Do Adaptation Investments Reduce Borrower Credit Risk?

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Abstract

Climate change poses a significant threat to sovereign debt sustainability by creating a feedback loop in which natural disasters raise borrowing costs and hinder economic recovery. While theoretical models suggest that financial and physical adaptation can mitigate these risks, empirical evidence on whether financial markets price real-world adaptation investments remains limited. This paper builds on the theoretical framework of Phan & Schwartzman (2024) and extends it through an empirical analysis of 44 countries over the period 2009–2023. Using panel fixed-effects regressions and event-study methodologies, we examine whether government spending on environmental protection reduces sovereign Credit Default Swap (CDS) spreads. Our results reveal heterogeneous market responses. Adaptation investment is linked to lower sovereign credit risk in high-risk countries, whereas in low-risk countries, it is associated with higher CDS spreads, suggesting that markets may view such spending as a fiscal cost. Furthermore, institutional readiness significantly amplifies the risk-reducing effects of adaptation spending.

Keywords: Climate Adaptation, Sovereign Credit Risk, CDS Spreads, Fiscal Capacity, Disaster Risk, Climate Vulnerability.

1 Introduction

Forward-looking assessments of sovereign risk increasingly incorporate the physical impacts of climate change. A growing body of theoretical literature emphasizes a "vicious cycle" faced by sovereigns following climate-related disasters. Natural disasters destroy capital and reduce output, forcing governments to increase borrowing to finance reconstruction. The resulting rise in the debt-to-GDP ratio increases default risk, prompting investors to demand higher sovereign spreads. Elevated borrowing costs, in turn, slow reconstruction and prolong periods of depressed output and elevated debt.

While theoretical models, such as Phan & Schwartzman (2024), illustrate how financial instruments like catastrophe bonds can smooth consumption and partially mitigate these dynamics, they rely primarily on calibrated simulations rather than direct empirical evidence. Consequently, it remains unclear whether financial markets price real-world government investments in physical adaptation. As governments allocate increasing resources toward climate resilience, credit markets may interpret these expenditures either as risk-reducing investments or as additional fiscal liabilities.

This paper addresses this gap by providing a cross-country empirical test of the "adaptation lever" hypothesis, which posits that public investment in climate adaptation may help protect the capital stock, dampen the economic impact of disasters, and lower perceived sovereign credit risk. Using panel data for 44 countries, we examine how markets price adaptation investment across different risk profiles and show that market responses differ sharply between high-risk and low-risk sovereigns.

Unlike existing empirical studies focusing on climate exposure, disaster incidence, or sovereign credit ratings, this paper examines whether policy-driven public adaptation investment itself is priced by sovereign credit markets. Using sovereign CDS spreads, we provide direct market-based evidence on how adaptation spending affects perceived default risk. Moreover, we show that this effect is highly heterogeneous, varying systematically with baseline sovereign risk and institutional readiness.

2 Literature Review

Our empirical analysis builds on the theoretical framework developed by Phan and Schwartzman (2024), which studies how climate-related disasters interact with sovereign debt dynamics. Their model provides a clear conceptual foundation for understanding why climate shocks can have persistent macroeconomic and financial effects, and why sovereign borrowing costs may remain elevated long after a disaster occurs.

2.1 Effects of Climate Shocks on Sovereign Risk

A main mechanism of Phan and Schwartzman (2024) is the existence of a self-reinforcing feedback loop between physical destruction and sovereign financial distress. When a climate-related disaster strikes, part of the physical capital stock (K_t) is destroyed. As shown by Phan and Schwartzman (2024), output (Y_t) depends positively on the available capital stock, so disaster-induced capital destruction immediately reduces productive capacity and leads to a decline in output. At the same time, governments typically increase borrowing to finance reconstruction and smooth consumption, which raises the debt-to-GDP ratio.

The combination of lower output and higher public debt worsens fiscal fundamentals and increases perceived default risk. As a result, investors demand higher sovereign spreads, raising borrowing costs. These higher financing costs constrain public investment and slow the rebuilding of capital, keeping output and capital below their pre-disaster trends. Through this mechanism, climate disasters generate highly persistent effects, with the model predicting that recovery can take up to 20 years.

2.2 Financial Adaptation and Its Limits

Phan & Schwartzman (2024) examine two forms of financial adaptation aimed at mitigating disaster-related fiscal stress: disaster insurance and catastrophe (CAT) bonds. Disaster insurance allows governments to smooth consumption by receiving payouts in disaster states in exchange for premia paid during normal times, while CAT bonds reduce or suspend debt repayment when predefined disaster thresholds are met.

Their quantitative results indicate that, although these instruments provide partial protection, they do not eliminate macro-financial vulnerability. Disaster insurance offsets only around 20% of climate-related welfare losses, while catastrophe bonds generate limited long-run welfare gains because they encourage higher borrowing in non-disaster periods. As a result, financial adaptation can attenuate short-term shocks but does not fully resolve long-run fiscal fragility.

Empirical evidence further suggests that financial markets price climate-related risks. Using a panel of 98 advanced and developing countries, Cevik and Jalles (2022) show that greater vulnerability to climate change is associated with higher sovereign bond yields and spreads, while higher climate resilience significantly lowers borrowing costs. These effects are particularly pronounced in developing and high-risk economies, indicating that climate-related risks are more heavily priced where fiscal space and institutional capacity are more limited. While this literature focuses on structural vulnerability and resilience rather than explicit adaptation measures, it suggests that sovereign risk premia respond systematically to a country's capacity to manage climate-related shocks. Building on this insight, our study examines whether adaptation investment is reflected in sovereign CDS spreads.

3 Empirical Strategy

Moving beyond theoretical modeling, our empirical analysis evaluates whether physical adaptation investments reduce sovereign credit risk in practice.

3.1 Data and Variable Construction

We construct a panel dataset covering 44 countries over the period 2009-2023. Due to data availability constraints, the sample consists primarily of advanced and upper-middle-income economies with liquid sovereign CDS markets.

Dependent Variable (CDS_{it}): The natural logarithm of the annual average 5-year sovereign CDS spread, sourced from Refinitiv/LSEG.

Adaptation Investment ($Adapt_{i,t-2}$): Government spending on environmental protection (IMF COFOG category 5.4), expressed as a percentage of GDP and lagged by two years to account for delayed resilience effects.

Climate Controls: ND-GAIN indices for **Vulnerability** and **Readiness**, and disaster frequency from the EM-DAT database.

Macroeconomic Controls: Debt-to-GDP ratio, GDP growth, inflation, and foreign reserves from the World Bank

Figure 1 presents the distribution of adaptation investment across the sample, with mean spending of approximately 0.68% of GDP.

A key concern is potential reverse causality, whereby higher sovereign risk could itself induce greater adaptation spending. To mitigate this concern, adaptation investment is lagged by two years, reflecting the delayed impact of physical adaptation on resilience and market perceptions. While this strategy reduces contemporaneous feedback, we acknowledge that it does not fully eliminate endogeneity, and therefore interpret the results as conditional correlations rather than strictly causal effects.

The use of instrumental variables or quasi-experimental designs is constrained by data availability and lies beyond the scope of this seminar paper.

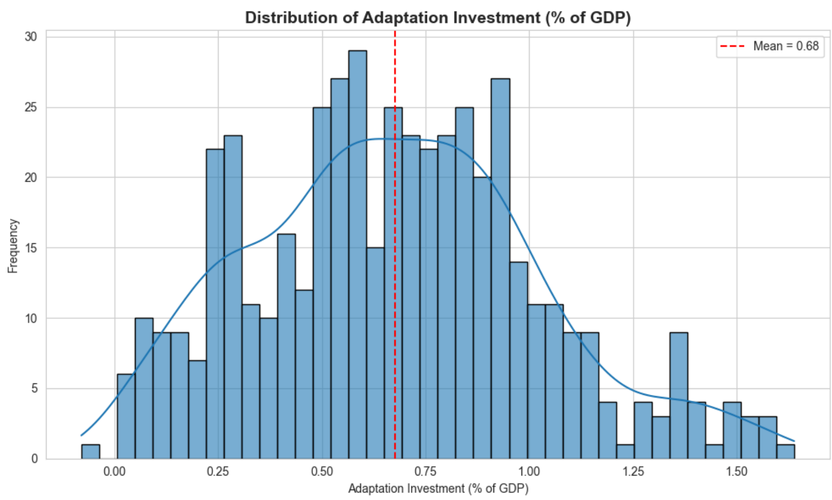

Figure 1: Distribution of government adaptation investment, measured as environmental protection spending (% of GDP), across 44 countries over 2009–2023. The vertical line denotes the sample mean.

3.2 Model Specification

We estimate a panel OLS regression with country and year fixed effects:

$$\log(CDS_{it}) = \alpha_i + \lambda_t + \beta_1 Adapt_{i,t-2} + \beta_2 Vul_{it} + \beta_3 Ready_{it} + \gamma' X_{it} + \epsilon_{it} \tag{1}$$

where CDS_{it} denotes the sovereign credit default swap (CDS) spread of country i in year t. The term α_i represents country fixed effects that control for time-invariant heterogeneity across countries, while λ_t denotes year fixed effects capturing global shocks common to all countries. $Adapt_{i,t-2}$ measures government adaptation investment lagged by two years. Vul_{it} and $Ready_{it}$ are indices of climate vulnerability and institutional readiness, respectively. X_{it} is a vector of macroeconomic control variables, and ϵ_{it} is the idiosyncratic error term.

Risk Classification. To analyze heterogeneous effects, countries are classified into risk quartiles based on their *average sovereign CDS spreads* over the sample period. Countries in the top quartile of average CDS spreads are classified as high-risk (Q4), while those in the bottom quartile are classified as low-risk (Q1). Since higher CDS spreads reflect greater perceived default risk, this classification provides a market-based measure of sovereign risk.

Figure 2 illustrates the negative relationship between climate vulnerability and institutional readiness.

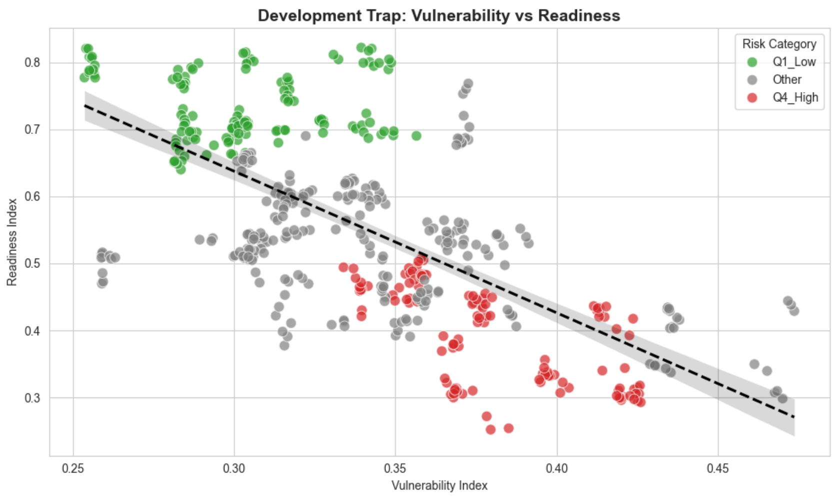

Figure 2: Relationship between climate vulnerability and institutional readiness based on ND-GAIN indices. Countries with higher vulnerability tend to exhibit lower institutional readiness, highlighting a potential development trap.

4 Empirical Findings

Our results indicate that the relationship between adaptation investment and sovereign risk is highly heterogeneous and depends on a country's risk profile.

4.1 The Resilience Premium in High-Risk Countries

In the full sample, adaptation investment is not significantly associated with CDS spreads. However, stratifying countries by risk reveals a clear divergence. For high-risk countries (Q4, high average CDS spreads), adaptation investment is strongly negative and statistically significant ($\beta = -0.635$, $p < 0.01$). This finding supports the existence of a resilience premium: markets reward adaptation spending in high-risk countries by lowering borrowing costs.

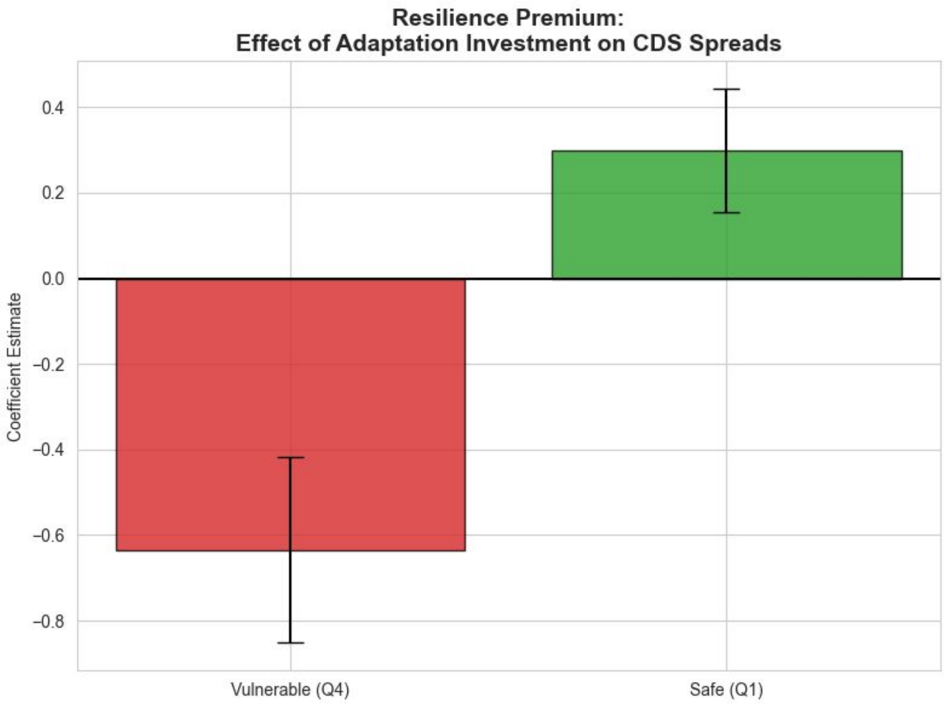

Figure 3: Estimated effect of lagged adaptation investment on sovereign CDS spreads, by sovereign risk quartile. Adaptation investment reduces CDS spreads in high-risk countries (Q4) but is associated with higher spreads in low-risk countries (Q1).

4.2 The Fiscal Burden in Low-Risk Countries

For low-risk countries (Q1, low average CDS spreads), adaptation investment is associated with higher CDS spreads ($\beta = 0.299$, $p < 0.05$). In these countries, markets may interpret adaptation spending as discretionary expenditure that may constrain fiscal space rather than as necessary risk mitigation.

4.3 The Role of Institutional Readiness

The interaction between adaptation investment and institutional readiness is positive and highly significant ($p = 0.001$). This indicates that adaptation spending is more effective in reducing sovereign risk when supported by strong institutions, suggesting that markets place greater confidence in adaptation efforts undertaken in countries with higher governance capacity.

4.4 Event Study Analysis

Event-study estimates around major disasters ($DisasterCount \geq 3$) show no significant immediate spike in CDS spreads for high-risk countries, indicating that disaster risk is largely priced into baseline spreads. However, even within disaster windows, lagged adaptation investment remains negative and significant.

5 Discussion and Limitations

5.1 Discussion in Light of the Literature

Our findings complement the theoretical predictions of Phan & Schwartzman (2024) by providing empirical evidence that physical adaptation investment is priced by sovereign credit markets, albeit selectively. While macroeconomic fundamentals remain the dominant determinants of CDS spreads, adaptation investment mitigates climate-related risk in highly exposed and high-risk countries.

5.2 Strengths and Weaknesses

Strengths: This study provides one of the first cross-country empirical analyses linking adaptation spending to sovereign CDS spreads. The use of interaction terms allows us to distinguish the role of institutional quality from spending levels alone.

Limitations: The sample is limited to countries with liquid CDS markets, environmental protection spending is an imperfect proxy for adaptation, and endogeneity concerns remain despite the use of fixed effects and lagged regressors.

6 Conclusion

This paper demonstrates that sovereign credit markets price climate adaptation investment in a heterogeneous manner. For high-risk countries, adaptation spending is associated with lower borrowing costs, consistent with a resilience premium. For low-risk countries, similar spending may be perceived as a fiscal burden. Crucially, the effectiveness of adaptation investment depends on institutional readiness.

These findings suggest that adaptation can play a meaningful role in reducing sovereign risk in vulnerable economies, provided it is supported by strong governance frameworks.

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Appendix

Data Sample (44 Countries)

Sample Period: 2009–2023 **Total Entities:** 44

Australia (AUS)	Austria (AUT)	Belgium (BEL)	Bulgaria (BGR)
Brazil (BRA)	Canada (CAN)	China (CHN)	Costa Rica (CRI)
Cyprus (CYP)	Czech Rep. (CZE)	Germany (DEU)	Denmark (DNK)
Egypt (EGY)	Spain (ESP)	Estonia (EST)	Finland (FIN)
France (FRA)	United Kingdom (GBR)	Greece (GRC)	Croatia (HRV)
Hungary (HUN)	Indonesia (IDN)	Ireland (IRL)	Iceland (ISL)
Israel (ISR)	Italy (ITA)	Japan (JPN)	Kazakhstan (KAZ)
Lithuania (LTU)	Latvia (LVA)	Netherlands (NLD)	Norway (NOR)
New Zealand (NZL)	Poland (POL)	Portugal (PRT)	Romania (ROU)
El Salvador (SLV)	Serbia (SRB)	Slovakia (SVK)	Slovenia (SVN)
Sweden (SWE)	Thailand (THA)	Ukraine (UKR)	South Africa (ZAF)

Appendix

Regression Output for Baseline,Interaction, and Robustness Results

Table 1: Baseline, Interaction, and Robustness Results

	All Countries			Q1: Low Risk		Q4: High Risk	
	Baseline	A×Vul	A×Ready	Mean	Median	Mean	Median
Adaptation Investment (lagged)	-0.077	-0.075	-0.070	0.299**	0.344**	-0.635***	-0.646***
	(0.125)	(0.123)	(0.109)	(0.144)	(0.142)	(0.216)	(0.220)
Climate Vulnerability	0.227	0.242	0.337	0.326	0.339	0.165	0.226
	(0.238)	(0.245)	(0.239)	(0.492)	(0.521)	(1.001)	(0.961)
Institutional Readiness	-0.117	-0.117	-0.062	0.164	0.078	-0.409	-0.401
	(0.231)	(0.232)	(0.211)	(0.256)	(0.242)	(0.305)	(0.284)
Adaptation × Vulnerability		0.034					
		(0.060)					
Adaptation × Readiness			0.256***				
			(0.078)				
Debt-to-GDP (log)	0.610***	0.613***	0.620***	0.550***	0.552***	0.761**	0.789***
	(0.139)	(0.140)	(0.129)	(0.179)	(0.192)	(0.316)	(0.298)
GDP Growth	-0.286***	-0.285***	-0.290***	-0.118**	-0.135**	-0.390***	-0.407***
	(0.065)	(0.065)	(0.066)	(0.050)	(0.052)	(0.054)	(0.054)
Inflation	0.118***	0.118***	0.129***	0.278***	0.308***	0.081***	0.086***
	(0.020)	(0.020)	(0.020)	(0.099)	(0.113)	(0.027)	(0.027)
Foreign Reserves	-0.014	-0.014	-0.017	-0.099	-0.069	-0.147	-0.210
	(0.012)	(0.012)	(0.011)	(0.079)	(0.064)	(0.309)	(0.306)
Constant	4.325***	4.336***	4.235***	3.179***	3.278***	4.453***	4.372***
	(0.011)	(0.025)	(0.028)	(0.518)	(0.534)	(1.161)	(1.106)
Observations	488	488	488	132	132	116	116
Countries	44	44	44	11	11	12	12
R^2 (Within)	0.062	0.061	0.107	-0.007	-0.023	0.379	0.403
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Dependent variable is the logarithm of 5-year sovereign CDS spreads (mean or median as indicated). All models include country and year fixed effects. Standard errors clustered at the country level are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.