On Climate Fat Tails and Politics

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Motivation

- large literature: potential for revision of climate change based on citizens' experience
  - surveys at smaller geographic areas (*e.g.*, specific states)
  - surveys at larger geographic areas (*e.g.*, national level)
    - phone surveys
    - surveys executed by large, well-know national organizations
    - internet-based surveys
  - surveys based on countries outside of North America
  - some survey at multiple points in time
    - local- or state-effects from climate events
    - geographically larger, such as national, scale
  - most focus on warmer temperatures; some ask whether either cooler or warmer anomalies matter
  - occasional focus on other variables (*e.g.*, precipitation)

Typical results

- most find some evidence that local climate effects influence beliefs
- some argue that local events are unimportant
- mixed results regarding connection between temperature trends and public opinion
- a handful argue that “tail events ” play an outsized role
  - suggestion that “fat tails” in temperature anomalies might influence increased political activism
- little attention paid to impact of climate on political behavior

Why politics?

- Peltzman (1984) model: politicians weigh costs and benefits to their constituency (*e.g.*, from regulatory intervention)
- some authors look at specific events (*e.g.*, Waxman-Markey bill)
- little to no attention to evolving political behavior over time
  - despite sub-text that citizens' beliefs are evolving
  - anticipation of increasing political pressure

our goal: investigate potential for fat tailed events to influence political behavior across time

Game plan

1. evaluate climate patterns at US state level over time
   - allowing for “jumps”, time-varying volatility
   - also consider levels of anomalies in temps, precip, drought
2. collect state-specific estimates of components characterizing fat tails
3. construct database with measures of political behavior by US state across time
   - League of Conservation Voters (LCV) measures (by US district)
     - score 0 - 100; higher scores indicate greater willingness to engage in environmentally active politics
     - interpret higher scores as consistent with climate activism
   - aggregate to state-level measure
4. combine with various socio-economic variables
   - allow for state-level effects (via random effects)

- ultimate goal: assess influence of state-level fat tail parameters upon political variable

Fat tails

- denote temperature anomaly in month t by x_t
  - model as Brownian motion with drift

$$\mathrm{d}x_t = \mu dt + \sigma \mathrm{d}z_t$$

  - $\mathrm{d}z_t$: increment of a Wiener process
  - μ: deterministic trend variance σ^2
- allow for transitory anomalous events ('jumps')
  - model as Poisson process, arrival rate λ
  - size of jump is Normal: mean θ, variance δ^2
- allow for time-varying volatility via GARCH
  - longer-lasting hot (or cold) spells
  - variance at time t is

$$h_t \equiv E_{t-1}(\sigma^2) = \kappa + \alpha_1(x_{t-1} - \mu)^2 + \beta_1 h_{t-1}$$

Maximum likelihood estimation

- we proceed by maximizing the log-likelihood function:

$$L(\phi; x_t) = -T\lambda - \frac{T}{2}\ln(2\pi) + \sum \ln\left[\sum_{n=0}^{\infty} \frac{\lambda^n}{n!} \frac{1}{\sqrt{h_t + n\delta^2}} \exp\left(\frac{-(x_t - \mu - n\theta)}{2(h_t + n\delta^2)}\right)\right]$$

  by choice of the parameter vector $(\mu, \kappa, \alpha, \beta, \lambda, \theta, \delta)$
- this representation subsumes the four possible stochastic processes

  PD: $\lambda = 0; h_t = \sigma^2$

  JD: $\lambda > 0; h_t = \sigma^2$

  GPD: $\lambda = 0; h_t = \kappa + \alpha(x_t - \mu)^2 + \beta h_{t-1}$

  GJD: $\lambda > 0; h_t = \kappa + \alpha(x_t - \mu)^2 + \beta h_{t-1}$

Data

database combines information from a variety of sources

- political data
  - LCV observations, annually 2001 - 2020
  - every US representative scored; aggregate → state score
  - political tendencies: 'Partisan Voting Index'
    - tabulated annually by Cook Political Report (by district, aggregate to state level)
    - https://www.cookpolitical.com/cook-pvi
- temperature anomalies (monthly, by state; 1958-2020)
  - https://www.ncei.noaa.gov/data/us-historical-climatology-network/2.5/access/
- demographic data
  - use variables highlighted in extant literature
    - population, % older than 65, % white, %male, % urban
  - American Community Survey (ACS)
    - https://data.census.gov/all?q=ACS

Fat tails?

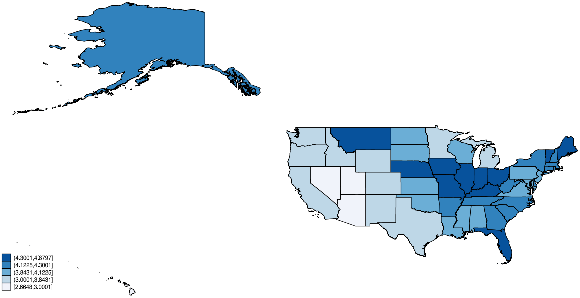

Fig. 1. Spatial variation of temperature anomalies fat tails (Kurtosis), by US state.
Note: Monthly observations from 1958–2020; Minimum value 2.6650 (HI); Maximum value 4.8797 (FL).

Jumps

- general support for combined jump - GARCH model

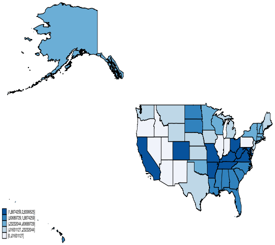

Fig. 2. Spatial variation of the estimated jump intensity from the GJD model ($\hat{\lambda}$), by US state.
Note: $\hat{\lambda}$ value for each state based on estimates in Tables 3, 4. Minimum (nonzero) value 0.0015 (ID); Maximum value 2.8400 (TN).

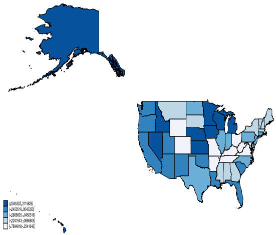

Fig. 3. Spatial variation of the estimated jump impact from the GJD model ($\hat{\lambda}\hat{\theta}$), by US state.
Note: $\hat{\lambda}, \hat{\theta}$ values for each state based on estimates in Tables 3, 4; Minimum value −0.7895 (MO); Maximum value 0.2116 (MN).

GARCH

- general support for combined jump - GARCH model

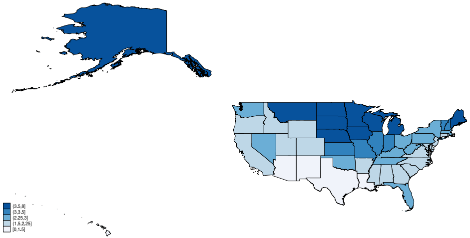

Fig. 4. Spatial variation of the average estimated variance ($\overline{h}$), by US state.
Note: $\overline{h}_t$ values calculated for each state using Eq. (3) and estimates in Tables 3, 4. Average taken for each state using 20 observations from 2001–2020. Minimum value 0.0956 (HI); Maximum value 6.7802 (MT).

LCV results, 1

Region	LCV	$\hat{\lambda}\hat{\theta}$	$\overline{h}_t$
Mountain	16.1300	-0.2194	4.1598
MidWest	37.0125	-0.1021	5.1836
NorthEast	76.9083	-0.1871	2.9929
SouthEast	29.7545	-0.2247	2.2539
SouthWest	37.2700	-0.0064	3.1119
West	60.4700	0.0096	2.4435
US	45.2740	-0.1405	3.4298

$\hat{\lambda}, \hat{\theta}$ based on ML estimates. $\overline{h_t}$ values calculated for each state using GARCH eqn, ML estimates. Average taken for each state using20 observations 2001 – 2020.

LCV results, 2

variable	Regression 1	Regression 2	Regression 3	Regression 4
population	0.0688	0.0942	0.0802	0.0673
percent white	-0.2798**	-0.2997***	-0.2927**	-0.2708**
percent male	-9.8918***	-9.5417***	-9.9266***	-9.7492***
percent below age 65	0.1199	-0.0440	0.1314	0.1382
percent population urban	-0.1780*	-0.1824*	-0.1793*	-0.1709*
coal for electricity	0.0383	0.0286	0.0447	0.0343
PVI	1.0999***	1.0604***	1.0826***	1.1085***
μ	15.0860	14.0771	15.1910	15.0368
κ	-8.6226***	-8.4167***	-8.5256***	-8.6351***
α	-183.3736***	-184.8393***	-185.1314***	-182.2579***
β	-141.6037***	-139.9853***	-142.4806***	-141.6787***
δ	0.6527	0.6687	0.7164	0.6811
θ	-1.1753***	-1.1964***	-1.1617***	-1.1608***
λ	-4.6818	-4.1186	-4.6379	-4.7387
Temperature anomaly		0.3047		
$(\text{Temperature anomaly})^2$		-1.2606*		
Precipitation anomaly			0.5014	
$(\text{Precipitation anomaly})^2$			1.0689	
DSCI anomaly				0.0031
$(\text{DSCI anomaly})^2$				-0.0001

Implications

- compelling evidence of fat tails in temperature anomalies
  - across space
  - heterogeneous effects
- evidence that estimated fat tail parameters influence political decisions by elected representatives
  - some evidence longer-lasting impacts are more important
    - most apparent in GARCH parameters
    - little indication that jump intensity influences results
  - average jump size does seem to influence political decisions
    - responding to high-profile events?
  - jump impact ($\lambda\theta$) may be important
- with exception of jump impact, all of these effects are in *opposite* direction to that anticipated
- overall, evidence does not support hypothesis that increasing impacts from climate change influence politicians to adopt more aggressive climate policies