Crime, Weather, and Climate Change

Author: Matthew Ranson

Presenter: Wisnu Sugiarto

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Motivation

- Short-term relationship between crime and weather. Higher temperatures cause increases in crime (Horrocks and Menclova, 2011; Brunsdon et al., 2009; Bushman et al., 2005; Cohn, 1990).
- Crime rates exhibit negative serial correlation over a span of weeks (Jacob et al., 2007). Hour-to-hour or day-to-day relationship between weather and crime is unlikely to be informative on long-term effects.

Research Issues

Question: What is the impact of climate change on US crime rates?

Objectives: Using historical data to estimate the causal relationship between weather and crime. Then, use the relationship to predict future crime levels.

Contributions:

1. Documenting a striking relationship between monthly weather patterns and crime rates through a semi-parametric specification and 30-year panel dataset.
2. Predicting how climate change will affect patterns of criminal activity in the US.

Background

Several hypotheses on why weather might affect crime:

- Weather is a variable in the production function for crime.
- Weather draws social interactions, increase crime.
- Ambient temperatures affect aggression, people's psychological propensity to commit violent criminal acts.

Data

- Uniform Crime Reporting (UCR) data from the US FBI.
- Global Historical Climatology Network Daily (GHCN-Daily) data from the National Climatic Data Center.

After combining datasets and cleaning them, the author has 891,000 unique county-by-year-by-month observations (2997 counties, 49 states including D.C., year 1980 to 2009)

Summary Statistics 1

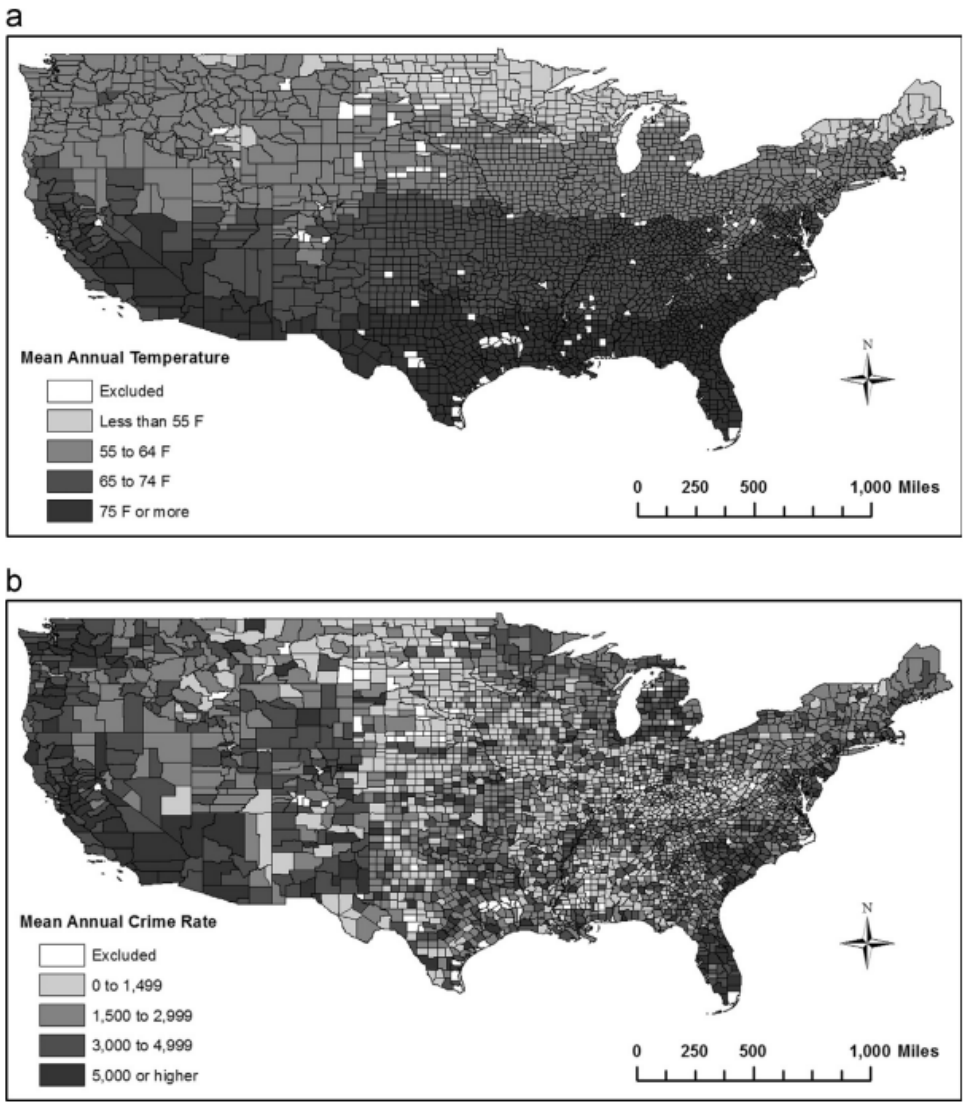


Fig. 1. Map of the study region: (a) mean annual maximum daily temperature (°F) and (b) Annual crime rate per 100,000 persons (all crimes). *Note*: The top panel depicts mean annual maximum daily temperature, by county. The bottom panel depicts the annual number of all crimes per 100,000 persons, by county. All statistics are based on data from 1960 to 2009.

Summary Statistics 2

Table 1
Summary statistics, by climate zone.

	Mean annual maximum daily temperature			
	< 55 °F	55–64 °F	65–74 °F	≥ 75 °F
Monthly crime rate (per 100,000 persons)				
Murder	0.1 (1.2)	0.2 (1.3)	0.4 (1.8)	0.6 (2.1)
Manslaughter	0.03 (0.51)	0.03 (0.50)	0.02 (0.45)	0.02 (0.42)
Rape	1.7 (4.3)	1.6 (3.7)	1.7 (3.6)	2.0 (3.5)
Aggravated assault	7 (15)	11 (17)	18 (22)	24 (25)
Simple assault	36 (46)	42 (43)	47 (54)	56 (59)
Robbery	1 (2)	3 (14)	4 (9)	5 (9)
Burglary	45 (48)	46 (45)	58 (47)	71 (53)
Larceny	132 (97)	136 (118)	131 (105)	155 (118)
Vehicle theft	10 (13)	12 (23)	14 (18)	16 (20)
Annual number of days in weather bin				
Max temp: < 10 °F	12 (10)	2 (4)	0 (1)	0 (0)
Max temp: 10–19 °F	19 (9)	6 (6)	1 (2)	0 (0)
Max temp: 20–29 °F	37 (9)	19 (11)	4 (5)	0 (1)
Max temp: 30–39 °F	52 (13)	43 (14)	17 (11)	3 (3)
Max temp: 40–49 °F	42 (10)	50 (13)	35 (12)	11 (7)
Max temp: 50–59 °F	41 (9)	51 (16)	51 (11)	32 (13)
Max temp: 60–69 °F	49 (12)	53 (13)	60 (13)	55 (13)
Max temp: 70–79 °F	65 (11)	64 (15)	69 (14)	78 (14)
Max temp: 80–89 °F	42 (15)	62 (18)	85 (19)	99 (26)
Max temp: 90–99 °F	6 (7)	14 (14)	40 (21)	78 (21)
Max temp: ≥ 100 °F	0 (1)	1 (2)	3 (7)	9 (17)
Precip: 0 mm	174 (46)	161 (44)	193 (40)	210 (45)
Precip: 1–4 mm	147 (37)	152 (34)	114 (29)	99 (30)
Precip: 5–14 mm	32 (11)	38 (14)	37 (12)	33 (13)
Precip: 15–29 mm	9 (5)	12 (6)	15 (6)	15 (7)
Precip: ≥ 30 mm	2 (2)	3 (3)	6 (4)	8 (5)
County characteristics				
Population	39,210 (56,471)	109,327 (273,217)	83,587 (346,614)	103,412 (285,195)
Pct white	96 (9)	95 (7)	86 (16)	77 (18)
Pct female	50 (1)	51 (1)	51 (2)	51 (2)
Pct ages 0–4	7 (1)	7 (1)	7 (1)	8 (1)
Pct ages 5–19	22 (3)	22 (3)	22 (3)	23 (3)
Pct ages 65-up	16 (4)	15 (4)	14 (4)	14 (5)
Pct metro center	2 (15)	8 (26)	7 (25)	4 (20)
Pct metropolitan	14 (35)	24 (42)	22 (42)	25 (43)
Pct urban	53 (50)	48 (50)	49 (50)	56 (50)
Pct rural	30 (46)	20 (40)	23 (42)	14 (35)
Counties	207	1112	1169	509
Complete county years	5364	29,316	28,567	10,984
County month obs.	64,368	351,792	342,804	131,808

Note: The table shows mean crime rates, weather conditions, and socioeconomic characteristics for all in-sample counties for the years 1980–2009. Numbers in parentheses indicate standard deviations. Results are presented separately for counties in each of four climate zones, based on mean annual maximum daily temperature.

Methodology 1

Assume that the number of crimes C_{iym} in month m of year y in county i of state s has a Poisson distribution with PDF given by:

$$f(C_{iym}|X_{iym}) = exp(-\mu(X_{iym}))\mu(X_{iym})^{C_{iym}}/C_{iym}! \quad (1)$$

- X_{iym} is the set of all observed covariates.
- $\mu(X_{iym}) \equiv E[C_{iym}|X_{iym}]$ provides a parametric form for the conditional mean of C_{iym} given X_{iym}.

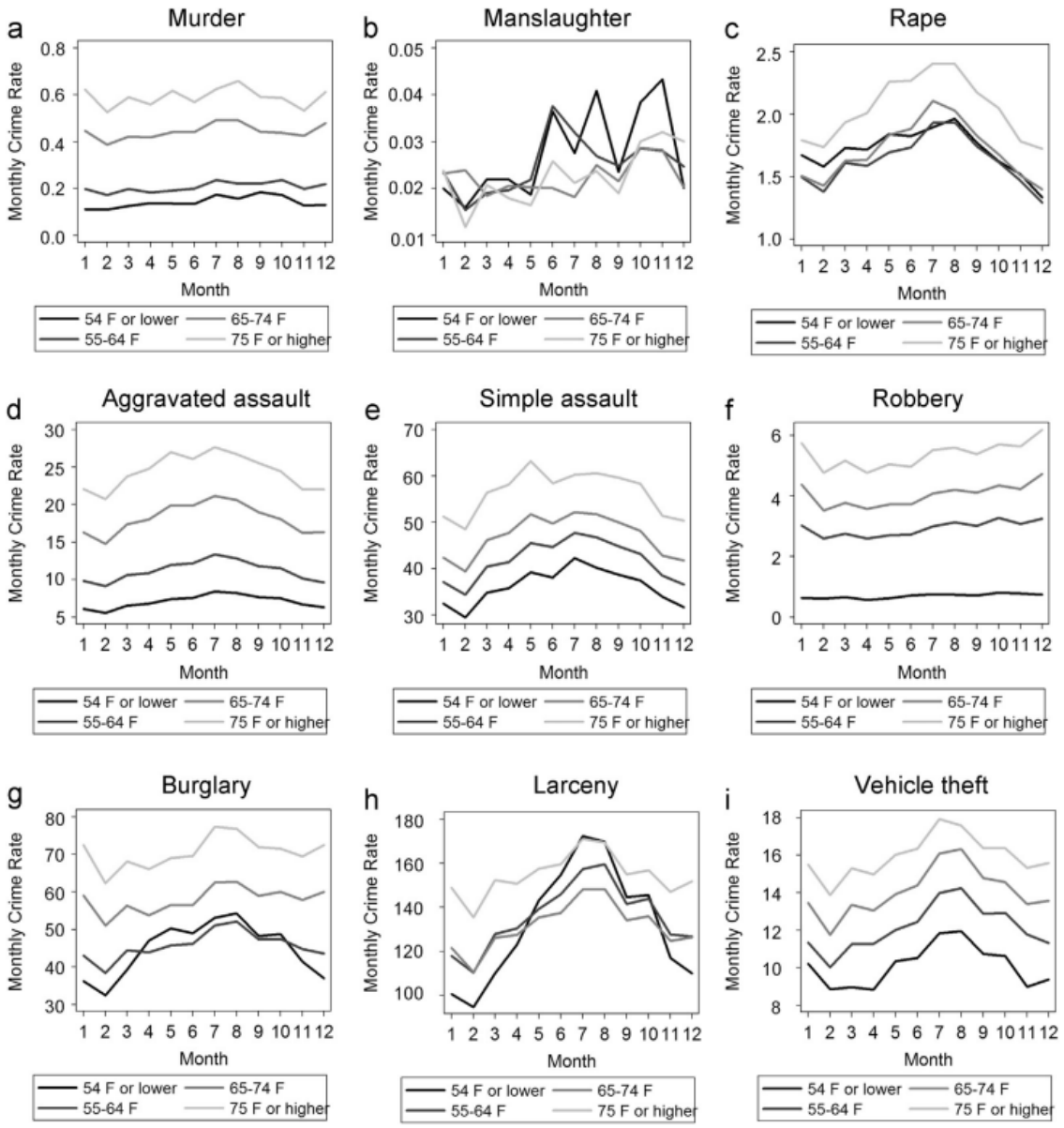
Methodology 2

Following standard practice, assume $\mu(X_{iym})$ takes an exponential form:

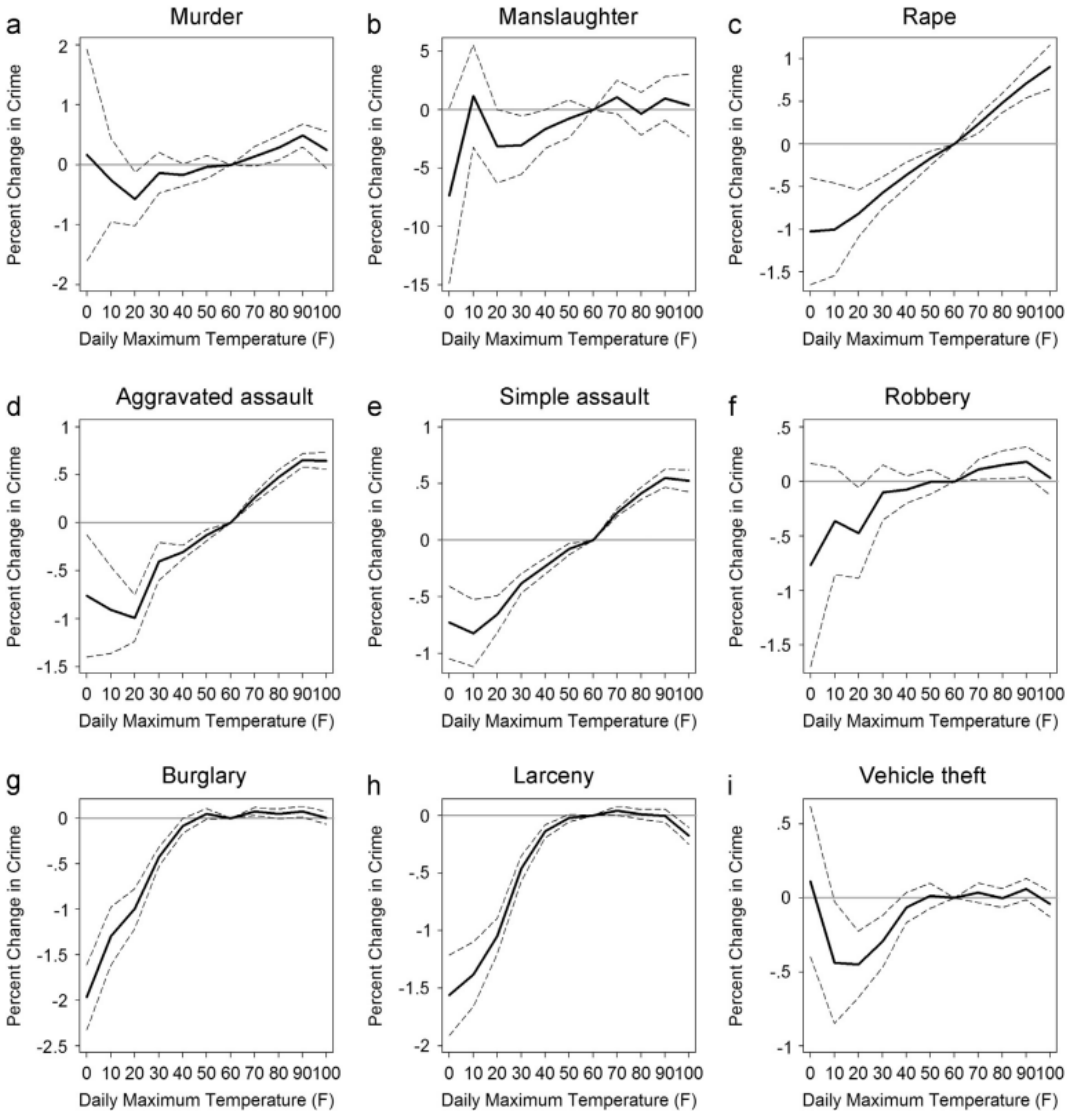
$$\mu(X_{iym}) = exp(\sum_{j=1}^{11} \alpha_0^j T_{iym}^j + \sum_{k=1}^{5} \beta_0^k P_{iym}^k + \sum_{j=1}^{11} \alpha_0^j T_{i,y,m-1}^j + \sum_{k=1}^{5} \beta_0^k P_{i,y,m-1}^k + \phi_{sm} + \theta_{iy}) \quad (2)$$

- ϕ_{sm} is a state-by-month- fixed effect.
- θ_{iy} is a county-by-year fixed effect.
- daily distribution of temperatures (T) within a month using 11 bin variables (Deschenes and Greenstone, 2011).
- daily distribution of precipitation (P) with five bins.
- a month lag of each temperature and precipitation are included to account for possible negative serial correlation.

Results: Weather and Crime Rate



Results: Daily Maximum Temperature on Monthly Crime



Predicted Impact of Climate Change on Crime

Table 3
The predicted impact of climate change on crime.

	Number of additional crimes		Social costs, by discount rate			
			3%		6%	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Murder	21,977	(12,349–33,368)	25.4	(13.7–38.7)	9.5	(4.8–14.8)
Manslaughter	2443	(−5938 to 11,911)	3.1	(−8.2 to 16.3)	1.3	(−3.8 to 7.2)
Rape	178,630	(102,472–263,451)	9.5	(4.8–14.4)	3.5	(1.3–5.6)
Aggr assault	1,220,537	(691,375–1,776,363)	19.2	(9.0–29.3)	6.9	(2.1–11.4)
Simple assault	2,276,755	(1,187,944–3,523,298)	9.0	(3.9–14.3)	3.2	(0.8–5.5)
Robbery	258,005	(3766–547,000)	1.2	(0.0–2.7)	0.5	(0.0–1.0)
Burglary	1,279,686	(502,866–2,113,597)	7.3	(0.8–13.2)	2.6	(−0.9 to 5.4)
Larceny	2,184,289	(400,215–4,348,172)	1.7	(−0.4 to 3.9)	0.6	(−0.6 to 1.6)
Vehicle theft	583,581	(258,021–948,395)	1.5	(0.6–2.5)	0.6	(0.2–1.0)
Total	8,005,904	(3,698,137–12,462,293)	78.1	(37.9–115.1)	28.7	(10.7–44.9)

Note: The "number of additional crimes" columns represent the total number of additional crimes that will occur due to climate change between 2010 and 2099, relative to the number that would occur if temperatures and precipitation stayed at the 2000–2009 averages. The "social cost" columns display the present value of the social cost of the additional crimes that will occur due to climate change, in billions of dollars. Future costs are discounted using two alternative discount rates: 3% and 6%. Numbers in parentheses are 95% confidence intervals calculated via bootstrapping.

Conclusion

- Robust statistical relationship between historical weather patterns and criminal activity.
- Climate change will have substantial effects on the prevalence of crime in the United States.

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