

# Dissecting Climate Risks: Are they Reflected in Stock Prices?

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# Motivation

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

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  - (?) Does decarbonisation pay off? (Pedersen et al. 2020)
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  - (?) Does decarbonisation pay off? (Pedersen et al. 2020)
  - (+) Investors may be sensitive to short-term effects
- **Is it physical or transition risks which are priced?**
  - **Camp #1:** Physical 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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- 1 **First time evidence** on what types of **market-wide** climate risks are reflected in U.S. stock prices
- 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.



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- U.S. common stocks returns & characteristics (daily data, CRSP, Compustat)
- Equity risk factors from authors' websites
- 'E' score from Refinitiv.

# Latent Dirichlet Allocation (Blei et al. 2003)

- 1 Decomposes the entire textual corpus into  $K$  **topics** ( $k = 1, \dots, K$ )
  - **Topic  $k$** : A probability distribution over unique words
- 2 Estimates **topic shares**: Percentage of a given article associated with the respective topic
  - **Article**: A probability distribution over topics
  - Intensity by which a topic appears in that article
- **$k$ -risk factor 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.

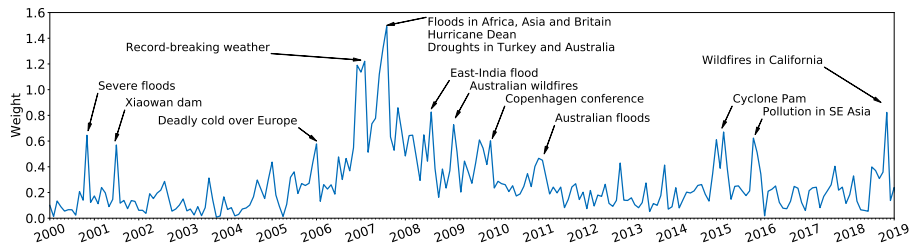




Topic 6

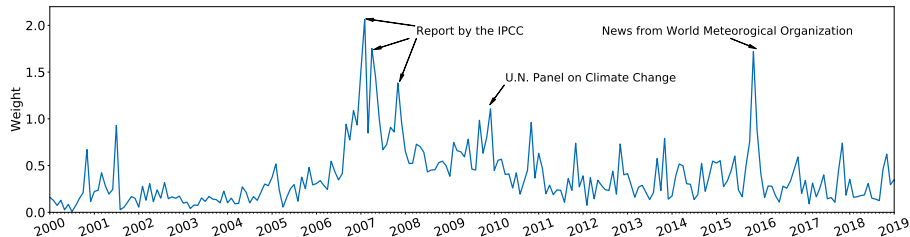


# Natural disasters factor



- Increases in the factor → Bad news for the economy
- Risks which will materialize in the long-term.

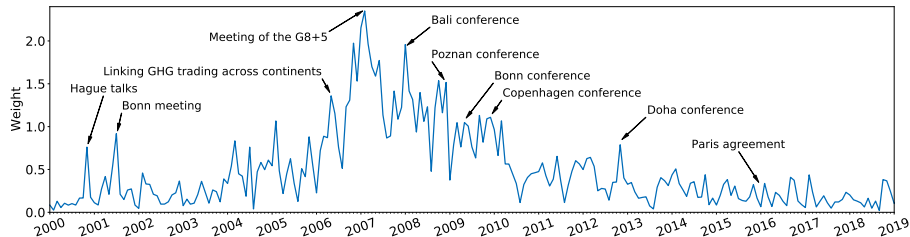
# Global warming factor



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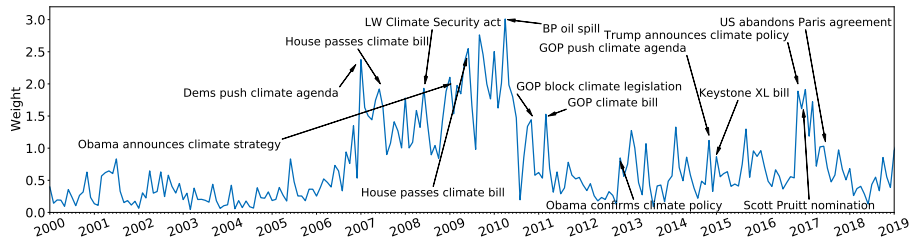


# International summits factor



- Increases in the factor → Bad news for the economy
- Risks which will materialize in the long-term.

# U.S. climate policy factor



- Increases → ?

- Bad or good news for the economy depending 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

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

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- 5 Estimate alpha of spread portfolio
  - Alternative models for estimating climate beta & alpha.



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

Alphas (Decile portfolios), 1<sup>st</sup> January 2000- 31<sup>st</sup> December 2018

Natural Disasters	Global Warming	Int. Summits	U.S. Climate
<b>Panel A: Market model</b>			
0.14 (0.3)	-0.0 (-0.2)	0.12 (0.42)	0.96*** (2.91)
<b>Panel B: FF 3F model</b>			
0.07 (0.24)	0.20 (0.67)	0.53* (1.73)	0.65** (2.34)
<b>Panel C: FFC model</b>			
-0.07 (-0.24)	0.03 (0.10)	-0.49 (1.65)	0.46* (1.66)
<b>Panel D: FF 5F model</b>			
0.03 (0.0)	0.05 (0.19)	-0.66** (-2.5)	0.2*** (2.75)
<b>Panel E: FF 5F + momentum</b>			
0.27 (0.9)	-0.09 (-0.34)	-0.76*** (-2.63)	0.61** (2.25)

# U.S. climate policy premium: An explanation

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- **Conjecture:** ↓ U.S. climate policy signals ↑ transition risks
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- *Investors would buy (short sell) stocks with negative (positive) textual climate betas*

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  - 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)
    - ⇒ 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
<b>Panel A: Market model</b>			
1.05** (2.33)	0.4** (2.12)	0.55 (1.55)	0.75*** (2.9)
<b>Panel B: FF 3F model</b>			
0.35 (0.91)	0.9*** (3.06)	0.06 (0.17)	0.70*** (3.11)
<b>Panel C: FFC model</b>			
0.17 (0.46)	0.97*** (3.29)	-0.11 (-0.43)	0.46** (2.52)
<b>Panel D: FF 5F model</b>			
0.4 (1.23)	1.23*** (3.2)	0.45* (1.73)	0.59** (2.15)
<b>Panel E: FF 5F + mom.</b>			
0.44 (1.26)	0.79*** (2.72)	0.21 (1.12)	0.42** (2.13)

# Climate policy portfolio characteristics

	1 (L)	2	3	4	5 (H)
<b>Panel A: Fama-French-Carhart model</b>					
Average return	0.80 <sup>*</sup> (1.84)	1.03 <sup>***</sup> (2.88)	0.87 <sup>***</sup> (2.84)	0.89 <sup>**</sup> (2.60)	1.07 <sup>***</sup> (2.66)
Climate beta	-0.48	-0.16	0.00	0.15	0.47
E score	35.12	40.37	41.66	40.29	34.86
E score (change)	7.12	6.26	5.70	6.22	6.05
log(size)	6.36	6.91	7.02	6.91	6.43
N	747.00	751.00	751.00	750.00	747.00
<b>Panel B: Fama-French five-factor model</b>					
Average return	0.71 (1.40)	1.01 <sup>***</sup> (2.76)	0.86 <sup>***</sup> (2.79)	0.95 <sup>***</sup> (3.09)	1.10 <sup>***</sup> (2.93)
Climate beta	-0.48	-0.16	0.00	0.16	0.48
E score	35.15	40.51	41.37	40.37	35.15
E score (change)	6.64	6.22	5.64	6.38	6.18
log(size)	6.38	6.92	7.01	6.91	6.43
N	747.00	748.00	752.00	752.00	747.00

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

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



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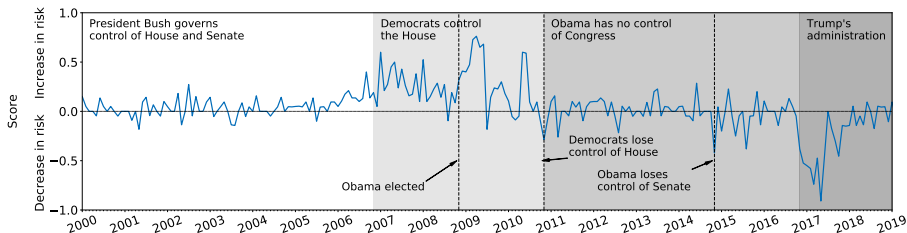
- Select articles with a topic share on the domestic policy factor  $> 40\%$   
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- Read each article and mark it with
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- **Narrative factor value at time  $t$** : Sum of the marks given to the articles 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
- ⇒ **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
<b>Panel A: Market model</b>		
-0.64* (-1.86)	-0.52 (-1.13)	-1.01** (-2.43)
<b>Panel B: FF 3F model</b>		
-1.03*** (-3.56)	0.77** (-2.37)	-1.39*** (-4.30)
<b>Panel C: FFC model</b>		
-0.85*** (-2.76)	-0.59* (-1.66)	-1.37*** (-3.61)
<b>Panel D: FF 5F model</b>		
-0.65** (-1.97)	-0.62 (-1.43)	-0.84*** (-2.97)
<b>Panel E: FF 5F + momentum</b>		
-0.31 (-1.07)	0.00 (0.00)	-0.93*** (-3.40)

# 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](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3795964)

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# Related literature

## ① **Climate Finance empirical literature** (Giglio et al., 2021a)

- **Real estate:** Bernstein et al. (2019), Baldauf et al. (2020), Giglio et al. (2021b)
- **Bonds:** Painter (2020), Seltzer et al. (2020), Goldsmith-Pinkham et al. (2021), Duan et al. (2021)
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## ② **Textual analysis in finance** (Gentzkow et al., 2019)

- *Market-wide climate factors:* Engle et al. (2020), Huynh and Xia (2020), Alekseev et al. (2021)
- *Firm-specific climate factors:* Kölbel et al. (2020), Li et al. (2020) and Sautner et al. (2020, 2021)

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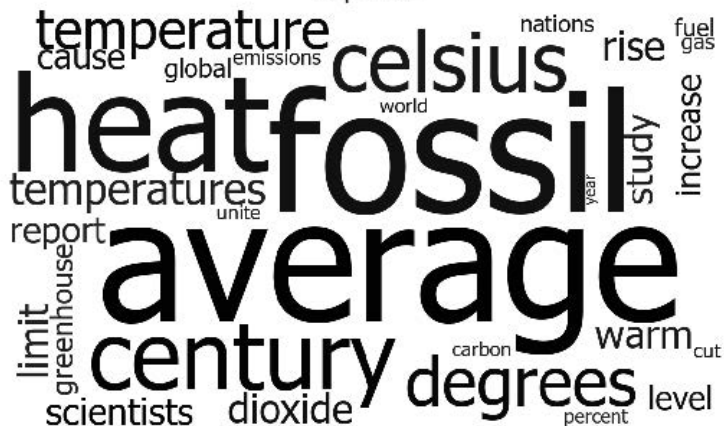
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## 3 Construction of accurate ESG ratings (Berg et al., 2020).



Topic 16





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

# 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
<b>Panel A: Market model</b>		
Textual	0.6** (2.09)	0.71** (2.44)
Narrative	-0.65 (-1.55)	-0.17 (-0.38)
<b>Panel B: FF 3F model</b>		
Textual	0.63** (2.54)	0.7*** (2.84)
Narrative	-0.96*** (-3.78)	-0.84*** (-2.75)
<b>Panel C: FFC model</b>		
Textual	0.43*** (3.06)	0.42** (2.2)
Narrative	-0.89*** (-2.68)	-0.65** (-2.14)
<b>Panel D: FF 5F model</b>		
Textual	0.56** (2.31)	0.46* (1.76)
Narrative	-0.53** (-2.45)	-0.46** (-2.17)
<b>Panel E: FF 5F + momentum</b>		
Textual	0.43** (2.58)	0.54*** (3.06)
Narrative	-0.69***	-0.57**