Bocconi

THE NATURE OF SOVEREIGN BONDS AS CENTRAL BANK COLLATERAL

Integrating Climate Mitigation and Biodiversity Protection Considerations into the Treatment of Sovereign Bonds in the European Central Bank's Collateral Framework

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Key highlights

Central banks' collateral frameworks – the set of rules determining which assets banks can pledge to obtain central bank liquidity, and with which haircuts – are essential to monetary policy transmission, and also have important impacts on the real economy and monetary-fiscal interactions.

Integrating climate change mitigation and biodiversity protection (which we jointly term "nature") considerations into the collateral framework is critical. Financial markets largely do not price the climate- and biodiversity-related transition risks borne by issuers. Nor do they price the long-term economic benefits of government action to mitigate climate change and protect biodiversity, even though these benefits are central to future price and financial stability.

The European Central Bank (ECB) has taken an important first step by applying additional haircuts to assets issued by non-financial corporations, based on their exposure to climate-related transition risks and uncertainty. However, these assets represent less than 2% of pledged collateral, and the measure does not cover biodiversity.

We therefore explore how the ECB could integrate nature into the treatment of sovereign bonds, which make up roughly 50% of eligible collateral and 10% of pledged collateral. We adapt existing methodologies that assess and rank how governments perform on climate change mitigation and biodiversity protection. We then translate these rankings into haircuts that we apply to more than 2,000 EU government securities eligible to ECB collateral framework.

The resulting additional haircuts could be significant: depending on calibration choices, they could amount to up to 6% of some countries' gross government debt – for Italy, this could amount to around €200 billion. By raising some countries' borrowing costs it could tighten their fiscal space and ability to invest in the ecological transition. This would increase their vulnerability to future physical and transition risks and impair the ECB's ability to achieve price and financial stability.

Other approaches therefore need to be explored. One possibility is to use haircut reductions or bonuses for stronger performers (rather than haircut increases for poor performers), to avoid reducing countries' fiscal space. This approach nevertheless carries its own trade-offs with central bank risk management and monetary policy transmission.

Behind the technicalities of collateral haircuts lies a much larger question: how monetary and fiscal authorities could act together at a time when nature-related crises put price, financial and fiscal stability at risk?

Executive summary

This report examines why and how considerations related to climate change mitigation and biodiversity protection (jointly referred to as "nature") could be integrated into the treatment of sovereign bonds in the European Central Bank (ECB) collateral framework.

The collateral framework is the set of rules determining which assets commercial banks (more precisely, the credit institutions eligible as counterparties to Eurosystem monetary policy operations) can pledge to obtain central bank liquidity, and at what value, i.e. after applying haircuts. Beyond being essential to monetary policy transmission, collateral frameworks matter for the financial system and the real economy: eligibility and haircut decisions signal relative asset risks, shape market prices, and influence issuers' borrowing costs, including those of governments. As such they affect fiscal space and create de facto interactions between monetary and fiscal policies.

Since June 2026, the ECB has taken a significant step by applying a "climate factor" to assets issued by non-financial corporations eligible as collateral[1]. In practice, the ECB complements its existing risk control measures by applying an additional haircut[2] to the eligible assets, based on their issuers' exposure to climate-related transition risks and uncertainty.

This report argues that, despite being an important first step, keeping this limited scope (debt issued as non-financial corporate bonds represents less than 2% of pledged collateral) is inconsistent with sound risk management and could distort counterparties' collateral choices. Ultimately, all assets accepted as collateral should be screened for nature-related transition risks, both to protect the central bank's balance sheet and to ensure the effectiveness of the monetary policy transmission mechanisms.

Against this backdrop, this report proposes extending and adapting the ECB climate factor to sovereign bonds, a particularly important asset class in the collateral framework, which make up roughly 50% of eligible and 10% of pledged collateral. Doing so is further justified by the fact that financial markets largely do not price the long-term economic benefits of government action to mitigate climate change and protect biodiversity, even though these benefits are central to future price and financial stability.

Moreover, the report expands the scope of the ECB climate factor, which focuses on climate change mitigation, by incorporating considerations related to biodiversity protection. This is fundamental to developing a comprehensive understanding of nature – a term that encompasses both climate and biodiversity – in line with scientific evidence and with central bankers' own recognition that these topics should be assessed jointly.

We identify three distinct – though sometimes overlapping – justifications for integrating nature-related considerations into the treatment of sovereign bonds in the ECB collateral framework. However, each rationale could imply a different implementation method, with divergent implications for monetary policy, financial valuations and the real economy.

1. A risk-based approach, which is the one explored quantitatively in this report, focuses on protecting the central bank's own balance sheet from the underpriced climate- and biodiversity-related transition risks borne by each issuer (country), assessed individually. Under this approach, the central bank applies higher haircuts to assets from issuers whose activities or policies are judged to make them susceptible to nature-related transition risks.
2. A resilience-based approach focuses on safeguarding the ECB's primary mandate of price and financial stability over a medium- to long-term horizon, given the inflationary and destabilizing potential of nature-related risks. Under this approach, the central bank could combine higher

[1] The scope will be expanded to certain eligible credit claims whose debtor is a non-financial corporation, by the end of 2027 at the earliest.
[2] Technically the ECB refers to this 'haircut' as an adjustment or reduction in the final collateral value rather than a haircut. In what follows we will use the term haircut and adjustment interchangeably.

haircuts, as in the risk-based approach, with haircut reductions for countries that perform better and therefore contribute more to future price stability.

3. An alignment-based approach focuses on supporting the EU's environmental objectives under the ECB's secondary objective, as set out in Article 127(1) TFEU[3]. In practice, this approach would primarily consist of applying lower haircuts, or even bonuses, to countries that adopt policies mitigating climate change and protecting biodiversity.

For the quantitative implementation, we focus on the risk-based approach described above[4], proceeding in three steps: First, we build on and adapt existing methodologies that assess and rank how governments perform on climate change mitigation and biodiversity protection: the ASCOR methodology for climate mitigation (ASCOR, 2026); and a composite of WWF's Biodiversity Risk Filter (WWF, 2026), the Yale Environmental Performance Index (Yale University, 2026), and the EU Consumption Footprint dataset (Joint Research Centre, 2026). The resulting scores show significant disparities across countries and a weak correlation between climate and biodiversity scores (Figure A). Second, we propose two formulas, partially building on the existing ECB climate factor, through which these climate and biodiversity rankings could be translated into haircuts. Finally, we apply these formulas to 2,384 government securities, issued by EU member states, which are eligible as collateral in the ECB framework.

Our results indicate that the aggregate impacts could be significant for several countries. For large EU economies (Italy, France, Germany and Spain), the additional adjustment resulting from the climate and biodiversity factors could increase the total value of the haircut applied by the ECB by a factor of two to five (Figure B). Such adjustments could amount to up to 6% of some countries' total gross government debt, which may be particularly consequential for countries where a large share of government debt is currently eligible as ECB collateral (Figure C). For example, in the case of Italy this would represent a loss in collateral value of up to €200 billion. However, these results depend heavily on calibration choices, such as the "floor parameter" that determines the highest haircut envisaged by the ECB.

These results suggest that while the risk-based approach – the only one we tested quantitatively, through haircut increases – is the most secure and aligned with the ECB's practices at first sight, it is also subject to significant challenges: by applying an additional haircut to sovereign bonds issued by countries with relatively poor climate mitigation and biodiversity protection rankings, the ECB could contribute to raising these countries' borrowing costs, thereby further tightening their fiscal space and their ability to invest in the ecological transition. This would increase their vulnerability to future physical and transition risks, and therefore impair the ECB's ability to achieve price and financial stability.

To limit these adverse effects, and in line with the resilience- and alignment-based approaches mentioned above, it could be necessary to differentiate via haircut reductions or bonuses for relatively stronger performers rather than by increases for weaker ones. This could help incentivise countries to better mitigate climate change and protect biodiversity, rather than disadvantage them for not doing so. However, such differentiation could create its own trade-off with central bank risk management and monetary policy transmission, for instance if the pool of sovereign assets with high nature-related scores is too small or consists of bonds with higher risks unrelated to climate and biodiversity.

Future work should therefore keep exploring these different approaches, from haircuts to bonuses, and their respective trade-offs, including by quantifying how each could affect monetary policy operations and transmission, debt sustainability, and each country's ecological transition pathway. Behind the

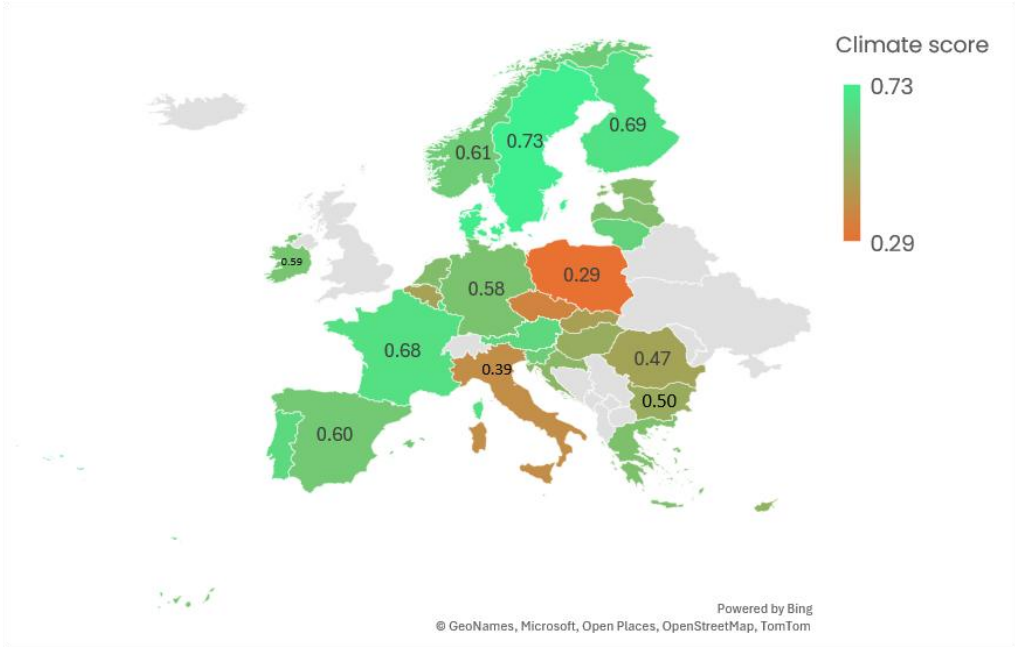
[3] Article 127(1) of the Treaty on the Functioning of the European Union requires that "without prejudice to the objective of price stability, the ESCB [European System of Central Banks] shall support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union as laid down in Article 3 of the Treaty on European Union" (European Union, 2016a).

[4] We leave for future work the adaptation of our methodology to the resilience- and alignment-based approaches.

technicalities of collateral haircuts lies a much larger question: how monetary and fiscal authorities will act together, and for whom, at a time when nature-related crises put price, financial and fiscal stability at risk.

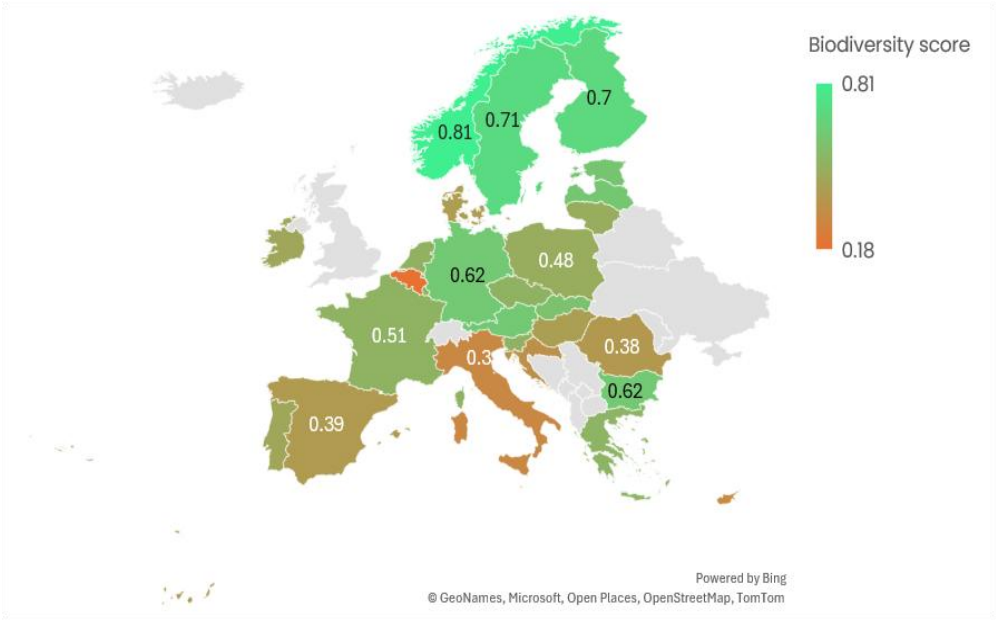
Figure A. Sovereign climate change mitigation and biodiversity protection scores

Climate change mitigation score



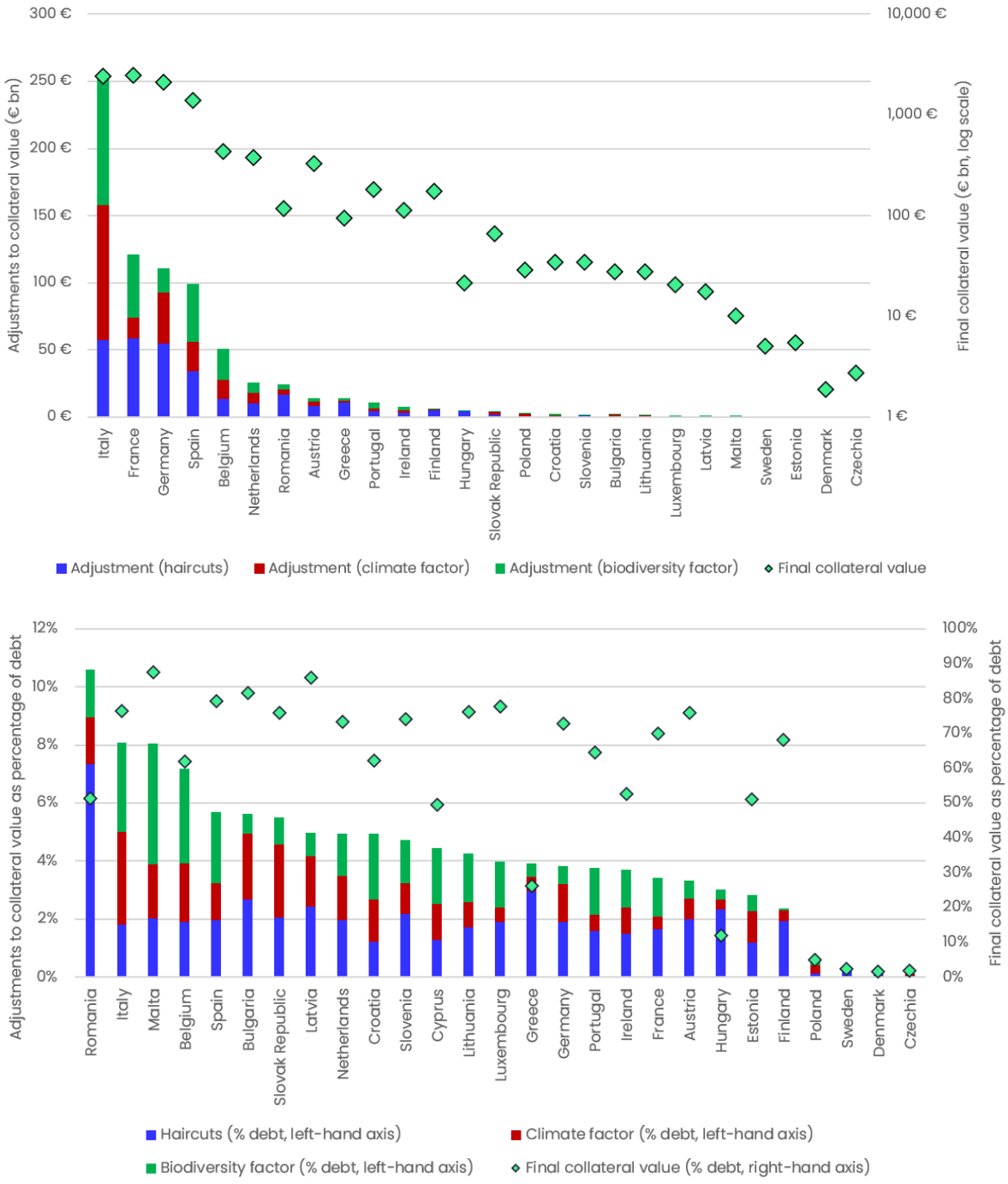
Source (2026): authors' calculations, based on TPI Centre (ASCOR data, 2025)

Biodiversity protection score



Source (2026): authors' calculations, based on WWF Biodiversity Risk Filter, Yale Environmental Performance Index, and EU Consumption Footprint data

Figure B and C. Adjustments to the collateral value of eligible sovereign bonds after integrating the climate and biodiversity factors, in billions of euros and as a percentage of a country's general government gross debt



Note: The climate and biodiversity factors are based on the logistic formula described in the report, and with a floor parameter set at 0.95. Source (2026): ECB (list of eligible assets, 23 June 2026), Eurostat (general government gross debt), LSEG Workspace (outstanding amounts and market price, 23 June 2026), TPI centre (ASCOR data, 2025), WWF Biodiversity Risk Filter, Yale Center, European Commission Joint Research Centre, authors calculations

Introduction

Central banks are increasingly being challenged on how they should act on climate change and biodiversity loss. Most of the debate has focused on the most visible instruments, such as asset purchases, interest rates and supervisory stress tests. Less attention has been paid to a more technical part of monetary policy implementation: the collateral framework. This is the set of rules that determines which assets commercial banks can pledge to obtain central bank liquidity, and at what value – that is, with which haircut.

Collateral frameworks are rarely headline news, but they underpin the daily transmission of monetary policy, and they protect the central bank's balance sheet against counterparty default. Their reach also extends beyond the central bank: eligibility and haircut decisions signal how risky an asset is, shape its price and affect its issuer's borrowing costs, whether the issuer is a bank, a firm or a government. Collateral frameworks therefore matter for the financial system and the real economy, even though their design and effects vary across jurisdictions.

Having acknowledged that climate change is a source of financial risk that markets price imperfectly, the European Central Bank (ECB) started to integrate climate considerations into its collateral framework in 2020. Since June 2026, it has applied a "climate factor", a haircut adjustment for issuers exposed to low-carbon transition risks and uncertainty. This is a significant step, and one of the first of its kind among major central banks.

Yet the climate factor currently applies only to non-financial corporate bonds (with a planned extension to certain eligible credit claims), which account for less than 2% of pledged collateral. The overwhelming majority of the collateral that counterparties mobilize therefore remains outside any dedicated treatment of transition risks. This narrow scope creates two problems. First, it is hard to reconcile with the principles of residual risk equivalence and adequate risk protection that underpin collateral frameworks. Second, it could also encourage counterparties to shift towards asset classes that are exempt from the climate factor, which would dilute the measure's effect.

This report examines how the ECB's approach could be extended to sovereign bonds. These bonds are the largest single asset class in the Eurosystem's collateral, accounting for roughly 50% of eligible collateral and 10% of what counterparties actually pledge. Sovereign bonds also raise issues that corporate bonds do not, in particular the fact that the haircut applied to these bonds can affect a nation's borrowing costs and therefore its very ability to engage in the ecological transition. Sovereign bonds eligible as collateral represent more than 60% of total debt in 17 of the 27 EU Member States, meaning that any change to their treatment – or the decision not to change it – has fiscal implications.

In other words, monetary and fiscal authorities already interact through collateral frameworks, whether or not central banks act on the matter. This is especially important because the long-term benefits of climate change mitigation and biodiversity protection are, according to the available evidence, only partially priced by financial markets (Appendix A). In this context, actions taken by the central bank may not only need to factor in considerations that are ignored by private market participants, but also influence their future behaviours.

Against this backdrop, the report makes three contributions.

First, it clarifies why nature-related considerations (understood to include climate change mitigation and biodiversity protection) could be integrated into the treatment of sovereign bonds. We distinguish three rationales, which sometimes overlap but have different legal foundations and different implications:

- A *risk-based* approach protects the central bank's balance sheet against underpriced transition risks borne by each issuer.
- A *resilience-based* approach supports the ECB's primary mandate of price and financial stability, given the inflationary and destabilising potential of nature-related risks.

- An *alignment-based* approach supports the EU's environmental objectives, in line with the ECB's secondary objective under Article 127(1) TFEU.

These rationales lead to different implementation choices, in particular between higher haircuts for weak performers and reduced haircuts, or bonuses, for strong performers. They also face different challenges, including the risks of exerting undue influence over elected governments and of fragmenting monetary policy transmission.

Moreover, the report widens the scope of the climate factor from climate change mitigation to biodiversity protection. Climate and biodiversity are related but distinct. A country can be close to meeting its emissions commitments while remaining far from meeting its biodiversity ones, and the two goals can even conflict, notably through land use. A climate-only factor would leave a blind spot, and could even reward countries that advance on one front at the expense of the other. We therefore propose a more comprehensive approach to nature, in line with scientific evidence and with central bankers' own recognition that climate and biodiversity should be assessed together.

Second, the report operationalises this proposal. We build on existing methodologies to rank sovereign performance: ASCOR for climate mitigation, and a composite of WWF's Biodiversity Risk Filter, the Yale Environmental Performance Index and the EU Consumption Footprint data for biodiversity. The climate and biodiversity scores differ widely across countries and are only weakly correlated, so the way they are combined matters. We then propose two formulas, partially building on the ECB's corporate climate factor, to translate these scores into haircuts. We apply them to the 2,384 government securities from the ECB's public list of eligible collateral. The quantitative analysis focuses on the risk-based approach, and so on increases in haircuts (haircut reductions and bonuses are discussed but not simulated).

We find that the aggregate effects could be large for some countries. For Italy, France, Germany and Spain, the additional adjustments could multiply the haircuts currently applied by the ECB by a factor of two to five. For Italy, this would amount to a loss in collateral value of up to around €200 billion, and for other countries up to 6% of gross government debt. However, these results depend heavily on calibration choices, such as the floor parameter that sets the maximum haircut.

Third, we reflect on the meaning of such results for future policymaking. In particular, the findings point to a tension at the heart of monetary policy: the risk-based approach is the most secure legally and the most consistent with existing ECB practice; yet by raising haircuts on countries with weak climate and biodiversity rankings it could raise their borrowing costs and further tighten their fiscal space, and with it their ability to invest in the transition. This would increase their vulnerability to future physical and transition risks, undermining the very price and financial stability the ECB is mandated to protect. The burden would also fall unevenly on Italy, which ranks 26th out of 28 countries on both scores, and on Central and Southeastern European countries, many of which face a harder transition because of coal dependence and lower incomes.

Exploring alternative approaches such as haircut reductions or bonuses for strong performers could limit these effects and encourage investment in the transition, which would be more in line with the resilience-based and alignment-based approaches presented above. But this approach would create its own trade-offs with risk management, if the pool of well-ranked sovereign assets is too small or consists of bonds that carry other, non-nature-related risks.

We do not attempt to resolve these trade-offs here. Instead, this report is meant as a basis for discussion among central bankers, policymakers and researchers, and as a first step towards a research agenda on the macrofinancial implications of collateral policies that integrate nature-related considerations. Our scores, formulas and calibrations show the potential orders of magnitude and the implications of different design choices, but they are not a final proposal for a specific Eurosystem rule.

The report is organised as follows. Section 1 explains why collateral frameworks matter for monetary policy and the wider economy, and reviews the ECB's existing climate factor. Section 2 sets out the

scope of sovereign bonds in Eurosystem collateral, the three rationales for incorporating nature-related considerations and their challenges, and the case for expanding the analysis to biodiversity. Section 3 presents the methodology for the climate and biodiversity scores and their translation into haircuts. Section 4 reports the results. Section 5 discusses their implications, including the combination of the two scores, geographical concentrations, the possibility of using haircut reductions or bonuses, the reliance on external assessments, and the need for future work to explore the political economy and macrofinancial implications of the different approaches tested and discussed throughout the report.

1. Collateral frameworks: technical but critical

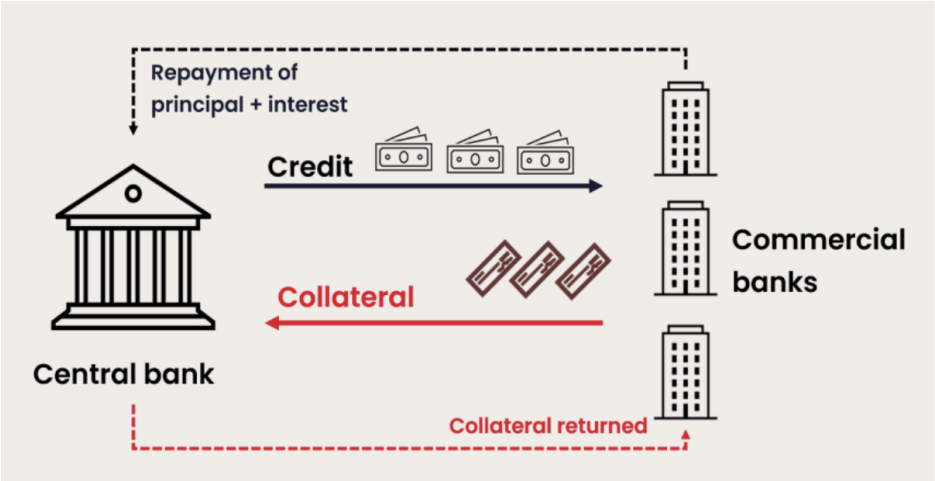
Central banks' collateral frameworks, while technical, sit at both the heart of monetary policy implementation and impact on economic and financial dynamics.

1.1 Collateral frameworks sit at the heart of monetary policy operations

Central banks provide a range of short- and long-term lending facilities that allow their counterparties – primarily commercial banks – to obtain central bank reserves (black arrow in Figure 1), a form of money used by banks to settle payments among themselves. In doing so, central banks are also able to transmit monetary policy, notably because they lend to counterparties at policy rates determined by their monetary policy committees. As such, these lending operations are essential both to ensuring market liquidity – so that counterparties do not run short of funds – and to the smooth transmission of monetary policy decisions (European Central Bank, 2017).

The collateral framework is a key pillar of these operations: access to central bank reserves via these lending facilities requires the counterparties – mainly commercial banks – to pledge eligible assets as collateral, shielding the central bank's balance sheet against counterparty risk in the case of default (the red arrow in Figure 1). That is, if a borrower defaults, the central bank can liquidate the pledged assets to recover its funds. Once the counterparty repays its loan, it is released from its collateral obligation and can recover the assets it pledged[5].

Figure 1. A simplified representation of the collateral framework



Source: Serrano Rodriguez et al. (2026)

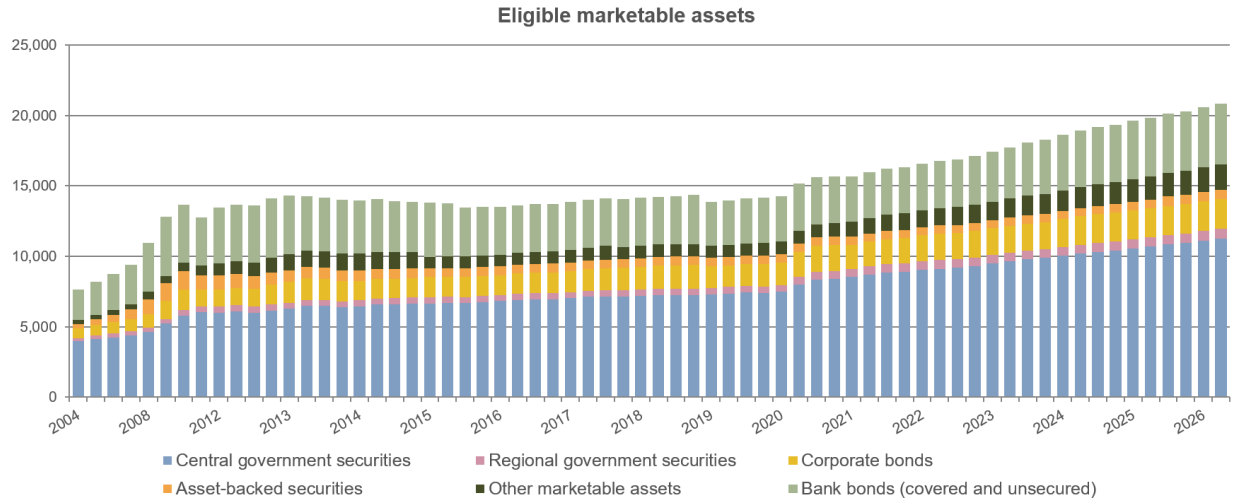
5 In practice, counterparties – at least in the Eurosystem, the central banking system of the eurozone – typically maintain a pool of pre-positioned collateral with their national central bank to quickly draw on central bank credit lines should market conditions worsen or unexpected funding needs arise. In this way, pledged collateral serves as a liquidity buffer.

Two elements are of particular importance to the collateral framework. First, the eligibility criteria, which establishes which assets – e.g. corporate bonds, sovereign bonds or asset-backed securities – are deemed sufficiently safe to be accepted as collateral, based on criteria such as credit rating, type of issuer and residual maturity. Second, the haircuts applied to some of these assets: haircuts reduce the collateral value of eligible yet relatively riskier assets below their market prices, providing a buffer against price volatility. That is, when a haircut is applied, the counterparty needs to pledge a higher value of assets to obtain the same loan from the central bank. The rules and principles governing this entire process – eligibility criteria, haircuts, and valuation methods – constitute what is known as a collateral framework.

While not uniform, a few guiding principles tend to underpin collateral frameworks (Oustry et al., 2020): (i) residual risk equivalence, whereby the framework avoids distorting markets or treating similar assets and issuers differently – although this point gives room to significantly diverging interpretations, as discussed later; (ii) a level playing field across counterparties, ensuring no eligible institution is excluded from liquidity operations – key to transmitting monetary policy uniformly across the financial system; (iii) simplicity (or operational efficiency), so the framework remains manageable for both the central bank and its counterparties without undue complexity; and (iv) adequate risk protection, requiring collateral of sufficient quality that, in the event of default, the central bank can recover its claim in full with high probability – meaning the framework must adequately limit credit, market, and liquidity risk.

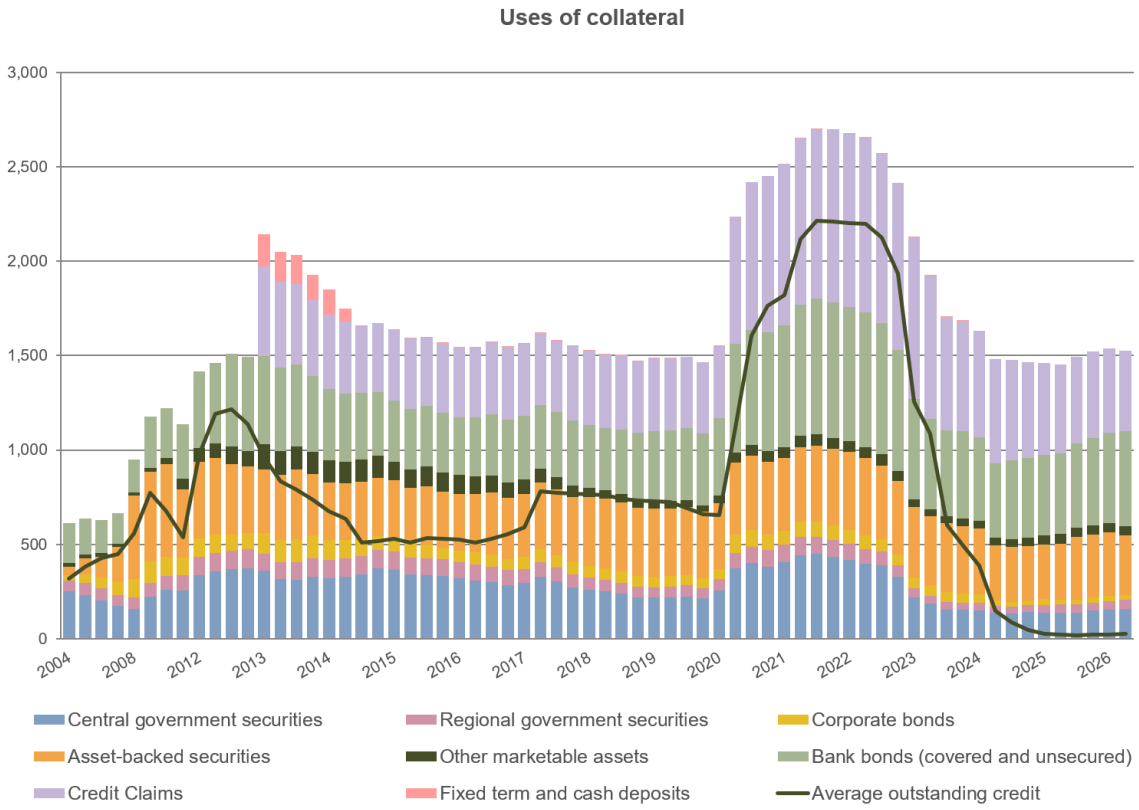
Within the Eurosystem, the universe of eligible collateral is dominated by sovereign bonds (central government securities), followed by bank bonds (unsecured and covered), corporate bonds, and asset-backed securities (Figure 2). However, the composition of collateral actually pledged by counterparties differs markedly from the composition of eligible collateral, and has also shifted considerably over time (Figure 3 and Figure 4). In 2026, pledged collateral is led by covered bank bonds, credit claims, and asset-backed securities, while government securities sit at a two-decade low. These aggregate figures, however, mask significant cross-country variation: counterparties in some countries tend to pledge domestic sovereign bonds, while those in other countries rely more heavily on private-sector debt as collateral. This could have significant implications for the potential application of the methodology we develop in this report, as discussed later.

Figure 2. Marketable assets eligible to the Eurosystem's collateral framework



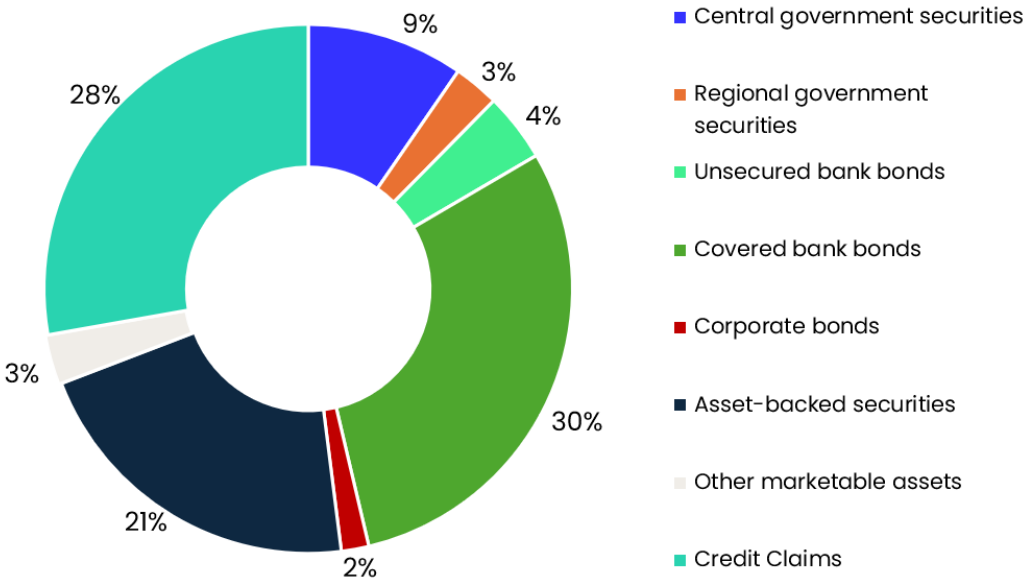
Notes: amounts are indicated in EUR billion; nominal amounts; averages of end of month data over each time period shown. Source: adapted from European Central Bank (2026a)

Figure 3 Assets pledged as collateral by Eurosystem counterparties



Notes: amounts are indicated in EUR billion, after valuation and haircuts; the use of collateral is based on averages of end of month data over each time period shown; credit is based on daily data. Source: adapted from European Central Bank (2026a)

Figure 4. Share of collateral use across asset classes



Source: European Central Bank (2026a). Data is for 2026Q1

1.2 The economic and financial impacts of collateral frameworks

Eligibility and haircut decisions do more than simply regulate access to central bank reserves: they send a signal about relative asset risk and, in doing so, shape market prices and behaviours. Assets that qualify as eligible collateral – particularly those subject to smaller haircuts – command greater demand from market participants, which prize the ability to mobilize them for central bank liquidity, especially in stressed conditions. Eligible securities tend to benefit from a 'collateral premium' that lowers funding costs for issuers and influences their issuance incentives. The converse holds equally: larger haircuts or outright exclusion from a collateral framework can exert material downward pressure on market prices (Nguyen, 2020; Nyborg, 2016; Mésonnier et al., 2022; Pelizzon et al., 2024).

In practice, these impacts on market prices and behaviours can vary significantly across jurisdictions (BIS, 2015; Serrano Rodriguez et al., 2026). For instance, the People's Bank of China's collateral framework is part of a broader mechanism of relending facilities targeting specific sectors and activities – e.g. green energy and small enterprises – in line with the country's strategic priorities. By contrast, central bank collateralized lending facilities see comparatively little use in the US and Japan, albeit for different reasons: in the US, the stigma attached to borrowing from the central bank discourages take-up, while in Japan the financial system's abundant liquidity simply reduces the need for it (Serrano Rodriguez et al., 2026).

The economic and financial weight of collateral frameworks also shifts over time. Their importance is most easily visible during periods of financial stress, when liquidity dries up and interbank trust breaks down. During the 2010-13 euro area sovereign debt crisis, for instance, the ECB allowed institutions to pledge credit claims that fell short of previously established eligibility criteria. Similarly, during the COVID-19 pandemic, many central banks relaxed both eligibility criteria and haircut calibrations to ease institutions' access to liquidity. Collateral frameworks also take on renewed importance as central banks 'normalize' their balance sheets (NGFS, 2026) – which typically occurs a few years after a major crisis, when risks of a liquidity crisis have been mitigated. Indeed, as excess liquidity recedes and commercial banks find it harder to source funding on the open market, the terms governing access to central bank liquidity can increasingly shape market conditions.

This being said, collateral frameworks also carry economic and financial weight during periods in which counterparties have little recourse to central bank credit. This is in part because, as mentioned above, counterparties – at least in the Eurosystem – typically maintain a pool of pre-positioned collateral with their national central bank to quickly draw on central bank credit lines should market conditions worsen or unexpected funding needs arise. As a result, the value of pledged collateral often exceeds the amount of outstanding refinancing operations. This has been particularly the case since 2023: although loans from the ECB declined sharply, the volume of pledged collateral has remained comparatively high (see Figure 3 on pledged collateral).

It is also important to acknowledge a more critical perspective on the impacts of collateral frameworks – namely, that they can generate de facto interactions between monetary and fiscal policies, even if central banks are reluctant to acknowledge them. In particular, Gabor (2021) argues that unlike in the post-World War II 'Keynesian' period in which central banks sought to keep borrowing costs low to support government spending, the current regime involves central banks intervening in government bond markets primarily to protect the private financial sector (i.e. current interventions are not intended to lower government borrowing costs). However, as central bank counterparties are heavily exposed to the market value of sovereign bonds used as collateral, central banks can end up acting as a market maker of last resort to backstop market liquidity and prevent financial instability. By framing these purchases as necessary for "easing financing conditions" for private finance rather than fiscal support, central banks avoid explicit coordination with the state's fiscal goals – in line with their stated independence – while still contributing to "derisking" government bonds. Nevertheless, in this regime the state remains disciplined by bond markets and fiscal rules, and lower government borrowing costs – if any – are only a "side-effect" of central bank interventions aimed at private finance, rather than a

primary policy target.

Without necessarily endorsing this argument in full – for instance, as discussed above, government bonds are not in fact the primary asset pledged by many counterparties – it remains worth acknowledging that collateral frameworks carry deeper implications for bond issuers' financial health, governments included, and by extension for fiscal space itself. In other words, collateral frameworks de facto create distinct channels of interactions between monetary policy, fiscal authorities and the private sector – and these warrant deeper scrutiny, especially when considering the proposed changes to collateral frameworks discussed in this report.

1.3 Integrating climate considerations in the collateral framework – focus on the ECB

Recognising that climate change poses financial risks that may be imperfectly priced by financial markets (see Appendix A), the ECB began incorporating climate-related considerations into its collateral framework in 2020 (European Central Bank, 2020). However, the introduction of the climate factor marked a more direct attempt to account for climate-related financial risks in collateral valuation. Announced in July 2025 (European Central Bank, 2025), the measure took effect on 15 June 2026 (European Central Bank, 2026b). It adjusts the collateral value of eligible marketable debt instruments issued by non-financial corporations and their affiliates according to their exposure to uncertainties associated with the transition to a low-carbon economy (Serrano Rodriguez et al., 2026). However, these instruments represent only a very small share of all eligible and pledged collateral (Figures 2 and 3). In July 2026, the ECB also announced an extension of the climate factor to certain eligible credit claims to non-financial corporations, with implementation expected by the end of 2027 at the earliest. The Governing Council has committed to reviewing the framework regularly.

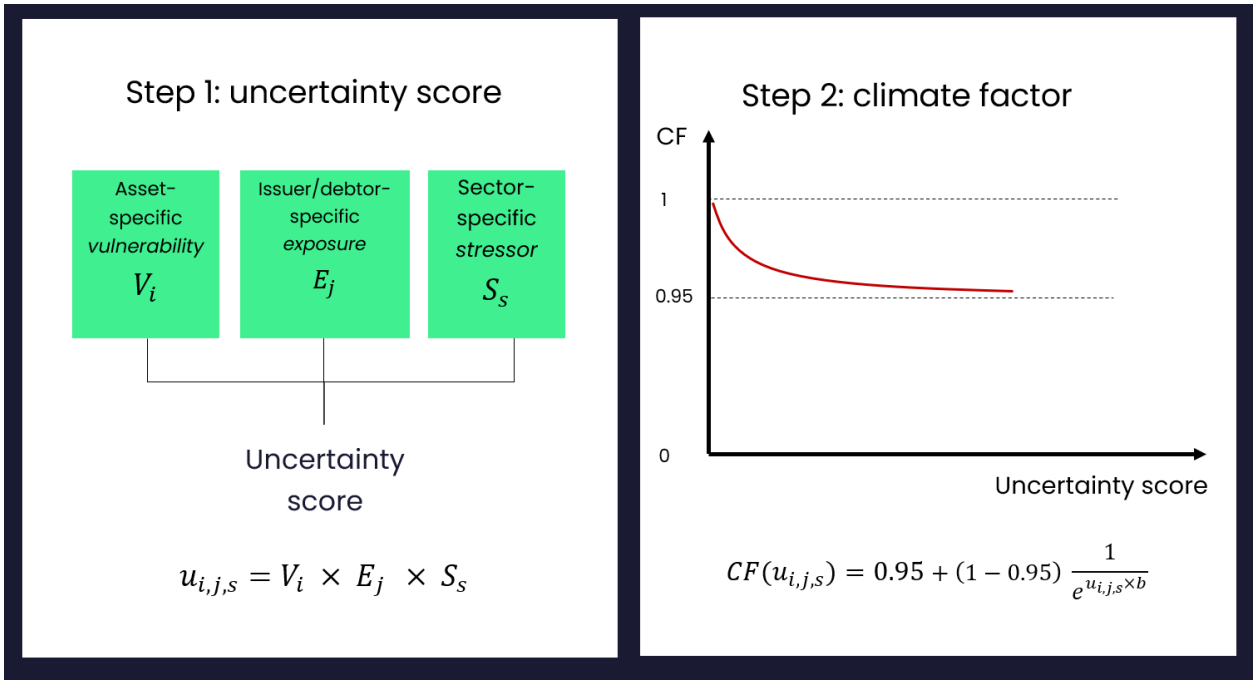
The ECB climate factor is a management tool designed to protect the Eurosystem balance sheet from abrupt falls in collateral values during liquidation due to transition related risks and uncertainties[6]. By targeting potential liquidation price risks, such as market instability from new laws or energy price spikes, it serves as an additional layer of security beyond standard valuation haircuts. This measure is intended to ensure refinancing operations continue to function smoothly during abrupt economic shifts linked to the low-carbon transition.

The design of the climate factor relies on what the ECB named an uncertainty score, derived from three specific layers of vulnerability (Step 1 of Figure 5): an issuer exposure score, a sector-level stressor, and the residual maturity of the asset. Issuer scores are determined by evaluating a company's past greenhouse gas emissions, the credibility of its future decarbonization targets, and the transparency of its climate disclosures. Crucially, this score is intended to measure how sensitive an individual firm is to sector-level shocks, (i.e. it's fundamentally related to the sector component). The sector-level stressor, meanwhile, captures the expected financial impact of an adverse transition shock on firms operating within the same economic sector. It is derived from the increase in expected shortfall under the adverse scenario of the Eurosystem climate stress test relative to a baseline scenario and therefore acts as a common market-wide adjustment applied uniformly to all issuers in a given sector. Carbon-intensive sectors expected to experience larger valuation losses under a disorderly low-carbon transition receive higher stressor values than sectors considered less exposed. Finally, asset-specific vulnerability is captured through the square root of the bond's residual maturity, under the assumption that longer-dated securities are more sensitive to future transition-related shocks. The uncertainty score is obtained by multiplying these three components and ultimately transformed into the final

6 As noted above, the Eurosystem refers to climate uncertainty (rather than risk) when discussing the integration of climate considerations within its collateral framework, yet this approach mostly falls within the risk-based approach described above – focused on protecting the central bank's balance sheet – although it also seeks to guarantee the transmission of monetary policy in light of climate change.

climate factor through a mathematical formula governed by parameters set by the Governing Council (Step 2 of Figure 5).

Figure 5. Steps through which the ECB incorporates a climate factor for non-financial corporate assets



Note: parameter *a* is set by the Governing Council, and is informed by the expected shortfall aggregated across all sectors in the climate stress test. As per the latest announcement, a is set to 0.95 (European Central Bank, 2026b); parameter *b* is also set by the Governing Council, and is informed by the median uncertainty score ū. Source: Serrano Rodriguez et al. (2026)

2. A nature factor for sovereign bonds: scope, rationales and challenges

The current scope of the climate factor leaves the majority of pledged collateral without a dedicated treatment of low-carbon transition risks. This narrow scope is not only problematic in terms of consistency, it could also prompt counterparties to alter their collateral mixes, shifting away from corporate bonds and credit claims toward asset classes exempt from the climate factor. This would both go against the guiding principles mentioned above that underpin collateral frameworks – in particular the residual risk equivalence adequate risk protection principles – and dilute the policy's overall impact.

However, broadening the climate factor to encompass the remainder of the ECB's eligible collateral framework would require tailoring the existing methodology to each asset class. For instance, the first pillar of the existing climate factor – a sector-specific stressor – may not apply to assets such as sovereign bonds, which are by nature multisectoral. Likewise, several methodologies have been developed to assess the climate alignment and risks of corporates (including financial corporates), but fewer methodologies exist for other asset classes such as asset-backed securities (André et al., 2022; Serrano Rodriguez et al., 2026). Against this backdrop, the remainder of this report focuses on why and how the ECB climate factor could be extended and adapted to one particular asset: sovereign bonds.

In this section, we first briefly review the scope represented by sovereign bonds in terms of eligible and pledged assets. We then present three approaches to integrating nature-related considerations into the treatment of sovereign bonds, each reflecting a distinct rationale. We term these the risk-based, resilience-based and alignment-based approaches.

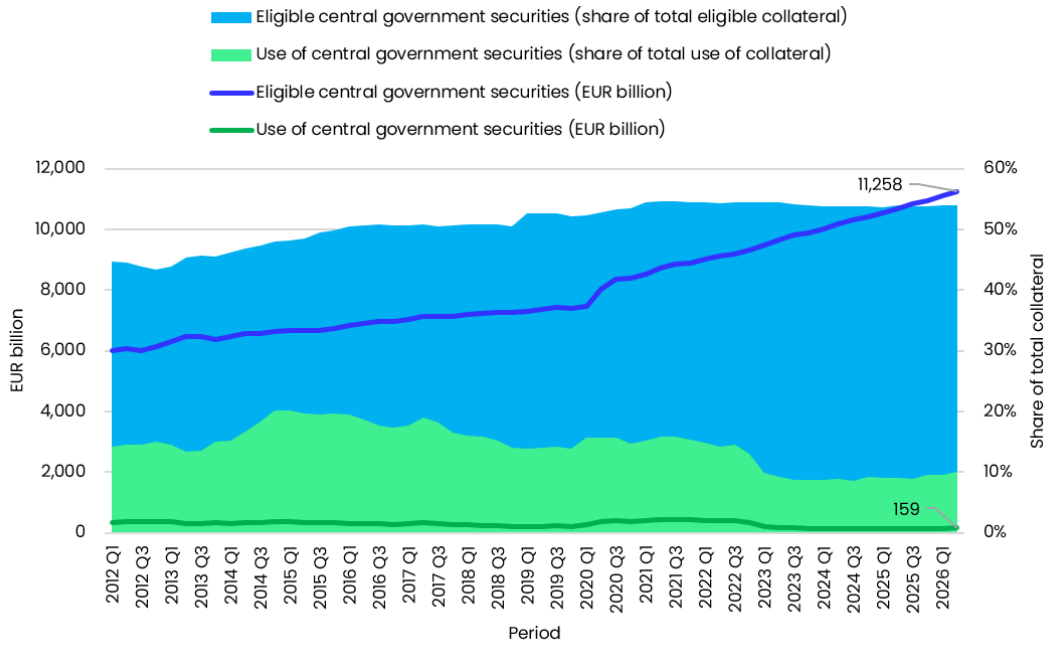
Taken together, these approaches suggest that there is no single way of incorporating nature-related considerations into the collateral framework. Rather, different approaches can justify different forms of differentiation, each reflecting a different balance between risk management, monetary policy implementation, and support for broader EU policy objectives. The choice between them therefore ultimately depends on the objectives the EU and the central bank seek to achieve, and the role they consider the collateral framework should play in supporting central bank risk management, price/financial stability, and broader transition objectives.

2.1 Focus on sovereign bonds – Scope

Sovereign bonds account for more than 54% of Eurosystem's eligible collateral (EUR 11,1 trillion) and around 10% of its pledged collateral, which represents EUR 159.2 billion (Figure 6). The amount of sovereign bonds eligible and pledged are different from one country to another, and depend on several factors such as the country's economic size, its public debt, and counterparties' preference for pledging this particular asset.

Government debt from the four largest economies of Europe (France, Germany, Italy and Spain) represent more than three quarters of the government debt eligible for collateral (Figure 7), with a considerable gap relative to all other countries. Beyond these four largest issuers, no other country has more than €1 trillion in eligible sovereign securities outstanding (Figure 8). The debt of Eurozone countries issued in other currencies is accepted as collateral with larger haircuts, while euro-denominated debt issued by European Economic Area (EEA) countries is accepted at a moderate haircut, with Poland and Hungary issuing the largest share of such bonds.

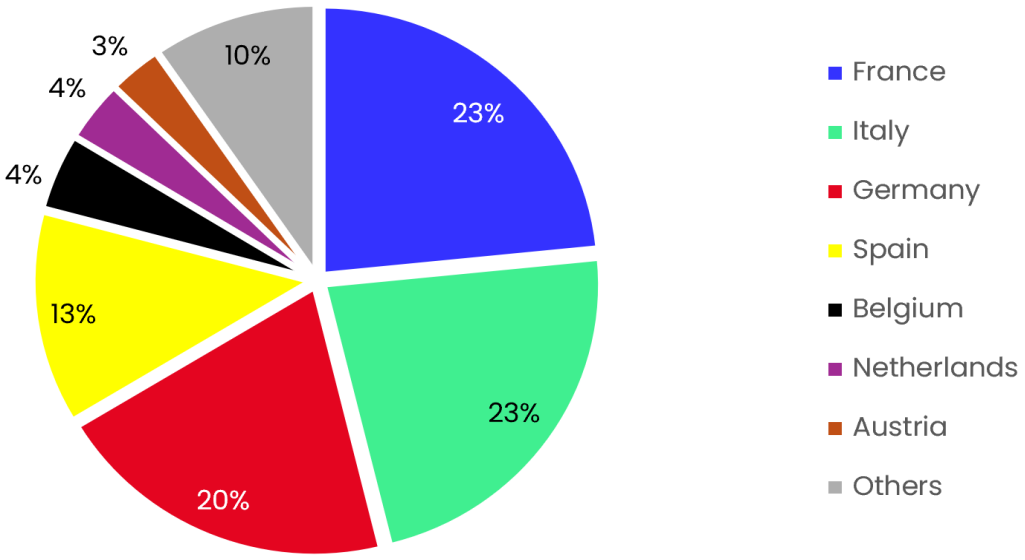
Figure 6. Sovereign bonds eligible and pledged as collateral, in EUR and as a share of total eligible and pledged collateral



Note: Eligible and used collateral in € billion, nominal amounts, averages of end-of-month data over

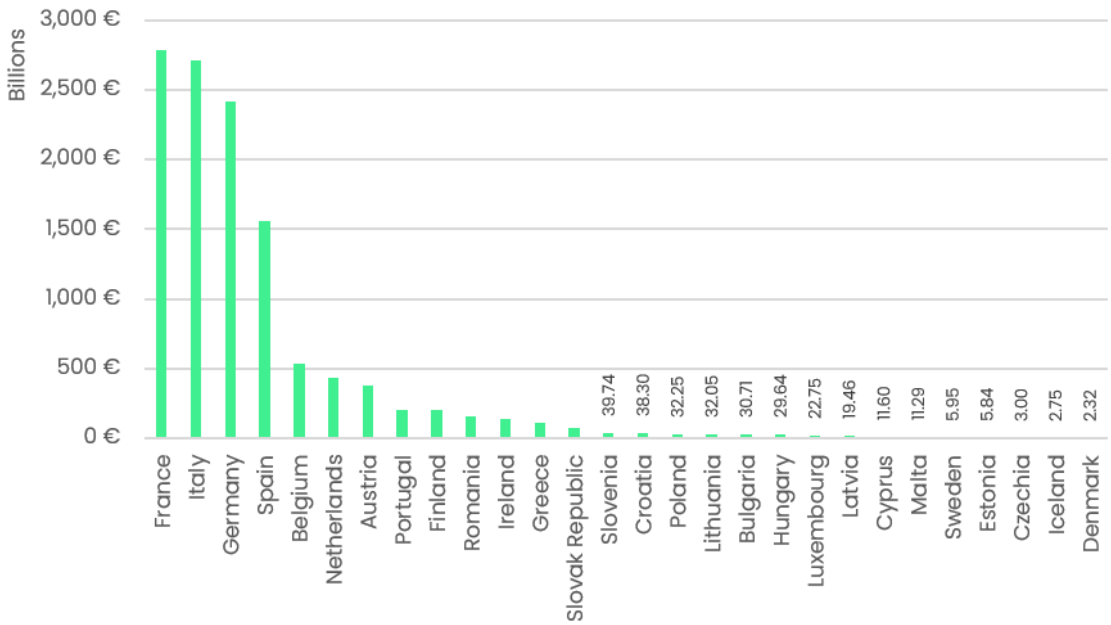
each time period shown. Use of collateral data is after valuation and standard haircuts. Source: Authors' calculations using data from the European Central Bank (2026a)

Figure 7 Sovereign bonds eligible as Eurosystem collateral, outstanding amounts by country (%)



Source (2026): ECB (list of eligible assets, 23 June 2026), LSEG Workspace (outstanding amounts and market price, 23 June 2026)

Figure 8 Total outstanding amounts of eligible sovereign bonds by issuer



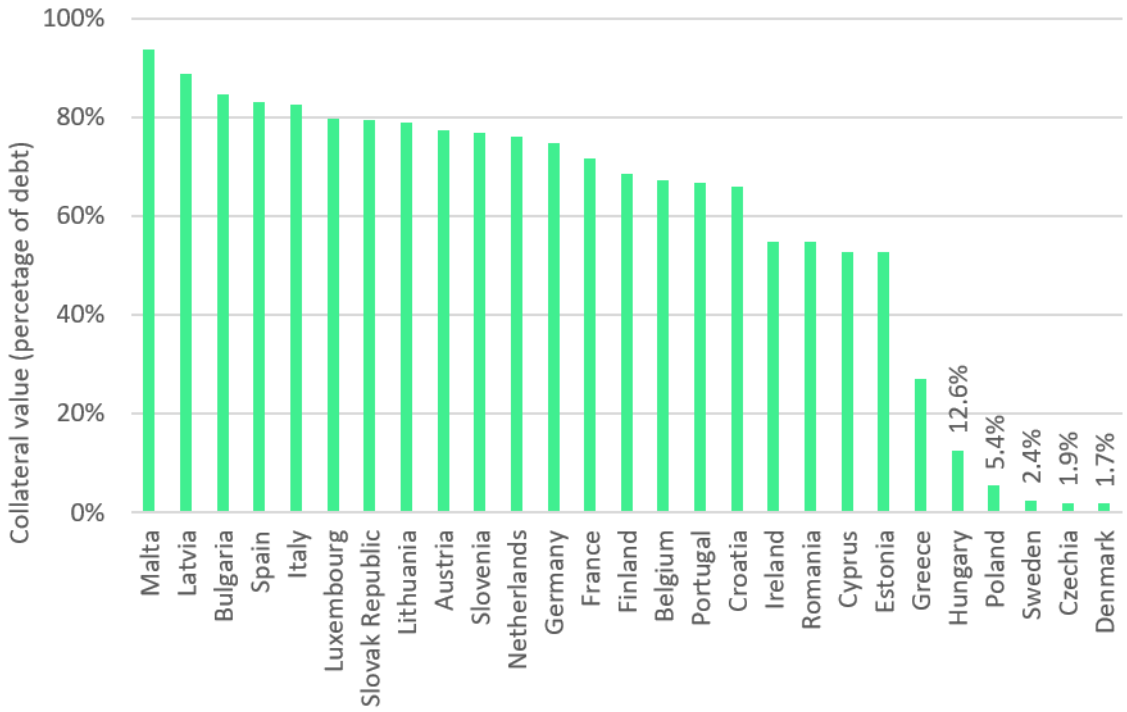
Source (2026): ECB (list of eligible assets, 23 June 2026), LSEG Workspace (outstanding amounts and market price, 23 June 2026)

It is important to note that governments' borrowing costs may be significantly impacted by haircuts applied by the ECB, given the volume of sovereign bonds eligible for the collateral. For instance, Figure 9 shows that the value of eligible sovereign bonds (after haircuts) represents more than 60% of the country's total debt for 17 out of the 27 EU member states, and more than 80% for five of them (Malta, Latvia, Bulgaria, Spain and Italy).

This indicates – in line with arguments made by Gabor (2021) among others – that monetary and fiscal authorities already interact through collateral frameworks and sovereign bond pricing. For instance, the bonds issued by countries such as Greece are subject to relatively large haircuts that can amount to up to 25% of the market value of the bond. This can have significant impacts on financial markets' perception of the country's debt sustainability, which in turn feeds into higher borrowing costs and constrained fiscal space.

In light of this, the way in which the ECB integrates nature-related considerations (including physical and transition risks) will also impact a country's fiscal position. Note that even if the central bank decides not to engage with such a topic, it is de facto shaping the outcome. Indeed – and as further discussed below – given the evidence that financial markets are largely unable to price in the long-term benefits brought by climate change mitigation and biodiversity protection, not reflecting these benefits in the collateral framework replicates and reinforces market mispricing.

Figure 9 Collateral value, after standard haircuts, of eligible sovereign bonds as a percentage of the country's general government gross debt



Source (2026): authors' calculations based on ECB (list of eligible assets, 23 June 2026), Eurostat (General government gross debt) and LSEG Workspace (outstanding amounts and market price, 23 June 2026).

2.2 Focus on sovereign bonds – Rationales and challenges

There are three ways central banks can justify incorporating nature-related considerations (including climate change and biodiversity) within their strategies and operations – including with regards to

their collateral frameworks. We term these the 'risk-based', 'resilience-based', and 'alignment-based' approaches. It is important to note that while these approaches are presented separately, in practice they can be combined and it can also be somewhat difficult to fully differentiate between them.

Three rationales: The Risk-, Resilience- and Alignment-based approaches

In a risk-based approach, the central bank adjusts its collateral framework to protect its balance sheet from potential financial losses from nature-related risks that cause a pledged asset to depreciate prior to its sale. It does this by applying higher haircuts to assets from issuers whose activities or policies are judged to make them susceptible to nature-related risks.

This approach can be justified by the fact that markets are likely to systematically underprice nature-related risks, notably with regards to sovereign bonds – as detailed in Appendix A. A growing body of literature indicates that nature-related transition risks affect sovereign creditworthiness through direct fiscal channels (rising transition-related expenditure alongside declining revenues from carbon-intensive activities), indirect macroeconomic effects (weaker output, competitiveness, and tax revenue in exposed sectors), and financial-sector feedback loops between sovereign and bank balance sheets. Empirical evidence confirms that markets only partially price these risks – higher emissions are generally associated with higher sovereign yields, while stronger climate commitments and, to a lesser extent, natural capital and biodiversity performance are associated with lower borrowing costs. However, this pricing remains incomplete and uneven: rating agencies incorporate climate indicators only selectively and largely after the Paris Agreement, market pricing and credit ratings often reflect different dimensions of environmental risk, and pricing appears more sensitive to salience – such as extreme weather events or major policy signals – than to a continuous and comprehensive assessment of underlying exposures, with biodiversity-related risk lagging even further behind climate risk in this respect.

In a resilience-based approach, the ECB adjusts its collateral framework to align it with its primary mandate. It does this by factoring in the systemic risks that nature degradation (including climate change) can create in the medium-term for price and financial stability, rather than only the idiosyncratic risk borne by each country, as in the previous approach.

The resilience-based approach can be justified by the fact that nature-related risks can impact on price and financial stability. For example, acute inflationary shocks and structural trends can be driven by rising temperatures (Faccia et al., 2021; Falck and Schulte, 2025), droughts and altered precipitation patterns (Kabundi et al., 2022; Kotz et al., 2024), and extreme weather anomalies like storms, hurricanes, and El Niño events (Bao et al., 2023; Cashin et al., 2017; Heinen et al., 2019). Similarly, biodiversity loss can also generate macroeconomic stability issues, while disorderly transitions can introduce transition risks that generate substantial inflationary and financial pressures (Carney, 2015; Jackson et al., 2026). In this context, and considering that financial markets do not price in the long-term benefits brought by climate stability and biodiversity, inaction from the central bank would be akin to accepting a continuous build-up of macrofinancial risks.

The resilience approach could justify mixing haircuts – as in the risk-based approach – with haircut reductions for countries that perform well or relatively better. In doing the latter, the central bank would not be actively supporting the transition but rather acknowledging that the signals it sends, by impacting countries' fiscal space, can also contribute to nudging them to mitigate future risks for price and financial stability.

In an alignment-based approach, the central bank adjusts the collateral framework with an explicit view to supporting nature-related EU policies, in line with its secondary mandate (as described in Article 127 of the Treaty on the Functioning of the EU [7]). In practice, this approach would primarily

7 Article 127(1) of the Treaty on the Functioning of the European Union (TFEU) requires that "without prejudice to

consist in applying haircut reductions or even bonuses to countries who adopt policies that mitigate climate change and protect biodiversity.

It is important to note that the three approaches do not rank identically in relation to their legal robustness or the level/type of empirical support they require. The risk-based approach is clearly the most secure from a legal perspective, as managing the financial risks to its own balance sheet is already a key central bank activity. The resilience-based approach is also relatively secure as it is based on the primary mandate. In contrast, the alignment-based approach is more exposed to the objection of whether nature considerations should receive special treatment when the government has numerous other public policy goals – that is, the objection is to central bank politicisation or mission creep.

Perhaps the main response to the objections relating to the alignment-based approach is that the secondary mandate is a genuine legal obligation and not an optional extra (even though it is subordinate to the primary mandate). That said, it should be noted that decisions taken on the basis of the secondary mandate are often the most ambitious and contested of all central bank actions, and as such require greater justification compared to when they are risk-based or related to the primary mandate (resilience-based). Finally, it is noteworthy that the three approaches outlined above can be combined and it can also be difficult to fully differentiate them.

Challenges for all three approaches

There are a number of challenges associated with integrating climate and nature considerations into the collateral framework, which arise to different degrees under the risk, resilience and alignment based approaches.

First, altering the haircuts applied to government bonds under a risk-, resilience- or alignment-based approach could be perceived as the central bank exerting undue influence over elected governments. This concern could justify moving away from a haircut approach – which could be perceived as the central bank penalizing countries that perform poorly – and instead towards a 'bonus' approach. Under such an approach those countries that perform well would receive reductions in their haircuts (i.e. bonuses) – a politically less controversial option than haircuts, particularly under the resilience- or alignment-based justification. The bonus approach would, however, imply that the central bank takes on additional risk. This creates a trade-off between the risk-management function of the collateral framework and the benefits of aligning it with the primary or secondary mandates. These additional risks would therefore need to be balanced against the positive impacts of adopting the approach.

Second, given that countries' contributions to nature-related systemic risks vary across EU Member States – with some economies being larger and/or more polluting per unit of GDP than others – applying this approach without appropriate methodological adjustments could result in larger countries being disadvantaged more or benefitting disproportionately. This could be inconsistent with the guiding principles of collateral frameworks discussed above, in particular the principle of ensuring a level playing field across counterparties.

Third, under the resilience- and alignment-based approaches, differentiating the treatment of sovereign debt may have only a limited effect on price stability, financial stability or support for government policy – unless the degree of differentiation is substantial. However, increasing the degree of differentiation also raises the risk of fragmenting the transmission of monetary policy, thereby

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the objective of price stability, the ESCB [European System of Central Banks] shall support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union as laid down in Article 3 of the Treaty on European Union" (European Union, 2016a). In turn, Article 3 of the Treaty on European Union indicates that the EU "shall work for the sustainable development of Europe … and a high level of protection and improvement of the quality of the environment." (European Union, 2016b).

reducing its effectiveness[8] (although it could also reduce fragmentation in some scenarios).[9] This raises the crucial question of how central banks should interpret such fragmentation.

Here it is useful to draw on the ECB's own distinction between warranted fragmentation, which reflects differences in economic fundamentals, and unwarranted fragmentation, which is self-fulfilling and detached from fundamentals. On this basis, spread widening that correctly reflects newly priced nature-related risks – for either each country or the system as a whole – would constitute warranted fragmentation. The potential effects of differentiated sovereign bond treatment within the collateral framework nevertheless highlight an important trade-off between monetary policy fragmentation and ensuring changes to the collateral framework are large enough to be effective.

This trade-off may be more significant under the resilience- and alignment-based approaches, as by seeking to materially impact price/financial stability or government policy they may require a greater degree of differentiation than the risk-based approach, which is concerned only with protecting the central bank's balance sheet against short-run price movements. The trade-off is also potentially more problematic under the resilience-based approach, as fragmentation here directly undermines the objective of the framework – i.e. price stability. Conversely in the risk- and alignment-based approaches any impairment to monetary policy is offset by benefits to risk management or policy support.

To sum up, while changes to the collateral framework that incorporate nature-related considerations can be justified using risk-based, alignment-based, or resilience-based approaches, each approach involves distinct benefits, costs, and trade-offs.

2.3 Towards a comprehensive approach to nature

Climate mitigation and the preservation of biodiversity are related, but substantially different tasks. The NGFS refers to this interaction as the climate-nature nexus, stressing that climate change and broader nature-related risks are distinct but interconnected and should not be considered in isolation (NGFS, 2023). Climate change is itself an important driver of biodiversity loss, affecting species, habitats and ecosystem functioning. At the same time, the degradation of ecosystems can exacerbate climate change by weakening carbon sinks and reducing ecosystems' capacity to adapt to climate-related physical shocks. Protecting and restoring nature can therefore contribute to climate mitigation and adaptation, while limiting climate change is itself important for preserving biodiversity.

The two objectives are nevertheless not perfectly aligned. The transition to a low-carbon economy can generate additional pressures on biodiversity. The extraction of critical minerals required for renewable energy technologies can contribute to habitat loss, water stress and pollution. Climate and biodiversity policies therefore involve synergies, but also trade-offs that make it necessary to consider both dimensions jointly and avoid assuming that progress on one necessarily implies progress on the other.

This distinction matters for the assessment of sovereigns. There is a risk that considering only a Climate Factor leaves a blind spot to countries which may be close to respecting their commitments regarding emissions, but are still very far from respecting their international and EU commitments on

8 For instance, relying on methodologies that assess the alignment of financial and non-financial corporates with climate objectives, Oustry et al. (2020) find that, in aggregate and despite some differences across methodologies and metrics, neither the Eurosystem eligible collateral universe nor the collateral pledged is "aligned" with the climate targets of the European Union. The authors argue that this misalignment implies that the Eurosystem marketable collateral can be considered exposed to climate-related transition risks. Moreover, the authors find that, should the ECB accept only climate-aligned (non-financial and financial corporate) assets as collateral, they may run into an insufficient pool of eligible assets to appropriately conduct monetary policy operations – suggesting that there may be trade-offs between the different approaches

9 Because sovereign spreads play a key role in the monetary policy transmission mechanism, collateral-induced spread widening can impair the singleness – and therefore the effectiveness – of monetary policy

biodiversity, such as the Kunming-Montreal Global Biodiversity Framework and the EU Nature Restoration Regulation. To avoid the risk of rewarding countries which prioritize climate mitigation at the expense of biodiversity preservation, we propose that a climate factor for sovereigns should also be combined with an assessment of countries' progress on biodiversity, thereby generating a more comprehensive approach to nature as a whole.

3. Methodology

Due to the particularities regarding sovereign bonds discussed above, it was not possible, or desirable, to directly replicate the method used by the ECB to determine the climate factor on corporate bonds. In light of this and considering how new and complex the topic is, our approach is not to propose a single optimal way of integrating climate and biodiversity considerations into the treatment of sovereign bonds in the ECB collateral framework, but rather to reflect on and test a range of approaches, spanning a pure risk-based perspective to less traditional ones grounded in the resilience and alignment approaches discussed above. We further seek to explore the trade-offs that could emerge depending on how this is implemented. However, in order to generate quantitative results, we focus on the risk-based approach described above, leaving the adaptation of our methodology to the resilience- and alignment-based approaches for future work (while also recognizing that there is likely to be substantial overlap between them). In practice, following a more risk-based approach entails the central bank applying larger haircuts to assets issued by entities whose activities or policies are judged to expose them to greater nature-related transition risks.

In what follows, we first present the existing methodologies on which we selectively rely to explore how climate and biodiversity considerations could be applied to the treatment of sovereign bonds in the ECB collateral framework: (i) for climate, the Assessing Sovereign Climate-related Opportunities and Risks (ASCOR) methodology – by the Transition Pathway Initiative (TPI) Global Climate Transition Centre at the London School of Economics; (ii) for biodiversity, a mix of indicators representing the pressures to, state of and responses to biodiversity loss, with data provided by the WWF Biodiversity Risk Filter, the 2026 Environmental Performance Index (EPI) hosted by Yale University, and the European Platform on Life Cycle Assessment of the European Commission Joint Research Centre. The purpose of relying on external methodologies is not only practical, it also enables the central bank to rely on accepted external assessors in a way that is consistent with existing practice under the Eurosystem Credit Assessment Framework (ECAF)[10], where sovereign credit judgement is delegated rather than performed by the central bank itself[11].

We then present the methodological choices which go into designing respectively a climate and biodiversity factor for sovereign bonds, including: the choices related to the use of traditional haircuts versus the application of 'bonuses'; the reason for not considering physical risks; the nature of the uncertainty score as either a relative ranking or as a measure against fixed targets; the role of the maturity of bonds in the framework; the weighting of different indicators; and the decision to keep biodiversity and climate scores separate rather than merged.

Lastly, we present the two formulas through which we translate the climate and biodiversity scores obtained through our methodologies into specific haircuts. The first one is based on the ECB climate factor for corporate bonds formula; the second one consists of a normalized logistic transformation in order to obtain a smooth S-shaped curve constrained between a minimum and maximum value.

10 ECAF is the risk procedure used by the ECB to ensure that all collateral pledged by banks in monetary policy operations meets high credit standards.

11 This being said, we acknowledge that the methodologies we rely on are subject to caveats and interpretations, meaning that the central bank would still need to construct its own aggregation of indicators. This reintroduces an element of discretion that the framework leaves to the user rather than settling itself.

3.1 Constructing a sovereign climate-related score

We now present the methodology we use to explore how climate considerations can be applied to the treatment of sovereign bonds in the ECB collateral framework

Introducing ASCOR

To assess how climate considerations could be integrated into the ECB's holding of sovereign bonds through its collateral framework, we focus on the ASCOR (Assessing Sovereign Climate-related Opportunities and Risks) methodology. ASCOR is a tool which evaluates countries' progress in the low carbon transition, including an assessment of the alignment of national emissions trends and targets with the global temperature goals of the Paris Agreement and an analysis of the degree to which countries have adopted a set of best practice, policies and laws. ASCOR was initiated by asset owners and developed by the Transition Pathway Initiative (TPI) Centre at the London School of Economics and increasingly used by financial market participants in a range of applications, including sovereign engagement and index development (Hizliok et al., 2025)

ASCOR is explicitly designed to assess how sovereigns are managing climate risks and opportunities through target setting and policy development and excludes factors which are largely outside of a government's control, such as exposure to physical risks from climate change (Scheer et al., 2025). This approach aligns well with the demands of assessing sovereign bonds for climate transition risks. The tool is designed for cross-country comparison: most metrics are in magnitudes relative to GDP and alignment indicators are in reference to country-specific benchmarks. The framework also recognises the principle of common but differentiated responsibilities and capabilities enshrined in the UN Framework Convention on Climate Change by exempting middle- and low-income countries from selected high-ambition indicators which are particularly challenging for emerging market economies to meet.[12]

Our analysis relies on ASCOR v1.2,[13] which is structured into three pillars: emissions pathways, climate policies and climate finance. These pillars are made up of 14 thematic areas (

Table 1). The results for each area are determined by underlying indicators and metrics (Table 2). Indicators are binary yes/no statements, while metrics are continuous measurements. Many yes/no indicators are derived by setting a threshold for a specific quantified metric. For example, the metric "What is the country's most recent emissions level?" is used to provide a binary answer for the indicator "Has the country improved its emissions profile over the past 5 years?". Other indicators are not based on metrics, such as the presence of a particular law, policy or target. The ASCOR tool does not provide an overall score for each country or for each pillar, with the highest level of aggregation being the 14 areas, which are judged as being either fully, partially or not met, or exempt (Scheer et al., 2025).

12 However, in the ASCOR framework none of the countries in the European Economic Area are classified as middle- or low-income countries. As a result, exemptions are not relevant for this report, except for determining which countries are assessed on their contribution to international climate finance (Annex II countries). Nevertheless, a central bank may choose to extend such exemptions to certain countries within a given income group if it determines that differentiated responsibilities continue to apply.

13 An updated methodology, ASCOR v2.0, is scheduled to be published on 3 November 2026 and will involve changes to the structure and indicators of the framework.

Table 1. Overview of ASCOR framework

Overview of the ASCOR framework		
Pillar 1. Emission	Pillar 2. Climate Policies	Pillar 3. Climate Finance
EP 1. Emissions trends EP 2. 2030 targets EP 3. 2035 targets EP 4. Net zero targets	CP 1. Climate legislation CP 2. Carbon pricing CP 3. Fossil fuels CP 4. Sectoral transitions CP 5. Adaptation CP 6. Just transition	CF 1. International climate finance CF 2. Transparency of climate costing CF 3. Transparency of climate spending CF 4. Renewable energy

Source: adapted from Scheer et al. (2025)

Table 2. Elements of the ASCOR framework structure

Pillar →	Area →	Indicator →	Metric
Broad ASCOR theme (e.g. Emissions Pathways)	Specific area of climate performance (e.g. EP 1. Emissions trends)	Binary question about whether the country has taken a specific action (e.g. EP 1.a)	Quantitiative metric to proivide context for some indicators (e.g. EP 1.a.i)

Source: adapted from Scheer et al. (2025)

Methodology

For this report, we propose a method which synthesizes the various indicators and metrics of ASCOR into a single score which can be used to calculate a country-level Climate Factor (analogous to the uncertainty score currently applied to corporate bonds). In doing so, we try to retain as much of the existing ASCOR data and structure as possible, making amendments only where needed to more clearly fit the rationales described above or for simplicity.

The structure of our composite score is given in Table 3. Following the labelling structure of ASCOR, the two pillars in our score are Results and Policies. Results are a consideration of measurable outcomes. Policies are targets, laws, or actions fully under the control of a sovereign. The two pillars are weighted equally between each other, and each area is weighted equally within each pillar. This gives a substantial weight to data for emissions and energy transition, as each area makes up a quarter of the final country-level score. Additional methodological choices are presented in Appendix B.

Table 3. Overview of Pillars and areas of our sovereign climate score, as adapted from ASCOR

Pillar	Areas	Content
Results (50%)	Emissions (consumption- and production-based)	• Most recent emissions level • Last 5-years emission trends • Difference between trend in emissions and 1.5C and fair share allocation emission benchmarks
	Energy transition	• Level of fossil fuel rents as percentage of GDP • Energy intensity of primary energy • Share of electricity generation from low carbon sources • Ratio of country's renewable energy opportunities relative to fossil-fuel-based capacity
Policies (50%)	2030 targets	• Targeted emissions reduction relative to 2019 emissions • Transparency of carbon credit use • Share of target achieved through carbon credits • Distance from the country's 1.5°C benchmark • Distance from the country's 1.5°C fair share allocation
	Net zero targets	• Net zero CO2 target year • Alignment with a global 1.5°C scenario • Accelerated deadline for high-income countries
	Climate legislation	• Framework climate law • Accountability elements in climate legislation
	Carbon pricing	• Operational carbon pricing system • Share of emissions covered by carbon pricing • Paris alignment of carbon pricing • Explicit carbon price level
	Fossil fuels	• Fossil fuel subsidy phase-out commitment • Fossil fuel subsidy phase-out year • Inventory of explicit fossil fuel subsidies • Explicit fossil fuel subsidies as a share of GDP • Commitment not to approve new coal mines
	Sectoral transitions	• Multi-sector climate strategy • Mandatory climate-related disclosure • 1.5°C-aligned net zero electricity target • Expansion of protected areas • Protected area as a share of land area
	Just transition	• Inclusive and institutionalised just transition approach • Green jobs strategy • Distributional safeguards in carbon pricing
	International climate contributions	• Average climate finance contribution as a share of GDP • Targeted climate finance contribution as a share of GDP
	Transparency in climate spending	• Disclosure of climate-related expenditure • Climate budget tagging

Source: Scheer et al. (2025). The table is the authors' elaboration.

For a given country i, the climate score is:

$$ClimateScore_i = \frac{1}{2} Results_i + \frac{1}{2} Policies_i$$

Most of the areas are taken from the ASCOR data with only minor changes to avoid double counting when both binary indicators and continuous metrics are present for the same underlying data. In the Policies pillar the following areas were taken in their entirety: 2030 Targets, Net Zero Targets, Climate Legislation, Carbon Pricing, Fossil Fuels, International Climate Contributions, and Transparency in Climate Spending. The Just Transition area was modified to exclude two general measures of a country's progress on human rights, as these indicators seemed to go beyond the specific focus on the climate transition. Two areas in ASCOR, one on 2035 Targets and one on Adaptation, were not included, due respectively to their lack of policy relevance in the EU context (where very few countries have explicit 2035 targets) and for falling outside the scope of our transition-alignment justification.

The Energy Transition area was created by combining the Renewable Energy Opportunities area of ASCOR, which includes four indicators assessing the pipeline of different types of renewable energy sources (capacity under construction, pre-construction or announced), with indicators from the Sectoral Transitions area measuring the relative importance of fossil fuel rents within each country. The other indicators within ASCOR's Sectoral Transitions area relate strictly to policy and were included as an area in the Policy pillar in our framework.

Finally, the emissions area is created by a three-part average of 1) the county's level and trend of emissions 2) the degree to which the country is respecting or violating the 1.5 degree warming limit and 3) the degree to which the country is respecting or exceeding its fair share allocation in a 1.5-degree scenario. The sub-indicator measuring emissions levels and trends is created by combining both the most recent level, and the five-year trend for production-based per capita emissions (including land use change) and consumption-based per capita emissions.

To produce comparable scores for each area, we follow the methodology proposed by Scheer et al. (2025) and updated in Hizliok et al. (2025) for calculating aggregate Pillars Scores using the ASCOR data. In this method all binary indicators and quantitative metrics within the frameworks are converted into numbers ranging from zero to one. Binary indicators are zero and one for "No" and "Yes", respectively. Quantitative metrics are normalised using the normal cumulative distribution of the transformed z-scores, with a number close to one indicating the best possible relative performance, and close to zero indicating the worst. Compared to a min-max standardisation, this method provides outlier robustness and an easy interpretation as an indicator of the sovereign's standing relative to peers[14]. The process also excludes from calculation any indicator or metric for which a country is either exempted or has no data[15]. These standardised indicator scores are then aggregated to the area level using an unweighted average, and then similarly aggregated to the pillar level (Table 3).

14 However, a distribution-based normalisation also has some drawbacks. For three metrics (see Annex B) reflecting the level of fossil fuel rents relative to GDP, the distribution-based normalisation method assigned a less than maximum score to countries that had already achieved the best possible outcome (a value of zero). The normalised score was modified to automatically assign a score of 1 in these cases.

15 Note that for a very small number of indicators with low data coverage, the omission of missing data could create a perverse incentive for poorly performing countries to withhold data. In practice, the variables most affected by data availability refer to the comparison of a country's emissions trends to a 1.5-degree compatible pathway, and these limitations come from a lack of country-level modelling analysis, not from a lack of underlying raw data from the countries themselves.

Climate scores obtained

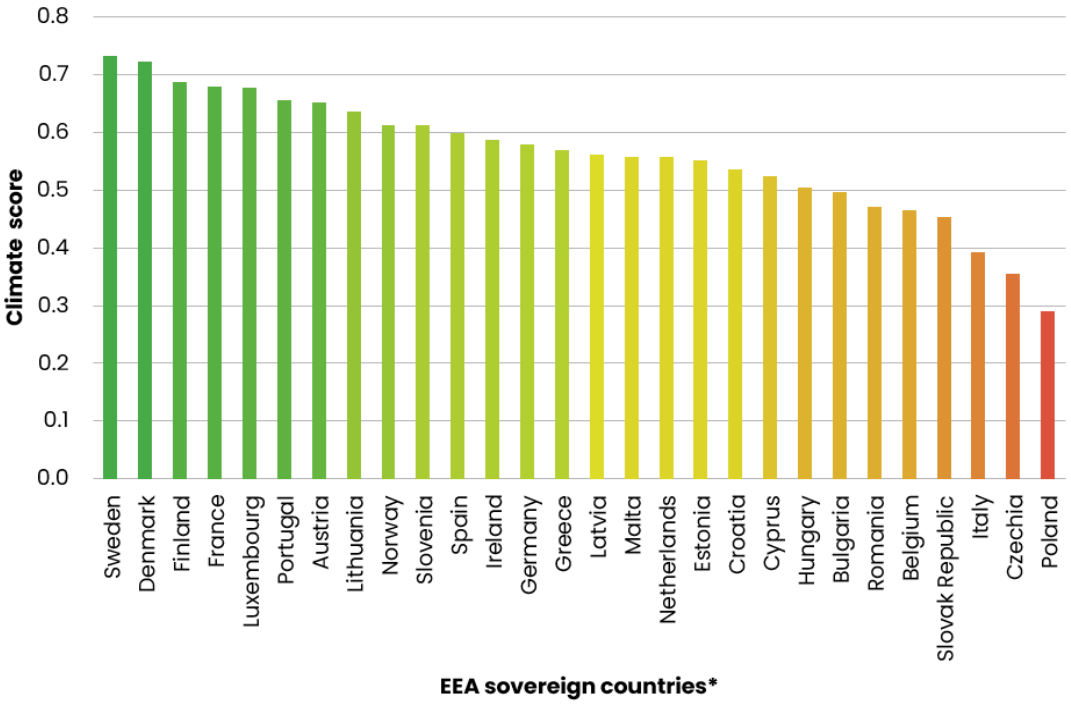
The countries receiving the highest climate scores in our methodology are Sweden and Denmark, followed by Finland, France and Luxembourg. Spain and Germany, two of the four largest issuers of collateral eligible debt, sit in the middle of the ranking at 11th and 13th respectively (Figure 10 and Figure 11). Belgium, Slovakia and Italy hold the lowest scores for Eurozone members, with Czechia and Poland registering the lowest scores overall.

A decomposition of the overall score across the areas that formed our methodology provides some light into the main drivers behind countries' performance, illustrating that similar overall scores can conceal fundamentally different profiles (Figure 12). Many sovereigns enjoy profiles that range from strong policy frameworks without correspondingly satisfactory outcomes, to relatively good results that are, nonetheless, supported by incomplete policy architecture. The contrast between *Results* and *Policies* has best exemplified by Germany, which has relatively weak *Emissions* (0.36) and *Energy-Transition* (0.44) performance, whereas it enjoys full scores on *Climate Legislation* and *Just Transition*, and 0.89 for *Net Zero Targets*. France, Norway and Ireland also show similar policy-led profiles with average or weak results. France's strong scores in many of the policies areas contrast with slightly above average in *Emissions* (0.55) and *Energy Transition* (0.59), whereas Ireland combines strong *Climate Legislation*, *Just Transition* and spending-transparency scores (all 1.00) with weak *Emissions* (0.36) and *International Climate Contributions* (0.15).

The reverse pattern appears most clearly in Cyprus, Estonia and Luxembourg. Cyprus records relatively strong *Results* (0.68 for *Emissions* and 0.62 for *Energy Transition*) with the absence of *Climate Legislation* (0.00) or policies addressing fossil-fuels (0.09). A similar situation exists for Estonia, while Luxembourg combines an exceptional *Energy Transition* performance (0.95) with an uneven policy profile, with high scores for *Climate Legislation* (1.00) or *Carbon Pricing* (0.83) but low scores for *Fossil Fuels* (0.15) and *International Climate Contributions* (0.32).

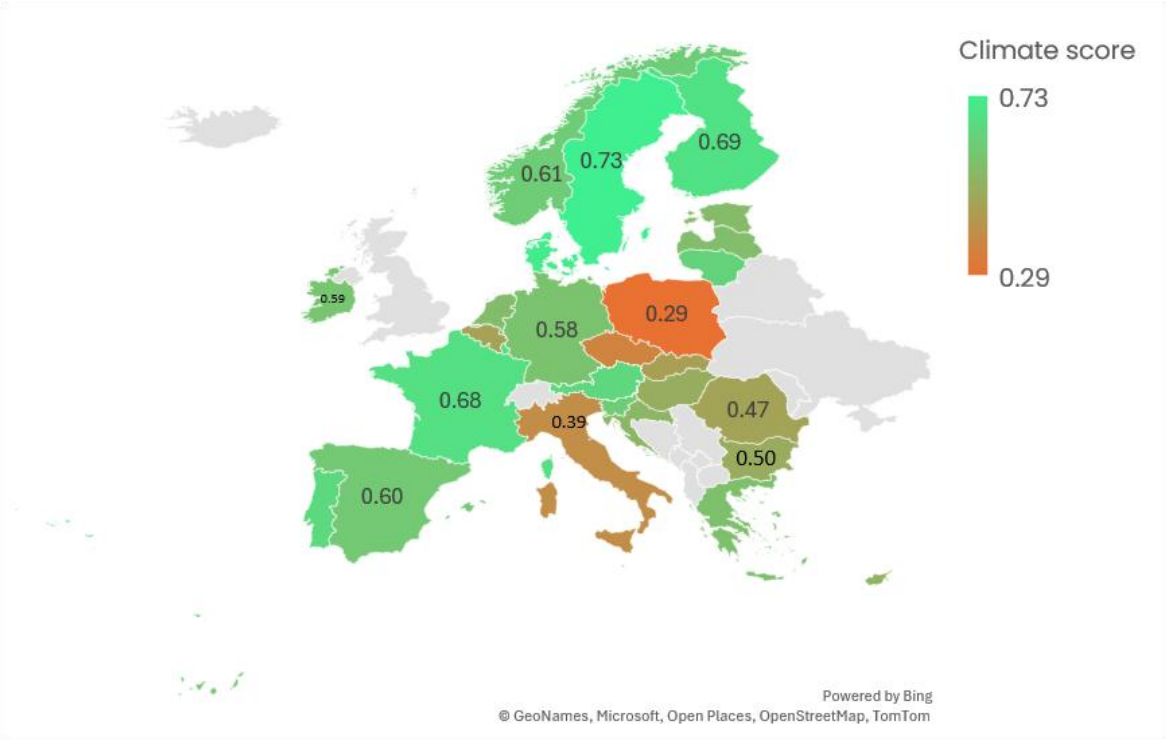
Sweden and Denmark lead due to their relatively good and consistent performance across the two pillars, whereas several mid-ranked countries combine isolated strengths with substantial gaps. At the bottom, Poland's low overall score is not caused by a single pillar, but by low scores for net-zero targets, *Climate Legislation* and spending transparency (all 0.00), and weak *Emissions* (0.26) and fossil-fuel legislation (0.04).

Figure 10. Sovereign climate scores for the European Economic Area (EEA), based on ASCOR



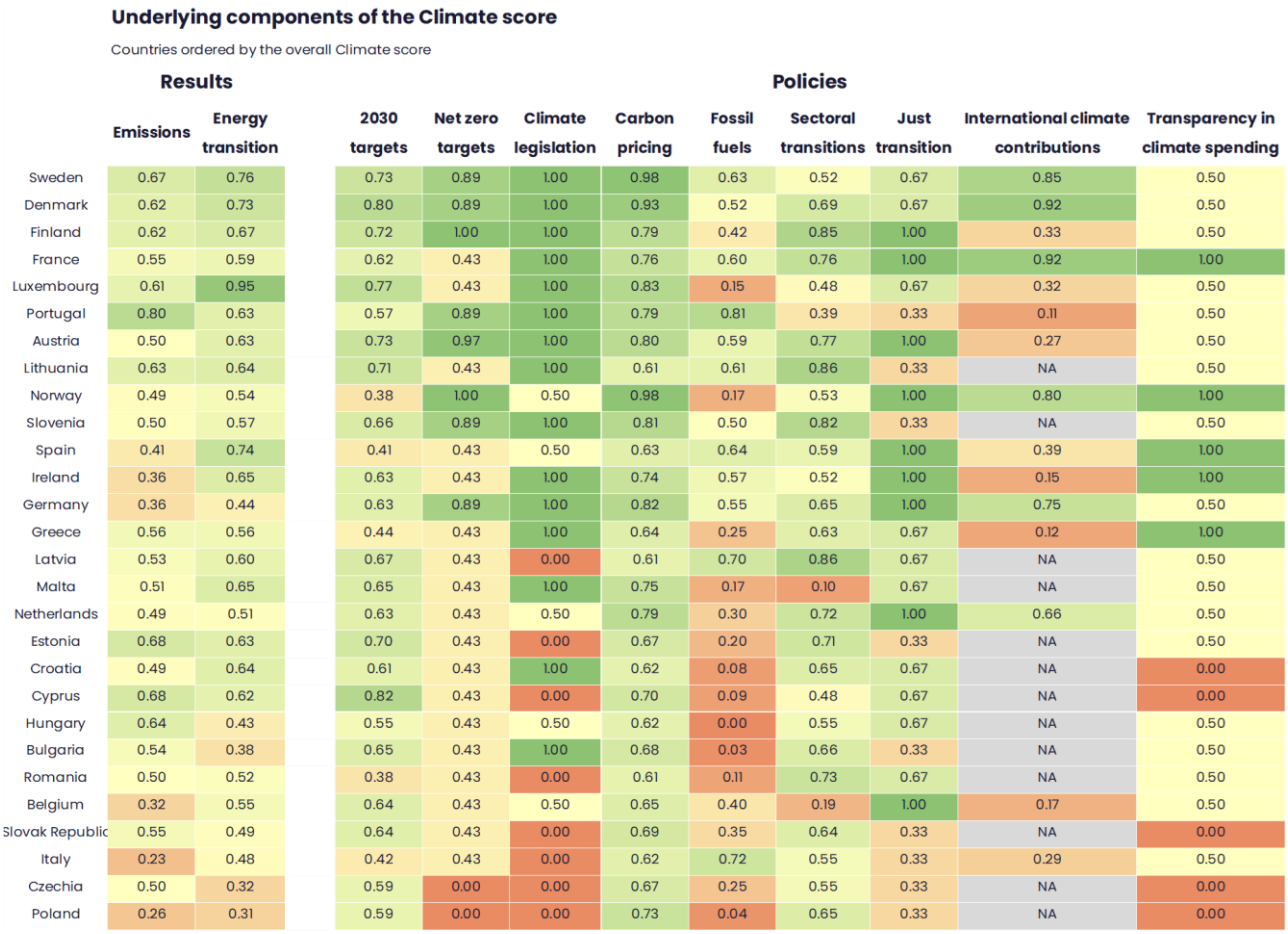
Source: authors' calculation based on TPI Centre (ASCOR data, 2025) *Iceland and Liechtenstein are not assessed by ASCOR.

Figure 11. Sovereign scores for the European Economic Area (EEA) countries*, based on ASCOR



Source: authors calculations based on TPI Centre (ASCOR data, 2025) *Iceland and Liechtenstein are not assessed by ASCOR.

Figure 12. Underlying components of the Climate score



Underlying components of the Climate score

Countries ordered by the overall Climate score

	Results		Policies								
	Emissions	Energy transition	2030 targets	Net zero targets	Climate legislation	Carbon pricing	Fossil fuels	Sectoral transitions	Just transition	International climate contributions	Transparency in climate spending
Sweden	0.67	0.76	0.73	0.89	1.00	0.98	0.63	0.52	0.67	0.85	0.50
Denmark	0.62	0.73	0.80	0.89	1.00	0.93	0.52	0.69	0.67	0.92	0.50
Finland	0.62	0.67	0.72	1.00	1.00	0.79	0.42	0.85	1.00	0.33	0.50
France	0.55	0.59	0.62	0.43	1.00	0.76	0.60	0.76	1.00	0.92	1.00
Luxembourg	0.61	0.95	0.77	0.43	1.00	0.83	0.15	0.48	0.67	0.32	0.50
Portugal	0.80	0.63	0.57	0.89	1.00	0.79	0.81	0.39	0.33	0.11	0.50
Austria	0.50	0.63	0.73	0.97	1.00	0.80	0.59	0.77	1.00	0.27	0.50
Lithuania	0.63	0.64	0.71	0.43	1.00	0.61	0.61	0.86	0.33	NA	0.50
Norway	0.49	0.54	0.38	1.00	0.50	0.98	0.17	0.53	1.00	0.80	1.00
Slovenia	0.50	0.57	0.66	0.89	1.00	0.81	0.50	0.82	0.33	NA	0.50
Spain	0.41	0.74	0.41	0.43	0.50	0.63	0.64	0.59	1.00	0.39	1.00
Ireland	0.36	0.65	0.63	0.43	1.00	0.74	0.57	0.52	1.00	0.15	1.00
Germany	0.36	0.44	0.63	0.89	1.00	0.82	0.55	0.65	1.00	0.75	0.50
Greece	0.56	0.56	0.44	0.43	1.00	0.64	0.25	0.63	0.67	0.12	1.00
Latvia	0.53	0.60	0.67	0.43	0.00	0.61	0.70	0.86	0.67	NA	0.50
Malta	0.51	0.65	0.65	0.43	1.00	0.75	0.17	0.10	0.67	NA	0.50
Netherlands	0.49	0.51	0.63	0.43	0.50	0.79	0.30	0.72	1.00	0.66	0.50
Estonia	0.68	0.63	0.70	0.43	0.00	0.67	0.20	0.71	0.33	NA	0.50
Croatia	0.49	0.64	0.61	0.43	1.00	0.62	0.08	0.65	0.67	NA	0.00
Cyprus	0.68	0.62	0.82	0.43	0.00	0.70	0.09	0.48	0.67	NA	0.00
Hungary	0.64	0.43	0.55	0.43	0.50	0.62	0.00	0.55	0.67	NA	0.50
Bulgaria	0.54	0.38	0.65	0.43	1.00	0.68	0.03	0.66	0.33	NA	0.50
Romania	0.50	0.52	0.38	0.43	0.00	0.61	0.11	0.73	0.67	NA	0.50
Belgium	0.32	0.55	0.64	0.43	0.50	0.65	0.40	0.19	1.00	0.17	0.50
Slovak Republic	0.55	0.49	0.64	0.43	0.00	0.69	0.35	0.64	0.33	NA	0.00
Italy	0.23	0.48	0.42	0.43	0.00	0.62	0.72	0.55	0.33	0.29	0.50
Czechia	0.50	0.32	0.59	0.00	0.00	0.67	0.25	0.55	0.33	NA	0.00
Poland	0.26	0.31	0.59	0.00	0.00	0.73	0.04	0.65	0.33	NA	0.00

Source: Authors' elaboration, based on TPI Centre (ASCOR data, 2026).

3.2 Constructing a sovereign biodiversity-related score

The Pressure-State-Response framework

Assessing countries' progress on biodiversity raises greater methodological challenges than for climate. Biodiversity loss is both multidimensional and highly dependent on spatial context. Unlike greenhouse gas emissions, which contribute to the global atmospheric stock regardless of where they are emitted, biodiversity loss and ecosystem degradation occur in specific places and result from multiple drivers. Assessing a country's performance therefore requires consideration not only of the state of its ecosystems, but also of the pressures acting upon them and the measures taken in response.

To this end, we structure the biodiversity score around the Pressure-State-Response (PSR) framework. This framework has been used by the OECD to organise biodiversity-related indicators. It distinguishes between environmental pressures, the state of the environment and actions taken in response to biodiversity loss (OECD, 2019). The PSR framework is well suited to the purposes of this report because it separates three dimensions that might otherwise be conflated when assessing countries' environmental performance. A country may, for example, exert relatively limited pressure on nature while starting from an already degraded ecological baseline. Conversely, it may have introduced relatively ambitious conservation policies and measures whose effects are not yet visible in the

condition of ecosystems. Distinguishing between Pressure, State and Response therefore makes it possible to retain information both on environmental outcomes and on policy action.[16]

For a given country i, the three dimensions are given equal weight[17]:

$$BiodiversityScore_i = \frac{1}{3}Pressure_i + \frac{1}{3}State_i + \frac{1}{3}Response_i$$

The three dimensions should be interpreted together, as each captures a dimension relevant to a country's potential exposure to nature-related transition risks. The *Pressure* dimension provides an indication of the scale of environmentally harmful activities that may need to adjust as public policy and market expectations relating to nature become more stringent. The *State* dimension describes the ecological starting point from which this transition takes place: where ecosystems are already severely degraded, restoration needs may be greater and stronger protective measures may be required. Finally, the Response dimension reflects the extent to which conservation and protection measures are already in place to manage these pressures and support the transition. Looking at any one of these dimensions in isolation may give an incomplete picture. Two countries with comparable policy frameworks may face very different transition challenges if one places substantially greater pressure on nature or starts from a more degraded ecological baseline.

Methodology

No single existing dataset covers all three dimensions of the PSR framework. We therefore combine information from three external sources: the WWF Biodiversity Risk Filter (Wingard et al., 2026; World Wide Fund for Nature, 2026), the Environmental Performance Index (EPI) developed by the Yale Center for Environmental Law & Policy (Wendling et al., 2026), and the European Commission Joint Research Centre's Environmental Footprint of Consumption (Sanyé Mengual et al., 2026; Joint Research Centre, 2026).

First, the WWF Biodiversity Risk Filter assesses biodiversity-related risks and contains information on both physical and reputational risks. We use its "Regulatory Deficiency Risk" indicator, which assesses the extent to which national biodiversity-related legislation is aligned with a set of legal best practices (Wingard et al., 2026)[18].

Second, the EPI provides a cross-country assessment of environmental performance. It evaluates 177 countries using 47 indicators organised across 12 issue categories and three broad policy objectives: Environmental Health, Ecosystem Vitality and Climate Change. Individual indicators are scored on a 0-100 scale according to countries' performance relative to environmental policy targets (Wendling et al., 2026)[19].

Finally, the JRC Consumption Footprint estimates the environmental impacts associated with

16 This structure is also consistent with the more detailed socio-ecological approach adopted by IPBES. The IPBES conceptual framework distinguishes, among other things, the state of nature, the direct drivers of change, and the institutions and governance systems that shape interactions between human societies and nature (Díaz et al., 2015)

17 Equal weighting is used as a baseline rather than as a claim that the three dimensions are equally important determinants of transition risk. Alternative weights are tested in Appendix C as a robustness test.

18 The Biodiversity Risk Filter was originally designed to assess corporate risks, and as of this writing has not been extended to sovereigns but some of the underlying data can inform an analysis of nature progress by countries. The Biodiversity Risk Filter also includes a set of indicators on physical risk, which are outside of the scope of our analysis.

19 Note that this approach is different from ASCOR, where many indicators are assessed against country-specific targets, or adjusted for GDP. This creates a strong relationship between GDP and EPI scores which is extensively discussed in Block et al. (2024) where the index is presented. While this relationship holds strongly across wide income gaps, it is less clear within similar income bands, as is the case for the nature indicators we are considering within Europe, where many of the best performers are from Central and Southeastern Europe.

household consumption in EU Member States using a bottom-up life-cycle assessment methodology. Representative products across five areas of consumption (food, mobility, housing, household goods and appliances) are combined with consumption data and life-cycle inventories to estimate environmental impacts throughout product supply chains. These impacts are reported across 16 Environmental Footprint categories and can also be aggregated into a single weighted score (Sanyé Mengual et al., 2026; Joint Research Centre, 2026)[20].

We use the indicators contained within these three sources and allocate them across the *Pressure*, *State* and *Response* pillars according to the aspect of nature-related performance they measure. The general structure of the biodiversity score is given in Table 4. The detailed indicators and weights are reported in Appendix C.

Table 4. Overview of Pillars and areas of our sovereign biodiversity score

Pillar	Component	Weight within pillar	Source
Pressure (⅓)	Direct activity-based pressures	50%	EPI – Ecosystem Vitality
	Consumption-based pressures	50%	JRC Consumption Footprint
State (⅓)	Biodiversity condition and ecological resilience	100%	EPI – Biodiversity & Habitat
Response (⅓)	Regulatory preparedness	50%	WWF Biodiversity Risk Filter
	Conservation and protection efforts	50%	EPI – Biodiversity & Habitat

The baseline specification retains some climate-related information because climate change is itself an important pressure on ecosystems and biodiversity. In particular, the JRC Consumption Footprint includes climate change among its environmental impact categories, while the Bioclimatic Ecosystem Resilience Index captures ecosystems' capacity to retain biodiversity under a changing climate. A stricter non-climate specification is tested in a sensitivity analysis presented in Appendix C.

Pressure

The *Pressure* pillar combines two complementary dimensions. The first, drawn from six categories within the EPI Ecosystem Vitality objective, captures direct activity-based environmental pressure performance, and covers forest and grassland loss, fishery depletion, air and water pollution and depletion of agricultural land. The second uses the JRC Consumption Footprint to capture environmental pressures associated with countries' consumption and supply chains, including impacts occurring outside the consuming country. The EPI and JRC components receive equal weight within the *Pressure* pillar[21].

20 The process used to produce the index is described in Pasqualino (2025, p. 79) and weightings for each sub indicator are provided in Appendix C of this report.

21 We make this choice so as not to arbitrarily give greater weight to either the 'domestic' pressures measured by the EPI indicators or the 'exported' pressures measured by the JRC Consumption Footprint. It is, however, possible to revisit this assumption depending on policy priorities.

State

The *State* pillar captures biodiversity conditions and ecological resilience. It is constructed from four indicators within the EPI "Biodiversity and Habitat" category: the Species Habitat Index, Red List Index, Biodiversity Habitat Index and Bioclimatic Ecosystem Resilience Index. The Red List and Biodiversity Habitat indices provide information on biodiversity conditions, while the Species Habitat Index captures changes in the habitat available to species. The Bioclimatic Ecosystem Resilience Index captures the capacity of ecosystems to retain biodiversity under a changing climate. The original relative EPI weights of these indicators are preserved within the *State* pillar, after rescaling them to sum to one.

Response

Finally, the *Response* pillar captures two complementary forms of sovereign action. The first captures the formal regulatory preparedness and is based on the WWF Biodiversity Risk Filter's "Regulatory Deficiency Risk" indicator (Wingard et al., 2026). This indicator assesses the extent to which a country's biodiversity-related legislation is aligned with a set of legal best practices. Because the WWF measure is expressed as a risk score, with higher values indicating greater regulatory deficiency, its direction is reversed when constructing the Biodiversity Score. The second component captures conservation and protection efforts using indicators from the "Biodiversity and Habitat" category of the Yale University EPI. These include marine and terrestrial protection, protection of Key Biodiversity Areas, protected-area representativeness and connectivity, and species protection. The two components receive equal weight within the *Response* pillar.[22]

Normalisation and missing data

The analysis covers 28 sovereigns of the European Economic Area: the EU-27 members and Norway. Although data is available for Iceland, it is excluded so that the sample of countries remains the same as that used in the Climate Score. Since the indicators that make up our Biodiversity Score use different units and scales, each one is normalized to a value between 0 and 1, following the process described above for the continuous indicators within the Climate Score framework.[23] For each component, we calculate how far a country's value lies above or below the sample average, measured in standard deviations (a *z*-score), and convert this value using the standard normal cumulative distribution function. A score of around 0.5 therefore corresponds to performance close to the sample average, while values closer to 1 indicate relatively stronger performance and values closer to 0 relatively weaker performance. For components where a higher value indicates worse environmental performance, the direction of the score is reversed. WWF and EPI indicators are therefore normalised across 28 countries. The JRC Consumption Footprint is available for the EU-27 but not for Norway and is normalised across the 27 countries for which data are available.

Where an underlying indicator is not applicable to a particular country (e.g., some marine indicators for landlocked countries) the weights of the available indicators are rescaled proportionally within the relevant component. We apply the same principle to missing source data. In particular, because the JRC

22 We make this choice so as not to give greater weight to either of the two key aspects of sovereign responses: the legal framework versus actual implementation of conservation and protection measures. Here too, it is possible to revisit this assumption depending on policy priorities.

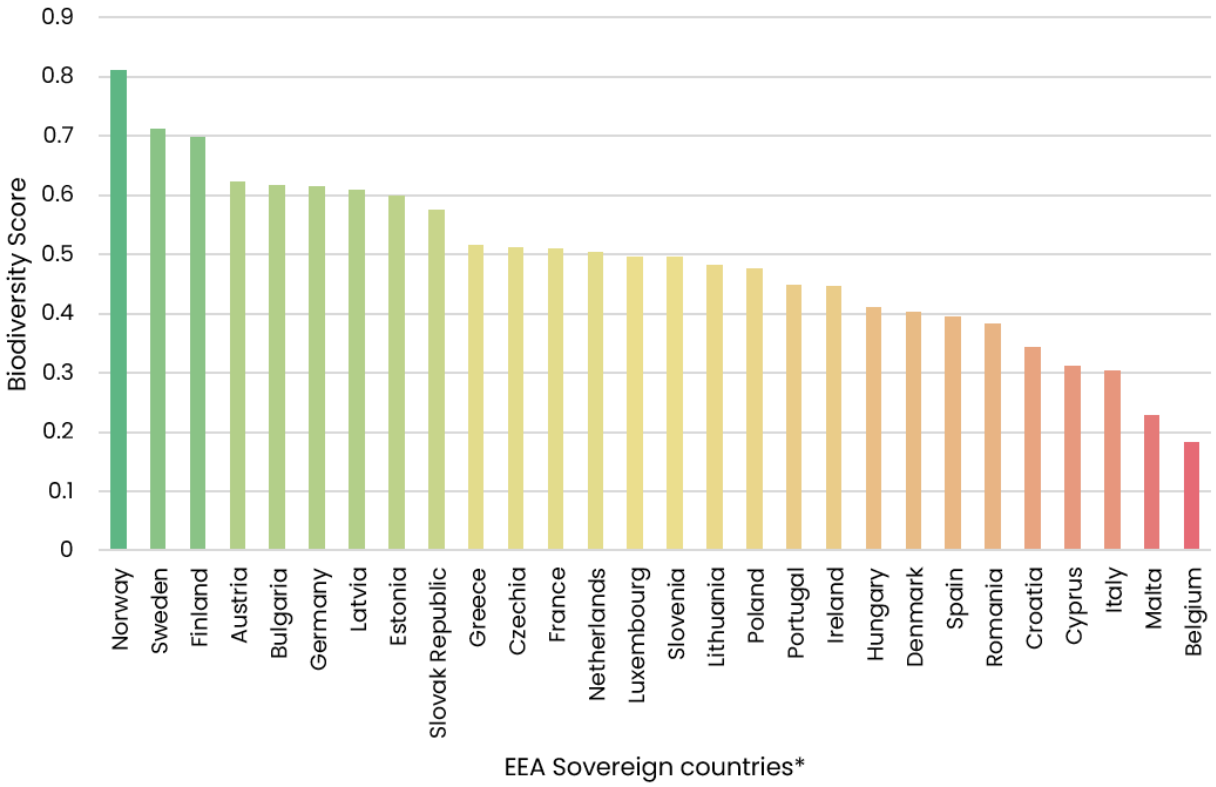
23 While the climate score includes normalization for some indicators which are continuous, it also includes a number of binary metrics. The resulting score is an average of these two types of assessment. Because of this, the scales of the Climate and Biodiversity scores are not directly comparable, as normalizing at the pillar level forces a wider distribution of scores for nature than would be expected either from the binary indicators or from the process of averaging together a large number of normalized indicators.

Consumption Footprint is unavailable for Norway, Norway's *Pressure* score is based entirely on its available EPI Pressure component. The implications of this treatment are examined separately in the sensitivity analysis provided in Appendix C.

Biodiversity scores obtained

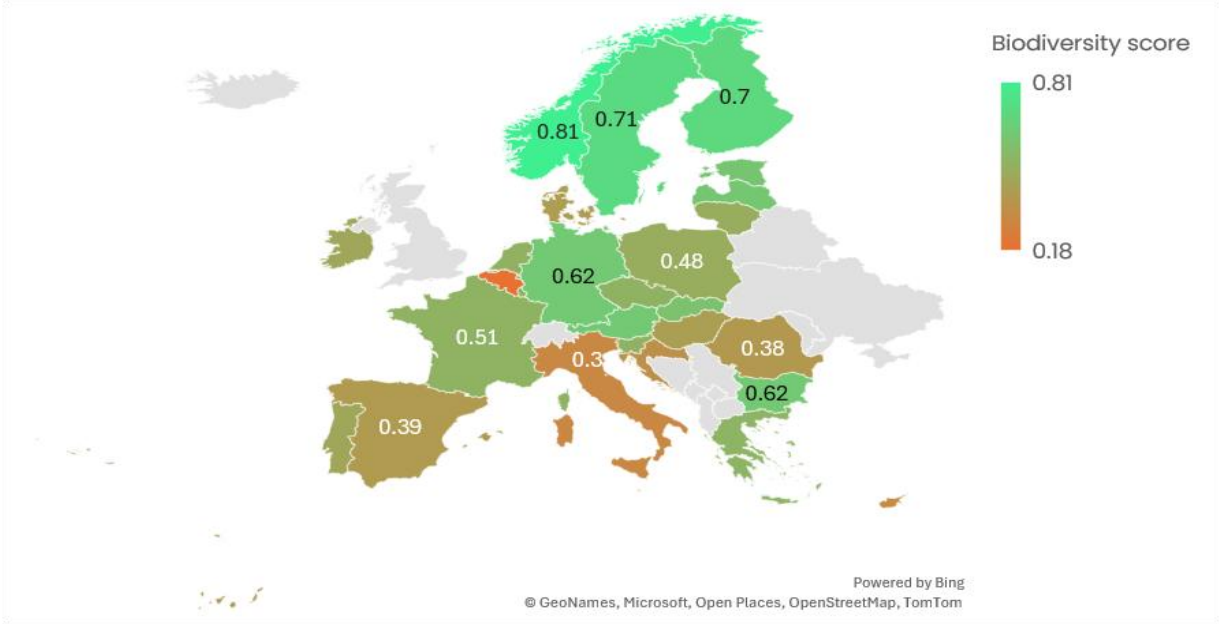
The results of the Biodiversity score are given in Figure 13 across 28 sovereigns. Norway records the highest score, followed by Sweden and Finland, while Belgium, Malta and Italy record the lowest scores. The ranking should be interpreted with some caution in the case of Norway, for which the JRC Consumption Footprint is unavailable and the *Pressure* pillar is therefore based solely on the EPI component. The sensitivity of Norway's position to this missing information is examined in Appendix C. Figure 14 further shows the geographic distribution of scores across Europe.

Figure 13 Countries ordered by the Biodiversity Score



Source: authors' own calculations. *Iceland and Liechtenstein are not included as they are not included in the climate score. The ranking of Norway is impacted by its lack of data for consumption-based biodiversity pressures, as described in Appendix C.

Figure 14. Biodiversity score across European countries



Source: authors elaboration.

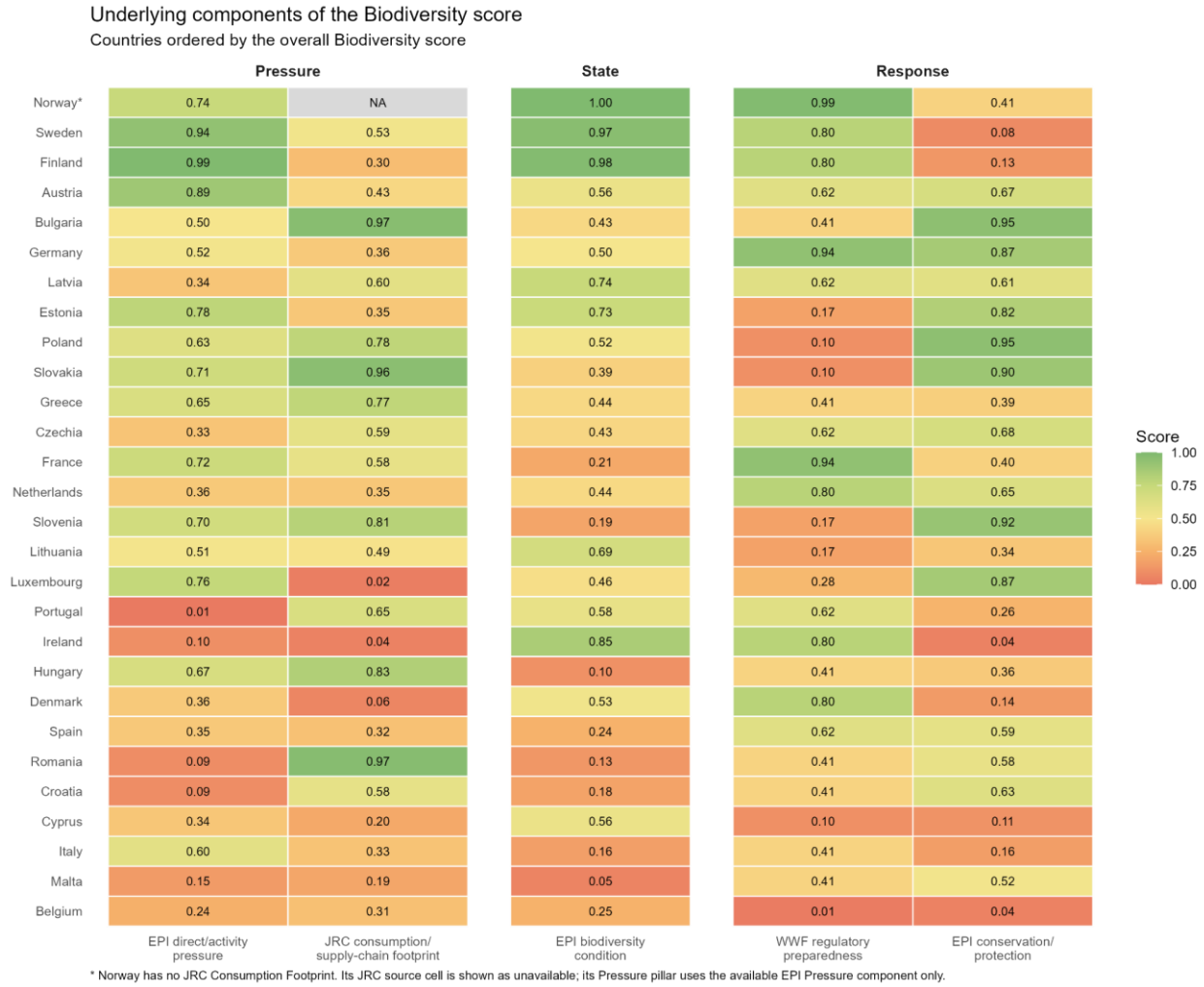
The overall score masks differences in PSR profiles. Countries with similar overall Biodiversity Scores may indeed face different nature-related transition challenges depending on whether their weakness arises from pressures, ecological condition or the policy response already in place, the correlation between these three pillars being relatively weak (ranging approximately from 0.08 to 0.25).

Closer examination of the three pillars reveals differences in what drives these profiles. Figure 15 decomposes *Pressure* and *Response* into their underlying components. Germany, for example, performs particularly strongly on both components of *Response*, with high scores for WWF regulatory preparedness (0.94) and EPI conservation and protection measures (0.87), while its *Pressure* and *State* components are closer to the middle of the sample. Ireland displays an almost opposite profile: it combines a relatively strong ecological *State* (0.85) and regulatory preparedness (0.80) with very weak scores for both direct activity-based pressures (0.10) and the consumption-based footprint (0.04), as well as for EPI conservation and protection measures (0.04).

The decomposition shows why retaining multiple components within *Pressure* and *Response* is useful. The two *Pressure* components can produce very different assessments: Luxembourg scores relatively strongly on the EPI direct activity-based component (0.76) but very weakly on the JRC consumption-based footprint (0.02), whereas Romania displays the reverse pattern (0.09 and 0.97 respectively). Across the countries for which both are available, the correlation between the EPI direct activity-based pressure component and the JRC consumption-based pressure component is only 0.08. This means that relatively strong performance on environmental pressures more directly associated with domestic economic activity does not necessarily imply a low environmental footprint from consumption and supply chains, and vice versa.

A similar divergence appears within *Response*. Poland and Slovakia, for example, score very weakly on WWF regulatory preparedness (0.10 in both cases) but strongly on EPI conservation and protection measures (0.95 and 0.90 respectively). Conversely, Sweden combines relatively strong regulatory preparedness (0.80) with a much lower EPI conservation and protection score (0.08). The correlation between WWF regulatory preparedness and the EPI conservation/protection component is -0.24. This means that a comparatively strong formal legal framework does not necessarily coincide with stronger conservation and protection performance.

Figure 15. Countries ordered by the Biodiversity Score – PSR decomposition



Source: authors elaboration.

3.3 Various methodological choices

Haircuts rather than bonuses

As discussed in the previous section, while standard negative haircuts are the mechanism via which a climate factor for sovereigns would be implemented under a risk-based justification, it is unclear if this approach would be most effective in the resilience and alignment-based approaches[24]. However, for the purposes of simplicity and comparability, our methodology will translate climate and biodiversity scores into standard negative haircuts to show the relative effects of the nature assessments on the same scale as is currently used by the climate factor on corporate bonds. In practice, however, the use of bonuses should be seriously considered for the extension of the factor to sovereigns, both to address concerns about negative impacts on vulnerable countries and to better align the framework with the resilience and alignment approaches.

24 For instance, under an alignment-based approach in which the ECB intended to support the stated nature priorities of the European Union, negative haircuts for poor performing sovereigns could be replaced with positive "bonuses" for the best performers. The use of bonuses would address some concerns about the climate factor negatively impacting some countries, but, if used in isolation, could increase the overall risk profile of the ECB's collateral holdings.

Ranking rather than targets

Assessing sovereigns' performance on nature can either be done in reference to fixed targets[25], or in relation to the performance of other countries. Two issues with target-based scores are (i) the difficulty of selecting fixed targets of all the indicators which could be considered; (ii) comparing against fixed targets raises the risk that for most of the indicators in our framework many countries would not be assessed positively. While this is not necessarily an issue from a pure risk-based perspective, it can become more problematic if one wants to enable the possibility of bonuses for countries that perform better than others.

Considering these challenges, the methodology presented here is based on a relative ranking of European countries' performances against one another. In particular, in constructing our indicators we make regular use of normalization, which assigns scores between 0 and 1 based on each county's distance in standard deviations from the mean score for an indicator. The normalization process allows us to compare countries' relative positions to one another on each index or indicator without giving undue weight to small changes in an absolute score which creates large shifts in rank. It also allows us to capture differences between countries for continuous indicators for which a fixed target may have assessed all countries negatively.

Excluding physical risks from the analysis

We follow the existing ECB approach, which applies the climate factor for non-financial corporate bonds only to the transition risks associated with the bond issuers. From a purely risk-based perspective, it is not immediately clear why the ECB should not also want to protect its balance sheet from losses stemming from the physical risks of climate change, which like transition risks, are understood to not be fully priced into market prices (Appendix A). However, in the risk-based and resilience-based approaches considering physical risk could be perceived as being unfair as the central bank could be perceived as 'punishing' countries which, due to the accident of their geography and potentially their lower adaptive capacity, face greater physical nature-related risks. The distribution of these impacts would also likely reinforce inequalities within Europe, with countries in Southern and Southeastern Europe particularly vulnerable due to above average predicted temperature increases.

Exclusion of residual maturity from our climate and biodiversity factors

In the ECB's climate factor for corporate bonds, residual maturity contributes to the uncertainty score through an asset-specific vulnerability component equal to the square root of residual maturity. Longer maturities therefore increase the score and result in a larger reduction in the value assigned to the collateral. This adjustment is applied in addition to the standard valuation haircut, which also varies with residual maturity and reflects, among other things, the greater sensitivity of longer-duration bonds to market-price movements.

The inclusion of residual maturity in the climate factor raises two related questions. First, to what extent are the risks associated with the greater price sensitivity of longer-dated bonds already captured by the standard valuation haircut? Although the ECB argues that historical market data may not adequately capture the magnitude or probability of future climate-related shocks, this does not

25 In its most literal formulation, a nature factor for sovereigns could be made against a fully fixed target of whether a country is in line with its international and EU commitments on climate. With this framing, all countries which are deficient on a given indicator would be penalized, with no regard to how far a country is from the target. In an extreme negative case, were all countries to be deficient in every indicator, every country would receive the same haircut, while in an extreme positive case of every country meeting its targets no haircuts would be assigned and the nature factor would effectively disappear.

establish that the additional maturity adjustment is necessary to address the risks in question – so that including the residual maturity in climate factor runs the risk of double counting. Second, even if an additional adjustment is warranted, does the chosen approach – multiplying the climate uncertainty score by the square root of residual maturity – provide an appropriate measure of the incremental risk? For example, the adjustment could underestimate the additional risk or apply an excessive adjustment that duplicates protection already provided by the standard haircut.

These questions are particularly relevant to our analysis of sovereign nature-related risks. European countries differ substantially in the maturity structures of their sovereign debt. As illustrated in Appendix D, our analysis indicates that differences in countries' average residual debt maturities are, in many cases, larger than differences in their performance in the nature indices. Including a negative adjustment for longer residual maturities in the nature factor could therefore make the resulting collateral treatment depend substantially on sovereign debt-management choices, potentially overshadowing differences in countries' underlying nature performance. Indeed, including residual maturities means that the nature elements only have a significant impact for bonds of similar maturities (we explore this option in Annex D). As such, in this section we exclude the residual maturity of individual bonds from our analysis, in order to focus more on each country's nature-related progress[26].

Weighting

The construction of the climate and biodiversity assessments necessarily include a weighting of different indicators. This weighting can be made to be more or less in line with the various justifications for the factor. At a high level, this could mean a risk-based approach emphasizing direct measures of transition risk, a resilience approach emphasizing changes to government policies and an alignment approach emphasizing the final results in terms of either emissions or the state of biodiversity. Our method attempts to balance the various goals, with specific weighting decisions left to the external data providers as far as possible. For the biodiversity assessment, where we were more active in combining results from different data providers, a sensitivity to weighting decisions is provided in Appendix C.

Keeping climate and biodiversity scores separate rather than integrated into a holistic nature score

While a comprehensive approach to nature-related issues may call for integrating climate and biodiversity into a single score, we decided to keep them separate at this stage for further transparency. The two scores (Table 5) are only weakly positively correlated, with a Pearson correlation of 0.34 and a Spearman rank correlation of 0.36: countries that perform relatively strongly on climate do not necessarily perform similarly on biodiversity, and vice versa. These results are important for the treatment of nature-related considerations for sovereign bonds in the collateral framework. Relying on a Climate Score alone leaves differences in countries' environmental performance unaccounted for. At the same time, the weak correlation means that any future framework combining climate and biodiversity considerations would require the ECB to make choices regarding the relative weightings and areas of overlap between the two scores.

[26] By excluding residual maturity, the statistical properties of our uncertainty scores change considerably compared to the estimates of uncertainty scores for the corporate climate factor (Serrano Rodriguez et al. (2026), as instead of having a bond-level observations for thousands of individual bonds, we have a single score for each country, which is applied uniformly to each bond issued by that country. This compression of observations also compresses the distribution of our uncertainty scores in a way which makes them incompatible with the specific mechanism used by the ECB to transform corporate uncertainty scores into haircuts. This issue and our solution to it are discussed below.

Table 5. Climate and biodiversity scores for each country with countries ranked according to their climate score (split into two columns)

Country	Climate Score	Biodiversity Score
Sweden	0.73	0.71
Denmark	0.72	0.4
Finland	0.69	0.7
France	0.68	0.51
Luxembourg	0.68	0.5
Austria	0.65	0.62
Portugal	0.65	0.45
Lithuania	0.63	0.48
Slovenia	0.61	0.5
Norway	0.61	0.81
Spain	0.6	0.39
Ireland	0.59	0.45
Germany	0.58	0.62
Greece	0.57	0.5

Country	Climate Score	Biodiversity Score
Netherlands	0.56	0.23
Malta	0.56	0.52
Latvia	0.56	0.61
Estonia	0.55	0.6
Croatia	0.54	0.34
Cyprus	0.52	0.31
Hungary	0.5	0.41
Bulgaria	0.5	0.62
Belgium	0.47	0.18
Romania	0.47	0.38
Slovak Republic	0.45	0.58
Italy	0.39	0.3
Czechia	0.35	0.51
Poland	0.29	0.48

Source: authors elaboration.

3.4 From uncertainty scores to collateral impacts

To estimate the climate and biodiversity factors, we partially follow the methodology used by the ECB for its climate factor for non-financial corporates. For every bond we compute an uncertainty score. In the original methodology for corporate bonds this score has three elements: a sector-specific stressor, an issuer-specific exposure and an asset-specific vulnerability. For this report, only an issuer-specific component for sovereign bonds is retained. The sector-specific component is dropped since a stressor similar to the one for corporate bonds is difficult to establish for sovereign bonds, whose proceeds are not linked to any specific sector of the economy. The asset-specific vulnerability is removed to provide a more narrow focus on the climate and biodiversity performance of the sovereign without the implications that residual maturity would pose, as explained in subsection 3.3. Appendix D presents an alternative formulation incorporating residual maturity and illustrating the impact of this feature on countries' final outcomes.

The uncertainty score is defined as:

$$u_{i,j} = E_j$$

Where:

- $u_{i,j}$ is the uncertainty score for asset i from issuer j.
- E_j is the complement of the climate or biodiversity score of a sovereign country j, that is, E = 1 – score; where *score* is the respective climate of biodiversity score of the country.

The uncertainty score is then transformed into the climate and biodiversity factors via the following formula, a type of exponential decay formula with a lower bound:

$$CF(u_{i,j}) = a + (1 - a)\frac{1}{e^{u_{i,j} \times b}}$$

Where:

- Parameter a is set by the Governing Council (in practice this cannot be easily predicted by the public). For the current climate factor for cooperate bonds it is set to 0.95, which is informed by the expected shortfall aggregated across all sectors in an adverse scenario. We also set it to 0.95, to enable comparison with the corporate results.
- Parameter b is set by the Governing Council, but informed by the median uncertainty score via this natural logarithmic formula:

$$b = ln\left(1 + \frac{1}{\tilde{u}}\right)$$

In addition to the exponential decay formula, we also test a normalized logistic transformation to translate the uncertainty score into a smooth S-shaped curve constrained between a minimum and maximum value. The incorporation of a logistic formula provides a wider range of results and thus a more meaningful distinction between securities with different climate risk profiles. As will be seen in the following section, the use of the exponential decay formula yields a compressed cluster of factors between 0.97-0.99[27], whereas a logistic approach generates greater haircut differentiation, creating incentives for countries to improve their climate performance and providing a more clear reward to the best performers. In this sense, one could argue that the exponential decay formula applies more strictly to a risk-based approach, whereas the logistic formula could apply to a central bank aiming to follow the alignment-based approach discussed above.

The function is:

$$CF(u) = a + (1 - a) * \frac{[L(u_{max}) - L(u)]}{[L(u_{max}) - L(u_{min})]}$$

Where the logistic function is:

$$L(u) = \frac{1}{1 + exp(-s * (u - m))}$$

And variables:

- M: midpoint of the transformation. In our case, this set to the median uncertainty score
- S: sensitivity or steepness parameter. In our case, this is set to parameter b as per the exponential decay formula.

4. Findings

We apply the Climate and Biodiversity scores described above to the list of government securities included in the ECB's public list of eligible collateral as of 23/06/2026[28]. The "issuer group" category allows for filtering according to the asset issuer; we focus on the category IG2 – Central government. Government bonds can only be eligible for collateral if the country is part of the European Economic Area (EEA). We exclude four bonds from Iceland, since one of our methodologies (ASCOR) does not assess this country. This results in 2,384 securities. A substantial share of these instruments consists of strip bonds, in which coupon payments are separated from the principal and traded as an independent security.

27 This may be due to the fact that the uncertainty scores for sovereign bonds are much more tightly clustered (they all fall between 0 and 1) than the uncertainty scores for corporate bonds, which do not have an upper limit. Applying the same formula used for corporates to our sovereign scores therefore produces a substantially compressed distribution of climate factor values.

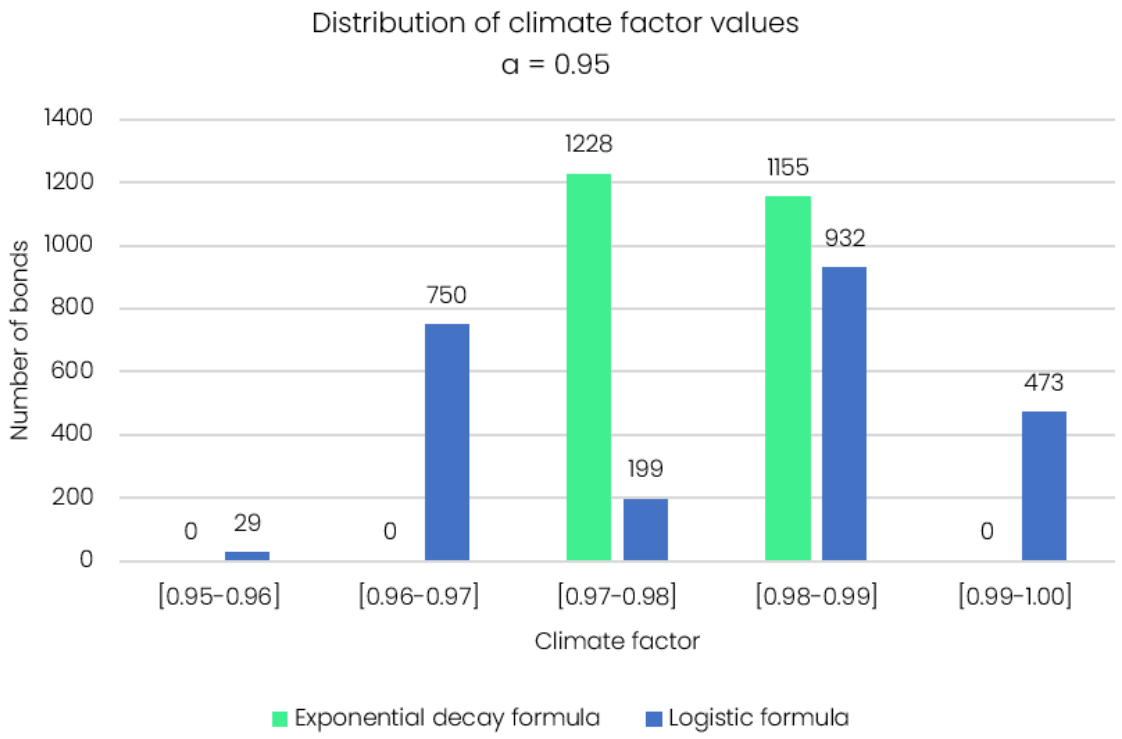
28 Current and historic data are available from European Central Bank (2026c).

4.1 Findings for the climate factor

As discussed in the previous section, we apply both the methodology proposed by the ECB for corporate bonds[29] – resulting in a distribution where most bonds have climate factors in the middle range – and a logistic transformation which creates a smoother and more extended distribution of climate scores.

Below, we show the results using these two formulas, with: (i) a floor parameter set at 0.95 for Figure 16; (ii) a floor parameter set at 0.9 for Figure 17. As a reminder, the choice of this floor parameter[30] can determine the impact of the penalties. As a general matter, one could argue that the lower the floor parameter, the less risk-averse the central bank would be, and the more its approach would align with the resilience- and alignment-based frameworks discussed in Section 2. For instance, by setting the floor at 0.9 instead of 0.95, the central bank would in effect be accepting that haircuts can be quite large – and, by extension, that monetary policy implementation may need to be significantly adjusted to accommodate climate considerations.

Figure 16. Distribution of climate factor values for eligible sovereign bonds, with floor parameter (a) set at 0.95

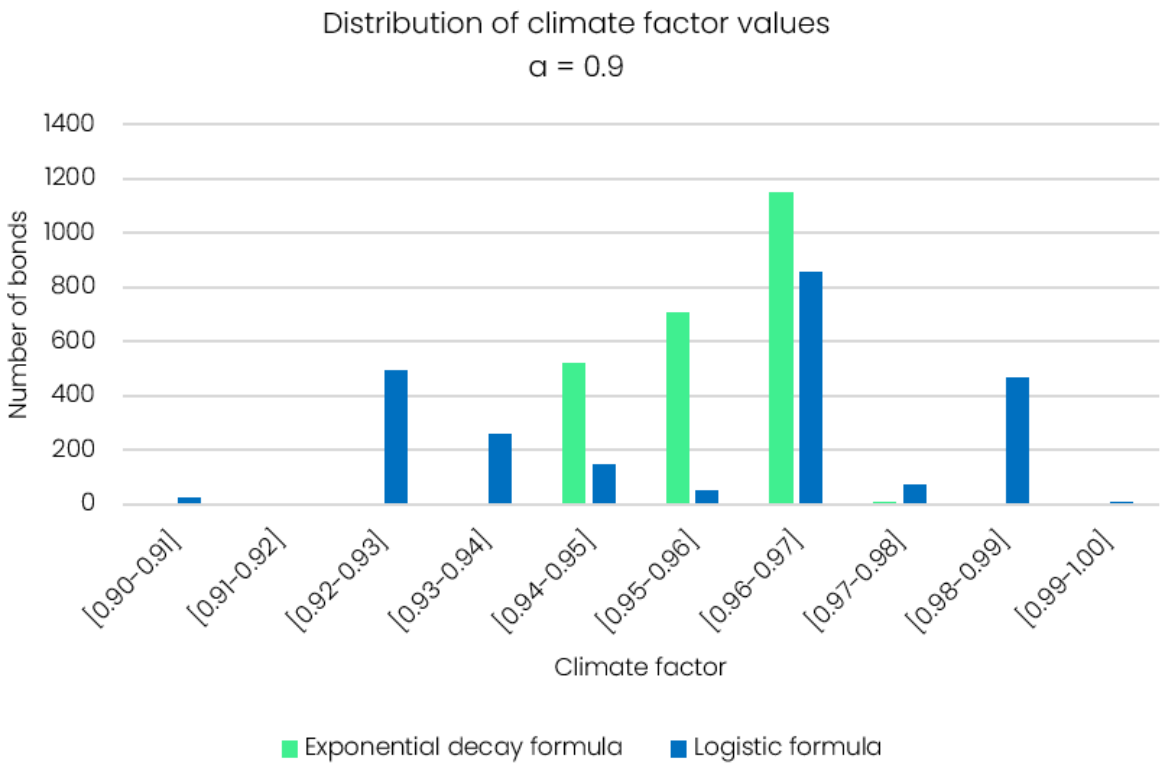


Source (2026): ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), authors calculations.

29 We call this approach the "exponential decay formula" in the following figures, in reference to the approach's underlying functional form.

30 As a reminder, this parameter a is set by the ECB Governing Council, informed by the expected shortfall aggregated across all sectors in the climate stress test.

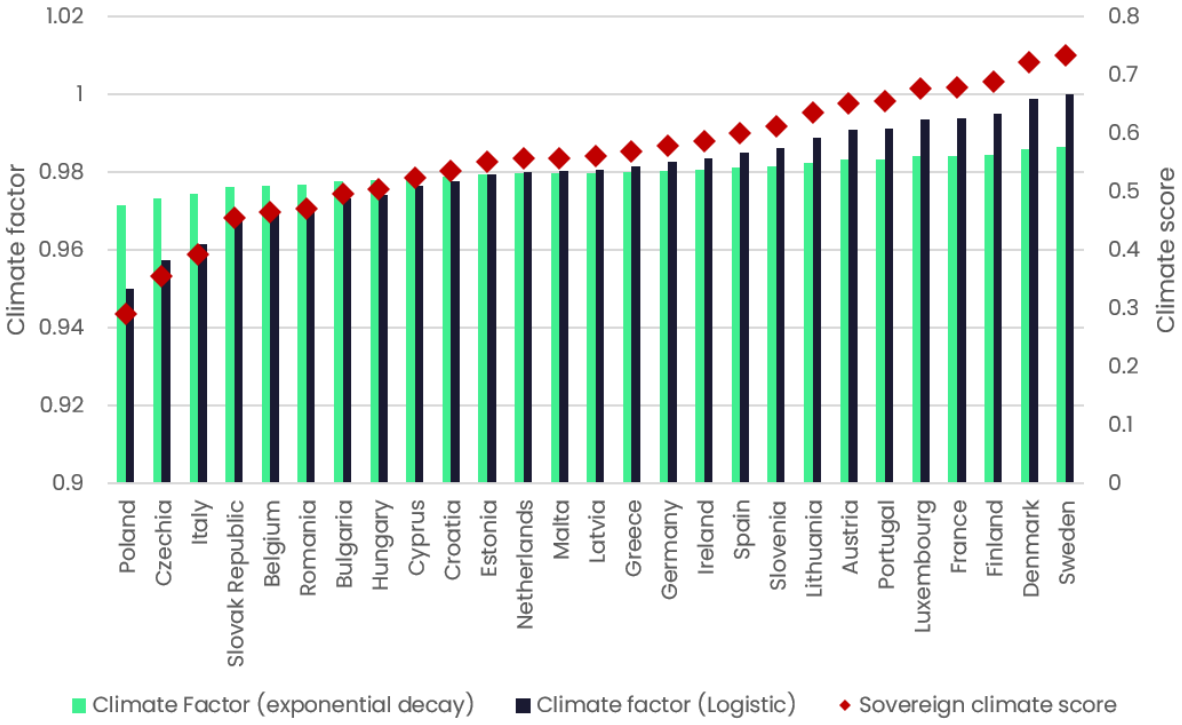
Figure 17. Distribution of climate factor values for eligible sovereign bonds, with floor parameter (a) set at 0.9



Source (2026): ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), authors calculations

In our analysis, the sovereign climate scores are the only driver of the uncertainty scores and thus the climate factor ultimately depends on the results and climate policies of the issuer country. The lowest climate factors are thus attributed to countries that score worse in our methodology. Figure 18 below show the climate scores (on the right-hand axis) of all countries with eligible sovereign bonds, with the average climate factor of the eligible bonds in the left-hand axis. As can be seen, the use of a logistic formula increases the factor differentiation, whereas the exponential decay transformation creates more stability and narrows the differences.

Figure 18. Average climate factor by country

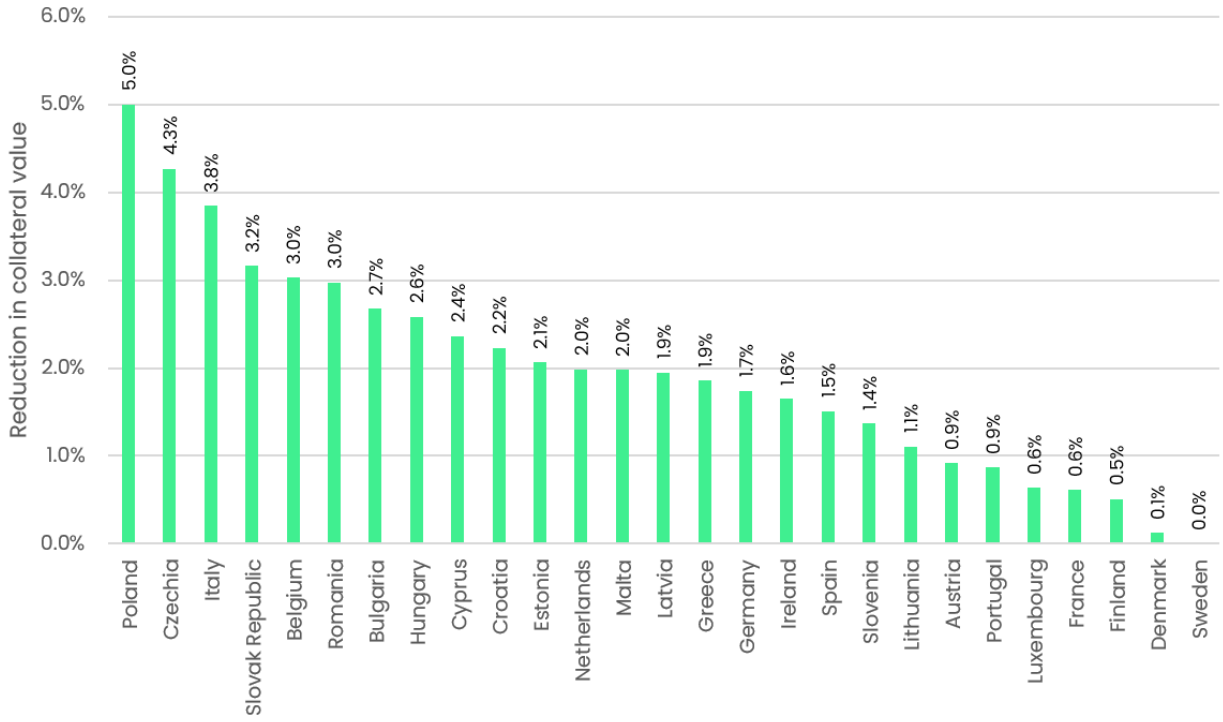


Source (2026): ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), authors calculations. Climate scores are indicated by the red diamonds against the right-hand axis.

The impact of our proposed climate factor, based on the logistic design, is illustrated in the figures below. Figure 19 presents the reduction in the collateral value of eligible sovereign securities, measured as the difference between their market value after standard haircuts and their final market value after applying the climate factor. The results show that Poland, Czechia and Italy experience reductions in their collateral value ranging between four and five per cent, whereas the adjustment is more minimal in the case of France or Finland, and null in the case of Denmark and Sweden.

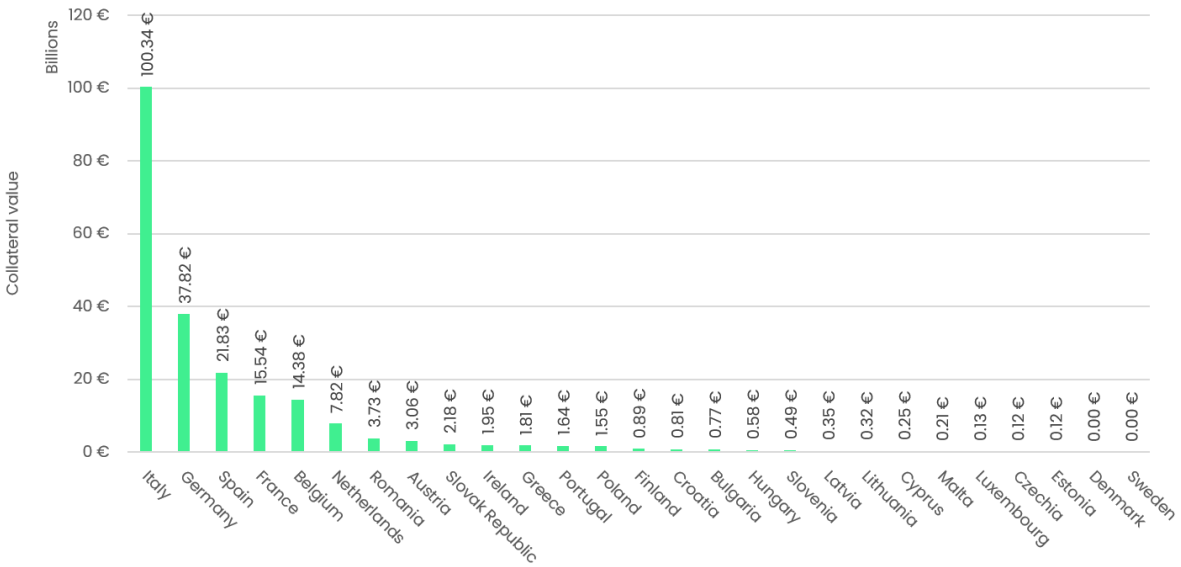
Figure 20 meanwhile ranks countries according to the magnitude of the resulting adjustment in absolute monetary values. Italy, Germany and Spain experience the largest reductions in collateral value following the application of the climate factor, with Italy's eligible collateral value falling by around EUR 100 billion alone. Conversely, Sweden and Denmark show little to no adjustment due to their relatively high climate country scores.

Figure 19. Reduction in collateral value of countries' sovereign bonds, after applying a Climate factor



Note: this is based on the logistic formula, and with a floor parameter set at 0.95. Source (2026): authors' calculations based on ECB (list of eligible assets, 23 June 2026), TPI Centre (ASCOR data, 2025) and LSEG Workspace (outstanding amounts and market price, 23 June 2026)

Figure 20. Loss in collateral value of sovereign bonds due to the implementation of a Climate factor

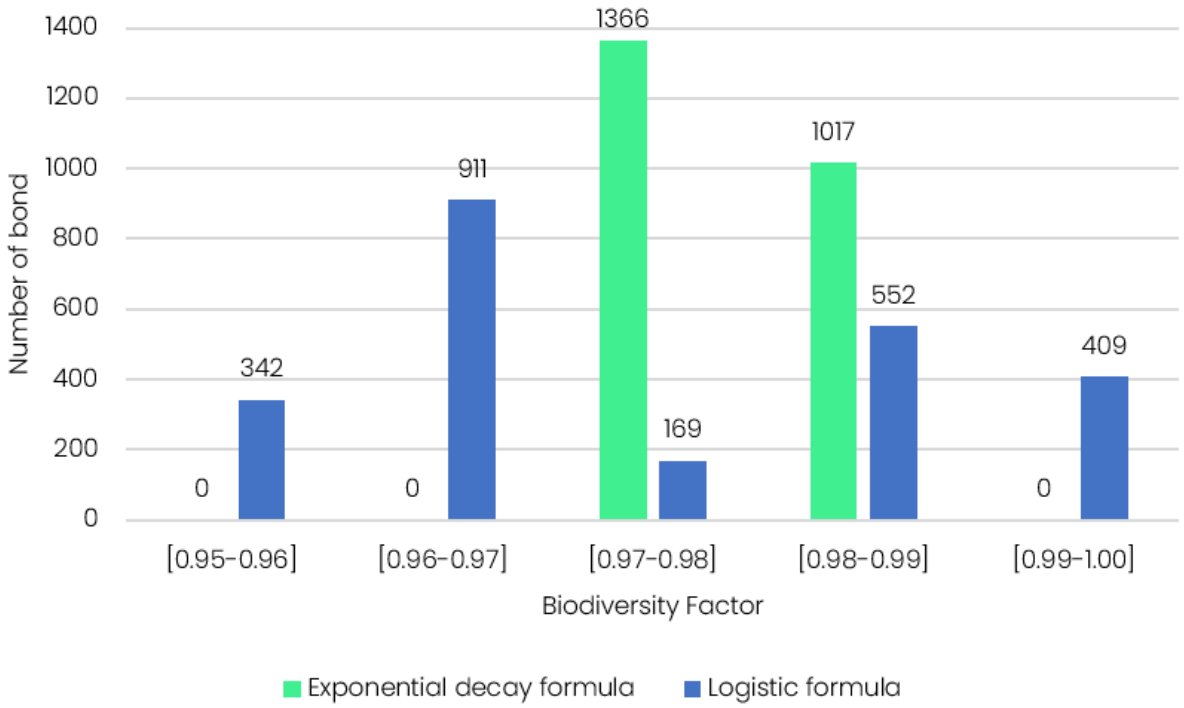


Note: these results are based on the logistic formula, and with a floor parameter set at 0.95. Source: authors' calculations based on ECB (list of eligible assets, 23 June 2026), TPI Centre (ASCOR data, 2025) and LSEG Workspace (outstanding amounts and market price, 23 June 2026

4.2 Findings for the biodiversity factor

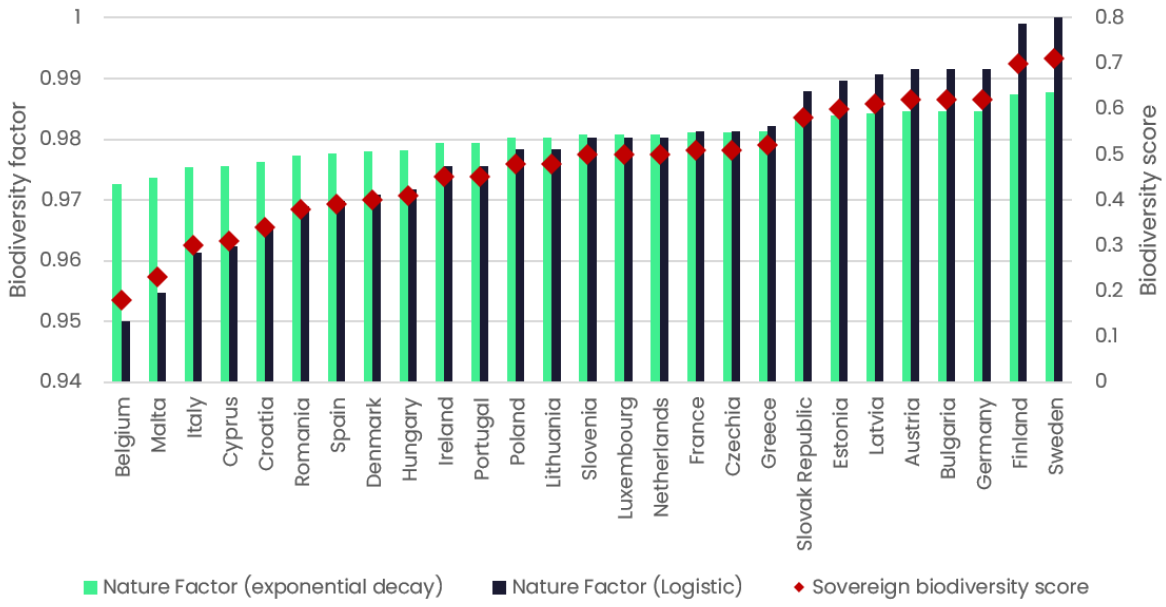
The process above is repeated for the biodiversity uncertainty scores, with the resulting biodiversity factors presented by number of bonds and by country (Figure 21 and Figure 22). The distribution of the biodiversity scores shows the same pattern across methodologies as that of the climate score, with a dense cluster of scores around the median associated with the exponential decay formula and a more evenly distributed set of scores with the logistic formula.

Figure 21. Distribution of biodiversity factor values, with floor parameter (a) set at 0.95



Source (2026): ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), WWF Biodiversity Risk Filter, Yale Centre, European Commission Joint Research Centre, authors calculations

Figure 22. Average biodiversity factor by country



Source (2026): ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), WWF Biodiversity Risk Filter, Yale Center, European Commission Joint Research Centre, authors calculations

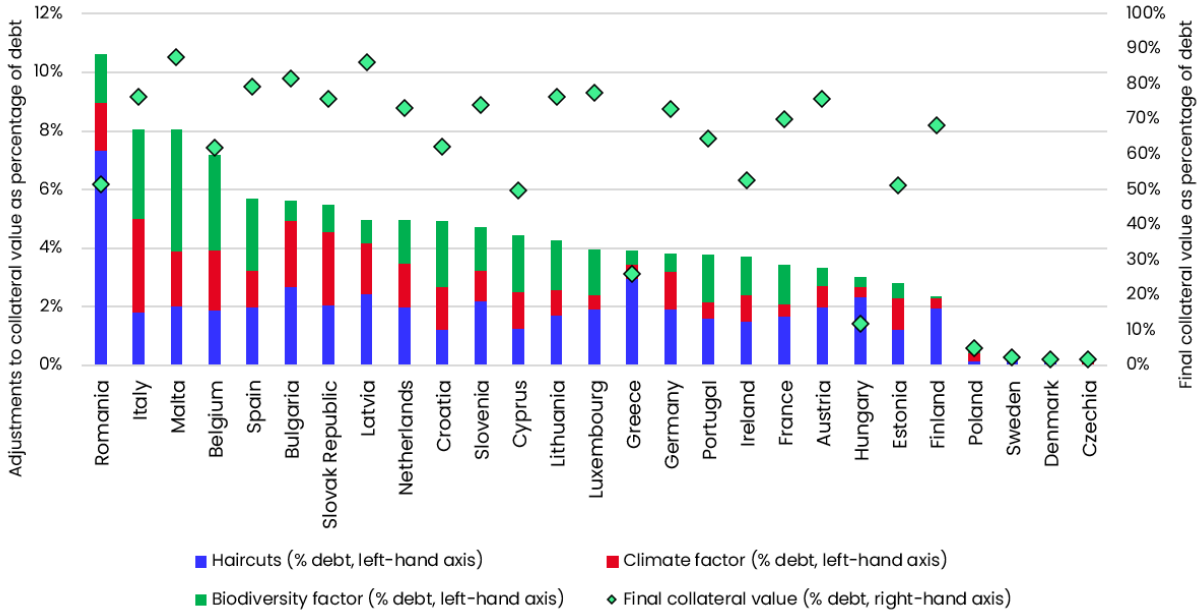
4.3 Findings from the addition of climate and biodiversity factors

To get a sense of the potential effect of a climate and biodiversity factor on the value of eligible collateral, we show the haircuts that would be obtained with our logistic formula in red (climate) and green (biodiversity), along with the standard existing haircuts (blue) for each country. We show these as percentages of each country's total outstanding debt, to indicate the relative impact for each country (Figure 23), and as absolute values to suggest the impact for the factor on the collateral system as a whole (Figure 24). The graphs also show a measure of the amount of debt eligible as collateral for each country (green squares), as a percent of total debt in Figure 24 and in absolute terms in Figure 23 (on a log scale).

These measures are particularly relevant for non-Eurozone countries, which vary in terms of the proportion of their debt they issued in euros and which therefore is eligible for inclusion in the collateral framework (from Romania which is over 50% denominated in euros to Sweden, Denmark and Czechia which are close to zero). To better show the relative magnitudes of the various effects, the climate and biodiversity factors are treated here separately and sequentially, with the climate factor applied first, and then the biodiversity factor. How they could be combined is a more substantial matter, as we discuss elsewhere.

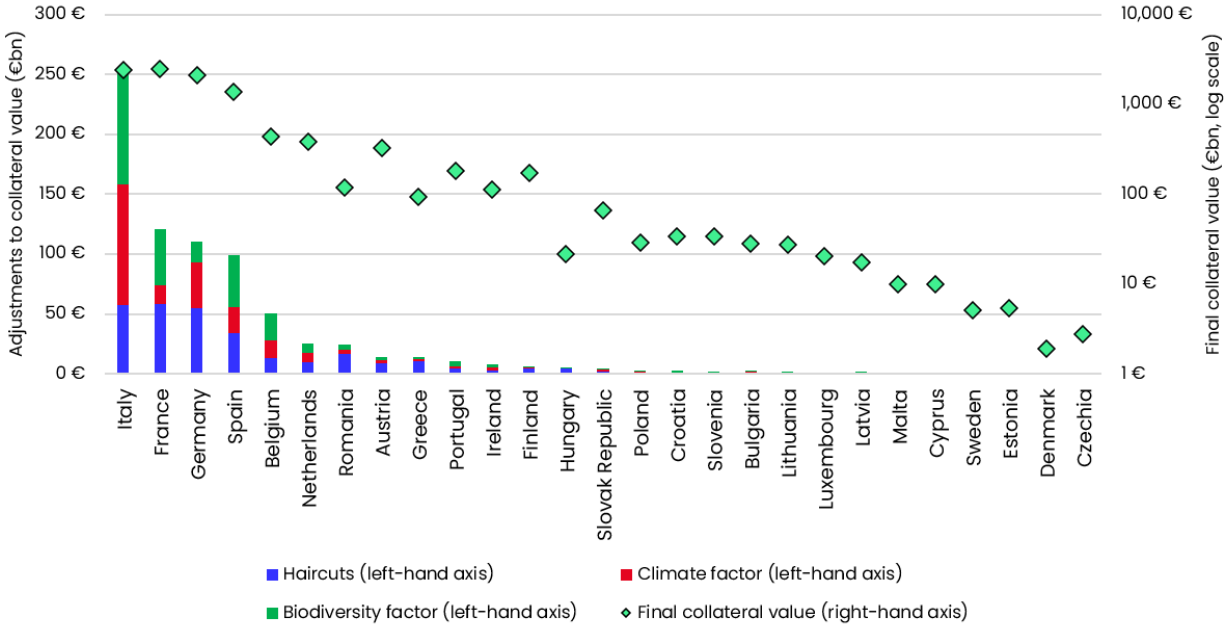
These initial findings point to how the specific distribution of climate and biodiversity scores obtained in our framework create potentially relevant impacts when applied as haircuts. If each factor were to be applied on a scale matching the climate factor for corporate bonds (as shown in the figures in this section), each of the two factors would act on a similar scale to the existing haircuts, leading to large changes in the effective haircut for countries with low climate and biodiversity scores. In absolute terms, the effect of the factors on Italy appear particularly significant, as discussed below, while the relative impacts on Romania, Malta and Belgium are also notable.

Figure 23. Final collateral value, after the climate and biodiversity factor (logistic formula & a = .95) as a percentage of a country's gross debt



Source (2026): authors' elaboration based on ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), LSEG Workspace (outstanding amounts and market price, 23 June 2026), WWF (Biodiversity Risk Filter), Yale Centre (Environmental Performance Index) and European Commission Joint Research Centre (EU Consumption Footprint).

Figure 24. Final collateral value after the climate and biodiversity factor (logistic formula & a= .95)



Source (2026): authors' elaboration based on ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), LSEG Workspace (outstanding amounts and market price, 23 June 2026), WWF (Biodiversity Risk Filter), Yale Centre (Environmental Performance Index) and European Commission Joint Research Centre (EU Consumption Footprint).

5. Conclusion, discussion and next steps

The rationales, methodology and results presented in the previous section illustrate how nature considerations (climate change mitigation and biodiversity protection) can be incorporated into the treatment of sovereign bonds in the ECB's collateral framework. This section discusses the implications of those findings in greater detail, including: the relationship between the climate and biodiversity scores; the geographical distribution of the results (including the concentration of risk) and the resulting need to explore applying haircut reductions; the role and challenges of relying on external nature-related assessment; and the need for future work to explore the macrofinancial consequences of the different methods tested and proposed in this report.

5.1 Climate and biodiversity scores: two scores or one?

There is only a weakly positive linear association between the climate and biodiversity scores. For example, Denmark ranks the second best on climate, but only 21st on biodiversity. Poland and Czechia rank the lowest on climate but are in the upper-middle range for biodiversity. Italy, Belgium and Cyprus rank towards the bottom on both scores. As a general trend, countries that perform relatively well on biodiversity rather than climate (Bulgaria, Slovakia, Poland and Czechia) are concentrated in Central and Southeastern Europe, whereas those that perform relatively better on climate (Denmark, Portugal, Ireland, Lithuania and Luxembourg) are primarily located in Northern and Western Europe

These results suggest that a climate-only or biodiversity-only approach would produce markedly different outcomes for sovereign bond differentiation within the collateral framework. As such, an important next step is to test alternative approaches combining the scores and evaluate their advantages and drawbacks. However, the substantial divergence between the two sets of scores means that the method used to combine them into a single indicator will have an important influence on the final rankings. Future work, to be conducted with ecological and environmental policy experts, should carefully explore different possible combinations.

5.2 Geographical concentration of risks: a case for bonuses?

Although excluding physical risks prevents southern European countries from being disadvantaged because of their geography[31], focusing on transition risks creates a different distributional concern. Twelve of the fourteen countries in the lower half of the climate indicator are located in Central or Southeastern Europe. This reflects, at least in part, a legacy of central planning and coal reliance, as well as lower per capita income levels that make the transition more difficult to achieve. The EU has already recognised these structural differences by incorporating differentiated treatment into instruments such as the Just Transition Fund, the Social Climate Fund, and GDP-based emissions targets (effort sharing). In this context, increasing haircuts could disadvantage poorer states and work against pre-existing EU instruments and laws in this area.

In addition to the geographical impacts discussed above, within the proposed framework a substantial share of the overall impact is concentrated on Italy. Italy ranks 26th out of 28 on both climate and biodiversity scores, while also being one of the largest issuers of eligible sovereign collateral. Moreover, because Italian banks hold and pledge large quantities of Italian sovereign debt as collateral, changes

31 We have argued elsewhere in this report that incorporating physical risks into the collateral framework would penalise countries for their geography rather than their policy choices. For this reason, physical risks were excluded from the assessment framework, so that differentiation is based solely on transition-related factors. The results support this design choice: despite being among the countries most exposed to heat, drought and sea-level rise, Portugal, Spain and Malta all rank in the upper half of the climate indicator. Excluding physical risks therefore helps decouple climate performance from geographical factors that governments have little or no ability to influence.

to the treatment of Italian government bonds would also affect the borrowing capacity of the Italian banking sector.

Beyond this case, any differentiation within the collateral framework is likely to fall disproportionately on countries that already have relatively high debt-to-GDP ratios and elevated sovereign spreads relative to core euro area countries. For these types of countries any reduction in collateral values could impact the fiscal space available to finance investments related to the net-zero transition and nature protection, thereby increasing future vulnerability to both physical and transition risks. These potential economic, political and legal consequences of imposing additional constraints on already highly indebted member states – and the potential impacts on their banking systems due to banks' bias towards pledging domestic sovereign bonds – strengthen a careful application of the methodology explored throughout this report.

One way to address this concern is to implement differentiation by lowering haircuts (or applying bonuses) for better-performing sovereigns, rather than by raising haircuts for poorer performers. This approach avoids the possibility that changes to the collateral framework will end up worsening a country's fiscal space and is therefore less likely to generate adverse macroeconomic consequences. It also shifts the emphasis from haircuts for countries with poor scores to supporting those with good ones, which may be easier to justify from a legal and political perspective. However, one drawback of reducing haircuts is that it may conflict with the central bank's risk management objectives, as discounts increase the risk of losses to the central bank in the event of counterparty default. The decision to use haircut discounts therefore implies a potential trade-off between the policy objectives of the collateral framework on one hand, and central bank risk management on the other.

5.3 External nature-related assessment: necessary but difficult

Operationalizing changes to the collateral framework requires an assessment framework capable of differentiating between sovereigns on the basis of their climate and biodiversity performance. In this report we have proposed using a mix of methods – an adaptation of ASCOR for the climate factor, and the WWF Biodiversity Risk Filter, Yale Environmental Performance Index and EU Consumption Footprint for the biodiversity factor. Using these external assessors is consistent with existing practice under the Eurosystem Credit Assessment Framework (ECAF) – the risk procedure used by the ECB to ensure that all collateral pledged by banks in monetary policy operations meets high credit standards – where sovereign credit judgements are delegated to credit rating agencies – named External Credit Assessment Institutions (ECAI).

However, there are also important differences between a potential approach that uses the assessment tools we explore in this report and the approach under the ECAF. ECAIs are registered with and supervised under a specific institutional environment[32], they are subject to conflict-of-interest rules and methodology-disclosure obligations, and they can be de-registered if they fail to meet regulatory standards. Consequently, the ECB can point to an established legal and supervisory framework for ECAF ratings when relying on their assessments.

By contrast, the methodologies used in this report are not subject to regulatory oversight, despite being credible and transparent. For example, ASCOR is an investor-led initiative developed with the Transition Pathway Initiative Centre at the London School of Economics and Political Science (LSE), the WWF Biodiversity Risk Filter is an NGO created tool, the Environmental Performance Index is an academic project based at Yale University, and the Consumption Footprint is the results of work by the European Commission's Joint Research Centre (JRC). As a result, these frameworks do not have the same legal and institutional safeguards as the ECAF. This makes it more difficult for the central bank

32 For instance, the European Banking Authority (EBA), European Securities and Markets Authority (ESMA), and European Insurance and Occupational Pensions Authority (EIOPA) jointly manage the mapping of ECAI ratings to credit quality steps and oversee registration and technical standards.

to justify using these approaches as a basis for differentiating between sovereign bonds if challenged. This being said, the current ECB climate factor also builds on a methodology that was developed in house and is not subject to a pre-determined regulatory environment.

Addressing this issue could then require either delegating the construction of the composite indicator to a credible external body or providing a transparent and scientifically justified methodology for selecting indicators and assigning weights. One possibility could be to align the weighting methodology to existing EU legislation and policy frameworks – such as the National Climate and Energy Plans (NECPs), the Fit for 55 package, or some other framework. This would strengthen the case that the collateral framework is in line with and supports pre-existing EU policy under the secondary mandate, rather than determining it. Additional safeguards could include freezing the methodology between fixed revision periods (to avoid sudden changes impacting haircuts), providing advanced notice of methodological revisions, conducting periodic sensitivity analyses (to ensure robustness), and establishing rules for handling missing data.

5.4 Impacts and implications: a macrofinancial political economy approach

The report identified three alternative justifications for incorporating climate and biodiversity considerations into the collateral framework for sovereign bonds, each with its own legal, economic and methodological implications. An important next step will therefore be to further develop and map the legal, evidential and economic requirements of each approach, and to understand how these translate into different methodological choices. For instance, as discussed in more depth in Section 2, a risk-based approach may differ substantially from an alignment- or resilience-based approach in terms of its legal justification and the way differentiation is implemented: from a methodological perspective, a risk-based approach may warrant only relatively modest differentiation based on climate and biodiversity risks, whereas an alignment- or resilience-based approach may justify larger differences. Similarly, increasing haircuts may be more justified under a risk-based approach, while a framework based on alignment or resilience may favour reductions in haircuts for stronger-performing sovereigns. Different approaches may also require different methods for constructing composite climate and biodiversity indicators and determining the overall degree of differentiation.

A subsequent priority will be to understand how these alternative approaches would differ in their macrofinancial and environmental effects. Under a risk-based approach, for example, the primary objective is to protect the central bank's balance sheet, which may require only relatively small adjustments to sovereign haircuts. In this case, the principal economic effect may arise through signalling rather than through material changes in sovereign financing conditions or government behaviour. By contrast, an approach based on the ECB's secondary mandate could justify larger degrees of differentiation, with correspondingly greater effects on sovereign borrowing costs and so broader economic conditions (fiscal space, ability to invest in the ecological transition, and so on). Larger impacts may even affect the transmission of monetary policy and generate monetary policy fragmentation, with implications for price stability.

These economic implications – particularly the interactions between monetary policy, fiscal policy and sovereign debt markets – will be examined in future work through a combination of theoretical analysis and macroeconomic modelling. The modelling component is particularly valuable because it allows both the quantification of potential effects and the identification of complex feedback mechanisms that may not be apparent through qualitative reasoning alone.

To support this work, we intend to develop the Transim 3 model (Jackson and Gallant, 2026) to include a collateral framework. The model contains a detailed representation of government finance, including 25 maturities of government debt; a complex financial sector, including a central bank capable of conducting quantitative easing and other unconventional monetary policy operations; more than 50 financial asset classes with endogenous prices; and multiple production sectors, including detailed energy industries that allow the simulation of net-zero transition pathways. Together, these features

provide a suitable framework for analysing the economic impacts and monetary and fiscal interactions arising from changes to the collateral framework. If desired, this model could also be extended to evaluate broader reforms, including the incorporation of climate and biodiversity considerations into other classes of eligible collateral.

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Appendix A – (Mis)pricing of climate- and nature-related risks in sovereign bond markets

Transmission channels

A growing literature shows that climate- and nature-related transition risks can affect sovereign creditworthiness and the market value of sovereign debt through direct fiscal, indirect macroeconomic and financial-sector channels.

A direct transmission channel operates through public finances. Governments may face substantial expenditure requirements associated with low-carbon infrastructure, support for affected households and industries, and the restructuring of energy systems. At the same time, the transition may reduce revenues derived from carbon-intensive activities or fossil-fuel production (Agarwala et al., 2021; Sun et al., 2023; Anyfantaki et al., 2025). Governments may also be exposed through state-owned enterprises and public guarantees if carbon-intensive assets lose value or become stranded. Nature-related transition policies may create comparable direct fiscal pressures where governments incur expenditure on ecosystem restoration, support for affected sectors, or face liabilities through state-owned enterprises exposed to restrictions on deforestation, resource extraction, pollution or environmentally harmful land use.

Transition risks also affect sovereigns indirectly through the wider economy. A delayed or disorderly climate transition may weaken output, employment, consumption, investment and trade competitiveness, particularly in countries dependent on carbon-intensive activities. Nature-related policies may generate similar adjustment pressures in economies reliant on agriculture, forestry, fisheries, mining or other activities with significant effects on ecosystems. Restrictions on environmentally harmful activities may reduce the value of productive assets and affect exports, employment and investment. These macroeconomic consequences can narrow the tax base and increase demands on public expenditure, thereby weakening debt sustainability. Conversely, the transition towards a low-carbon and nature-positive economy may strengthen the productive base and reduce longer-term macroeconomic and fiscal vulnerabilities. Kraemer and Volz (2022) argue that incorporating natural capital and ecosystem services into debt-sustainability analysis can materially alter projections of economic growth, government revenue and public debt. Kulenkampff (2025), in a scenario analysis for Ghana, similarly find that reduced deforestation and improved forest management can support growth, reduce public debt and interest expenditure, and strengthen sovereign creditworthiness.

A further transmission mechanism operates through the financial sector. Transition-related losses incurred by banks and other financial institutions may generate liabilities for governments, while a deterioration in sovereign creditworthiness can weaken institutions holding large quantities of domestic government bonds. These feedback effects may amplify an initial transition shock and increase both sovereign financing costs and financial instability (Agarwala et al., 2021; Zenios, 2021; Bernhofen et al., 2024).

Evidence of transition risk incorporation into sovereign yields and credit assessments

Empirical evidence suggests that financial markets increasingly respond to those transition risks. Collender et al. (2023) find that higher emissions are associated with higher ten-year sovereign yields and spreads, while renewable-energy consumption and lower dependence on natural-resource rents are associated with lower borrowing costs in advanced economies. Anyfantaki et al. (2025) likewise find that higher carbon emissions are associated with higher sovereign yields, particularly in developing countries and after the Paris Agreement. This suggests that investors require compensation

for the adjustment costs and fiscal vulnerabilities of carbon-intensive economies.

Markets also appear to reward certain forms of transition preparedness. Anghel et al. (2025) find that lower emissions intensity, stronger climate-policy commitments, environmental taxation and government environmental expenditure are generally associated with lower short- and long-term sovereign yields. Cappiello et al. (2025) find that transition-related indicators became more influential in sovereign credit ratings after the Paris Agreement with stronger emissions-reduction commitments and declining emissions intensity associated with better ratings, and fossil-fuel dependence associated with lower ones. Scenario-based studies also show that the design and timing of transition policy can materially affect sovereign default probabilities, risk premia and debt sustainability (Seghini and Dees, 2025; De Angelis et al., 2026).

The evidence for nature-related transition risk is less developed. Nevertheless, Wang (2021) finds that increases in renewable natural capital, particularly forests and sustainably managed agricultural land, are associated with lower sovereign borrowing costs within countries, whereas dependence on non-renewable resources tends to increase yields. Semet et al. (2021) find that environmental indicators help explain sovereign spreads. Wollenweber et al. (2026) also associate stronger biodiversity-related environmental performance with lower sovereign spreads, with larger effects among already vulnerable issuers.

The existing literature therefore indicates that transition risks are not ignored. Carbon intensity, renewable-energy deployment and environmental policy can influence sovereign yields or ratings.

Evidence of such pricing remaining incomplete

Evidence of some pricing of transition risks does not establish that these risks are fully incorporated into asset valuations. Eren et al. (2022) identify several obstacles, including deep uncertainty about future policies and incomplete information about exposures. Moreover, many transition effects are expected to materialise over long horizons. As such, they may receive limited weight in current valuations even where investors possess the relevant information (Barnett et al., 2020; Bolton et al., 2020; Hansen, 2022; Eren et al., 2022).

Evidence specific to sovereigns points towards selective incorporation of climate-related transition risks. The increased focus on transition-related indicators following the Paris Agreement documented by Cappiello et al. (2025) has been selective: only a subset of these indicators has gained prominence, and their relevance differs across countries. Semet et al. (2021) find no overlap between the ESG indicators explaining sovereign spreads and those reflected in sovereign credit ratings, indicating that market prices and rating assessments capture different dimensions of environmental risk. Likewise, Anyfantaki et al. (2025) and Anghel et al. (2025) report considerable variation across climate indicators, countries and maturities.

The evidence is even more limited for nature-related transition risks. Semet et al. (2021) find that environmental factors are less clearly represented in credit ratings than in bond spreads. David (2025) concludes that biodiversity risk is not yet directly incorporated into government-bond. In addition, the mixed results reported by Wang (2021) and Şeker and İşgüven (2025) illustrate the sensitivity of conclusions to the indicators, specifications and country samples considered. Rather than suggesting that nature-related transition risks are financially irrelevant, this variability may reflect immature measurement frameworks and limited market understanding.

Much of the remaining evidence concerns corporate securities rather than sovereign bonds and therefore does not, by itself, establish the precise extent of transition-risk underpricing in sovereign debt markets. Nevertheless, the underlying pricing frictions are also relevant to sovereign issuers. One indication of incomplete pricing is that market responses appear to depend on the salience of climate risk. Choi et al. (2020) find that carbon-intensive firms underperform during periods of abnormally warm weather, when investor attention to climate change is heightened. Ilhan et al. (2021) similarly

find that the cost of protection against downside tail risk is higher for carbon-intensive firms and increases further when public attention to climate change rises. If the relevant exposures were continuously and fully reflected in valuations, temporary changes in investor attention would be expected to have a more limited effect on relative asset prices.

Pricing also appears to respond strongly to major policy signals. Carbone et al. (2021) find that firms most exposed to the low-carbon transition experienced a relative deterioration in their credit ratings following the Paris Agreement, with a larger effect among European firms. Ehlers et al. (2022) similarly identify evidence of carbon-risk pricing in syndicated loans following the Paris Agreement. These findings show that markets can reprice transition exposures when the likelihood of policy action becomes more credible. At the same time, the stronger pricing observed following a major policy event suggests that these exposures may not have been fully reflected beforehand and that future changes in policy expectations could generate further abrupt adjustments.

Survey evidence is consistent with these empirical findings. Stroebel and Wurgler (2021) report that a large majority of finance academics, market professionals, regulators and economists consider climate risk to be underestimated in asset prices. Although such perceptions do not independently demonstrate underpricing, they reinforce the conclusion that market participants themselves regard prevailing valuation practices as insufficient to capture the scale, uncertainty and long-term nature of climate-related risks.

Appendix B – Additional details on the climate sovereign score

Our design of the climate sovereign score builds on almost all of the indicators and metrics from ASCOR. It removes those considered to double count the same aspects, such as indicators which rely on an underlying metric. In those cases, the metric is always taken over the binary indicator, as the former provides a more nuanced assessment than the latter. In addition, the whole area of *Adaptation* is removed, since climate-related physical risk is not within the scope of this work, and two indicators related to the just transition area were not included due to being considered not relevant. The remaining indicators were then grouped in the following areas and two pillars: *Results* and *Policies*.

The full listing of included indicators is provided in Table 6 with their labels as classified in the ASCOR dataset. The descriptions of each indicator as provided by ASCOR is given in Table 7.

Table 6. Overview of the climate score built on ASCOR

Pillar	Area	Indicators/metrics
Results (50%)	Emissions	EP 1.a.i-ii; EP 1.b.i; EP 1.c.i
	Energy transition	CP 3.c.i; CP 3.d.i-ii; CP 4.b.i; CP 4.d.i; CF 4.i-iv;
Policies (50%)	2030 targets	EP 2.a.i; EP 2.b; EP 2.b.i; EP 2.c.i; EP 2.d.i
	Net zero targets	EP 4.a.i; EP 4.b; EP 4.c
	Climate legislation	CP 1.a; CP 1.b
	Carbon pricing	CP 2.a; CP 2.b.i; CP 2.c; CP 2.c.i
	Fossil fuels	CP 3.a; CP 3.a.i; CP 3.b; CP 3.b.i; CP 3.c; CP 3.d
	Sectoral transitions	CP 4.a; CP 4.b; CP 4.c; CP 4.d; CP 4.e; CP 4.e.i
	Just transition	CP 6.b;CP 6.c;CP 6.d
	International climate contributions	CF 1.a.i; CF 1.b.i
	Transparency in climate spending	CF 3.a;CF 3.b

Source: ASCOR (2026)

Table 7. Description of indicators and metrics used

Indicator/metric	Description
EP 1.a.i	The most recent value for consumption and production emissions per capita.
EP 1.a.ii	The country's most recent emissions trend, calculated over year-on-year, 3-year, and 5-year horizons using a generalized least squares (GLS) regression with a logarithm-like transformation.
EP 1.b.i	The percentage difference between the country's 1.5°C benchmark and the emissions level in 2030 extrapolated from the most recent 5-year trend. A negative value means the trend achieves the benchmark.
EP 1.c.i	The percentage difference between the country's fair share allocation and the extrapolated 2030 emissions level. A negative value means the trend achieves the fair share.
EP 2.a.i	The country's targeted emissions reduction adjusted to a common base year of 2019, to allow cross-country comparison.
EP 2.b	Whether the country's 2030 target disclosure clearly quantifies reliance on carbon credits, offsets, or internationally transferred mitigation outcomes (ITMOs), or explicitly states that no such instruments will be used.
EP 2.b.i	The percentage of the 2030 target that will be met using carbon credits, as stated in the country's disclosure.
EP 2.c.i	The percentage difference between the country's targeted 2030 emissions level and its 1.5°C benchmark. A negative value means the target achieves the benchmark.
EP 2.d.i	The percentage difference between the country's targeted 2030 emissions level and its fair share allocation. A negative value means the target achieves the fair share.
EP 4.a.i	The year in which the net zero CO_2 target is set, as disclosed by the country.
EP 4.b	Whether the country's net zero CO_2 target is set for 2050 or earlier, in line with global 1.5°C scenarios.
EP 4.c	Whether the country's net zero CO_2 target is set for 2045 or earlier, reflecting an accelerated deadline expected of high-income countries.
CP 1.a	Whether the country has a framework climate law that: sets a strategic direction for decarbonisation aligned with the Paris Agreement; is enshrined in legislation, or an equivalent executive instrument in particular political systems; and establishes at least one compliance obligation.
CP 1.b	Whether the country's framework climate law specifies all three accountability elements: who is accountable to whom for at least one obligation; how compliance is assessed; and what happens in cases of non-compliance.

CP 2.a	Whether the country has an operational carbon price, either a carbon tax or an emissions trading system (ETS), at the supranational, national, or sub-national level. Pilot or under-consideration systems are insufficient.
CP 2.b.i	The percentage of national greenhouse gas emissions covered by an explicit carbon price.
CP 2.c	Whether at least one carbon pricing system in the country aligns with the Paris Agreement, either by having a carbon tax rate at or above the Paris-aligned price floor (US$105/$tCO_2e$ in 2025), or by having an ETS with an emissions cap reduction rate consistent with the country's 1.5°C benchmark.
CP 2.c.i	The most recent price level of the carbon pricing system with the highest price, expressed in US$/$tCO_2e$.
CP 3.a	Whether the country has committed in a legislative or executive document to a specific deadline for phasing out fossil fuel subsidies, or has no explicit fossil fuel subsidies according to IMF, OECD, IEA and/or UNSDG databases.
CP 3.a.i	The year by which the country has committed to phase out fossil fuel subsidies, or the year it stopped subsidising fossil fuels.
CP 3.b	Whether the country has published an inventory of its explicit fossil fuel subsidies, including as part of budgetary reporting or phaseout commitments. If the country has no fossil fuel subsidies, per available data, assessed as “Not applicable”.
CP 3.b.i	The most recent level of explicit fossil fuel subsidies as a percentage of GDP.
CP 3.c	Whether the country has committed not to approve new coal mines. Only applicable to countries with at least one operating coal mine.
CP 3.c.i	The level of coal rents (the difference between the value of coal production at world prices and total production costs) as a percentage of GDP.
CP 3.d	Whether the country has committed not to approve new long-lead-time upstream oil and gas projects, or has established a moratorium or ban on oil and gas exploration or production. Only applicable to countries with oil or gas reserves.
CP 3.d.i	The level of oil rents (the difference between the value of crude oil production at regional prices and total production costs) as a percentage of GDP.
CP 4.a	Whether the country has a climate strategy setting quantified sector-specific emissions targets or projections for 2030 or net zero, combined with at least one related policy or regulation for each of: electricity, transport, industry, LULUCF/agriculture/forestry, and a fifth significant-emissions sector.
CP 4.b	Whether the country has both an energy efficiency law, or energy law with strategic direction for efficiency, and an energy efficiency target set in its NDC, long-term strategy, or an executive document.
CP 4.b.i	The country's energy intensity of primary energy, expressed in megajoules per US$2017 of PPP-adjusted GDP.

CP 4.c	Whether the country has established mandatory climate-related disclosure through an implemented or scheduled law, or has announced a date for such requirements to take effect.
CP 4.d	Whether the country has committed to net zero electricity by a deadline aligned with 1.5°C: 2035 for advanced economies, 2040 for China, or 2045 for the rest of the world.
CP 4.d.i	The percentage of the country's electricity generated from low-carbon sources (calculated by subtracting the share from coal, oil, and natural gas from 100 per cent).
CP 4.e	Whether the country has increased its protected areas as a percentage of total land area over the past five years, or already protects at least 30 per cent of its land, the Kunming-Montreal threshold.
CP 4.e.i	The country's protected area as a percentage of total land area, covering terrestrial and inland waters.
CP 6.b	Whether the country has a just transition strategy or approach that: involves social dialogue with workers; engages at least three specified stakeholder groups; and establishes a just transition commission
CP 6.c	Whether the country has a green jobs strategy that identifies employment opportunities from the low-carbon transition and sets actions or policies to harness them.
CP 6.d	Whether the country's carbon pricing implementation includes a clear mechanism or acknowledgement addressing regressive distributional impacts on lower-income citizens. Assessed as “Not applicable” if the country has no carbon pricing.
CF 1.a.i	The country's three-year average international climate finance contribution as a percentage of GDP.
CF 1.b.i	The country's targeted level of international climate finance contributions as a percentage of projected GDP in the target year.
CF 3.a	Whether the country discloses climate-related expenditure with a total amount and a breakdown by category, for example mitigation, adaptation or specific measures, published in budgets, spending reviews, open budget portals, statistics office databases, or green bond reports.
CF 3.b	Whether the country regularly applies climate budget tagging or an equivalent systematic and consistent practice to track climate-related expenditure.
CF 4.i	The ratio of the country's prospective solar energy pipeline (capacity under construction, in pre-construction, or announced) to its current fossil-fuel-based electricity capacity. A ratio above 1 indicates the solar pipeline exceeds existing fossil capacity.
CF 4.ii	The ratio of the country's prospective wind energy pipeline to its current fossil-fuel-based electricity capacity.

CF 4.iii	The ratio of the country's prospective geothermal energy pipeline to its current fossil-fuel-based electricity capacity.
CF 4.iv	The ratio of the country's prospective hydroelectric energy pipeline to its current fossil-fuel-based electricity capacity.

Source: ASCOR (2026)

Following the methodology of Scheer et al. (2024), all binary indicators are transformed into 1 for "Yes" and 0 for "No", whereas quantitative metrics are transformed z-scores. Quantitative metrics are normalised relative to their distribution across the 28-country sample. For each metric, the mean and sample standard deviation are calculated. This standardisation makes metrics expressed in different units comparable while preserving countries' relative position within the reference sample. For metrics where a higher value represents better performance, the transformed-z score for country i is calculated as:

$$S_i = \Phi\left(\frac{x_i - \mu}{\sigma}\right)$$

Where Φ denotes the cumulative distribution function of the standard normal distribution. For metrics where a lower value represents better performance, the sign of the standardised value is reversed. This transformation produces scores between 0 and 1: a country at the EEA mean receives a score of 0.5, while progressively stronger and weaker observations approach 1 and 0, respectively. If all valid country observations for a metric are identical, so that $\sigma = 0$, the score is set to 0.5. The formulas normalising the metrics assessing the fossil fuel's rents as a percentage of the country's GDP (metrics CP 3.c.i; CP 3.d.i and CP 3.d.ii) are amended to reward countries with figures of zero (that is, no rents come from fossil fuels) with a score of 1 (best possible performance for the score).

The resulting item scores are aggregated using unweighted arithmetic averages, into the areas shown in Table 6 above, and these in turn into pillars and the overall score. Items classified as exempt, not applicable or unavailable are left blank and are excluded.

The aggregate sub-scores for the Results and Policies pillars, along with the overall scores are given in Table 8, with scores representing a better performance shaded towards green and those representing a poorer performance shaded towards red.

Table 8 Pillar and overall scores of EEA sovereigns

Country	Results	Policies	Overall score
Austria	0.566	0.737	0.652
Belgium	0.434	0.497	0.466
Bulgaria	0.458	0.536	0.497
Croatia	0.565	0.507	0.536
Cyprus	0.650	0.399	0.524
Czechia	0.412	0.300	0.356
Denmark	0.675	0.768	0.722

Estonia	0.657	0.444	0.551
Finland	0.643	0.732	0.688
France	0.569	0.788	0.678
Germany	0.403	0.755	0.579
Greece	0.561	0.576	0.569
Hungary	0.532	0.478	0.505
Ireland	0.504	0.670	0.587
Italy	0.357	0.429	0.393
Latvia	0.566	0.556	0.561
Lithuania	0.637	0.634	0.635
Luxembourg	0.782	0.571	0.677
Malta	0.583	0.533	0.558
Netherlands	0.500	0.615	0.558
Norway	0.518	0.707	0.613
Poland	0.287	0.294	0.290
Portugal	0.712	0.600	0.656
Romania	0.511	0.430	0.471
Slovak Republic	0.523	0.386	0.454
Slovenia	0.533	0.690	0.612
Spain	0.577	0.621	0.599
Sweden	0.713	0.753	0.733

Source: ASCOR (2026), authors calculations. The most recent year when the assessment was done is 2025. Iceland and Liechtenstein are not assessed by ASCOR and thus not included. Emission Pathways excludes absolute emissions levels.

Sensitivity to changes in binary policies

As shown in Figure 12 in Section 3, which decomposes the overall score into its different areas, some categories such as *Climate Legislation* are inherently binary because they are composed exclusively of indicators assessing the existence of specific legislative measures.

As a sensitivity analysis presented in Table 9, we estimate the impact that the adoption of additional

legislation would have on countries' overall scores. To do so, we assume that all countries adopt the same set of policies assessed as best practices in the ASCOR framework. We do this by changing the binary indicators to 1 within each policy area while leaving all other indicators unchanged, and estimate the resulting effect on scores. We then repeat the exercise by setting all binary policy indicators across all policy areas to 1 simultaneously. The areas of *Carbon Pricing* (containing indicators CP.2.a and CP.2.c) already show 1 for all 28 sovereigns, whereas *Climate Finance* is not considered because it holds only metrics (CF.1.a.i, CF.1.b.i). These two areas therefore remain unchanged.

Table 9. Sensitivity to policy-areas in climate score

Specification	Binary indicators modified	Change relative to baseline	Pearson correlation	Spearman rank correlation	Mean absolute change	Maximum rank change
Baseline	N/A	0	1	1	0	0
2030 targets	EP.2.b	0.0004	0.9998	1.0000	0.0004	0
Net zero targets	EP.4.b, EP.4.c	0.0157	0.9972	0.9934	0.0157	2
Climate legislation	CP.1.a, CP.1.b	0.0227	0.9773	0.9589	0.0227	6
Fossil fuels	CP.3.a, CP.3.b, CP.3.c, CP.3.d	0.0221	0.9937	0.9896	0.0221	5
Sectoral transitions	CP.4.a, CP.4.b, CP.4.c, CP.4.d, CP.4.e	0.0178	0.9947	0.9907	0.0178	4
Just transition	CP.6.b, CP.6.c, CP.6.d	0.0202	0.9890	0.9776	0.0202	6
Transparency in climate spending	CF.3.a, CF.3.b	0.0300	0.9864	0.9655	0.0300	6
All Policies areas combined	All of the above	0.1289	0.8067	0.7094	0.1289	16

Based on these results, we conclude that no single legislative area is a major determinant of the overall score, although the Climate Legislation, Just Transition and Transparency in climate spending area can result in ranking changes of up to six positions. Nevertheless, even the largest single-area intervention increases the average score by only 0.030, while the Spearman rank correlation remains above 0.95 in all cases, indicating that the ranking is robust to any individual legislative gap. When all policy indicators are set to 1 simultaneously, however, the effects become more pronounced: the average score increases by 0.129 and the Spearman rank correlation falls to 0.709. This suggests that, while no individual policy area determines a large share of the overall score, the consistent adoption of climate-aligned legislation across multiple policy areas can have a substantial impact on sovereign scores and rankings.

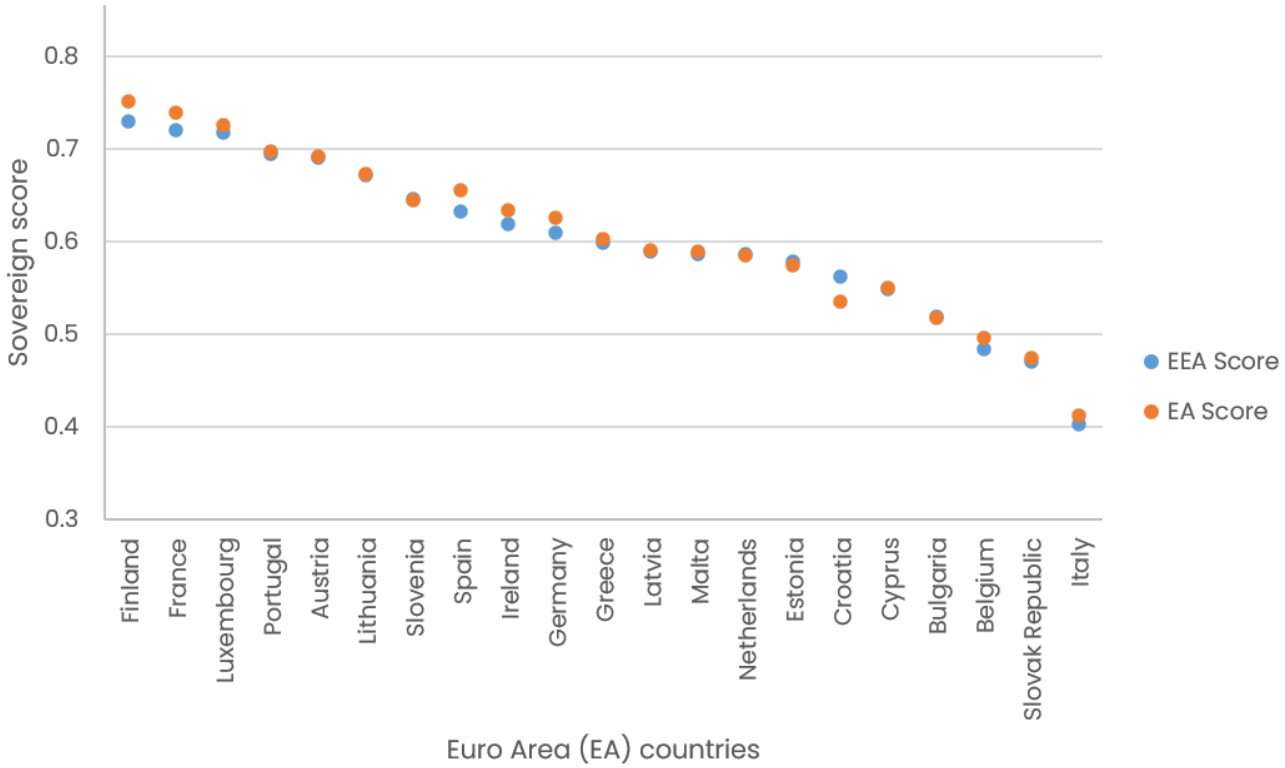
Although the ASCOR framework already evaluates most metrics and targets against country-specific benchmarks and takes into account the relative macroeconomic landscape (for instance, by using GDP

as reference point), the construction of an aggregate score inevitably involves more choices and value judgements. Policymakers may wish to consider whether certain areas such as net zero targets and climate legislation, by definition more binary than others, make sense consistently across different countries. The approach presented here represents one of many possible methodological choices. It does not imply that alternative weighting schemes, aggregation methods, or area selection are less valid. Rather, it illustrates how the ASCOR framework can be operationalized to produce a composite measure while acknowledging the existence of other plausible approaches.

Sensitivity to inclusion of EEA countries

Although the scope of countries considered can also affect the score – this being a measure of relative performance – differences between scores obtained from considering the Euro Area (EA) as opposed to the wider European Economic Area (EEA) are minimal. A comparison between the scores calculated with the two scopes shows that there are no major deviations, and only two pairs of countries exchange ranks (Spain and Slovenia, and Cyprus and Croatia) (see Figure 25). While the choice of scope does not seem to impact the relative positions of countries, it does impact the overall scale of scores assigned by our methodology, as both the top two and bottom two countries in overall score are EEA but not Eurozone members (Denmark, Sweden, Czechia, Poland).

Figure 25. Changes in scores depending on scope considered



Source: ASCOR (2026), authors calculations

Appendix C – Additional details on the biodiversity score

Table 10 shows the detailed breakdown of the contents of the biodiversity score, along with the weighting for each indicator. Table 11 provides further detail about the contents of the regulatory preparedness score, based on Wingard et al. (2026).

Table 10. Overview of the pillars, areas, and weightings used in the Biodiversity score

Pillar	Source component	Component weight	Underlying indicator / category	Internal weight
Pressure (33.3% of final score)	EPI direct activity-based environmental pressure performance – EPI, Ecosystem Vitality	50% of Pressure	Fisheries (FSH)	11.11%
			Forests (FOR)	22.22%
			Grasslands (GRS)	22.22%
			Air Pollution (APO)	22.22%
			Agriculture (AGR)	11.11%
			Water Resources (WRS)	11.11%
	JRC consumption-based footprint – Consumption Footprint	50% of Pressure	Climate change	21.06%
			Ozone depletion	6.31%
			Particulate matter	8.96%
			Ionising radiation	5.01%
			Photochemical ozone formation	4.78%
			Acidification	6.20%
			Terrestrial eutrophication	3.71%
			Freshwater eutrophication	2.80%
			Marine eutrophication	2.96%
			Freshwater ecotoxicity	1.92%
			Human toxicity, cancer	2.13%
			Human toxicity, non-cancer	1.84%
			Land use	7.94%
			Water use	8.51%

			Fossil resource use	8.32%
			Mineral and metal resource use	7.55%
State (33.3% of final score)	EPI biodiversity condition and ecological resilience – EPI, Biodiversity & Habitat	100% of State	Species Habitat Index (SHI)	14.29%
			Red List Index (RLI)	28.57%
			Biodiversity Habitat Index (BHI)	28.57%
			Bioclimatic Ecosystem Resilience Index (BER)	28.57%
Response (33.3% of final score)	WWF regulatory preparedness – Biodiversity Risk Filter, Regulatory Deficiency Risk	50% of Response	Application	15%
			Scoping	15%
			Rights, Access and Entitlements	5%
			Institutions and Governance	15%
			Management Instruments	30%
			Subnational Biodiversity Law	5%
			Offences and Penalties	15%
	EPI conservation and protection measures – EPI, Biodiversity & Habitat	50% of Response	Marine Habitat Protection (MHP)	16.13%
			Marine KBA Protection (MKP)	16.13%
			MPA Effectiveness (MPE)	3.23%
			Terrestrial Biome Protection (TBN)	12.90%
			Terrestrial KPA Protection (TKP)	12.90%
			Protected Area Representativeness Index (PAR)	12.90%
			Protected Area Connectedness Index (PAC)	12.90%

			Species Protection Index (SPI)	12.90%

Sources: Wingard et al. (2026), Wendling et al. (2026), and Pasqualino et al. (2025)

Table 11 Overview of sub-indicators in WWF regulatory preparedness index

Application	Status of National Biodiversity Strategies and Action Plans (NBSAP) Biodiversity Conservation Policy Statement in Law
Scoping	Definition of Biodiversity Definition of Wild Fauna Definition of Wild Flora Definition of Protected Areas Definition of Ecological Corridors and Networks Definition of Invasive Alien species Definition of a Threatened Species
Rights, Access and Entitlements	State's Duty to Protect and Conserve Biodiversity
Institutions and Governance	Biodiversity Management Authority Coordination among National Government Authorities Public Participation
Management Instruments	Monitoring of Biodiversity Data Compilation and Sharing – National Level Environmental Impact Assessments (EIA) and Strategic Environmental Assessments (SEA) Offset Requirements Protected Areas Protected Species Management
Subnational Biodiversity Law	Requirement to Meet National Standards Coordination Among Local and National Authorities
Offences and Penalties	Pollution Crimes Habitat Destruction Violation of invasive species prohibitions Violation of EIA requirements

Sources: Wingard et al. (2026), Wendling et al. (2026), and Pasqualino et al. (2025)

Sensitivity to weighting choices

Sensitivity to the weighting of PSR pillars

The equal weighting of *Pressure*, *State* and *Response* in the baseline specification provides a simple starting point, but it should not be interpreted as implying that the three dimensions necessarily contribute equally to nature-related transition exposure. Different applications of our framework could reasonably place greater emphasis on environmental pressures, existing ecological conditions, or policy responses.

This question is particularly relevant for the *State* pillar. Although the three pillars receive identical

weights in the baseline, *State* displays greater cross-country dispersion than either *Pressure* or *Response* in our sample (standard deviations of 0.274, 0.209 and 0.184 respectively). Equal weights therefore do not imply equal influence on cross-country differences in the final score. Moreover, the ecological State of a country reflects not only current policy but also inherited environmental conditions and past pressures, which may justify placing greater or lesser emphasis on it depending on the purpose of the assessment.

We therefore examine how country scores and rankings change as the weight assigned to *State* varies from 10% to 50%. To isolate this choice, the remaining weight is divided equally between *Pressure* and *Response* in every specification.

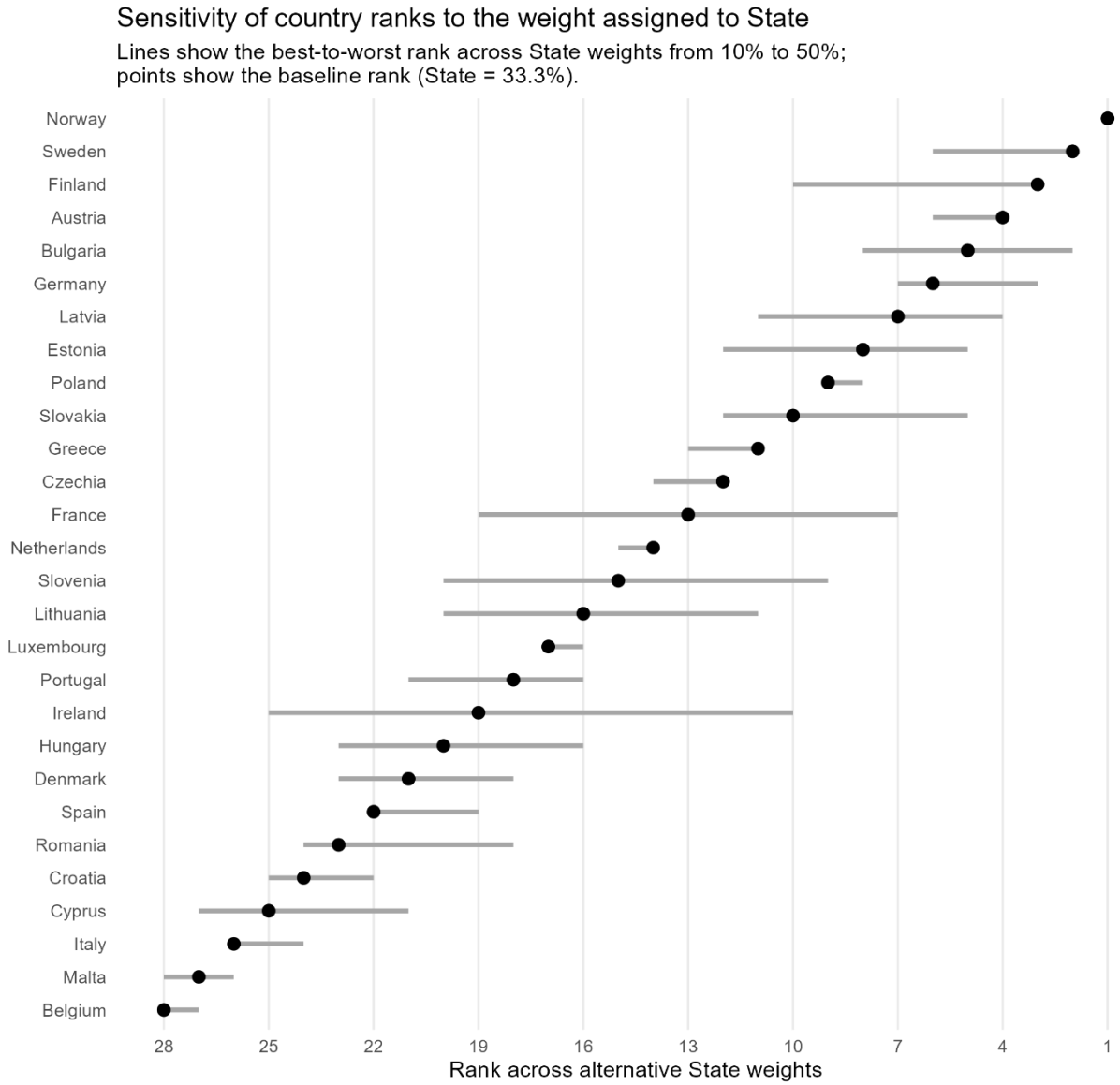
Table 12 shows that country rankings are meaningfully, although not uniformly, sensitive to the relative weight assigned to the State pillar. Moderate deviations from equal weighting leave the overall ordering largely intact: when State receives a 20% or 40% weight, Spearman rank correlations with the baseline remain 0.966 and 0.980 respectively. More pronounced departures generate larger changes. Assigning only 10% to State reduces the rank correlation to 0.904 and produces movements of up to seven positions, while a 50% State weight produces a rank correlation of 0.930 and a maximum movement of nine positions.

Table 12 Sensitivity of the Biodiversity Score to alternative weights given to the State pillar

State weight	Pressure weight	Response weight	Score correlation	Rank correlation	Mean abs. rank change	Max rank change
10.0%	45.0%	45.0%	0.887	0.904	2.93	7
16.7%	41.7%	41.7%	0.941	0.941	2.36	5
20.0%	40.0%	40.0%	0.963	0.966	1.79	5
33.3%	33.3%	33.3%	1.000	1.000	0.00	0
40.0%	30.0%	30.0%	0.992	0.980	1.00	4
50.0%	25.0%	25.0%	0.957	0.930	2.14	9

Figure 26 shows that the effects are concentrated among countries with asymmetric PSR profiles. Ireland, for example, moves from 25th when State receives a 10% weight to 10th when it receives 50%, because of its comparatively strong State but weaker Pressure performance. France moves in the opposite direction, from 7th to 19th, as its relatively stronger Pressure and Response performance receives less weight.

Figure 26 Sensitivity of the Biodiversity Score to alternative weights given to the State pillar



Sensitivity to the weighting of State indicators

The construction of the *State* pillar involves a greater degree of methodological discretion than the other source components. The pillar is constructed by extracting four indicators from the EPI Biodiversity and Habitat category (the Species Habitat Index, the Red List Index, the Biodiversity Habitat Index and the Bioclimatic Ecosystem Resilience Index) and rescaling their original EPI weights within a new standalone State measure. In the baseline specification, we preserve the relative EPI weights of these indicators: 1/7 for the Species Habitat Index and 2/7 for each of the other three indicators. These weights were, however, designed for the broader EPI Biodiversity and Habitat category rather than for a standalone measure of ecological State.

We therefore test an alternative specification assigning equal weight to each of the four State indicators (Table 13). This is relevant because *State* displays greater cross-country dispersion than either *Pressure* or *Response* in our sample. Consequently, despite the equal one-third weights assigned to the three PSR pillars, State can exert greater influence on differences in countries' overall Biodiversity Scores. Testing its internal weighting therefore provides an assessment of whether this relatively influential pillar is

being driven by the weights inherited by the EPI.

Table 13. Sensitivity of the Biodiversity Score to equal weighting of State indicators

Specification	State indicator weights (SHI / RLI / BHI / BER)	Correlation of State scores	Correlation of Biodiversity Scores	Rank correlation	Mean absolute rank change	Maximum rank change
Baseline	14.3% / 28.6% / 28.6% / 28.6%	-	-	-	-	-
Equal State weights	25% / 25% / 25% / 25%	0.983	0.993	0.991	0.71	3

The results are robust to the internal weighting of the State pillar. Equal weighting produces a correlation of 0.983 between the alternative and baseline *State* scores, and a correlation of 0.993 between the resulting overall Biodiversity Scores. The Spearman rank correlation is 0.991, with an average absolute movement of less than one rank and a maximum movement of three ranks. Austria records the largest change, moving from fourth to seventh, while Norway, Sweden and Finland remain the three highest-ranked countries. The relatively large dispersion of the State pillar does not make the overall ranking particularly dependent on the specific relative weights inherited from the EPI.

Sensitivity to the exclusion of climate-related information

In this report, we define nature in the broad sense adopted by IPBES, encompassing both the living and non-living components of the natural world and the interactions between them. Biodiversity is therefore a central element of nature, but not its only component; climate is also part of the wider natural system. From this perspective, climate change can exert pressure on biodiversity by altering habitats, ecosystem functioning and ecological resilience.

The baseline Biodiversity Score therefore retains some climate-related information. In particular, climate change is one of the 16 environmental impact categories included in the JRC Consumption Footprint, while the Bioclimatic Ecosystem Resilience Index (BER) included in the *State* pillar measures ecosystems' capacity to retain biodiversity under a changing climate.

Because the report also considers climate separately through the Climate Score, we nevertheless test how much these climate-related components influence the Biodiversity Score. We therefore consider three alternative specifications: excluding the JRC climate-change category, excluding BER from *State*, and excluding both simultaneously to construct a stricter non-climate specification.

Table 14. Sensitivity of the Biodiversity Score to the exclusion of climate-related information

Specification	Change relative to baseline	Pearson correlation	Spearman rank correlation	Mean absolute rank change	Maximum rank change
Baseline	Full JRC footprint; BER included	1.000	1.000	0.00	0
JRC non-climate	Exclude JRC climate-change category	0.999	0.997	0.29	2
State excluding BER	Exclude BER from State	0.965	0.953	1.79	7
Strict non-climate	Exclude JRC climate change and BER	0.967	0.957	1.71	7

Table 14 shows that the climate-related component of the JRC Consumption Footprint has very little influence on the Biodiversity Score. Removing it leaves both scores and rankings almost unchanged: the Pearson correlation with the baseline is 0.999, the Spearman rank correlation is 0.997, and no country moves by more than two positions.

The treatment of BER is more consequential. Excluding BER from the *State* pillar reduces the rank correlation with the baseline to 0.953 and produces movements of up to seven places. The combined strict non-climate specification produces very similar results, with a Pearson correlation of 0.967, a Spearman correlation of 0.957 and a maximum movement of seven positions. Most of the sensitivity to climate-related information arises therefore through BER rather than through the climate component of the JRC Consumption Footprint.

The strict non-climate specification nevertheless remains strongly correlated with the baseline overall, although the effects are material for some individual sovereigns. Greece, for example, falls from 11th to 18th, while Poland rises from 9th to 5th and Luxembourg from 17th to 13th. This means that the formulation adopted in the baseline does not fundamentally alter the cross-country ranking, but the inclusion of climate-related ecosystem resilience can affect the relative position of particular countries.

Sensitivity to missing JRC data for Norway

The JRC Consumption Footprint is available for EU Member States but not for Norway. Under the baseline methodology, missing information is handled through proportional reweighting of the available components within a pillar. Norway's *Pressure* score is based entirely on its EPI direct activity-based pressure component, rather than on the 50-50 combination of EPI and JRC information used for the other countries. Because Norway records the highest overall Biodiversity Score in the baseline specification, it is important to assess whether this position is sensitive to the unavailable JRC component.

We therefore recalculate Norway's score under a range of hypothetical normalised JRC values from 0 to 1, while leaving all other countries unchanged.

Table 15. Sensitivity of Norway's Biodiversity Score to alternative hypothetical JRC scores

Hypothetical JRC score	Norway Pressure score	Norway Biodiversity Score	Rank
0.00	0.371	0.688	3
0.25	0.496	0.730	1
0.50	0.621	0.771	1
0.75	0.746	0.813	1
1.00	0.871	0.855	1

Table 15 shows that Norway's first-place ranking depends to some extent on the missing JRC information, but its position near the top of the distribution is robust. Even under the most adverse hypothetical JRC score of zero, Norway falls only to third place. It remains first whenever its hypothetical normalised JRC score exceeds approximately 0.15. The missing JRC observation should therefore be kept in mind when interpreting Norway's precise position, but it does not explain its broader placement among the highest-scoring sovereigns.

Appendix D – Considerations on residual maturity

The findings presented in Section 4 of this report are based on an uncertainty score which contains only a sovereign issuer-specific component. Accordingly, for the purposes of this report, nature-related uncertainties associated with a sovereign bond depend solely on issuing country's profile and performance on climate- and biodiversity-related variables. This simplified specification allows us to isolate the effect of these dimensions on the climate and biodiversity factors applied to sovereign bonds, but it does not fully follow the methodology used by the ECB for non-financial corporate bonds and credit claims.

A methodology closer to the uncertainty score used in the climate factor for non-financial corporate bonds and credit claims would require two additional components: an asset-specific component based on residual maturity and a market-factor stressor. For non-financial corporations, the sector-level stressor reflected the increase in expected shortfall under an adverse scenario relative to a baseline scenario in the Eurosystem climate stress test. An equivalent component is less straightforward for sovereign bonds, since sovereign issuers cannot readily be assigned to a single economic sector. Although this Appendix does not go into detail about a sovereign stressor component, results from the last Eurosystem stress test could be used, such as projected changes in sovereign bond spreads, or weighting the sectoral expected shortfall by each country's sectoral composition.

Regarding residual maturity, this Appendix explores more deeply what a climate and biodiversity factor for sovereigns would look like when incorporating an asset-specific vulnerability in the uncertainty score.

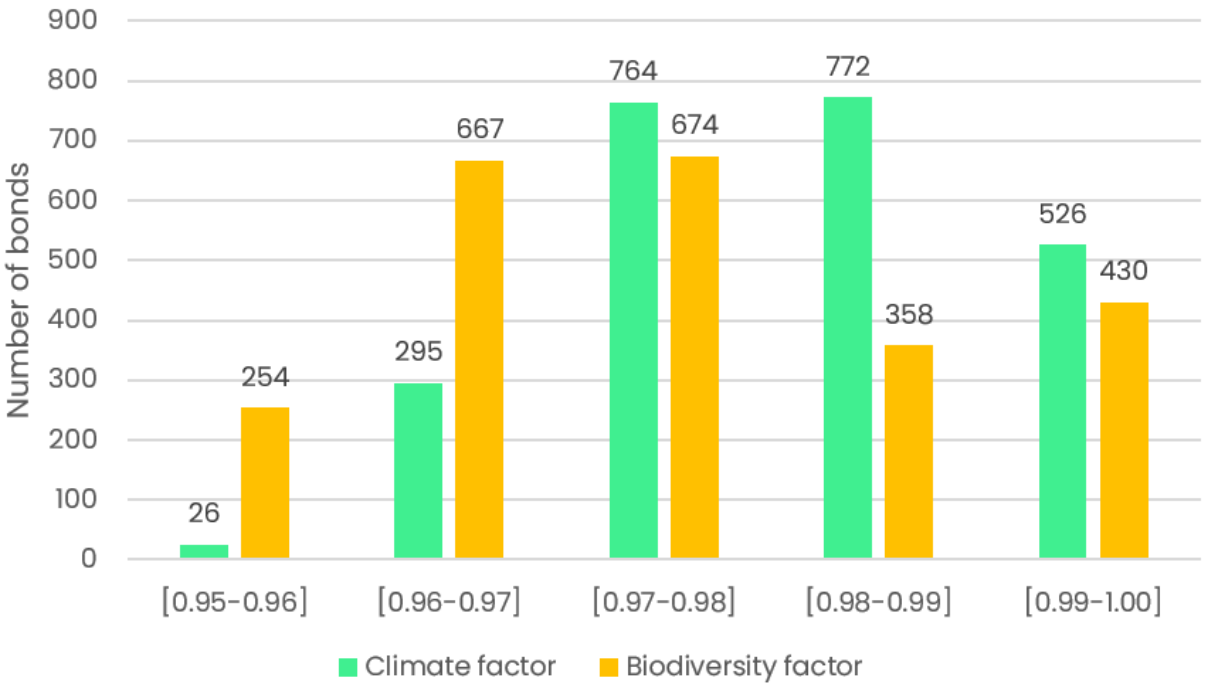
$$u_{i,j} = E_j \times V_i$$

Where:

- $u_{i,j}$ is the uncertainty score for asset i from issuer j.
- V_i is the square root of the bond's residual maturity.
- E_j is the complement of the climate or biodiversity score of a sovereign country j, that is, E = 1 - score; where *score* is the respective climate or biodiversity score of the country.t

As a result of considering residual maturity, the values for both climate and biodiversity factors become more distributed across different bands, reflecting the wider heterogeneity in uncertainty. This also means that the exponential decay formula used for transforming the uncertainty score into a factor does not result in a concentration of values but rather in a smoother distribution. The average biodiversity factor is lower than the climate factor, reflecting the somewhat worse performance of most countries on biodiversity according to the framework designed. See Figure 27 below.

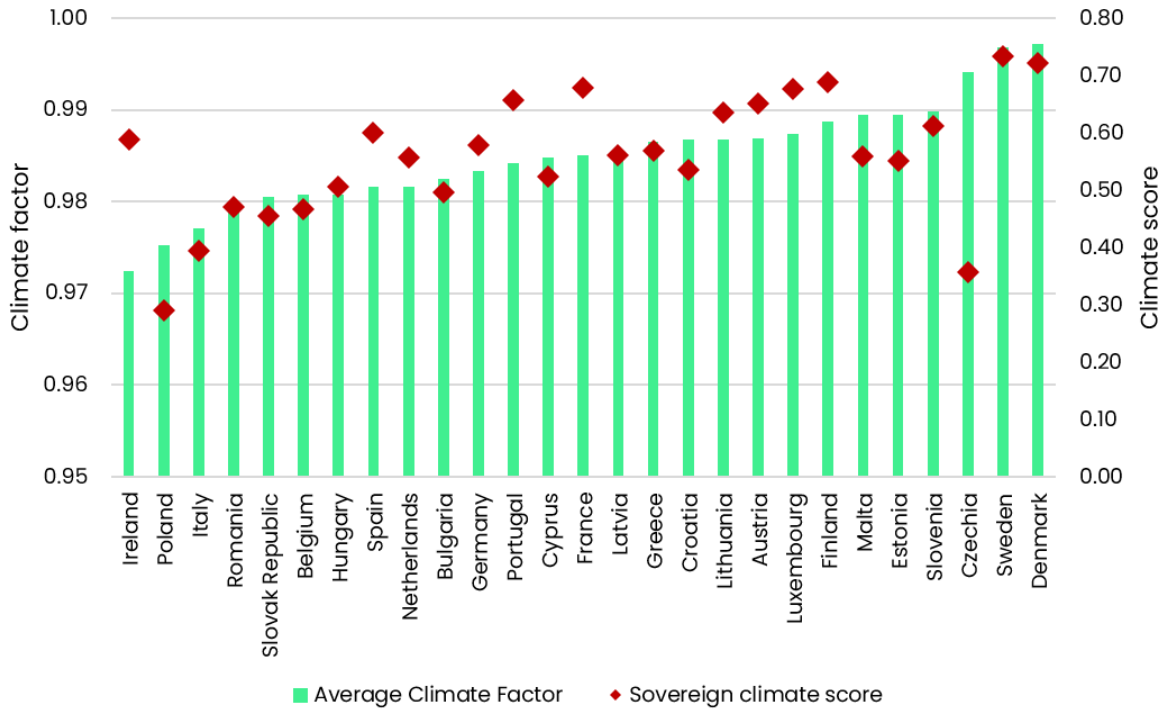
Figure 27. Distribution of climate and biodiversity factor values for eligible sovereign bonds, considering residual maturity and with floor parameter (a) set at 0.95



Source (2026): authors' elaboration based on ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025), WWF (Biodiversity Risk Filter), Yale Centre (Environmental Performance Index) and European Commission Joint Research Centre (EU Consumption Footprint).

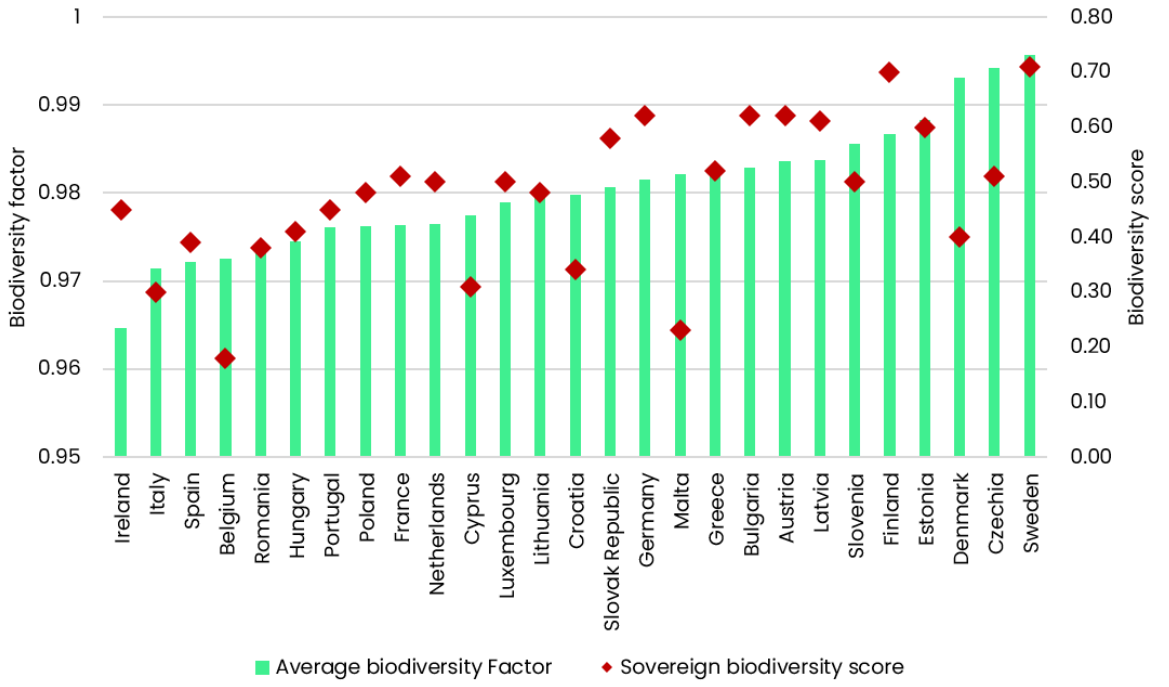
A potential caveat of including residual maturity in a climate or biodiversity factor for sovereign bonds is that differences in countries' maturity profiles may drive the resulting adjustments to collateral values more strongly than differences in their underlying climate or biodiversity scores. As shown in Figure 28, Ireland, whose eligible sovereign bonds in our sample have relatively long residual maturities, receives relatively low climate factors despite its above-average climate score. Conversely, Czechia's four eligible sovereign bonds have relatively short residual maturities, resulting in comparatively high climate factors despite the country's relatively weak climate performance. A similar divergence between the resulting factors and the underlying country scores can be seen when residual maturity is incorporated into the biodiversity factor (Figure 29).

Figure 28. Average climate factor and climate score for an uncertainty score including asset-specific vulnerability



Source (2026): authors' elaboration based on ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025)

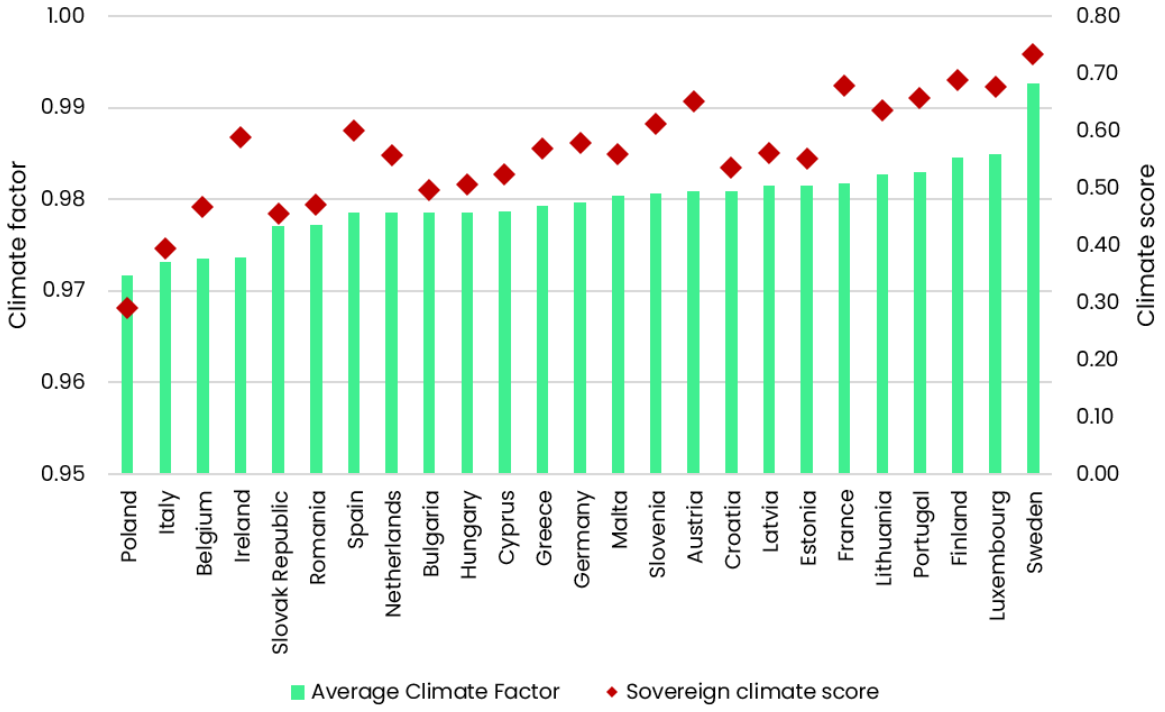
Figure 29. Average biodiversity factor and biodiversity score for an uncertainty score including asset-specific vulnerability



Source (2026): authors' elaboration based on ECB (list of eligible assets, 23 June 2026), WWF (Biodiversity Risk Filter), Yale Centre (Environmental Performance Index) and European Commission Joint Research Centre (EU Consumption Footprint).

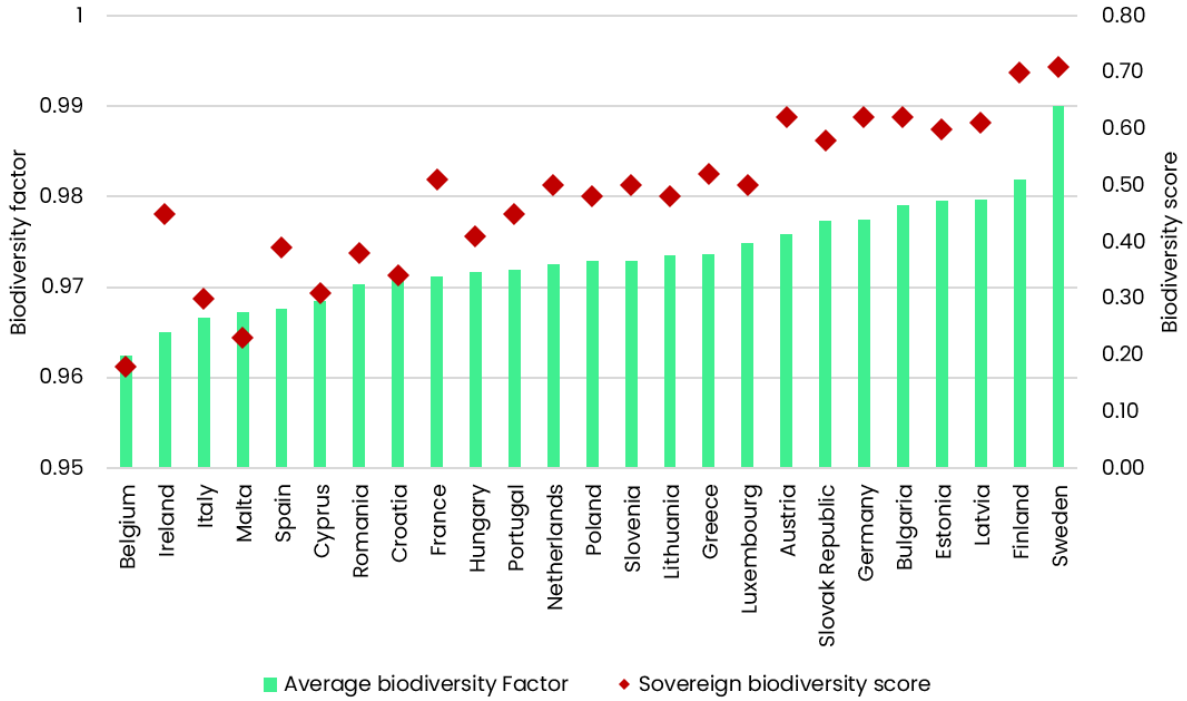
However, any divergence from climate or biodiversity scores, and their respective factors, appears to be driven largely by a small number of bonds with extreme residual maturities. When the analysis is restricted to bonds with residual maturities between 2 and 90 years, the resulting average adjustments are more closely aligned with the underlying climate and biodiversity scores. This restriction excludes Czechia, whose eligible sovereign bonds all have extremely short maturity profiles. Figure 30 and Figure 31 illustrate the resulting relationship for the climate and biodiversity factors, respectively.

Figure 30. Average climate factor and climate score (maturities between 2 and 90 years)



Source (2026): authors' elaboration based on ECB (list of eligible assets, 23 June 2026), TPI centre (ASCOR data, 2025)

Figure 31. Average biodiversity factor and biodiversity score (maturities between 2 and 90 years)



Source (2026): authors' elaboration based on ECB (list of eligible assets, 23 June 2026), WWF (Biodiversity Risk Filter), Yale Centre (Environmental Performance Index) and European Commission Joint Research Centre (EU Consumption Footprint).