Ask BERT: How Regulatory Disclosure of Transition and Physical Climate Risks affects the CDS Term Structure

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Motivation

- Climate-related risks are becoming more and more relevant
  - Transition risks: regulatory reform intended to combat global warming
  - Physical risks: emerge from extreme (weather) events
- Adequate disclosure aids efficient pricing of risks
- Securities and Exchange Commission (SEC) requires firms to report self-identified (climate) risks in their annual 10-K filings (e.g. item 1.A Risk factors)
- We use BERT, a state-of-the-art NLP technique, to develop firm-specific measures of climate risks based on (qualitative) regulatory disclosure
- Analyse effect on term structure of credit default swap (CDS) spreads
  - Climate change affects firms at different horizons → various CDS maturities
  - CDS market unlikely to be driven by preferences, focus on risk (hedging)

The effect of (climate) risk disclosure on credit spreads: theory

Risk-perception effect

Risk disclosure may increase perception of corporate risk (Kothari et al., 2009)

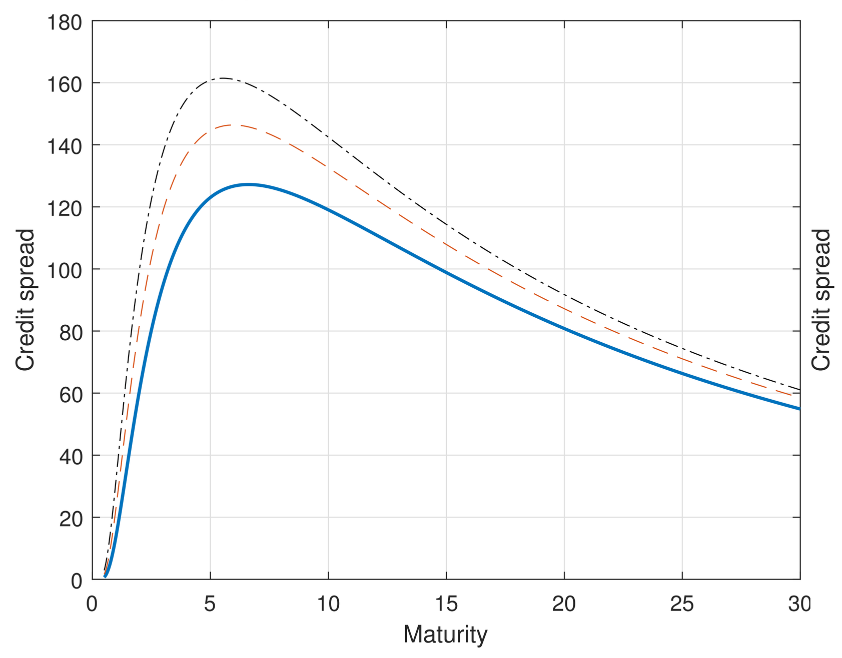
Transition risk

- Argument based on the classical Merton (1974) model
- Smooth transition to new regulatory regime will reduce firm's asset value

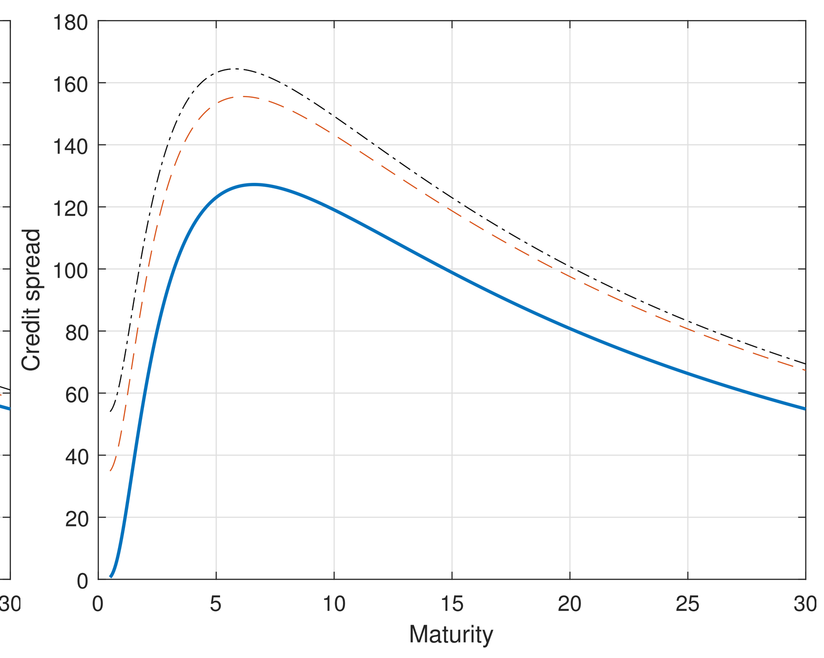
Physical risk

- Increase in the severity and frequency of (extreme) climate events
- Adding jumps to model (Zhou, 2001)

(a) Decreasing asset value



(b) Adding jumps



Information uncertainty effect

Risk disclosure may reduce information asymmetry between firms and investors

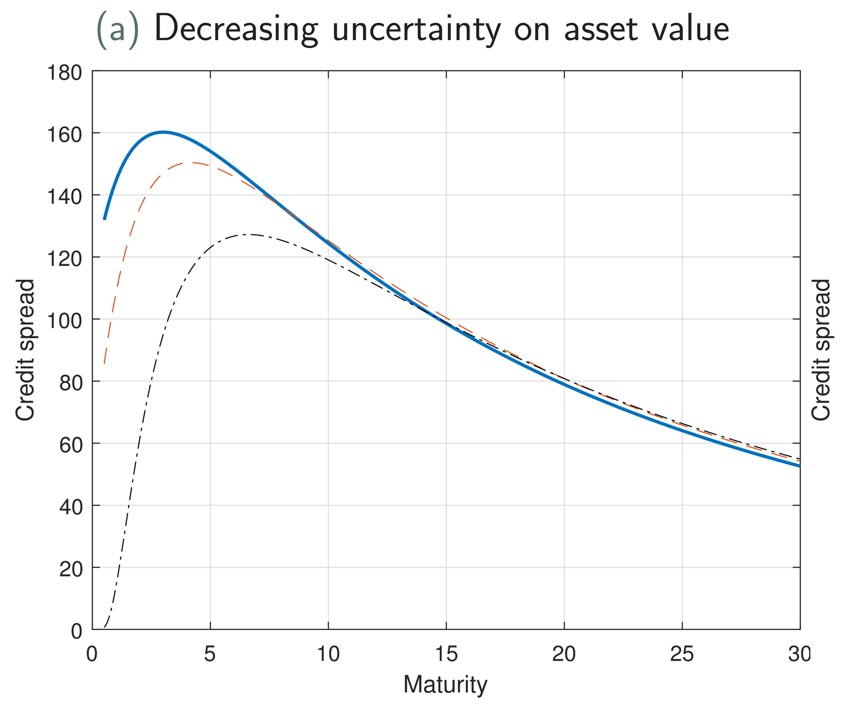
Transition risk

- Disclosure reduces information uncertainty on firm's asset value (Duffie & Lando, 2001)

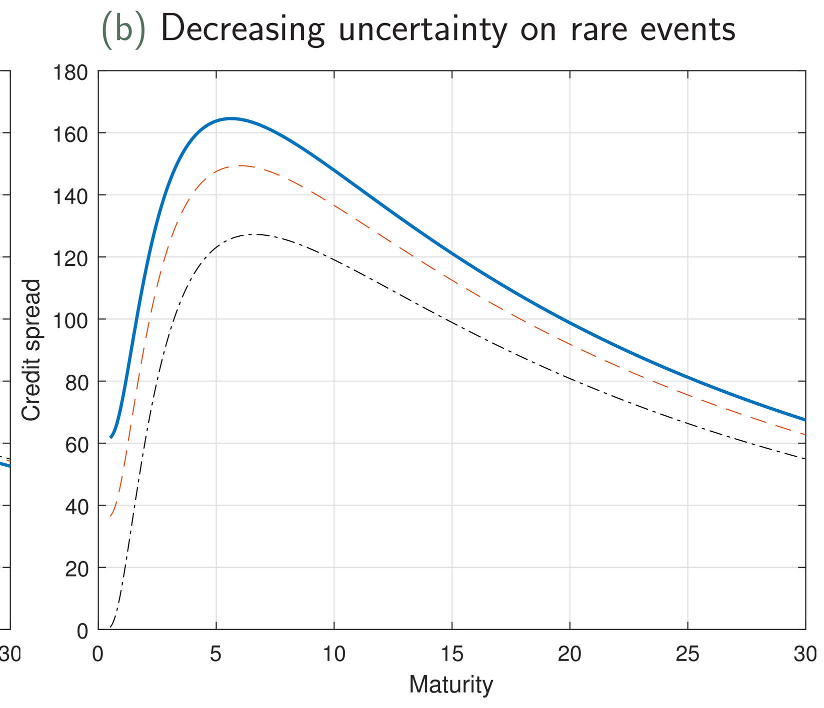
Physical risk

- Argument follows from implications of imprecise knowledge about rare events under ambiguity aversion (Liu et al., 2005)

(a) Decreasing uncertainty on asset value



(b) Decreasing uncertainty on rare events



Data

- CDS data from Thomson Reuters Datastream
- 10-K filings in SEC's Edgar database
- Period: February 2010 - December 2018
- Firm-specific and macroeconomic controls taken from prior literature (Collin-Dufresne et al., 2001; Ericsson et al., 2009; Han & Zhou, 2015)

Methodology – Industry classification

Sustainability Accounting Standards Board's (SASB) Sustainable Industry Classification System (SICS)

- Emphasizes a company's sustainability profile
- SASB's materiality map
  - Industry level climate risk materiality (Matsumura et al., 2018)
  - Climate risks (disclosure) only relevant in so-called 'material' industries
  - Different materiality subsamples: general and focus on physical risk
- Industry level clustering of standard errors

Methodology – BERT

= Bidirectional Encoder Representations from Transformers

- Developed at Google (Devlin et al., 2019)
- Contextual neural language model
- Used on Item 1.A in 10-K reports
  - Look for presence of climate-relevant topics (CN task)
  - Assessment transition or physical risk (TP task)

→ Sentence level (raw) score
→ Aggregated on document level (= firm-year level)

⇒ *Transition* and *Physical* score

Table 1: Model performance

	CN Task		TP Task	
Model	**Acc**	**F1**	**Acc**	**F1**
Baseline	81.07	82.03	58.60	48.60
BERT-Single	94.17	94.07	**90.78**	**90.27**
BERT-Multitask	98.06	98.02	85.44	82.36
BERT-GCE	94.17	94.07	90.29	89.68
BERT-Multi-GCE	**99.51**	**99.50**	89.81	88.45

Methodology – Regression setup

Baseline model - Panel first-difference model

$$\Delta S^m_{i,t+1} = \beta_T \Delta Transition_{i,t} + \beta_P \Delta Physical_{i,t} + \Phi \Delta X_{i,t} + \Theta \Delta Y_t + \epsilon_{i,t+1},$$

with $S^m_{i,t+1}$ next month's (average) m-year spread

Paris agreement, December 2015

- Accelerated the global push for climate regulation
- Especially relevant for transition risk disclosure
- Effect *Transition* should be even stronger after the Paris agreement

→ Introduce post-Paris dummy and interact with *Transition* and *Physical*

Main results

General climate material sample

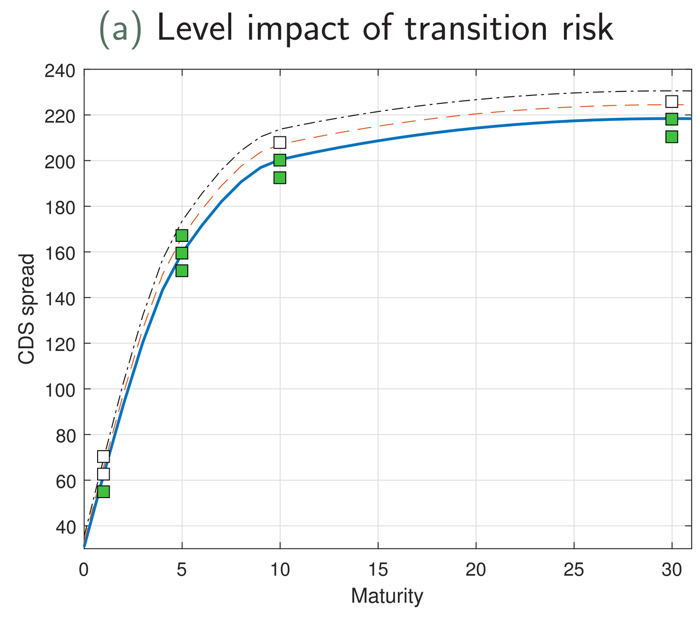
Table 2: Results for subsample of material industries, controlling for the Paris agreement

	ΔS^{1Y}	ΔS^{1Y}	ΔS^{5Y}	ΔS^{5Y}	ΔS^{10Y}	ΔS^{10Y}	ΔS^{30Y}	ΔS^{30Y}
$\Delta Physical$	18.283	29.860	25.538	17.304	23.175	19.490	22.125	20.953
	(16.381)	(40.673)	(19.078)	(14.276)	(17.956)	(13.909)	(17.660)	(13.802)
$\Delta Transition$	10.940	−6.376	33.592**	0.548	35.364*	5.288	32.050*	4.723
	(7.618)	(13.647)	(16.656)	(19.797)	(18.338)	(20.791)	(19.284)	(21.181)
$\Delta Physical \times Post$		−66.581		12.901		−5.912		−15.442
		(115.552)		(103.051)		(85.884)		(81.507)
$\Delta Transition \times Post$		74.968*		135.017***		123.703**		112.892**
		(43.759)		(50.174)		(48.843)		(43.981)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9972	9972	9972	9972	9972	9972	9972	9972
R-squared	0.028	0.030	0.068	0.076	0.067	0.074	0.062	0.067

S.e. in parentheses. *, **, and *** denote p-levels below 10%, 5%, and 1%.

A one-standard-deviation increase in *Transition* leads to an increase of 6.99bps (4.4%) in the average five-year CDS spread for the post-Paris period.

(a) Level impact of transition risk



Focus on physical risk material industries

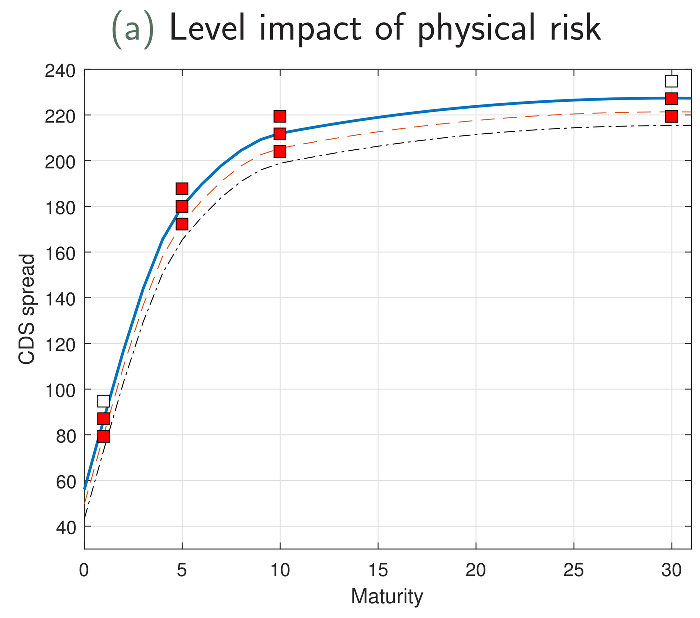
A one-standard-deviation increase in *Physical* results in a decrease in the average five-year CDS spread of 7.37bps (-4.1%).

Table 3: Results for subsample of physical material industries

	ΔS^{1Y}	ΔS^{5Y}	ΔS^{10Y}	ΔS^{30Y}
$\Delta Physical$	− 379.924**	− 419.190***	− 372.812***	− 342.756**
	(178.394)	(134.813)	(128.073)	(138.702)
$\Delta Transition$	168.027**	198.936***	183.583***	168.935***
	(78.750)	(59.814)	(45.513)	(43.728)
Controls	Yes	Yes	Yes	Yes
N	6971	6971	6971	6971
R-squared	0.028	0.030	0.068	0.076

S.e. in parentheses. *, **, and *** denote p-levels below 10%, 5%, and 1%.

(a) Level impact of physical risk



Robustness check – Substantial advantage new BERT measure?

- Carbon emissions data as proxy for transition risk
- Comparing with keyword-based NLP algorithms
  - CookESG research/CERES climate risk measure based on 10-K reports (Berkman et al., 2019)
  - Scores from Sautner et al. (2020), based on textual analysis of earnings conference calls

⇒ BERT measures provide most consistent results in our CDS context

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