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From words to deeds – incorporating climate risks into sovereign credit ratings

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Climate-related risks are increasingly recognised as an important threat to long-term fiscal sustainability, raising questions about the extent to which credit rating agencies integrate these risks into their sovereign rating assessments. This article addresses this question in a large sample of advanced, emerging and low-income economies using detailed measures of climate risks. It finds that higher temperature anomalies and more frequent natural disasters – measures of physical risk – lead to lower credit ratings. However, the overall impacts are low and their effects negligible compared with other rating determinants. Ambitious CO_2 reduction targets and actual emission reductions have been reflected in higher ratings, but only since the 2015 Paris Agreement, suggesting increased attention has been paid in recent years to risk related to the transition to a greener economy. Additionally, highly indebted countries and countries reliant on fossil fuel revenues have been assigned lower ratings post-2015, while exporters of transition-critical materials have received higher ratings. These findings highlight the need for caution in using credit ratings for regulatory and macroeconomic policy, as they seem to only partially account for environmental considerations.

Climate change can exert significant pressure on countries' fiscal positions. This occurs through well-documented channels, including rising costs associated with more frequent and severe natural disasters, essential investment in adaptation, and financing the transition to a green economy (Mallucci, 2022; Klusak et al., 2023; Volz et al., 2020; and Zenios, 2022). Sovereign credit ratings aim to measure a country's creditworthiness and should take these pressures into account. But do they?

Credit rating agencies (CRAs) have recognised that climate change can significantly affect sovereign ratings. For example, pressed by central banks and regulators,[2] CRAs have begun disclosing how they incorporate climate risks into their rating methodologies.[3] Major CRAs have also acquired stakes in firms specialising in climate risk data and analytics, as they strive to build capacity and expertise in evaluating climate-related financial risks.[4] Moreover, historical data show that natural disasters often lead to rating downgrades, especially for shock-prone, low-income countries.[5]

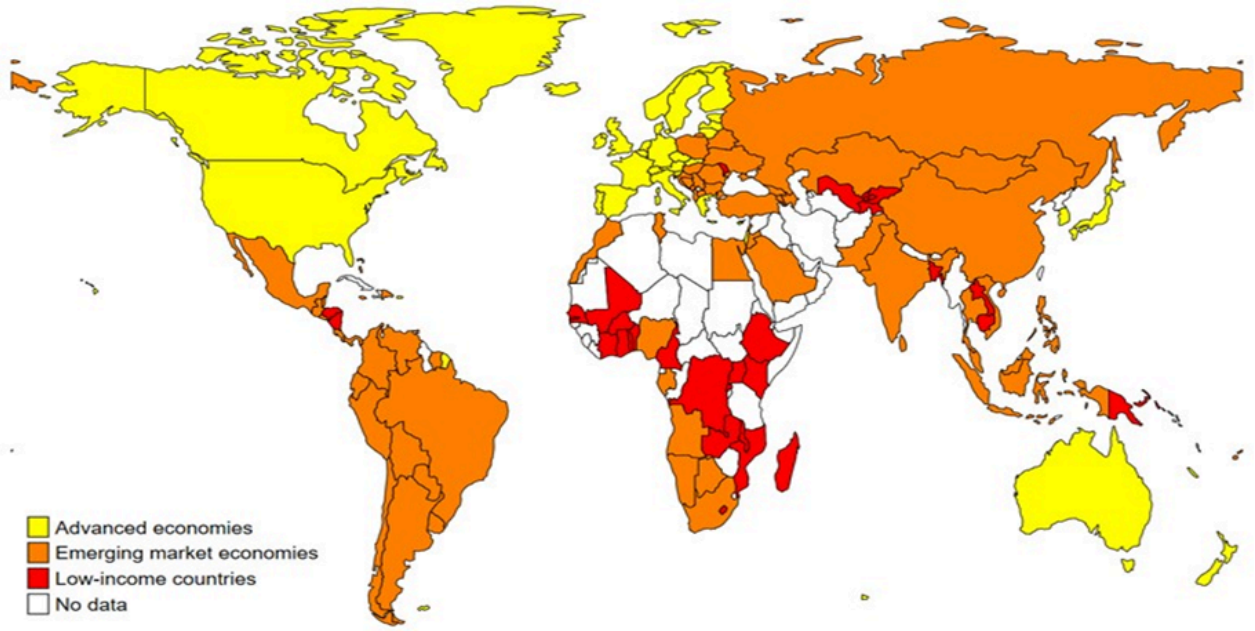
At the same time, several obstacles hinder the full and systematic integration of climate risks into CRAs' rating frameworks. These include data limitations, the high uncertainty about the economic impact of climate change, doubts about governments' commitments to net-zero emission targets, and the relatively short time horizon of credit ratings compared with the long-term nature of climate change (Kraemer, 2021).

Thus, the extent to which sovereign ratings incorporate climate risks is an empirical question. In our study (Cappiello et al., 2025), we examine whether CRAs include physical and transition climate risks in their

models and also whether they have assigned greater weight to climate-related factors since the Paris Agreement was adopted in 2015. Our analysis draws on data covering an extended period and a large sample of countries, including advanced, emerging and low-income economies (Figure 1).

Figure 1

Countries included in the analysis



Source: Cappiello et al. (2025).

Note: The dataset covers 124 countries in total, of which 33 are advanced economies, 62 emerging market economies and 29 low-income countries.

We focus on the sovereign ratings issued by the four major credit rating agencies – S&P Global Ratings, Moody's, FitchRatings and Morningstar DBRS. Because rating disagreement among these agencies is limited, with approximately 90% of ratings differing by no more than one notch since 1991, we use the average ratings across all these agencies as our dependent variable.

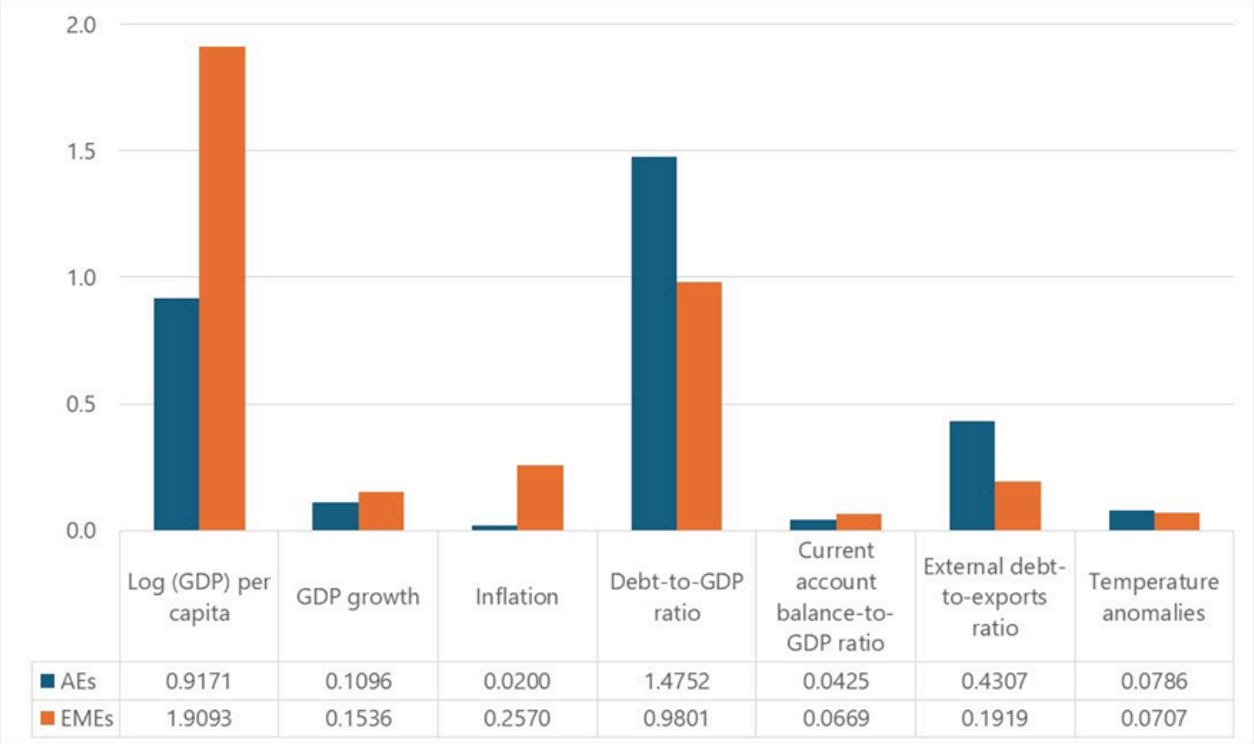
Our findings suggest that CRAs take physical risk exposure into account when assessing the probability of sovereign default, which is consistent with anecdotal evidence that natural disasters can lead to downgrades, particularly for low-income countries. Conversely, countries that are more resilient to extreme weather events – typically, advanced economies – tend to receive higher ratings.

However, transition risk factors, such as carbon emissions, primary energy consumption, and CO_2 reduction targets, are not reflected in ratings. Moreover, even when climate variables are statistically significant, they still only have a marginal impact on credit ratings (Figure 2).

Figure 2

Economic impact of temperature anomalies on sovereign credit ratings

(credit rating notches)



	Log (GDP) per capita	GDP growth	Inflation	Debt-to-GDP ratio	Current account balance-to-GDP ratio	External debt-to-exports ratio	Temperature anomalies
AEs	0.9171	0.1096	0.0200	1.4752	0.0425	0.4307	0.0786
EMEs	1.9093	0.1536	0.2570	0.9801	0.0669	0.1919	0.0707

Source: Cappiello et al. (2025).

Notes: The figure shows the absolute value of the effect of a (1% Winsorised) one standard deviation shock of macroeconomic and climate risk variables on sovereign credit ratings for advanced economies (AEs) and emerging market economies (EMEs). The impact elasticities are derived from a panel regression covering 124 countries over the period 1999-2021. The dependent variable is the average of the sovereign ratings issued by S&P Global Ratings, Moody's, FitchRatings and Morningstar DBRS.

Have CRAs changed their assessment of climate risks since the Paris Agreement?

The Paris Agreement marked a significant turning point in public awareness of the consequences of climate change and the urgent need for policy action. This heightened awareness has resulted in more stringent climate policies worldwide that increasingly warrant their inclusion in credit ratings. In addition, after the Paris Agreement was adopted in 2015, all major CRAs signed the UN Principles for Responsible Investment in May 2016, committing to systematically evaluate the relevance of environmental factors in credit assessments and to review how these factors are integrated into credit analysis. Thus, it is reasonable to conjecture that since these events CRAs have reassessed climate change risks and incorporated transition costs into their models for evaluating sovereign creditworthiness. To test this

hypothesis, we define a natural experiment using the Paris Agreement as an exogenous event that may have shifted CRAs' assessments of climate-related risks.

To determine whether major CRAs have updated their models to reflect this commitment to include environmental factors, we rank countries' exposures to climate risks using the Climate Change Risk Country Scoring Model developed by Ferrazzi et al. (2021). We categorise countries into two groups – countries with high exposure to climate risks (the treatment group) and those with low exposure (the control group) – using the median score as a divider. We apply a difference-in-difference methodology for estimation.

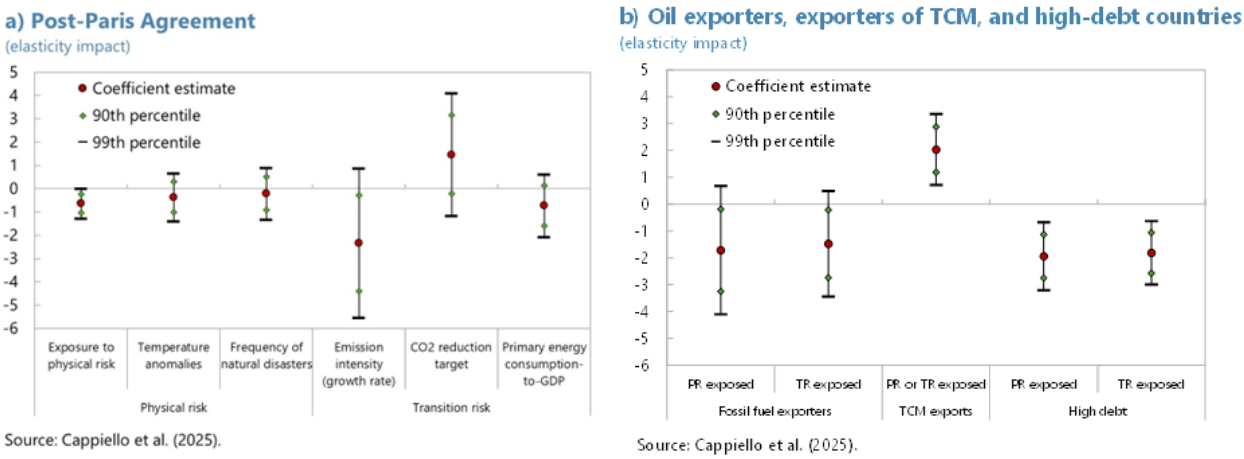
Our findings show that since the Paris Agreement CRAs have assigned lower ratings to countries with higher exposure to physical risk relative to the control group (Figure 3, panel a). This suggests that CRAs recognise that increasingly frequent natural disasters can have a significant impact on sovereign balance sheets, particularly in low-income countries, and that these risks should be adequately reflected in credit risk models. Additionally, we observe a shift in how CRAs evaluate transition risk, with higher ratings awarded to countries that commit to more ambitious CO_2 emission reduction targets and achieve lower CO_2 emission intensity post-Paris Agreement. This indicates that CRAs have started to "reward" countries, including smaller ones, that diversify away from reliance on fossil fuels and adopt cleaner energy sources.

The role of stranded assets, transition-critical materials, and fiscal capacity

Finally, we investigate three country-specific factors that may amplify or mitigate the effects of climate risk exposures: reliance on fossil fuel revenues, high sovereign debt levels and reserves of commodities crucial for the green transition. We find that these factors significantly influence sovereign ratings (Figure 3, panel b). Sovereigns more dependent on fossil fuel revenues and exposed to both physical and transition risks have tended to receive lower ratings since the Paris Agreement, likely owing to the "stranding" of assets, i.e. fossil fuel reserves potentially losing value before the end of their expected economic life owing to decarbonisation efforts. Additionally, countries with high sovereign debt generally receive lower credit ratings post-2015, indicating that high debt levels amplify climate risk exposures. The significant coefficients suggest that constrained fiscal capacity limits a country's options for mitigating the impacts of rising physical risk and for funding the green transition. Conversely, countries that are major exporters of transition-critical materials (TCM) – such as copper, graphite, nickel, manganese, lithium, cobalt and rare earths – tend to receive higher ratings despite climate risks.

Figure 3

Estimated effects of climate risks on sovereign credit ratings post-Paris Agreement



Source: Cappiello et al. (2025).

Notes: Panel a) shows coefficient estimates from six difference-in-difference models for physical risk (PR) and transition risk (TR). "Exposure to physical risk" is interacted with a post-Paris Agreement (PPA) dummy variable, set to one after 2015. "Temperature anomalies" and "Frequency of natural disasters" are interacted with the PR and PPA dummy variables. "Emission intensity" is interacted with the TR and PPA dummy variables. The "CO_2 reduction target" interacts with the TR dummy variable, while the "Primary energy consumption-to-GDP ratio" interacts with the TR and PPA dummy variables. Panel b) shows coefficient estimates from five difference-in-difference models, augmented with information on fossil fuel reliance, transition-critical material (TCM) exports, and indebtedness levels. The first two coefficients represent triple interactions among climate risk exposure dummy variables (PR and TR), the PPA dummy variable, and fossil fuel reliance, defined as a time-invariant dummy variable equal to one if the country is among the top 20 fossil fuel exporters. The third coefficient represents the triple interaction among an exposure dummy variable (to PR or TR), the PPA dummy variable, and TCM exports as a percentage of the country's total exports. The fourth and fifth coefficients represent double interactions between the PPA dummy variable and a high-debt dummy variable, set to one if the country's debt-to-GDP ratio in 2015 exceeds the median for advanced economies and emerging market economies prior to 2015. The sample period for all estimates is from 1999 to 2021.

Conclusions

Our results provide insights for market participants and policymakers, as credit ratings are widely used to assess the default probability of sovereign debt and are integral to various economic and regulatory policies. If sovereign ratings do not systematically reflect climate change risks, there is a risk of future asset repricing, which could transmit to different parts of the financial system, potentially affecting banks, insurers, and other financial institutions that hold sovereign bonds. This could lead to financial instability, if climate-related shocks cause sudden rating downgrades and asset value losses.

Moreover, underestimation of climate risks in credit ratings could mislead market participants into taking on risks which they are not fully aware of and which are therefore not adequately reflected in risk premia. Conversely, sovereigns that implement effective adaptation and mitigation measures may not receive

adequate rewards in the form of lower borrowing costs. When using sovereign debt as collateral in monetary policy operations, central banks may hold assets that are more vulnerable to climate-related shocks than they think, if the credit ratings used do not reflect climate risks. Therefore, our findings highlight the need for caution when using credit ratings for regulatory and macroeconomic policy, as these ratings appear to underestimate environmental factors.

References

Cappiello, L., Ferrucci, G., Maddaloni, A. and Veggente, V. (2025), "Creditworthy: do climate change risks matter for sovereign credit ratings?", *Working Paper Series*, No 3042, ECB, Frankfurt am Main, March.

Ferrazzi, M., Kalantzis, F. and Zwart, S. (2021), "Assessing climate change risks at the country level: the EIB scoring model", *Working Paper Series*, No 2021/03, European Investment Bank.

Klusak, P., Agarwala, M., Burke, M., Kraemer, M. and Mohaddes, K. (2023), "Rising Temperatures, Falling Ratings: The Effect of Climate Change on Sovereign Creditworthiness", *Management Science*, Vol. 69, No 12, pp. 7468-7491.

Kraemer, M. (2021), "The future is today: Why truly long-term sovereign ratings are needed now", *CEPS Policy Insights*, No 2021-11, September.

Mallucci, E. (2022), "Natural disasters, climate change, and sovereign risk", *Journal of International Economics*, Vol. 139, 103672.

Volz, U., Beirne, J., Ambrosio Preudhomme, N., Fenton, A., Mazzacurati, E., Renzhi, N. and Stampe, J. (2020), *Climate Change and Sovereign Risk*, SOAS University of London, Asian Development Bank Institute, World Wide Fund for Nature Singapore and Four Twenty Seven, London, Tokyo, Singapore, and Berkeley, California.

Zenios, S.A. (2022), "The risks from climate change to sovereign debt", *Climatic Change*, Vol. 172(30), pp. 1-19.

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2.

For example, in 2024 the European Securities and Markets Authority proposed amendments to the CRA Regulation (EU Delegated Regulation 447/2012), with the aim of enhancing transparency regarding the integration of climate factors into credit rating methodologies.

3.

S&P Global Ratings, Moody's, FitchRatings and Morningstar DBRS published several documents to explain the role of environmental, social and corporate governance (ESG) factors in their sovereign rating assessments (for an overview, see Table 14 in Cappiello et al., 2025).

4.

For instance, Moody's acquired majority stakes in Four Twenty Seven and Vigeo Eiris. S&P Global Ratings purchased the ESG rating business of RobecoSAM in 2019. Morningstar DBRS acquired Sustainalytics in 2020, and Fitch Group launched Sustainable Fitch in 2021 to provide ESG ratings for financial instruments.

5.

For example, S&P Global Ratings downgraded Grenada's sovereign credit rating following Hurricane Ivan in 2004, citing concerns about debt repayment priorities and fiscal pressures. Similarly, Moody's downgraded St. Maarten's rating following Hurricane Irma in 2017, and FitchRatings downgraded Namibia's rating in 2019, attributing the decision to economic weakness exacerbated by severe drought conditions. In 2022 Pakistan's rating was also downgraded by FitchRatings owing to widespread flooding that diminished foreign exchange reserves and aggravated external liquidity and funding conditions.