Net zero sovereign bond portfolios

Katharina Schwaiger,[1] Riyadh Ali[2] and Andrew Ang[3]

Abstract

We seek to construct fixed income portfolios for sovereign bonds with climate insights. Our climate methodology for sovereign bonds can be applied as an overlay on any benchmark and tilts towards sovereigns more prepared for the transition to a low-carbon economy and away from those which are less prepared. The tilts seek to reduce sovereign carbon emissions in line with the Paris Agreement. Carbon emissions are represented by historical emissions, and we add forward-looking transition metrics to represent a country's future preparedness. We report findings for both developed markets and emerging markets sovereign portfolios and show that improved climate metrics may be achieved while retaining a similar risk-return profile vis-à-vis the benchmark.

JEL classification: G11, G28, Q54, Q56.

[1] BlackRock, katharina.schwaiger@blackrock.com.

[2] BlackRock, riyadh.ali@blackrock.com.

[3] BlackRock, andrew.ang@blackrock.com.

1. Introduction

Sovereign bonds can be important for many investors as a potential source of safety, liquidity, income and diversification, and as a source of returns. In addition, many investors are mandated to hold government bonds. Despite the central role of sovereign bonds in investor portfolios, there are few studies that integrate environmental, social and governance (ESG) considerations or seek to reduce carbon emissions in this asset class – in contrast to the now large literature integrating ESG and decarbonising portfolios in equities. In this paper, we seek to show how investors can potentially meet climate objectives in sovereign bond portfolios for both developed markets and emerging markets.

We show how to take into account environmental considerations in sovereign allocations, with a particular focus in tilting sovereign portfolios in efforts to reduce carbon emissions. Our framework can be interpreted as tilts to E (the environmental component of ESG) for sovereigns better prepared for the transition to a low-carbon economy. The tilts seek to satisfy the requirements to be a Paris-Aligned Benchmark (PAB), in line with the recommendations set by the European Union Technical Expert Group on Sustainable Finance (EU TEG (2019)) and the guidelines issued by the Institutional Investors Group on Climate Change (IIGCC (2021)) to try to limit average global temperature increases to well below 2°C by the end of the 21st century as specified by the 2015 Paris Agreement. The sovereign climate tilts can be dialled up or down, according to investors' risk preferences, and overlaid on any sovereign benchmark.

As an example of our sovereign climate framework, we assume a sovereign benchmark that obtains a long-run, diversified sovereign exposure. We compute the alphas implied by the benchmark weights and use those in an optimisation, imposing constraints that lower carbon emissions and uplift sovereign environmental (E) characteristics. Thus, we obtain a maximal risk-return portfolio with improved sovereign E criteria. The flexibility of incorporating any sovereign benchmark is important given the large sovereign bond allocations by many investors and the risk-reducing role of sovereign bonds during stress periods (see recently, for example, Jacobsen and Lee (2020); Ren et al (2020)). Additionally, governments have an essential role in reducing global warming by setting frameworks and incentives to reduce carbon emissions. Therefore, the inclusion of E data, such as carbon emissions, in sovereign allocations recognises this impact.

The literature investigating ESG and climate influences on sovereign and corporate bonds is still relatively small. Cevik and Jalles (2020) find that climate change has impacted sovereign bond yields: climate change affects the resilience and vulnerability of economies and government budgets, in excess of traditional determinants of sovereign risk. This makes it more urgent to show how to take into account sustainable information into sovereign bond allocations – especially as potential predictors of excess returns. An older literature has examined how country ratings or political risk is priced in markets, with early papers being Howell and Chaddick (1994) and Erb et al (1996), but these studies concentrate mainly on equity markets. Our results are consistent with Martinelli and Vallee (2021) and Rahman et al (2021) who show that taking into account ESG considerations in sovereign bonds does not detract from returns, but our focus is on meeting the requirements of a Paris-aligned sovereign bond portfolio with climate-related sovereign metrics. Our approach is most similar to Kaul et al (2021) in specifying a tracking error optimisation with constraints incorporating lower carbon emissions and improved climate criteria, but with further analysis, and we also examine climate-aware sovereign EM portfolios. In particular, we highlight the relationship between tracking error, or active risk, relative to exogenous sovereign benchmarks that are needed to implement the climate-aware tilts.[4]

The rest of this paper is organised as follows. In Section 2, we describe climate data on a country level – both current but also forward-looking. In Section 3, we describe a proposed optimisation framework to take into account climate considerations in sovereign bonds, focusing on constructing climate-aware sovereign bond portfolios. We present the empirical hypothetical results in Section 4. The final section concludes.

2. Data

Sovereign debt has been an important part of investor portfolios since the development of international sovereign debt markets in the 1820s (see Flandreau and Flores (2009)), but only recently have sovereign sustainability priorities become important considerations for investors. In this section, we focus on integrating climate (ie Environmental, or E) aspects of sovereigns in an investment strategy. Governments have perhaps the most important role in reducing climate externalities (see, for example, Nordhaus (2021)). Providers of sovereign ESG scores also place a significant weight on E characteristics, such as those published by the World Bank (Gratcheva et al (2020)).

While our framework is relevant for any sovereign bond portfolio, in our empirical work we specify a sovereign benchmark for developed markets and for emerging markets. For developed markets the benchmark consists of equal-weighted 10-year bond futures in Australia, Canada, Germany, Japan, the United Kingdom and the United States. For emerging market economies (EMEs), the benchmark consists of equal-weighted 10-year bond futures in India, Korea, Mexico, Poland, South Africa, Singapore and Thailand. These represent some of the most liquid and frequently traded developed and EME sovereign bonds as of March 2023. China may be another country to include and, despite being the world's largest absolute emitter of greenhouse gases, it ranks well in the cross section using the greenhouse gas emissions per capita metric and as a country it has committed to carbon neutrality by 2060.[5]

We use two data sets that measure a country's emission as well as climate profile: carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions as well as the Germanwatch Climate Change Performance Index (CCPI) for each country. GHG emissions other than CO_2 include methane, nitrous oxide and hydrofluorocarbons and other fluorinated gases (perfluorocarbons and sulphur hexafluoride).[6] The CO_2 data contain emissions related to fossil fuel use and industrial processes such as cement production. Our data on CO_2 and GHG emissions are obtained from MSCI

4 Diversification and asset allocation may not fully protect you from market risk.

5 See for example: China – Climate Performance Ranking 2023 | Climate Change Performance Index (ccpi.org).

6 Non-CO2 emissions defined under the Kyoto protocol are found in Annex A of https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf.

and are stated in emissions per capita per year in terms of tonnes per capita. We have CO_2 and GHG emissions at the country level from 2019.

The Germanwatch CCPI incorporates forward-looking metrics and policy assessment relevant for a country's alignment with the Paris Agreement. The data set covers 57 countries and the EU; these countries account for more than 90% of global GHG emitters and data are available since 2005.[6] The CCPI assesses each country's performance in four categories: GHG Emissions (40% of the overall ranking), Renewable Energy (20%), Energy Use (20%) and Climate Policy (20%).[7] We take CCPI data from 2017 since the underlying methodology of the CCPI has been revised and adapted to the new climate policy landscape of the Paris Agreement since that date.[8] Countries can achieve a rating of up 100 and can further be classified into a Very High, High, Medium, Low and Very Low rating. Only a Very High rating would suggest that the country is aligned with the Paris agreement, but as of 2023 no country has achieved that rating yet.

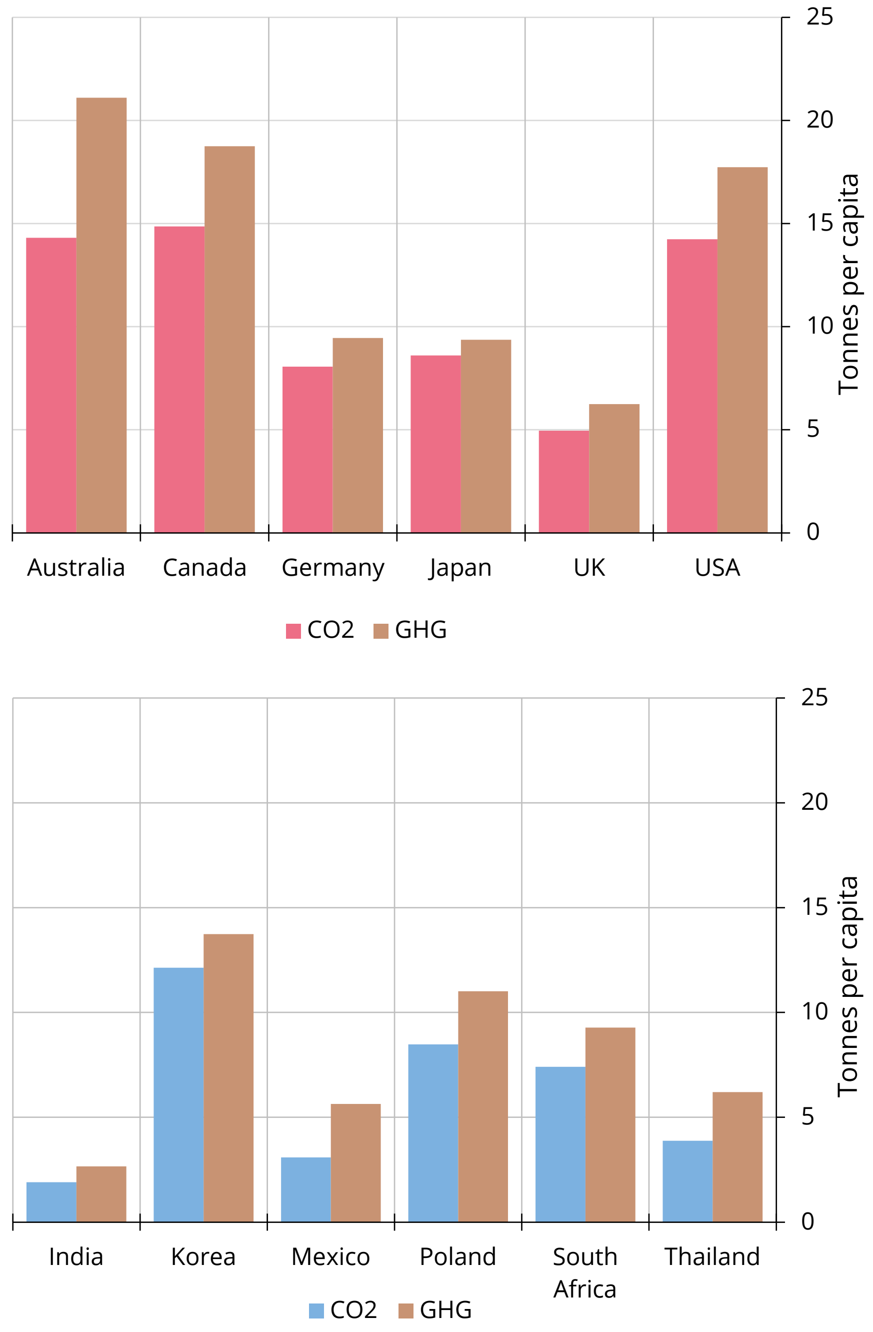
Graph 2.1 graphs the latest GHG and CO_2 emissions per capita, and Graph 2.2 shows the latest CCPI profiles for the countries in our investment universe consisting of Australia, Canada, Germany, Japan, the United Kingdom and the United States, as well as India, Korea, Mexico, Poland, South Africa and Thailand as of the last update in January 2023. The emissions data are reported as April 2021. Since $CO_2$is the major component of GHG emissions, both CO_2 and GHG are highly correlated, at around 95% across the developed markets countries in the cross section. Australia has amongst the highest emission intensity of both CO_2 and GHG, at 14.31 and 21.1 tonnes per capita, respectively, followed by Canada and the United States, while the United Kingdom has the lowest within the group, at 4.95 and 6.24 tonnes per capita, respectively. For EMEs, Korea has the highest per capita emissions at 12.13 (CO_2) and 13.74 (GHG), while India has the lowest within the group, at 1.9 and 2.66 tonnes per capita, respectively. Looking at the CCPI scores at 2023 (Graph 2.2), the United Kingdom is ranked the highest by CCPI (with a score of 63.07) in our developed market universe, followed by Germany and Japan. Canada is the worst with a score of 26.47. For our EME universe, India has the highest score at 67.35, followed by Mexico, while Korea has the lowest with 24.91.

7 The full set of metrics included in the CCPI are described at ccpi.org/methodology.

8 The methodology was revised to include emissions from deforestation by CCPI in 2013. Some other sectors, such as agriculture, were not included until 2017 due to data issues. In 2018 the methodology changed to include all GHG emissions (from only energy-related CO2) and Germanwatch began to started to check whether countries set their targets correctly and are fulfilling their promise made in 2015 at the climate conference in Paris.

GHG and CO_2 emissions per capita by country | Graph 2.1

Tonnes per capita

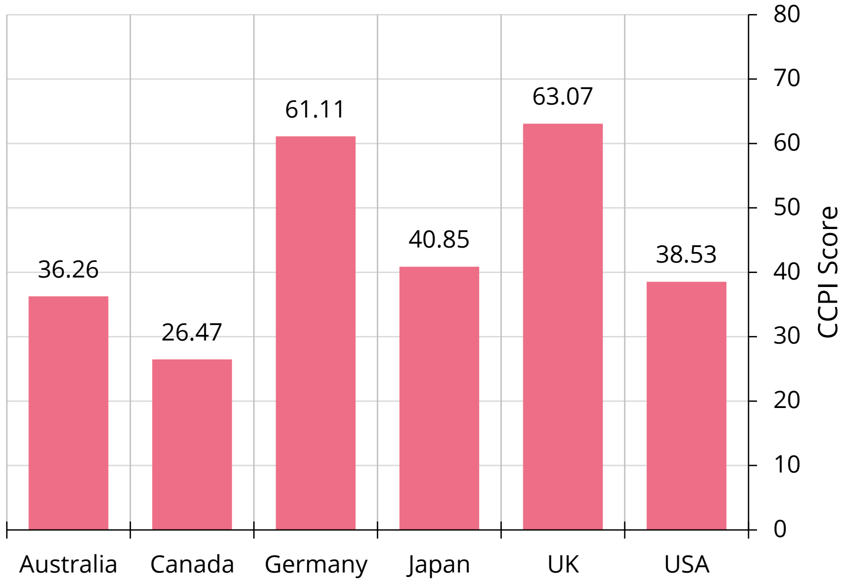


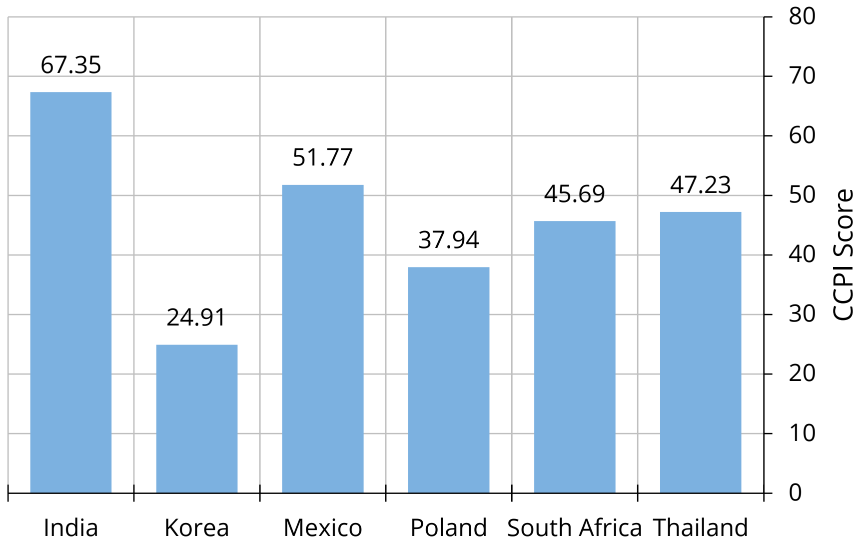
Source: MSCI. Data as of January 2023.

Climate Change Performance Index (CCPI) score for DM and EM countries

Graph 2.2

Score





Source: CCPI. Data as of January 2023.

3. Methodology

Our approach is motivated by the need to limit global temperature warming to well below 2°C by the end of the 21st century, which was the aim of the Paris Agreement adopted by 186 countries in 2015. According to the most recent Sixth Assessment of the Intergovernmental Panel on Climate Change (IPCC (2021)), this goal requires significant and ongoing decreases in greenhouse gas (GHG) emissions to approach the same level of carbon emissions as in 1850–1900 by 2050, which is the net zero transition.[9] In order to help investors align their portfolios with these climate goals, the European Union has adopted a set of standards developed by the Technical Expert Group on Sustainable Finance (EU TEG (2019)). These were adopted into law by the EU in 2020.[10] In addition, we also follow the guidelines issued by the Institutional Investors Group on Climate Change (IIGCC (2021)), which were also formulated to help investors meet the Paris Agreement goals.

We take as given a well diversified sovereign benchmark. Relative to that benchmark, we specify a series of tilts which overweight the countries best prepared for the transition and tilt to those countries with lower carbon emissions. Conversely, we reduce the positioning in countries with poor alignment to the Paris Agreement and countries with higher carbon emissions. This seeks to align with the recommendations outlined by the EU TEG and IIGCC, which specify to "tilt portfolios towards higher performing issuers… to the maximum extent possible, exceeding the average benchmark score".[11] The benchmark is defined by both the EU TEG and IIGCC as the Climate Change Performance Index (CCPI), which is published by Germanwatch.[12]

Since we specify tilts relative to an exogenously specified benchmark, our approach corresponds to setting a sovereign bond climate overlay. This has several potential advantages. First, the benchmark builds in the different motivations for investors to hold sovereign bonds, which include diversification to risky assets like equities (Campbell et al (2020)), liquidity and safety (Brunnermeier (2009)), collateral requirements (Gorton and Laarits (2018)), to seek excess returns in sovereign bonds by harvesting macro factor premia (Ang and Piazzesi (2003); Pauksta et al 2022)), style factor premia (Fama and Bliss (1987); Campbell and Shiller (1981); Ilmanen (2011)), the regulatory treatment of sovereign issues for insurance companies, pensions, and other institutions (BIS (2017)), and other reasons. The benchmark captures the primary reasons for holding a given sovereign bond portfolio and the climate overlay then adjusts those weights in line with those countries most aligned with the Paris Agreement. Second, our methodology can be applied on any sovereign portfolio. Finally, we can dial up or down the tilts of the climate overlay to attempt to trade off

9 See www.ipcc.ch/site/assets/uploads/2021/08/IPCC_WGI-AR6-Press-Release_en.pdf. The only one of the climate shared socioeconomic pathways (SSP) considered by IPCC (2021) that meets the criteria of the Paris Agreement is SSP1-1.9. The recommendations by the EU TEG and IIGCC are specifically intended to help investors create portfolios that seek to attain SSP1-1.9.

10 See COMMISSION DELEGATED REGULATION (EU) of 17.7.2020 supplementing Regulation (EU) 2016/1011 of the European Parliament and of the Council as regards minimum standards for EU Climate Transition Benchmarks and EU Paris-aligned Benchmarks.

11 See https://ec.europa.eu/info/sites/default/files/business_economy_euro/banking_and_finance/documents/190930-sustainable-finance-teg-final-report-climate-benchmarks-and-disclosures_en.pdf.

12 https://germanwatch.org/en/CCPI.

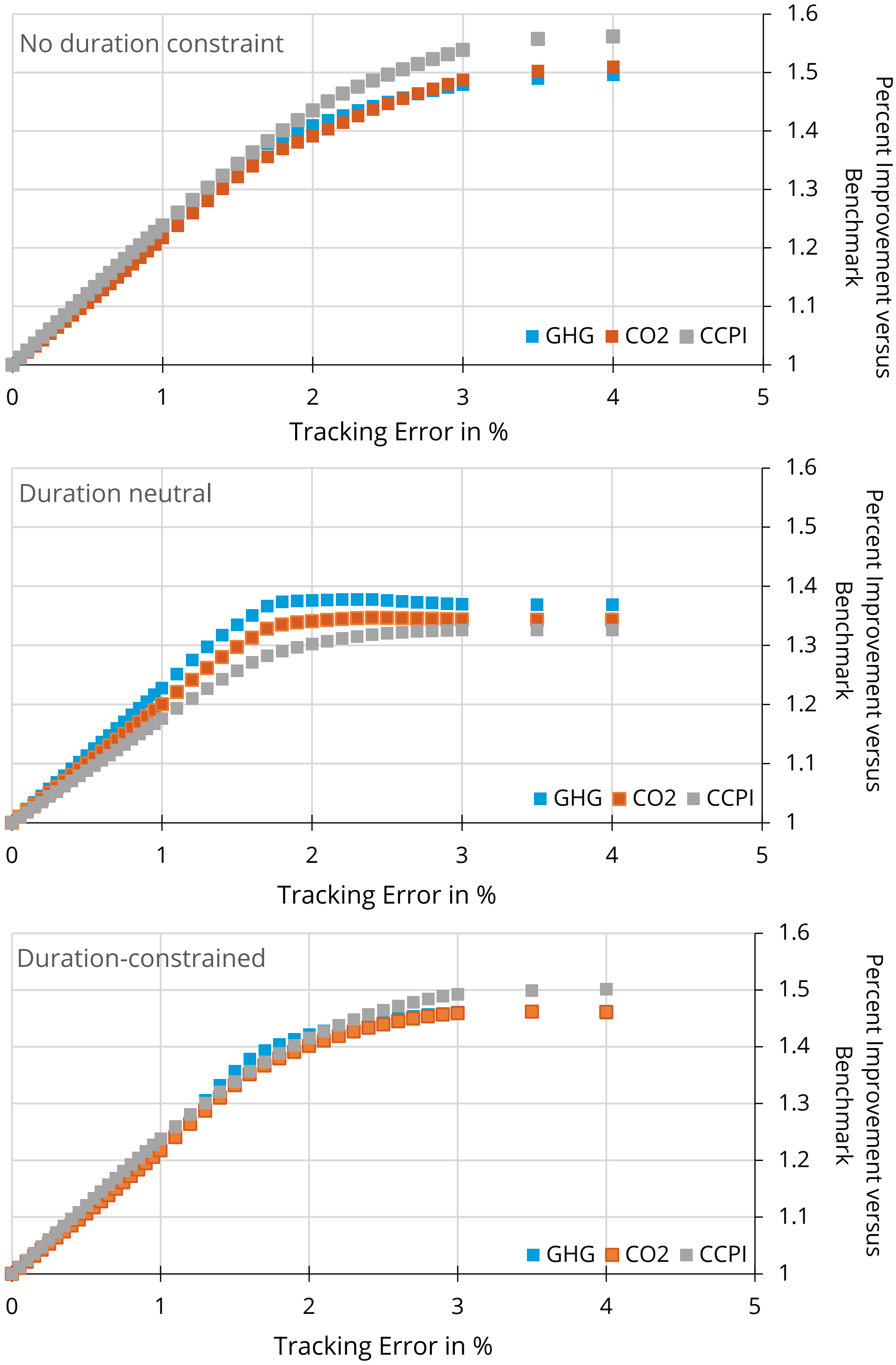
climate vis-à-vis other investment considerations in the investor's sovereign bond allocation.

Our first analysis is maximising the portfolio's CCPI score $A_{ccpi}h$, while fixing the tracking error to the benchmark index with weights h_{bmk} where h are the holdings of the environmental-optimised portfolio and A_{ccpi} is a vector of CCPI climate scores. Given the negative correlation between CPPI and the carbon emission metrics of over 70% (Graphs 2.1 and 2.2), we can observe the resulting portfolio's carbon emissions of both GHG $A_{GHG}h$ and CO2 $A_{CO2}h$, where A_{GHG} and A_{CO2} are the GHG and CO_2 emissions for each country. Relevant for fixed income instruments, we also observe the duration profile and investigate the effects of no duration constraints, duration neutrality (portfolio duration = benchmark duration) and duration bounds of ± 0.5 years. In Graph 3.1 and 3.2, we show the results for the developed market portfolio and the EME portfolio, respectively. We can observe that the higher the tracking error budget, the higher the improvement of the portfolio level environmental characteristics: with a tracking error of 1%, the developed market portfolio has an improvement of around 20% in all environmental characteristics, while for the EME portfolio the improvement is 20% for CPPI and almost double for GHG and CO_2. When doubling the tracking error to 2%, the climate characteristics also improve by almost double, but the effect is not linear and the improvement slows down afterwards. When duration constraints are added, the improvement effect is even further limited. In the case of the EME portfolio, the CCPI improvement is additionally limited by the holdings constraint, which limits the potential allocation into high-scoring countries – and in fact only India has a much higher CCPI score than the average, while in the developed market portfolio both Germany and the United Kingdom are much higher than the average.

Trade-off between tracking error and climate metrics improvement for developed markets portfolio

Graph 3.1

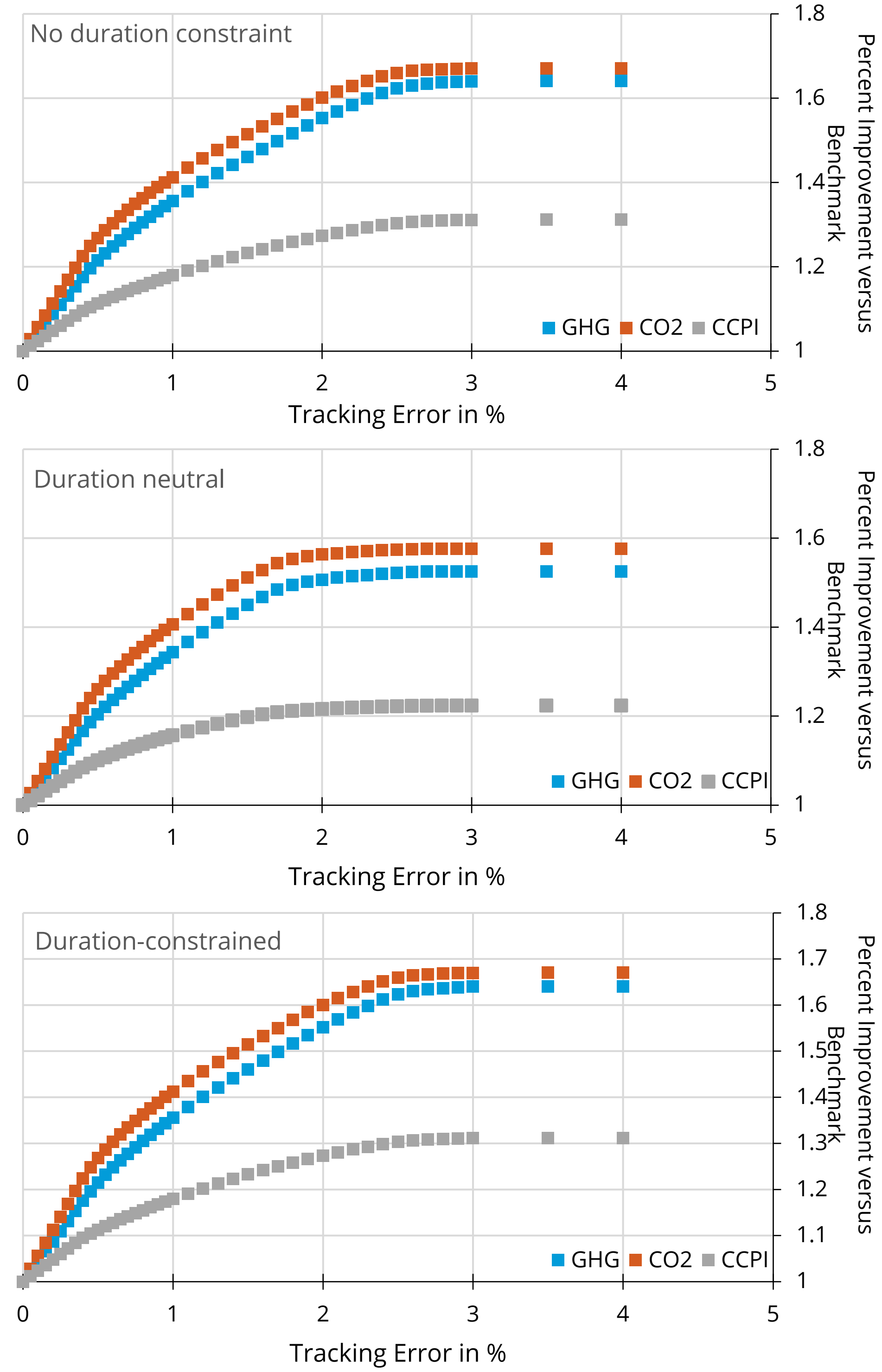
Percent



Source: CCPI, MSCI, BlackRock Calculations. Data as of March 2023.

Trade-off between tracking error and climate metrics improvement for EME portfolio | Graph 3.2

Percent



Source: CCPI, MSCI, BlackRock Calculations. Data as of March 2023.

For the second analysis we follow the approach of Kaul et al (2022) and we denote the sovereign weights of the benchmark index as h_{bmk}. We first infer implied alphas, $\alpha_{implied}$, from the benchmark weights. We assume a mean-variance representative agent, so we can write, following Black and Litterman (1991) and others:

$$\alpha_{implied} \propto V h_{bmk}, \quad (1)$$

where V is the covariance matrix of the benchmark sovereign returns.

To incorporate our environmental targets, we specify a new optimisation taking the implied alphas from the benchmark and additional constraints to upweight the CCPI rating and reduce carbon emissions:

$$\max_{h} \alpha_{implied}^{\top} h - \lambda h^{\top} V\, h, \quad (2)$$

such that

$$\begin{aligned} A_{ccpi} h &\geq LB_{ccpi} \times A_{ccpi} h_{bmk} \\ A_{GHG} h &\leq UB_{GHG} \times A_{GHG} h_{bmk} \\ A_{CO2} h &\leq UB_{CO2} \times A_{CO2} h_{bmk} \end{aligned} \quad (3)$$

where h are the holdings of the E-optimised portfolio such that $h - h_{bmk}$ reflects the active Environmental tilts relative to the sovereign benchmark. Equation (2) is a standard mean-variance optimisation with risk aversion λ taking the implied alphas from the sovereign benchmark (see equation (1)).

The climate constraints in equation (3) can be interpreted as follows. First, we seek to target an increase of 10% or more in the CCPI score. Second, we specify a reduction of 14% or more reduction in GHG and CO_2 emissions intensity relative to the benchmark. These increases in the CCPI score and decreases in GHG and CO_2 emissions can be changed for different investors placing more or less importance in the E considerations. We calibrate the risk aversion coefficient, λ, such that without additional constraints (ie using only equation (3)), $h = h_{bmk}$.

In addition, we further specify other investment constraints:

$$\sum h = \sum h_{bmk} \quad (4)$$

$$h \geq 0.05 \times h_{bmk}$$

$$Duration \cdot h_{bmk} - years \leq Duration \cdot h \leq Duration \cdot h_{bmk} + years$$

The first constraint is that the active weights, $h - h_{bmk}$, sum to zero, which reflects the active tilts relative to the benchmark. The second constraint places a lower bound of 5% below benchmark weights. This also ensures that we take no leveraged sovereign weights relative to the benchmark. Finally, we specify the duration exposure to be similar to the current sovereign benchmark at within ±0.5 years of deviation from benchmark duration.

We apply the methodology to a developed market sovereign benchmark of equal-weighted 10-year bond futures in Australia, Canada, Germany, Japan, the United Kingdom and the United States and to an EME sovereign benchmark of equal weighted bond futures in India, Korea, Mexico, Poland, South Africa and Thailand.

4. Empirical results

Graph 4.1 presents the hypothetical results of the optimisation in equations (2)–(4) in this universe. Panel A reports the holdings of the E-optimised portfolio in brown relative to the equal-weighted benchmark in red (each with a weight of 16.7%) as of March 2023. The climate optimisation reduces the positioning in Canada, at 8.1%, because the CCPI score of Canada is significantly low at 26.47 relative to the CCPI of the portfolio of 44.38 (see Graph 2.1). Conversely, the weight of Japan is 24.3%: the large overweight is due to the GHG and CO_2 emissions of Japan, which are low relative to the portfolio. Australia and the United States have high carbon emission intensities, at 21.1 for Australia and 17.73 for the United States for GHG per capita, compared with 13.77 for the benchmark portfolio. This explains the underweight positions to Australia and the United States, and the optimiser consequently overweights the United Kingdom, Germany, and Japan. While the United Kingdom has the best environmental characteristics, it also has the highest duration, which results in a limited overweight position compared with Germany and Japan, which have a duration closer to the benchmark. This has not always been the case, as Panel B shows how the United Kingdom used to be the largest position, followed by Japan and Germany.

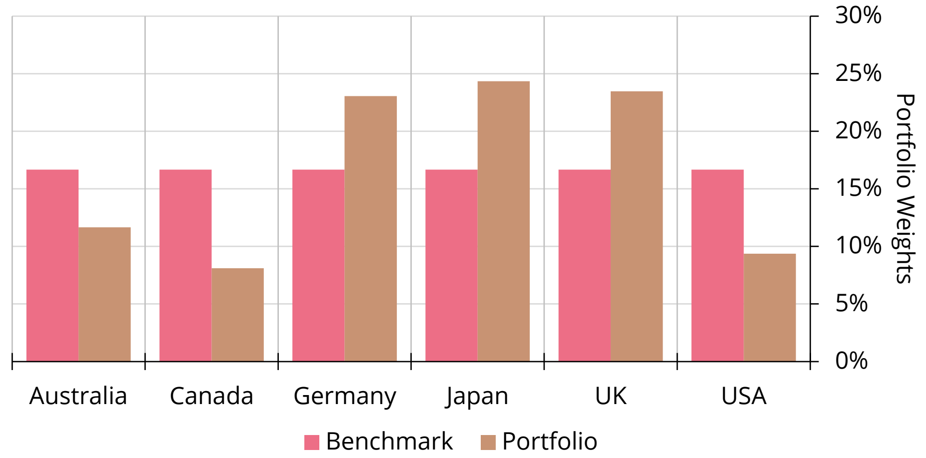
In Panel C of Graph 4.1, we report the cumulative hypothetical returns of the climate overlay. The optimisation is run at the daily frequency. The CCPI climate ratings are updated annually in December and we use the same ratings information for the following year. MSCI GHG and CO_2 emissions per capita are available at the monthly frequency, and we forward-fill the data over the next month. We show the raw cumulative returns of the sovereign portfolio and the optimised portfolio with climate tilts. The raw returns of the benchmark and climate portfolio are very close. Over the sample from 2017 to 2023, the climate overlay strategy tracks the benchmark closely. At the beginning of the sample, there is some outperformance, whereas from November 2018 to April 2020 the excess returns detract. Nevertheless, there is a close correspondence. We do not expect the climate overlay to itself have alpha, rather Panel C shows that the climate portfolio tracks the sovereign benchmark closely with an average tracking error of 3%. The benchmark has an IR of –0.09, while the climate portfolio has an IR of –0.1.

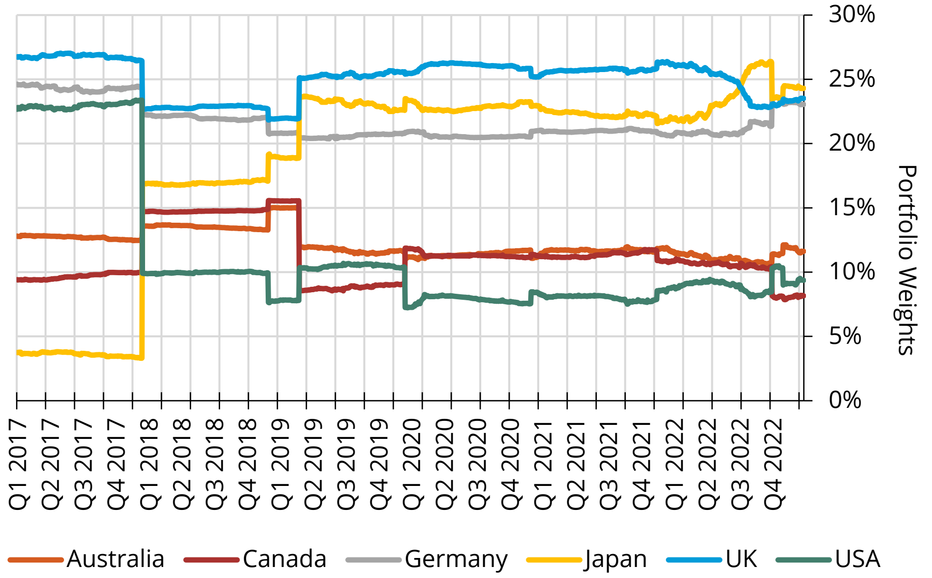
We repeat the analysis for the EM portfolio and Graph 4.2 presents the hypothetical results of the optimisation in equations (2)–(4) in this universe. Panel A reports the holdings of the E-optimised portfolio in brown relative to the equal-weighted benchmark in red (each with a weight of 16.7%) as of March 2023. The climate optimisation reduces the positioning in Korea, at 6.43%, because the CCPI score of Korea is significantly low at 24.91 relative to the CCPI of the portfolio of 45.82 (see Graph 1). Conversely, the weight of India is 27.19%: the large overweight is due to the high CPPI score, and GHG and CO2 emissions of India which are low relative to the portfolio. For the remaining countries the portfolio weight is similar to the benchmark weight as they in particular have similar CCPI scores ranging from 37.94 for Poland to 51.77 for Mexico. Panel B plots the historical holdings: India is mainly the largest position with Thailand being favoured only in 2021.

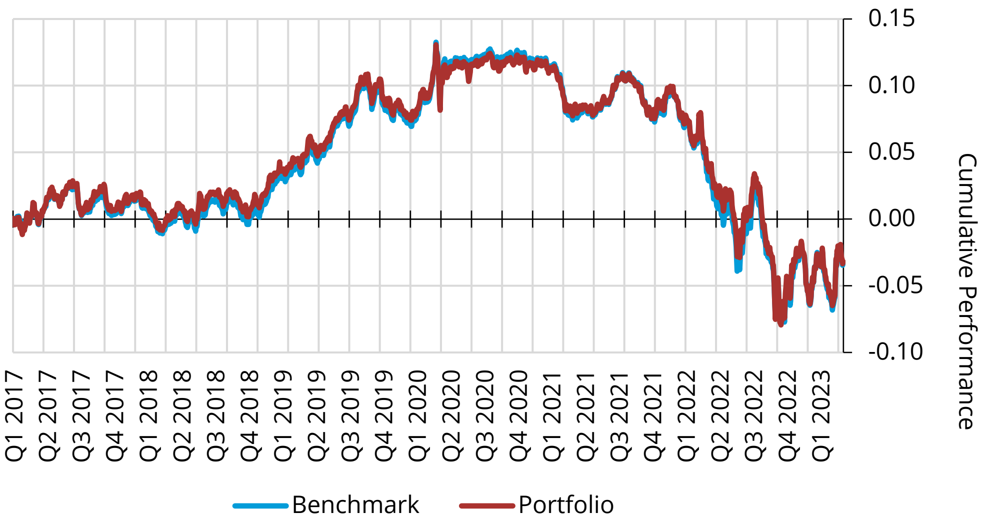
In Panel C of Graph 4.2, we report cumulative hypothetical returns of the climate overlay. We show the raw cumulative returns of the sovereign portfolio and the optimised portfolio with climate. The raw returns of the benchmark and climate portfolio are very close. Similar to the developed market portfolio over the sample from 2017 to 2023, the EME climate overlay strategy tracks the benchmark closely with an average tracking error of 3%. At the beginning of the sample, there is some outperformance, whereas from November 2018 to April 2020 the excess returns detract. Nevertheless, there is a close correspondence. We do not expect the climate overlay to itself have alpha, rather Panel C shows that the climate portfolio tracks the sovereign benchmark closely. The benchmark has an IR of 0.15, while the climate portfolio has an IR of 0.21. Compared with the developed market portfolio, the IRs are higher, and the performance is more driven by larger overweights and underweights – overweight India and underweight Korea.

Climate overlay strategy: holdings and cumulative performance for developed markets portfolio — Graph 4.1

In per cent as of March 2023







Source: CCPI, MSCI, BlackRock Calculations. Data as of March 2023.

The hypothetical performance returns are provided for illustrative purposes only and are not meant to be representative of actual performance returns of, or to project or predict returns for, any account, portfolio, strategy or asset allocation. The hypothetical performance period is from January 2017 to March 2023.

*The displayed hypothetical returns are subject to a number of significant limitations. They are illustrative of a product or strategy that does not exist, and therefore do not reflect the deduction of any fees or expenses, including advisory, management and performance fees, as well as brokerage fees, commissions and other expenses that might normally apply. In addition, the allocation decisions reflected in the hypothetical returns were not made under actual market conditions and cannot completely account for the impact of financial risk in actual portfolio management.

The performance shown above is hypothetical and does not represent the investment performance or the actual accounts of any investor(s) or any fund(s). The securities with the hypothetical performance were selected with the full benefit of hindsight, after their performance over the period shown was known. Past hypothetical performance results are not indicative of future returns.

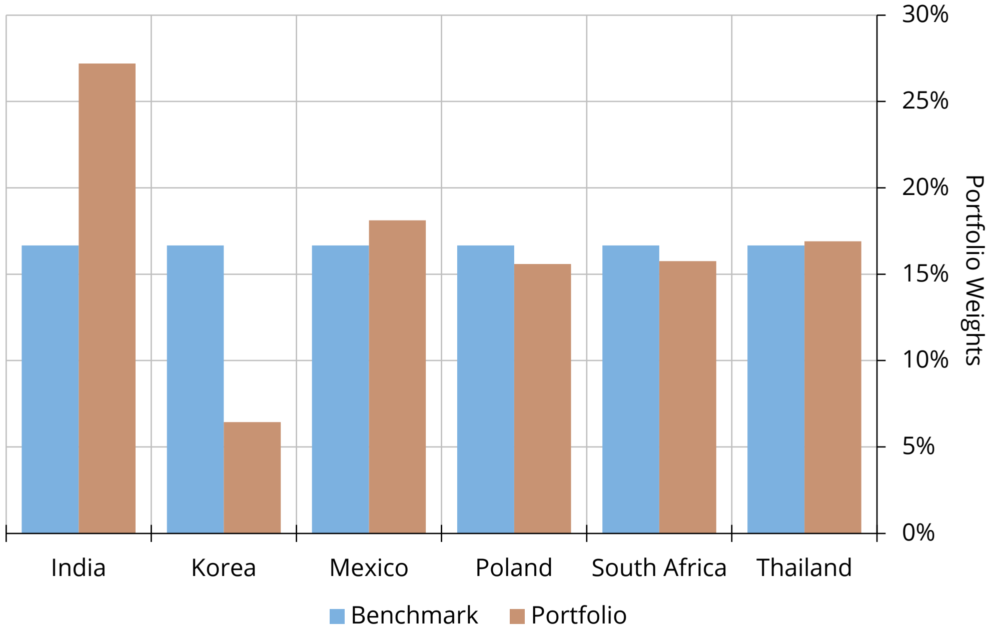
The performance shown does not represent any existing portfolio, and as such, is not an investible product. This represents the model-driven allocations, explained in Section 3 (Methodology), to the underlying well-diversified sovereign benchmark. The underlying performance is based on actual historical performance. The aggregate performance of the model is hypothetical and the model is formulated with benefit of hindsight.

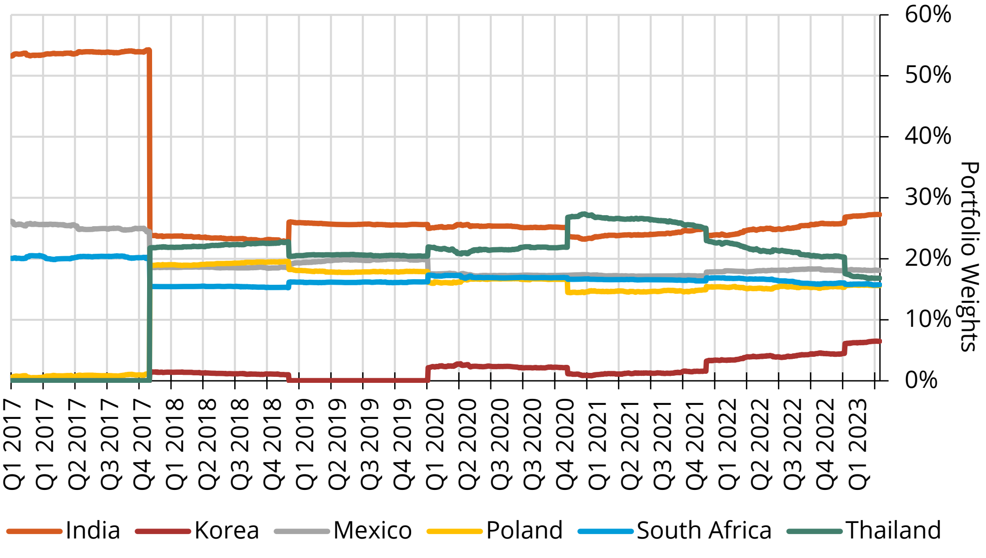
There are frequently sharp differences between a hypothetical performance record and the actual record subsequently achieved. Therefore, hypothetical performance records invariably show positive rates of return. Another inherent limitation of these results is that the allocation decisions reflected in the performance record were not made under actual market conditions and, therefore, cannot completely account for the impact of financial risk in actual portfolio management.

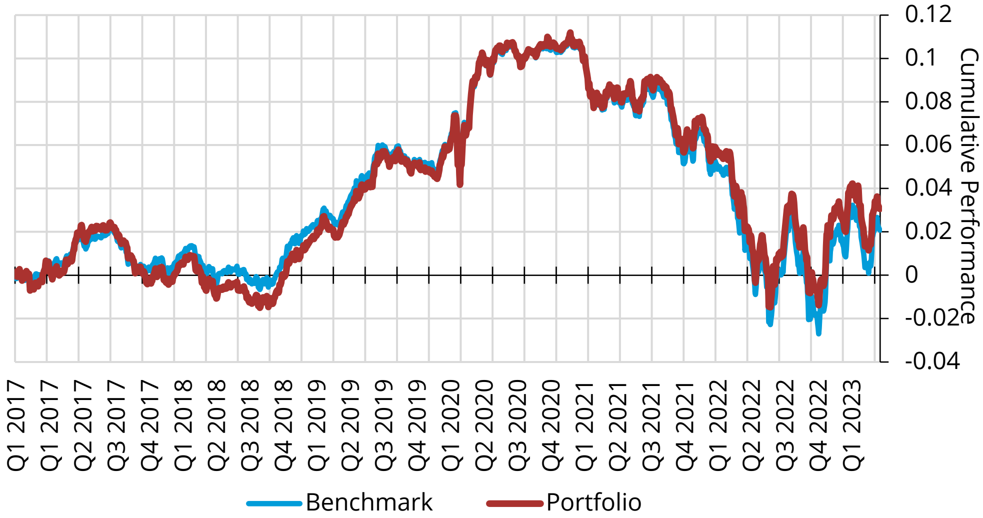
Climate overlay strategy: holdings and cumulative performance for EME portfolio

Graph 4.2

In percent as of March 2023







Source: CCPI, MSCI, BlackRock Calculations. Data as of March 2023.

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Conclusion

We have sought to show how to incorporate sustainability considerations in sovereign bond portfolios for both developed and EME countries. We show how to incorporate positive tilts for countries that are more prepared for the transition to a low-carbon economy and negative tilts for countries that are less prepared. These tilts use information from the Climate Change Performance Index along with explicit reductions in carbon dioxide and greenhouse gases, which follow the recommendations laid out by the EU's Technical Expert Group on Sustainable Finance (EU TEG) and the Institutional Investors Group on Climate Change (IIGCC) for Paris-

Aligned Benchmarks. We show that with a low tracking error of up to 1%, both developed market and EME portfolios can have an improved climate profile with an increase of around 20% in both backward-looking (CO_2 and GHG) as well as forward-looking (CCPI) metrics – and, in the case of EMEs, an improvement of as much as 40% in the backward-looking metrics. The methodology of the sovereign climate overlay can be applied to any sovereign benchmark. We believe our results have the potential to be important for policymakers, as well as asset owners and asset managers, who may need to hold sovereign bonds for investment or regulatory purposes and would like to apply sustainability considerations in their sovereign bond portfolios.

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