The Economic Consequences of climate change on Sovereign Debt

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Abstract

The emergence of climate change, driven by anthropogenic activities, now constitutes a major threat to the world economic landscape and despite the global nature of climate change, national policies for its mitigation and adaptation vary widely. While there is a large body of literature on its potential economic risks, the empirical research exploring the link between climate change and sovereign risk remain scare. With this study I have not only tried to capture the effect of climate change vulnerability and resilience on sovereign bond yields in 35 countries over the period 1995-2016, but also investigate the temporal variation in their effects. The main hypothesis is that the financial markets, when factoring climate risks into credit assessments, would demand higher interest rates from countries more susceptible to climate change impacts. Conversely, nations demonstrating greater resilience to climate disruptions are expected to experience lower borrowing costs. In my study I have found that the vulnerability and resilience have a significant impact on cost of sovereign borrowing, after controlling for the conventional determinants of sovereign risk.

Introduction

The systematic risk due to climate change over global economy and financial markets is not hidden, the consequences of climate change can be felt all over the world. But the extent to which a particular country is vulnerable to climate anomalies depends on the size and composition of its economy, capacity to adapt and the resilience of its institutions and physical infrastructure. Literature indicates that there are significant negative effects of climate related shifts in the physical environment on economic growth. This study empirically establishes one such negative effect that is on sovereign borrowing cost. According to literature government bonds are exposed to both transition risk and physical risk related to climate change. The expenses related to nations making the shift to a greener economy mainly constitute the transition risk, as these expenses are majorly financed by government. Physical climate risk, on the other hand, describes the harm and disruptions brought on by extreme weather conditions like heat waves, floods, and storms that have an immediate impact on economy and sovereign debt. In this study I mainly focus on the countries' exposure to physical risks. By using a new dataset of climate change vulnerability and resilience created by the Notre Dame Global Adaptation Institute (ND-GAIN), we extend the conventional determinants of government bond yields and spreads to investigate the impact of climate change on the pricing of sovereign risk. The main policy takeaway from this study is that, despite the fact that climate change cannot be stopped, governments may nevertheless strengthen economic resilience to withstand shocks and improve public financial management.

Research objectives

The present study investigates the following objectives:

- **Objective 1:** To empirically verify the negative effect of climate change on sovereign borrowing.
- **Objective 2:** To find the temporal variation of climate change's impact on sovereign debt.

Data overview

The balanced panel dataset utilized in this study includes observations from 35 advanced and developing countries between 1995 and 2016. The dependent variable is government bond spread as measured by 10-year foreign-currency-denominated government bond spread vis-a-vis the U.S. benchmark. The major explanatory variables of importance are vulnerability and resilience to climate change, as evaluated by the ND-GAIN indices, which represent a country's overall susceptibility to climate-related disruptions and capability to deal with climate change repercussions, respectively. Figure 1 displays the temporal profile of the vulnerability and resilience indices for the full dataset.

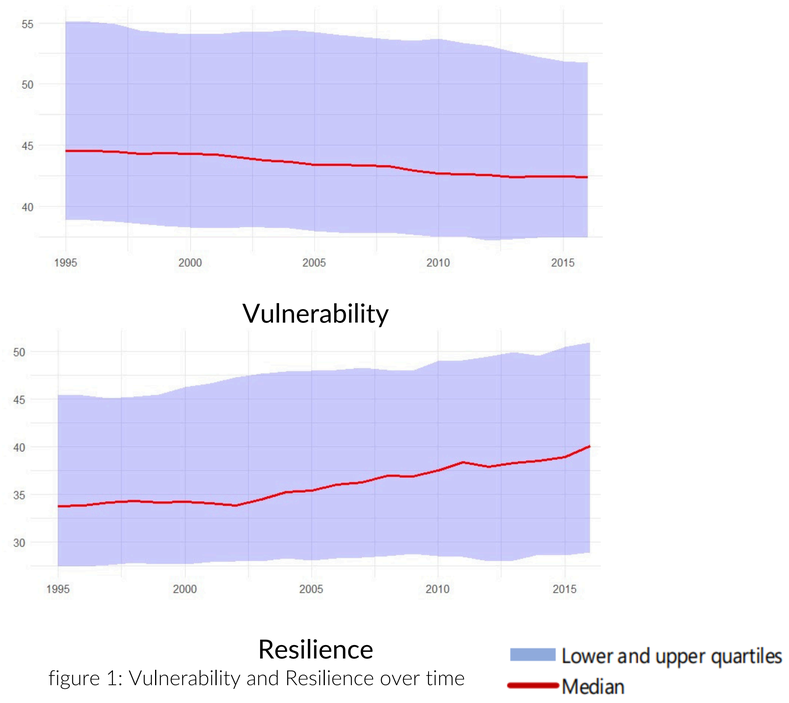

figure 1: Vulnerability and Resilience over time

It is apparent from statistic that vulnerability reduces over time. It also illustrates that resilience has increased over time, particularly since the early 2000s. It is worth noting that the vulnerability score is calculated using 36 factors, whereas the resilience score is calculated using 9 factors.
In line with the previous research, I include a set of control variables, including the growth rate of real GDP, consumer price inflation, the public debt-to-GDP ratio, the budget balance-to-GDP ratio, international reserves as a share of GDP, bureaucratic quality, government effectiveness and terms of trade..

Empirical strategy and results

First, we analyse the time series properties of data to avoid spurious result by conducting panel unit root test, for this we use the Im-Persaran-Shin (2003) procedure. The test results shows that bond spreads are stationary and climate indices become stationary after first differencing.
To empirically evaluate the influence of climate change on sovereign bond spreads, we use a panel linear model with the following specification:

$$y_{it} = \beta_1 \Delta vul_{it} + \beta_2 \Delta res_{it} + \beta_3 X_{it} + \eta_i + \mu_t + \epsilon_{it}$$

The dependent variable is the bond spread in country i and time t and independent variables are vulnerability, resilience and other control variables. We have tried 7 different specification based on the inclusion of independent variables in the analysis. The results these 7 specifications are shown in the Table 1.

	Dependent variable: Bond spread						
Specification	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Vulnerability		2.013***		1.616***	0.572***		0.326*
		(0.267)		(0.297)	(0.183)		(0.194)
Resilience			-0.421***	-0.234***		-0.219***	-0.188***
			(0.071)	(0.078)		(0.049)	(0.052)
Real GDP growth	-0.167***				-0.179***	-0.193***	-0.197***
	(0.035)				(0.035)	(0.035)	(0.035)
Inflation	0.387***				0.371***	0.369***	0.362***
	(0.026)				(0.027)	(0.026)	(0.026)
Debt	0.050***				0.052***	0.054***	0.055***
	(0.007)				(0.007)	(0.007)	(0.007)
Budget balance	0.041				0.039	0.043	0.041
	(0.038)				(0.038)	(0.038)	(0.038)
International reserves	-0.006				-0.005	-0.008	-0.007
	(0.015)				(0.015)	(0.015)	(0.015)
Bureaucratic quality	-0.792				-0.675	-0.240	-0.251
	(0.781)				(0.777)	(0.781)	(0.780)
Government effectiveness	-0.797				-0.589	-0.271	-0.227
	(0.710)				(0.709)	(0.711)	(0.711)
Terms of trade	0.006				0.014	0.011	0.015
	(0.011)				(0.011)	(0.011)	(0.011)
Note:							*p<0.1; **p<0.05; ***p<0.01

Table 1: Results of the fixed effect panel linear model

- As a baseline, we start with a specification that includes only macroeconomic and institutional variables, as shown in column (1) of Table 1. This serves as a point of reference for our analysis.
- In columns (2), (3), and (4), we present parsimonious specifications where we individually and jointly include climate change vulnerability and resilience as explanatory variables.
- In columns (5), (6), and (7), we introduce the climate variables alongside the macroeconomic variables.
- Across all specifications, the coefficient for climate change vulnerability ranges from 0.326 to 2.013. Importantly, it remains consistently positive and statistically significant. Similarly, the coefficient for resilience ranges from -0.421 to -0.188, consistently negative and statistically significant.

These results support our hypothesis and consistent with the previous research.

Then we apply the time varying panel linear model on the balanced panel dataset. The results of this analysis are specified in figure 2. It can be inferred from the results that the impact of vulnerability or resilience to climate change vary non-linearly over time. The effect of vulnerability and resilience (in terms of magnitude) decreases from 1996, having its minimum in 2004-05, and then increases from 2005 onwards.

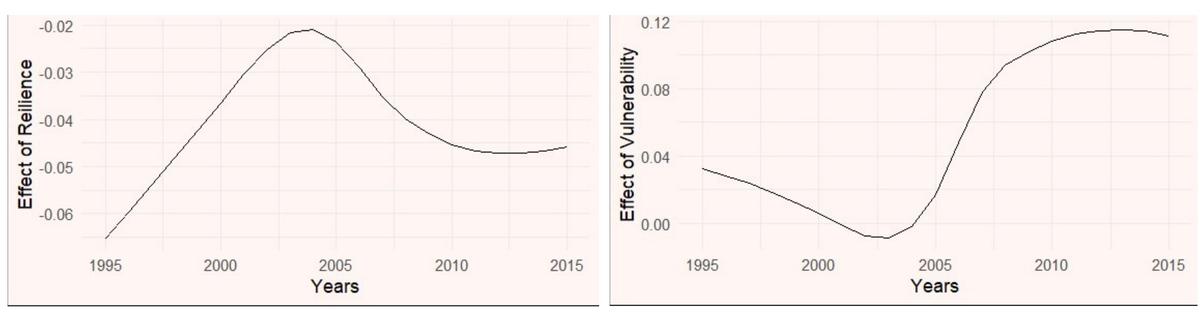

figure 2: Results of the time varying panel linear model

Conclusions

- The fixed effect model indicates that as vulnerability to climate change increases bond spread also increases which means that vulnerability increases the cost of sovereign borrowing.
- Similarly, it also shows that as resilience to climate change increases bond spread decreases which indicate a that resilience decreases the cost of sovereign borrowing.
- The time varying panel linear model indicates that the effect of climate change on sovereign borrowing cost is increasing from 2005 onwards.

What is already known about this subject?

- Currently there is a vast literature on the negative impacts of climate change on the economic growth of a country and there is a well-defined set of variables that influence the cost of sovereign borrowing.
- Studies have demonstrated that the cost of sovereign borrowing is related to the country's exposure to and ability to manage climate change impacts using unbalanced panel data.

What does this study add?

- This study utilizes the time-varying panel linear model to analyse the temporal dynamics of climate change vulnerability and resilience, providing insights into how their effects evolve over time.
- This study also verifies the significance of climate change variables in determining sovereign borrowing costs using a balanced panel dataset.

References

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