Climate Change and Labor Market Dropouts*

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Abstract

Labor force participation of prime-aged males in the U.S. has secularly declined for a half century since 1970s, threatening the formation of partnership and fertility. I test a hypothesis that long-run climate change nudged their labor market exits, a significant fraction of whom are working outdoors under heightened exposure to hot days. Combining granular daily temperature data and labor force participation across U.S. Commuting Zones during 1970-2019, I find that accumulated exposure to hot day with mean temperature 80F accounts for 20-30% of increased non-participation of prime-aged males. Climate change significantly accounts for market exits of black males, historically agglomerated in the Southeast, where warming was severest.

JEL Classification: J22, J12, J13, Q54

Keywords: Climate change, labor force participation of males.

1 Introduction

Throughout the human history, labor force participation of prime-aged males has been premise for survival for the species. Solid economic foundation of males dictated partnership with females and demographic procreation. Until the 1950s, the dropout rate for prime-aged males had been less than 2%. Since the late 1960s, however, the number has consistently on the rise to an alarming height of 12% in 2019. (U.S. Bureau of Labor Statistics; BLS) As

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economic idleness of males hurts the value of the marriage market, along with increased earning by females, this plausibly hinders the family formation and threatens the social welfare system. In fact, both marriage and fertility rate has been consistently declining in parallel to declining labor force attachment of males.[1]

The drivers of secular decline of labor attachment is largely inconclusive. (See Krueger (2017) for a comprehensive survey) Most of prior drivers such as computerization (Autor and Dorn (2013)), automation by industrial robots (Acemoglu and Restrepo (2020); Lerch (2020); Grigoli, Koczan and Topalova (2020)), international trade (Autor et al. (2014); Autor et al. (2019)) and offshoring (Ebenstein et al. (2014); Harrison and McMillan (2011)), presume a declining labor demand along with skill-biased technology change (See Acemoglu (2002); Card and DiNardo (2002)), suggesting the deterioration of the labor market opportunities for unskilled males.

These popular drivers, however, have activated relatively recently (conservatively, after 1980s)[2], thus, not persistent enough to cover the half century phenomenon since 1970. Moreover, identification is challenging as most of the literature adopts shift-share instruments from sector-level variables.

This paper proposes a hypothesis that a long-run climate change, markedly accelerated in the late 1960s, contributes to declining participation rate for prime-aged males. To skeptics, I start by an observation of long-run macro trend that the onsets of the drop of labor force participation of prime-aged males and rapid climate change coincides as shown in Figure 1.

[1] Center of Disease and Control (CDC) shows that both marriage rate and fertility rate in the U.S. has been consistently declining after the local peak of 1972 and 1957, respectively.

[2] The ICT revolution occurred from 1990s. In fact, the first affordable personal computer was sold by Apple in 1976, and disseminated by IBM in 1981. International Federation of Robotics shows that the installment of industrial robots in the U.S. accelerated especially after the Great Recession. The scale of free trade surged from the China Syndrome after China enrolled in WTO in 2001.

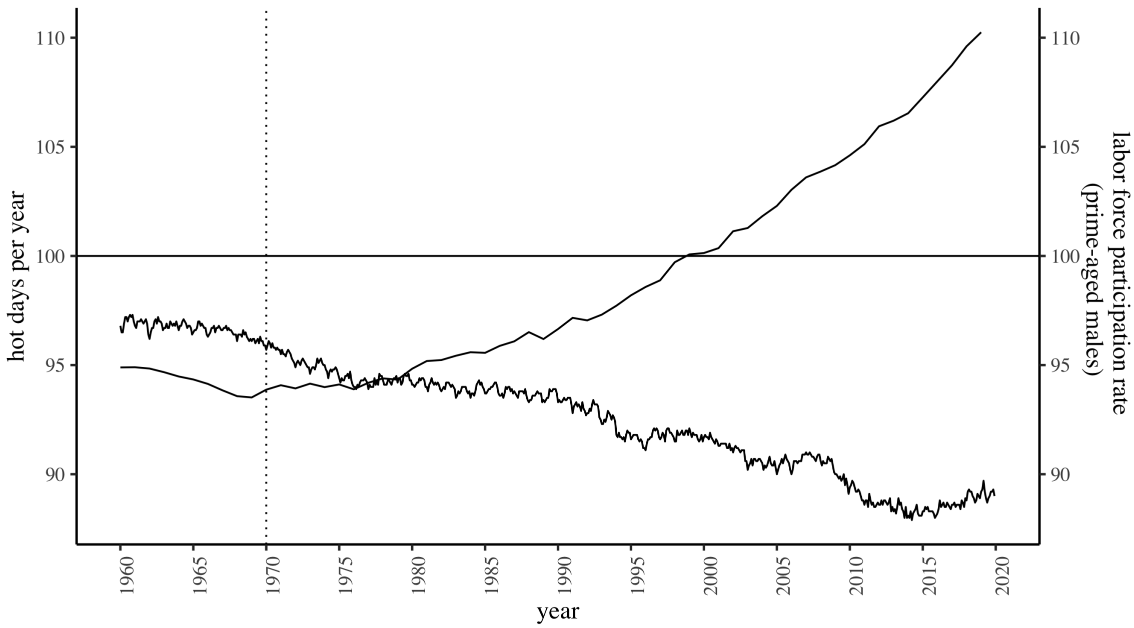

Figure 1: Nationwide trend of annual hot days (left axis) and labor force participation rate of prime-aged males (right axis; 1960-2019, U.S.)

Note: Hot days are days of mean temperature of 80F and above. Participation rate for for males at 25-54 years old (not seasonally adjusted) is from U.S. Bureau of Labor Statistics. The temperature is from National Oceanic and Atmospheric Administration (NOAA). The nationwide temperature is an average of county-level temperature, weighted with county-level populations of prime-aged males. (See construction of temperature data for the main text.)

Climate scientists agree that a sharp uptick of global warming started in the late 1960s (Global Climate Report, NOAA).[3] In the same period, the number of hot days in the U.S. rose. Intriguingly in parallel, the prime-aged male dropouts increased as indicated by a falling participation rate. Guided by the macro trend, I explore whether climate change is at least partially, responsible for labor market dropouts, especially of prime-aged men. The story presumes the fact that men disproportionately work outside than female in manual-intensive sectors (e.g. agriculture, stockbreeding, fishing, construction, mining or a part of manufacturing; outside service such as gardeners). As outdoor work requires physically strenuous activities, a typical worker undergoes increased physical or psychic cost under larger exposure to more hot days. Consequently, if predicted suffering from their warm-

[3]Since the mid 1960s, Intergovernmental Panel on Climate Change (IPCC) has showed that the world has experienced an unprecedented rise in temperature for two millennia. (See Masson-Delmotte and (eds.))

ing experience exceeds some threshold, he is nudged to transfer to the indoor sector (e.g. home, restaurants, super markets or perhaps ideally, office). Moreover, workers in outside occupations are typically less-educated. Because of their poor market opportunities indoor, they are more likely to drop out of the labor force to go indoor at home. Intriguingly, both business and residential air conditioners spread in the 1960s, and the relative cost of working outside presumably spiked in the same period. (Biddle (2008)) As the secular decline of labor attachment for males is observed across developed countries (See e.g. Grigoli, Koczan and Topalova (2020)), global warming can be qualified for culprit for this worldwide phenomena as well as technical change.

To examine the climate-labor nexus, I assemble a panel of daily temperature obtained from the National Climatic Data Center (NCDC) and labor force participation of prime-aged males across U.S. regions during the post-war period (1950-2019). Specifically, I take a pair of geographic units in the U.S. mainland; 722 Commuting Zones (decade in 1970-2000), and 3108 counties (2000-2019, annually).

As the weather data heavily fluctuates on a daily random walk along a seasonal cycle, climate change is measured by a long-run trend of over a decade. Although global warming is induced from accumulating production around the globe, its regional manifestation is purely shaped by topological factors (e.g. elevation), plausibly independently from local production. I document a significantly rich regional variation of climate change, where some regions experienced cooling. (See Figure 3) This near-exogenous treatment offers a clean natural experiment for identifying the long-run exposure to heat on the labor force participation, as one individual takes the meteorology as granted when they choose a mode of labor attachment. I find that climate change alone accounts for 20-30% of the drop of participation rate of prime-aged males.

The paper contributes to the aforementioned literature to explore the cause for labor market dropouts of the prime-aged males. Very few however, explores the labor supply side drivers. (e.g. the spread of morbidity and physical pain in Krueger (2017); augmented disability benefit in Autor and Duggan (2003)). Albeit not in the context of labor supply, the closest idea of the paper is presented by Graff Zivin and Neidell (2014). Using the cross-sectional data during 2004-2006 and time use records from American Time Use Survey, they find that *daily* extreme weather alter the *daily* time allocation, by shrinking labor hours or shifting outdoor leisure to indoor. My paper complements their findings by considering the long-run *climate change* on labor supply choice. My story to raise the relative cost of outside work is also compatible to a recent hypothesis by Aguiar et al. (2021) on the role of computer game technology to increase the value of indoor leisure.[4]

The paper also belongs to the literature on weather or climate change. The literature generally found significant harms of extreme weathers, especially on health and mortality. (Deschenes and Moretti (2009); Barreca et al. (2016)) A small line of papers examine the climate effect on economic outcomes (e.g. Dell, Jones and Olken (2012) for growth rates; Dell, Jones and Olken (2014) for a survey), however, the predominant interest lies in adaptation of an agricultural sector, where its production is susceptible to weathers. (See Deschênes and Greenstone (2007) for agricultural outputs; Graff Zivin and Neidell (2012) for productivity in agriculture workers.) To the best of my knowledge, this is the first paper to explore the effect of long-run climate change on labor supply.

2 Data

To identify the climate-participation association, I assemble a panel of climates (long-run trend of weathers), participation rate across counties during the post-war 7 decades in the U.S.

2.1 Climate change

The weather station data are drawn from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA). Global Historical Climatology Network Daily (GHCN-Daily), which is an integrated database of daily climate summaries from land surface stations. GHCN-Daily contains the most complete collection of US daily climate summaries available including the reports from the outside cooperators (such as local

[4] Gomez, Hansford and Krause (2007) examine a link between weather and turnouts of U.S, presidential elections across counties to find that bad weather is advantageous for the Republicans to inhibit the voting of the disadvantaged.

universities) under quality assurance checks. The key variables for the analysis are the daily maximum and minimum temperature. Following the convention of the climate literature, the mean temperature is an average of these two.[5]

To construct the annual measures of climate from daily weather records, I select weather stations that have more than 360 records in any given year.[6] The number of stations increased from 1950 to 2019 with entry and exits. Figure2 shows the long-run trend and geographic distribution of stations with near perfect records in 2019.

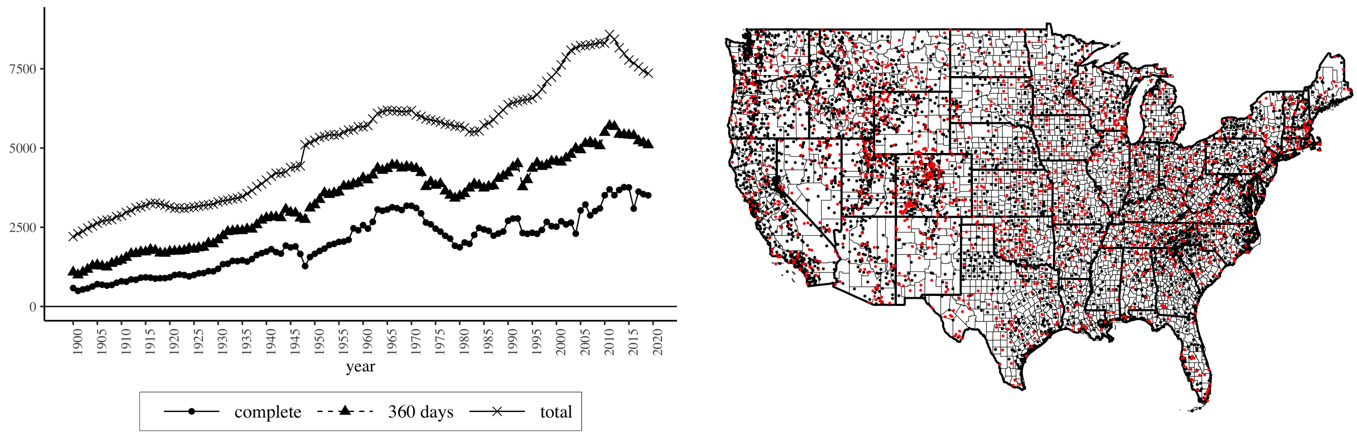

Figure 2: Weather stations in the U.S. (left: number of stations (1900-2019); right: distribution of stations (2019))

Note: Black points are stations with complete day available in 2019. Red points are stations with 360 day data available in 2019. Borders are counties.

The station-level temperature is then aggregated to Commuting Zone or county-level by taking an inverse-distance weighted average of all the records from the closest 3 stations from each population centroid. The data of each temperature is inversely weighted by squared power of distance from the regional population centroid.[7]

I find a substantial geographical variation of temperature dynamics within the country, and even within climate region by NOAA. Figure 3 shows the current level and change of

[5] Temperature change is approximately linear between the minimum and the maximum.

[6] Outliers are observed in the stations with missing data. After omitting outliers, missing data is filled with year-month averages. Compared to the year-complete stations, this significantly add the sample stations.

[7] The county-level population centroid in 2020 is taken from the Census Bureau, and I compute the CZ-level population centroid by population weighted average of the county centroids.

hot days from 1970 to 2019. I define a day is hot if its mean temperature is 80F and above and climate change is N year prior average of the number of hot days. ($N \geq 5$) I proxy the number of hot days per year as a key dependent variable of interest.

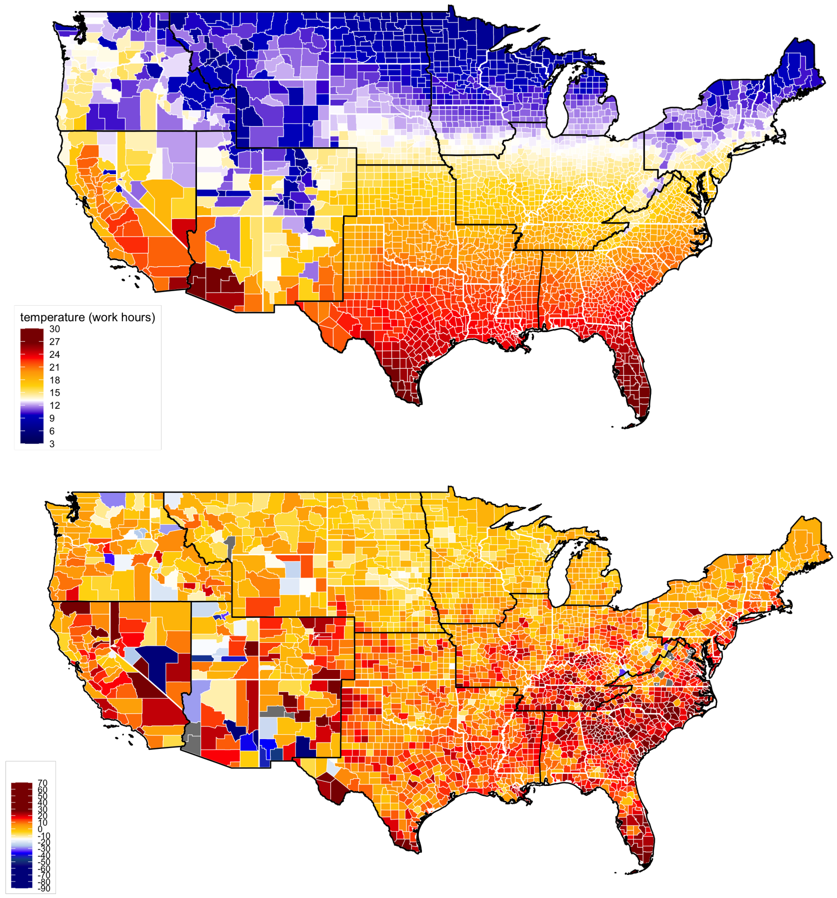

Figure 3: Mean temperature for business hours (Fahrenheit, 2010-2019) and change of hot days (1970-2019) across U.S. counties

Note: The bold black line is climate regions from NOAA. The climate regions are defined as follows: Northeast: CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI, VT; Central: IL, IN, KY, MO, OH, TN, WV; East North Central: IA, MI, MN, WI; West North Central: MT, NE, ND, SD, WY; Northwest: ID, OR, WA; West: CA, NV; Southwest: AZ, CO, NM, UT; South: AR, KS, LA, MS, OK, TX; Southeast: AL, FL, GA, NC, SC, VA. A hot day has a mean temperature during business hours (8AM-6PM) with 80F and above. The number of hot days in 1970 and 2019 is a ten year average of annual hot days during 1961-1970 and 2010-2019, respectively.

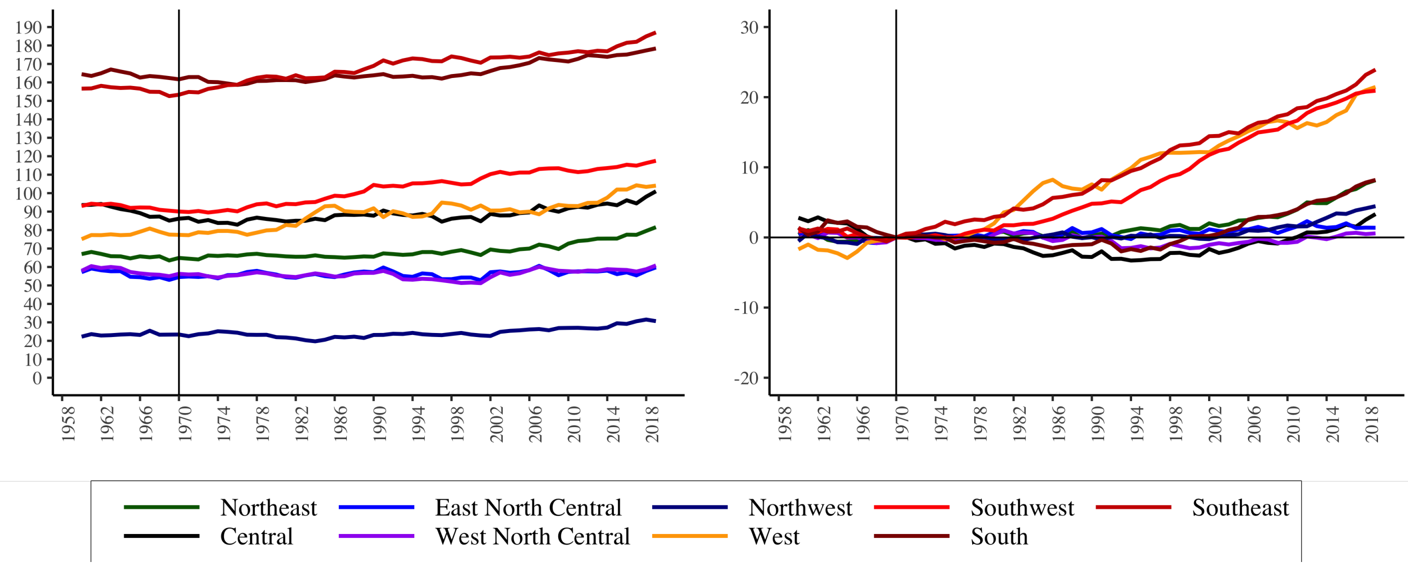

Figure 4: The number of hot days across climate regions (1949-2019; left: hot days (10 year prior average); right: increase of hot days from 1970 (30 year prior average))
Note: A hot day has a mean temperature during business hours with 80F and above. Aggregated to climate regions weighted with population based on temperature from GHCN-Daily. The climate regions are same as Figure 3.

Consistently with the graphics, initially cool regions (Northeast, East North Central, West North Central) indicates no significant trend for warming. I compute the average temperature of business hours including commuting time (8AM-6PM) as $tmin + 0.75(tmax - tmin)$ assuming that temperature linearly fluctuates between minimum at 5AM and maximum at 2PM.[8]

2.2 Labor Force Participation of Males

To compute the participation rate for prime-aged (age 25-54) males, I combine a multiple sources. For Commuting Zones, I use Census (1950-2000, by decade) from IPUMS and American Community Survey (2005-2019, annually), For counties, the population data comes from SEER (Surveillance Epidemiology and End Results) Program from National Cancer Institute for 1969-2019. For 1950-1980 by decade, labor force data comes from the Historical

[8]Set $x \equiv tmax - tmin$. Before the peak for 8am-2pm, $tmin + 2/3x$. After the peak for 2pm-6pm, $tmin + 7/8x$. Taking an weighted average with hours, a mean temperature for business hours is $tmin + 0.75x$.

Census. The county ×industry (NAICS)-level quarter employment comes from the Quarterly Workforce Indicator (4 quarters × 1990-2019). Figure 5 shows a change of participation rate of prime-aged males from the onset of climate change (1970) to the recent decade (2010-2019).

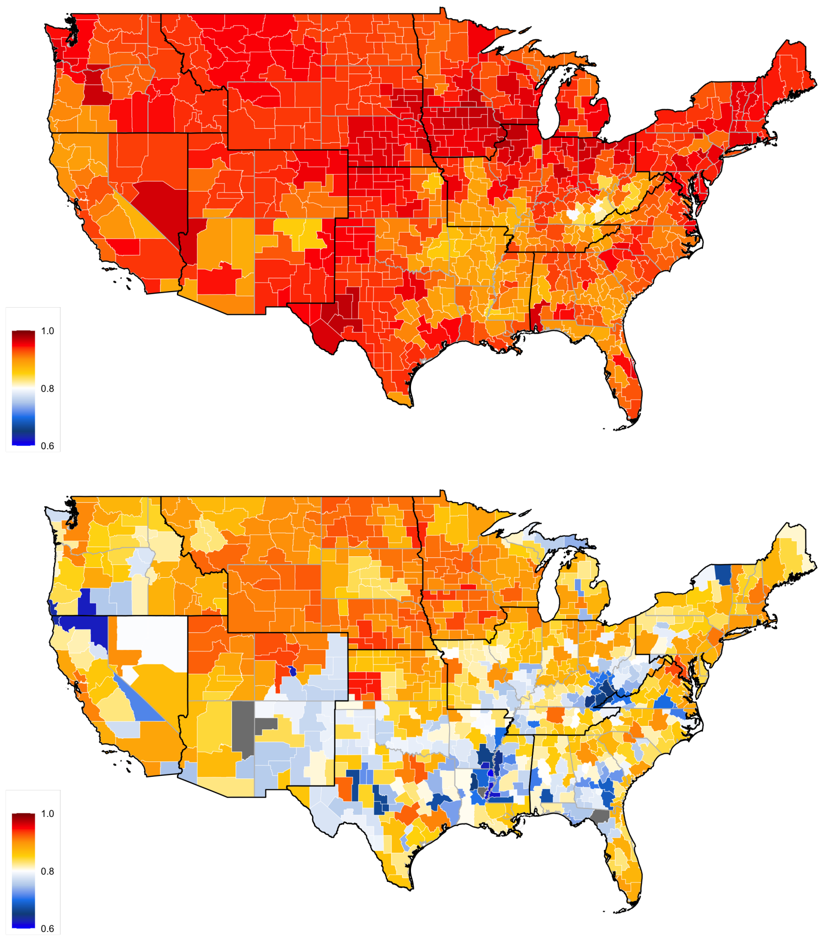

Figure 5: Labor force participation rate of males across Commuting Zones (1970 (top) vs. 2010-2019 (bottom))

Note: Each unit is a county boundary at 2019. Bold line is a climate zone from NOAA.

In 1970, most of Commuting Zones had a high participation rate above 90%. During 2010-2019, however, a great divergence of participation emerges across regions. As an initially cold area (Northwest, West North) keeps relatively higher participation, an initially hot area (Southeast and South) underwent significant drops of participation. This is consistently with a story that climate warming reduces participation of a hot area by generating more hot days, but improves participation of a cold area by reducing cold days. Furthermore, as Figure 4 shows, the hot area (especially Southeast, West, Southwest) experienced the severest warming, fueling the divergence of participation rates across regions.

3 Analysis

I identity the effect of climate change on labor force participation rate of prime-aged males. To motivate the analysis, Figure 6 illustrates a negative link between the change of annual hot days and labor force participation of prime-aged males during 1970 and 2000 across Commuting Zones in the U.S. mainland. After weighted with the initial period population, the two variables show significantly negative correlations.[9]

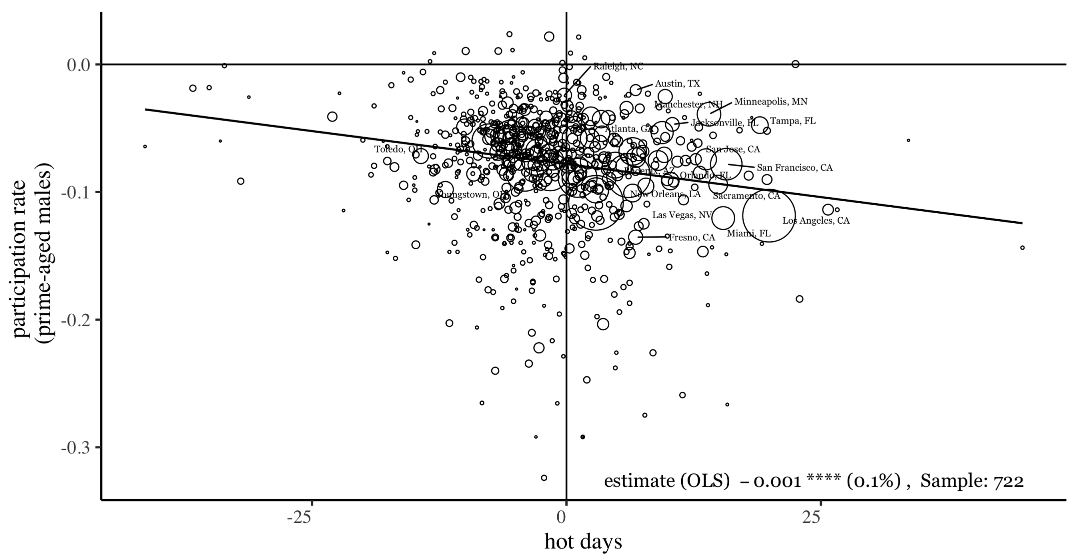

Figure 6: Hot days and Labor force participation of prime-aged males during 1970-2000 (Top: across states during 1960-2000, bottom: across Commuting Zones)
Note: Hot days have mean temperature of business hours is over 80F. Limited to prime-aged (age 25-54) males. Labor force participation is computed from IPUMS of Population Census. A regression is weighted by a prime-aged population in 1960, captured by the size of each bubble.

Alternatively, a state-level link from 1960 to 2000 shows a similarly negative link. Using a county-level variation from 2000 to 2019 also shows a negative link between hot days and employment rates. (See Figure 7 and 8, respectively in Appendix)

[9]Intriguingly, an entertainment city of Las Vegas, where the majority of the population in Nevada agglomerates, experienced one of the largest warmings and dropout rates.

To formerly demonstrate the effect of climate change, I regress the non-participation rate of prime-age males with hot days in Table 1.

Table 1: Climate change and Labor force participation of prime-aged males (across Commuting Zones; 1970-2000)

	participation rate (log)			
	(1)	**(2)**	**(3)**	**(4)**
hot days (ma10)	-0.001 ***	-0.0004 **	-0.0004 **	-0.0004 **
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
cold days (ma5)	-0.0004 *	-0.0005 **	-0.0005 ***	-0.0005 **
	(0.0003)	(0.0002)	(0.0002)	(0.0002)
black ratio		-0.365 ***	-0.355 ***	-0.377 ***
		(0.052)	(0.052)	(0.071)
immigrant ratio		-0.121 ***	-0.106 ***	-0.119 ***
		(0.022)	(0.026)	(0.028)
high-school dropout ratio			-0.027	-0.037
			(0.037)	(0.037)
blue-collar ratio			0.099 **	0.111 **
			(0.042)	(0.047)
young ratio (age 25-35)				-0.042
				(0.036)
single ratio				0.170
				(0.123)
ratio of having a child				0.139
				(0.116)
ratio of living at state of birth				-0.025 ***
				(0.006)
czone and year fixed effects	Yes	Yes	Yes	Yes
Adjusted R-squared	0.846	0.861	0.862	0.866
Observations	2,888	2,888	2,888	2,888

Note: Limited to 722 Commuting Zones in the U.S. mainland. Hot days have mean temperature of business hours is over 80F, and cold days have that of less than 40F. Limited to prime-aged (age 25-54) males. Labor force participation rate is computed from IPUMS of Population Census. The standard errors are clustered at state level. *** $p < 1\%$; ** $p < 5\%$; * $p < 10\%$.

In a long-difference model, the regression uses decadal average of annual hot days as a proxy for long-run climate. Evaluating at the sample mean, the analysis shows that the increase of hot days accounts for 20-30% of the dropouts of the prime-aged males. This serves as an evidence that long-run climate change contributes to labor supply choices.

4 Concluding remark

Employing an exogenous variation of climate change across U.S. regions as a natural experiment, the paper helps solving the puzzle of secular trend of declining participation of males. From the econometric point of view, the paper develops an instrument for regional economic idleness, especially of prime-aged males. An econometric tool may be useful for economists to assess the mechanism of other labor demand shocks (automation, trade, offshoring etc.) via male idleness on a series of outcomes (e.g. labor, health, mortality, crimes).

The paper limits the study in the U.S., however, the climate change is global phenomenon. It is natural to explore global warming affects the country-level labor supply in the long run. This is left for a future work.

Appendix

State-level analysis

As well as Commuting Zones, the state-level graphics shows an analogous negative link between hot days and labor force participation rate of males during 1960-2000.

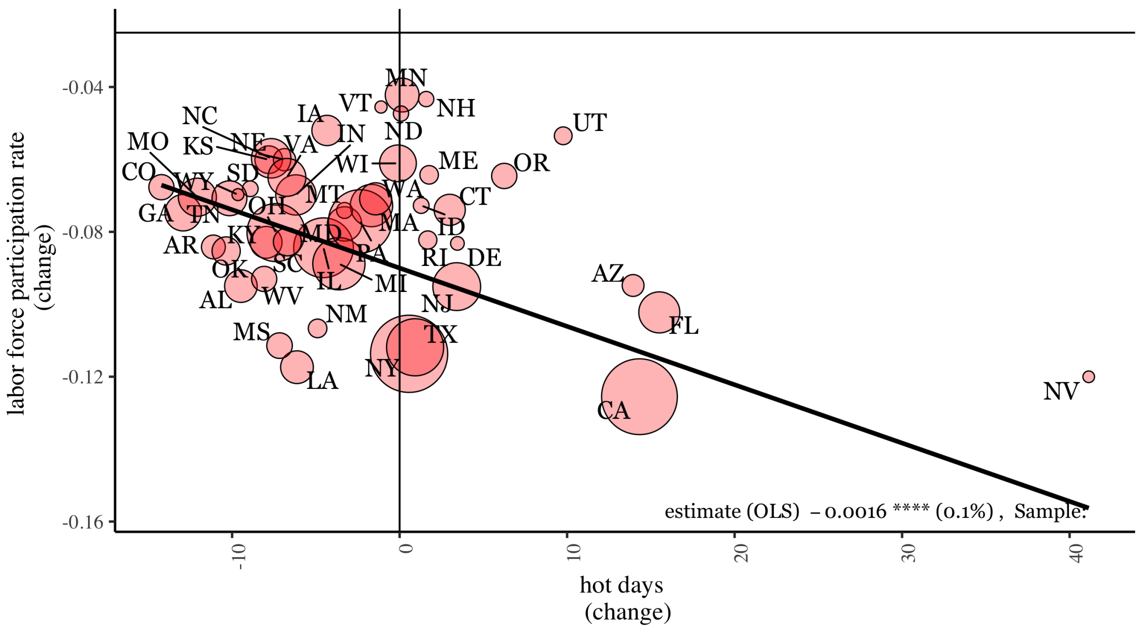

Figure 7: Hot days and Labor force participation of prime-aged males during 1960-2000 (across states)

Note: Limited to the states in the U.S. mainland. Hot days have mean temperature of business hours is over 80F. Limited to prime-aged (age 25-54) males. Labor force participation is computed from IPUMS of Population Census. A regression is weighted by a prime-aged population in 1960, captured by the size of each bubble.

County-level analysis

Figure 8 illustrates a significantly negative link between hot days and employment rates across U.S. counties during 2000-2019, which is computed from prime-aged employment from QWI divided by prime-aged population from SEER.

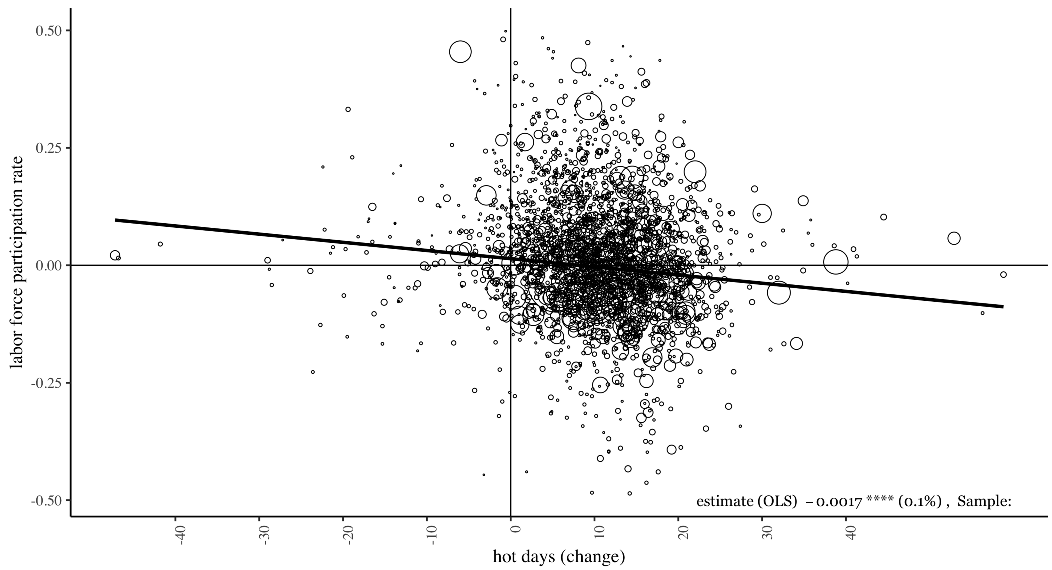

Figure 8: Hot days and Employment rates of prime-aged males (2000-2019; county-level)
Note: Limited to counties in the U.S. mainland. Hot days have mean temperature of business hours is over 80F. Limited to prime-aged (age 25-54) males. Employment rate is computed from QWI and SEER. A regression is weighted by a prime-aged male population in 2000, captured by the size of each bubble.

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