



This Changes Everything: Climate Shocks and Sovereign Bonds

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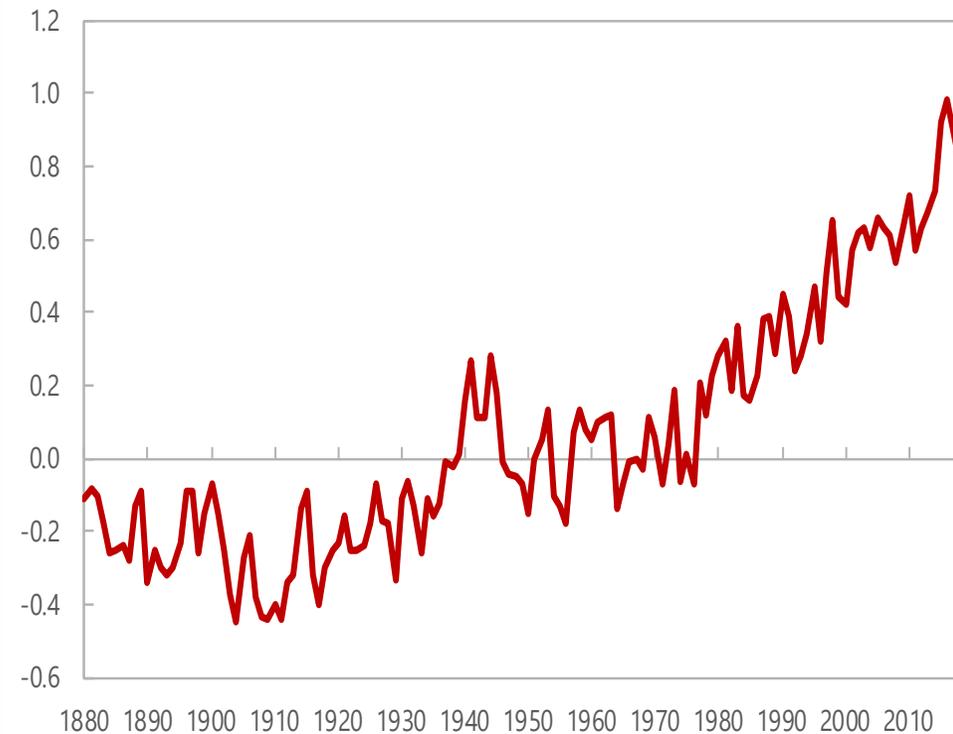
Climate change already poses a systemic risk to the global economy

The global average surface temperature has increased by 1.1° Celsius since 1880.

- ▶ Weather anomalies are projected to worsen as the global annual mean temperatures increase by as much as 4° Celsius over the next century.
- ▶ The consequences of climate change will be felt across the world, but potential vulnerability to extreme weather events depends on the size and composition of economies, the resilience of institutions and physical infrastructure, and the capacity for adaptation and mitigation.

Global Temperature Anomalies

(Degrees Celsius, deviation from trend)



What's the impact of climate change on the cost of government borrowing?

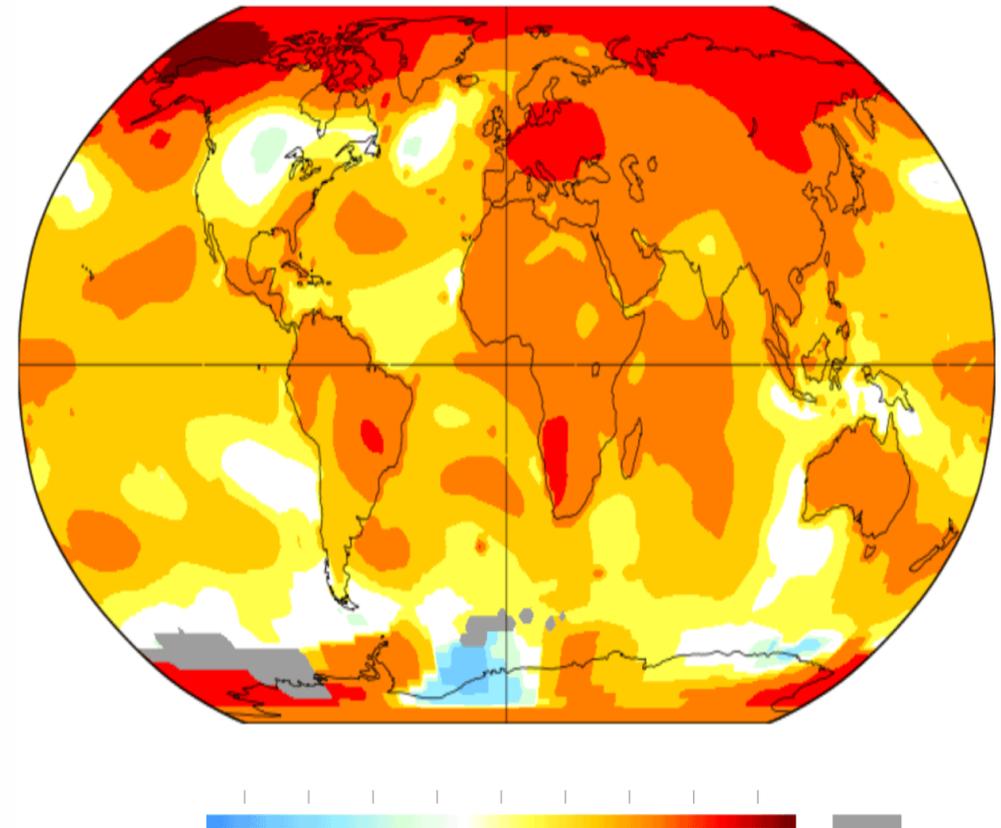
There is a large body of literature documenting potential negative effects of climate change on economic growth.

But research on the link between climate vulnerability and sovereign risk remains scarce.

This paper contributes to the literature by analyzing the impact of climate change vulnerability and resilience on the cost of government borrowing in a panel of 54 countries over the period 1995–2017.

Global Temperature Anomalies

(2018-2019 compared with 1951-1980 average)



Taking advantage of a new database of vulnerability and resilience to climate change

We extend the conventional determinants of government bond yields and spreads to investigate the impact of climate change on the pricing of sovereign risk across countries and over time, using a new database developed by the Notre Dame Global Adaptation Institute (ND-GAIN).

- ◆ The novel ND-GAIN indices summarize a country's overall susceptibility to climate-related disruptions and capacity to adopt to the consequences of climate change.
- ◆ The vulnerability index assesses climate vulnerability according to performance in six life-supporting sectors—food, water, health, ecosystem services, human habitat and infrastructure.
- ◆ The resilience index assesses climate readiness according to capacity leverage investments to adaptation actions in three areas—economic readiness, governance readiness and social readiness.

Empirically investigating the impact of climate change on sovereign risk (1)

We employ alternative static and dynamic estimation methodologies and take into account macroeconomic factors (real GDP growth, inflation, debt, budget balance, and international reserves).

- Baseline results demonstrate a consistent picture.
- Climate change vulnerability has a significant effect on long-term (10-year) government bond spreads relative.
- The coefficient on climate change vulnerability ranges between 0.452 and 2.528 depending on the model specification, but always remaining statistically significant.

Climate Change and Sovereign Risk—Baseline Estimations

Specification	1	2	3	4	5	6
Dependent Variable	Spreads	Spreads	Spreads	Spreads	Spreads	Spreads
Vulnerability	2.528*** (0.766)		2.297*** (0.694)	0.593** (0.296)		0.452** (0.274)
Resilience		-0.404*** (0.143)	-0.291** (0.115)		-0.186*** (0.071)	-0.164** (0.066)
Control variables	No	No	No	Yes	Yes	Yes
# of countries	54	54	54	53	53	53
# of observations	1,017	1,017	1,017	949	949	949
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.47	0.49	0.50	0.74	0.74	0.74

Note: Robust standard errors reported in brackets. A constant is included in each regression, but not shown in the table. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Empirically investigating the impact of climate change on sovereign risk (2)

We also find that investing in adaptation and mitigation helps improve climate resilience and, thereby, lowers government bond spreads.

- The coefficient of climate change resilience ranges between -0.164 and -0.404 depending on the model specification, but always remaining statistically significant.
- These effects of climate change vulnerability and resilience remain robust when we introduce control variables for solvency, liquidity and economic stability, for which we obtain coefficients that consistent with the findings in previous studies.

Climate Change and Sovereign Risk—Baseline Estimations

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Partitioning the sample reveals a substantial contrast between advanced and developing countries

- Both climate change vulnerability and resilience have no pronounced effects on the cost of government borrowing in advanced economies.
- The magnitude and statistical significance of the estimated coefficients are much greater in the case of developing countries.
- These results remain robust even after controlling for conventional macroeconomic factors.
- This reflects weaker capacity in developing countries to adapt to and mitigate the consequences of climate change.

Climate Change and Sovereign Risk—Country Groups

Specification	1	2	3	4	5	6
Dependent Variable	Spreads	Spreads	Spreads	Spreads	Spreads	Spreads
Country Group	Advanced	Advanced	Advanced	Developing	Developing	Developing
Vulnerability	0.036 (0.171)		0.046 (0.164)	1.454** (0.763)		1.458** (0.731)
Resilience		0.007 (0.041)	0.009 (0.04)		-0.701*** (0.187)	-0.702*** (0.186)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
# of countries	32	32	32	21	21	21
# of observations	639	639	639	310	310	310
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.61	0.61	0.61	0.76	0.74	0.76

Note: Robust standard errors reported in brackets. A constant is included in each regression, but not shown in the table. *** p<0.01, ** p<0.05, * p<0.1

Greater vulnerability to climate change is associated with higher cost of government borrowing

- According to our benchmark specification, a one percentage point increase in climate vulnerability is associated with an increase of 0.45 percent in long-term government bond spreads, while a one percentage point improvement in climate resilience leads to a decrease of 0.16 percent in bond spreads.
 - ◆ **However, sub-sample estimates show that these effects significantly greater in emerging market economies.**
- A one percent increase in climate vulnerability leads to an increase of 1.46 percent in long-term government bond spreads of developing countries, while 1 percent improvement in climate resilience lowers bond spreads by 0.7 percent.

These effects amount to a significant difference across countries

- Long-term government bond spreads in our sample of developing countries average about 500 basis points.
- The estimated coefficient imply that a one percentage point increase in climate change vulnerability would increase sovereign debt risk premia by 7.3 basis points.
- Similarly, a one percentage point increase in climate change resilience would decrease risk premia by 3.5 basis points.
 - ◆ These may seem small, but the difference between countries in the 25th and 75th quintile amounts to:
 - **110 basis points for climate vulnerability**
 - **53 basis points for climate resilience**

Several sensitivity checks validate the robustness of baseline results

- First, we replace the dependent variable with alternative measures of the cost of government debt (i.e., 5-year bond spreads and bond yields).
- Second, we truncate the sample at the 5th and 95th percentiles to exclude potential outliers.
- Third, we deal with potential endogeneity by estimating the model using the Two Stage Least Squares estimator and lagged climate change indices as instruments.
- Finally, given the persistence of bond spreads, we estimate a dynamic specification of the model using the system GMM approach.

These results confirm the robustness of our baseline empirical findings—both for vulnerability and resilience to climate change, even after controlling for conventional macroeconomic determinants of the cost of sovereign risk.

Climate change is inevitable, but policymakers can still enhance resilience to absorb shocks

In this paper, we analyze the effects of climate change on sovereign risk as measured by government bond yields and spreads in a panel of 54 countries during 1995–2017.

- Climate vulnerability has a significant effect on the cost of government borrowing
 - ▶ Countries with greater vulnerability to climate change pay a higher interest rate on government bonds, which is especially pronounced in developing countries.
- Climate resilience has a significant negative impact on the cost of borrowing.
 - ▶ Countries that are more resilient to climate change have lower bond yields and spreads relative to countries with greater vulnerability to climate change.

Climate change is inescapable, but the empirical analysis indicates that enhancing structural resilience through mitigation and adaptation, strengthening financial resilience through fiscal buffers and insurance schemes, and improving economic diversification and policy management can help cope with the consequences of climate change for public finances in particular and economic development in general.