Attention to Global Warming

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ABFER

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  - CO_2 emissions
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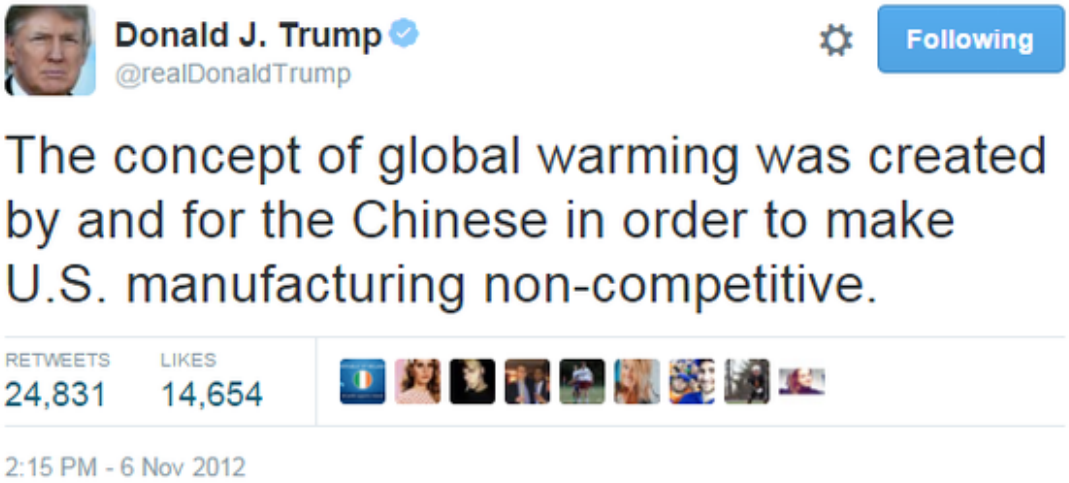
  - 97% consensus (Cook et al., 2013) in the scientific literature
- Are people's beliefs aligned with the scientific evidence?
- It is important to understand aggregate belief and effort
  - Policies and campaigns against global warming depend on people's collective behavior



Trump: "Global warming is a hoax"

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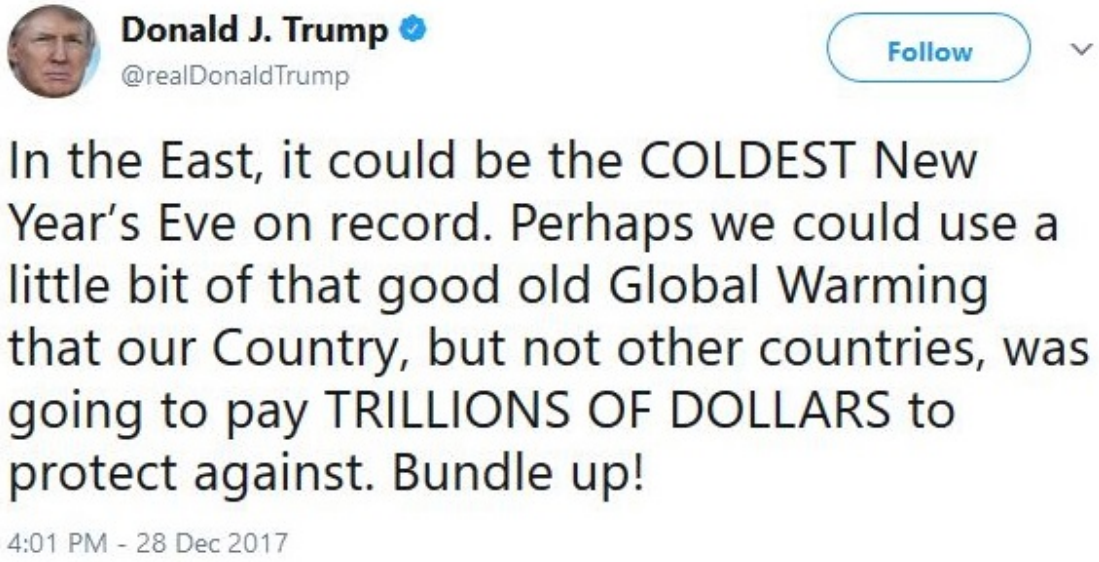
- "Global Warming will Harm Me Personally"
  - National Average: 40%

- December 28, 2017



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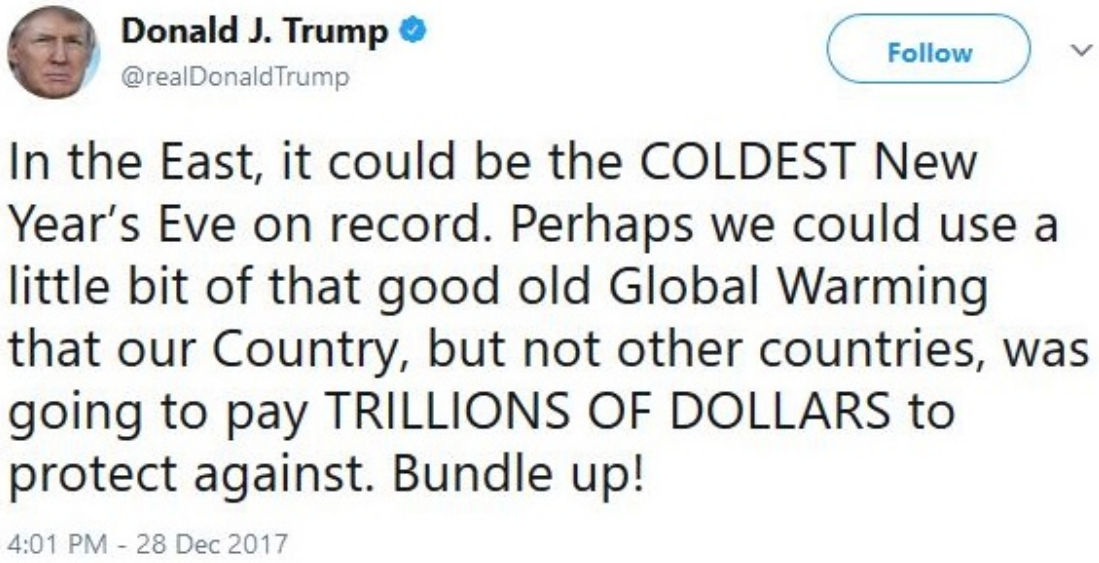

- "But Mr. Trump's tweet made the common mistake of looking at local weather and making broader assumptions about the climate at large." — *The New York Times*

Attention-Grabbing Local Weather Events

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  - People are exposed to local temperatures and weather conditions

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- People revise their beliefs when there are extreme weather events **in their area**
  - First-hand personal experiences of weather
  - The impact is amplified through communication channels and media

Our Measures

- Survey evidence
  - Climate change and Psychology literature: Konisky, Hughes, and Kaylor (2016), Broomell, Budescu, and Por (2015), Zaval, Keenan, Johnson, and Weber (2014), Akerlof et al. (2013), Howe et al. (2013), Myers et al. (2012), Li, Johnson, and Zaval (2011)
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  - Objective measures that are measured frequently
    - Covering 74 cities with major stock exchanges globally

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- We use attention measures and stock prices
  - Objective measures that are measured frequently
    - Covering 74 cities with major stock exchanges globally
  - Stock prices reflect aggregate belief at the local area
    - Stocks with high exposure to climate risk
    - Channels: cashflow (policy or production) or socially responsible investing

Major Hypotheses

1. Do investors pay more attention to global warming when experiencing extreme weather in their area?

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2. If investors pay more attention, does their behavior affect asset prices?
   - Home bias: Prices of local stocks are affected by local investors
   - Hirshleifer and Shumway (2003)

Related Work

- Reactions to climate and other external conditions
  - People are more likely to buy health insurance when air pollution is high (Chang, Huang, Wang, 2017)
  - Choice to purchase warm-/cold-weather vehicle types depend on the weather at the time of purchase (Busse et al., 2015)
  - Underreaction to trends in droughts exacerbated by global warming (Hong, Li, and Xu, 2017a, b)
- Experiential learning
  - Learn through experience (Kolb, 1984)
  - Climate change literature that uses surveys

Data

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- International stocks and fund positions
  - Datastream, FactSet

Local Abnormal Temperature

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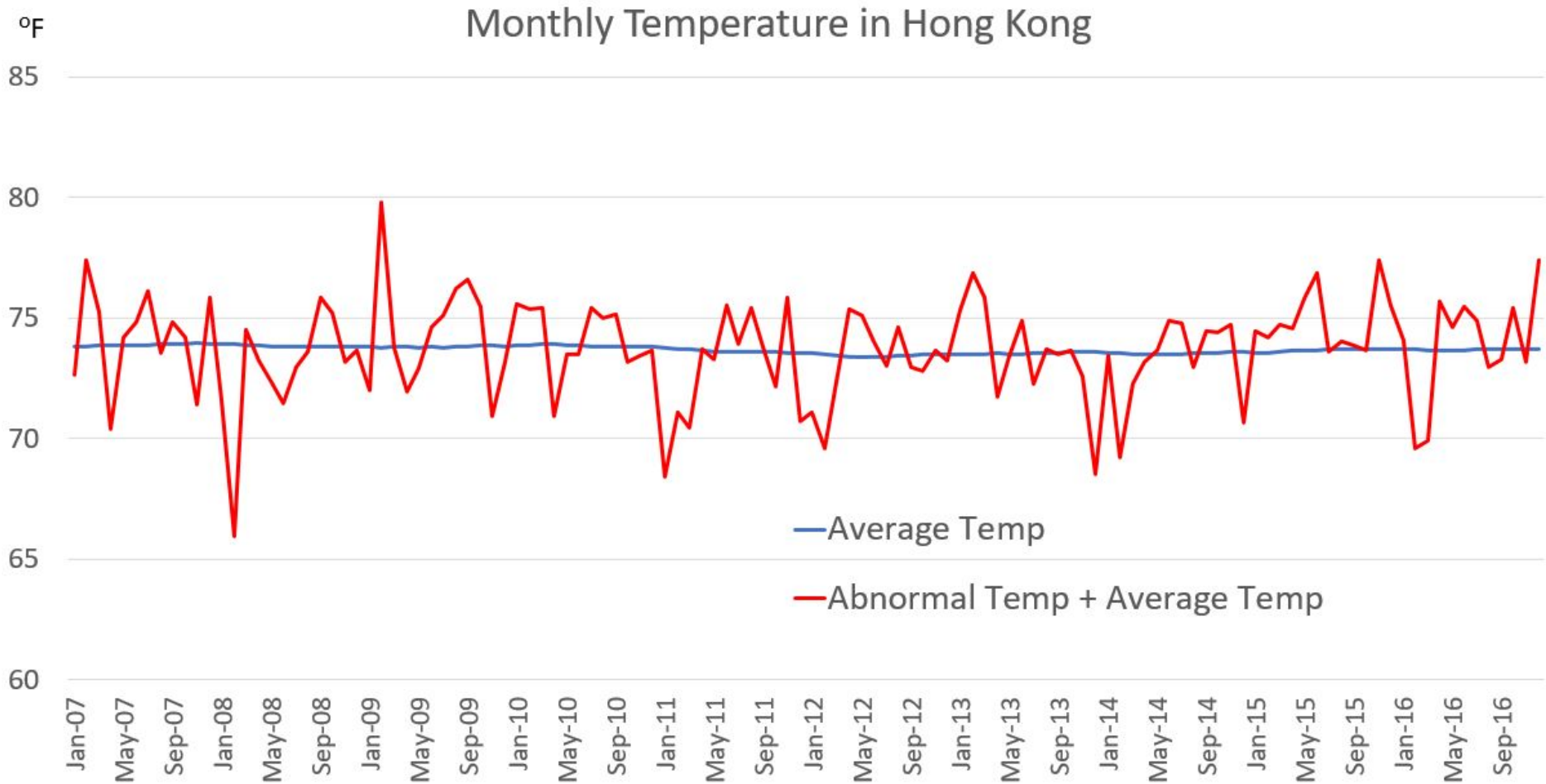
Monthly Temperature in Hong Kong
°F
85
80
75
70
65
60
Average Temp
Abnormal Temp + Average Temp
Jan-07
May-07
Sep-07
Jan-08
May-08
Sep-08
Jan-09
May-09
Sep-09
Jan-10
May-10
Sep-10
Jan-11
May-11
Sep-11
Jan-12
May-12
Sep-12
Jan-13
May-13
Sep-13
Jan-14
May-14
Sep-14
Jan-15
May-15
Sep-15
Jan-16
May-16
Sep-16

Google Search

- LHS: $DSVI_{it}$ is the log change of SVI, adjusted for seasonality
- 2004 to 2017, and SEs are clustered by city and month

$$DSVI_{it} = \alpha + \beta Ab\_Temp_{it} + v_t + \epsilon_{it}$$

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Dep. Var.: $DSVI$ (%)	(1)	(2)
Ab_Temp	0.541	
	(2.30)	
Ab_Temp Quintile 2		0.824
		(0.46)
Ab_Temp Quintile 3		2.176
		(1.39)
Ab_Temp Quintile 4		1.890
		(1.00)
Ab_Temp Quintile 5		4.181
		(2.46)
Year*Month FE	Yes	Yes
N	11,925	11,925
R^2	0.033	0.033
# exchanges	74	

Future Work

- RHS: Other extreme weather conditions
  - Rain/snowfall: captures droughts, floods, rain/snowstorms
  - Wind speed: captures hurricanes and typhoons

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- RHS: Other extreme weather conditions
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  - Wind speed: captures hurricanes and typhoons
- LHS: Media attention
  - RavenPack assigns a sentiment score to news, capturing the tone of the story
  - We will study high vs low carbon emission firms
    - Frequency (number of articles mentioning company i)
    - Attitude (average sentiment score of articles mentioning company i)
- LHS: Institutional attention
  - Bloomberg news searching and reading activity
  - Available at the stock level, covering U.S. and international stocks

High Emission Industries

- Inter-governmental Panel on Climate Change (IPCC) identifies the following industry sectors as major emission sources
  - Energy
  - Transportation
  - Buildings and construction
  - Industrial processes (e.g., mineral, metal, chemical)
  - Agriculture, Forestry and Other Land Use (AFOLU)

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- We hand match Datastream industries with IPCC definitions, e.g.,
  - Coal $\rightarrow$ Mining and quarrying (1A2f4)
  - Gold Mining $\rightarrow$ Mining and quarrying (1A2f4)
  - General Mining $\rightarrow$ Mining and quarrying (1A2f4)
- All firms in high emission industries are classified as high emission firms

Local Returns and Local Temperatures

- For each city i at month $t-1$, form the portfolios of emission and clean firms
- Calculate portfolio returns over t: raw or size-adjusted
- Emission Minus Clean (EMC_t)

$$EMC_{it} = \alpha + \beta Ab\_Temp_{it} + v_t + \epsilon_{it}$$

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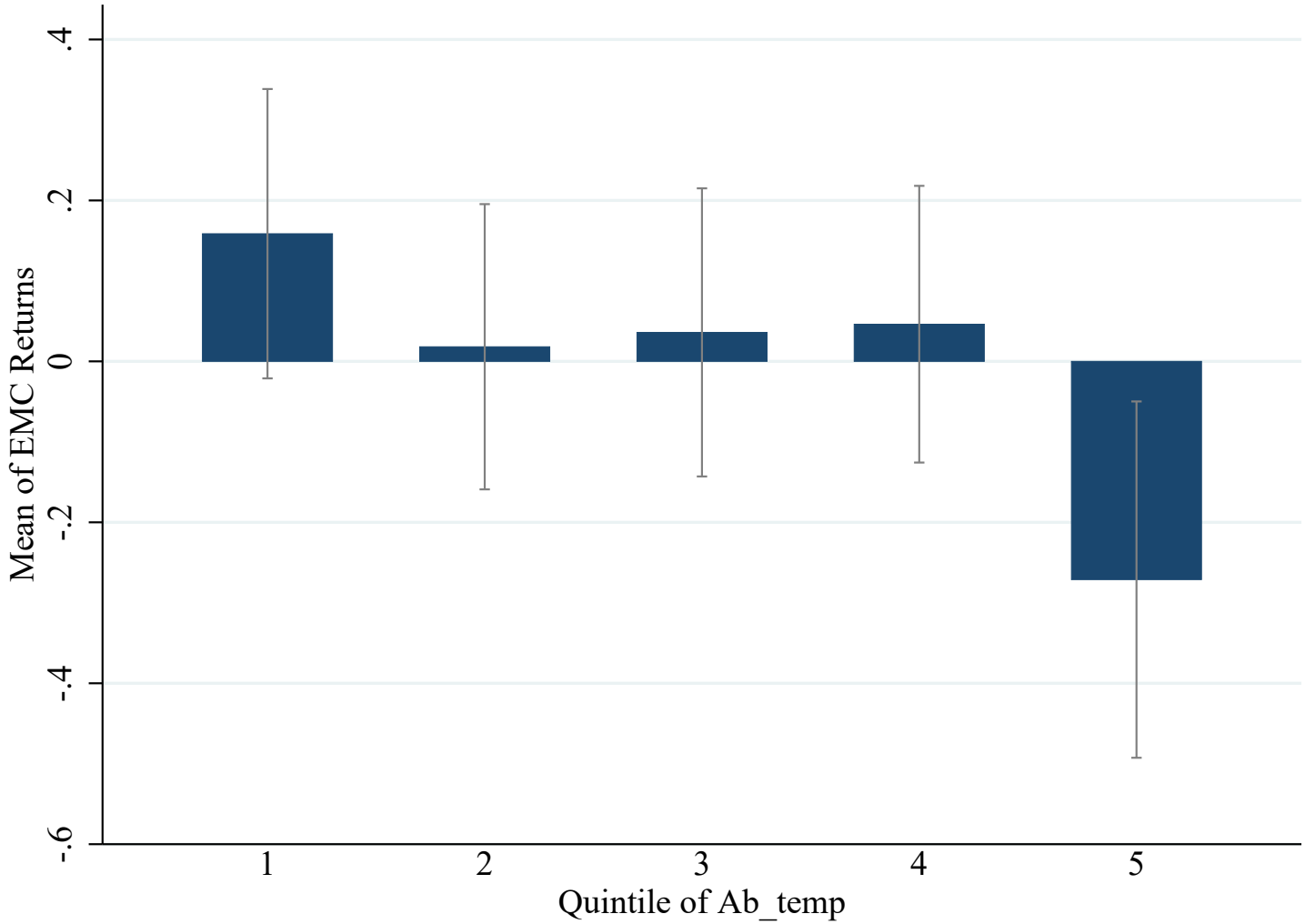
EMC on Abnormal Temperature: 2001-2017

%	EMC(adj_ret)		EMC(raw_ret)		EMISSION	CLEAN
	(1)	(2)	(3)	(4)	(5)	(6)
Ab_Temp	-0.058		-0.067			
	(-3.18)		(-2.65)			
Ab_Temp Quintile 2		-0.150		-0.286	-0.038	0.112
		(-1.19)		(-1.65)	(-0.48)	(1.90)
Ab_Temp Quintile 3		-0.136		-0.302	-0.043	0.093
		(-0.96)		(-1.54)	(-0.43)	(1.67)
Ab_Temp Quintile 4		-0.134		-0.203	-0.085	0.049
		(-1.18)		(-1.59)	(-1.39)	(0.85)
Ab_Temp Quintile 5		-0.478		-0.596	-0.283	0.195
		(-4.01)		(-3.72)	(-3.29)	(3.97)
Month*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	12615	12615	12615	12615	12615	12615
R^2	0.036	0.036	0.034	0.034	0.030	0.039
# exchanges	74					

Standard errors are clustered by exchange city and month

EMC on Abnormal Temperature: 2001-2017



EMC on Abnormal Temperature: 1983-2000

%	EMC(adj_ret)		EMC(raw_ret)		EMISSION	NORMAL
	(1)	(2)	(3)	(4)	(5)	(6)
Ab_Temp	-0.001		0.047			
	(-0.05)		(1.40)			
Ab_Temp Quintile 2		0.099		0.418	0.052	-0.046
		(0.45)		(1.86)	(0.48)	(-0.38)
Ab_Temp Quintile 3		0.116		0.261	0.054	-0.062
		(0.46)		(0.97)	(0.39)	(-0.48)
Ab_Temp Quintile 4		0.092		0.477	0.044	-0.049
		(0.51)		(1.99)	(0.39)	(-0.63)
Ab_Temp Quintile 5		-0.042		0.362	-0.002	0.040
		(-0.21)		(1.30)	(-0.02)	(0.38)
Month*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8998	8998	8998	8998	8998	8998
R^2	0.039	0.039	0.038	0.038	0.041	0.033
# exchanges	63					

Long-term EMC on Abnormal Temperature

- Long term EMC return over 3 or 6 months (to see if there is continuation or reversal)

$$EMC_{i,t+1,t+n} = \alpha + \beta Ab\_Temp_{it} + v_t + \epsilon_{it}$$

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$$EMC_{i,t+1,t+n} = \alpha + \beta Ab\_Temp_{it} + v_t + \epsilon_{it}$$

  - Slow updating in beliefs $\rightarrow \beta = 0$
  - Overreaction/over-extrapolation/projection bias $\rightarrow \beta > 0$

Long-term EMC Returns: 2001-2017

Dep Var: EMC(adj_ret)	$t+1$ to $t+3$	$t+1$ to $t+6$	$t+1$ to $t+3$	$t+1$ to $t+6$
	(1)	(2)	(3)	(4)
Ab_Temp	-0.049	-0.014		
	(-1.43)	(-0.47)		
Ab_Temp Quintile 2			-0.281	-0.067
			(-1.26)	(-0.24)
Ab_Temp Quintile 3			-0.192	-0.049
			(-1.45)	(-0.21)
Ab_Temp Quintile 4			-0.430	-0.116
			(-2.67)	(-0.46)
Ab_Temp Quintile 5			-0.365	-0.092
			(-1.55)	(-0.39)
Month*Year FE	Yes	Yes	Yes	Yes
N	12615	12615	12615	12615
R^2	0.049	0.063	0.049	0.063
# exchanges	74			

Robustness 1: Major Exchanges (Factset sample)

%	EMC(adj_ret)		EMC(raw_ret)		EMISSION	NORMAL
	(1)	(2)	(3)	(4)	(5)	(6)
Ab_Temp	-0.056		-0.051			
	(-2.16)		(-1.89)			
Ab_Temp Quintile 2		-0.073		0.014	0.005	0.079
		(-0.72)		(0.10)	(0.09)	(1.80)
Ab_Temp Quintile 3		-0.005		-0.070	0.114	0.119
		(-0.02)		(-0.22)	(0.64)	(1.39)
Ab_Temp Quintile 4		-0.135		-0.021	-0.056	0.078
		(-0.95)		(-0.14)	(-0.68)	(1.22)
Ab_Temp Quintile 5		-0.547		-0.466	-0.363	0.185
		(-2.43)		(-2.50)	(-2.15)	(2.47)
Month*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	5992	5992	5992	5992	5992	5992
R^2	0.069	0.070	0.070	0.070	0.061	0.078
# exchanges	33					

Sample includes New York, London, Paris, Toronto, Berlin, Stockholm, Nagoya, Amsterdam, Zurich, Milan, Oslo, Dublin, Brussels, Copenhagen, Hong Kong, Madrid, Singapore, Helsinki, Luxembourg, Johannesburg, Sydney, Mumbai, Vienna, Lisbon, Warsaw, Athens, Dusseldorf, Frankfurt, Hamburg, Munich, Stuttgart, Tokyo, Osaka

Robustness 2: Energy vs Non-energy Firms

Dep Var: EMC(adj_ret)	Energy		Non-energy	
	(1)	(2)	(3)	(4)
Ab_Temp	-0.083		-0.046	
	(-2.54)		(-2.16)	
Ab_Temp Quintile 2		-0.137		-0.170
		(-0.60)		(-1.28)
Ab_Temp Quintile 3		-0.291		-0.088
		(-1.33)		(-0.59)
Ab_Temp Quintile 4		-0.187		-0.105
		(-1.00)		(-0.85)
Ab_Temp Quintile 5		-0.405		-0.487
		(-1.90)		(-3.59)
Month*Year FE	Yes	Yes	Yes	Yes
N	10744	10744	12538	12538
R^2	0.059	0.059	0.031	0.031
# exchanges	70		74	

Robustness 3: MSCI Emission Ratings

- MSCI carbon emission scores
  - available from 2007
  - Scale of 0 – 10, industry adjusted, the higher the cleaner
  - We define high emission firms as ones with scores < 3, while clean firms > 7
- High carbon emission example
  - Virgin America Inc Average score $= 1.9$
- Low carbon emission example
  - Toyota Motor Corporation Average score $= 9.4$

Robustness 3: MSCI Emission Ratings, 2008-2017

%	EMC(adj_ret)		EMC(raw_ret)		EMISSION	CLEAN
	(1)	(2)	(3)	(4)	(5)	(6)
Ab_Temp	-0.139		-0.140			
	(-2.48)		(-2.32)			
Ab_Temp Quintile 2		-0.290		-0.311	-0.036	0.254
		(-0.47)		(-0.50)	(-0.10)	(0.65)
Ab_Temp Quintile 3		-0.774		-0.832	-0.439	0.335
		(-1.68)		(-1.71)	(-1.65)	(0.70)
Ab_Temp Quintile 4		-0.105		-0.062	-0.042	0.063
		(-0.25)		(-0.14)	(-0.11)	(0.18)
Ab_Temp Quintile 5		-0.860		-0.891	-0.273	0.587
		(-1.79)		(-1.68)	(-0.77)	(1.54)
Month*Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	795	795	795	795	795	795
R^2	0.369	0.369	0.379	0.380	0.409	0.237
# exchanges	14					

Future Work

- Fund positions from Factset
  - Net institutional buying activity of high carbon emission industries/firms
  - Expect it to be negatively related to abnormal temp
  - In the long term, the same investor sell more, or other investors follow?

Conclusion

- Global warming is a long-term trend
  - Usually not visible on a personal level
  - People focus more on personal experiences and attention-grabbing weather events
- In an abnormally warm month in the area, we show
  - More search activity on Google
  - Prices of carbon-intensive industries and firms go down
    - No reversal in the longer-term
- Beliefs are updated based on attention-grabbing local weather events and personal experiences of weather
  - Even if they are irrelevant to overall climate change