Overview

In the run-up to COP 26, reconciling the competing national agendas towards the global climate crisis remains a challenge. Having some understanding of the potential economic and financial risks, in the event of a disorderly transition or no transition at all, could be useful.

In this condensed version of the *Anticipating the climate change risks for sovereign bonds* series, we estimate the economic and financial impacts of transition and physical risks in the 25 countries of the World Government Bond Index (WGBI) universe and find:

- The magnitude of the estimated economic impacts is very high, with tens of GDP percentage points at risk from both transition and physical risks by 2050 in the most vulnerable economies. Economically significant impact could become evident as early as 2030.

- Due to the divergence in fiscal capacity, countries that would most likely be affected economically by climate change would not necessarily be those that would incur the highest financial loss.

- Finally, the results highlight the benefits of an orderly transition to the development of sustainable economic and financial activities, and confirm that investors should take climate change consequences very seriously into account.
1. From climate-assessed scenarios to default risk

Sovereign bonds investors need to consider climate change risks into their asset allocation decisions. Climate change implies two main categories of risks for financial stakeholders, from (i) physical impacts and (ii) transitioning to a carbon-neutral economy. A clear understanding of these risks is important to reallocate financial resources in a manner that is consistent with the Paris Agreement objectives. The latter seek to limit the likelihood of capital being destroyed by climate damages and investments turning into "stranded assets."

Our two-parts study\(^1\) is a first step toward the wider project of investigating the use of forward-looking analyses to assess climate change risks, as recommended by regulatory international institutions. Building on the Network for Greening the Financial System\(^2\) (NGFS) approach, we explore two independent “worst-case” scenarios. The methodological framework enables a country-level assessment of the physical risk through the lens of a hot house world scenario, and the transition risk via a disorderly transition scenario.

For the physical risks, our hot house world scenario follows the RCP 8.5 trajectory (a business-as-usual trajectory, without any additional mitigation efforts), which would lead to a global warming of about 4°C by 2100. The country assessment methodology relies on analysis from Burke and Tanutama (2019)\(^3\) that establishes a relationship between productivity loss and temperature increase. Their study does not capture the impact of extreme weather events and the rise in sea levels.

Regarding the transition risk, a specific methodology is developed in the study to estimate the potential economic and financial shock of a very abrupt or disorderly transition. The approach assumes that the economies would make no further effort until the depletion of their “carbon budget” consistent with a 2°C target (determined with the CLAIM methodology\(^4\)). Rather, they would use—in the final year—last resort technologies to respect their commitment to achieve the mitigation goal of the Paris Agreement.

Potential GDP losses in both scenarios are evaluated for the 25 constituent economies of the FTSE World Government Bond Index (WGBI) in comparison to a baseline (i.e., no climate change impact in the case of the hot house world scenario and no mitigation efforts in the disorderly transition scenario). These estimated GDP losses should be then reflected in the debt dynamic for which the impacts of climate change are twofold:

- In the hot house world scenario, physical damage would increase the debt-to-GDP ratio since it lowers fiscal revenues as losses affecting infrastructures, employment, manufactured products and services should reduce the tax base;
- In the disorderly transition scenario, abatement costs are assumed to be fully funded by the government because investment in backstop technologies\(^5\) is mainly a matter of public policy. It would, therefore, add to the budget balance and increase the debt-to-GDP ratio.

Then we build default probabilities, using a proprietary model that is based on an empirical calibration of default threshold\(^6\). Lastly, we simulate the potential fallout of climate change on sovereign bond yields and returns via a simple financial model.

---

2. The NGFS is a network of 87 central banks (ECB, BoJ, BoE, Fed, etc.) and 13 supervisors (IMF, WBG, BIS, etc.), launched at the One Planet Summit in 2017 in Paris, aiming at strengthening the global response required to meet the goals of the Paris agreement and to enhance the role of the financial system to manage climate change-related risks.
5. In our study, the climate change backstop technologies are carbon removal solutions, the last resort options when countries wait for the very last moment to implement mitigation measures (see part one of the study for more details).
2. Physical risks: from economic to financial impact

The differing effects on economies from temperature increases (see Chart 1) are driven by one main factor: the heterogeneity in their starting climate conditions. The higher starting average temperature around the equator will result in greater estimated damages from global warming in that region. Overall, most of the WGBI economies would suffer a negative impact from unmitigated global warming.

Chart 1. Change in GDP per capita in the hot house world scenario by 2050

Under the *hot house world* scenario (see Chart 2), only emerging markets economies (*i.e.*, Malaysia, South Africa and Mexico) and Southern Europe economies (*i.e.*, Portugal, Italy, Greece and Spain) could be expected to default by 2050. This highlights the various economic exposures to physical risks and the diverse financial resilience between countries. Proximity from the equator generally increases the potential economic impact resulting from the adaptation costs of climate change. While Australia and the United States are expected to incur a large increase in debt-to-GDP ratio (+21 percentage points for both of them), these economies still retain some fiscal capacity, given their large default threshold estimates.
3. Transition risks: from economic to financial impacts

Chart 3 shows the total abatement costs estimates (in terms of GDP) associated to the residual emissions after depletion of the carbon budgets. The total abatement costs of an economy are incurred from the depletion year and would continue every year as long as residual emissions remain at the same level. With the highest abatement costs-to-GDP ratio, South Africa, Mexico, Poland, the United States, Australia and Canada are the most exposed to transition risks. The situation is all the more worrying for countries where the depletion year of their carbon budget is very close. This includes Australia, the United States and Canada (respectively 2025, 2026 and 2026 vs 2031 for Poland and 2036 for South Africa).
Since the WGBI universe is predominantly made up of advanced economies, which seem to be the most exposed to the risks of a disorderly transition (they have used up a lot of their carbon budget already and the magnitude of costs is higher in this scenario), the number of defaulting economies is higher than under a hot house world scenario (see Chart 4). Overall, up to 10 economies could experience episodes of financial stress (i.e., South Africa, Australia, Poland, Japan, Italy, Portugal, Greece, Spain, Mexico and Israel).

Like for the hot house world scenario, there are differences in financial resilience. Even if most economies in the WGBI universe are expected to experience a large increase in their debt-to-GDP ratio, some would still have enough fiscal capacity due to their large default threshold estimates. For Italy, it appears that, despite a smaller increase in its indebtedness from financing the transition to a decarbonised economy (+39 percentage points, compared for instance to Germany’s 82), its limited access to fiscal support would be leading the country to experience episodes of high sovereign credit stress within just a few decades.
According to our financial modelling, while physical risks could start to impact bond returns as early as 2030 (followed by transition risks a few years later), by 2050 the projected declines in returns are globally comparable in both the hot house world and disorderly transition scenarios.\(^7\)

---

\(^7\) More information on the impacts of climate change on sovereign bond yields and returns is available in the following paper: *Anticipating the climate change risks for sovereign bonds - Part 2: Insights on the financial impacts*; FTSE Russell, June 2021.
About FTSE Russell

FTSE Russell is a leading global provider of benchmarks, analytics and data solutions with multi-asset capabilities, offering a precise view of the markets relevant to any investment process. For over 30 years, leading asset owners, asset managers, ETF providers and investment banks have chosen FTSE Russell indexes to benchmark their investment performance and create investment funds, ETFs, structured products and index-based derivatives. FTSE Russell indexes also provide clients with tools for performance benchmarking, asset allocation, investment strategy analysis and risk management.

To learn more, visit ftserussell.com; email info@ftserussell.com; or call your regional Client Service Team office

<table>
<thead>
<tr>
<th>Region</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMEA</td>
<td>+44 (0) 20 7866 1810</td>
</tr>
<tr>
<td>North America</td>
<td>+1 877 503 6437</td>
</tr>
<tr>
<td>Asia-Pacific</td>
<td></td>
</tr>
<tr>
<td>Hong Kong</td>
<td>+852 2164 3333</td>
</tr>
<tr>
<td>Tokyo</td>
<td>+81 3 4563 6346</td>
</tr>
<tr>
<td>Sydney</td>
<td>+61 (0) 2 8823 3521</td>
</tr>
</tbody>
</table>


FTSE Russell® is a trading name of FTSE, Russell, FTSE Canada, MTSNext, Mergent, FTSE FI, YB and BR. “FTSE®”, “Russell®”, “FTSE Russell®”, “MTS®”, “FTSE4Good®”, “ICB®”, “Mergent®”, “The Yield Book®”, “Beyond Ratings®” and all other trademarks and service marks used herein (whether registered or unregistered) are trademarks and/or service marks owned or licensed by the applicable member of the LSE Group or their respective licensors and are owned, or used under licence, by FTSE, Russell, MTSNext, FTSE Canada, Mergent, FTSE FI, YB or BR. FTSE International Limited is authorised and regulated by the Financial Conduct Authority as a benchmark administrator.

All information is provided for information purposes only. All information and data contained in this publication is obtained by the LSE Group from sources believed by it to be accurate and reliable. Because of the possibility of human and mechanical error as well as other factors, however, such information and data is provided “as is” without warranty of any kind. No member of the LSE Group nor their respective directors, officers, employees, partners or licensors make any claim, prediction, warranty or representation whatsoever, expressly or impliedly, either as to the accuracy, timeliness, completeness, merchantability of any information or of results to be obtained from the use of the FTSE Russell products, including but not limited to indexes, data and analytics or the fitness or suitability of the FTSE Russell products for any particular purpose to which they might be put. Any representation of historical data accessible through FTSE Russell products is provided for information purposes only and is not a reliable indicator of future performance.

No responsibility or liability can be accepted by any member of the LSE Group or their respective directors, officers, employees, partners or licensors for (a) any loss or damage in whole or in part caused by, resulting from, or relating to any error (negligent or otherwise) or other circumstance involved in procuring, collecting, compiling, interpreting, analysing, editing, transcribing, transmitting, communicating or delivering any such information or data or from use of this document or links to this document or (b) any direct, indirect, special, consequential or incidental damages whatsoever, even if any member of the LSE Group is advised in advance of the possibility of such damages, resulting from the use of, or inability to use, such information.

No member of the LSE Group nor their respective directors, officers, employees, partners or licensors provide investment advice and nothing contained herein or accessible through FTSE Russell products, including statistical data and industry reports, should be taken as constituting financial or investment advice or a financial promotion.


Past performance is no guarantee of future results. Charts and graphs are provided for illustrative purposes only. Index returns shown may not represent the results of the actual trading of investable assets. Certain returns shown may reflect back-tested performance. All performance presented prior to the index inception date is back-tested performance. Back-tested performance is not actual performance, but is hypothetical. The back-test calculations are based on the same methodology that was in effect when the index was officially launched. However, back-test data may reflect the application of the index methodology with the benefit of hindsight, and the historic calculations of an index may change from month to month based on revisions to the underlying economic data used in the calculation of the index.

This document may contain forward-looking assessments. These are based upon a number of assumptions concerning future conditions that ultimately may prove to be inaccurate. Such forward-looking assessments are subject to risks and uncertainties and may be affected by various factors that may cause actual results to differ materially. No member of the LSE Group nor their licensors assume any duty to and do not undertake to update forward-looking assessments.

No part of this information may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior written permission of the applicable member of the LSE Group. Use and distribution of the LSE Group data requires a licence from FTSE, Russell, FTSE Canada, MTSNext, Mergent, FTSE FI, YB, BR and/or their respective licensors.