

A Machine Learning Based Anatomy of Firm Level Climate Risk Exposure

Kai Li Tingyu Yu

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What we do

Motivation: The lack of anatomy of different aspects of climate risk exposure directly measured at the firm level.

Main contribution: Construct firm level climate risk exposures using NLP techniques and earnings call transcripts from 2001 to 2020.

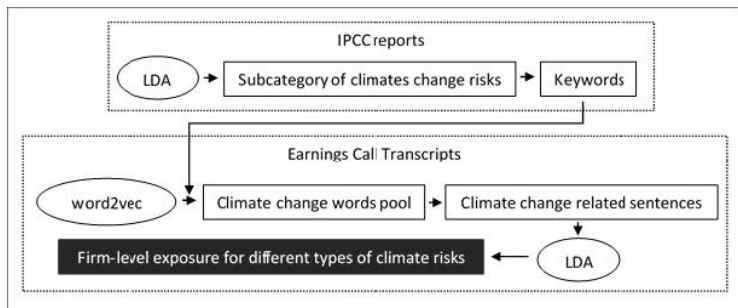


Figure 1: NLP procedure to construct firm-level climate exposure

What we find

Our procedure automatically generates five topics.

- ▶ We label them as Technology, Renewable, Carbon, Disaster, and Weather according to their word distributions.

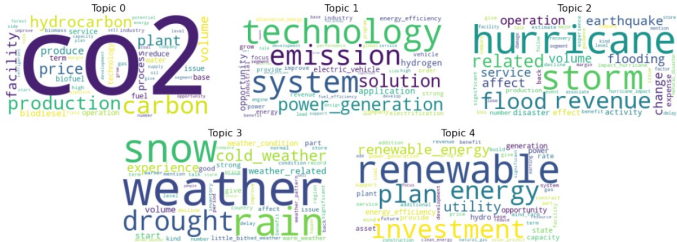


Figure 2: Word clouds for topics in transcripts

What we find

Our procedure automatically generates five topics.

- ▶ Three of them depict transition risks and two belong to physical risks.

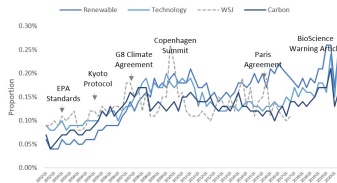
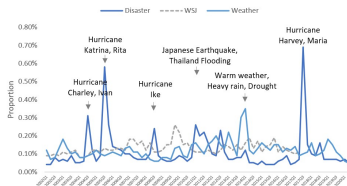


Figure 3: Mean value across firms over time

Validation

- ▶ Topics Disaster and Weather are positively associated with realized hazard dummy.
- ▶ Firms with high E score and underlying categories' scores tend to discuss transition related topics more.

Variables	Physical risks		Variables	Transition risks		
	Disaster	Weather		Carbon	Renewable	Technology
Real disaster	0.11** (2.50)	-0.02 (-1.30)	E score	0.24*** (3.43)	0.20*** (2.93)	0.300*** (4.44)
Hurricane	0.76*** (2.88)	-0.05 (-1.68)	Emission	0.31*** (4.60)	0.10 (1.53)	0.13** (2.24)
Flood	0.07* (1.79)	-0.02 (-1.37)	Innovation	0.28*** (3.06)	0.36*** (4.12)	0.55*** (7.90)
Drought	-0.03 (-0.18)	0.17*** (3.48)	Resource	0.10 (1.64)	0.07 (0.95)	0.14*** (2.68)
Control	Yes	Yes		Yes	Yes	Yes
Industry FE	No	No		Yes	Yes	Yes
YearQtr FE	Yes	Yes		Yes	Yes	Yes

Table 1: Validation tests

Implications of climate risk exposure

- ▶ Topics Disaster and Weather hurt sales growth.
- ▶ Institutions ownership is negatively related to Carbon and Renewable, while mutual funds tend to invest in firms with high exposure to Technology.

Variables	Sales growth	I/K	Emp growth	Inst. Own.			
				All	Salient ind.	Ex. salient	MFO
Technology	0.44**	0.02	0.03	-0.19	0.18	-0.58**	1.03*
Carbon	0.77***	0.14***	0.42***	-1.33***	-0.64**	-1.25***	0.14
Weather	-0.22**	0.02	0.12	0.44	-0.31	0.85***	0.11
Disaster	-0.22**	0.07**	-0.32***	-0.05	-0.3	0.11	-0.04
Renewable	-0.08	0.03	0.30**	-2.42***	-1.80**	-0.86**	-0.99*
State&YQ FE	No	No	No	Yes	Yes	Yes	Yes
Industry&YQ FE	Yes	Yes	Yes	No	No	No	No

Table 2: Implication of climate risk exposure

Firm valuations

- ▶ Topic Technology is positively correlated to firm value, especially for firms with low institutional ownership.
- ▶ Carbon and Renewable are negatively associated with firm value in recent ten years.
- ▶ Disaster has a value decreasing effect, which becomes insignificant in recent years.

Variables	log(Tobin's Q)						
	All	2002-2010	2011-2020	IO.Low	IO.High	Salient	Ex. salient
Technology	1.42*** (3.32)	2.15*** (3.49)	0.92** (1.99)	1.93*** (3.81)	0.36 (0.64)	2.42*** (3.81)	0.98* (1.80)
Carbon	-0.77** (-1.96)	0.33 (0.76)	-1.48*** (-3.02)	-0.87* (-1.72)	-0.53 (-1.08)	0.57 (0.92)	-1.64*** (-3.28)
Weather	0.74* (1.90)	0.62 (1.62)	0.82* (1.70)	0.78 (1.58)	0.28 (0.57)	0.1 (0.17)	1.03** (2.11)
Disaster	-0.56*** (-2.63)	-0.91*** (-3.16)	-0.31 (-1.20)	-0.52* (-1.68)	-0.54** (-2.28)	-0.57* (-1.70)	-0.52** (-1.99)
Renewable	-1.55*** (-4.70)	-0.37 (-0.60)	-1.98*** (-5.39)	-1.61*** (-4.47)	-1.51*** (-2.59)	-1.10*** (-2.81)	-2.18*** (-3.86)
IndYear&YQ FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3: Firm valuations

Pricing of topic Disaster

- ▶ A long-short portfolio based on the topic Disaster generates a positive return of 5% per annum, which cannot be explained by common risk factors and other firm characteristics.
- ▶ This positive relation has a one-year delay, which could be caused by slow learning speed about the disaster risk.

	Disaster							
	L	M	H	H-L	L	M	H	H-L
	Panel A: FF5				Panel B: HXZ5			
α	-0.38**	-0.04	0.15	0.53***	-0.10	0.07	0.27*	0.37**
t-stat	(-2.00)	(-0.31)	(0.81)	(3.19)	(-0.65)	(0.54)	(1.93)	(2.48)

Table 4: Asset pricing factor test for topic Disaster