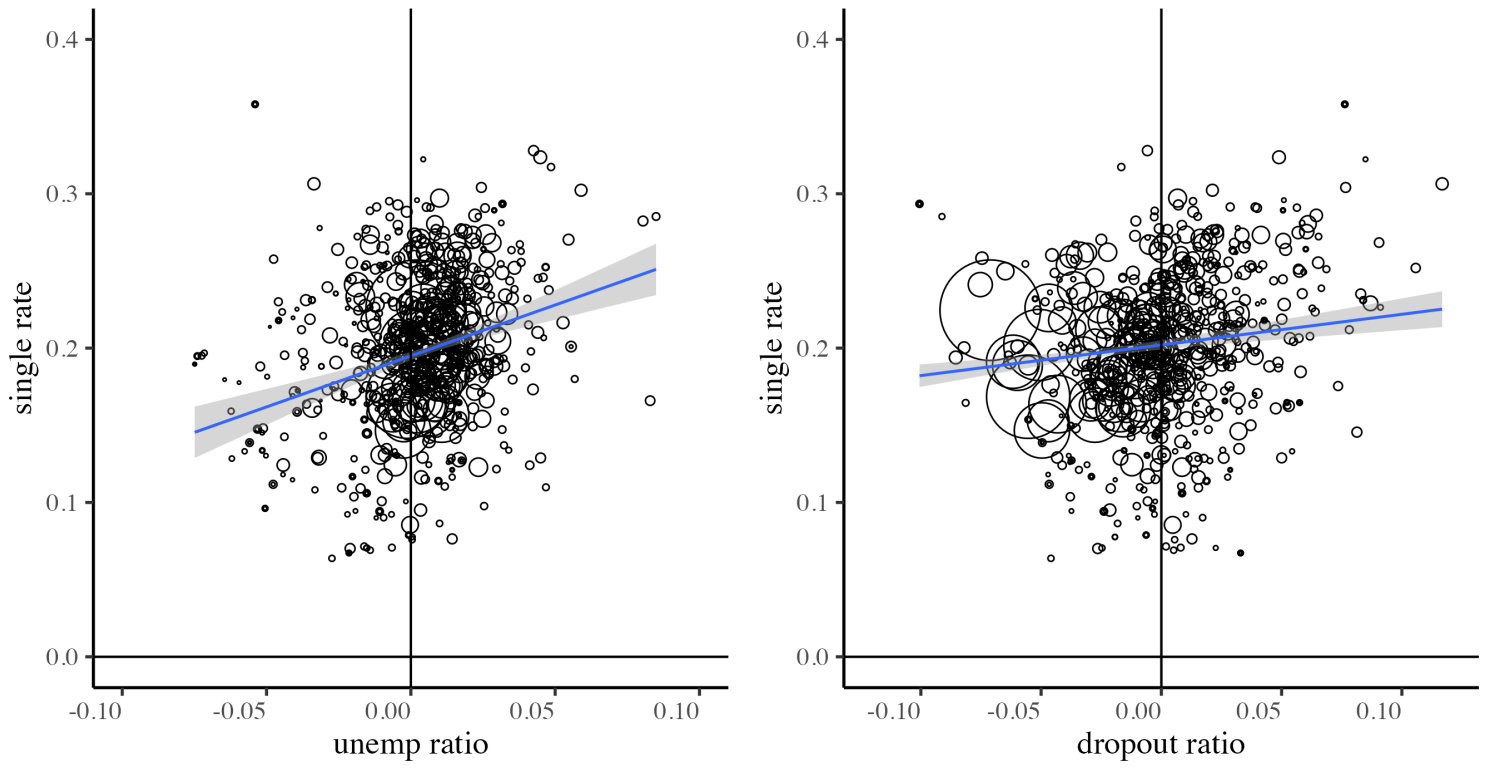


Note: $***: p < 1\%$; $**: p < 5\%$;$*: p < 10\%$. *Weighted by an annual employment.*

5. Non-workers are typically more single?

Unsurprisingly, **Non-working rate** of males is strongly associated with **a single rate** of females (and males).

Figure: The male unemployment (left) and dropout (right) rates and female single rates (change from 2000-2019)



Note: Census, ACS.

Concluding Remark

The paper suggests that **climate change eroded the partner value of young males** by hurting their physical advantage of working outdoors.

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