Impact of Climate Risk on Fiscal Space: Do Religious Tensions and Financial Development Matter?

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Outline

Research question

Motivation

- How do climate vulnerability risk impact fiscal space?
- Big natural disasters are likely to necessitate large fiscal outlays for relief and recovery efforts
- Climate change-related fiscal expenditures pose a major threat to fiscal space / sustainability in the future
- Examine the link between climate risk and fiscal space in a systematic and rigorous way
  - Levels of Vulnerability: Climate risk premium
  - Levels of Political Stability (Different forms)
  - Levels of Financial Development
- More stable political environment (less religious tensions, for example) is likely to reduce the impact of fiscal cost of climate shocks
- Financial development is also expected to mitigate climate-related fiscal risks
  - Confirmation of the climate risk premium (Beirne et al., 2021; Cevik and Jalles, 2022; Zenios, 2022)
  - **Do Religious Tensions and Financial Development Matter?**

Research question

Literature overview

- **Climate risks:** economic growth (Oppenheimer et al., 2004; Tol et al., 2004; Mendelson et al., 2006; Diffenbaugh and Burke, 2019; Dasgupta et al., 2023)
- Exacerbates inequality in developing countries (Cappellia et al., 2021; Dasgupta et al., 2023)
- Mitigating the socio-economic impact of climate change and rising temperatures, countries must possess a high adaptive capacity (Tol et al., 2004), a diversified economy (Dissart, 2003), political stability (Dell et al., 2012), and strong institutional leadership (Pike et al., 2010)
- You et al. (2014) examine the link between democracy, financial openness, and carbon dioxide emissions.

Research question

Testable Assumptions

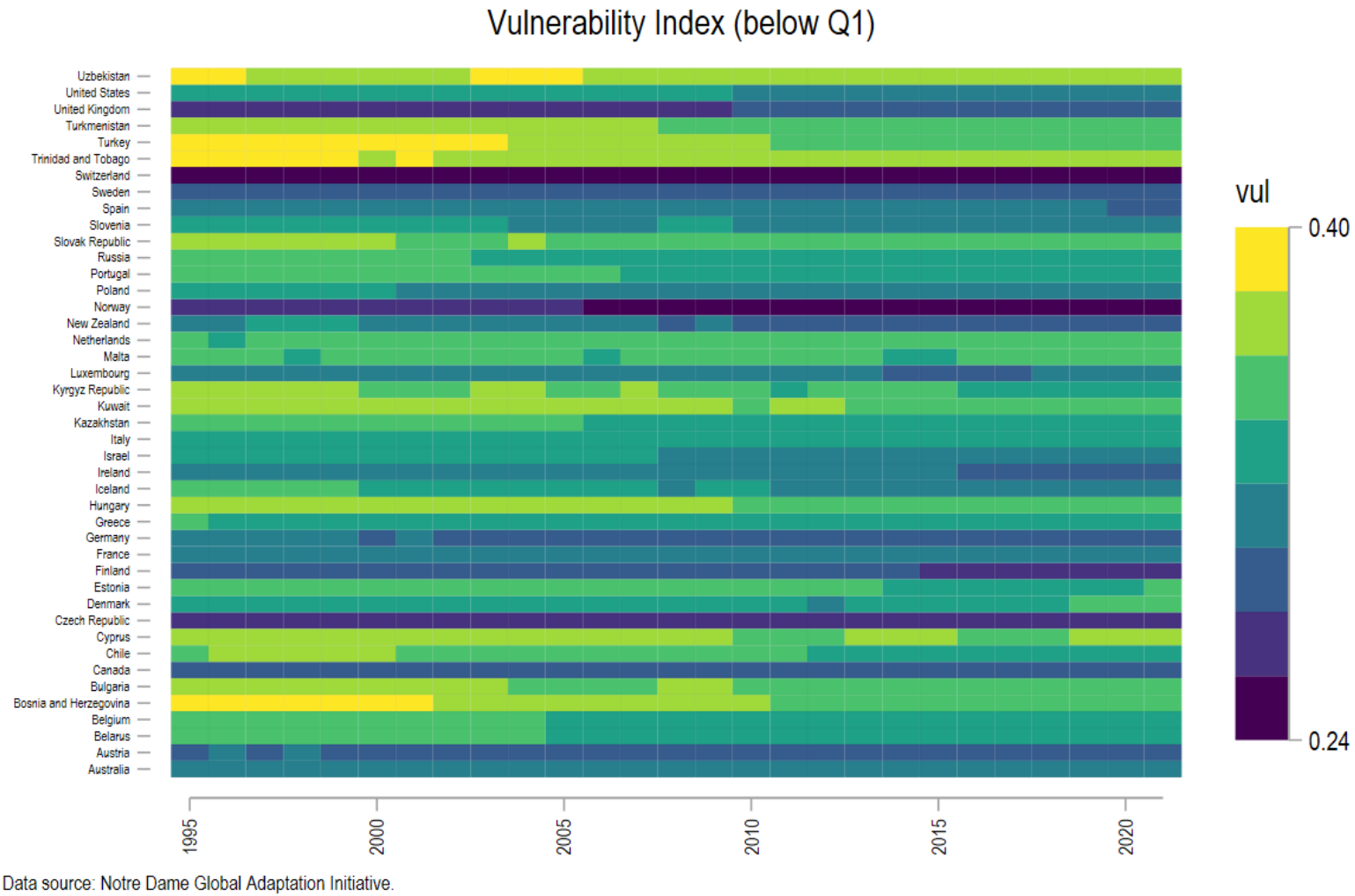
- **H1:** Climate risks adversely affect fiscal space (Higher bond Yields (climate risk premium) / Lower sovereign ratings);
- **H2:** Financial development is a mitigating factor for the climate risk premium: perception of better capacity to deal with transition and physical risks;
- **H3:** Political instability (Conflicts, **Religious tensions**) induces a perception of a lower capacity to deal with transition and physical risks

Preview of the results

- A unit increase in vulnerability causes an increase in bond yields between 0.5 and 1 percent and a maximum decrease of 1 for the sovereign ratings (S&P: 21 AAA, 20 AA+, . . . , 5 CCC+,. . .) at the horizon of 1 and 2 years;
- **Contribution 1:** Political stability reduces the adverse spillover effects of climate risks on fiscal space;
- **Contribution 2:** Financial development also weakens the link between climate risks and fiscal space;
- **Contribution 3:** Asymmetric effects in the sense that the most fiscally constrained economies are subject to the largest climate-related risk premia

Research question

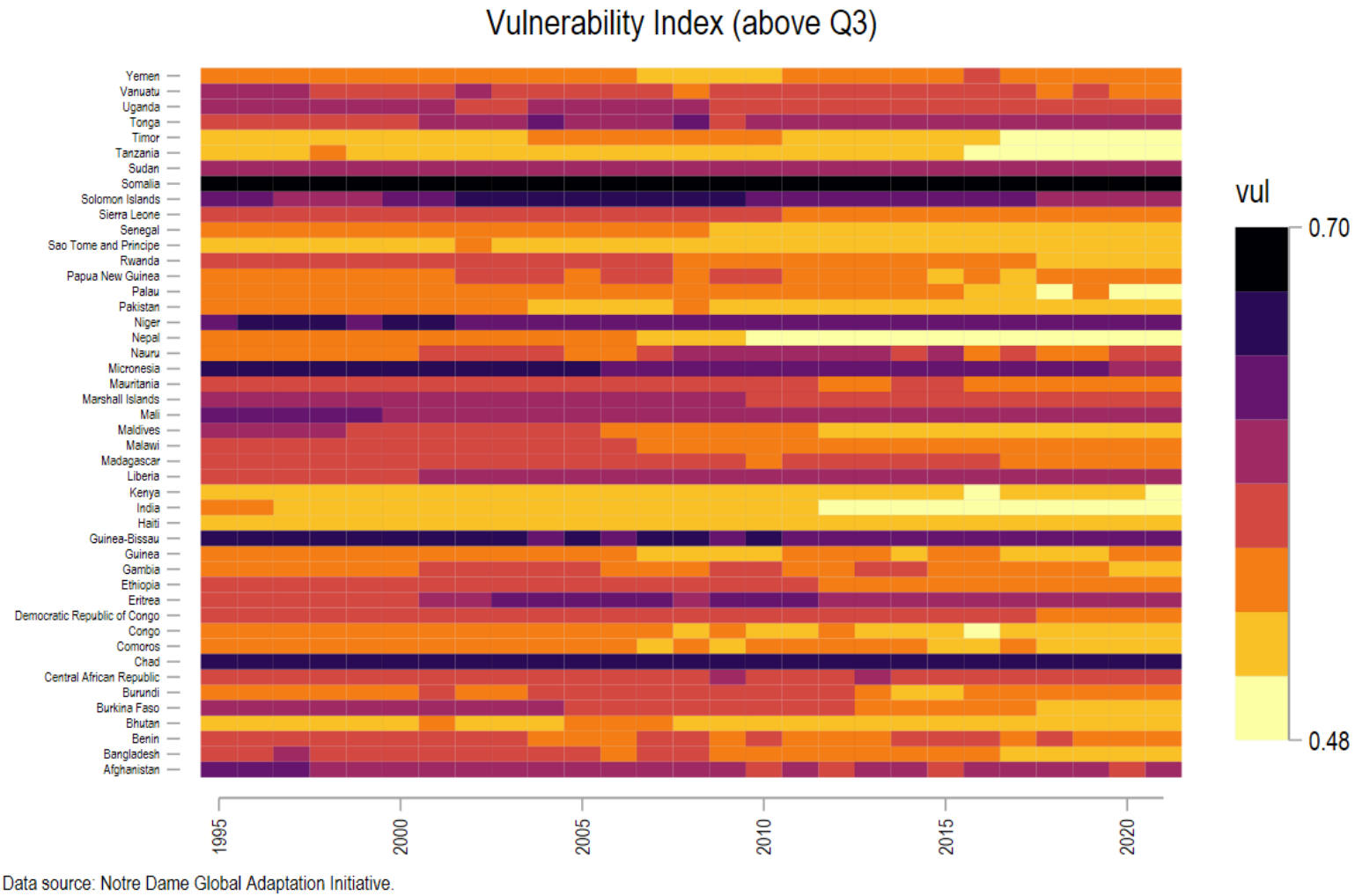
Figure 1. Heat plot for the low vulnerability score



Source: authors' calculations.

Research question

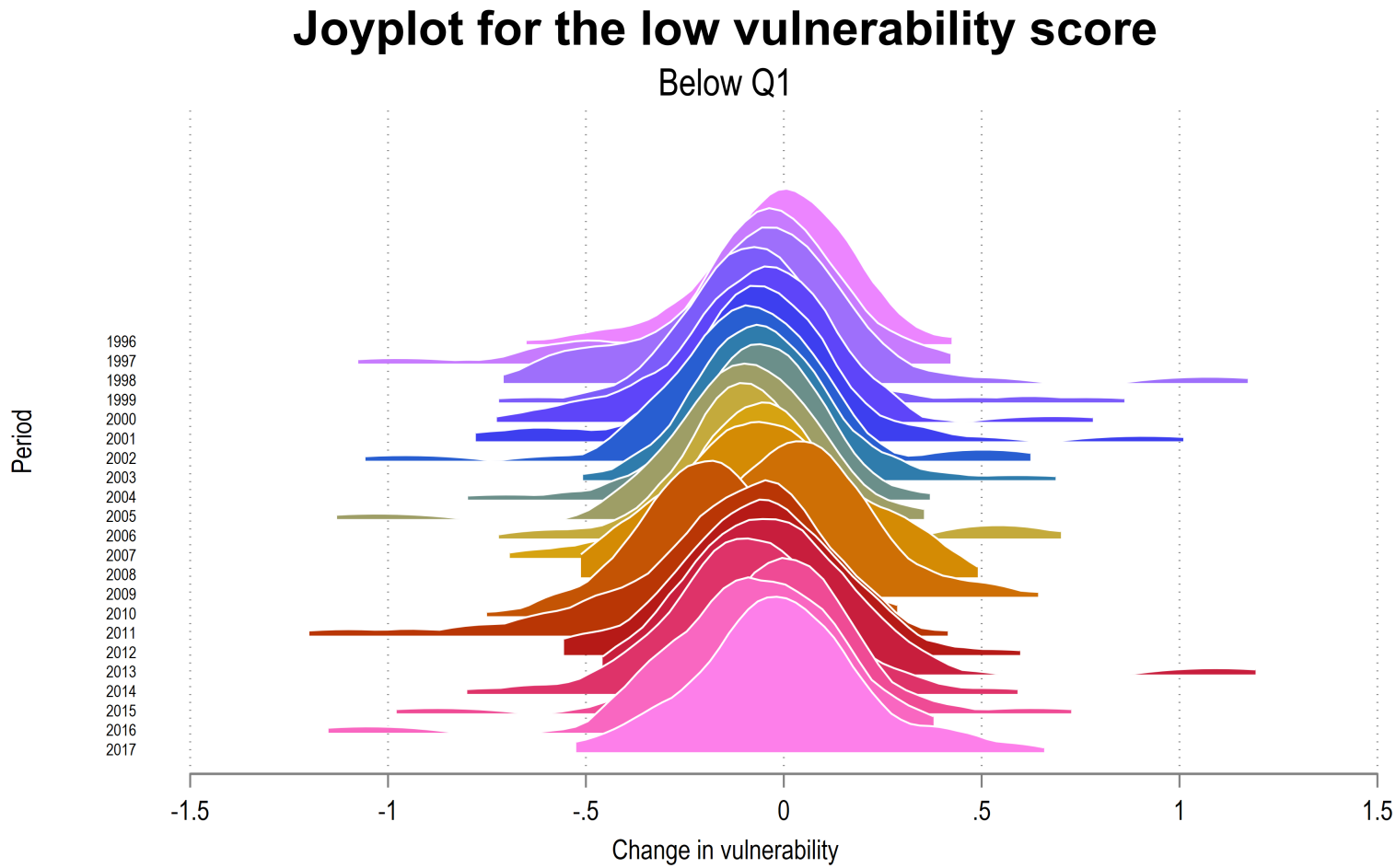
Figure 2. Heat plot for the high vulnerability score



Source: authors' calculations.

Research question

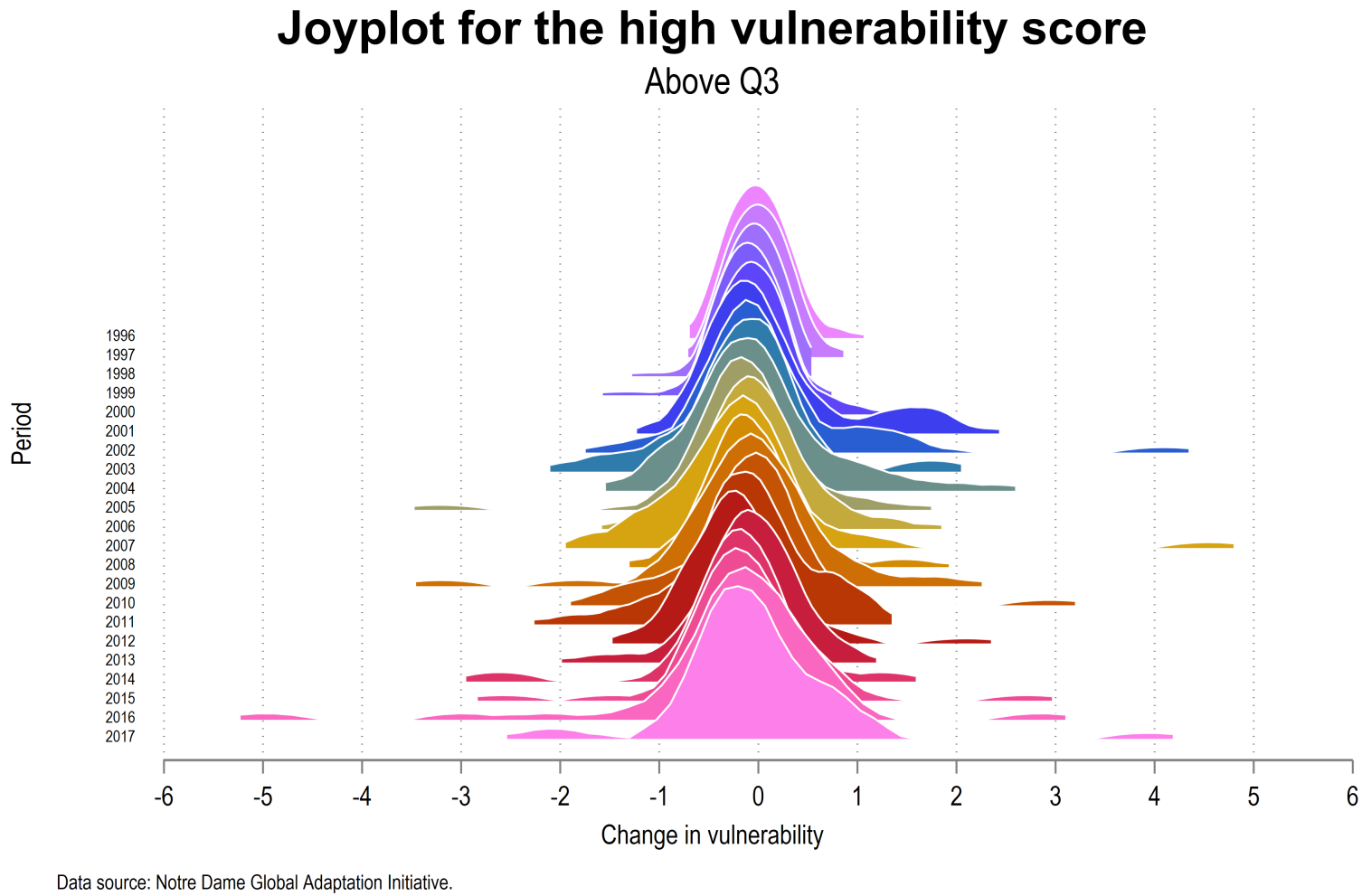
Figure 3. Changes in the vulnerability score



Source: authors' calculations.

Research question

Figure 4. Changes in the vulnerability score



Source: authors' calculations.

Research question

Table 1. Contemporaneous-correlation table

Variables	Variation in vulnerability score
Government bonds yields	-0.05
P-values	(0.04)
Nb. Obs.	2052
Foreign currency long-term sovereign debt ratings	0.09
P-values	(0.00)
Nb. Obs.	3007

Source: authors' calculations.

Research question

Table 2. Contemporaneous-correlation table

Variables	Variation in vulnerability score
Financial Institution index	0.04
P-value	(0.00)
Nb. Obs.	4576
Financial Market index	0.04
P-value	(0.01)
Nb. Obs.	4576
ICRG index - External Conflict	-0.02
P-value	(0.16)
Nb. Obs.	3489
ICRG index - Internal Conflict	0.01
P-value	(0.73)
Nb. Obs.	3489
ICRG index - Government Stability	-0.04
P-value	(0.03)
Nb. Obs.	3489
ICRG index - Law and Order	0.02
P-value	(0.32)
Nb. Obs.	3489
ICRG index - Ethnic Tensions	0.01
P-value	(0.71)
Nb. Obs.	3489
ICRG index - Religious Tensions	0.00
P-value	(0.85)
Nb. Obs.	3489

Source: authors' calculations.

Research question

Table 3. Reverse causality: Bond yields

Variables	Variation in vulnerability score
$Bonds_t$	0.01
	(0.34)
$Bonds_{t-1}$	-0.01
	(0.41)
$Bonds_{t-2}$	0.01
	(0.32)
$Bonds_{t-3}$	-0.01
	(0.22)
$Bonds_{t-4}$	0.00
	(0.73)
Constant	-0.09
	(0.13)
Observations	1,670
R-squared	0.02

Note: authors' calculations. P-values in parentheses. Country and time-FE included.

Research question

Table 4. Reverse causality: Sovereign ratings

Variables	Variation in vulnerability score
$Sovrate_t$	-0.01
	(0.25)
$Sovrate_{t-1}$	0.01
	(0.51)
$Sovrate_{t-2}$	-0.01
	(0.72)
$Sovrate_{t-3}$	0.02
	(0.16)
$Sovrate_{t-4}$	-0.01
	(0.27)
Constant	-0.11**
	(0.04)
Observations	2,632
R-squared	0.05

Note: authors' calculations. P-values in parentheses. Country and time-FE included.

Outline

Data and Methodology

Empirical approach

- Annual data from 1995 to 2021 for a sample of 199 countries, $n \times T = 199 \times 27 = 5373$ (maximum possible observations).
- Panel local projections, State-dependent local projections *à la* Ramey and Zubairy
  - The **shock** on the climate variables: Variation in ND-GAINS vulnerability scores; Variation in the first principal component in the less correlated dimensions in ND-GAINS vulnerability scores subcomponent;
  - The **response** of fiscal variables: Bonds yields on government bonds and Sovereign ratings on foreign currency long-term sovereign debt
  - **State-dependence/subsampling** along: Financial Development (FDI indexes, Svirydzenka, 2016); Political Stability (ICRG indexes for Political Risks);
- Baseline specification:

$$
\begin{aligned}
y_{i,t+h} &= b_h S_{i,t} + \gamma_h y_{i,t-1} + \alpha' z_{i,t-1} + v_{i,t+h} \\
\text{IRF}(h) &= \hat{b}_h, \quad h = 0, 1, ...
\end{aligned} \tag{1}
$$

- Impulse/Treatment variable, S: change in the vulnerability score; Response variable, y: bond yields or sovereign ratings

Empirical approach

- **Recent papers on the LP's / VAR's IRFs:**
- Lloyd and Manuel (2024): One-step (with appropriate controls) vs Two-step approach in the Local Projection approach (OVB)
- Olea Montiel, Plagborg-Møller, Qian and Wolf (2024): LP's are more robust to various form misspecification, while VARs are not (No free lunch for VARs: need to increase the lags to achieve correct coverage, and not necessary to get the lag length exactly right to achieve correct coverage in LPs)

Data and Methodology

Table 5. Descriptive statistics for the involved variables

Variables	Count	Mean	Q1	Median	Q3	SD	Min	Max
Climate risk vulnerability variable								
ND-GAIN overall vulnerability	4,784	0.442	0.372	0.43	0.517	0.0955	0.244	0.696
Fiscal space variables								
Government bonds, yields %	2,052	6.078	3.97	5.256	7.351	3.656	0.438	23.31
Sovereign debt ratings, index	3,300	12.36	8	11.87	16.67	5.181	1	21
Domestic controls								
Current Account Balance	4,510	-2.276	-7.167	-2.773	1.739	14.01	-148	311.7
Gov. Net Lending/Borrowing	4,859	-2.02	-4.613	-2.335	0.016	6.551	-59.74	125.1
General Gov. Gross Debt	4,694	55.83	29.48	46.25	69.83	44.59	0	600.1
CPI % year-on-year	3,607	0.501	0.132	0.291	0.592	0.843	-1.223	8.925
Banking crises dummy	4,356	0.012	0	0	0	0.109	0	1
Currency crises dummy	4,356	0.018	0	0	0	0.132	0	1
Debt crises dummy	4,356	0.006	0	0	0	0.079	0	1
Global controls								
MSCI World index	4,440	0.524	0.006	0.89	1.285	1.42	-4.297	3.184
US Government bonds, yields %	4,440	3.686	2.386	3.697	4.675	1.332	1.778	6.048
CBOE Volatility Index: VIX	5,373	20.48	15.48	19.66	25.6	5.903	11.09	32.7

Source: authors' calculations. Global controls are replaced by time fixed effects in the most recent version of the paper.

Table 6. Comparing fundamentals and institutional features for different levels of vulnerability

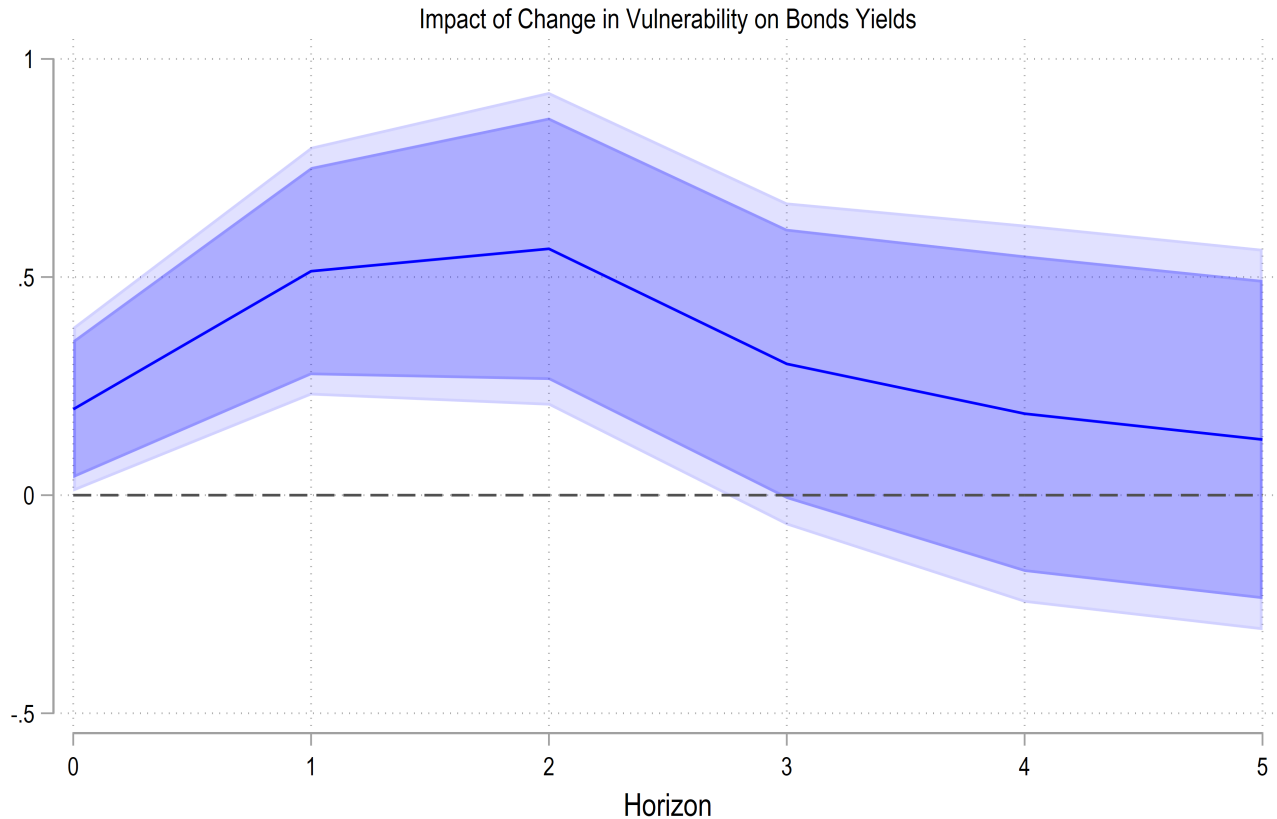
	VUL High (Above Q3 of VUL) 1,196 (25.0%)	**VUL Low (Below Q3 of VUL)** 3,588 (75.0%)	**Total** 4,784 (100.0%)	**Test**
ND-GAIN overall vulnerability	0.57 (0.04) 0.07	0.40 (0.06) 0.16	0.44 (0.10) 0.22	<0.001
Government bonds, yields %	7.67 (3.55) 0.46	5.93 (3.63) 0.61	6.08 (3.66) 0.60	<0.001
Treasury Bills, yields %	9.83 (6.34) 0.65	6.36 (6.03) 0.95	7.01 (6.24) 0.89	<0.001
Foreign currency sovereign debt ratings	7.30 (1.38) 0.19	12.64 (5.14) 0.41	12.23 (5.15) 0.42	<0.001
Chinn-Ito index, normalized	0.34 (0.32) 0.94	0.57 (0.37) 0.65	0.52 (0.37) 0.72	<0.001
Exchange Rate Stability Index	0.57 (0.28) 0.48	0.62 (0.31) 0.50	0.61 (0.31) 0.50	<0.001
Financial Institution index	0.18 (0.07) 0.41	0.45 (0.21) 0.48	0.38 (0.22) 0.57	<0.001
Financial Market index	0.03 (0.08) 2.48	0.26 (0.26) 1.03	0.20 (0.25) 1.24	<0.001
ICRG index: External Conflict	9.11 (1.64) 0.18	10.10 (1.32) 0.13	9.92 (1.44) 0.14	<0.001
ICRG index: Corruption	1.95 (0.78) 0.40	2.91 (1.22) 0.42	2.74 (1.21) 0.44	<0.001
ICRG index: Bureaucracy Quality	1.22 (0.81) 0.66	2.44 (1.03) 0.42	2.22 (1.10) 0.49	<0.001
ICRG index: Democratic Accountability	3.19 (1.32) 0.41	4.22 (1.65) 0.39	4.03 (1.64) 0.41	<0.001
ICRG index: Ethnic Tensions	3.08 (1.06) 0.34	4.24 (1.19) 0.28	4.03 (1.25) 0.31	<0.001
ICRG index: Government Stability	8.09 (1.66) 0.21	8.17 (1.58) 0.19	8.16 (1.60) 0.20	0.258
ICRG index: Internal Conflict	7.76 (1.62) 0.21	9.48 (1.64) 0.17	9.17 (1.76) 0.19	<0.001
ICRG index: Law and Order	2.80 (0.98) 0.35	3.98 (1.29) 0.32	3.77 (1.32) 0.35	<0.001
ICRG index: Military in Politics	2.08 (1.32) 0.64	4.24 (1.56) 0.37	3.85 (1.73) 0.45	<0.001
ICRG index: Religious Tensions	3.67 (1.34) 0.36	4.78 (1.21) 0.25	4.58 (1.30) 0.28	<0.001
ICRG index: Socioeconomic Conditions	3.23 (1.38) 0.43	6.22 (2.28) 0.37	5.68 (2.43) 0.43	<0.001
ICRG index: Investment Profile	6.68 (1.77) 0.27	8.65 (2.11) 0.24	8.30 (2.19) 0.26	<0.001

Source: authors' calculations.

Outline

Results

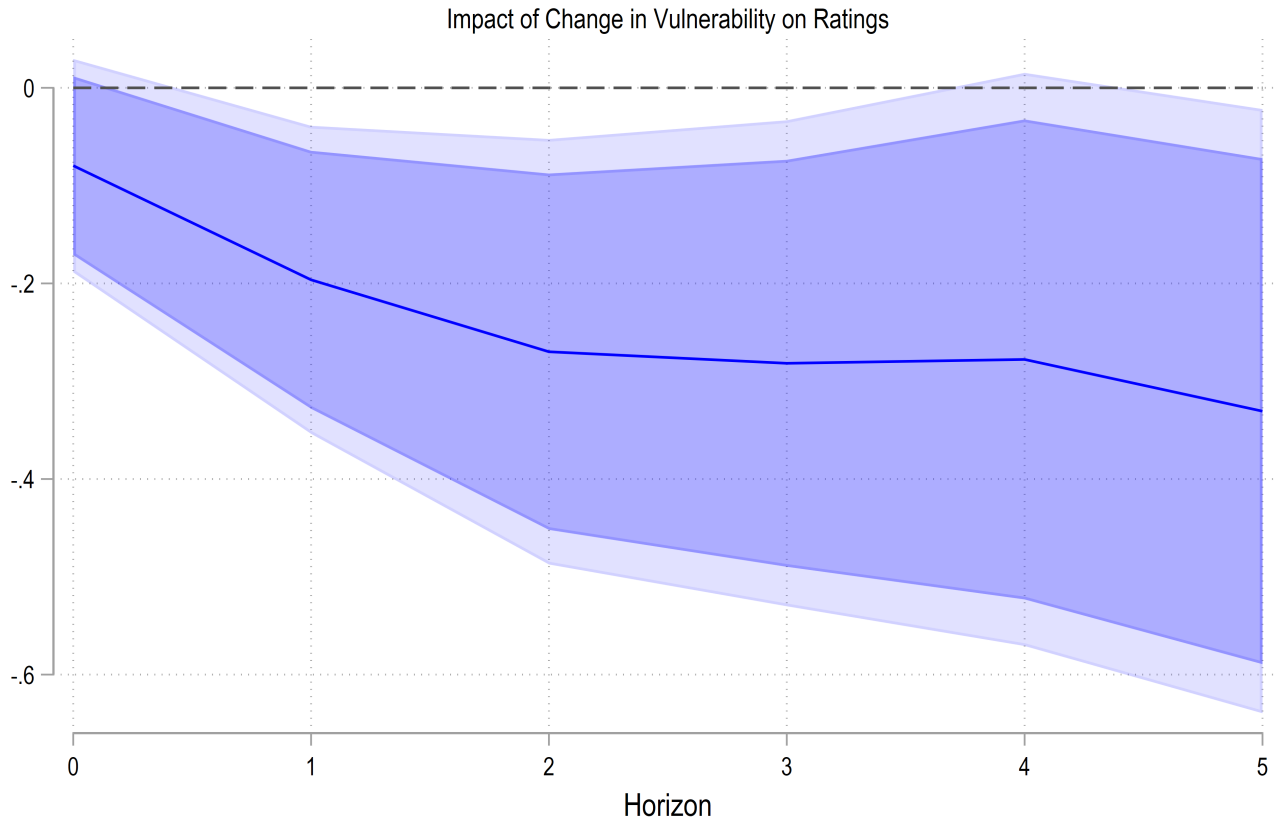
Figure 5. Panel LP for the bond yields (No control)



Note: authors' calculations. The shock is a change in vulnerability. Country and time FE are included, and standard errors are obtained through bootstrapping. Light/dark blue confidence intervals are 95/90% level confidence intervals. We include the future climate risk shocks up to 5 years and no controls. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results

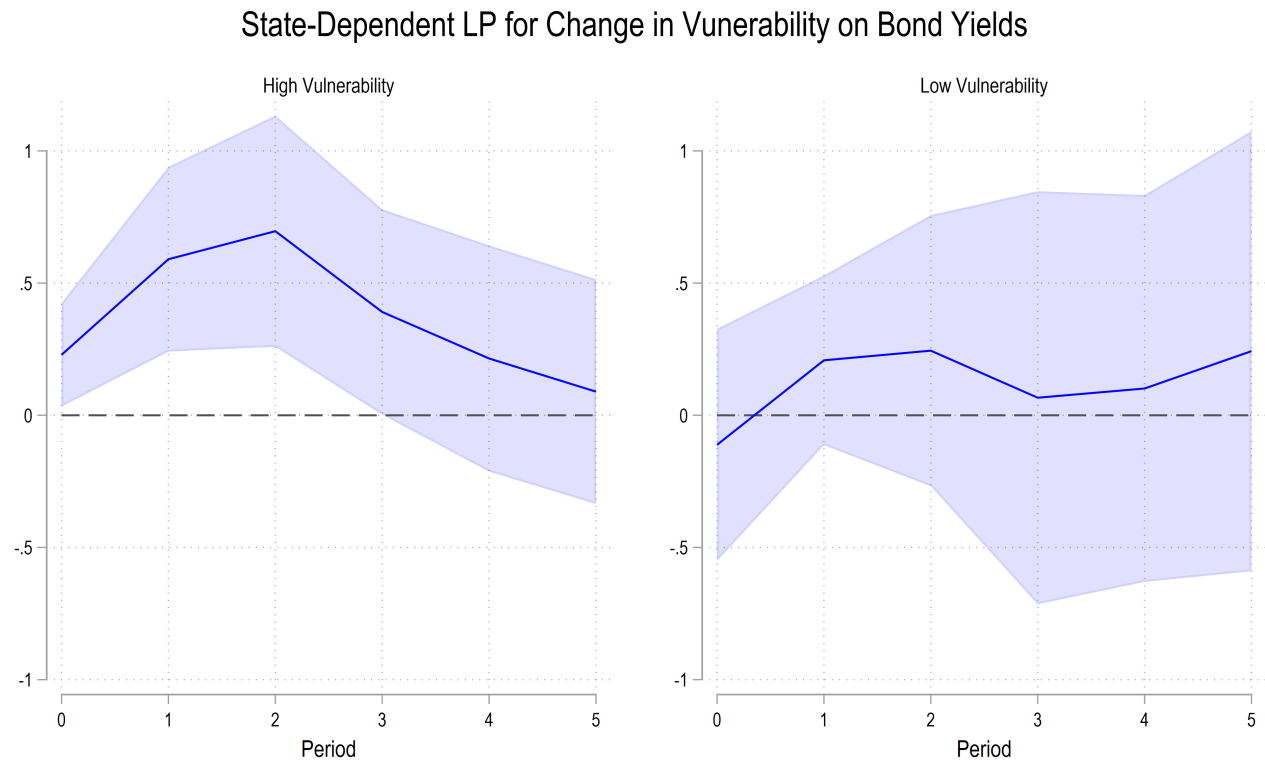
Figure 6. Panel LP for the sovereign ratings (No control)



Note: authors' calculations. The shock is a change in vulnerability. Country and time FE are included, and standard errors are obtained through bootstrapping. Light/dark blue confidence intervals are 95/90% level confidence intervals. We include the future climate risk shocks up to 5 years and no controls. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results

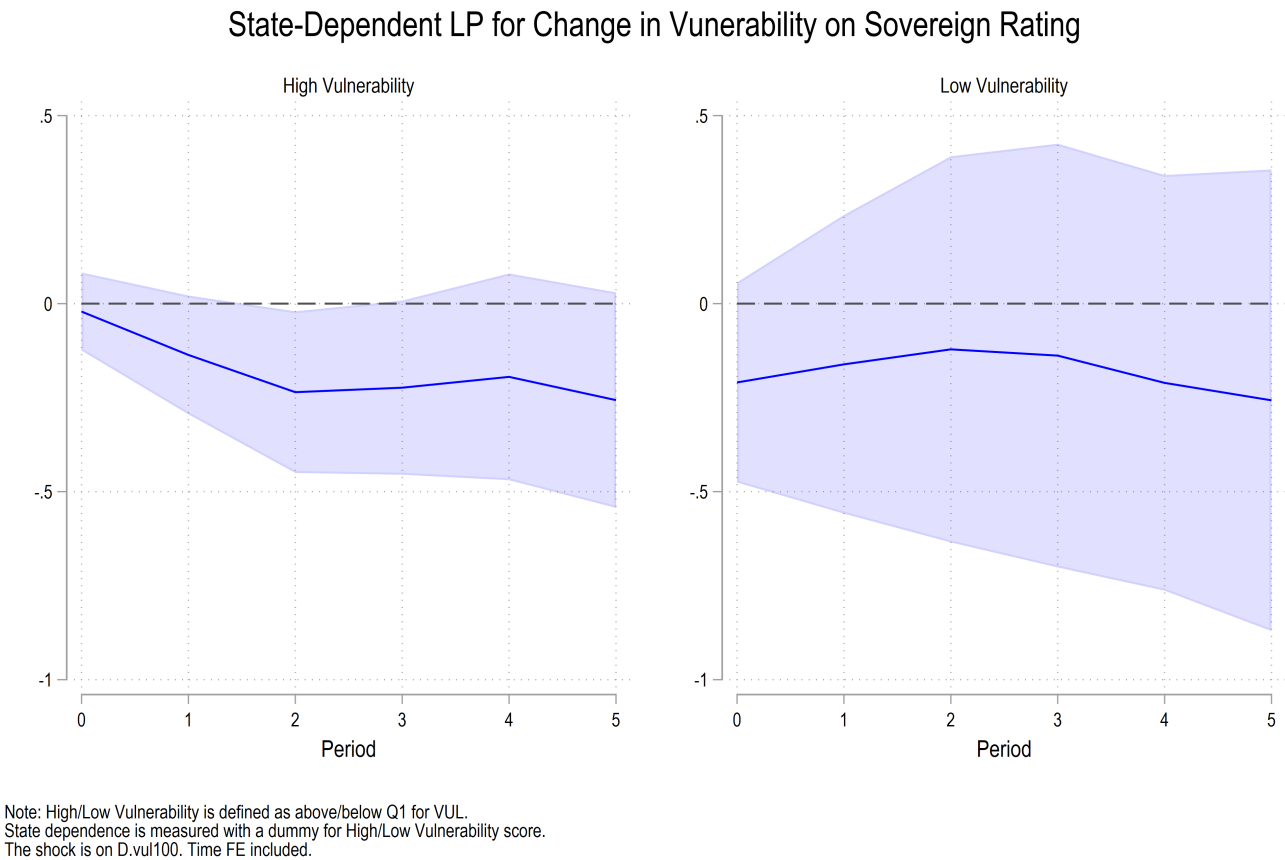
Figure 7. Panel State-dependent LP for the bond yields (Vulnerability - Threshold Q1)



Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 95% Confidence Intervals in light blue. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results

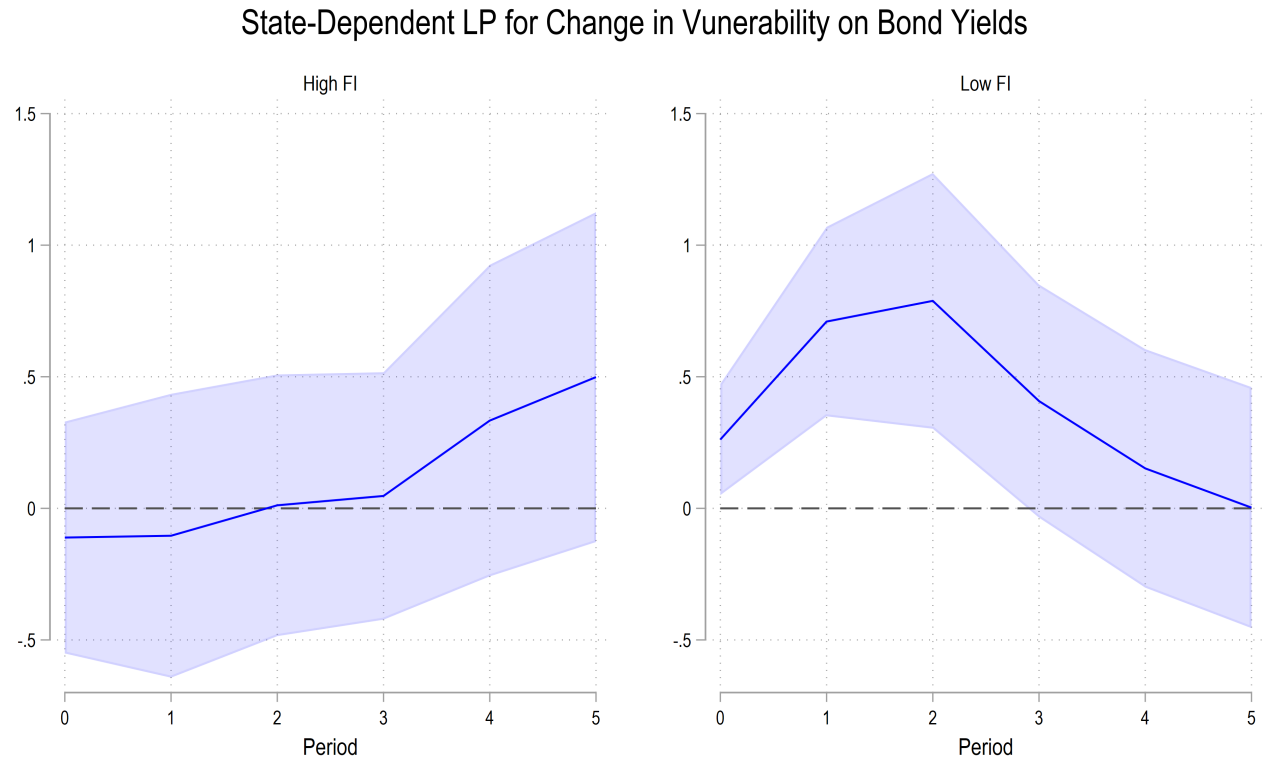
Figure 8. Panel State-dependent LP for the sovereign ratings (Vulnerability - Threshold Q1)



Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 95% Confidence Intervals in light blue. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results

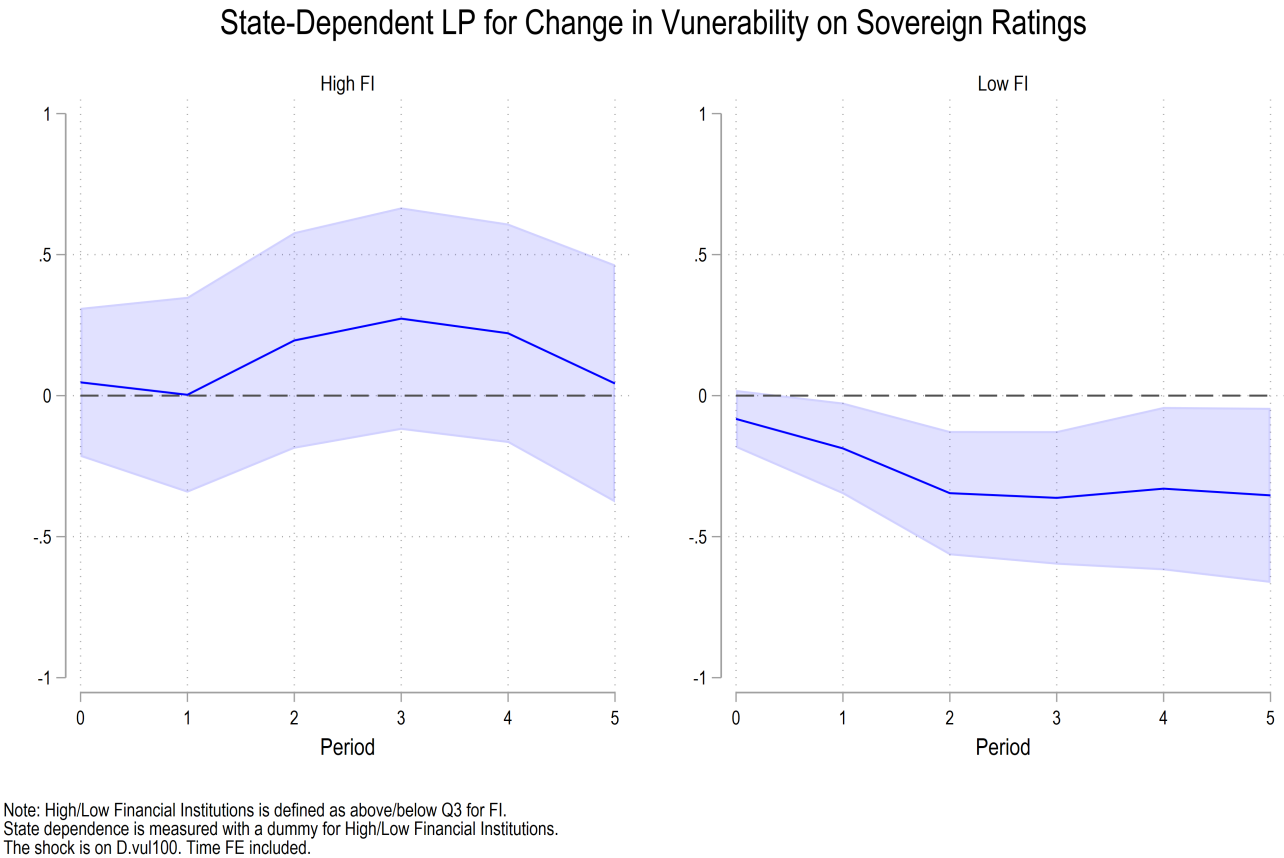
Figure 9. Panel State-dependent LP for the bond yields (Financial Institutions - Threshold Q3)



Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 95% Confidence Intervals in light blue. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results

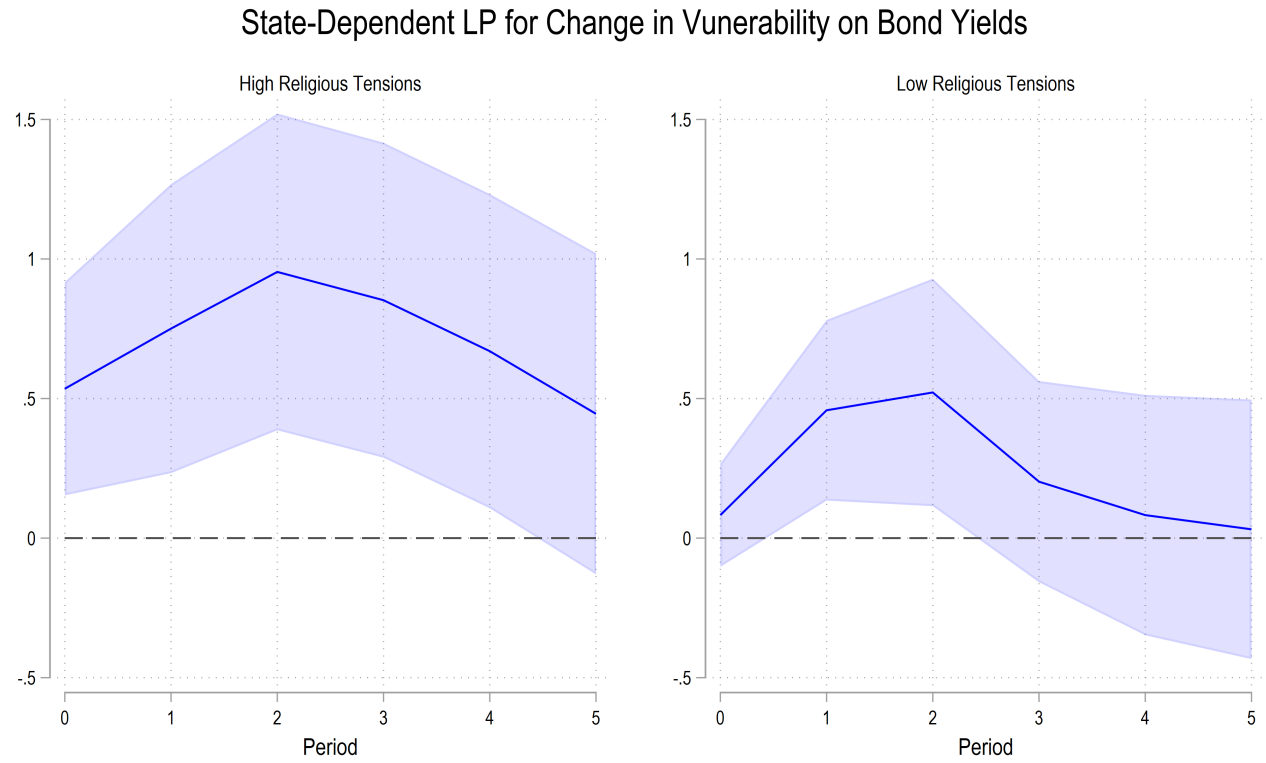
Figure 10. Panel State-dependent LP for the sovereign ratings (Financial Institutions - Threshold Q3)



Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 95% Confidence Intervals in light blue. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results

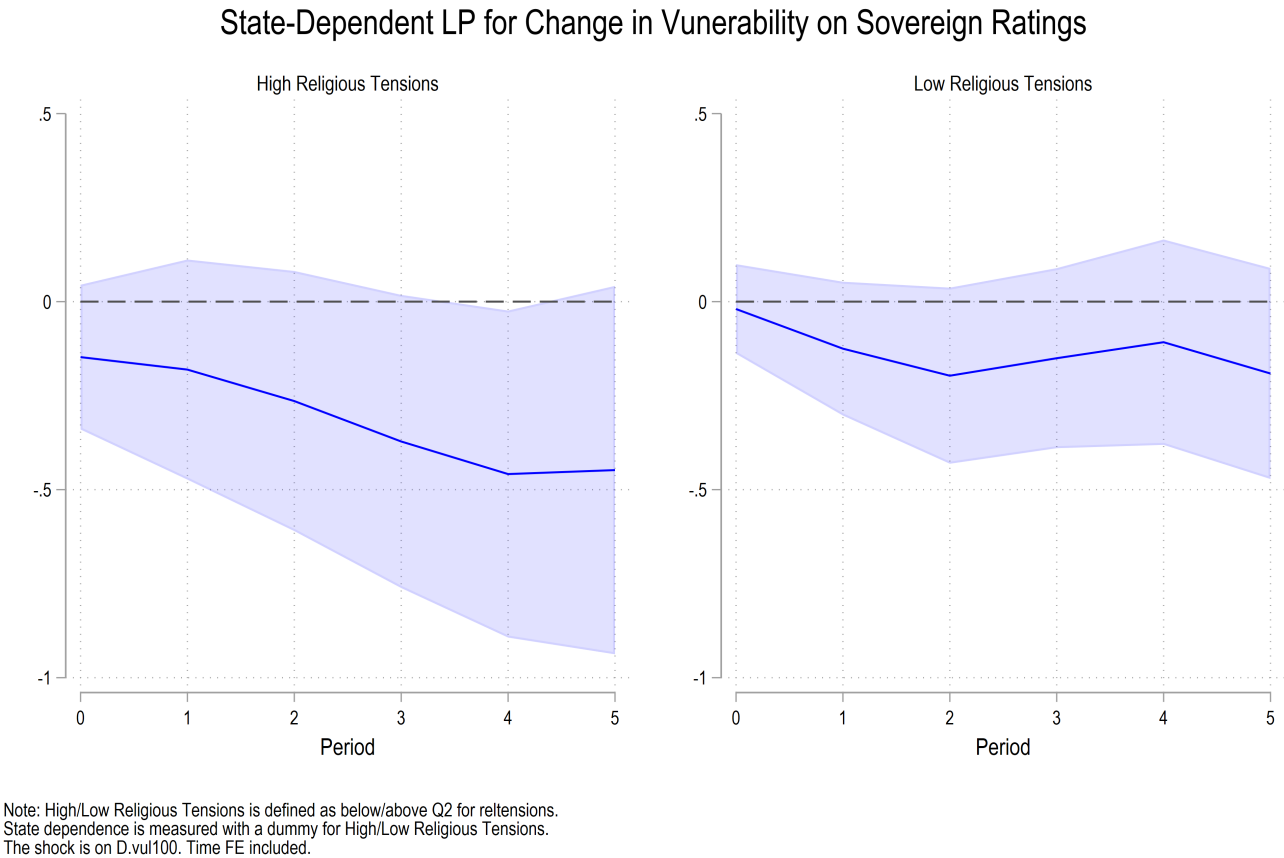
Figure 11. Panel State-dependent LP for the bond yields (Religious Tensions - Threshold Q2)



Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 95% Confidence Intervals in light blue. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results

Figure 12. Panel State-dependent LP for the sovereign ratings (Religious Tensions - Threshold Q2)

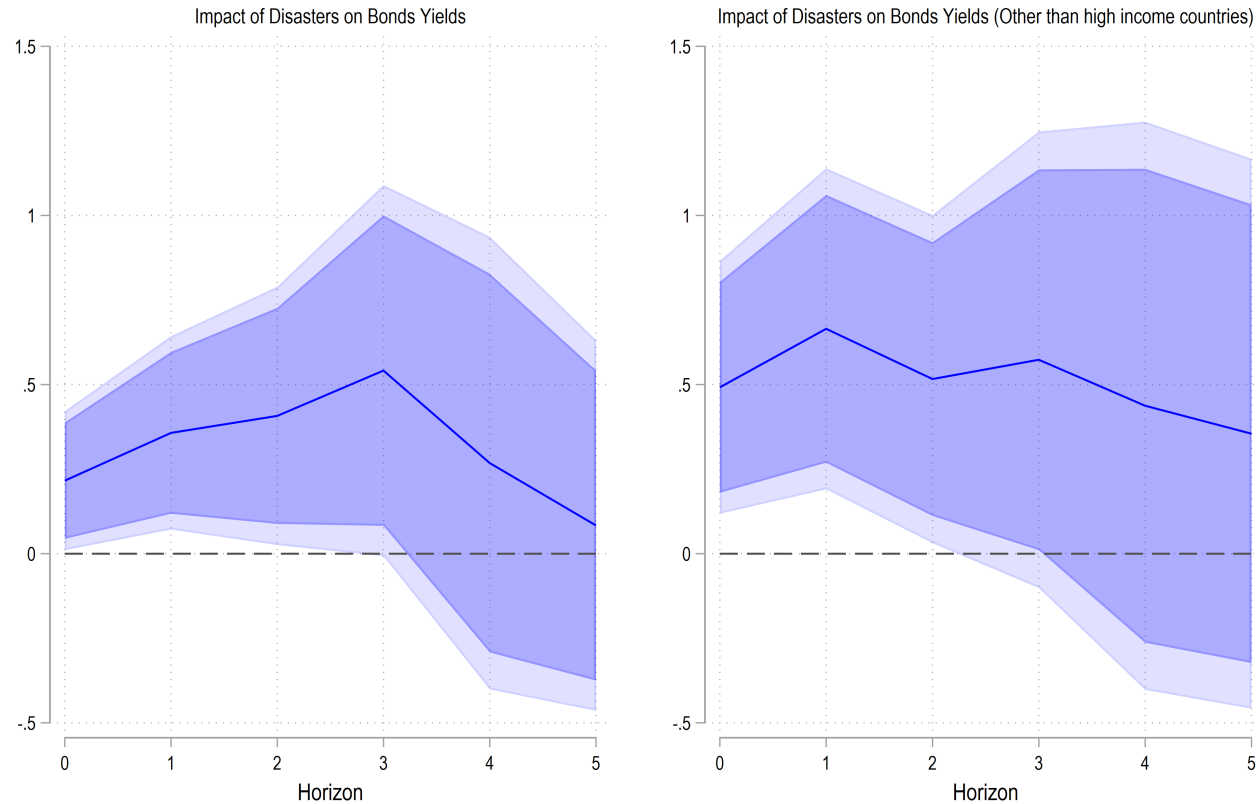


Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 95% Confidence Intervals in light blue. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), and no controls.

Results - Robustness

- We use the EM-DAT database to analyze how 630 major natural disasters from 1995 to 2019 affect bond yields. Following Klomp (2015), we create a dummy variable for these disasters, defined as: "investors view natural disasters as shocks that undermine government debt sustainability, potentially causing sovereign default." In the local projection exercise, we add the forward shocks up to seven years following the correction of Teulings and Zubanov, and to consider that large-scale natural disasters are rare events. If we exclude the high-income countries group, the effect of large-scale natural disasters generates a stronger premium.

Figure 13. Panel State-dependent LP for the bond yields (Natural disasters)



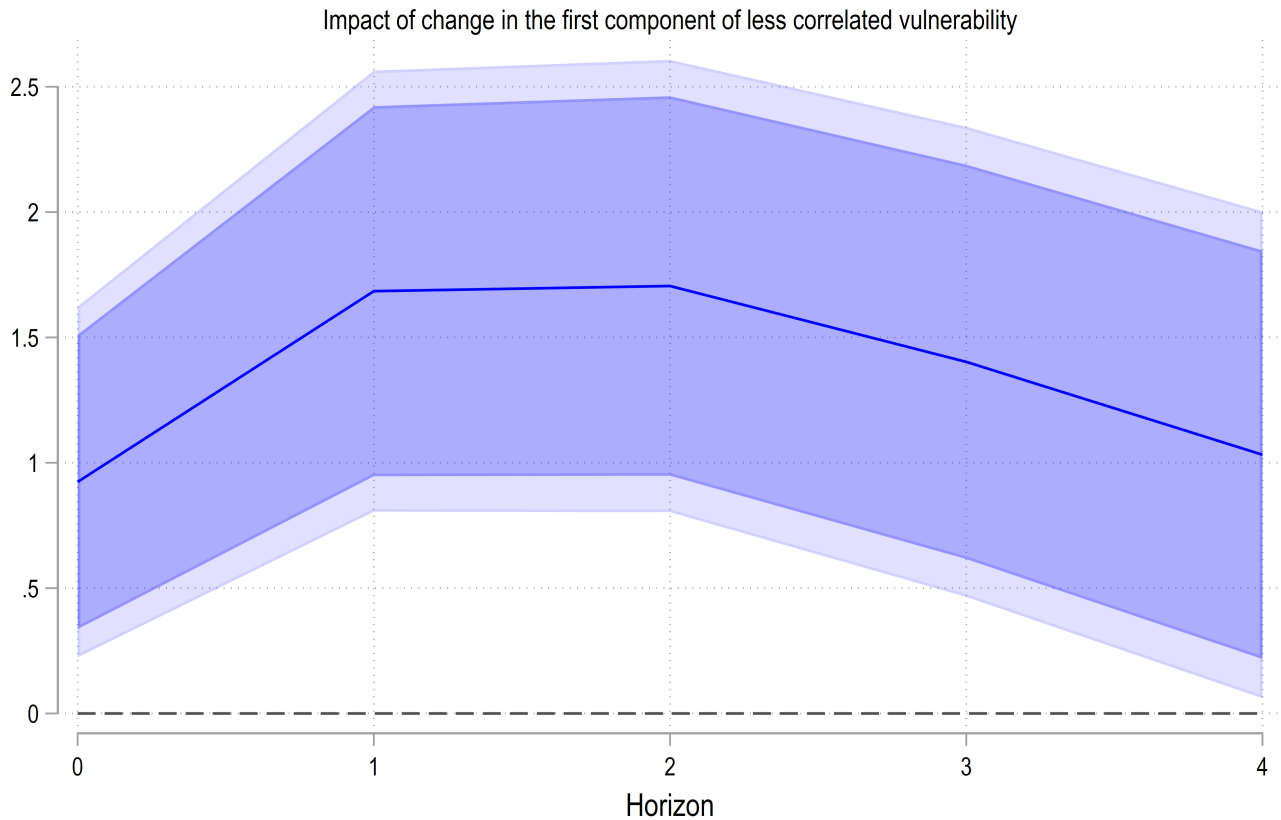
Note: Authors' calculations. Note: authors' calculations. The shock is a unit change in the vulnerability variable. 95% confidence intervals in gray. Country groups are defined according to the World Bank's classification.

Results - Endogeneity

- Following Kling et al. (2021), we collected the data for the least correlated dimensions of the ND-GAINS score with macroeconomic variables;
- 7 dimensions out 36 that displayed moderate correlation with macroeconomic variables **and** that are not time-invariant:
  - FOOD_03: food import dependency;
  - WATE_03: fresh water withdrawal rate;
  - ECOS_04: ecological footprint;
  - ECOS_05: protected biome;
  - ECOS_06: engagement in international environmental conventions;
  - INFR_03: dependency on imported energy;
  - INFR_04: population living under 5m above sea level.
- Principal component analysis with 3 components.
- We use, as the shock, the change in the first component (VUL_N).
- VUL_N is correlated at 82 percent with the vulnerability score and less correlated with economic outcomes.

Results - Endogeneity

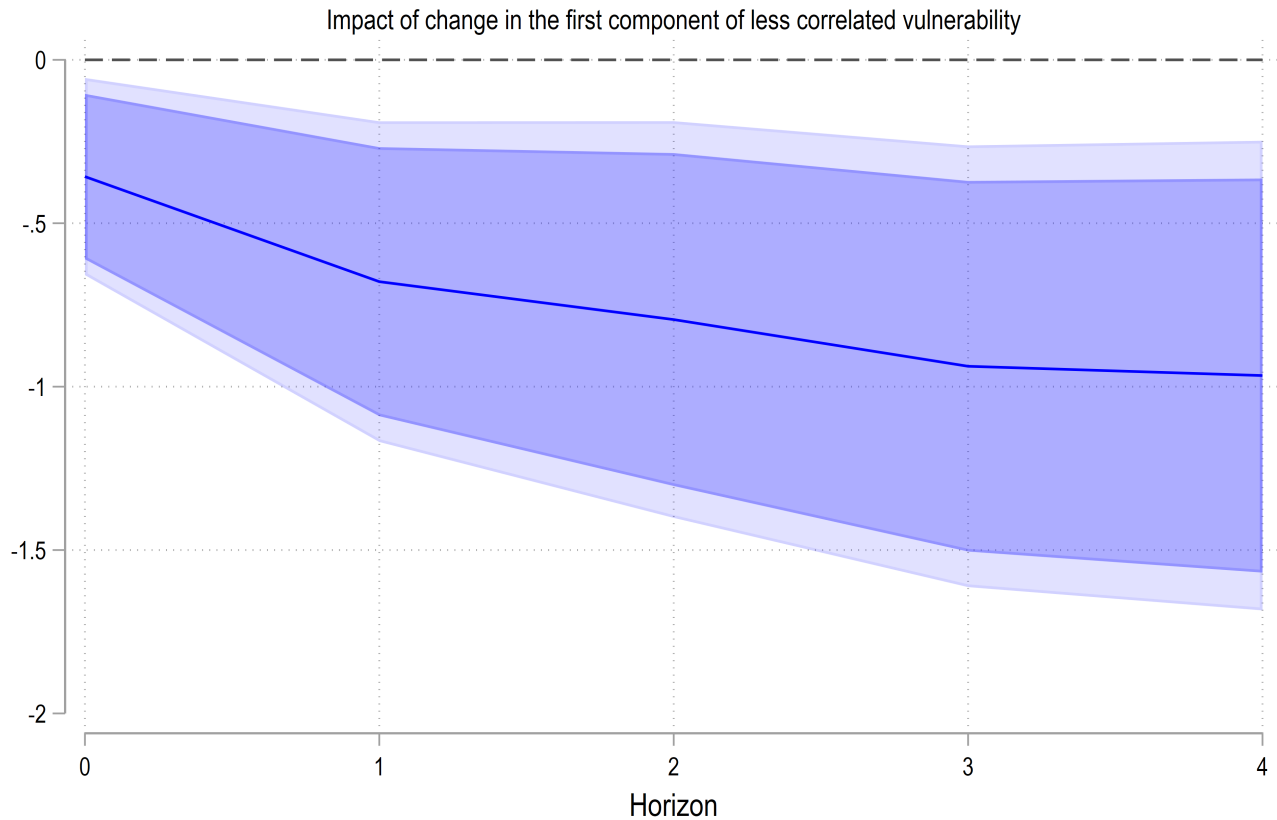
Figure 14. Panel LP for the bond yields (change in VUL_N)



Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 90 and 95% Confidence Intervals in dark and light blue, respectively. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), with controls.

Results - Endogeneity

Figure 15. Panel LP for the sovereign ratings (change in VUL_N)



Note: Authors' calculations. The shock is a unit-shock on the change in vulnerability variable. Country and time fixed effects are included, and standard errors are clustered at the country level. 90 and 95% Confidence Intervals in dark and light blue, respectively. We include the future climate risk shocks up to 5 years, following Teulings and Zubanov (2014), with controls.

Final thoughts

Key takeaways

- Negative spillovers of exposure to climate change on fiscal space are most pronounced for economies most vulnerable to climate change
- Effects are mitigated in countries with more stable political environments and better developed financial markets
- ***Religious tensions are the most powerful component of political risks in shaping the (negative) financial market perceptions.***
- A unit-increase in vulnerability causes an increase in bond yields between 0.5 and 1 percent and a maximum decrease of 1 for the sovereign ratings (S&P: 21 AAA, 20 AA+, . . . , 5 CCC+,. . .) at the horizon of 1 and 2 years;
- While fiscal consolidation is the key to mitigating the adverse effect of climate risks on fiscal space, our results suggest that both political stability and financial development can contribute as well