CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

# Breaking Rules During Record-Breaking Heat

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The session will begin shortly.

UCLA Luskin Center for Innovation

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## A. Patrick Behrer
Stanford University

## Nicholas Sanders
Cornell University

## Dylan Brewer
Georgia Institute of Technology

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MEASURING & REDUCING SOCIETAL IMPACTS

UCLA Luskin Center for Innovation

# A. Patrick Behrer

Economist, The World Bank

@abehrer

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## Heat, Crime, and Punishment

# Heat, Crime, and Punishment

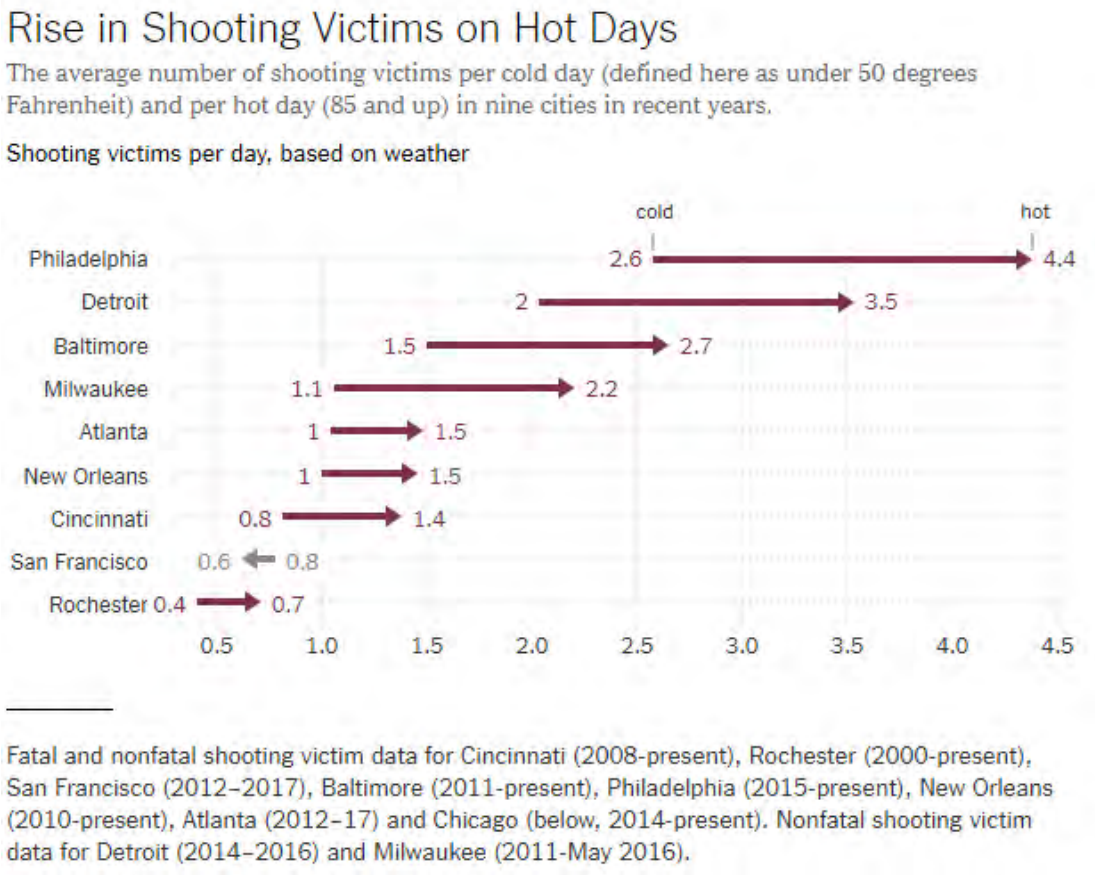
A. Patrick Behrer [1] Valentin Bolotnyy [2]

[1]World Bank

[2]Hoover Institution, Stanford University

Climate Adaptation Research Symposium
September 8, 2021

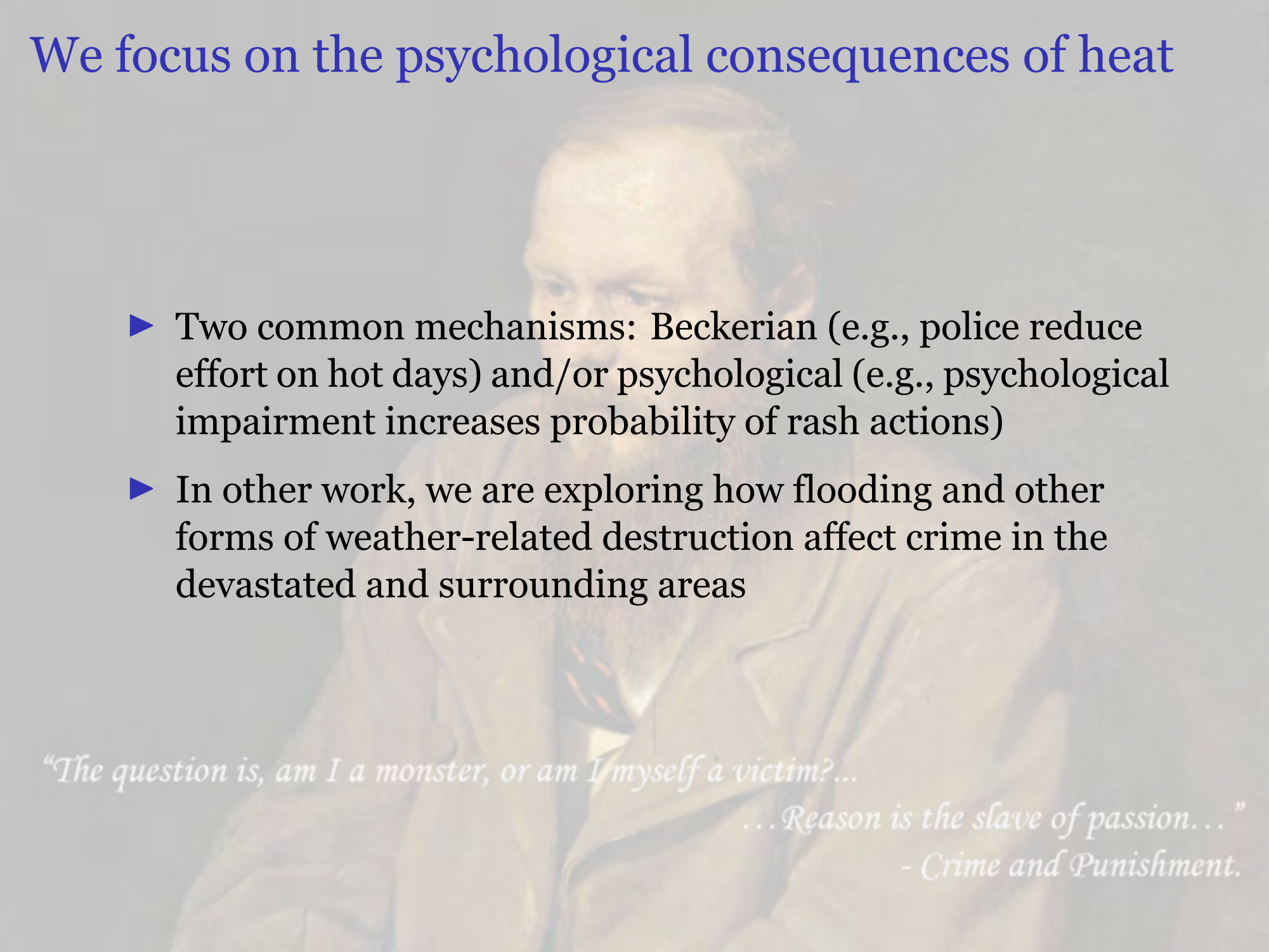
# How will a changing climate affect crime?




- Many papers on negative effects of heat on crime (Ranson 2014, Burke et al. 2015, Garg et al. 2020), emotion (Anderson et al. 2000), and cognition (Park et al. 2020). A few papers on negative effects of heat on judges (Heyes and Saberian, 2019)

# We focus on the psychological consequences of heat

- Two common mechanisms: Beckerian (e.g., police reduce effort on hot days) and/or psychological (e.g., psychological impairment increases probability of rash actions)
- In other work, we are exploring how flooding and other forms of weather-related destruction affect crime in the devastated and surrounding areas



# Criminal defendants are not the only participants in the justice system

Arrests, and prosecution, is a multi-step and multi-sided process. Heat could play a roll in multiple stages of this process. We examine its impact on civilians, police officers, prosecutors, and judges – key individuals involved in criminal events

# Data

| | |
|---|---|
| **Arrest data** | From Texas Department of Public Safety (TPDS). Every arrest (≈3MM) in Texas from 2010-2017. Demographics on arrested individual (incl. home address), arrest charge, and trajectory through the criminal justice system. Counties provide reports to state – report completeness is tied to eligibility for state grant programs. |
| **Reported Crime** | All crimes reported to Houston Police Department from 2010-2017. |
| **Weather Data** | PRISM Climate data on max and min temp, precipitation, dew point, and vapor pressure deficit. |
| **U.S. Census** | 5-year American Community Survey (ACS) data on median income and median housing age at block level. |

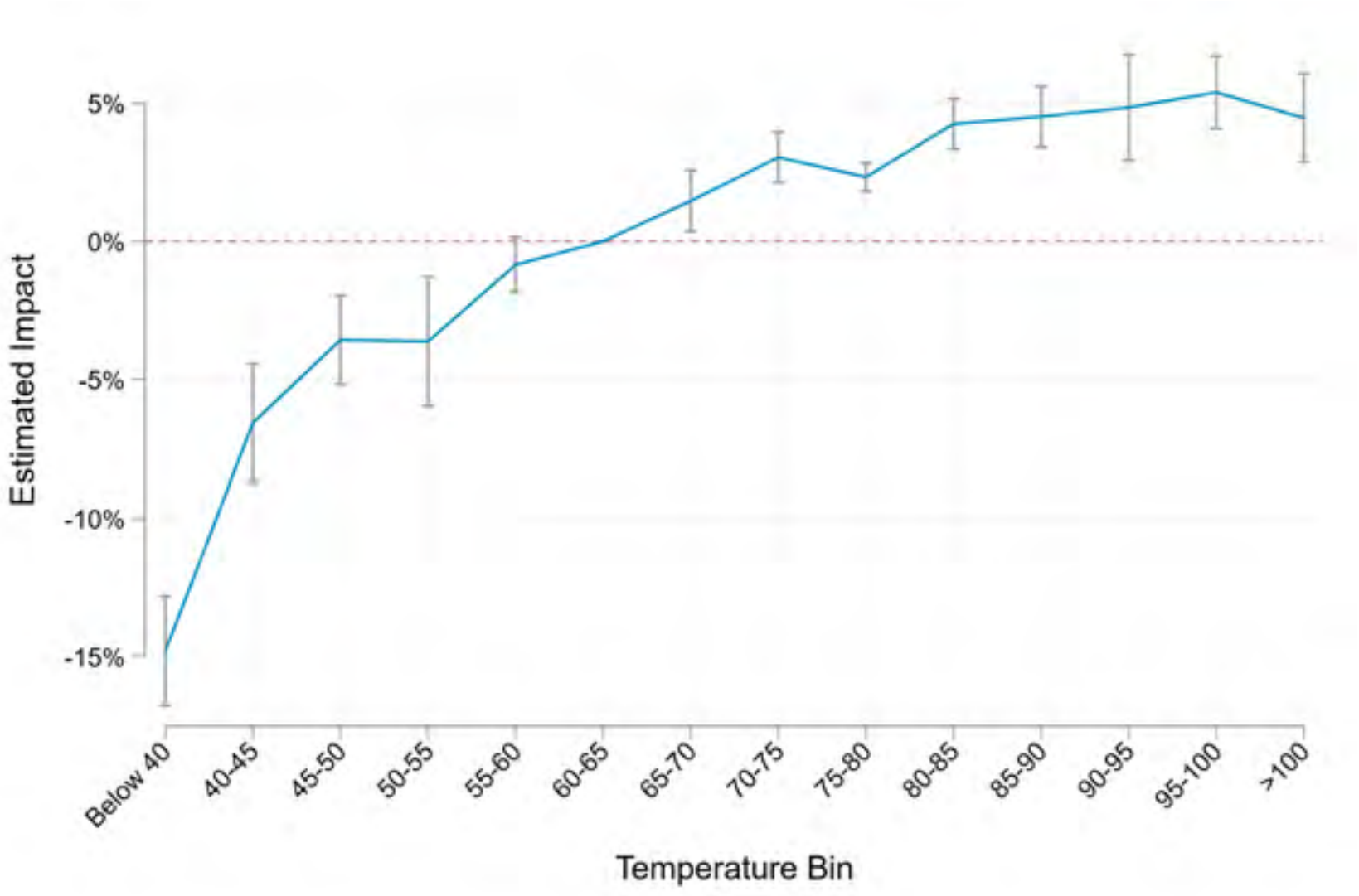
# We estimate the standard Poisson FE model

$$log\left(Y_{idmy}\right) = \beta_k \sum T_{idmyk} + \rho_l \sum R_{idmyl} + \delta_y + \psi_i + \eta_d + \Omega_m \quad (1)$$

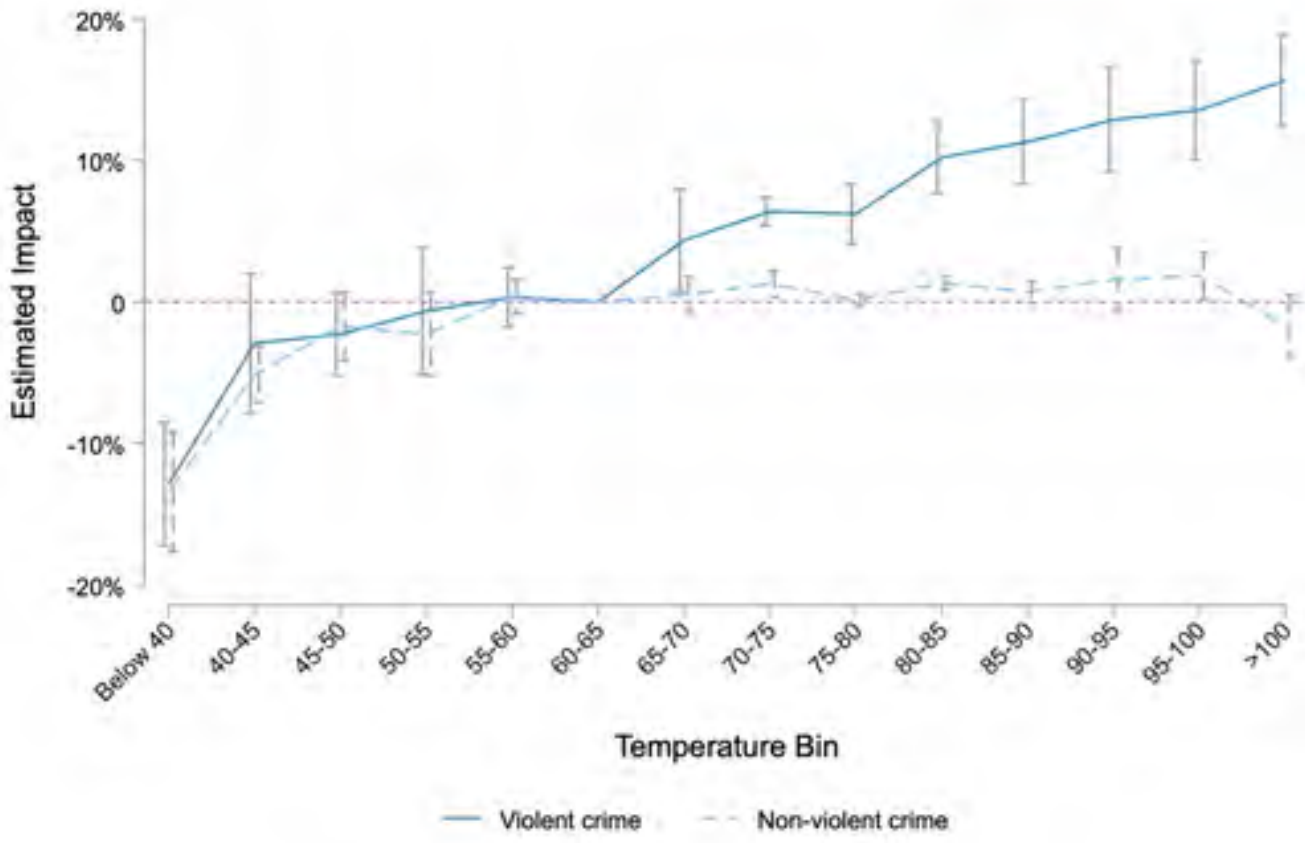
- $\log(Y_{idmy})$ is the conditional mean of crimes ($C_{idmy}$) given our covariates.
- $T_{idmyk}$ is an indicator for whether the max. temp. in county $i$ on day $d$ in month $m$ and year $y$ is in the $k^{th}$ temp. bin.
- We use one bin for temperatures below 40°F and one for those above 100°F. Bins in between are in 5°F increments and we omit the 60-65°F bin.
- $\beta_k$ **measures approx. percentage change in daily crimes if the max temp. is in bin** $k$ **relative to the 60-65°F bin.**

# Results

# Exposure to heat increases crime

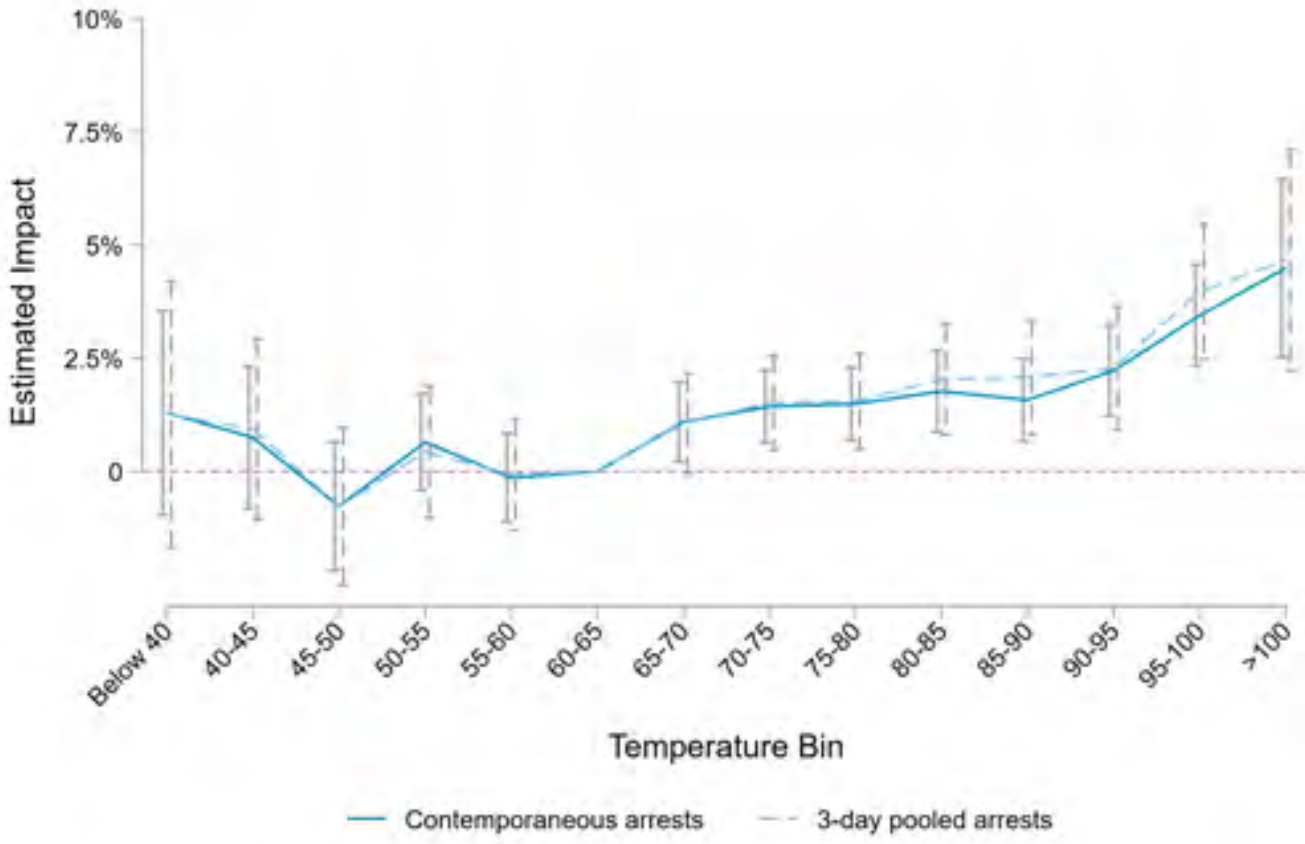


# The increase is almost entirely violent crime



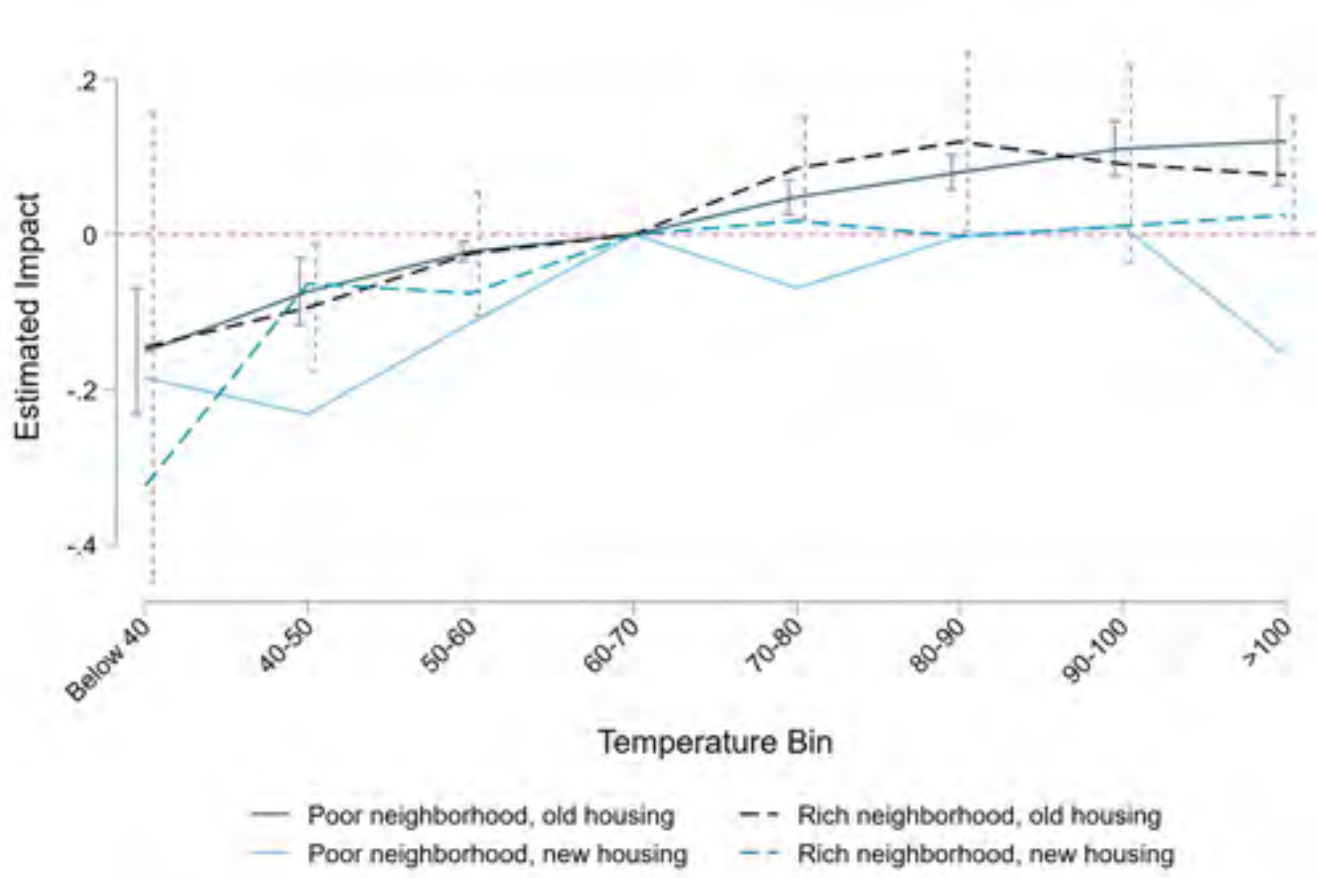

Violent crime: assault, aggravated assault, homicide, manslaughter, kidnapping, domestic assault, and weapons crimes.
Non-violent crime: larceny, burglary, stolen property, traffic, marijuana possession, and marijuana dealing.

# Reported crimes increase more than arrests on hot days




This is the estimated percentage change in the difference (reports-arrests) of reported crime and arrests in Houston on hot days. The pooled results compare reports on day *n* to arrests made on day *n* plus arrests on the subsequent three days.

# Older housing stock appears to matter more than income in mitigating impacts



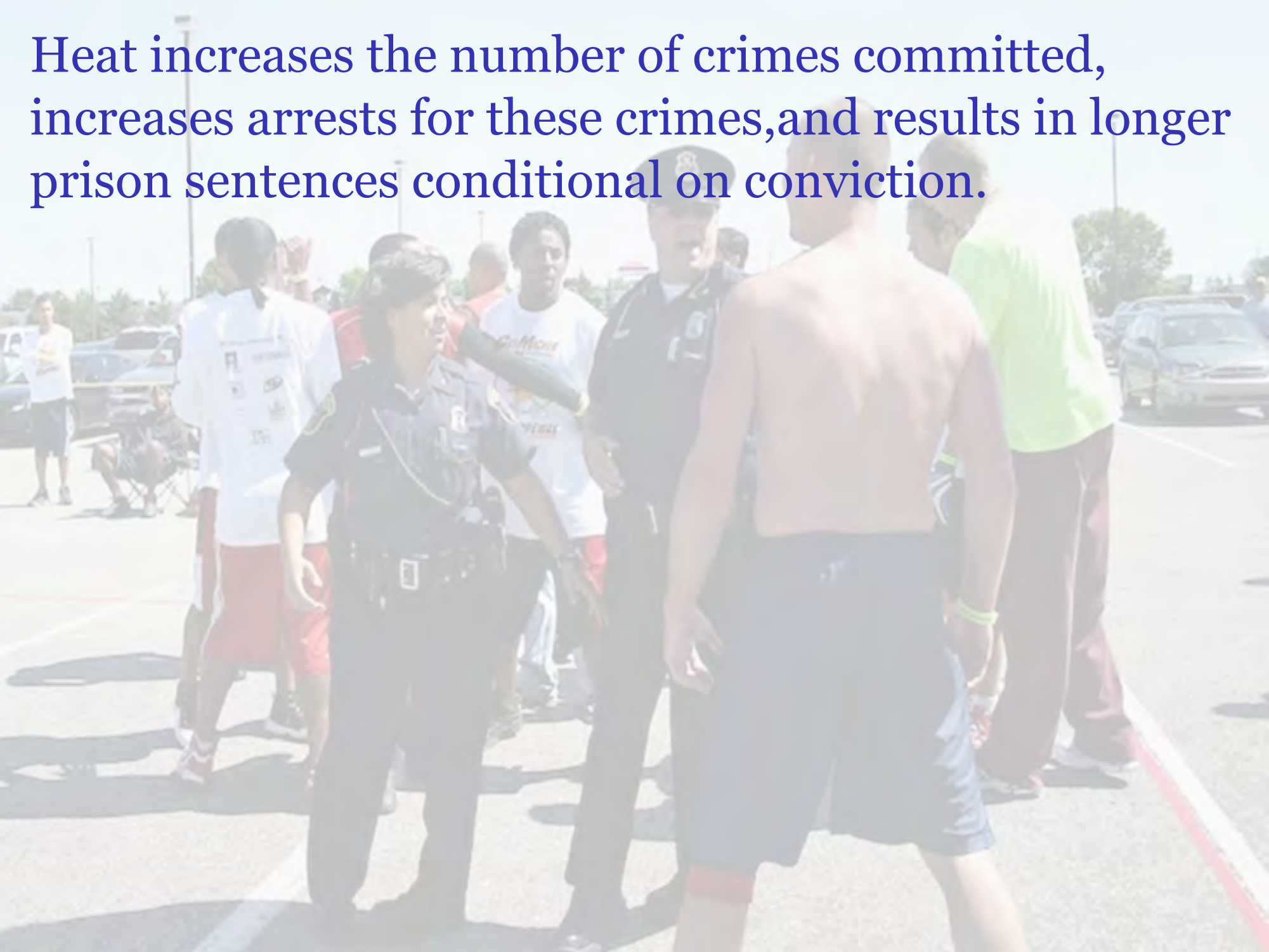

We estimate our primary specification separately for each combination of 4 income quartiles and 2 housing age bins. We report here the results from the top and bottom income quartile in each housing bin. We omit error bars on the high income lines for readability. They are wide.

# We see no impacts on prosecutors but judges appear to be harsher on hotter days

| | Outcomes | | Punishments | |
|---|---|---|---|---|
| | Conviction | Dismissal | Log(Confinement) | Log(Fines) |
| T above 90F | 0.609 | -1.216** | 0.065** | 0.040** |
| | (0.464) | (0.588) | (0.030) | (0.018) |
| T 85-90F | -0.195 | 0.030 | 0.016 | -0.012 |
| | (0.242) | (0.304) | (0.016) | (0.010) |
| T 80-85F | -0.096 | 0.128 | 0.025 | -0.007 |
| | (0.204) | (0.258) | (0.015) | (0.010) |
| N | 1,140,602 | 1,140,602 | 763,199 | 1,071,518 |
| Outcome mean,: | 69.12 | 29.45 | 578.71 | 546.83 |
| Fixed Effects: | | | | |
| County | Yes | Yes | Yes | Yes |
| Month | Yes | Yes | Yes | Yes |
| Year | Yes | Yes | Yes | Yes |
| DOW | Yes | Yes | Yes | Yes |

Notes: Errors clustered at courts and shown in parentheses. In columns 1 and 2 outcomes are measured as the percentage of cases with that result. Coefficients indicate the percentage point increase in the outcome for an additional day in each bin. Confinement is measured in days, fines measured in dollars. All regressions are linear panel fixed effects. All include controls for the total cases heard in the day, dew point, and vapor pressure deficit minimum. * p=0.1, ** p=0.05, *** p=0.01.

Heat increases the number of crimes committed, increases arrests for these crimes,and results in longer prison sentences conditional on conviction.



# Climate change & Adaptation

# Predicting future climate change and adaptation

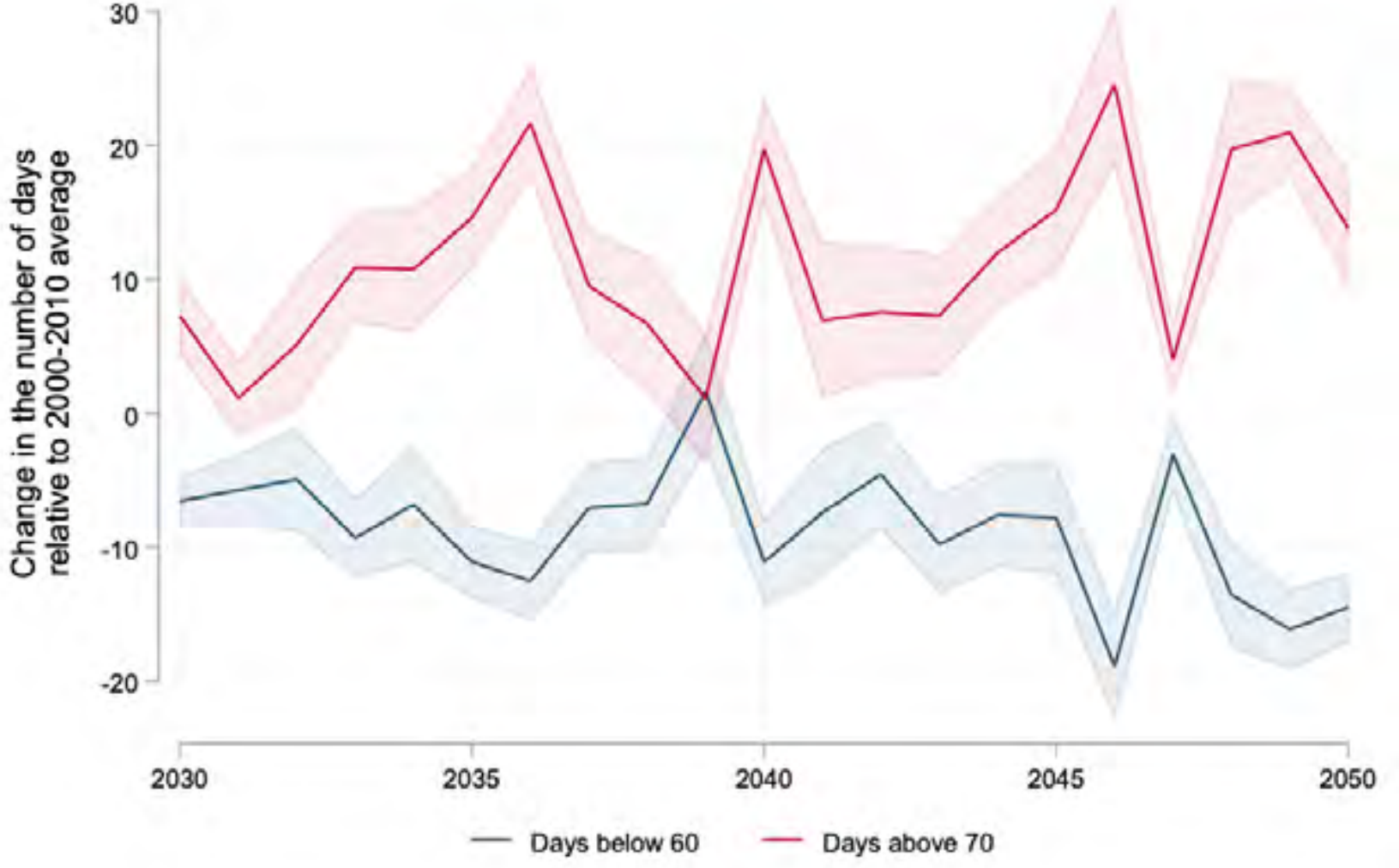
**Climate projections**

- Data come from Rasmussen et al. (2017) and are described in Hsiang et al. (2017).
- We incorporate the output of between 28 and 44 global circulation models for each RCP scenario.
- We collect annual estimates of maximum temperature for counties in Texas from 2025 to 2050.

**Adaptation**

- We project income growth and housing stock turnover based on observed growth rates by block group in our sample.
- In each year we separately calculate the impact of heat on crime using coefficients from 12 different housing age/income regressions.

# Climate change substantially increases hot days in Texas



# We find that there is scope for adaptation to reduce heat's impact on crime

# But uneven adaptation has substantial distributional consequences

**Today:**

Black and Hispanic households have substantially lower average incomes than White households.

They also live in older housing on average.

**That translates into:**

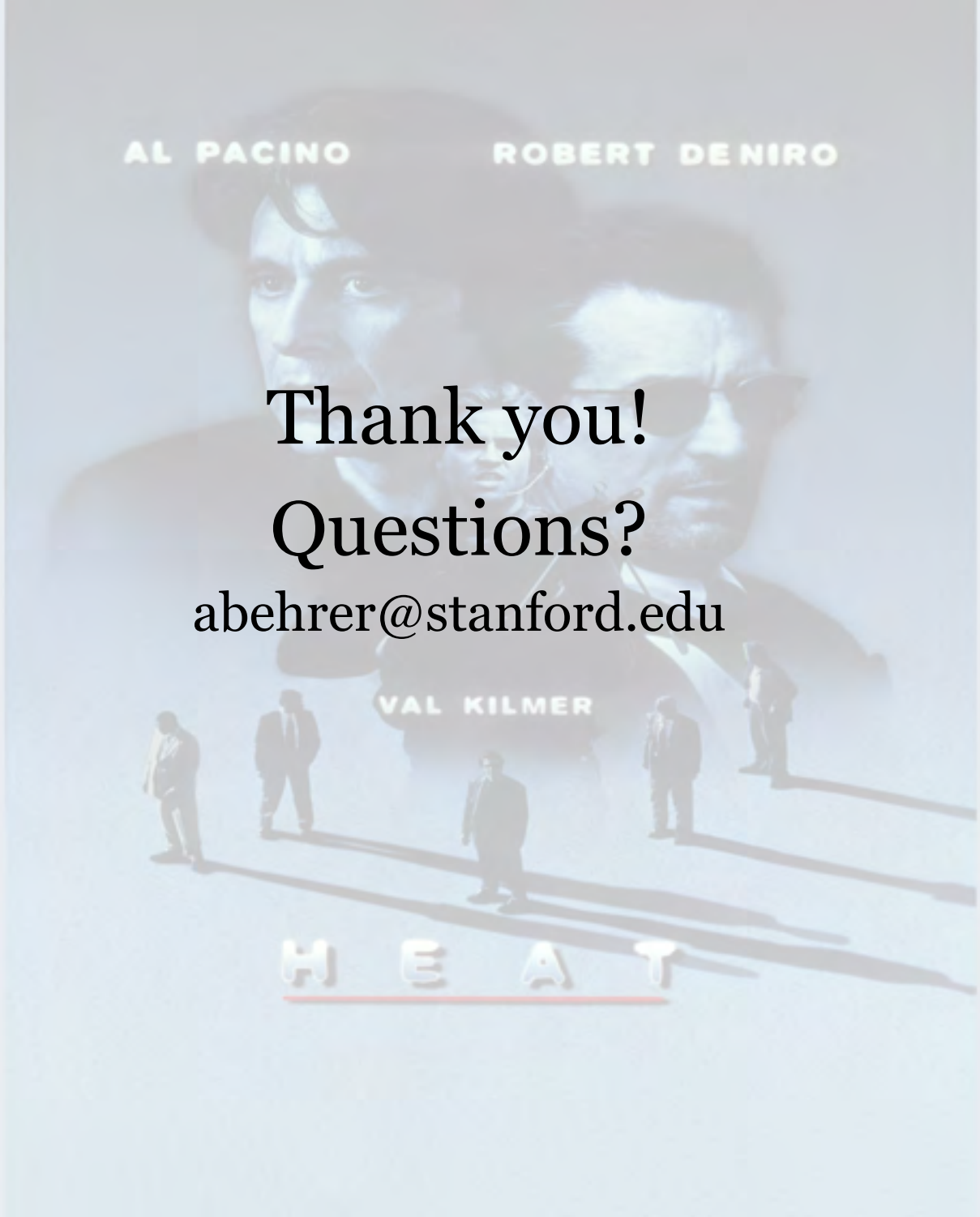
Climate change driven increases in crime that are 21%-25% larger for Hispanic and Black Texans than White Texans.

Future impacts that are 70% larger for the poorest Texans relative to the richest.

**These results are not driven by differences in future exposure or the marginal impact of heat on these groups.**

# Summary

- Heat increases crime, especially violent crime, likely through a psychological channel. Cold decreases violent and non-violent crime in similar ways, reducing crime by chilling people out and primarily keeping people at home
- Those working in teams (police officers, prosecutors, juries) see smaller effects on their behavior than those operating alone (citizens, judges)
- Areas with higher income and newer buildings see smaller negative effects of heat on crime
- Adaptation can mitigate these impacts but raises substantial distributional concerns. Policy-makers should focus on raising incomes, building new housing with climate control, encouraging teamwork, and reducing ease of access to weapons.




# Thank you!

# Questions?

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# Nicholas Sanders

Assistant Professor, Cornell University

@nj_sanders

## The Constitutional Questions of Climate Change: Heat and Violence With Constrained Mitigation

# Constitutional Questions of Climate Change: Heat and Violence with Constrained Mitigation

Anita Mukherjee
University of Wisconsin

Nicholas J. Sanders
Cornell University & NBER

UCLA Climate Adaptation Research Symposium

September, 2021

# Heat and Violent Conflict

- Work in medical field/psychology/sociology/economics suggests link between heat and conflict
  - Pertinent issue in the face of climate change and rising average temperatures
- Studies include large scale (civil wars, riots) and individual action (violent and property crime, destructive behavior)
- More heat —> more conflict
  - Hard to separate effects of resource constraints, increased reporting, altered police activity
  - We can't observe mitigation (e.g., AC) and avoidance behavior (changing plans and staying indoors for the day), both of which are additional costs of facing heat
- We study the heat and violence relationship within correctional facilities in Mississippi

# The Importance of Studying Heat in Prisons

- Prison conditions impact 2.5 mil. people in US (2.2 mil. inmates in 1,800 facilities, plus employees)
- Prison violence prevalent and growing
  - 21% of male inmates assaulted over a 6-month period
  - Key concern for guards/prison staff as well
- Leads to many social costs, including death, injury, trauma, extended sentences/denied parole

# The Importance of Studying Heat in Prisons

- Eighth amendment bans “cruel and unusual punishment,” backdrop of numerous lawsuits regarding lack of temp control
  - AC generally prevalent in Southern states, yet rarely in prisons (0 in our data)
- Cost of installation and role of punishment both arguments against controls
- Politicized issue of temperature controls to appear “tough on crime”
  - Not just about costs —> Louisiana spent over $1 million fighting AC installment anticipated to cost $250K
- Courts in Wisconsin, Arizona, and Mississippi have ruled “incarceration in extremely hot or cold temperatures violates the Eighth Amendment”, but no action yet to implement AC
  - No federal laws mandating temperature control in prisons and jails

# The Importance of Studying Heat in Prisons

- Anecdotes
  - “so hot in there I would put my hand to the wall and it would get burned”
  - "[...] my cellmate and me would take turns sleeping on the floor. You’d clean the floor, throw water down so it was like a puddle and lie down on it on a sheet.”
  - “in some facilities [...] inmates residing in a given cell block are given ice water to pass down the row of cells, which often leads to violence and hoarding of the vital resource.”
- Overcrowding, aging infrastructure, and inmate health needs exacerbate issue

*“Deadly Heat” in U.S. Prisons is Killing Inmates and Spawning Lawsuits*, The Intercept
*'People are in danger': the prisoners feeling the effects of US climate crisis*, The Guardian

# Prisons and the Bigger Picture

- Prisons also serve as a rare situation where we have good data with effectively no mitigation or avoidance
- While the makeup of prison may not mimic the general population, their situation is similar to many of those living in poverty around the world
  - No AC and/or unstable power grids, constrained mobility
- These effects are closer to the "raw" effects of heat on violence, and may more accurately describe the effects of heat in many parts of the world

# Data Analysis

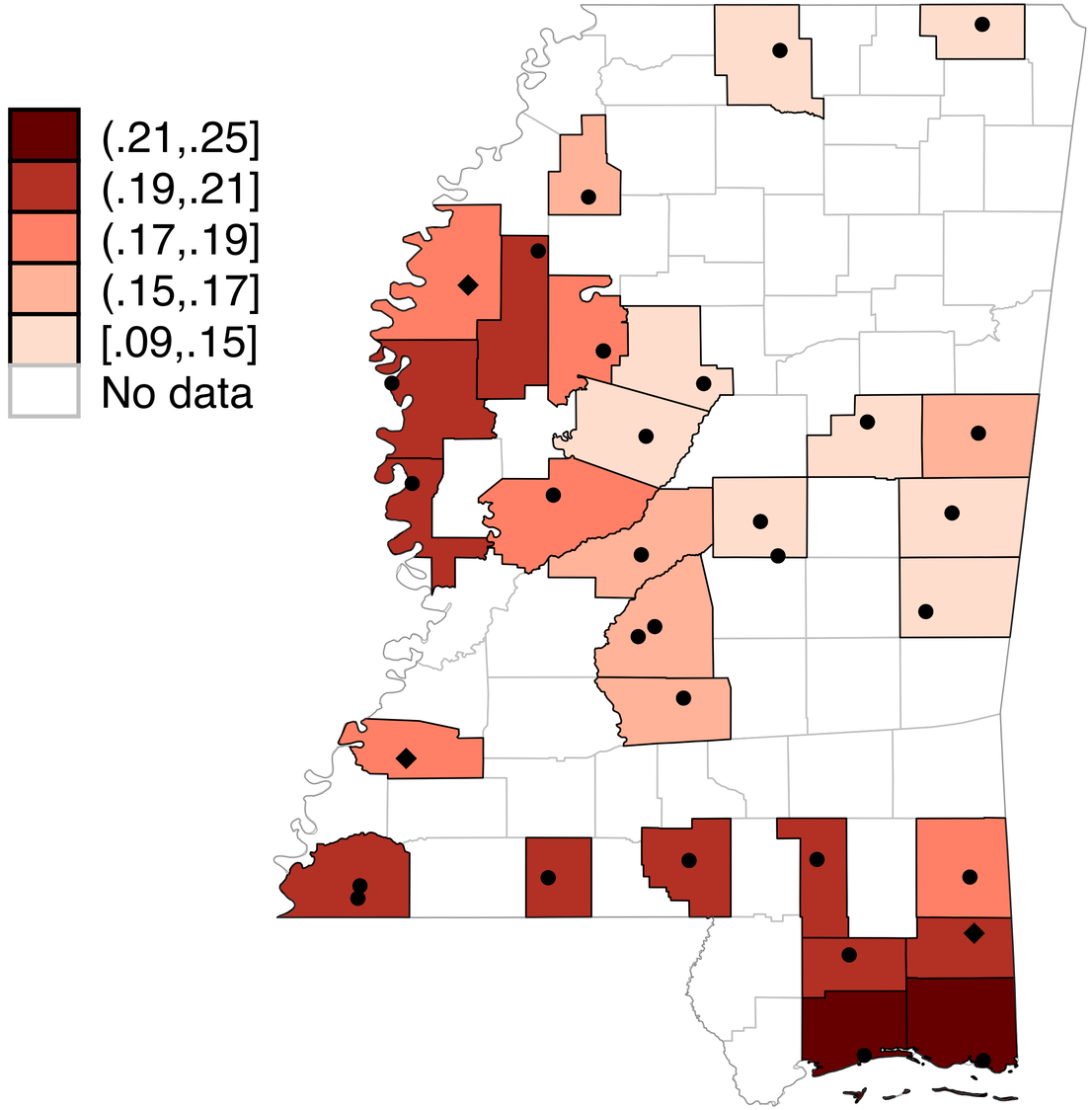
- Looking at daily infractions, adjusting for seasonality, general trends in both violence and temperatures
- Given prior work on temperature, we use binned temperature ranges rather than looking at linear temperature ranges

- "Compared to a 60-69F average day, how much more violence do we see on a 70-79F or 80F+ day?"
  - Effects appear to show up around days with average temperatures of 80F+

# High Temperatures Across the State of Mississippi

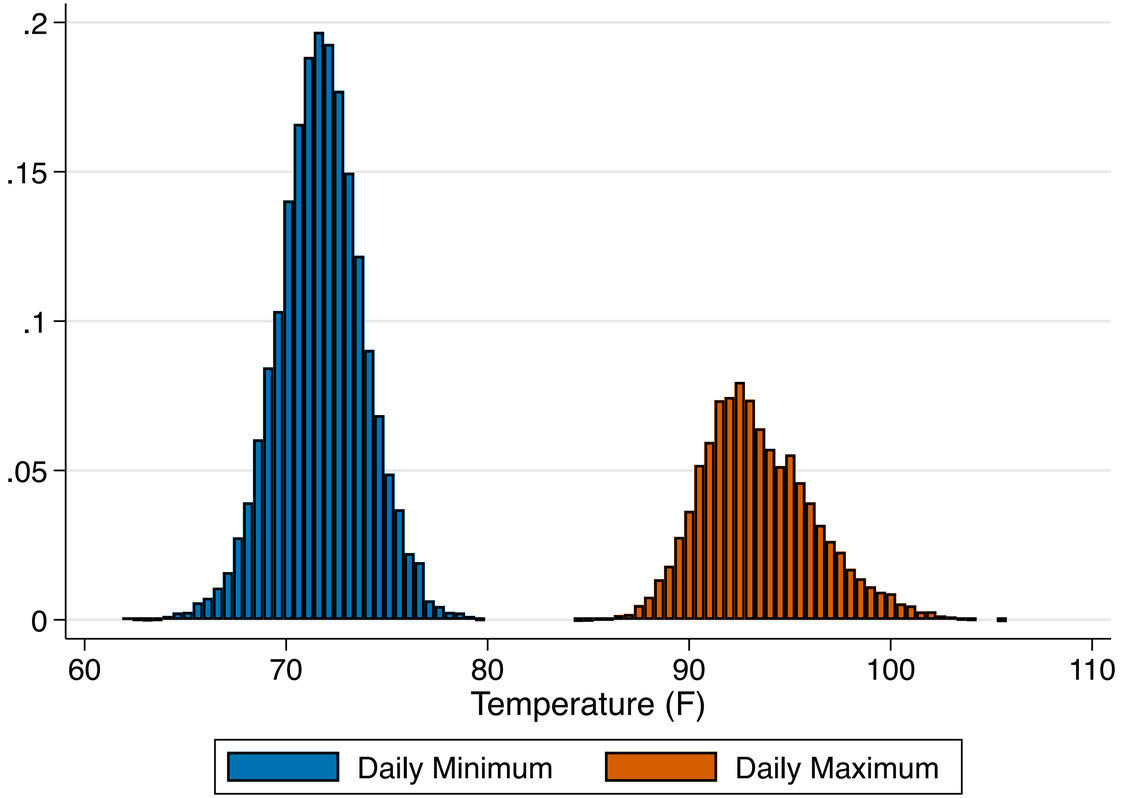
- 36 facility locations across 29 counties
  - Circles - single location
  - Diamonds - multiple at same address

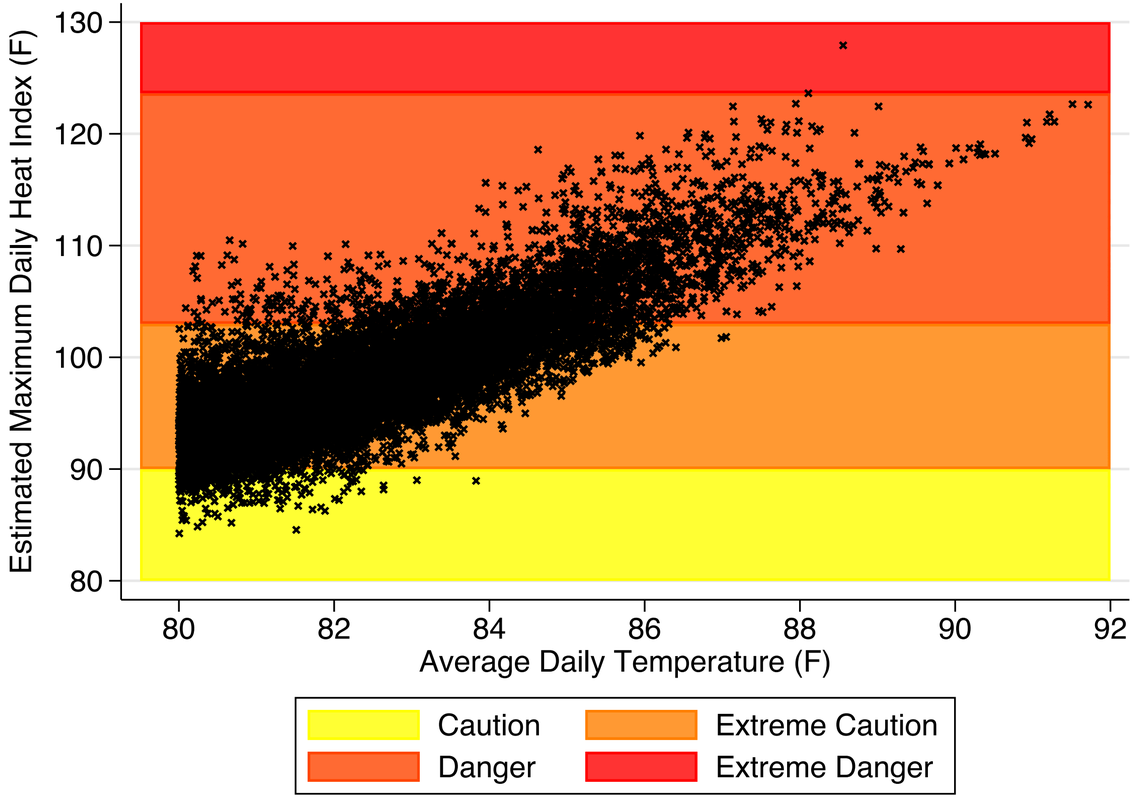
- Share of the year with average daily temperatures 80F+ by county
  - Lowest around 9% of days
  - Highest around 24% of days



# The Upper Bin - What's an 80F+ Day?

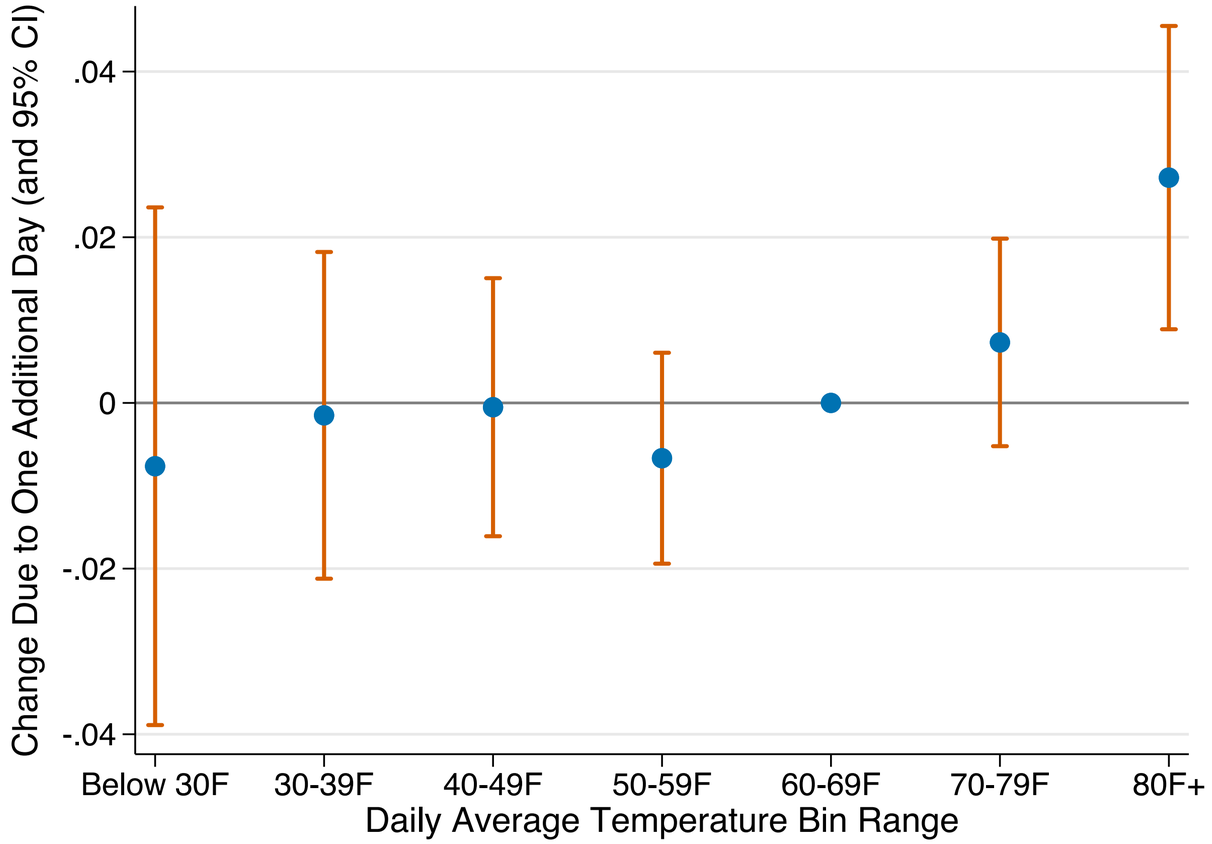
- 80F+ might not sound that hot, but recall that's average (including night)
- Heat index plays a large role in humid states like Mississippi




- External temp under-estimates heat index inside —> 150F in summer

# # of Intense Violence Incidents That Day




- Mean is ~ 0.10 incidents per facility/day
  - i.e., on average facilities have around 36 violent incidents per year

- Move a day from 60-69F to 80F+
  —> ~ **0.03 more incidents**
  (27% increase)

- Move a day from 60-69F to 80F+
  —> ~ **0.04 more incidents per 1,000 prisoners**
  (21% increase)

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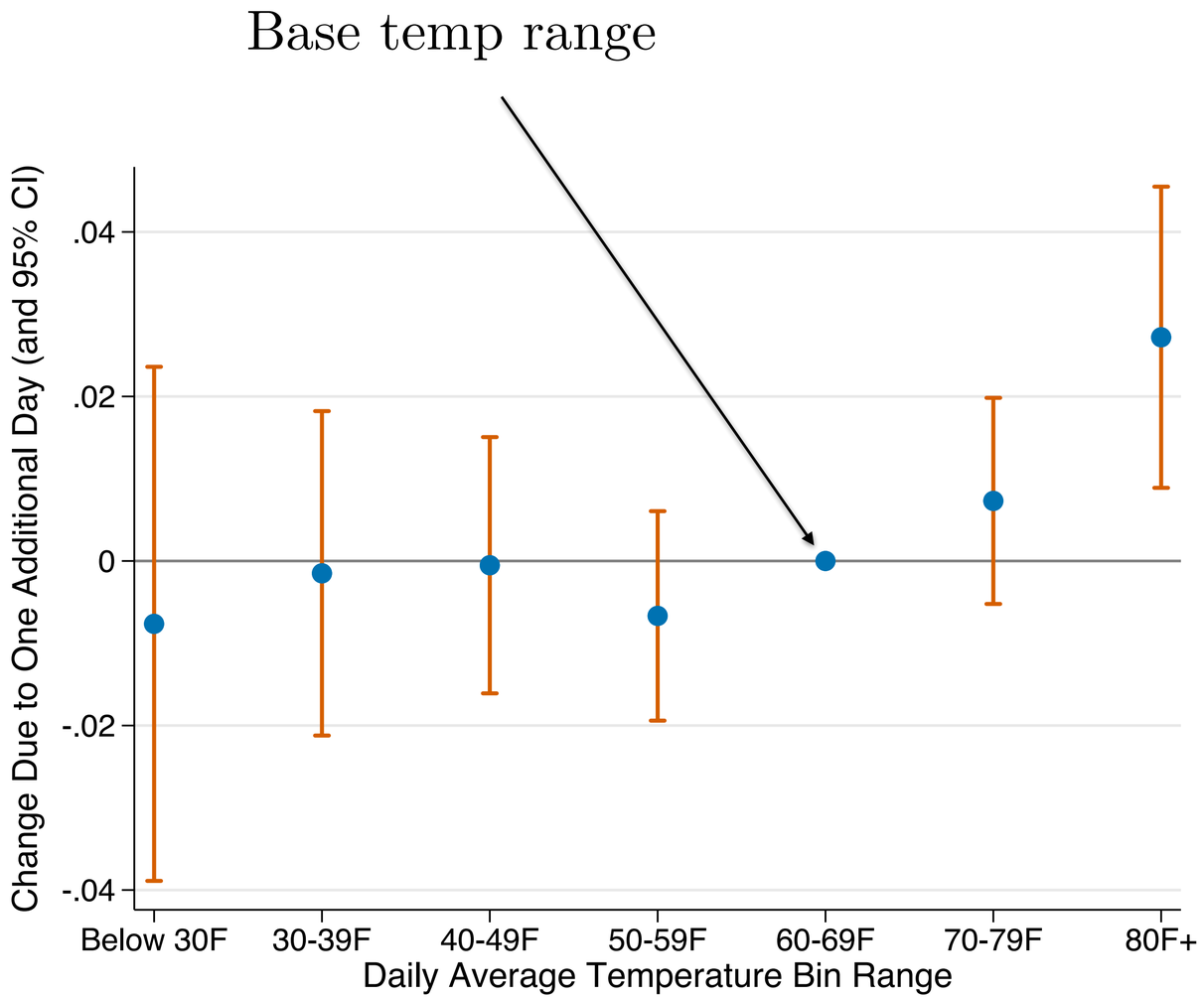


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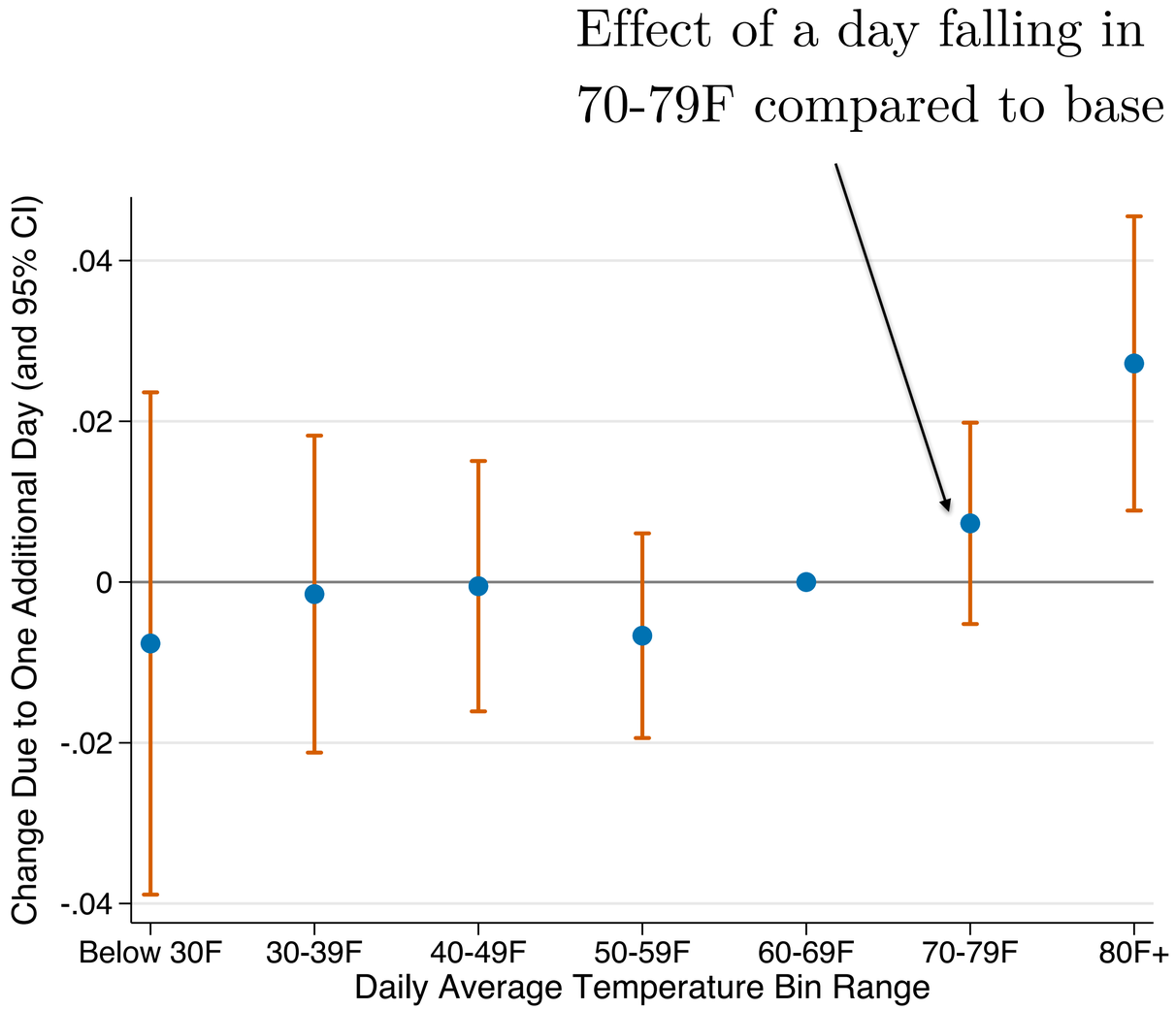


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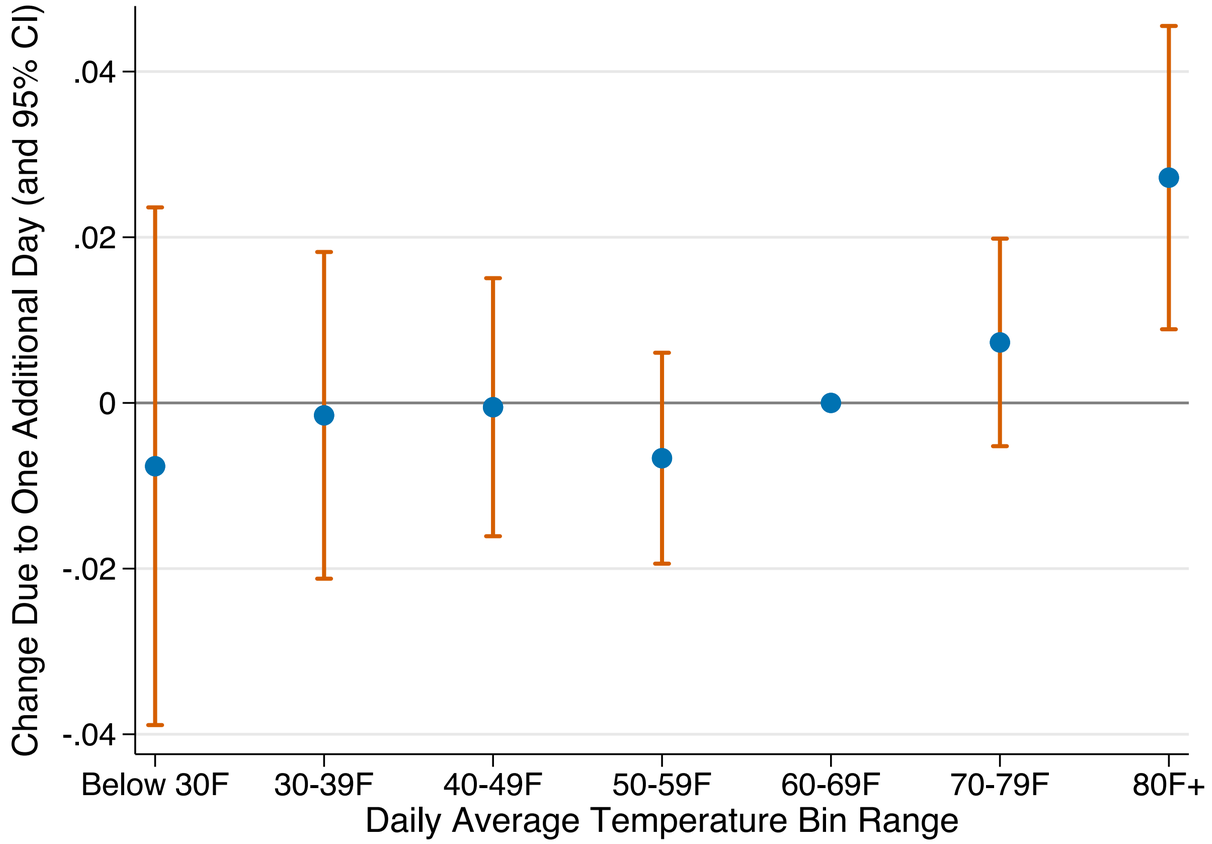


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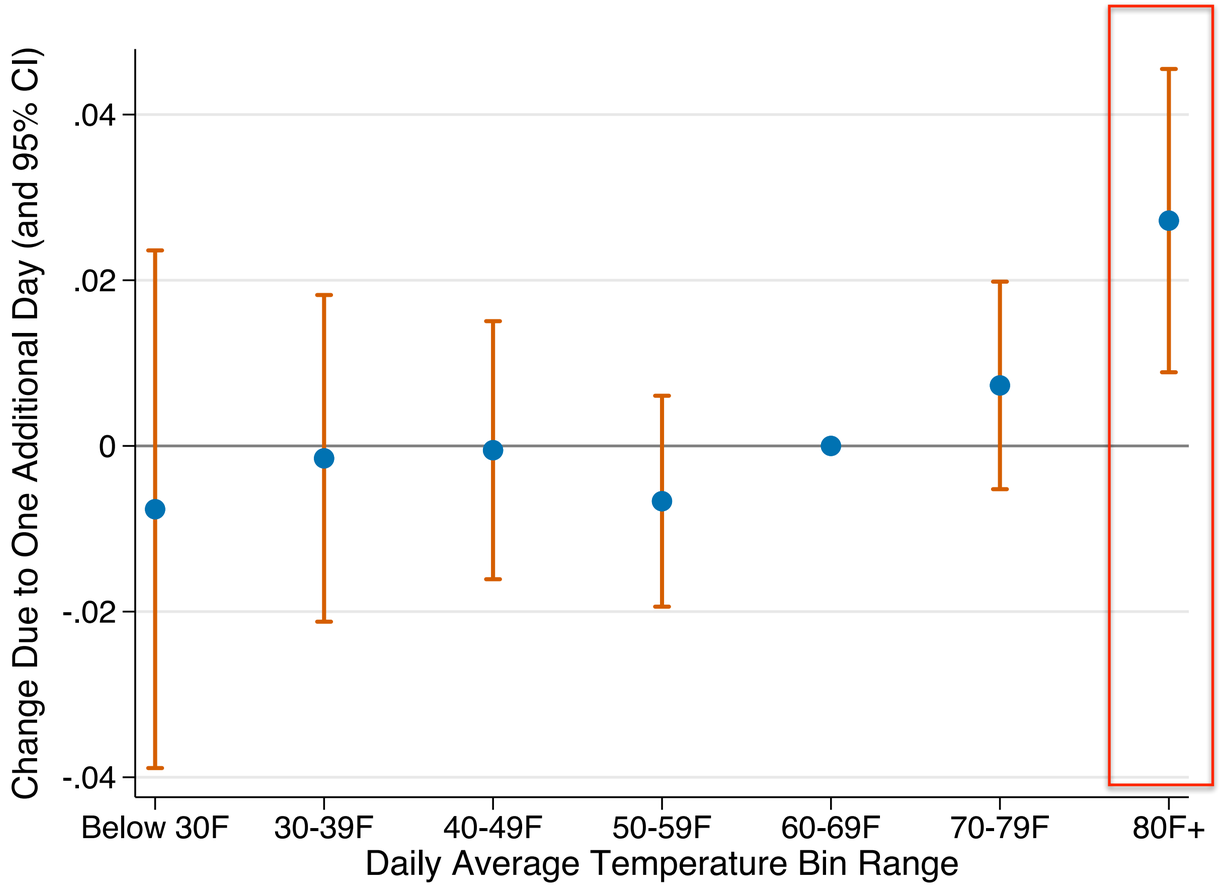


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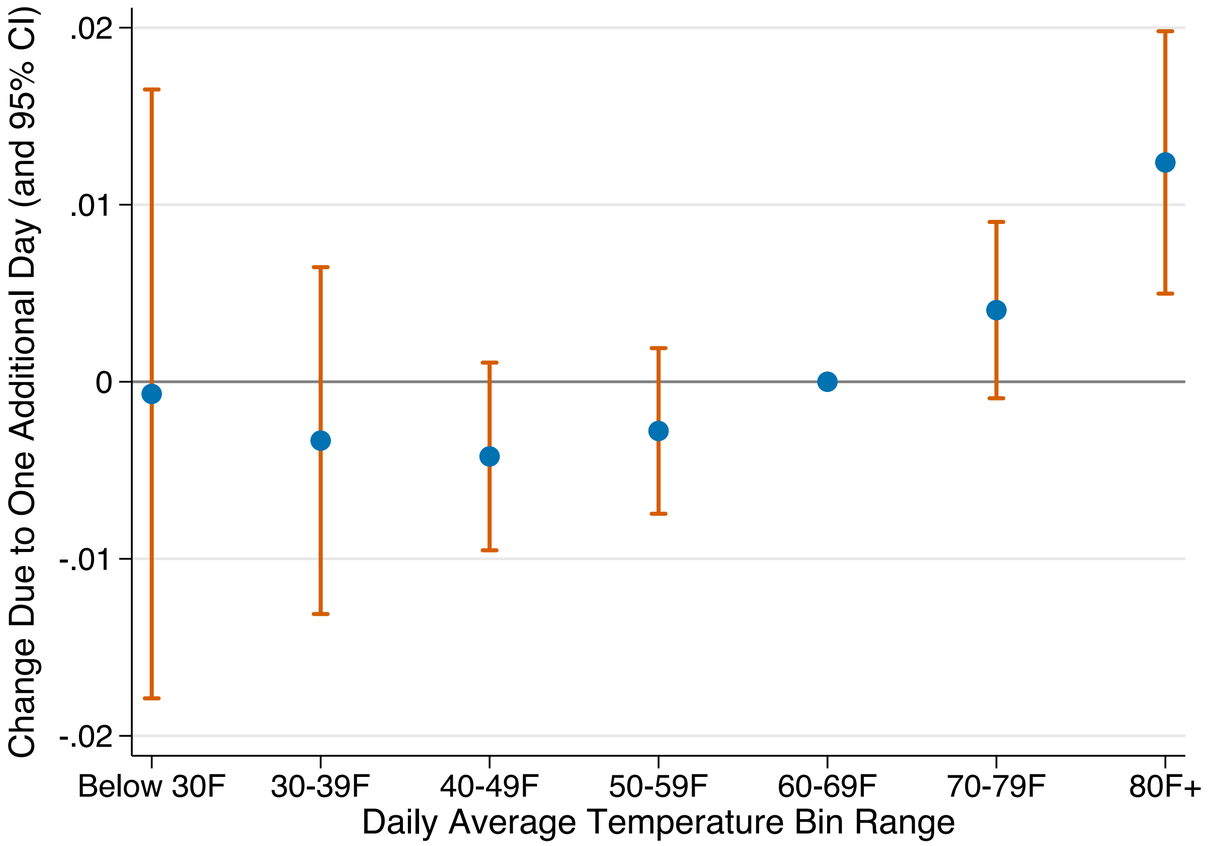


- Mean is ~ 5% prob. per facility/day
  - i.e., on the average facility/day, there's a 5% probability of a violent incident
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  —> **1.2 percentage point increase in prob. of a violent incident** (24% increase)

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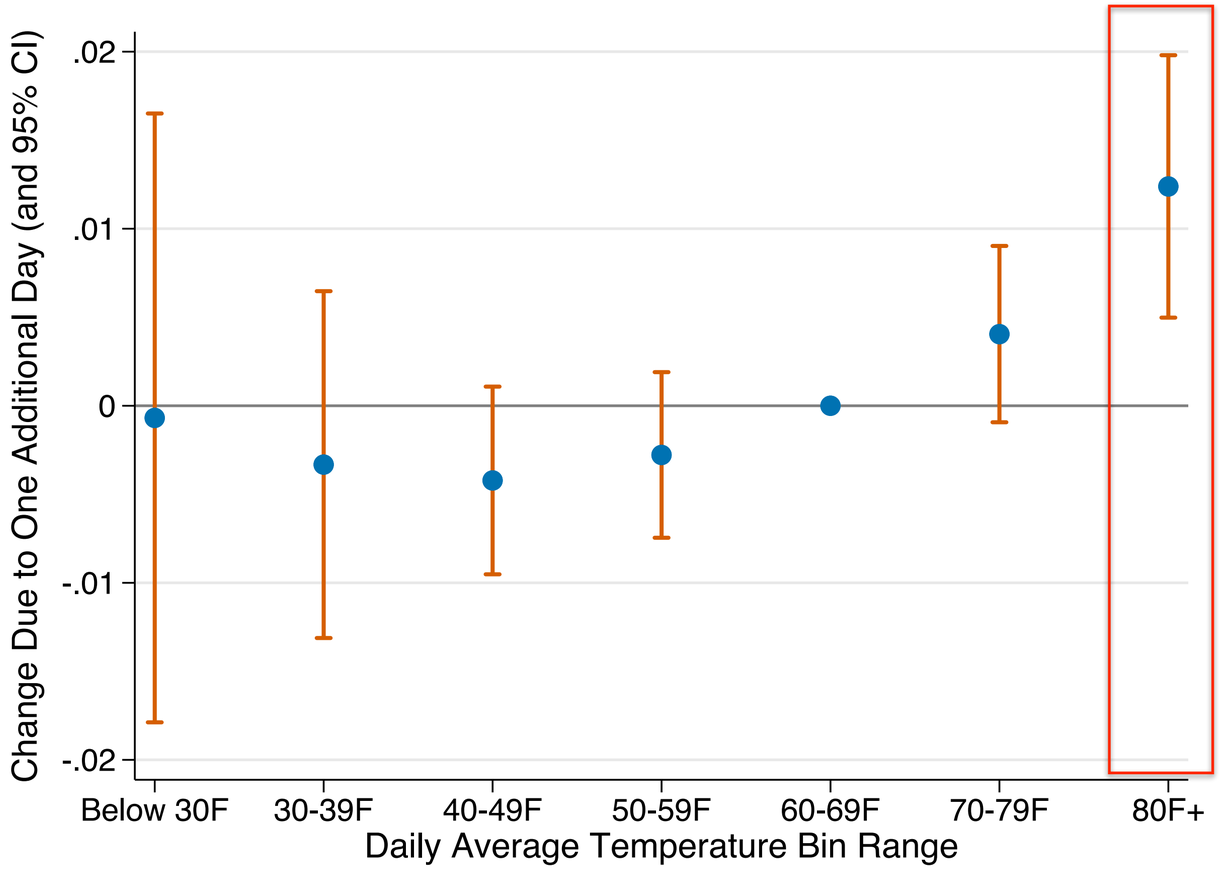


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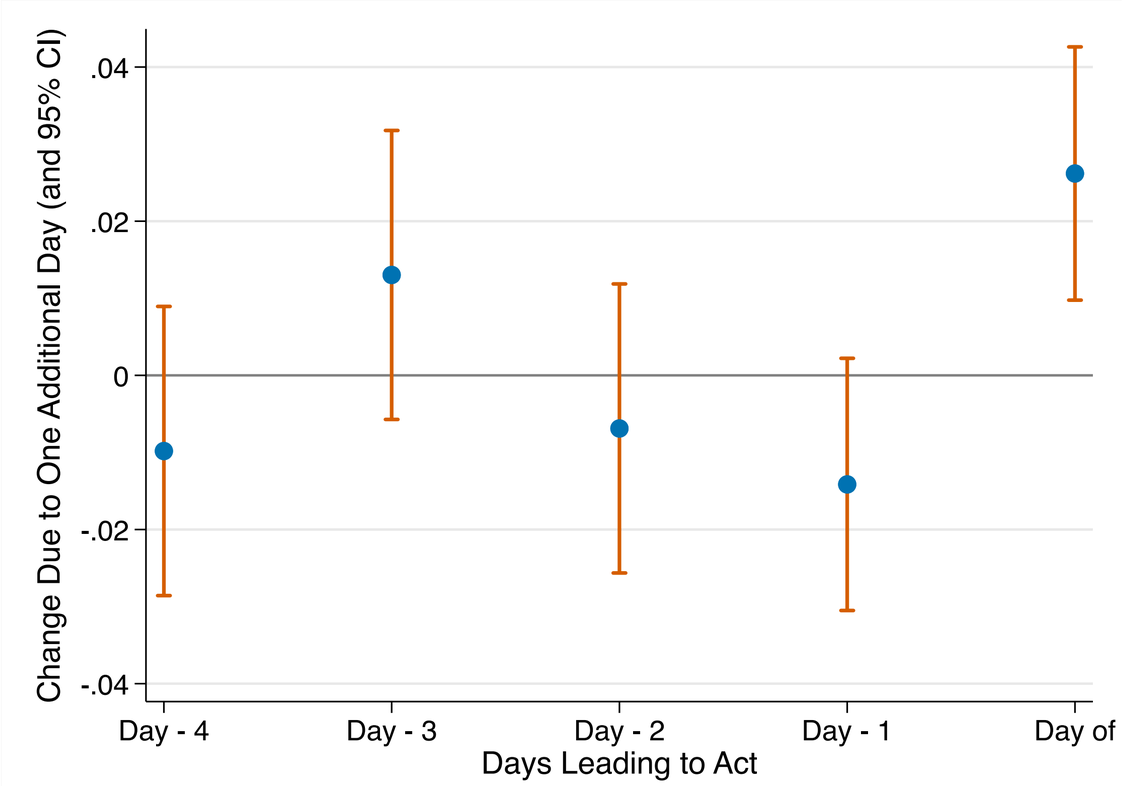
# Some Potential Mechanisms for Observed Effects: Cumulative Effects?

- Maybe heat makes sleeping hard, sleep deprivation leads to issues, frustrations build, etc.
- Simultaneously controlling for 80F+ in prior days doesn't change main estimate magnitude
- Models controlling for count of consecutive 80F+ in the last week don't, either
  - And only current day estimates are statistically different from zero



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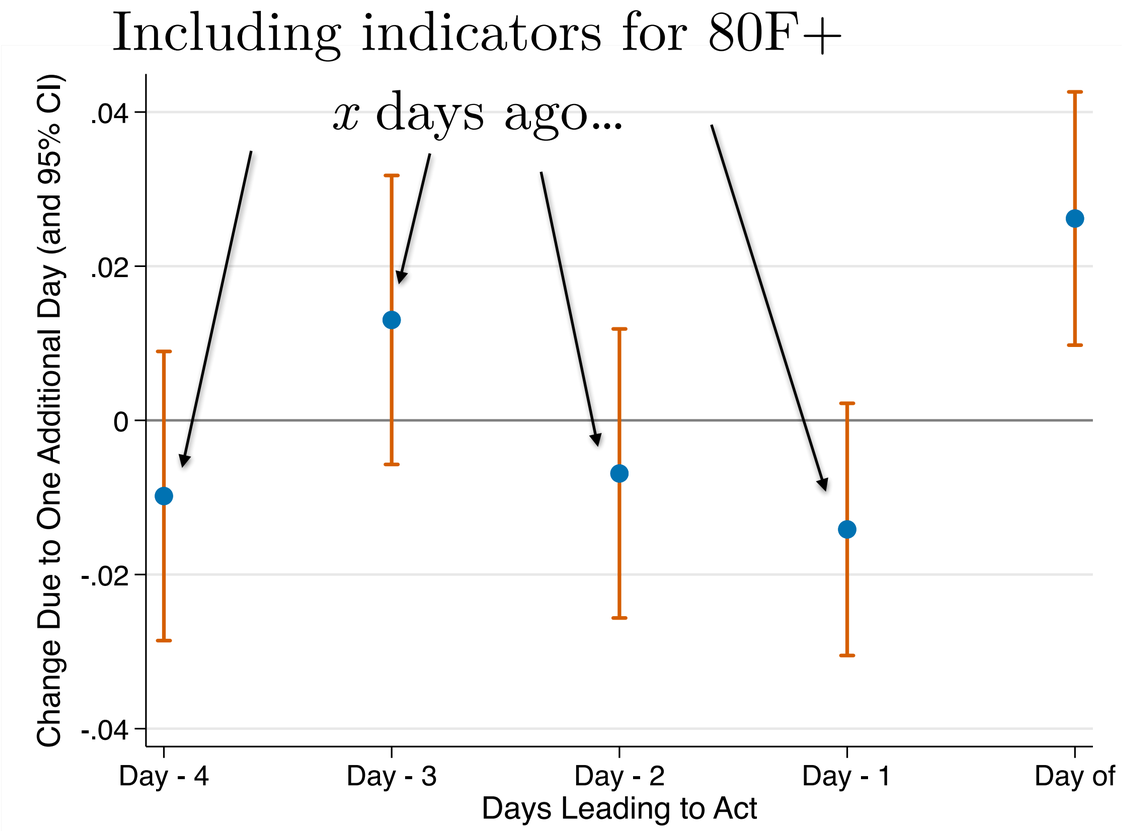

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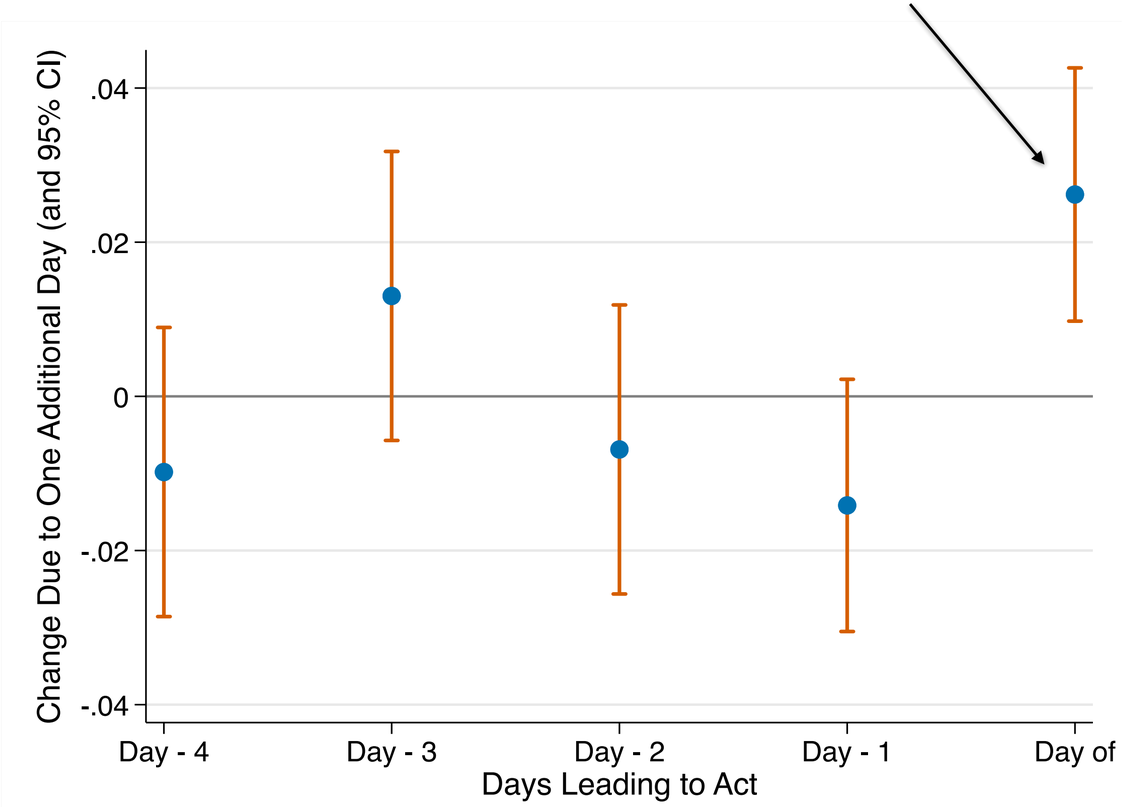
...doesn't eliminate estimate on today's 80F+

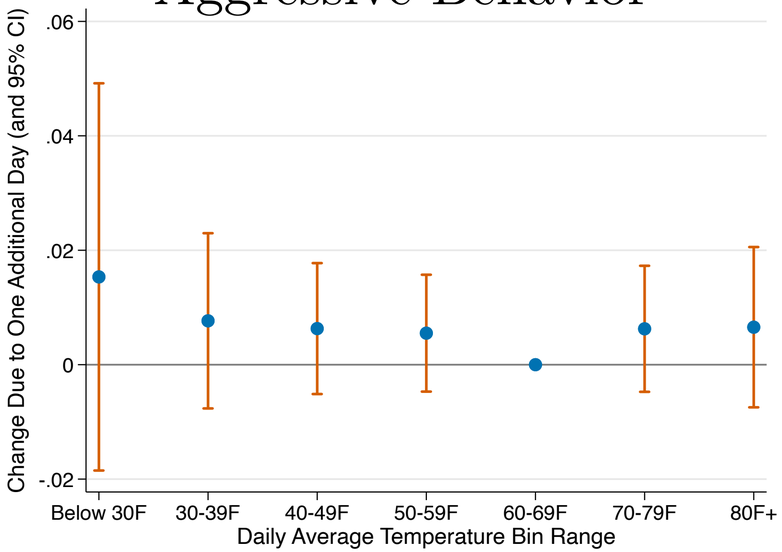


# Some Potential Mechanisms for Observed Effects: Altered Reporting?

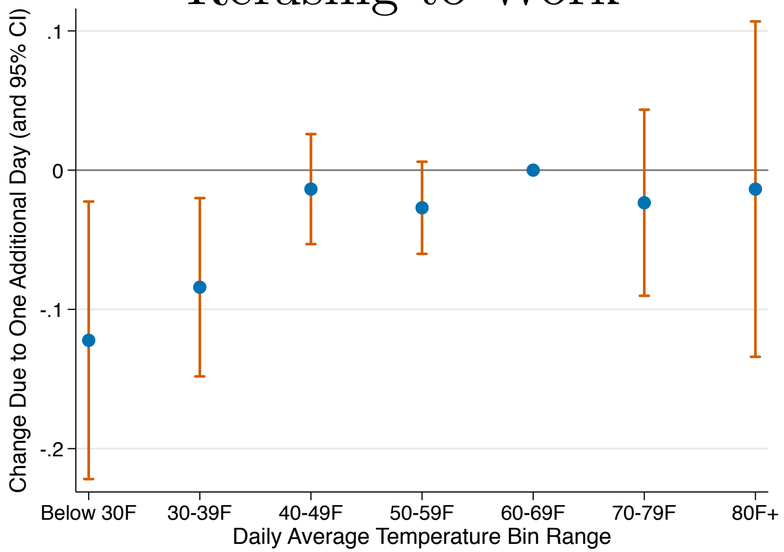
- Heat reduces availability for physical activity, increasing general frustration
- Guards are in worse moods?
  - They're hot too – but in most cases have break rooms with AC
- Similar binned analysis for less drastically-violent offenses

# Some Potential Mechanisms for Observed Effects: Altered Reporting

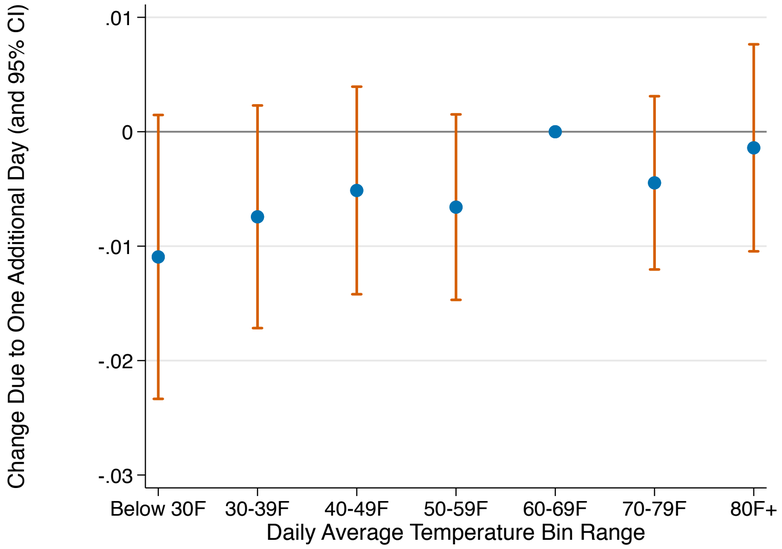
## Aggressive Behavior



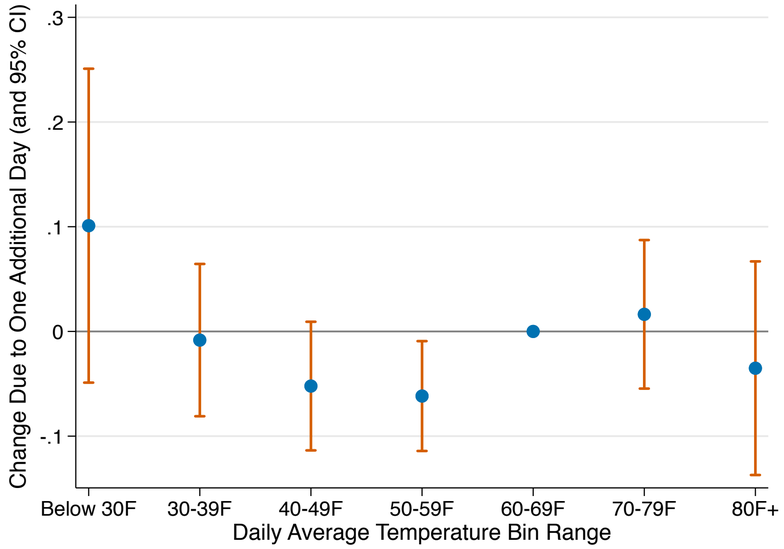

## Refusing to Work




## Demonstration




## Disobedience



# Conclusions and Implications

- More evidence high temps contribute to violence
  - Scenario with fewer avoidance/mitigation/reporting issues
  - Climate change means this problem likely to spread and intensify

- Specific prison policy implications: withholding temperature control increases prison violence
  - Downstream potential consequences
    - Injury or death of inmates and workers (though hard to observe in our data)
    - Extended prison sentences leading to increased incarceration costs
  - Important considerations in true cost of omitting temperature controls

# Dylan Brewer

Assistant Professor, Georgia Institute of Technology

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## Do People Listen When It Matters? Evidence From Smart Thermostat Data on Compliance With Governmental Emergency Requests During Extreme Weather Events

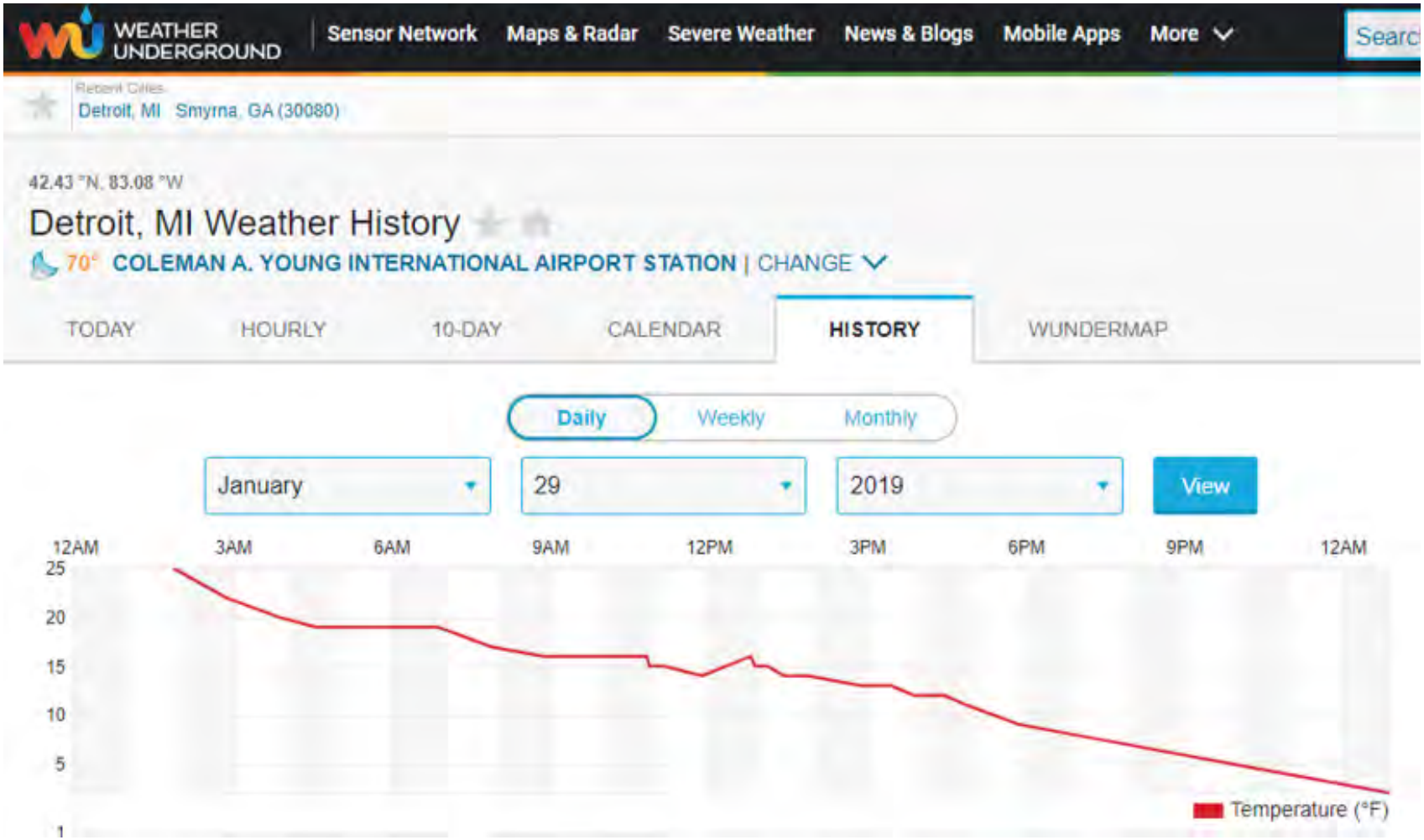
# Do people listen when it matters? Evidence from smart thermostat data on compliance with governmental emergency requests

Dylan Brewer & Jim Crozier

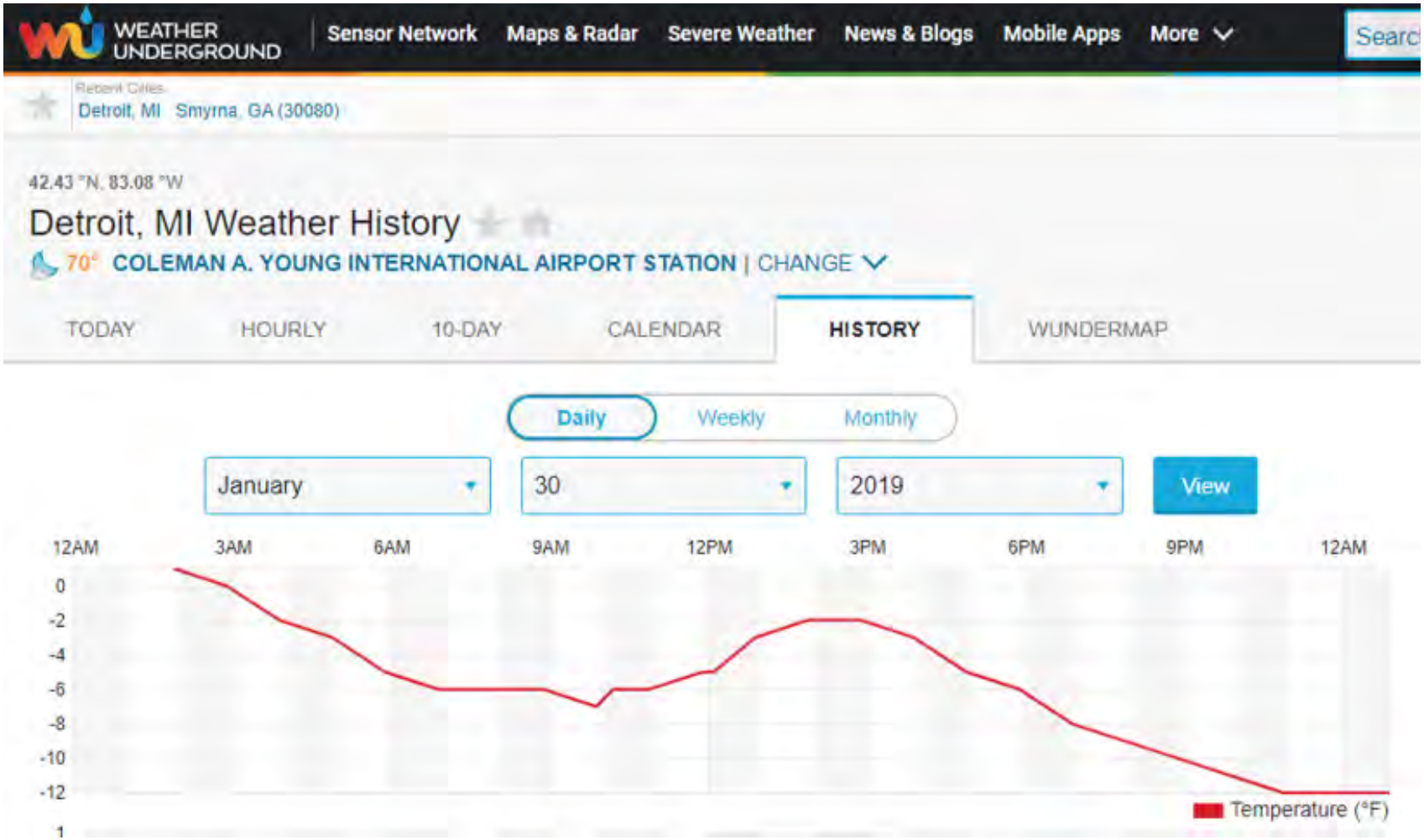
Georgia Institute of Technology
School of Economics

September 1, 2021

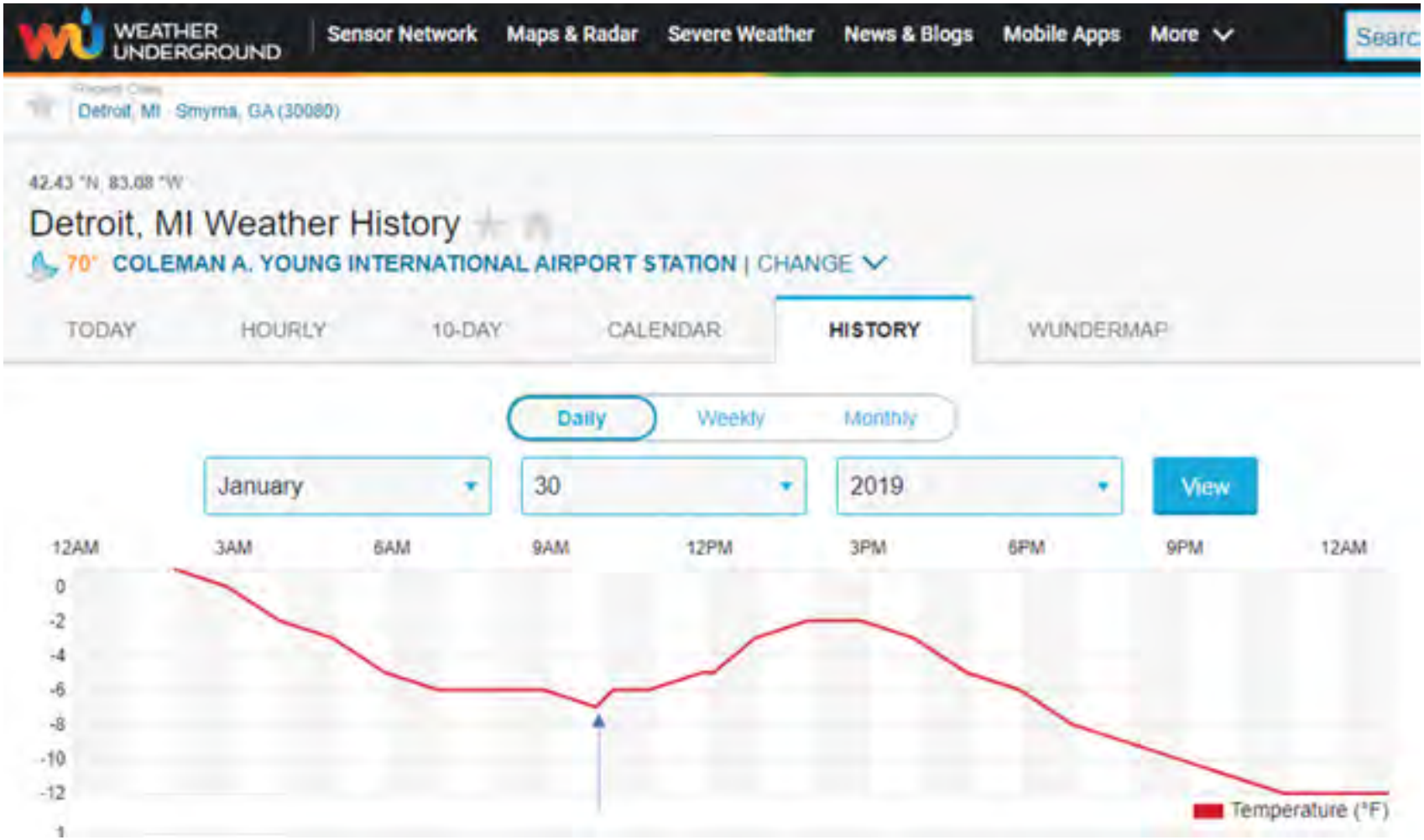
# January 29, 2019



# January 30, 2019



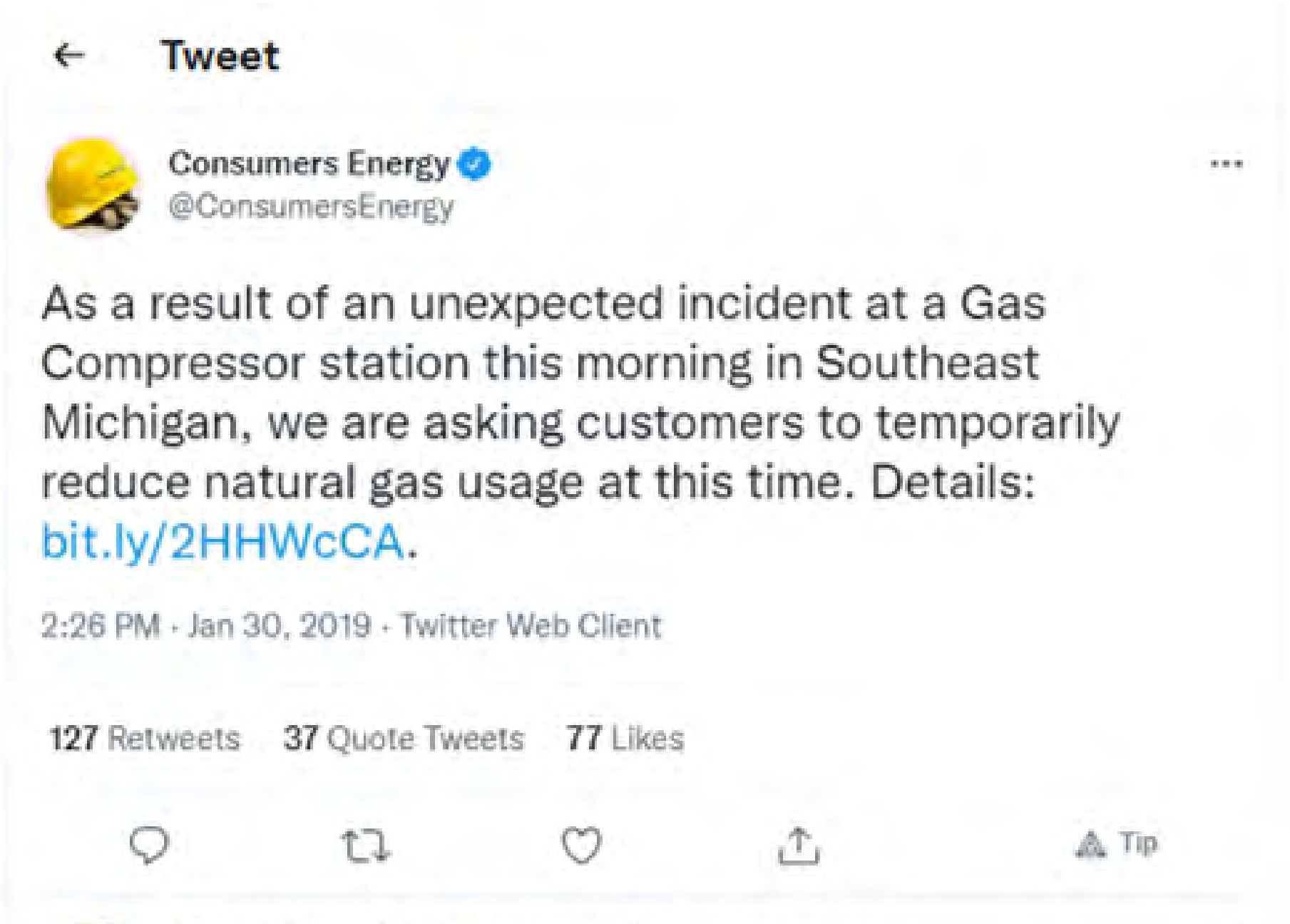
# January 30, 2019



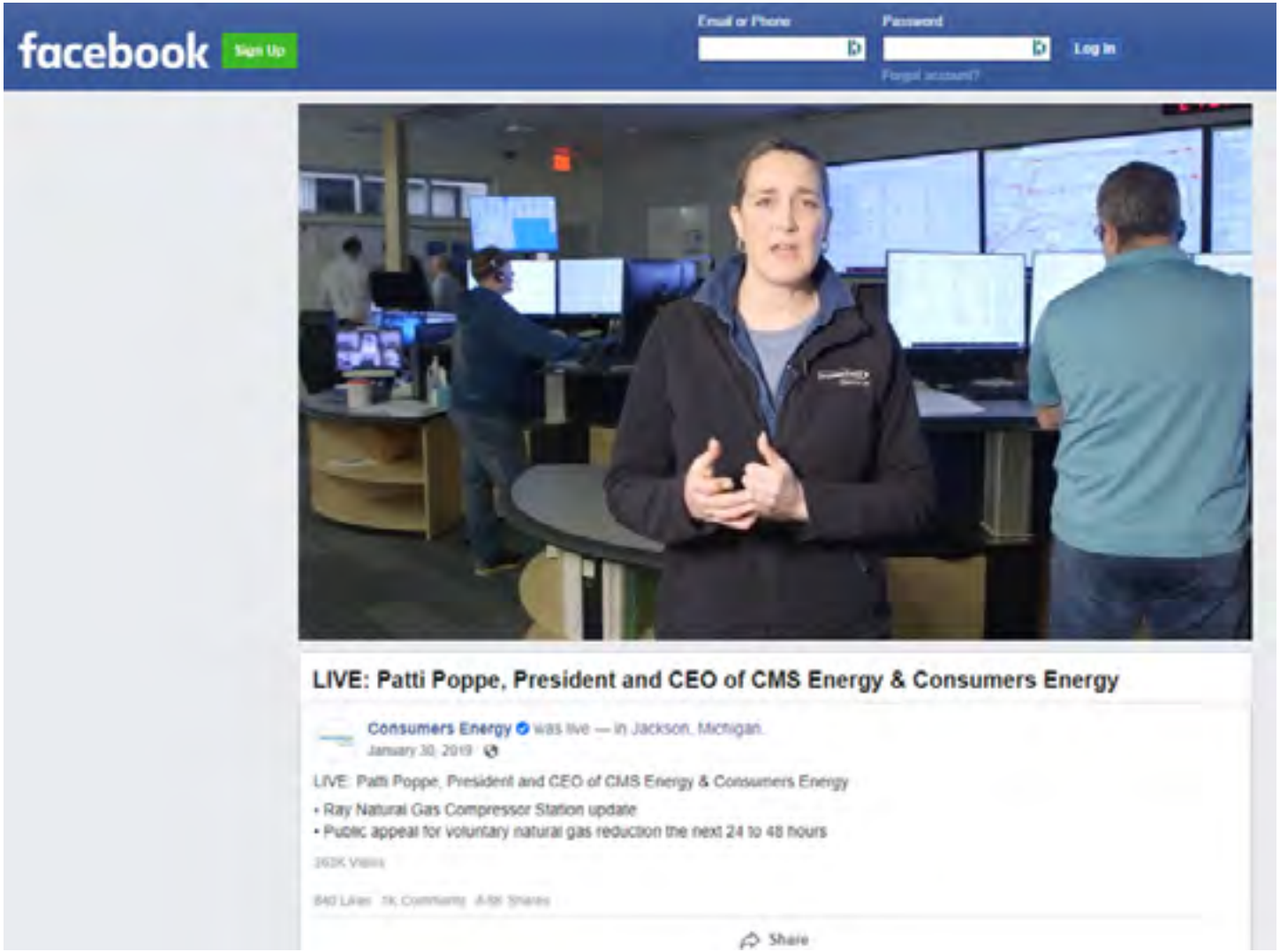
# 10:30 am: Fire at a natural gas compressor station

Source: https://www.wxyz.com/news/utility-fire-at-consumers-energy-station-in-macomb-co-caused-loud-noise

# Voluntary request for reductions



# Facebook Live: Reduce thermostats to 65 F



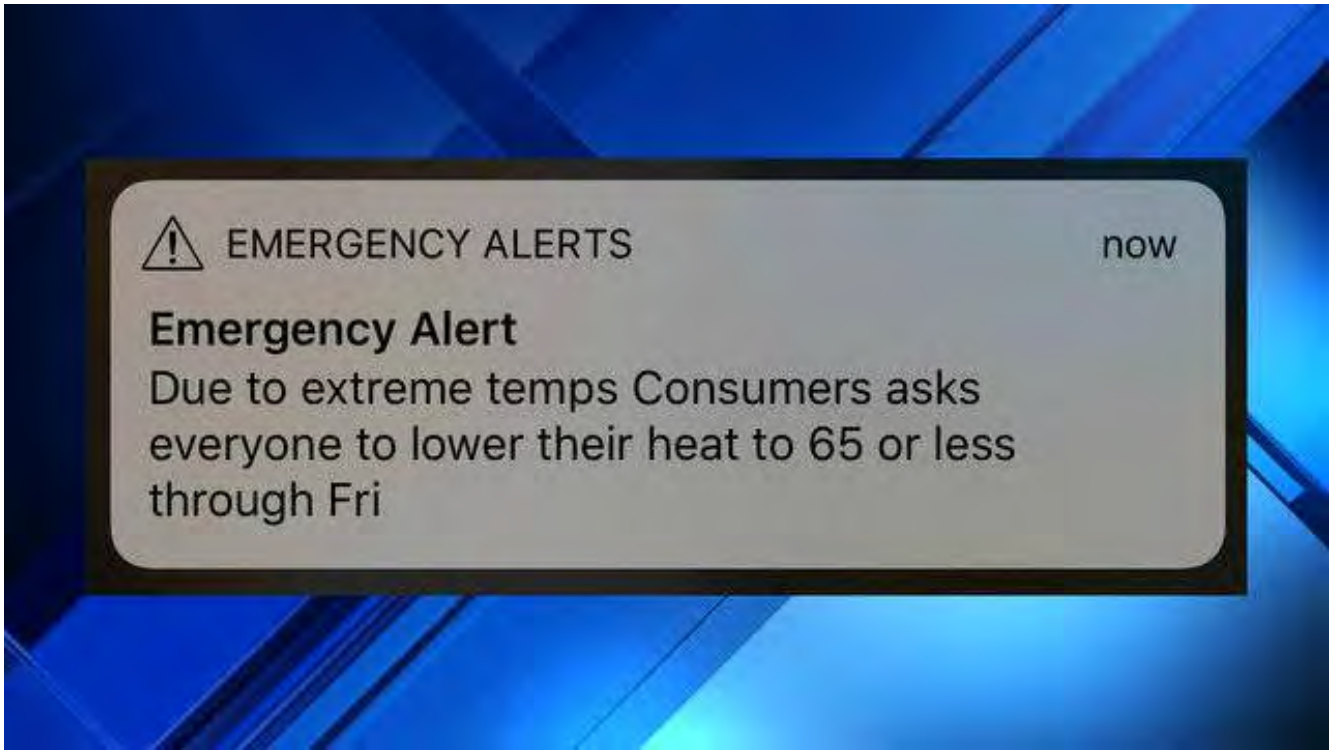
# What could go wrong?

If demand exceeds supply: total system failure.

No heat with temperatures below zero.

# Heading into the night

# 10:30 pm




Source: https://www.clickondetroit.com/news/2019/01/31/michigan-gov-whitmer-uses-emergency-alert-system-to-ask-residents-to-turn-heat-down/

# This paper

Use smart thermostat data from ecobee to study how households responded to this emergency request for reductions.

- Did people listen when it mattered?
- Who listened?
- What can we learn that can help us manage future emergencies?

# Climate?!

How is an extreme cold event related to a warming climate?

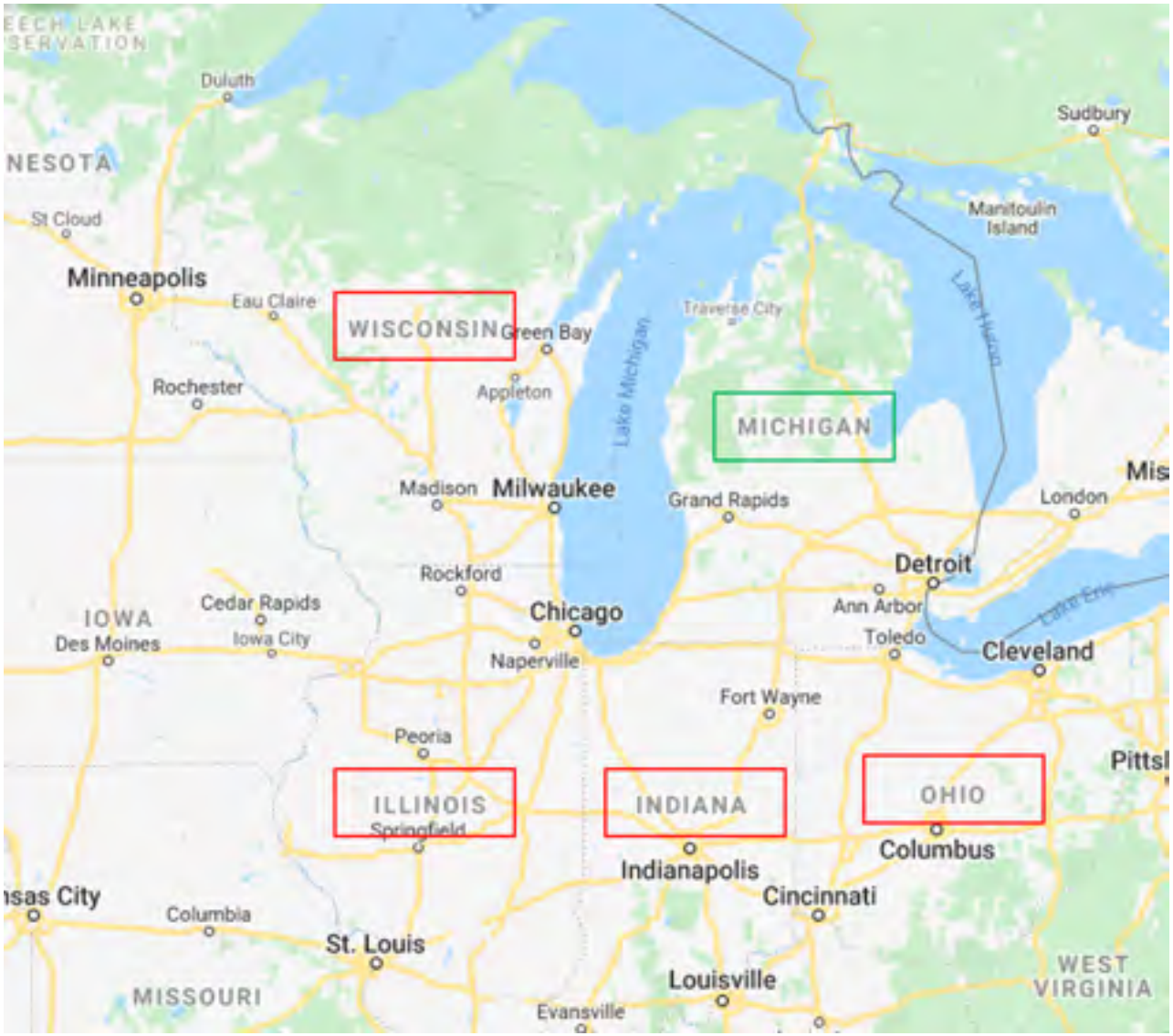
- Currently debated
- Theory: melting sea ice can create feedbacks that disturb the polar vortex, causing cold winds above the Arctic to dip down to North America
- Even if not true, relevant to a broad set of climate emergencies

# The data

Smart thermostat data from ecobee:

- Five-minute interval data aggregated to the hour
- Thermostat setting, outdoor temperature and humidity
- Location up to city
- Limited information about the home and number of occupants

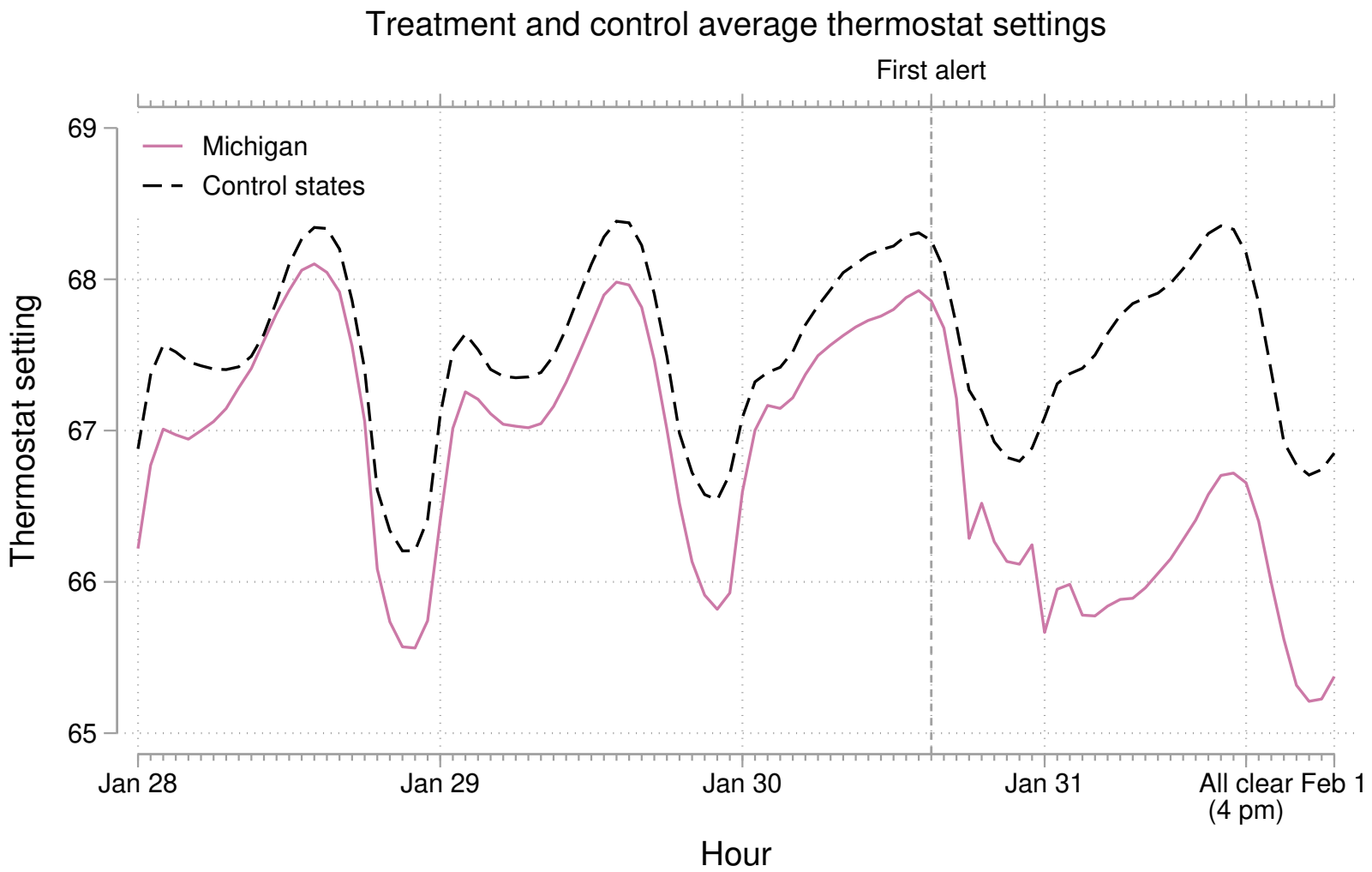
# Empirical strategy



# Treatment and controls

- January 1 - February 7th
- 2,701 Michigan households' hourly data for 2,372,207 observations
- 7,953 Control households' hourly data for 7,053,179 observations

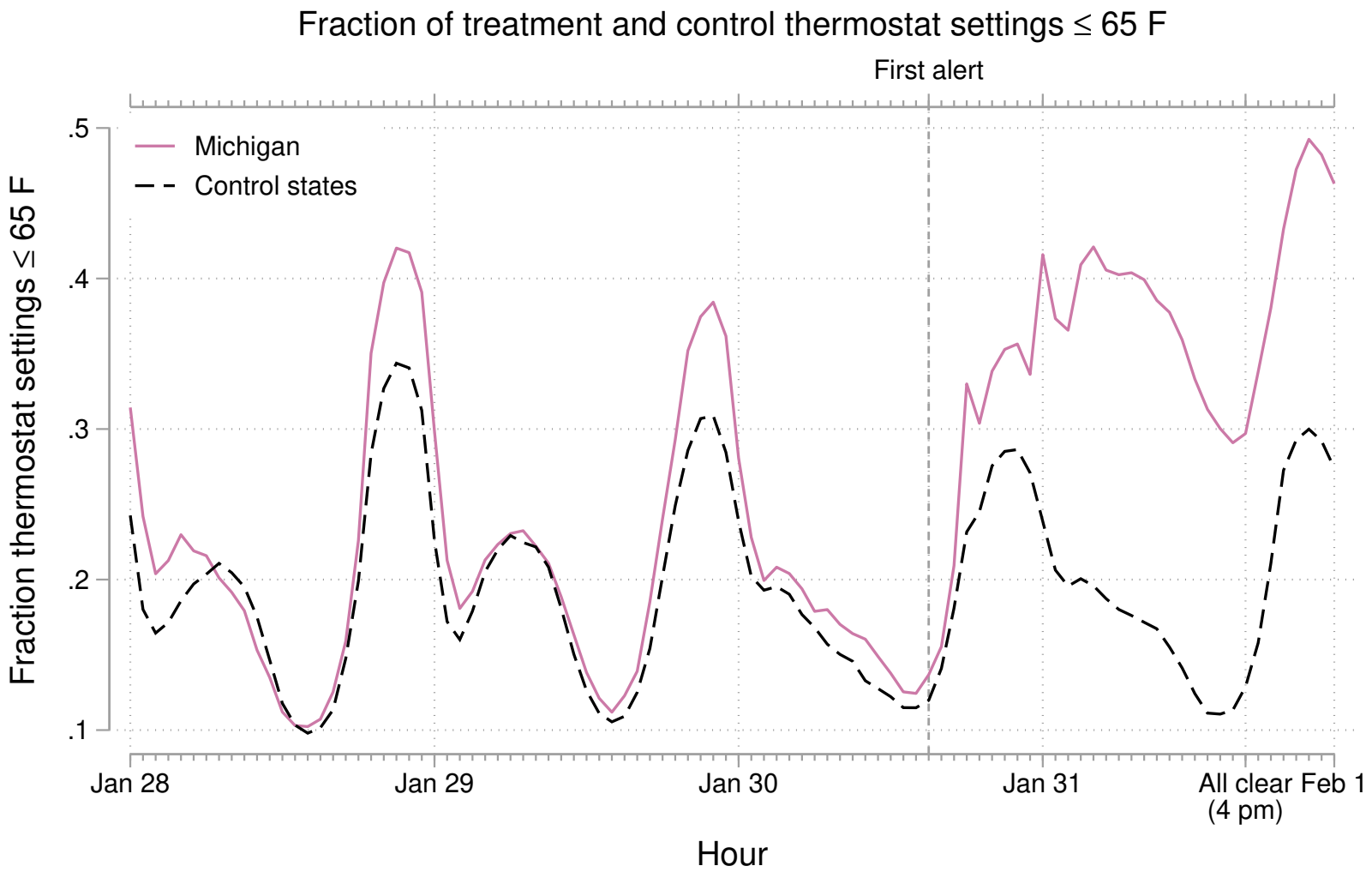
# Thermostat setting



# Thermostat setting

Overall effect: The average household in Michigan reduced the thermostat by 0.8 degrees F.

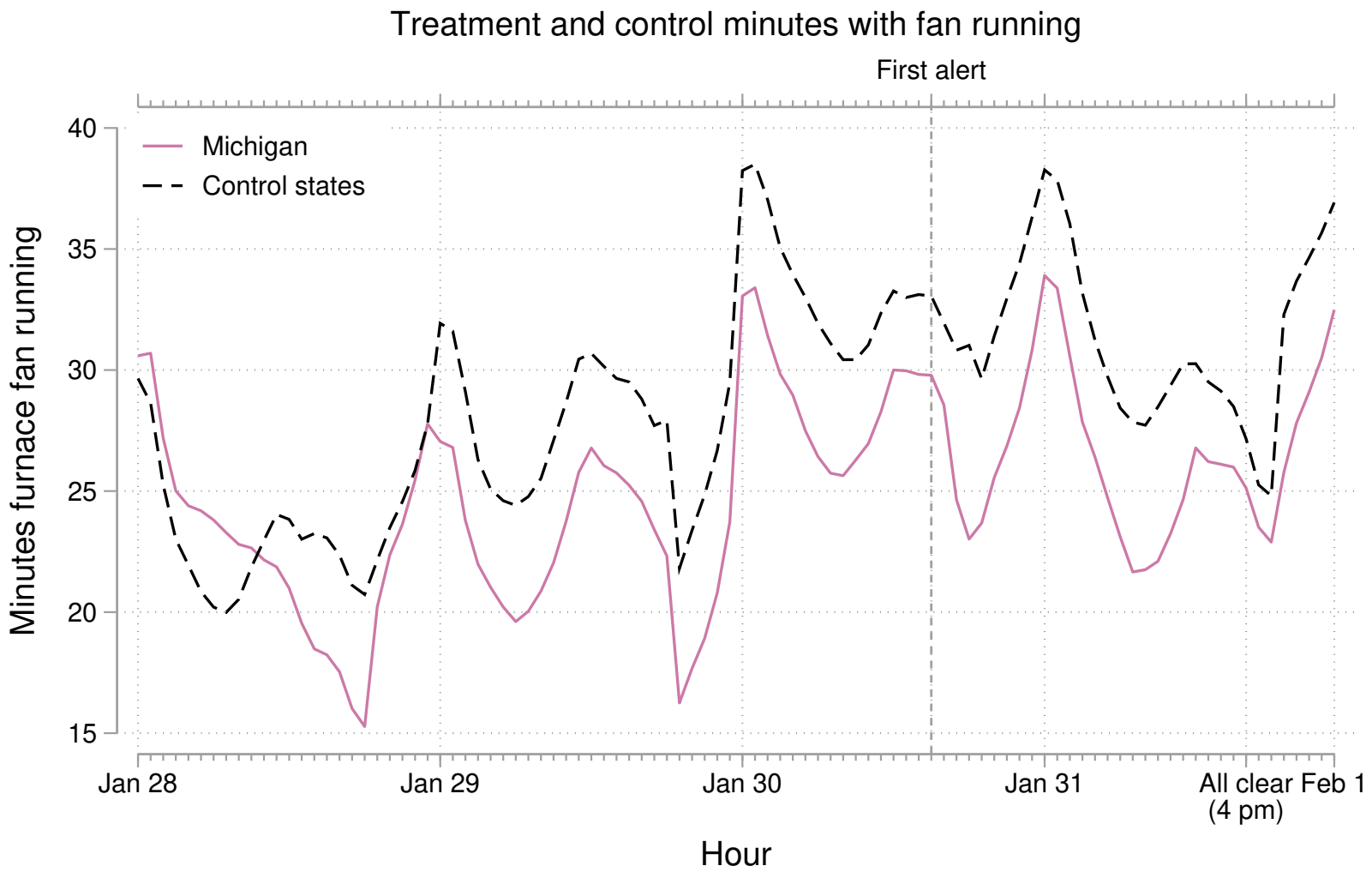
# Compliance


Fraction of treatment and control thermostat settings ≤ 65 F
First alert
Michigan
Control states
Fraction thermostat settings ≤ 65 F
.5
.4
.3
.2
.1
Jan 28
Jan 29
Jan 30
Jan 31
All clear Feb 1
(4 pm)
Hour

# Compliance rate

- 24 percent of Michiganders would have had their thermostats below 65 F anyway
- An additional 11 percent of Michiganders brought their temperature below 65 F because of the request

# Fan running time



# Fan running time

- Reduced furnace fan running time by 1.5 minutes per hour on average
- Relative to a 27 minutes per hour average running time
- Roughly 5.6% decrease in energy use ignoring potential ramping costs

# Effective intervention

- Intervention takes time and a major platform to take hold
- 0.8 degree F reduction
- 11 percent of additional households complied
- 5.6% reduction in furnace run intensity

# All clear


Tweet
Consumers Energy
@ConsumersEnergy
To our MI neighbors who came together to help in our state's time of need: THANK YOU. As of midnight tonight, we are calling an ALL CLEAR to our voluntary natural gas reduction. bit.ly/2WsrjWh
ALL CLEAR
Consumers Energy
Count on Us
4:32 PM · Jan 31, 2019 · Twitter Web Client

# What else can we learn?

Who complied and who defied?

- COVID-19
- Politicization of emergency response

# Governor Whitmer

Governor Whitmer elected in 2018 and took office just days before the emergency.

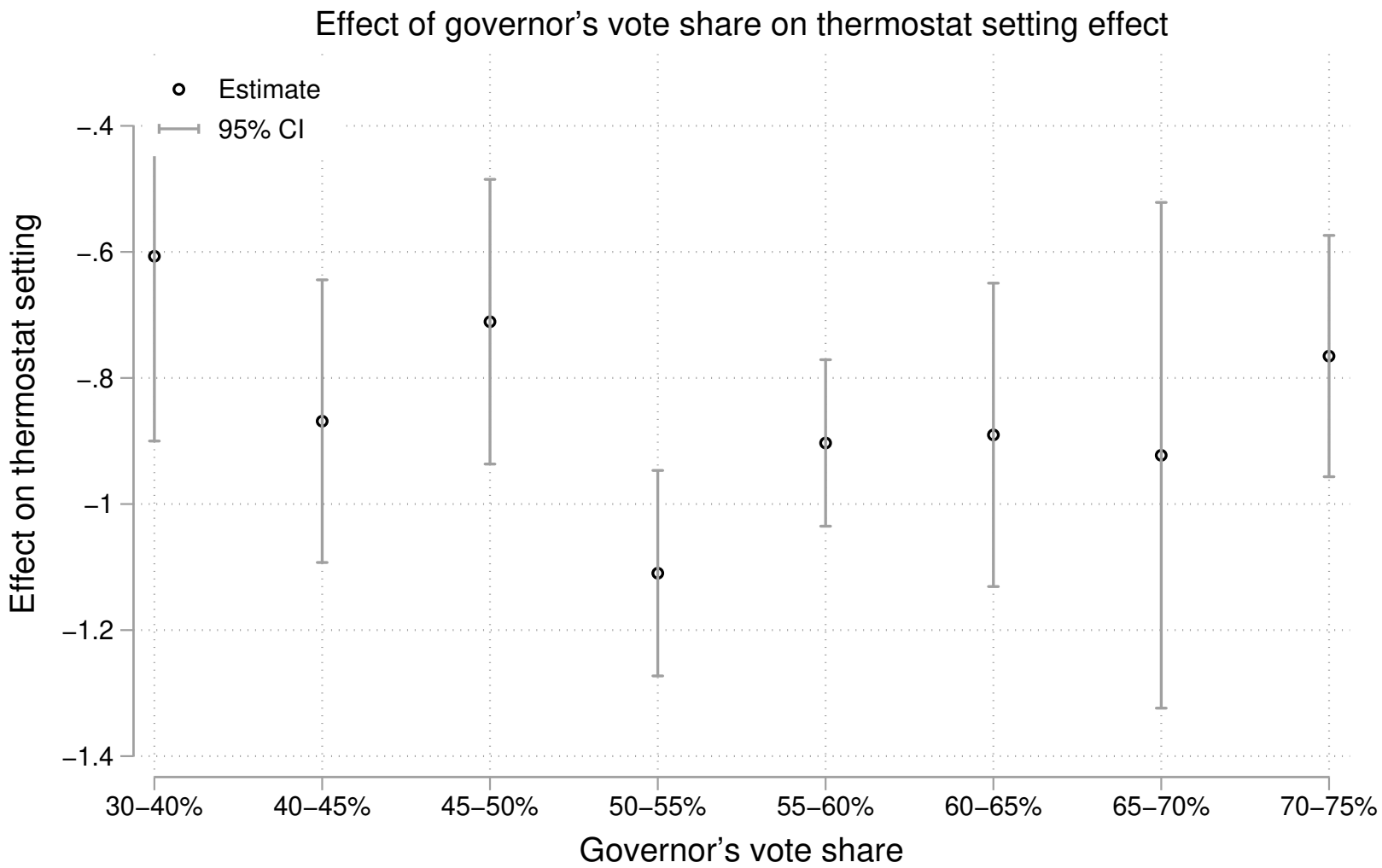
- Democratic Party
- 53.3% of votes
- Later became a key (polarizing) figure in the COVID-19 crisis response

# Election data

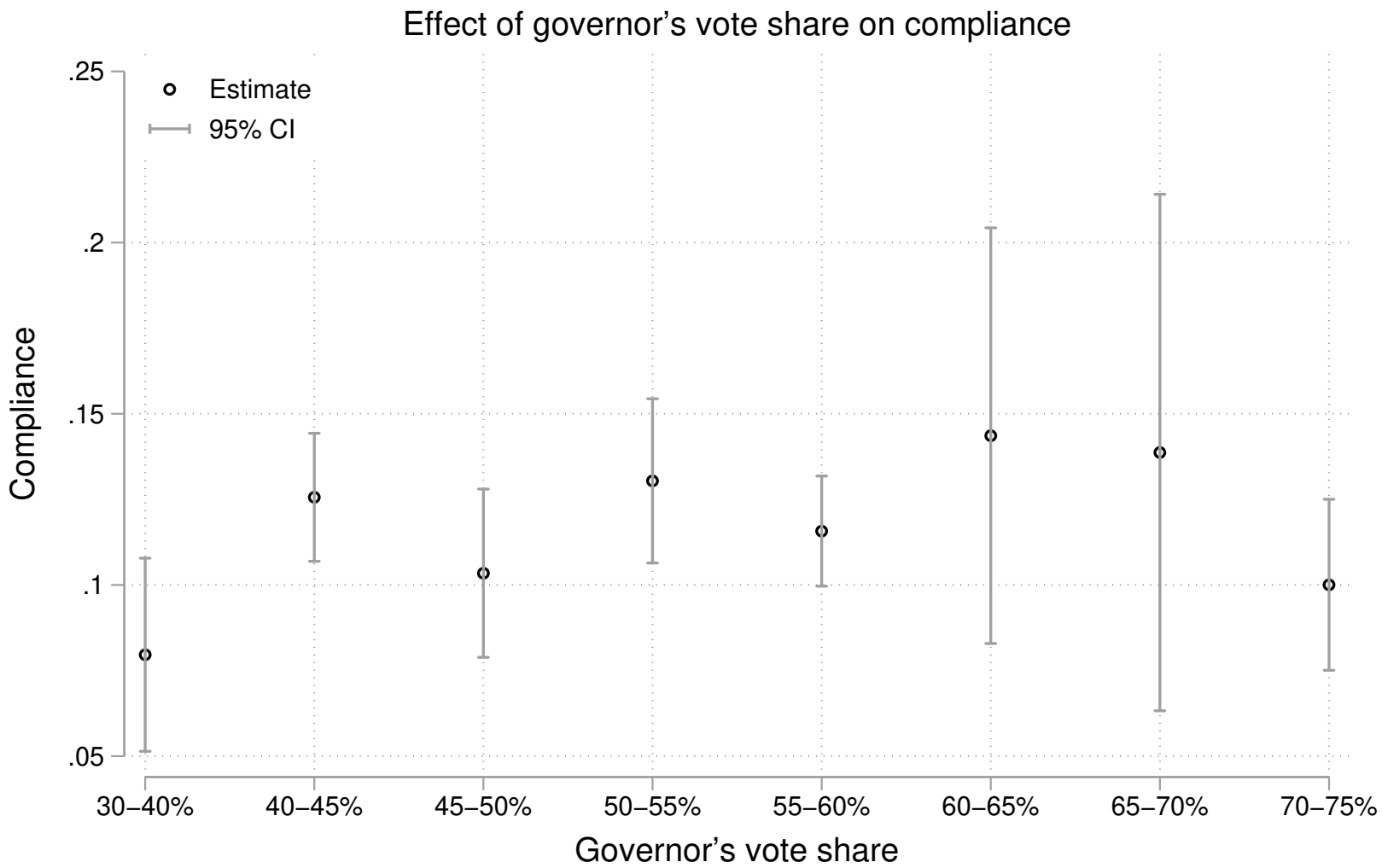
CQ Press county vote share data

- Match county vote share to cities
- Vote shares for counties where we observe households range from 30-75 percent

# Evidence of defiance



# Evidence of defiance



# Conclusions

- Voluntary requests can be effective, but require time and a large platform
- Anchoring effects (choosing 65 F) can reduce the impact of a nudge
- Political polarization reduces effectiveness during a crisis
- Formalizing emergency demand response processes can guarantee larger and faster reductions

# Up next – 3:30-5pm PT

**SESSION 4.1**

The Effects of Temperatures on Behavior

**SESSION 4.2**

Adaptation at Home: Consumption, Building Codes, and Insurance

**SESSION 4.3**

Quantifying and Minimizing Water Quality Impacts

**SESSION 4.4**

Integrating Climate and Transportation Planning

CLIMATE ADAPTATION
RESEARCH SYMPOSIUM

MEASURING & REDUCING SOCIETAL IMPACTS

# Thanks for tuning in!

UCLA Luskin Center for Innovation