Research

How could climate change impact sovereign risk?

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Table of contents

Executive summary

In this paper, we introduce the notions of climate risks and how they would translate into sovereign risk. Physical risks correspond to the potential economic and financial losses caused by climate-related hazards and are divided in two categories: acute hazards and chronic hazards. Transition risks can be defined as the risk of economic dislocation and financial losses associated with the process of adjusting toward a low-carbon economy and can be divided in three main sources: the level of ambition and the speed of the transition, the anthropogenic greenhouse gas (GHG) content of the energy mix and the energy intensity of the economy. Physical risks could weigh on fiscal expenditures due to adaptation costs and lower fiscal revenues, with potential global warming impacts on economic activity. Furthermore, migration induced by climate change could increase political instability in the host countries. Transition risks could impact fiscal expenditures through mitigation costs, and there is some risk in terms of transition policy management.

Introduction

The concept of climate risk has gathered considerable momentum over the course of the past two decades, culminating in the agreement of the Parties (COP) during the Paris 21st Conference in 2015. It set ambitious country-level carbon emission targets with the long-term objective to limit the increase of global average temperature to well below 2 °C above pre-industrial levels (1850-1900), and to limit the increase to 1.5 °C by 2100 – a level widely regarded as the threshold for substantially reducing the societal and economic impact of climate change. A wide spectrum of financial markets participants, such as investors, asset owners or central banks, are increasingly becoming aware of the issues related to the physical climate risks and the associated economic costs. While the level of awareness of the physical risks of climate change has never been higher, the complexity of the various climate risks factors and how they may impact specific financial assets is less well explored. This can be attributed to many factors, particularly the time-horizon of climate risks: paradoxically, the significant cost of climate change is back-loaded for future generations, and the current one has almost no direct incentive to address it. This, coupled with the inherent short-termism observed in the capital markets, lack of incentives for the current generation of market participants and the less-well understood interplay between a combination of financial and climate risk factors, suggests that markets require transparent and objective research and investment tools to help manage the emerging risks of climate change for a range of asset classes, including sovereign bonds.

The longer investment horizon of the sovereign bond asset class aligns well with the forecasted economic costs and associated challenges of climate change. Climate risks are likely to materialize well beyond the general short-term perspectives of financial investments but are likely to affect the long-term investment horizon of sovereign bond investors, such as banks and asset owners. Therefore, alongside traditional fundamental sources of relative value and risk, such as the perceived health of government finances, inflation expectations and the future path of interest rates, sovereign bond investors should increasingly consider the materiality of climate change.

As sovereign bonds represent an important asset class in the credit market, this seems to be a key part to address. In this paper, we introduce what could be the impact of climate change for sovereigns *via* the changes in fiscal policy, social contract and political stability, in both advanced and emerging economies.

First, we discuss the characterization of climate risks, which can be divided between climate physical and transition risks. Second, we address the concern of the financial impact of these risks.

We try to address both topics in this paper, introducing the integration of climate risks in sovereign risk assessment.

Defining climate risks

Climate risks, as defined by Mark Carney in his famous 2015 speech "*Breaking the tragedy of the horizon: climate change and financial stability*"[1], are composed of two main sources: physical and transition risks. Each one would translate in rising financial instability in the future.

Physical risks: Climate-related hazards

Physical risks correspond to the potential economic and financial losses caused by climate-related hazards (Monnin, 2018[2]). They can be divided in two main categories: (i) acute hazards and (ii) chronic hazards.

Acute hazards

Climate-related hazards are considered acute when they arise from extreme climate events, such as severe storms, cold waves, droughts, or floods (Monnin, 2018). As highlighted by Chart 1, floods and storms or cyclones were the most frequent acute hazards between 1998-2017. Within these acute hazards, literature focuses mostly on cyclones and hurricanes, as 35% of the global population is seriously at risk from tropical cyclones (Hsiang and Jina, 2014[3]), making them one of the most broadly relevant forms of disasters, in addition to being one of the costliest (Bevere *et al*., 2011[4]).

Due to climate warming, the intensity of cyclones is expected to increase by 2-11% by 2100 as well as the frequency by 6-34% on global average, as the temperature increase at the surface of the ocean is a key driver in the formation of cyclones (Knutson *et al.* 2010).

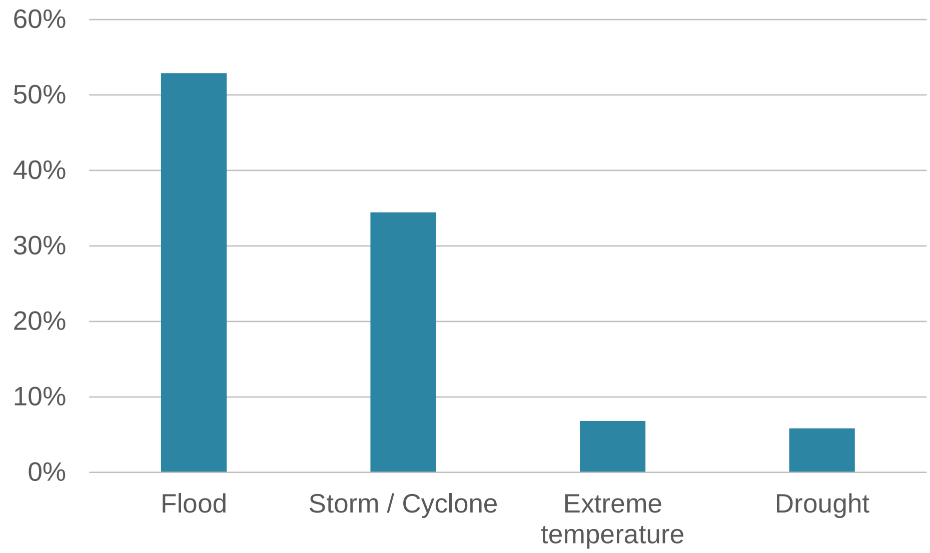
[1] https://www.bis.org/review/r151009a.pdf

[2] Monnin, P. (2018). Integrating Climate Risks into Credit Risk Assessment-Current Methodologies and the Case of Central Banks Corporate Bond Purchases. Council on Economic Policies, Discussion Note, 4.

[3] Hsiang, S. M., & Jina, A. S. (2014). The causal effect of environmental catastrophe on long-run economic growth: Evidence from 6,700 cyclones (No. w20352). National Bureau of Economic Research.

[4] Bevere, L., Rogers, B., & Grollimund, B. (2011). Natural catastrophes and man-made disasters in 2010: A year of devastating and costly events. National Emergency Training Center.

Chart 1. Share of Acute Hazards per Type, 1998-2017



Sources: CRED, UNISDR, Beyond Ratings

Chronic hazards

Climate-related hazards are considered chronic when they arise from progressive shifts in climate patterns, such as increasing temperature, sea-level rise and changes in precipitation (Monnin, 2018).

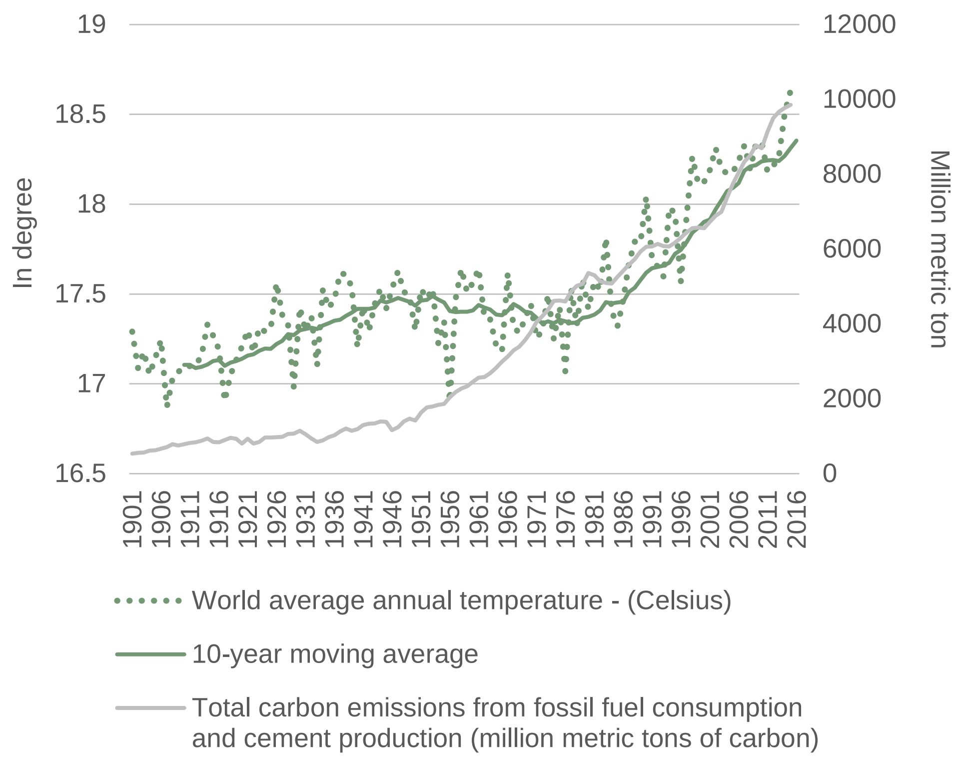
Since the turn of the 20th century, the Earth's average surface temperature has increased significantly (by 1.5°C, see Chart.2). The speed at which this increase has taken place in the past 30 to 40 years appears to be unprecedented in the past twenty thousand years (Mejia *et al.*, 2018[5]). Most scientists agree that such global increase is mainly driven by anthropogenic greenhouse gas (GHG) emissions, the central cause of global warming (Intergovernmental Panel on Climate Change, 2014[6]). This causality between GHG emissions and temperature increase is due to radiative forcing, corresponding to the GHG concentration in the atmosphere and generally measured in watt per square meter (W/m^2) or in part per million air molecules (ppm). Scenarios of temperature increase are set according to scenarios on evolution of this GHG concentration, the representative concentration pathways (RCP).

Although considerable uncertainty prevails on temperature projections, the scientific consensus predicts that without further action to tackle climate change, average temperatures could rise by 4°C or more by the end of the century if no mitigation policy is set (Mejia *et al.*, 2018).

[5] Mejia, M. S. A., Mrkaic, M. M., Novta, N., Pugacheva, E., & Topalova, P. (2018). The Effects of Weather Shocks on Economic Activity: What are the Channels of Impact?. International Monetary Fund.

[6] Geneva, S. (2013). Intergovernmental Panel on Climate Change, 2014. Working Group I Contribution to the IPCC Fifth Assessment Report. Climate Change.

Chart 2: Temperature Increase and Carbon Emissions



Note: Average global temperature has already risen by around 1.5°C since 1900. In the same time, carbon emissions from fossil fuel consumption and cement production has increased by more than 9 000 million metric tons.

Sources: World Bank, Beyond Ratings, Carbon Dioxide Information Analysis Center

Transition risks: Meeting the target

Every year, the level of global CO2 emissions increases (emissions from fossil fuel consumption and cement production have increased by more than nine thousand million metric tons since 1900, see Chart 2). As previously mentioned, the Paris 21st COP in 2015 sets the long-term objective to limit the increase of global average temperature to well below 2 °C above pre-industrial levels (1850-1900), and to limit the increase to 1.5 °C by 2100. This implies ambitious plans toward the decarbonation of economies. This mitigation strategy would lead to transition risks, which can be defined as the risks of economic dislocation and financial losses associated with the process of adjusting toward a low-carbon economy (Monnin, 2018). Transition risks are driven by three main categories: (i) the level of ambition and path of the transition (ii) GHG content of the energy mix and (iii) energy intensity of the economy.

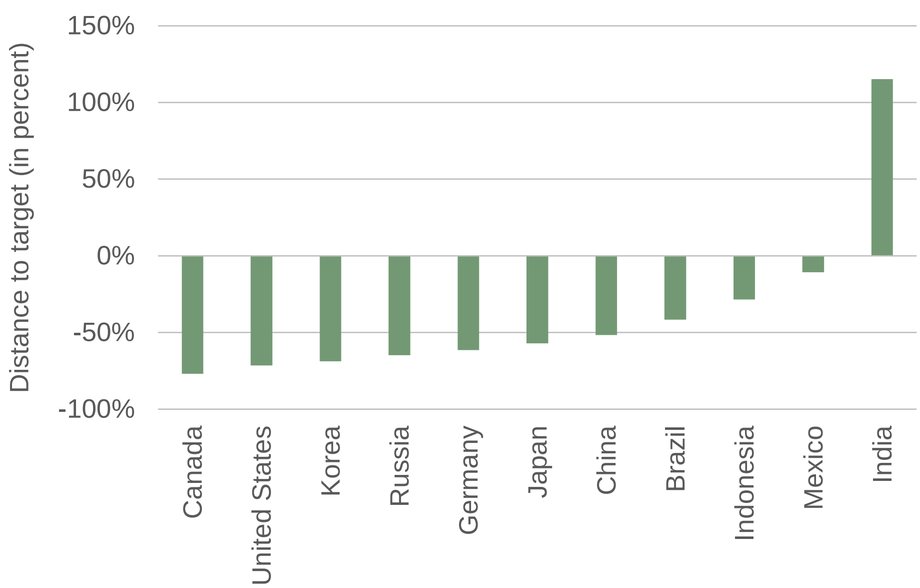
Ambition level and transition path

More commonly used goals, in terms of transition, include a level of GHG emissions, which leads to a limited increase in global temperatures of either 1.5°C or 2°C by 2100. The first target is the most ambitious and the one that minimizes the physical damages of climate change. The second target corresponds to the objectives of the Paris Agreement (2015).

The Paris Agreement binds all signatories to provide Nationally Determined Contributions (NDCs), an outline of each country’s strategy to reducing GHG emissions. Given that the sum of current NDCs would result in an average temperature increase in 2100 of the order of 3°C to 3.2°C (Giraud *et al.*, 2017[7]), a national “carbon budget” (distance between the current GHG emissions level and this determined GHG emissions target) compliant with the 2°C objective has been determined using the *Beyond Ratings’ Climate Liabilities Assessment Integrated Methodology* (CLAIM). This carbon budget corresponds to the amount of efforts needed in order to be 2°C compliant. The further the distance, the higher the efforts required to meet the transition target. The path itself, toward a reduction of emissions, can also have consequences for transition risks. Indeed, for an identical level of cumulative emissions reductions, an early and smooth transition should result in lower transition risks, compared to a late and sudden transition.

Chart 3 represents the distance to target in 2030 for the 10 most GHG emitting countries in 2015. Required efforts are huge for the United States (-72% of GHG emissions) or Canada (-78%). Noteworthy, the CLAIM methodology attributes to India a carbon budget far higher than its current emissions (mainly due to the demographic factor).

Chart 3: 2015 GHG Emissions Distance to Target (2030)



Source: Beyond Ratings

GHG content of the energy mix

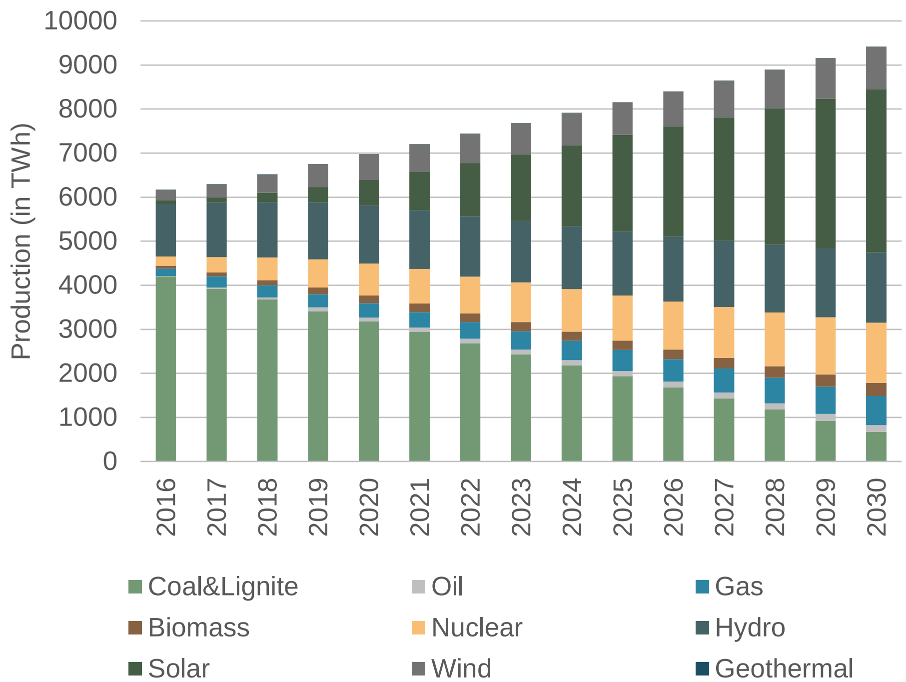
The importance of energy on GHG emissions is reflected by the fact that about 65% of emissions in the world are currently due to the use and production of energy (Marrero, 2010[8]). Therefore, the current carbon content of the country’s energy mix and its optimal decarbonation is an important part when considering transition risks. Chart 4 shows the optimal trajectory of energy mix decarbonation

[7] Giraud, G., Lantremange, H., Nicolas, E., & Rech, O. (2017). National carbon reduction commitments: Identifying the most consensual burden sharing.

[8] Marrero, G. A. (2010). Greenhouse gases emissions, growth and the energy mix in Europe. Energy Economics, 32(6), 1356-1363.

toward 2030 for China (Beyond Ratings' National Climate and Investment Pathway *Methodology*). Coal-fired generation is gradually replaced by solar and wind generation. The share of renewable energy (including hydroelectric production) increases from 25% today to 80% in 2030.

Chart 4: Estimation of a Chinese Electricity Mix That Respects a 2°C Scenario



Source: Beyond Ratings

Energy intensity of the economy

Beside GHG intensity of the energy mix, another topic when assessing the risk linked with the overall GHG contents of an economy is the energy intensity of the output. Indeed, the impact of energy consumption on emissions would depend both on the primary energy mix and on the final use of this energy (Marrero, 2010). Meeting the emissions reduction target requires also to decouple energy and economic growth by minimizing energy intensity of the economic structure.

This component of transition risks is driven by: (i) the energy efficiency and (ii) the sectoral distribution of the economy. The first is linked to the country's progress in technology, while the second is related to the choice of specialization of the country. Ultimately, both tends to be concomitant with the level of development.

How do climate risks translate into sovereign risk?

Once climate risks are described, one should ponder how these risks could translate into sovereign risk. Indeed, ultimately, the economic impacts of both physical and transition risks will weigh on public finances, and the social impacts could lead to an increase in political instability.

Physical risks: Impact would be non-linear

Climate-related hazards disrupt the economy and potentially stress a country's financial and political stability. In this section, we analyze how physical risks could affect: (i) fiscal revenues; (ii) fiscal expenditures and (iii) political stability.

Impact on fiscal revenues

Burke *et al.* (2015[9]) highlight the non-linear effect of increasing temperature on economic output. Indeed, labour productivity exhibits highly non-linear responses to local temperature for all countries (even in advanced economies). The authors show that productivity is peaking at an annual average temperature of 13°C, declining strongly at higher temperatures. These results illustrate that economic activity in all regions is coupled to the global climate, and indicate that, if future adaptation follows past adaptation, unmitigated warming is expected to reshape the global economy by reducing average global incomes by roughly 23% by 2100, relative to scenarios without climate change. This declining productivity would affect government finances, as tax revenues are tied to the economic output.

Adaptation costs would weigh on fiscal expenditures

Alongside standard set of macroeconomic and structural policies, the International Monetary Fund (IMF) highlights in a recent working paper (Meija *et al.,* 2019[10]) the need for specific strategies designed to adapt to climate change. These investments in "*climate-smart infrastructure*" (for example irrigation, drainage or seawalls) illustrate the adaptation costs of climate change, which are expected to particularly weigh on low-income countries government fiscal policy (Meija *et al.,* 2019).

Climate migration could lead to increasing political instability

In addition to impacts on public finances, political instability could rise due to climate risks issues. This political instability could come from rising inequality, both within and between countries. As a distributional effect between countries, one could mention potential risks due to coming climate migration. Indeed, as highlighted by Black *et al.* (2011[11]), the effects of global environmental change, including coastal flooding, reduced rainfall in drylands and water scarcity, will almost certainly alter patterns of human migration, leading to important population movements. As people living in less developed countries may be more likely to leave affected areas, that may cause conflicts in receiving areas (Reuveny, 2007[12]). Finally, within a country, climate change could lead to higher

[9] Burke, M., Hsiang, S. M., & Miguel, E. (2015). Global non-linear effect of temperature on economic production. Nature, 527(7577), 235.

[10] Mejia, M. S. A., Baccianti, C., Mrkaic, M. M., Novta, N., Pugacheva, E., & Topalova, P. (2019). Weather Shocks and Output in Low-Income Countries: The Role of Policies and Adaptation. International Monetary Fund.

[11] Black, R., Bennett, S. R., Thomas, S. M., & Beddington, J. R. (2011). Climate change: Migration as adaptation. Nature, 478(7370), 447.

[12] Reuveny, R. (2007). Climate change-induced migration and violent conflict. Political geography, 26(6), 656-673.

inequality due to some of the economic effects of slow growth regime (the *Piketty hypothesis*, Jackson *et al.,* 2016[13]).

Transition risks: Managing mitigation policy

Efforts needed to meet the emissions target would be a function of both the ambition of emissions reduction and the path towards this transition. This could translate into sovereign risk through channels such as: (i) the mitigation costs and (ii) the potential negative impact of abrupt changes in tax policy on fiscal revenues.

Mitigation costs

Regarding the fiscal implications of transition issues, emphasis should be put on the efficiency of government spending for mitigation. Indeed, green fiscal policy is not confined only to the use of taxes to incentivize more environmentally friendly production, transportation and consumption patterns, but it has also to do with government spending (through subsidies and investment) that affects the use of renewables, energy efficiency, energy storage, etc. Regarding the efficiency of this mitigation investment, literature states that: "*green subsidies and green public investment improve ecological efficiency, but their positive environmental impact is partially offset by their macroeconomic rebound effects. A green fiscal policy mix derives better outcomes than isolated policies*" (Dafermos and Nikolaidi, 2019[14]).

Negatively impacted industries could lower fiscal revenues

A poorly managed transition policy could lead to shocks on economic activity. Indeed, depending on the respective country's size of fossil fuel or renewable energy sectors, green policies, such as carbon taxes would impact positively or negatively firms' profitability, and then the economic activity.

This phenomenon is highlighted by Battiston and Monasterolo (2019[15]): "*2°C-aligned climate mitigation scenarios […] leads to unanticipated shocks in economic trajectories of fossil fuel and renewable energy sectors* […]". This leads to potential shocks from firms' profitability to sectors' gross value added, and then would impact sovereign fiscal revenues.

Further research

Monitoring indicators, such as those mentioned in this study, can help to highlight potential weaknesses in terms of physical or transition risks, as well as the resilience of the country (and potential increase in political instability in case of a lack of resilience). In further research, emphasis should be put on modelling more precisely what could be the financial impact of climate risks in the sovereign asset class.

[13] Jackson, T., Victor, P., & Naqvi, A. (2016). Towards a stock-flow consistent ecological macroeconomics (No. 114). WWWforEurope Working Paper

[14] Dafermos, Y., & Nikolaidi, M. (2019). Fiscal policy and ecological sustainability: A post-Keynesian perspective (No. PKWP1912).

[15] Battiston, S., & Monasterolo, I. (2019). A Climate Risk Assessment of Sovereign Bonds' Portfolio. Available at SSRN 3376218.

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