Climate Regulatory Risk and Corporate Bonds

American Bank Conference on Development Economics

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July 9, 2024

*The views expressed in this paper are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

Importance of Climate Risk

- Increasing investor awareness and concern over climate risk.
- Climate risk can adversely affect asset prices, and is hard to hedge.
  - Past research showed climate and environmental risks are priced in a variety of financial markets (Karpoff et al 2005; Chava 2014; Bolton and Kacperczyk 2021; Ilhan, Sautner and Vilkov 2021; Painter 2019).

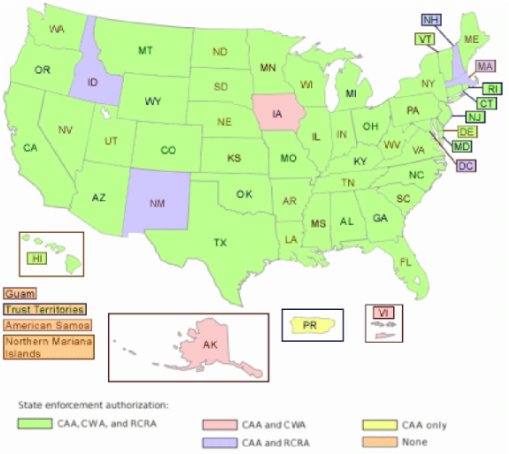
Research Question and Methodology

- **Research Question:** Does climate risk affect corporate bond risk and pricing, particularly through regulatory risk?
- Environmental profile data from (1) CDP scope 1 carbon emissions and (2) Sustainalytics environmental score
- Regulatory exposure data from EPA.
- Natural experiment using Paris Agreement as a shock to expected new climate regulations.
  - Estimate a Merton model to better understand the effect.

Main Findings

- Bonds issued by firms with weaker environmental profiles exposed to stricter regulatory enforcement have higher yield spreads and lower ratings.
- Bond spreads increased and credit ratings decreased for bond issuers more exposed to climate risk following the Paris Agreement.
  - ◊ Credit ratings for bonds issued by firms in high emissions industries decreased by 0.6 notch relative to those issued by other firms following the Paris Agreement.
  - ◊ Bond spreads for bonds issued by firms in high emissions industries increased by 38 bps relative to those issued by other firms following the Paris Agreement.
  - ◊ Results strongest for firms exposed to strict regulatory enforcement.
  - ◊ Merton model estimation indicates the changes are driven by a change in volatility

State Enforcement of Environmental Regulations



US federal-regulation enforced at the state-level

Regulatory Data

- Exploit differences in state-enforcement of federal environmental regulations.
  - ◊ Integrated Compliance Information System for Federal Civil Enforcement Case Data.
  - ◊ Enforcement for Clean Water Act (CWA), Clean Air Act (CAA) and Resource Conservation and Recovery Act (RCRA).
  - ◊ Measure environmental regulatory stringency as total state penalties scaled by number of plants (Konisky 2007).
- Using firm sales data from the National Establishment Time Series Database, calculate firm regulatory stringency:

$$RegStringency_{j,t} = \sum_{s \in S_j} \left(\frac{StateRevenue_{j,s}}{TotalRevenue_j} \times EPAEnforcements_{s,t} \right)$$

Interaction Regressions

- Run the following regression:

$$Outcome_{it} = \beta_1 EnvProf_{jt-1} + \beta_2 Reg_{jt-1} + \beta_3 (EnvProf_{jt-1} * Reg_{jt-1}) + \beta_4 X_{it-1} + FE + \epsilon_{it},$$

- β_3 captures effect of interaction between environmental profile and regulation on outcome.
- Use at-issue bonds to capture cross-state variation EPA enforcement.
- Outcome Variables: Bond yield spreads and credit ratings.
- Environmental Profile Proxies: Scope 1 carbon emissions, carbon emission intensity (emissions divided by firm revenue) and Sustainalytics environmental score.

Outcome = CreditRatings

$$Rating_{it} = \beta_1 EnvProf_{jt-1} + \beta_2 Reg_{jt-1} + \beta_3 (EnvProf_{jt-1} * Reg_{jt-1}) + \beta_4 X_{it-1} + FE + \epsilon_{it},$$

	(1)	(2)	(3)	(4)	(5)	(6)
Environmental Score × Reg Stringency	-0.005**			-0.006***		
	(0.002)			(0.002)		
Emissions × Reg Stringency		0.007**			0.009***	
		(0.004)			(0.003)	
Carbon Intensity × Reg Stringency			0.073			0.101
			(0.068)			(0.063)
Environmental Score	-0.009***			-0.004		
	(0.003)			(0.003)		
Emissions		0.007***			0.003	
		(0.002)			(0.002)	
Carbon Intensity			0.162***			0.088**
			(0.053)			(0.044)
Controls	Y	Y	Y	Y	Y	Y
Time Fixed Effects	Y	Y	Y	Y	Y	Y
Industry Fixed Effects	N	N	N	Y	Y	Y
Adj. R^2	0.587	0.555	0.574	0.546	0.526	0.527
Obs	1,940	1,312	1,312	1,938	1,309	1,309

Outcome = BondYieldSpreads

$$Spread_{it} = \beta_1 EnvProf_{jt-1} + \beta_2 Reg_{jt-1} + \beta_3 (EnvProf_{jt-1} * Reg_{jt-1}) + \beta_4 X_{it-1} + FE + \epsilon_{it},$$

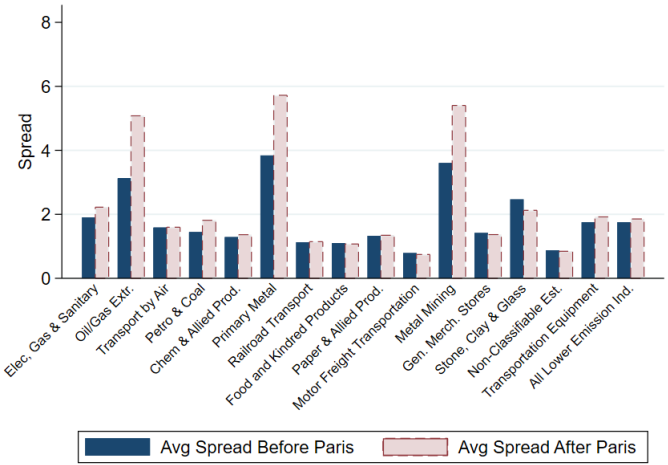
	(1)	(2)	(3)	(4)	(5)	(6)
Environmental Score × Reg Stringency	-0.005*			-0.006**		
	(0.003)			(0.003)		
Emissions × Reg Stringency		0.007*			0.009**	
		(0.004)			(0.004)	
Emission Intensity × Reg Stringency			0.073			0.101
			(0.070)			(0.069)
Environmental Score	-0.009***			-0.004		
	(0.003)			(0.003)		
Emissions		0.007***			0.003	
		(0.003)			(0.003)	
Emission Intensity			0.162***			0.088*
			(0.052)			(0.049)
Controls	Y	Y	Y	Y	Y	Y
Time Fixed Effects	Y	Y	Y	Y	Y	Y
Industry Fixed Effects	N	N	N	Y	Y	Y
Adj. R^2	0.596	0.672	0.678	0.601	0.715	0.715
Obs	1,940	1,312	1,312	1,938	1,309	1,309

Paris Agreement Shock

- **Paris Agreement:** On December 12, 2015, 175 nations signed the Paris Agreement, agreeing to strengthen response to climate change.
- Goal to limit 21st century global temperature rise to 1.5 degrees Celsius – requires new regulations.
- Shock to climate regulatory risk **otherwise unrelated to firm default risk.**

"The voluntary nature of a country's actions 'makes more detailed assessment of the credit impact of the Paris Agreement difficult, although the trend is clear and broadly negative for those sectors with the highest exposure to carbon emissions regulation that we have identified.' " – Brian Cahill, Moody's Managing Director

Effect of Paris Agreement on Bond Spreads by Polluting Industry



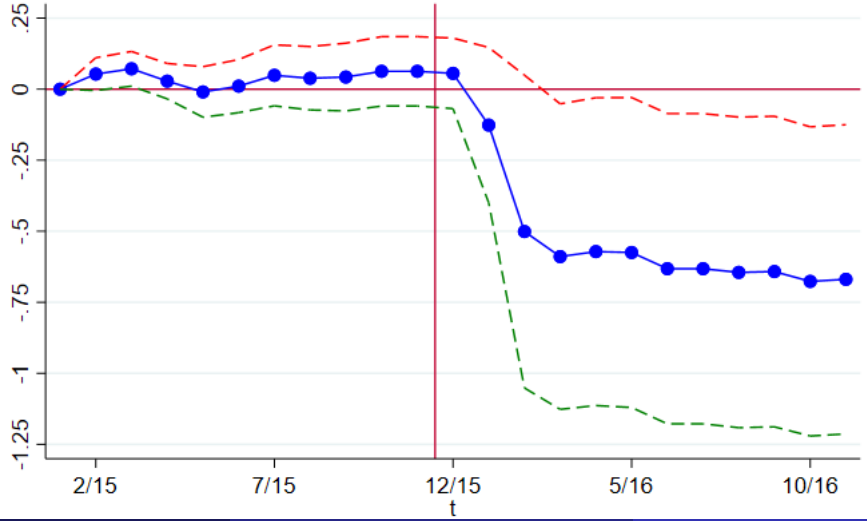
Difference-in-differences – Ratings

- Run the following difference-in-differences regression:

$$Rating_{it} = \beta_1(EnvProf_j * AfterParis_t) + \gamma_i + \kappa_t + \epsilon_{it}.$$

- Environmental Profile Treatment:
  - ◊ Below median environmental score indicator
  - ◊ Top 15 carbon emitting industries
  - ◊ Top quartile scope 1 carbon emissions
  - ◊ Top quartile scope 1 carbon emission intensity
- γ_i, κ_t are security fixed effects and month fixed effects.
- Use pre and post period of 12 months.

Difference-in-Differences – Ratings



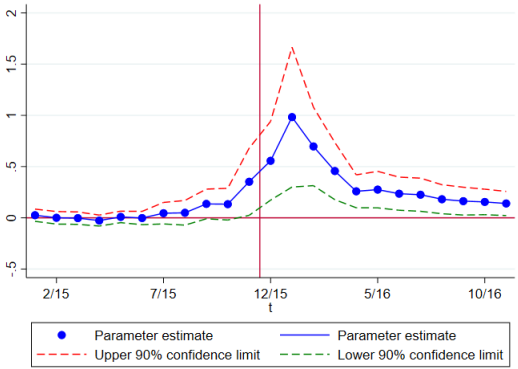
Difference-in-differences – Spreads

- Run the following difference-in-differences regression:

$$Spread_{it} = \beta_1(EnvProf_j * AfterParis_t) + \gamma_i + \kappa_{tp} + \epsilon_{it}.$$

- Bond spreads may be sensitive to oil markets – match on issuer equity oil beta and other characteristics.
- γ_i security fixed effects and κ_{tp} month-pair fixed effects.

Difference-in-Differences – Spreads



Change in Ratings Concentrated in High Regulation States

	(1)	(2)	(3)	(4)
fter Paris × Top-Quartile Emissions × High Reg	-1.371***			
	(0.414)			
After Paris × Top-Quartile Carbon Intensity × High Reg		-1.385***		
		(0.383)		
After Paris × High Emissions Industry × High Reg			-1.094**	
			(0.462)	
After Paris × Low Environmental Score × High Reg				-0.990**
				(0.449)
Time FE	Y	Y	N	N
Security FE	N	Y	N	Y
Adj. R^2	0.182	0.189	0.134	0.126
Obs	23,184	23,184	33,336	33,336

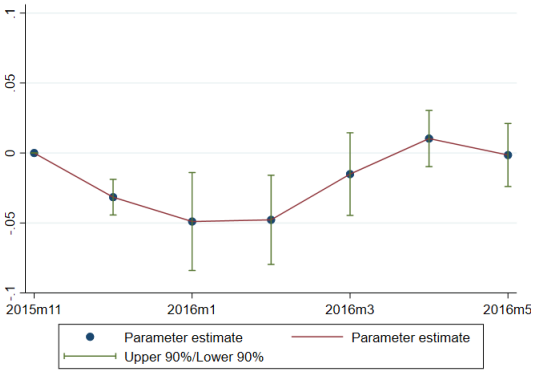
- Triple-difference shows drop in ratings concentrated in states with strict regulatory enforcement.

Change in Spreads Concentrated in High Regulation States

	(1)	(2)	(3)	(4)
After Paris × Top-Quartile Emissions × High Reg	0.199			
	(0.225)			
After Paris × Top-Quartile Carbon Intensity × High Reg		0.264		
		(0.176)		
After Paris × High Emissions Industry × High Reg			0.700*	
			(0.356)	
After Paris × Low Environmental Score × High Reg				0.911**
				(0.386)
Pair-Time FE	Y	Y	N	N
Security FE	N	Y	N	Y
Adj. R^2	0.050	0.066	0.044	0.029
Obs	12,096	10,416	31,008	21,504

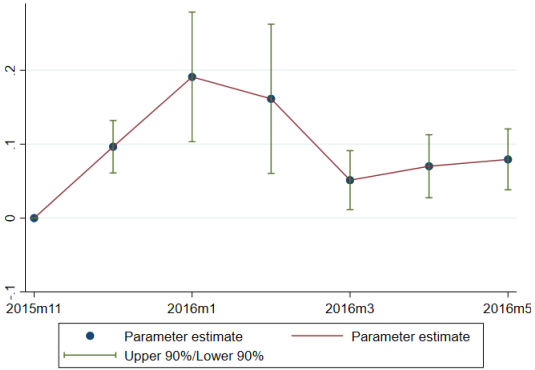
- Triple-difference shows increase in spreads concentrated in states with strict regulatory enforcement.

Merton Model Imputed Asset Values



Decline in asset values quickly reverses.

Merton Model Imputed Asset Volatilities



Drop in asset volatility large and persistent.

Conclusion

- Results show that corporate bond investors and ratings agencies respond to climate regulatory risk.
- Consistent with survey views of institutional investors, regulatory risk is an important channel through which climate risk impacts bond investors.
- Change in volatility drives results – climate policy uncertainty impacts asset prices.