Dissecting Climate Risks: Are they Reflected in Stock Prices?

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- Market-wide risks from climate change are multifaceted: Physical & Transition risks

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  - (-) Decarbonizing portfolios $\Rightarrow \uparrow$ transaction costs (Bessembinder, 2017)
  - (?) Does decarbonisation pay off? (Pedersen et al. 2020)
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- **Is it physical or transition risks which are priced?**
  - **Camp #1**: *P*hysical risks are not priced $\Rightarrow$ Need for government's intervention
  - **Camp#2:** Physical risks *are not* priced & Government's intervention *is* priced, yet no need for intervention.

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2. We dissect market-wide climate risks by textual analysis
   - **Novel measures** of market-wide physical & transition climate risks
3. **Provide and validate** a possible explanation for the results
4. **Document** which firms are the most exposed to these risks.

Dataset

- Reuters news: 1st Jan. 2000 - 31st Dec.2018
  - More than 13 million articles from Refinitiv News Archive
  - Screening & looking for "*climate change*" or "*global warming*" $\rightarrow$ $\approx$34,000 articles

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  - More than 13 million articles from Refinitiv News Archive
  - Screening & looking for "*climate change*" or "*global warming*" $\rightarrow$ $\approx$34,000 articles
- U.S. common stocks returns & characteristics (daily data, CRSP, Compustat)
- Equity risk factors from authors' websites & Hiraki and Skiadopoulos (2023) SSD measure
- ESG & CO_2 emissions data from Refinitiv.

Latent Dirichlet Allocation (Blei et al. 2003)

1. Decomposes the entire textual corpus into K **topics** $(k = 1, .., K)$
   - **Topic** k: A probability distribution over unique words
   - **Article**: A probability distribution over topics

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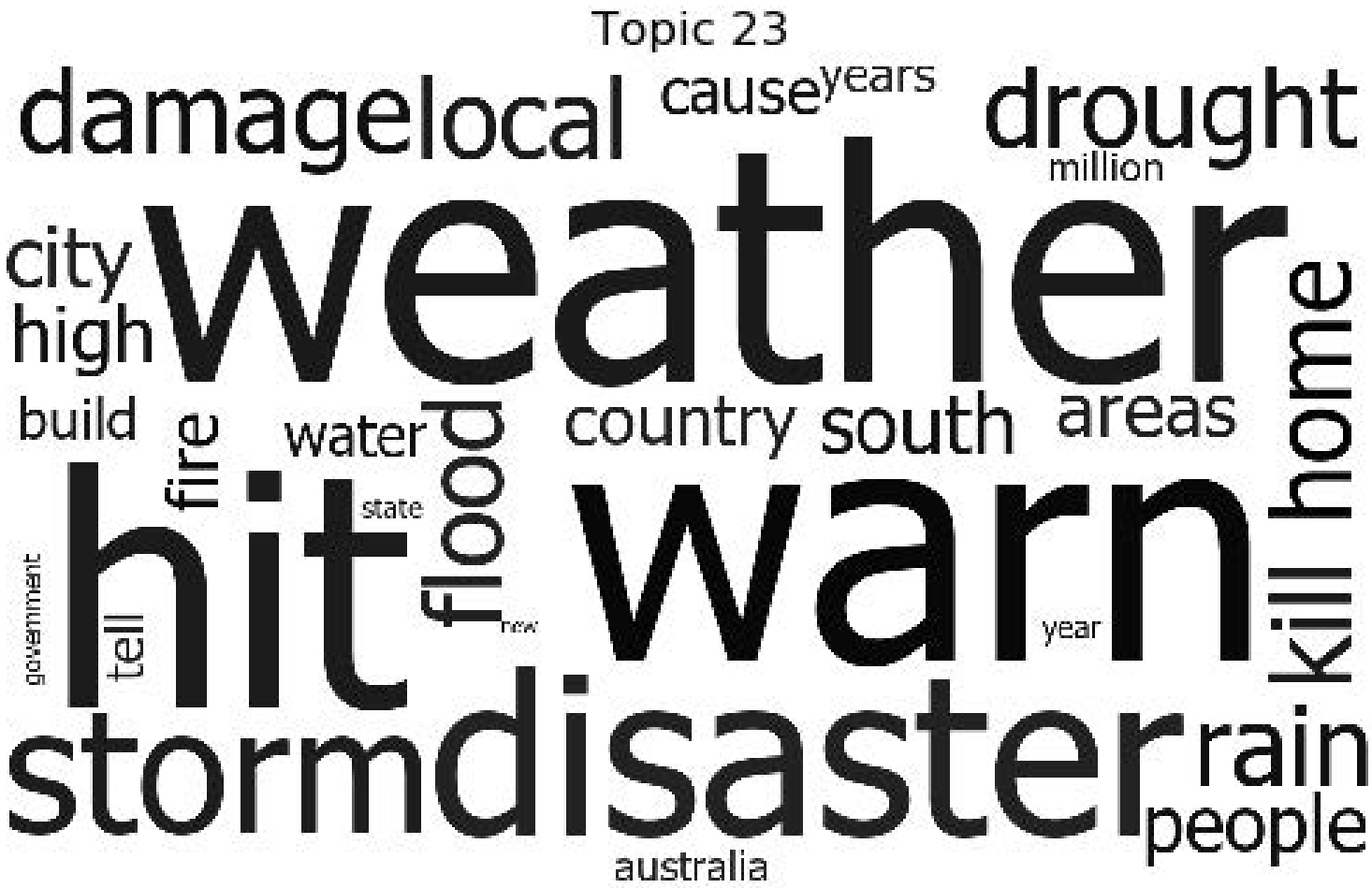
   - **Topic** k: A probability distribution over unique words
   - **Article**: A probability distribution over topics
2. Estimates **topic shares**: Percentage of a given article's text associated with the respective topic
   - Intensity by which a topic appears in that article

- k-**risk measure value at time** t: *Intensity of news coverage of a given topic on that day*
- **We identify four topics**: Natural disasters, Global warming, International summits, U.S. climate policy.

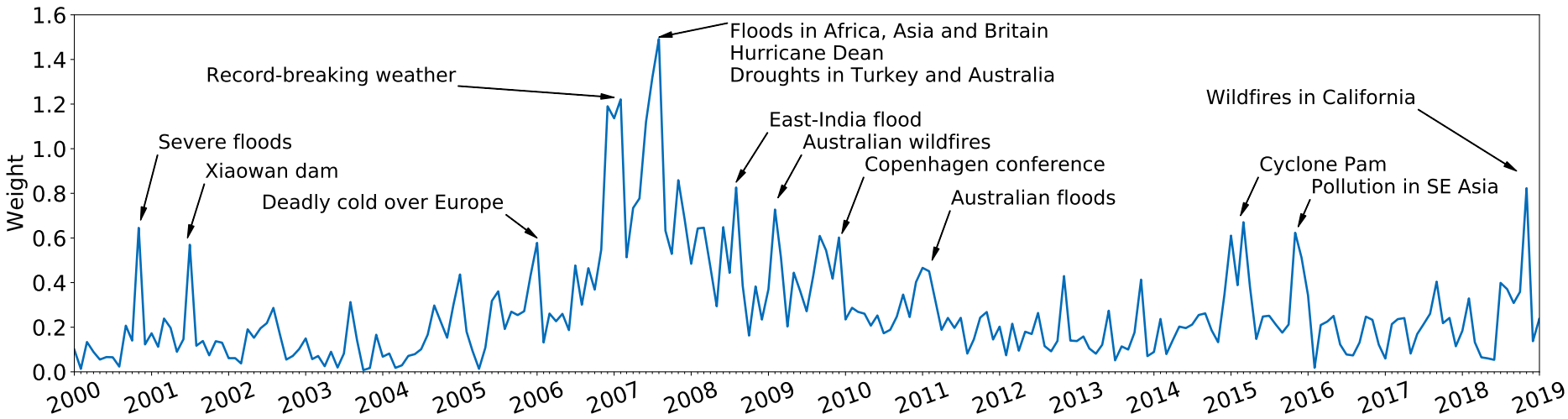
Labeling Topics: Natural disasters



Labeling Topics: U.S. climate policy I

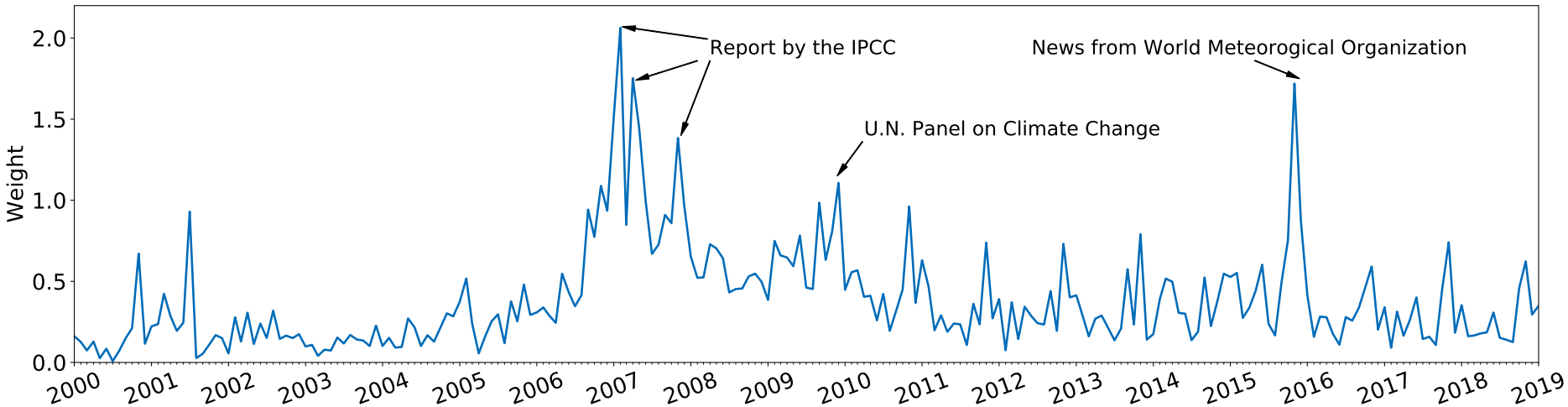
Labeling Topics: U.S. climate policy II

Natural disasters factor



- Increases in the measure $\longrightarrow$ Bad news for the economy
- Risks which will materialize in the long-term.

Global warming factor



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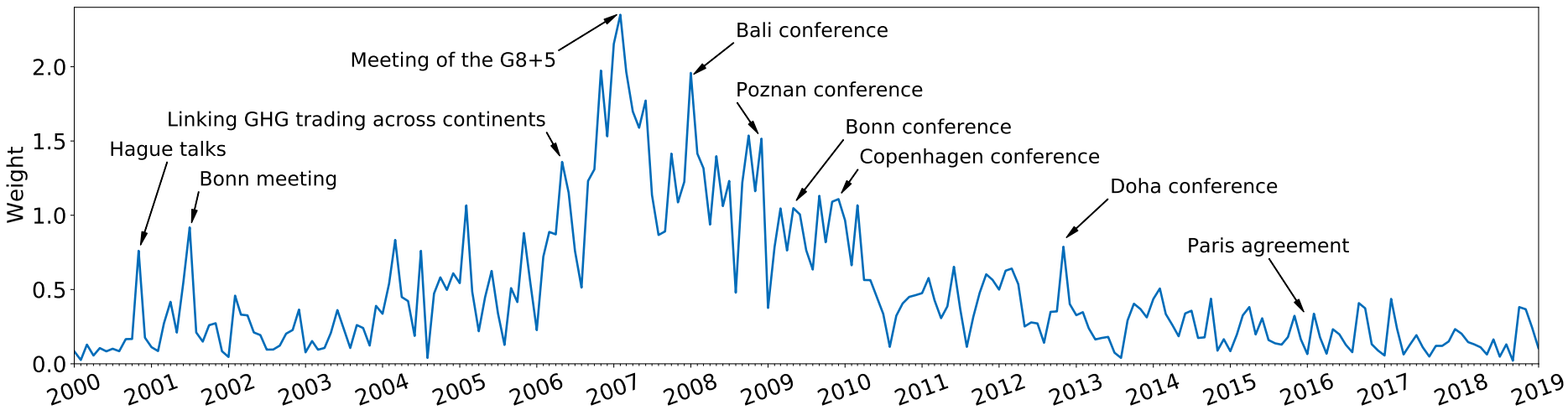
International summits factor



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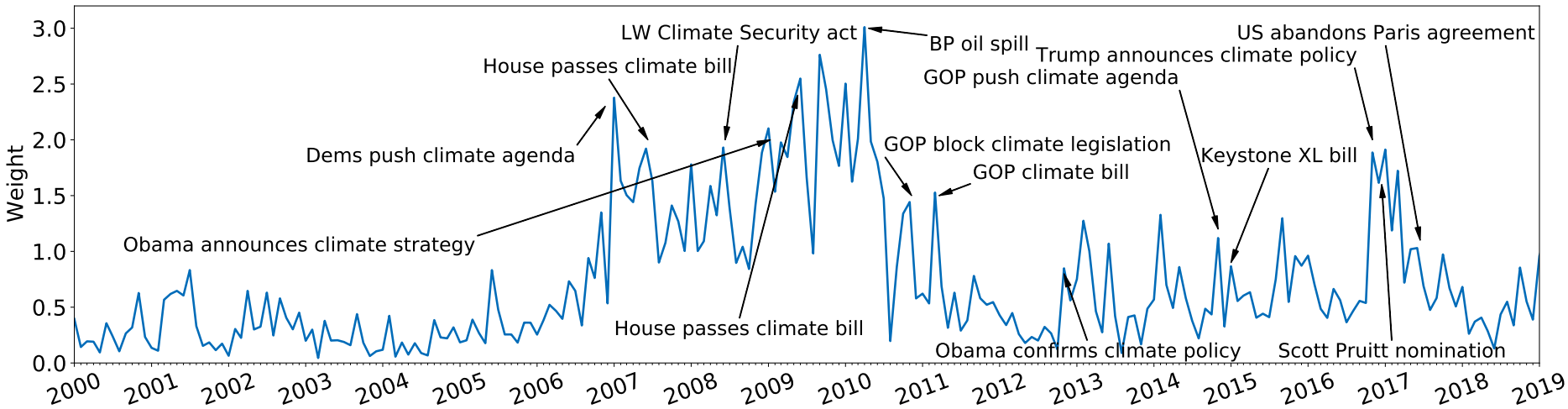
U.S. climate policy factor



- Increases $\longrightarrow$ Bad or good news for the economy?
  - Depends on which Party conquers the Congress
- Risks will materialize in the short-term.

Asset pricing tests

- For each stock i, at each time t, we estimate the climate beta with respect to each textual factor F_t separately

$$r_{it} - r_{ft} = c_i + \beta_i F_t + \gamma_i' X_t + \varepsilon_{it} \tag{1}$$

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4. Rolling window estimation: Repeat Steps (1 - 3) until we exhaust the sample
5. Estimate alpha of spread portfolio
    - Alternative models for estimating climate beta & alpha.

Are factors priced? Jan 2000 - Dec 2018 (Deciles)

Alphas (Decile portfolios), 1st January 2000- 31st December 2018

Natural Disasters	Global Warming	Int. Summits	U.S. Climate
Panel A: Market model			
0.14	-0.0	0.12	0.96***
(0.3)	(-0.2)	(0.42)	(2.91)
Panel B: FF 3F model			
0.07	0.20	0.53*	0.65**
(0.24)	(0.67)	(1.73)	(2.34)
Panel C: FFC model			
-0.07	0.03	-0.49	0.46*
(-0.24)	(0.10)	(1.65)	(1.66)
Panel D: FF 5F model			
0.03	0.05	-0.66**	0.2***
(0.0)	(0.19)	(-2.5)	(2.75)
Panel E: FF 5F + momentum			
0.27	-0.09	-0.76***	0.61**
(0. 9)	(-0.34)	(-2.63)	(2.25)

U.S. climate policy premium: An explanation

- *Possible explanation*: **Intertemporal hedging**

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- **Conjecture**: $\downarrow$ U.S. climate policy signals $\uparrow$ transition risks
  - $\longrightarrow$ "bad" news for the economy
  - $\longrightarrow$ deteriorates the investor's opportunity set
- *Investors would buy (short sell) stocks with negative (positive) textual climate betas*

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- **Strategies to check proposed explanation**: Check the risk-premium's sign by ensuring that the conjecture holds
  1. *Choose* an appropriate sample period (Sub-sample analysis)
  2. *Re-construct* the policy factor by marking the content of news (narrative analysis, Romer & Romer, 2010)
     - $\Rightarrow$ Know what the factor fluctuations signal.

Subsample analysis

- Post Nov 2012:
  - Lack of a majority for Democrats in the U.S. House of Representatives
  - After 2014, the Democrats also lost control of the Senate
  - Trump took over in Nov. 2016

Decile sorts on U.S. Climate		Quintile sorts on U.S. Climate	
Pre-2012	Post-2012	Pre-2012	Post-2012
		Panel A: Market model	
1.05**	0.4**	0.55	0.75***
(2.33)	(2.12)	(1.55)	(2.9)
		Panel B: FF 3F model	
0.35	0.9***	0.06	0.70***
(0.91)	(3.06)	(0.17)	(3.11)
		Panel C: FFC model	
0.17	0.97***	-0.11	0.46**
(0.46)	(3.29)	(-0.43)	(2.52)
		Panel D: FF 5F model	
0.4	1.23***	0.45*	0.59**
(1.23)	(3.2)	(1.73)	(2.15)
		Panel E: FF 5F + mom.	
0.44	0.79***	0.21	0.42**
(1.26)	(2.72)	(1.12)	(2.13)

Climate policy portfolio characteristics

	1 (L)	2	3	4	5 (H)
Panel A: Fama-French three-factor model					
Return	0.60	0.97***	0.87***	0.97***	1.23***
	(1.27)	(2.72)	(2.85)	(3.05)	(2.92)
Climate β	−0.48	−0.16	0.00	0.16	0.48
ESG score	35.36	40.63	41.51	40.19	34.86
E score	24.14	31.15	33.00	31.53	24.87
Share of polluters	0.25	0.18	0.15	0.17	0.24
Direct emissions intensity	447.55	426.91	505.00	463.95	536.91
Scope 3 emissions intensity	493.84	488.21	542.68	518.99	644.06

U.S. climate policy: Construction of a narrative factor

- Select articles with a topic share on the domestic policy factor $> 40\%$ $\longrightarrow 3,500$ articles

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  - $+1$, if it signals an increase in transition risks,
  - -1, if it signals a decrease in transition risks,
  - 0, if its content is mixed

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- Read each article and mark it with
  - $+1$, if it signals an increase in transition risks,
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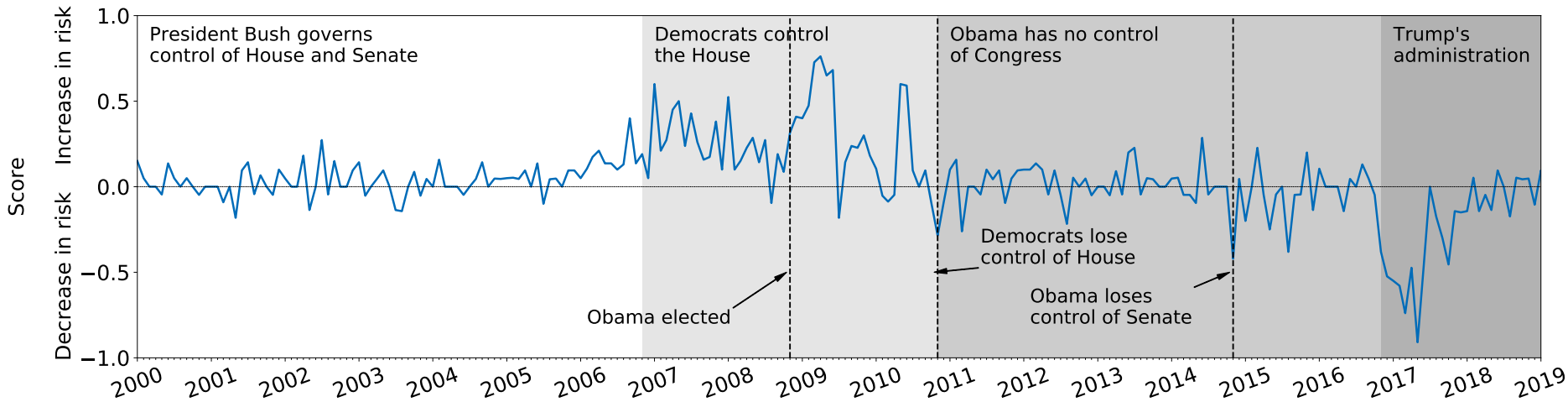
  - 0, if its content is mixed
- **Narrative factor value at time** t: Sum of the marks given to the articles over day t.

U.S. climate policy narrative factor

Sign of the risk premium under hedging hypothesis



- By construction, decreases in the factor signal good news for the economy
- $\Rightarrow$ **Risk premium of the U.S. climate policy narrative factor**: It should be negative under the hedging argument.

Asset pricing tests: Narrative factor (Decile)

2000-2018	2000-2012	2012-2018
Panel A: Market model		
-0.64*	-0.52	-1.01**
(-1.86)	(-1.13)	(-2.43)
Panel B: FF 3F model		
-1.03***	0.77**	-1.39***
(-3.56)	(-2.37)	(-4.30)
Panel C: FFC model		
-0.85***	-0.59*	-1.37***
(-2.76)	(-1.66)	(-3.61)
Panel D: FF 5F model		
-0.65**	-0.62	-0.84***
(-1.97)	(-1.43)	(-2.97)
Panel E: FF 5F + momentum		
-0.31	0.00	-0.93***
(-1.07)	(0.00)	(-3.40)

Do climate policy factors conflate EPU / Political risks?

- Conditional bivariate sorts (Bali et al., 2017)
- Control variables: EPU (Baker et al., 2016), Political risk (Hassan et al., 2019)

First control variable:	EPU	PRisk
Panel A: Market model		
Textual	0.6**	0.71**
	(2.09)	(2.44)
Narrative	-0.65	-0.17
	(-1.55)	(-0.38)
Panel B: FF 3F model		
Textual	0.63**	0.7***
	(2.54)	(2.84)
Narrative	-0.96***	-0.84***
	(-3.78)	(-2.75)
Panel C: FFC model		
Textual	0.43***	0.42**
	(3.06)	(2.2)
Narrative	-0.89***	-0.65**
	(-2.68)	(-2.14)
Panel D: FF 5F model		
Textual	0.56**	0.46*
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Panel E: FF 5F + momentum		
Textual	0.43**	0.54***
	(2.58)	(3.06)
Narrative	-0.69***	-0.57**

Conclusions

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  4. Results are consistent with both camps
- **Future research:** Why are not **all** risks priced? Investors' short-termism and/or lack of information, or not systemic.

Thank you for your attention and time !

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3795964

Factor values & Policy impact:
https://sites.google.com/view/george-skiadopoulos

gskiado@unipi.gr, g.skiadopoulos@qmul.ac.uk

Related literature

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1. **Climate Finance empirical literature** (Giglio et al., 2021a)
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   - *Firm-specific climate factors*: Kölbel et al. (2020), Li et al. (2020) and Sautner et al. (2020, 2021)

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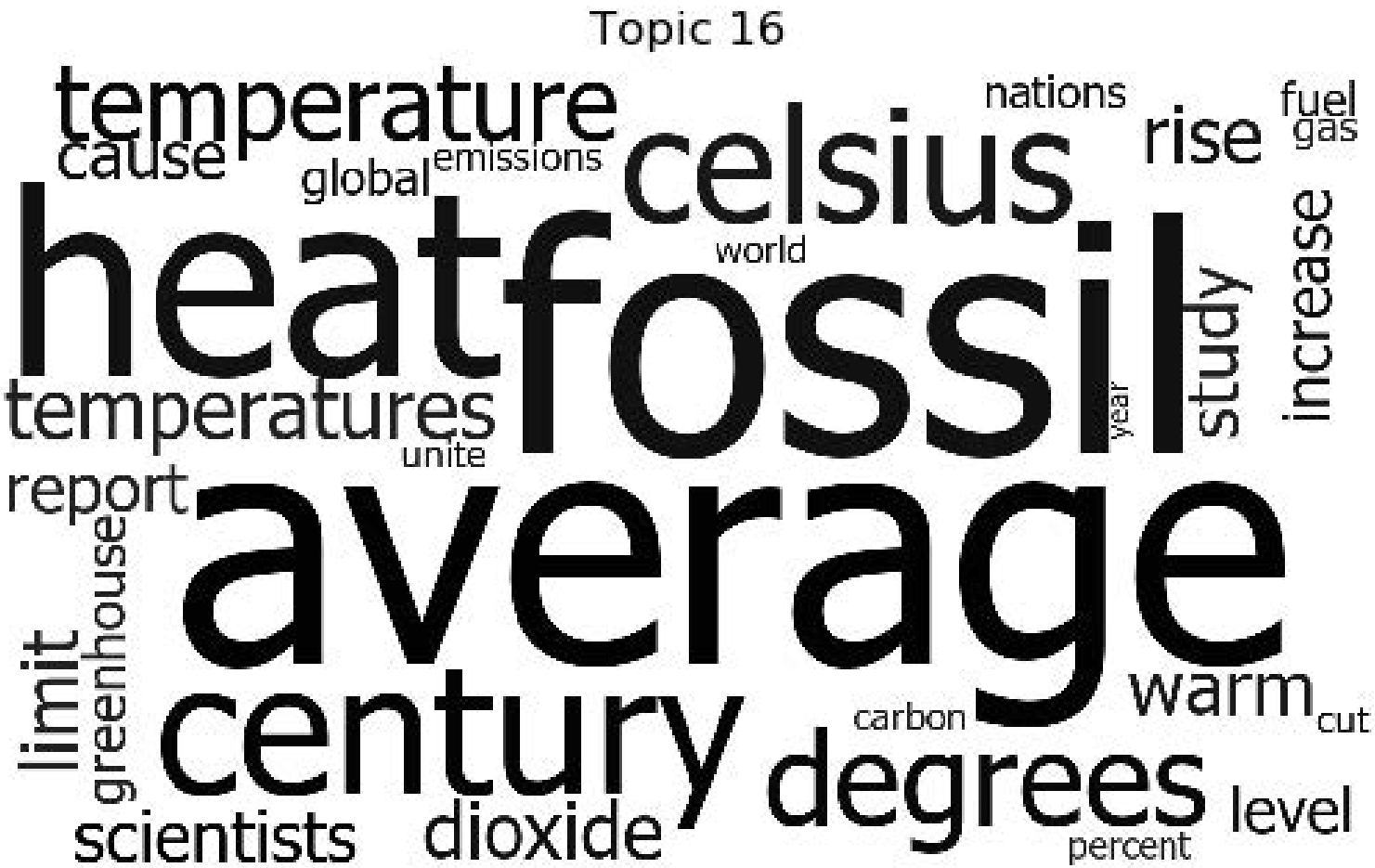
Labeling Topics: Global warming



Labeling Topics: International summits

Topics: Correlations

	U.S. Climate policy	Int'l summits	Global warming	Natural disasters	mktrf	hml	smb	rmw	cma	umd
U.S. Climate policy	1.00	0.30	0.27	0.18	-0.02	-0.02	0.01	0.02	-0.02	-0.00
Int'l summits	0.30	1.00	0.31	0.24	-0.01	0.01	0.00	0.02	-0.01	-0.00
Global warming	0.27	0.31	1.00	0.34	-0.01	-0.01	-0.01	0.02	-0.01	0.01
Natural disasters	0.18	0.24	0.34	1.00	-0.02	-0.03	-0.02	0.02	-0.01	0.04
mktrf	-0.02	-0.01	-0.01	-0.02	1.00	0.06	0.12	-0.44	-0.28	-0.30
hml	0.02	0.01	-0.01	-0.03	0.06	1.00	-0.18	0.06	0.45	-0.33
smb	0.01	0.00	-0.01	-0.02	0.12	-0.18	1.00	-0.35	-0.05	0.13
rmw	0.02	0.02	0.02	0.02	-0.44	0.06	-0.35	1.00	0.26	0.17
cma	-0.02	-0.01	-0.01	-0.01	-0.28	0.45	-0.05	0.26	1.00	0.11
umd	-0.00	-0.00	0.01	0.04	-0.30	-0.33	0.13	0.17	0.11	1.00

1. Low correlations $\Rightarrow$ LDA has successfully dissected climate risks
2. Why the low correlations? Long-term vs. Short-term effects.

Asset pricing tests: Narrative factor (Quintile)

2000-2018	2000-2012	2012-2018
Panel A: Market model		
-0.23	-0.01	-0.71
(-0.77)	(-0.02)	(-1.52)
Panel B: FF 3F model		
-0.58***	-0.20	-1.05***
(-2.64)	(-0.78)	(-3.67)
Panel C: FFC model		
-0.48**	-0.24	-0.93***
(-2.30)	(-1.05)	(-2.86)
Panel D: FF 5F model		
-0.39*	-0.16	-0.69**
(-1.89)	(-0.62)	(-2.53)
Panel E: FF 5F + momentum		
-0.26	-0.05	-0.60**
(-1.20)	(-0.19)	(-2.08)

Asset pricing tests: Other Narrative factors (quintiles, 1st Jan 2000 - 31st Dec 2018)

International Summits	Global Warming	Natural Disasters
Panel A: Fama-French three-factor model		
−0.29*	0.32	0.20
(−1.68)	(1.46)	(1.16)
Panel B: Fama-French-Carhart model		
−0.13	0.27	0.25
(−0.70)	(1.48)	(1.26)
Panel C: Fama-French five-factor model		
−0.42*	−0.13	0.19
(−1.97)	(−0.66)	(0.96)
Panel D: Percentage of significant alphas across models and portfolio partitions		
0.0%	0.0%	0.0%