1 (2025) 100026

Contents lists available at ScienceDirect

Finance Research Open

journal homepage: www.sciencedirect.com/journal/finance-research-open

What is the impact of natural disasters on sovereign risk? Expect the unexpected!

Luca Agnello [a,*], Vítor Castro [b], Ricardo M. Sousa [c], Shawkat Hammoudeh [d]

[a] University of Palermo, Department of Economics, Business and Statistics (SEAS), Viale delle Scienze, 90128 Palermo, Italy
[b] Loughborough University, Loughborough Business School, Loughborough, Leicestershire LE11 3TU, United Kingdom; University of Minho, Centre for Research in Economics and Management (NIPE), Campus of Gualtar, 4710-057, Braga, Portugal
[c] University of Minho, Department of Economics and Centre for Research in Economics and Management (NIPE), Campus of Gualtar, 4710-057 - Braga, Portugal; London School of Economics and Political Science, LSE Alumni Association, Houghton Street, London WC2 2AE, United Kingdom
[d] Drexel University, LeBow College of Business, 3141 - Chestnut Street, Philadelphia, PA 19104, USA

ARTICLE INFO

JEL classification:
Q54
H30
H60

Keywords:
Natural disasters
Credit default swaps
Sovereign risk
Local projections
Spillovers
Expectations

ABSTRACT

Using a rich high-frequency and a cross-country panel of daily sovereign CDS spreads, we employ local projections to estimate the dynamic response of sovereign risk to the occurrence of natural disasters. We find that climatological and, to a lesser extent, hydrological events have a small and short-lived effect on the sovereign CDS spreads. We also explore whether anticipatory effects arise before a disaster unfolds, and confirm that the expectations of imminent disasters do not substantially affect CDS pricing. On the other hand, we show that the sovereign risk is dominated by regional and global financial spillovers, thus reflecting the systemic nature of the sovereign credit markets. Our results also suggest that governments may benefit from developing disaster-specific risk reduction and fiscal resilience strategies, as well as early-warning models that integrate disaster forecasting into risk monitoring frameworks. Sovereigns' coordination and risk-pooling mechanisms may also be essential in times of regional calamities. Moreover, portfolio hedging strategies should include short-term protective positions in the vulnerable sovereigns during known disaster seasons. Disaster-integrated ESG strategies could also enhance the portfolio resilience.

1. Introduction

In the current financial landscape that is characterized by a growing awareness of climate-related risks and an increasingly interlinked global financial system, assessing the effect of natural disasters on sovereign risk has never been more crucial. Indeed, markets are expected to internalize the risks posed by environmental shocks, as natural disasters become more frequent and severe due to climate change. Wars and climatic disasters are likened to unexpected macroeconomic and financial shocks, which can reduce productivity, damage infrastructure, and hinder economic growth that would, eventually, worsen fiscal deficits, increase public debt levels and cause sovereign defaults. Yet, the evidence on how sovereign credit markets, especially the CDS segment, react to such events remains limited. This is even more surprising given the real-time and forward-looking nature of sovereign CDS spreads as sovereign risk and default probability benchmarks.[1]

Against this backdrop, our study examines the impact of natural disasters on sovereign CDS spreads, using high-frequency and cross-sectional data and a flexible data-driven econometric strategy. Specifically, we start by building a novel daily panel data of sovereign CDS spreads, comprising nearly 250,000 observations from Markit, and merge it with detailed natural disaster information sourced from the Emergency Events Database (EM-DAT).

This identification strategy leverages the exogeneity of natural disasters, by defining dummy variables that capture their occurrences and estimating their effects, using local projections *à la* Jordà (2005). This approach enables us to trace the trajectory of sovereign CDS spreads over different time 'post-disaster' horizons, while controlling for

* Corresponding author.
E-mail addresses: luca.agnello01@unipa.it (L. Agnello), V.M.Q.Castro@lboro.ac.uk (V. Castro), rjsousa@eeg.uminho.pt, rjsousa@alumni.lse.ac.uk (R.M. Sousa), hammousm@drexel.edu (S. Hammoudeh).

[1] Vítor Castro and Ricardo Sousa also acknowledge financial support from the FCT. NIPE's work is financed by National Funds of the FCT – Portuguese Foundation for Science and Technology within the project "UIDB/03182/2020; UIDP/03182/2020".

https://doi.org/10.1016/j.finr.2025.100026
Received 2 June 2025; Received in revised form 13 June 2025; Accepted 16 June 2025
Available online 20 June 2025

regional and global financial spillovers and default episodes.

From an empirical point of view, we find that natural disasters in aggregate have only short-lived and small effects on the sovereign CDS spreads. However, when disaggregating by typology, climatological and hydrological disasters, it can lead to statistically significant increases in spreads, albeit with modest magnitudes that dissipate within a couple of days. The results are robust across alternative specifications, particularly, those where the disaster dummy is redefined to capture the effect of anticipatory expectations.

More strikingly, we show that changes in the regional and global CDS spreads exhibit far more persistent and quantitatively larger effects on the individual countries' CDS spreads, thus, underscoring the importance of financial contagion and global sentiment in driving sovereign risk pricing. Our (cumulative) impulse-response functions reveal that these spillovers dominate the impact of domestic natural disasters, at least, in the short-to-medium term.

This research contributes to the emerging field at the intersection of environmental economics and sovereign risk, therefore, expanding our understanding of how natural hazards shape financial risk perceptions. By using a flexible, and transparent estimation method and daily frequency data, we provide new insights for market participants and policy institutions.

The rest of the paper is organised as follows. Section 2 discusses the related literature. Section 3 presents the econometric methodology. Section 4 describes the data, while Section 5 summarises the empirical results. Finally, Section 6 concludes.

2. Literature review

The relationship between natural disasters and sovereign creditworthiness has gained increasing attention as climate risks become more systemic. Although the macroeconomic effects of natural disasters have been thoroughly examined (e.g., Noy, 2009; Cavallo & Noy, 2011), their influence on sovereign financial instruments, such as credit default swaps (CDS), is less explored. Thus, we contribute to the growing literature investigating the transmission of environmental shocks to sovereign risk metrics.

Several economic studies acknowledge the economic consequences of disasters, but often neglect their market-level financial effects. Strobl (2011), for example, finds that hurricanes reduce economic growth in the U.S. costal counties, especially because rich individuals move away from the affected regions. Meanwhile, Kousky (2014) underscores the broad fiscal burden of disasters, including higher public debt and lower tax revenues, potentially affecting investors' perceptions of sovereign default risk. Along the same line, Mallucci (2022) shows that severe hurricanes in the Caribbean region have led to higher sovereign borrowing costs and public debt-to-GDP ratios. More recently, Alalmaee (2024) argues that natural disasters can generate financial instability, especially in middle- and low-income sovereigns.

In the context of sovereign CDS markets, Augustin (2018) and Fontana and Scheicher (2016) highlight the role of CDS spreads as forward-looking and high-frequency indicators of default risk. Their sensitivity to global financial conditions and country-specific shocks makes them particularly well-suited for capturing the impact of rare, albeit impactful events, such as natural disasters. Empirical works, such as Arezki et al. (2011), also show how exogenous shocks, including resource price volatility, affect CDS markets. Cheng and Chang (2025) use a fixed-effects estimator and annual data to assess how rare disaster shocks affect sovereign defaults in developing countries. The authors emphasize that the sovereign default risk, as proxied by CDS spreads, increases in response to natural disasters, due to higher government spending and external debt service payments. However, these effects can be mitigated by the depreciation of the local currency-denominated external debt.

Although natural disasters can be considered exogenous events, the financial market responses to them may not be uniform. For instance, Nguyen et al. (2025) find that while disaster shocks can cause short-term disruptions in the financial markets, the extent of the persistence of these effects might depend on the country's institutional resilience and fiscal space. Additionally, Kahn (2005) demonstrate that in countries with weak institutions, even moderate disasters can produce significant risk repricing. Using a sample of natural disasters in European Union (EU) countries, Di Tommaso et al. (2023) also note that these rare events that lead to: *(i)* higher sovereign CDS spreads that, nevertheless, vary substantially across regions; (ii) more regional inequality, given the higher sovereign borrowing costs and reduced fiscal space across member states; and *(iii)* cross-border propagation of sovereign risk.

Concerning market-based risk pricing, the literature remains sparse on disaster typology. Yet, since typology matters, Pagnottoni et al. (2022) argue that biological (e.g., exposure to mold, venom or vector-borne diseases) and climatological events (e.g., heatwaves, cold spells, heavy precipitation, droughts and wildfires) have more powerful financial consequences compared to other natural disasters , because of their potential link to systemic climate risk. Furthermore, Andries et al. (2025) suggest that the climatological events carry informational content about the long-term climate adaptation risks, which affect bank lending and produce systemic risk spillovers, thus, being priced in sovereign debt markets.

The dynamic dimension of disaster-induced financial shocks is also key for understanding how sovereign risk evolves in response to natural disasters. Studies applying the impulse-response analyses, such as Jordà (2005), suggest that local projections are especially useful in understanding how shocks propagate over time. While this approach has been used to study monetary and fiscal policy shocks and a panoply of empirical applications, its use in the context of disaster-driven sovereign risk is completely novel. By tracking CDS spread changes following natural disaster shocks, we can estimate both immediate market reactions and their persistence over time.

Our work also relates to the research on financial contagion. Longstaff et al. (2011) show that sovereign risk is significantly affected by global and regional factors. Specifically, sovereign CDS spreads co-move across borders, suggesting that investors react to both domestic fundamentals and broader regional and global financial conditions.

Finally, energy and environmental economics studies have also started to integrate financial metrics. For example, in a rare intersectional analysis, Cevik and Jalles (2022) find that countries more exposed and less resilient to climate risk tend to have higher sovereign borrowing costs. Although this line of investigation is still in its early stages, it underscores the financial relevance of climate-related and natural disaster shocks.

Summing up, while macroeconomic studies have long established the economic cost of natural disasters, their translation into sovereign risk, especially using high-frequency market data, remains insipient. Thus, our paper aims to bridge this gap by using local projections to isolate the causal effect of natural disaster typologies on sovereign CDS spreads, while controlling for regional and global risk spillovers.

3. Econometric methodology

We evaluate the dynamic impact of natural disasters on sovereign CDS spreads by following Jordà (2005) and estimating, for each daily horizon h (with $h = 1, 2, \ldots, H + 1$), a panel local linear projection regression that can be written as:

$$\Delta CDS_{i,t+h-1} = \alpha_i^h + \tau_t^h + \beta^h \Delta CDS_{i,t-1} + \theta^h disaster_{i,t} + \Gamma^h X_{i,t} + \mu_{i,t+h-1}, \tag{1}$$

where the $\Delta CDS_{i,t}$ denotes the daily change in the sovereign CDS spread in basis points (henceforth, bps), and $disaster_{i,t}$ is a dummy variable that takes the value of one if, at least, a specific natural disaster occurs at the date t, and zero, otherwise.[2] $X_{i,t}$ is a vector of controls that includes: *(i)* a dummy variable that accounts for sovereign (selective) default announcements (*sp_sd*); and *(ii)* $\Delta Regional\_CDS_{i,t}$ and $\Delta Global\_CDS_{i,t}$ which are variables that capture the interconnectedness and interdependence of CDS markets in the same spirit of Longstaff et al. (2011). Specifically, $Regional\_CDS_{i,t}$ controls for potential spillovers across CDS markets of countries within the same region, while $Global\_CDS_{i,t}$ accounts for spillovers from CDS markets of countries outside a country's region, and h is the time horizon (i.e., h-days ahead). Finally, α_i^h and τ_t^h are fixed- and time-effects, respectively.

The coefficient θ^h directly quantifies, for each time horizon h, the response of sovereign CDS spreads to a natural disaster occurred at time t. In order to measure the aggregate impact of natural disasters over time, we also compute cumulative impulse-response functions (CIRFs), in addition to the IRFs. These reflect the total effects of natural disasters over all time horizons up to the horizon of interest (i.e., $h = H + 1$). Compared to ordinary IRFs, the cumulative IRFs reduce the potential noise associated with the period-by-period response. Both IRFs are means that allow one to visualize the immediate CDS market reactions and their persistence over time following natural disaster shocks.

4. Data

The daily sovereign CDS spread data used in our analysis is retrieved from Markit and covers the 01 January 2002 – 31 December 2020 period. It comprises USD-denominated CDS spreads for 73 (emerging and developed) sovereigns grouped into 10 regions: Africa, Asia, Caribbean, Eastern Europe, Europe, India, Latin America, Middle East, Oceania and Anglo-Saxon regions (including the US and the UK). We exclude Argentina, Azerbaijan, Greece, Indonesia, Lebanon, Oman, UAE and Ukraine from the sample due to the large number of missing observations and the abnormal spikes in the sovereign CDS spread series.

The selected tenor of the contract is equal to 5 years, because it is the most liquid and frequently quoted part maturity of the credit curve (Markit, 2008). The CDS contracts follow the document clause of 'Complete Restructuring (CR)' and the underlying reference entity is the foreign currency sovereign debt issued by individual governments, as highlighted by Bai and Wei (2017). In the case of Australia and New Zealand, the data based on the CR clause is not sufficiently available, hence, the Modified Restructuring (MR) clause is used. However, the clauses do not affect the ability of the spreads to capture sovereign risk.

The restructuring clause or `doc clause' defines the credit events that trigger the swap under a CDS agreement. In February 2014, the International Swaps and Derivatives Association (ISDA) updated its credit derivatives definitions and, on 22 September 2014, CDS trading began in accordance with the new definitions. As in the study by Greenwood-Nimmo et al. (2019), contracts governed by old and new clauses are distinguished by adding a `14′ suffix to the Markit data (e.g., CR versus CR14).

We note that the shift in definitions causes no structural break, so we merge the pre- and post-2014 data. Thus, we use CR data up to 21 September 2014 and CR14 data from 22 September 2014 onwards, with a few exceptions. In particular, for Australia and New Zealand, the 'CR/CR14' data contains numerous missing observations, while the 'MR/MR14' data for these countries is complete. Consequently, we use the US dollar denominated 5-year 'MR/MR14' contract for the Modified Restructuring for these sovereigns.

As for the list of natural disasters by date, it is extracted from the Emergency Events Database (EM-DAT) maintained by the Centre for Research on the Epidemiology of Disasters (CRED) of the Catholic University of Louvain (UCLouvain) and carefully documented in Delforge et al. (2025). It is one of the most comprehensive databases of natural and technological disasters worldwide, starting from 1900 until the present. Based on the EM-DAT, we consider five different categories of natural disasters, namely :[3]

I. 'biological', i.e. disasters caused by exposure to living organisms and/or their toxic substances;
II. 'climatological', i.e., disasters caused by climate anomalies, namely, long-lived, meso- and macro-scale atmospheric processes;
III. 'geophysical', i.e., disasters originating from solid earth;
IV. 'hydrological', i.e., disasters caused by the movement and distribution of surface and subsurface freshwater and saltwater; and, finally,
V. 'meteorological', that is, disasters caused by short-lived/small to mesoscale extreme weather and atmospheric conditions (e.g., extreme temperature and thunderstorms).

The set of variables entering the vector $X_{i,t}$ in Eq. (1) includes:

- The 'regional' sovereign CDS spread for each country (*regional_cds*), which is the average CDS spread across all other sovereigns within the same region. This is a benchmark that assesses how a country's CDS spread correlates with its regional peers;
- The 'global' sovereign CDS spread for each country (*global_cds*), which is calculated by averaging the CDS spreads of all sovereigns outside that country's region. This measure should capture the global component of sovereign credit risk and reflect how a country's CDS spread is influenced by global market factors; and
- The (selective) default' dummy variable (*sp_sd*), which identifies sovereign default episodes, as proxied by the 'selective default' rating compiled by the Cavanaugh et al. (2013) and extended by Agnello et al. (2018), as well as the list of selective default rating announcements documented in Standard & Poor's (2020, 2021, 2022, 2023). It takes the value of one in the date of the selective default rating announcement, and zero, otherwise. Thus, this variable allows us to investigate the effect that default announcements have on sovereign risk, and whether this is significantly different for default and non-default announcement dates, or not.

Table 1 presents the summary of the statistics of all variables included in the analysis. All in all, we assemble a panel of close to 250,000 usable data points.

5. Empirical results

5.1. Evidence for the baseline model

The main empirical results for the impact of natural disasters on sovereign CDS spreads are reported in Table 2. Although natural disasters do not generally have a significant impact, climatological events (e.g., droughts or wildfire) and, to some extent, hydrological events (e.g., floods and landslides) do affect ΔCDS. These events lead to a daily increase of roughly 0.6 basis points (bps) in the change of sovereign CDS spreads. In simple terms, they cause increases in sovereign CDS spreads, because they raise the perceived risk of default. Those natural disasters

[2] As reported in panel B of Table 1, there are only a few instances where there is more than a natural disaster event of the same typology occurring at the same time t (e.g., independent meteorological events recorded at time t and spreading across different regions/areas of the same country i).

[3] The EM-DAT database also lists extra-terrestrial events (i.e., hazards caused by asteroids, comets and meteoroids), but we exclude them due to the occurrence of only one event (occurred in Russia in 2013) in our analysis.

Table 1
Summary statistics.

Panel A					
Variable	Obs	Mean	Std. dev.	Min	Max
cds	306,612	178.3378	247.303	0.903743	5059.085
sp_sd	361,934	5.53E-06	0.002351	0	1
regional_cds	304,657	178.464	190.4714	1.078947	3239.275
global_cds	345,509	187.3059	92.89632	36.14448	631.2657

Notes: cds stands for each sovereign's CDS spreads, sp_sd is selective defaults, and regional_cds and global_cds correspond to regional and global CDS spreads, respectively.

Panel B. Frequency distribution of natural disasters				
	1	2	3	Total
Biological events	83	2	0	87
Climatological events	86	0	0	86
Geophysical_events	267	0	0	267
Hydrological events	1299	11	2	1327
Meteorological events	1017	7	0	1031

Notes: Biological events (infectious diseases, outbreaks or bioterrorism). Climatological events (e.g., heatwaves, cold waves, heavy precipitation, and droughts). Geophysical events (e.g., earthquakes, volcanic eruptions, landslides, mudflows, and tsunamis. Hydrological events (e.g., floods, droughts, and storm surges). Meteorological events (e.g., weather like rain and snow to more extreme events like hurricanes and heatwave).

Table 2
Empirical results.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
L.dcds	−0.0494	−0.0494	−0.0494	−0.0494	−0.0494	−0.0494	−0.0494
	[0.048]	[0.048]	[0.048]	[0.048]	[0.048]	[0.048]	[0.048]
sp_sd	0.5820***	0.5811***	0.5815***	0.5814***	0.5816***	0.5808***	0.5812***
	[0.078]	[0.078]	[0.078]	[0.078]	[0.078]	[0.078]	[0.078]
D.regional_cds	0.1218***	0.1218***	0.1218***	0.1218***	0.1218***	0.1218***	0.1218***
	[0.024]	[0.024]	[0.024]	[0.024]	[0.024]	[0.024]	[0.024]
D.global_cds	0.2350***	0.2350***	0.2350***	0.2350***	0.2350***	0.2350***	0.2350***
	[0.030]	[0.030]	[0.030]	[0.030]	[0.030]	[0.030]	[0.030]
disaster_event	0.2474						
	[0.207]						
Biological_event		−1.8478					−1.8765
		[1.934]					[1.929]
Climatological_event			**0.6367*****				**0.6365*****
			[0.173]				**[0.169]**
Geophysical_event				0.6355			0.6439
				[0.736]			[0.736]
Hydrological_event					**0.6110***		**0.6144***
					[0.329]		**[0.329]**
Meteorological_event						−0.2390	−0.2376
						[0.206]	[0.206]
Constant	0.7684***	0.7704***	0.7699***	0.7699***	0.7676***	0.7705***	0.7681***
	[0.208]	[0.209]	[0.208]	[0.208]	[0.208]	[0.208]	[0.209]
Time effects	Y	Y	Y	Y	Y	Y	Y
Observations	299,583	299,583	299,583	299,583	299,583	299,583	299,583
R-squared	0.032	0.032	0.032	0.032	0.032	0.032	0.032
Number of id	73	73	73	73	73	73	73

Notes: This Table summarises the estimation of Eq. (1). Robust standard errors in brackets. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

can damage infrastructure, disrupt production, and reduce GDP, particularly in vulnerable sectors (such as, agriculture, energy and tourism). This weakens government revenues (via lower taxes), corporate earnings and the ability of borrowers to repay debt. Thus, investors demand higher CDS spreads as a compensation for the increased default risk. In addition, governments often face higher spending (in the form of disaster relief or reconstruction costs) and lower revenue after such events. This leads to budget deficits, more borrowing and higher sovereign risk. Natural disasters might increase uncertainty, leading to a "flight to quality", with investors selling risky assets and moving to safe havens. Hence, CDS spreads rise due to the stronger demand for protection in volatile environments. Droughts and floods can also hurt bank loan portfolios, especially if borrowers are concentrated in affected areas. As the perceived risk of the banking sector increases, CDS spreads of financial institutions also tend to rise.

Regarding the other controls, we find that selective defaults (*sp_sd*) are associated with higher CDS spreads in a particular country. For example, default announcements imply an immediate rise of about 0.58 bps in ΔCDS. Selective defaults undermine investors' trust, as borrowers may prioritize certain debt financial instruments over others. This raises concerns about the debt management transparency, the future repayment ability, and the potential for broader or repeated defaults. Consequently, investors demand higher CDS premia to insure against this elevated and unpredictable risk.

Higher CDS spreads in a particular country are also linked with increases in both regional (*regional_cds*) and global CDS (*global_cds*) spreads. These spreads typically rise because of heightened global risk aversion – for instance, due to financial crises, geopolitical instability, or macroeconomic uncertainty. In such environments, investors tend to reassess risk across all markets. They may also pull back from riskier assets, especially in emerging or less liquid markets, and demand higher compensation (via CDS spreads) even for countries not directly affected. This reflects the contagion effect, where a country's CDS spreads rise not due to its own fundamentals, but because of deteriorating global sentiments. For example, during the 2008–2009 financial crisis or the COVID-19 pandemic, CDS spreads widened globally – even in countries with stable macroeconomic and financial conditions – because of systemic fear and liquidity withdrawals.

Finally, our empirical evidence indicates that persistence dynamics in ΔCDS is negligible, which is not surprising, as CDS spreads tend to adjust quickly to new information, especially on a daily basis. In fact, according to the efficient market hypothesis, financial prices should promptly incorporate all available information. This implies that ΔCDS should quickly mean-revert, therefore further reducing the persistence in daily changes. Thus, this fast adjustment shows that there is little autocorrelation in daily changes of sovereign CDS spreads. Moreover, by first-differencing the data, any persistence in the levels of CDS spreads is likely to erode, thus, resembling a white-noise pattern.

We should, so far, stress that our discussion focused on the immediate effect of natural disasters on sovereign CDS spreads. However, their impact may prevail, exponentiate or dissipate only a few days after their occurrence. Therefore, a more detailed analysis of the reaction of ΔCDS to the natural disaster shocks is required.

The results are provided in Figs. 1 and 2. The former figure depicts the impulse response functions (IRFs) to a specific natural disaster shock on sovereign CDS spreads, while the latter plots the respective cumulative IRFs. Overall, they confirm the significant effect, on impact, of regional and global CDS spread shocks, as well as those of unexpected climatological and hydrological disasters. Nevertheless, the effect of these natural disasters dies out within a few days after the shock. This short-lived response of sovereign CDS spreads can be due to the way financial markets process the informational content incorporated in the initial rise of uncertainty versus its material impact on sovereign risk over longer horizons. Markets tend to react quickly to breaking news, often pricing in the worst-case scenarios, before the full information is available. Investors may expect economic disruption, fiscal strain, or insurance losses, which triggers a short-term rise in perceived credit risk. In the immediate aftermath, some investors rebalance portfolios or reduce exposure to the affected regions, which can lead to temporary illiquidity and wider sovereign CDS spreads. Therefore, natural disasters may act as catalysts of broader investor risk aversion and an increased demand for CDS as a hedge, even if the sovereign's fundamentals have not changed. However, as information about the scale of the disaster, the government response, and the insured losses get diffused, investors may adjust their expectations. If the damage is contained or offset by external aid – which is the case when they have significant repercussions –, the perceived default risk drops back.

5.2. Expectations about future natural disasters

To check whether expectations of an imminent natural disaster impact sovereign CDS spreads (e.g., a cyclone approaching that can be detected some days before its arrival), we re-estimate our baseline model by re-defining $disaster_{i,t}$ as a dummy variable that is equal to one k-days before the occurrence of the natural disaster, and zero, otherwise, i.e.:

$$\Delta CDS_{i,t+h-1} = \alpha_i^h + \tau_t^h + \beta^h \Delta CDS_{i,t-1} + \theta^h disaster_{i,[t-k,t]} + \Gamma^h X_{i,t} + \mu_{i,t+h-1}. \tag{2}$$

We consider a window event of a maximum of four days before the event (i.e., $k = 1, \ldots, 4$).

The respective results are presented in Table 3 and show some evidence that financial markets start to react to the expectations of climatological and hydrological events the day before they occur, but not prior to that. Thus, investors use CDS to hedge against sovereign risk but appear to avoid early hedging to reduce costs and avoid false alarms. In the imminence of a natural disaster (and when actually occurs), the perceived probability of occurrence and its potential severity reach the thresholds that justify paying a CDS premium. This means that investors often wait until the event is approaching and the risks are clearer (e.g., the exact path of a hurricane or the flood risk level) before adjusting the

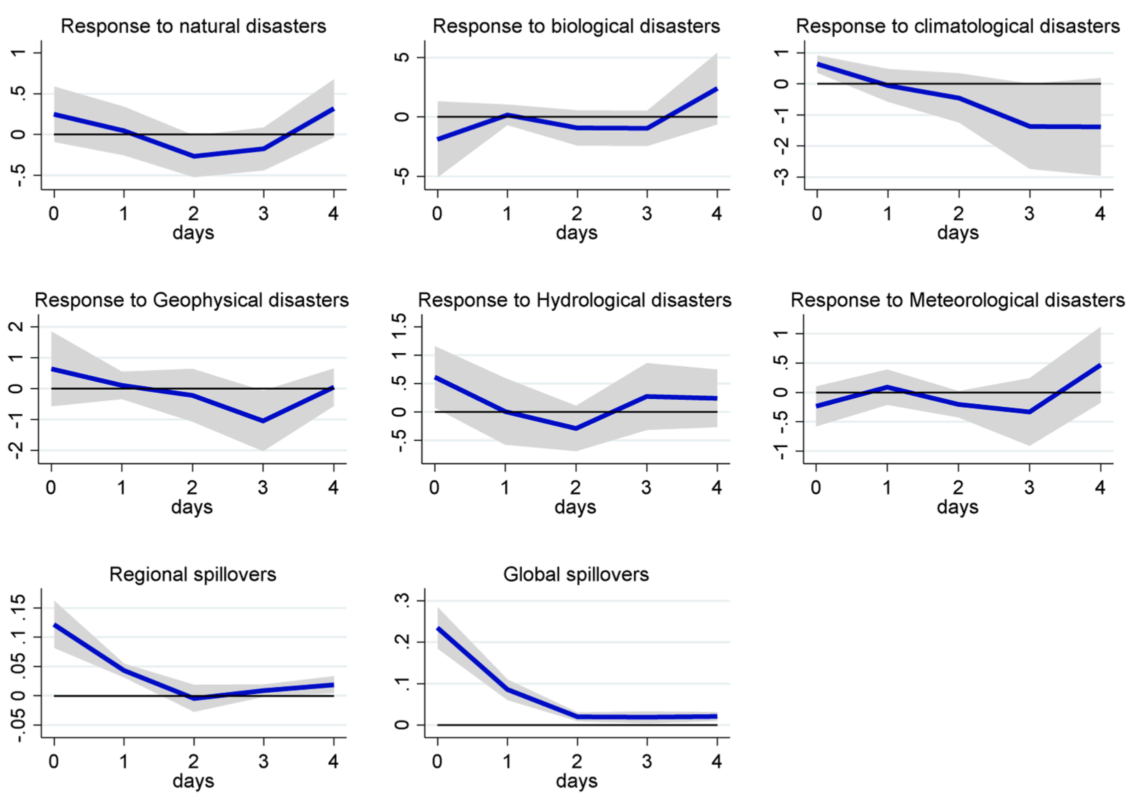

Fig. 1. Impulse-response functions.
Notes: The 90 % confidence bands are shaded in grey.

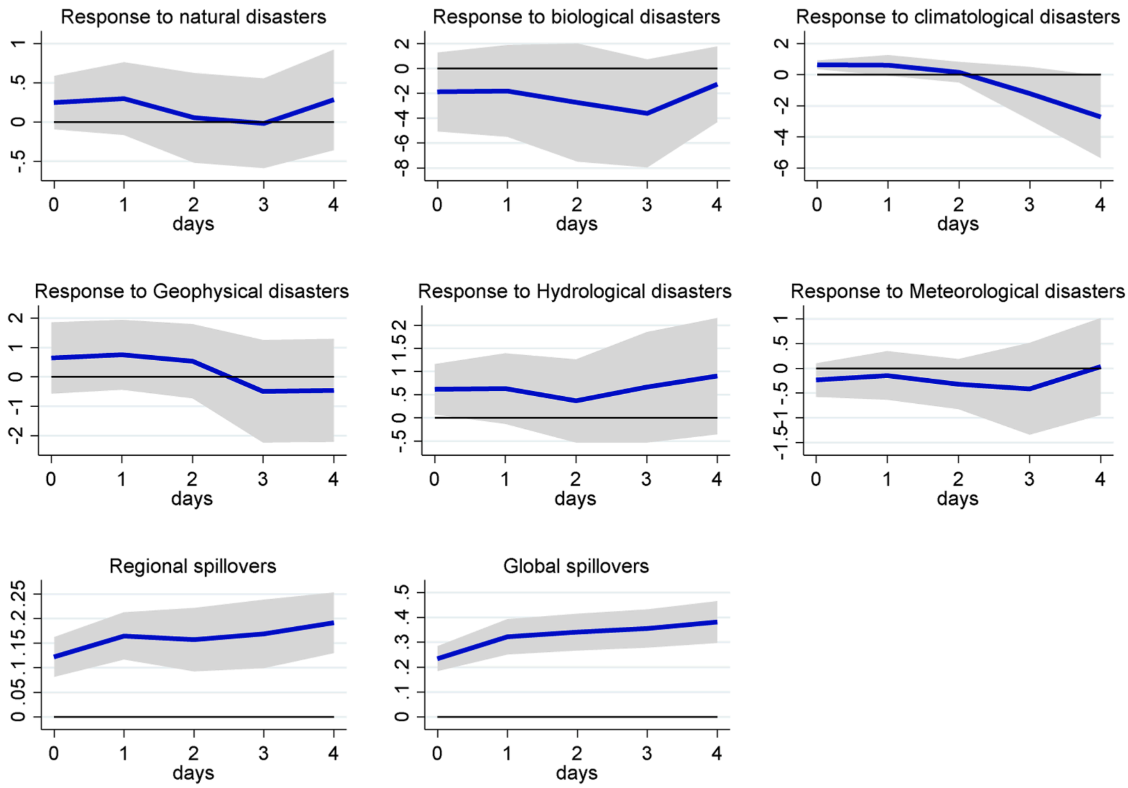

Fig. 2. Cumulative impulse-response functions.
Notes: The 90 % confidence bands are shaded in grey.

CDS positions.

In sum, our results show that sovereign CDS spreads do react to natural disasters, in particular, climatological and hydrological disasters, when they occur (or are on the way). However, they are not significantly affected by expectations and the impact of natural disasters is short-lived, dying out within a few days after they occur when investors' predictions begin to realign with the sovereign's fundamentals.

This suggests that sovereign CDS markets respond only temporarily and reactively to natural disasters, but not proactively to climate risks. As markets only react to disasters as they happen or immediately before, and quickly revert to pre-event pricing, this indicates a lack of long-term risk pricing. Eventual structural, slow-moving climate risks (e.g., increasing disaster frequency or fiscal strain from repeated events) are not reflected in the sovereign CDS spreads. This means that markets are still treating climate-related disasters as transitory, localized events, rather than as potential early warnings of a structural shift in sovereign risk profiles from eventual climate changes.

6. Conclusions

This study investigates the impact of natural disasters on sovereign credit risk by focusing on sovereign CDS spreads as a market-based risk proxy. Using a rich dataset of daily CDS spreads for sovereigns, comprising nearly 250,000 observations, and employing the local projections *à la* Jordà (2005), we estimate the dynamic response of sovereign risk to the occurrence of natural disasters. Our empirical strategy incorporates regional and global spillovers, incidence of sovereign defaults, and disaster shocks across a variety of typologies from the comprehensive EM-DAT database maintained by CRED at UCLouvain. We also explore whether anticipatory effects arise before a disaster unfolds.

The central contribution of this study lies in its high-frequency, cross-country estimation of sovereign risk responses to disaggregated natural disaster events. Prior literature has largely examined the macroeconomic or fiscal impacts of disasters, but with less attention paid to sovereign risk pricing in financial markets. We fill this gap by showing that the market response to natural disasters is both nuanced and typology dependent.

Specifically, we find that climatological and, to a lesser extent, hydrological events have a short-term but statistically significant effect on sovereign CDS spreads. Other disaster categories, including geophysical or meteorological events, do not appear to significantly affect market perceptions of sovereign default risk. Interestingly, this effect dissipates after one to two trading days. These results suggest that the sovereign CDS markets absorb, and process natural disaster information rapidly and selectively and quickly re-adjust expectations towards the sovereigns' fundamentals.

Moreover, our findings emphasize the dominant role of regional and global financial spillovers. Indeed, regional and global CDS spreads have a persistent and substantial effect on domestic sovereign risk, thus indicating the systemic nature of sovereign credit markets. These insights underscore that sovereign risk pricing is affected more by broader market sentiments and financial contagion than by isolated domestic shocks. Additionally, including anticipatory analyses that account for pre-disaster signals, we confirm that expectations of imminent disasters do not materially alter CDS pricing.

From a policy and practitioner standpoint, these results carry relevant implications. First, for sovereign issuers and debt managers, the evidence that markets distinguish across disaster types supports the need for targeted disaster risk management policies. Thus, governments may benefit from disaster-specific risk reduction and fiscal resilience strategies.

Second, financial market participants, including risk managers and institutional investors, should account for the brief but real sovereign risk implications of certain disaster types. Therefore, portfolio-hedging strategies might include short-term protective positions in vulnerable sovereigns during disaster seasons or known climatological risk windows.

Table 3
Expectations about future natural disasters.

	k-day(s) before the disaster event			
VARIABLES	1 day	2 days	3 days	4 days
L.dcds	−0.0494	−0.0494	−0.0494	−0.0494
	[0.048]	[0.048]	[0.048]	[0.048]
sp_sd	0.5815***	0.5810***	0.5811***	0.5813***
	[0.078]	[0.078]	[0.078]	[0.078]
D.regional_cds	0.1218***	0.1218***	0.1218***	0.1218***
	[0.024]	[0.024]	[0.024]	[0.024]
D.global_cds	0.2350***	0.2350***	0.2350***	0.2350***
	[0.030]	[0.030]	[0.030]	[0.030]
Biological_event_1_0	−1.9015			
	[1.515]			
Climatological_event_1_0	0.4228*			
	[0.230]			
Geophysical_event_1_0	0.2559			
	[0.428]			
Hydrological_event_1_0	0.4834*			
	[0.257]			
Meteorological_event_1_0	−0.0459			
	[0.117]			
Biological_event_2_0		−0.1388		
		[0.805]		
Climatological_event_2_0		0.2263		
		[0.336]		
Geophysical_event_2_0		0.2411		
		[0.318]		
Hydrological_event_2_0		0.2157		
		[0.204]		
Meteorological_event_2_0		−0.1775		
		[0.129]		
Biological_event_3_0			−0.0486	
			[0.612]	
Climatological_event_3_0			−0.0653	
			[0.274]	
Geophysical_event_3_0			0.1554	
			[0.330]	
Hydrological_event_3_0			0.1941	
			[0.198]	
Meteorological_event_3_0			−0.0900	
			[0.123]	
Biological_event_4_0				−0.1133
				[0.548]
Climatological_event_4_0				−0.0921
				[0.253]
Geophysical_event_4_0				0.1690
				[0.312]
Hydrological_event_4_0				0.1753
				[0.172]
Meteorological_event_4_0				−0.0535
				[0.116]
Constant	0.7667***	0.7686***	0.7683***	0.7679***
	[0.208]	[0.209]	[0.208]	[0.208]
Observations	299,583	299,583	299,583	299,583
R-squared	0.032	0.032	0.032	0.032
Number of id	73	73	73	73

Notes: This Table summarises the estimation of Eq. (2). Robust standard errors in brackets. *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Third, the observation that natural disasters have a limited and short-lived effect on sovereign CDS spreads suggests that financial markets, while responsive, may not fully price in the long-term fiscal and macroeconomic consequences of such shocks. This presents both a risk and an opportunity: for countries with frequent or severe disaster exposure, it may indicate under-pricing of climate risk; for investors, it gives leeway for incorporating forward-looking climate vulnerability indicators into pricing models.

Fourth, the crucial role of regional and global spillovers highlights the importance of external financial conditions in sovereign risk dynamics. Thus, policymakers should recognize that domestic fundamentals may not be the only determinants of borrowing costs. This implies that coordination among sovereigns and multilateral institutions may be essential in times of global financial stress or regional calamities. In particular, coordinated regional responses to disasters, including financial safety nets or pooled risk-sharing mechanisms, could reduce market volatility and reinforce investor confidence.

Fifth, the effectiveness of anticipatory risk pricing appears limited. Markets do not significantly react in advance of predictable disaster events, such as cyclones detected days before landfall. This suggests either a gap in market efficiency or a high threshold for action. Therefore, governments and credit rating agencies may benefit from developing early warning models and integrating disaster forecasting into risk monitoring frameworks.

Finally, for investment managers, our results underscore the need of incorporating non-economic variables – particularly, environmental ones – into sovereign risk models. Indeed, factor-based models that ignore disaster typology and regional co-movements may miss critical dimensions of risk. Consequently, forward-looking ESG integration strategies, complemented by scenario analysis of disaster events, can enhance portfolio resilience.

Summing up, our study advances the literature by revealing that not all natural disasters are priced equally by financial markets and that the nature and context of a disaster critically shape sovereign risk dynamics. These insights can enhance sovereign risk assessment models and inform the design of proactive policy tools to mitigate the adverse financial consequences of climate-related and natural shocks.

While our study offers new evidence on how natural disasters affect sovereign CDS spreads using daily data, some limitations remain. For instance, the disaster shocks may coincide with other events (e.g., macro and political shocks), making clean identification difficult. Additionally, despite the broad coverage, the classification and measurement of disaster typologies are subject to the availability of the EM-DAT data, which may be more limited in lower-income countries or low-transparency jurisdictions. Moreover, our local projections' estimations assume linear responses, which may not fully capture the nonlinear dynamics or threshold effects due to extreme events. Lastly, the relatively short-lived market response observed in the empirical results raises questions about whether financial markets fully internalize the long-term fiscal and economic consequences of natural disasters.

Future research could address some of these limitations. For instance, by exploring more granular identification strategies, the consideration of sovereign bond yield curves or credit ratings as alternative or complementary sovereign risk measures may deliver richer insights into market pricing mechanisms. Moreover, future studies may assess the heterogeneous effects across country groups, such as advanced economies versus emerging markets, or countries with different disaster preparedness and fiscal space levels. They could also explore investor expectations, incorporating forward-looking indicators or disaster risk forecasts. Finally, the research could extend the time horizon to evaluate whether repeated disasters in a short timeframe lead to compounding effects on sovereign creditworthiness, or whether market participants gradually become desensitized to such shocks. These avenues when data is more available would deepen our understanding of how environmental risk is priced in sovereign credit markets.

Ethical statement

The authors acknowledge that: the manuscript has not been submitted to more than one journal for simultaneous consideration; the submitted work is original and has not been published elsewhere in any form or language (partially or in full), unless the new work concerns an expansion of previous work; the study has not been split up into several parts to increase the quantity of submissions and submitted to various journals or to one journal over time; the results have been presented clearly, honestly, and without fabrication, falsification or inappropriate data manipulation; and no data, text, or theories by others were presented as if they were the author's own, and proper acknowledgements to other works have been given.

The authors also note that our study did not require: any specific approval by the appropriate ethics committee (as the research did not involve humans and/or animals); any informed consent (as the research did not involve human participants); or a statement on welfare of animals (as the research did not involve animals).

CRediT authorship contribution statement

Luca Agnello: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Vítor Castro:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ricardo M. Sousa:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Shawkat Hammoudeh:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interests

The authors do not have any relevant financial or non-financial interests directly or indirectly related to the work submitted for publication to disclose.

Research data policy and data availability statement

The data that support the findings of this study are available from the authors upon request.

Authorship principles statement

The authors declare that they have contributed to all phases of the study, including: conception and design, material preparation, data collection and analysis, manuscript writing and commenting, and reading and approval of the final manuscript.

Declaration of generative AI in scientific writing

The authors have nothing to declare.

Data availability

Data will be made available on request.

References

Agnello, L., Castro, V., & Sousa, R. M. (2018). The legacy and the tyranny of time: exit and re-entry of sovereigns to international capital markets. *Journal of Money Credit and Banking, 50*(8), 1969–1994.
Alalmaee, H. (2024). *Natural disasters and banking stability. Economies, 12*, 31.
Andries, A. M., Ongena, S., & Sprincean, N. (2025). Climate-related financial policy and systemic risk. *Swiss Finance Institute, Research Paper No. 30*, 1–50.
Arezki, R., Candelon, B., and A. Sy, 2011. Sovereign rating news and financial markets spillovers: evidence from the European debt crisis. International Monetary Fund, IMF Working Paper, no. 68.
Augustin, P. (2018). The term structure of CDS spreads and sovereign credit risk. *Journal of Monetary Economics, 96*, 53–76.
Bai, J., & Wei, S.-J. (2017). Property rights and CDS spreads: when is there a strong transfer risk from the sovereigns to the corporates? *Quarterly Journal of Finance, 7*(4), Article 1750013.
Cavallo, E., & Noy, I. (2011). Natural disasters and the economy – A survey. *International Review of Environmental and Resource Economics, 5*(1), 63–102.
Cavanaugh, M., Phua, Y. F., & Young, B. J. (2013). Sovereign rating and country T&C assessment histories. *Standard & Poor's Ratings Direct*, 1–52. January.
Cevik, S., & Jalles, an J. T. (2022). This changes everything: climate shocks and sovereign bonds. *Energy Economics, 107*, 105856.
Cheng, J., & Chang, S. (2025). Rare disasters, local currency-denominated external debt and sovereign default risk. *Economics Letters, 250*, Article 112313.
Delforge, D., Wathelet, V., Below, R., Lanfredi Sofia, C., Tonnelier, M., van Loenhout, J. A. F., & Speybroeck, N. (2025). EM-DAT: the Emergency events database. *International Journal of Disaster Risk Reduction.* , Article 105509. https://doi.org/10.1016/j.ijdrr.2025.105509. Available at.
Di Tommaso, C., Foglia, M., & Pacelli, V. (2023). The impact and the contagion effect of natural disasters on sovereign credit risk. An empirical investigation. *International Review of Financial Analysis, 87*, Article 102578.
Fontana, A., & Scheicher, M. (2016). An analysis of euro area sovereign CDS and their relation with government bonds. *Journal of Banking & Finance, 62*, 126–140.
Greenwood-Nimmo, M., Huang, J., & Nguyen, V. H. (2019). Financial sector bailouts, sovereign bailouts, and the transfer of credit risk. *Journal of Financial Markets, 42*, 121–142.
Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review, 95*(1), 161–182.
Kahn, M. E. (2005). The death toll from natural disasters: the role of income, geography, and institutions. *Review of Economics and Statistics, 87*(2), 271–284.
Kousky, C. (2014). Informing climate adaptation: A review of the economic costs of natural disasters. *Energy Economics, 46*, 576–592.
Longstaff, F. A., Pan, J., Pedersen, L. H., & Singleton, K. J. (2011). How sovereign is sovereign credit risk? *American Economic Journal: Macroeconomics, 3*(2), 75–103.
Mallucci, E. (2022). Natural disasters, climate change, and sovereign risk. *Journal of International Economics, 139*, Article 103672.
Markit. (2008). *Markit credit indices: a primer*.
Nguyen, H. M., Feng, A., & Garcia-Escribano, M. (2025). Understanding the macroeconomic effects of natural disasters. *International Monetary Fund, IMF Working Paper No. 46*, 1–26.
Noy, I. (2009). The macroeconomic consequences of disasters. *Journal of Development Economics, 88(2)*, 221–231.
Pagnottoni, P., Spelta, A., Flori, A., & Pammoli, F. (2022). Climate change and financial stability: Natural disaster impacts on global stock markets. *Physica A, 599*, 127514.
S&P. (2020). Default, transition, and recovery: 2019 annual Sovereign Default and Rating Transition study. *Standard & Poor's Global Ratings*, 18 March.
S&P. (2021). Default, transition, and recovery: 2020 annual Sovereign Default and Rating Transition study. *Standard & Poor's Global Ratings*, 28 April.
S&P. (2022). Default, transition, and recovery: 2021 annual Global Sovereign Default and Rating Transition Study. *Standard & Poor's Global Ratings*, 4 May.
S&P. (2023). Default, transition, and recovery: 2022 annual Global Sovereign Default and Rating Transition study. *Standard & Poor's Global Ratings*, 12 June.
Strobl, E. (2011). The economic growth impact of hurricanes: evidence from U.S. coastal counties. *Review of Economics and Statistics, 93*(2), 575–589.