Universität Zürich[UZH]

A Machine Learning-based Anatomy of Firm-level Climate Risk Exposure

Big Data and AI for Sustainable Investing Conference

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Motivation

- Physical risk: Increasing frequency of natural disasters and chronic weather events.
- Transition risk: Potential stringent policy can induce the transition to a low-carbon economy.

Reliable measures about firms' climate sensitivity and adaptation are critical to understanding and managing climate risks.

Our work

Hu, W., Li, K., and Yu, T. (2022), A Machine Learning-based Anatomy of Firm-level Climate Risk Exposure. Available at SSRN 4025598.

New measure: Text-based firm-level climate risk exposures.

- Anatomy: Unsupervised learning to decompose topics.
  - Transitional: **Carbon**, **Renewable**, **Technology**.
  - Physical: **Disaster**, **Weather**.
- Sentiment: Separate efforts or worries facing transition risk.

Empirical analysis:

- Materialized **physical risks** can result in **economic damages**.
- Firms actively developing **renewable investment** and **green technology** enjoy **higher valuations**.
- The value effects are significant when investors pay **close attention** to climate change.

Measurement: a 4-Step Approach

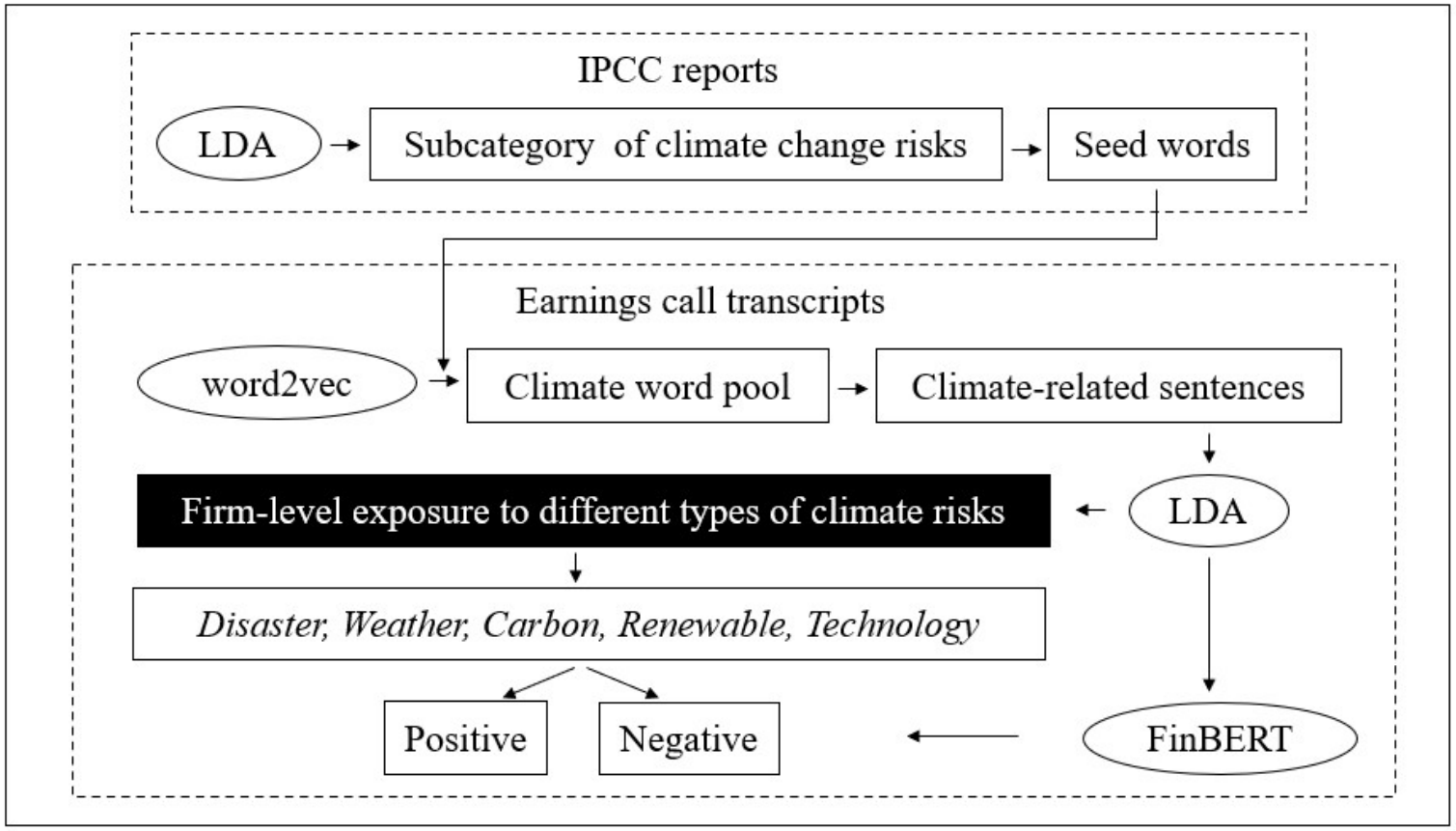

Figure: NLP procedure to construct firm-level climate exposure

Result 1: Physical risk and firm valuation

$$R_{it} = \alpha + \beta^k \textit{Climate discussion}_{it}^k + \gamma \mathbf{X}_{it} + \delta_i + \delta_t + \epsilon_{it}$$

- Physical topics significantly decrease firm values.

	(1)	(2)	(3)	(4)
	Contemporaneous Excess Returns			
Disaster	-0.06**			
	(-2.06)			
- Positive		0.06*		
		(2.07)		
- Negative		-0.13***		
		(-4.25)		
Weather			-0.11***	
			(-3.32)	
- Positive				0.06*
				(1.74)
- Negative				-0.19***
				(-5.44)
Observations	365,507	365,507	365,507	365,507
Control	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Month FE	Yes	Yes	Yes	Yes

Result 2: Transition risk and firm valuation

- Positive transitional topics increase firms' valuations.

	(1)	(2)	(3)	(4)	(5)	(6)
			Contemporaneous Excess Returns			
Carbon	0.02					
	(0.26)					
- Positive		0.07				
		(1.17)				
- Negative		-0.08**				
		(-2.58)				
Renewable			0.09***			
			(2.94)			
- Positive				0.13***		
				(4.06)		
- Negative				-0.08**		
				(-2.61)		
Technology					0.11***	
					(4.10)	
- Positive						0.13***
						(4.90)
- Negative						-0.09***
						(-3.24)
Observations	365,507	365,507	365,507	365,507	365,507	365,507
Control	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Month FE	Yes	Yes	Yes	Yes	Yes	Yes

Result 3: Attention to climate change

- The value effects mainly exist in the period with close attention to climate change.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Technology								
	Technology High		**Technology Low**		**WSJ High**		**WSJ Low**	
Technology	0.11***		0.03		0.17***		-0.01	
	(4.29)		(0.53)		(7.11)		(-0.12)	
- Positive		0.14***		0.01		0.19***		-0.00
		(4.89)		(0.20)		(5.99)		(-0.05)
- Negative		-0.13***		-0.04		-0.15***		-0.05
		(-5.54)		(-1.01)		(-3.57)		(-1.39)
Panel B: Renewable								
	Renewable High		**Renewable Low**		**WSJ High**		**WSJ Low**	
Renewable	0.09**		0.08		0.06		0.03	
	(2.14)		(1.63)		(1.15)		(0.52)	
- Positive		0.13***		0.10		0.10		0.07
		(3.33)		(1.36)		(1.62)		(1.35)
- Negative		-0.09**		-0.02		-0.10***		-0.05
		(-2.64)		(-0.47)		(-3.09)		(-1.43)

Result 4: Cash flow vs discount rate

Cash flow channel:

$$\Delta ROA_{i,t} = \alpha + \beta^k \textit{Climate discussion}^k_{i,t} + \gamma \mathbf{X}_{it} + \delta_i + \delta_t + \epsilon_{i,t}$$

Discount rate channel:

$$R_{i,t+1} = \alpha + \beta^k \textit{Climate discussion}^k_{it} + \gamma \mathbf{X}_{it} + \epsilon_{it}$$

- The impact on cash flow is transient.
- Firms exposed to physical risk earn higher expected returns.
- Firms with green commitment enjoy a lower cost of equity.

$\rightarrow$ Discount rate channel plays a more vital role in the value effect.

Conclusion

- Anatomy: Unsupervised learning to decompose climate topics.
  - Transitional: **Carbon**, **Renewable**, **Technology**.
  - Physical: **Disaster**, **Weather**.
- Sentiment: Whether the potential stringent environmental regulation will positively or negatively affect firms' operations.
- Quantify the effects of climate change on firm valuations.
  - **Perform better** than existing measures.
  - **Discount rate** channel **weighs more** heavily in the value implication.