

Climate Risk and Central Bank Operations: Evolving Good Practices and Innovative Approaches

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Abstract***

Central banks are increasingly incorporating climate-related considerations into their monetary operations as evidence grows that physical and transition risks can affect financial stability, monetary policy transmission and the value of assets held on central bank balance sheets. This article reviews recent developments in the greening of monetary policy and non-monetary policy portfolios, examining emerging practices across major central banks and drawing on discussions from the Banco de España conference Climate Risk and Sustainable Finance: Bridging Policy, Research and Practice. It analyses the evolution of climate-related tilting of asset purchase programmes, targeted refinancing operations and collateral frameworks, with particular attention to reforms introduced in the latter by the European Central Bank and the Bank of England. This article argues that monetary authorities are gradually moving beyond climate-aligned asset purchases towards the integration of climate considerations into collateral valuation and risk-management frameworks. It finds that further progress could be achieved by extending climate risk methodologies to additional asset classes, strengthening the coherence of existing policy tools, incorporating physical climate risks more systematically and beginning to address material nature-related risks. While important operational and methodological challenges remain, the experience of central banks suggests that climate- and nature-related financial risks can increasingly be incorporated into monetary operations in ways that are consistent with central bank mandates and established risk-management objectives.

Keywords: central banking, monetary operations, climate risk, collateral frameworks, asset purchases, refinancing operations, nature risk, climate factor, ECB, Bank of England.

1. INTRODUCTION

The concept and practice of monetary policy transmission is core to how central banks fulfil their price stability mandate, influencing interest rates and borrowing costs in the

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financial system and throughout the real economy. Monetary operations, including direct lending and repo operations¹ secured by collateral as well as asset purchase facilities, are central to how monetary policy is implemented in practice. These actions, which are governed by risk management frameworks, influence the availability of liquidity in the financial system and, in turn, the borrowing costs that transmit monetary policy to the real economy. Central banks' emergency measures in response to the Global Financial Crisis and the Covid-19 crisis demonstrated the efficacy of more elaborate central bank toolkits. This wider range of tested tools offers opportunities for central banks to contribute to reducing the likelihood of future crises, including those that could result from growing climate transition and physical risks.

As understanding and measurement of physical and transition risks improve, many central banks are considering how to more effectively incorporate climate risk into their monetary operations. In recent years, a number of central banks have introduced climate-related considerations into their balance sheets through risk-management tools that incorporate climate risks into their asset purchase programmes and collateral frameworks. The European Central Bank (ECB) and Bank of England, for example, have incorporated climate-related considerations into their monetary and non-monetary portfolios and integrated climate risks into collateral. Several major Asian central banks have initiated targeted lending operations that support lower-cost financing of the private sector to incentivise the greening of the real economy. In addition, the Bank for International Settlements established dedicated green bond funds to invest central bank reserves in green bonds.

One important aspect of central banks' operations is their collateral framework, which determines the eligibility and valuation of collateral. Accepting a wide range of assets lets central banks supply vital reserves to the banking system. Central banks value collateral below market price (applying a discount known as a "haircut") in their lending operations to financial counterparties in order to absorb sudden drops in asset value. The greater the risk, the higher the haircut. Given that growing evidence of climate risks suggests potential future market and credit losses on a wide range of collateral, central banks are making concerted efforts to understand and effectively assess current and future risks to valuations.

The Network for Greening the Financial System's 2023 membership survey on monetary policy and climate change noted that almost a third of responding central banks had implemented climate-related adjustments to their collateral framework, a majority of which were from the euro area (NGFS, 2023). In 2024, the Bank of England became the first major central bank to formally incorporate climate-related transition and physical risks into collateral haircuts (Bank of England, 2024). The ECB followed in 2025 by announcing a climate factor that adjusts the value of collateral to reflect transition risk (ECB, 2025b). While the climate factor was initially applied

¹ Liquidity-providing operations whereby the central bank buys assets, which serve as collateral, in exchange for cash. The assets are then repurchased at a later date.

to corporate bonds, which represent a small portion of eligible collateral, it was nevertheless an important step in signalling to markets that transition risk is material and can be identified and converted into risk metrics. In July 2026, the ECB decided to extend the application of climate factors to certain eligible non-financial corporate credit claims, further broadening the incorporation of climate-related transition risk into its collateral framework (ECB, 2026).

To reflect on central bank practices amid growing evidence of physical and transition risks, in 2026 the Banco de España hosted a conference in collaboration with the NGFS and the London School of Economics, including the Centre for Economic Transition Expertise (CETEx). The conference, titled “Climate Risk and Sustainable Finance: Bridging Policy, Research and Practice”, included a session on incorporating climate considerations into monetary operations with a focus on how asset purchase and emerging collateral policies incorporate climate risks.

This article will address approaches and developments with respect to the greening of monetary operations. The second section outlines the key issues raised by practitioners in the market operations session of the Banco de España conference. The third section elaborates on the recent ECB and Bank of England announcements to more thoroughly embed climate risks in their collateral policies, methodological considerations assessed by CETEx in a recent publication and examples of climate-related practices adopted by other central banks. The fourth section discusses opportunities to further embed climate risks in monetary operations.

2. EMBEDDING CLIMATE INTO MONETARY OPERATIONS — INSIGHTS FROM THE BANCO DE ESPAÑA CONFERENCE²

The Banco de España’s panel on greening central banks’ portfolios, held as a session within its conference on bridging policy, research and practice of climate risks, included speakers from the Bank of England, the ECB, and Banco de España, and was moderated by LSE CETEx.³

In this session, panelists reflected on how central banks are moving from broad climate commitments to practical changes in central bank operations, including their monetary and own funds as well as their collateral frameworks. They emphasized that implementation must be firmly grounded in central banks’ mandates, and that when climate and nature-related risks affect balance sheets, market functioning, monetary policy transmission and price stability, taking action lies within these mandates. Panelists also highlighted the importance of

² Session 3: Greening central banks’ portfolios. Recording of conference session at Climate risk and sustainable finance: bridging policy, research, and practice, Madrid, 25 March. <https://www.youtube.com/watch?v=TUqCg6AjZAs>

³ James Talbot (Executive Director of the International Directorate, Bank of England; Chair, NGFS Workstream Monetary Policy); Irene Heemskerk (Head of Climate Change Centre, ECB); Juan Ayuso (Director General Operations, Markets and Payment Systems, Banco de España); and Robert Patalano (Professor in Practice, Executive Director, LSE Centre for Economic Transition Expertise — CETEx) moderated the session.

institutional credibility and transparency, and they stressed the need to avoid overly mechanical approaches that penalise credible transition activity, especially where high-emitting firms or public sector issuers are actively trying to move towards lower-carbon pathways.

Key issues emerging from the discussion

First, *articulation of mandate and purpose*. Discussants agreed that central banks need to explain why they are acting, whether for balance-sheet risk management, financial stability, or public-sector leadership to create a conducive environment to accelerate the transition. Communicating the extent to which policy decisions involving climate fall under the primary or secondary mandate helps counterparties and markets understand the context. Regarding monetary operations, this communication should reflect on how the central bank is responding to climate risks that markets may not fully price, while remaining sufficiently aligned with the operating principle of market neutrality.

Second, *central bank operations have undergone an operational shift across both monetary and non-monetary policy portfolios*. As the size of asset-purchase portfolios has declined amid the gradual normalisation of monetary policy, their role in either risk management or the need to incorporate climate risk into portfolio management has become less relevant. Attention is moving towards collateral frameworks and how to embed climate factors in collateral valuations. In addition, central banks are exploring sustainable investment approaches for their non-monetary policy holdings, such as their own funds and foreign reserves portfolios. And, in some jurisdictions, liability-side instruments, such as tiered reserve requirements or climate-differentiated remuneration on bank reserves, are being considered.⁴

- The Bank of England's current focus is on incorporating climate risk into its collateral framework. Since a large share of its collateral is made up of residential mortgage pools, the Bank has incorporated physical and transition risks into haircuts, using scenario analysis for flood risk, subsidence risk and energy-price shocks. It has also restricted eligibility of mortgages non-compliant with energy efficiency standards. The BoE discussant suggested the distinction was between risk management and transition incentives: both are possible, but they require different justification and different tolerance for balance-sheet risk. The large degree of heterogeneity across central banks, not only in terms of mandates but also monetary policy operating frameworks and institutional starting points, will shape how different approaches can be applied across jurisdictions.

4 See NGFS (2026). It notes several types of greening of liabilities, including green reserve requirements, issuing green short-term debt securities (monetary bills) and/or certificates of deposits, and offering central bank accounts to NBFIs involved in sustainable/climate projects. The central banks of Lebanon, Philippines and Indonesia offer concrete examples of green liability policies.

- The ECB discussant traced the ECB's approach back to the 2021 monetary policy strategy review, which recognised climate change as relevant to the ECB's mandate and supported a climate roadmap covering modelling, data, operations and transparency. She explained that the ECB's corporate bond tilting was primarily designed to reduce climate risk exposure, but also contributed, within the primacy of price stability, to wider EU climate objectives.
- The Banco de España discussant highlighted that for non-monetary policy portfolios, sustainable and responsible investment was added as a new investment principle in 2019, alongside efficiency, professionalism, market neutrality and prudence. A dedicated portfolio was made up of green investment funds and direct holdings in green, social and sustainability-related bonds. He highlighted that central banks may not be large enough to move markets through purchases alone but can lead by example through transparent and prudent practice.

Third, *data gaps and methodological challenges*. Discussants agreed that data gaps remain a major obstacle to advancing policies to incorporate climate risk. Key gaps that impede progress include Scope 3 emissions and forward-looking transition metrics, and data gaps regarding climate information with respect to covered bonds and public sector securities.

- The Banco de España discussant highlighted double counting, data lags and the lack of forward-looking public sector transition metrics as unresolved barriers, while arguing that imperfect data should not become an excuse for inaction.
- The ECB discussant suggested to start with what is actionable, rather than focusing on where data and methodologies are missing. Beginning with small, manageable steps can be effective, allowing for gradual improvement through an iterative process. In this way, it is possible to start with available data and test what works, while taking care to avoid instruments that are too blunt. She also noted the potential for spillover effects between initiatives. For example, introducing climate disclosures enabled the ECB to collect insights later used for portfolio tilting. Similarly, the climate factor in the ECB's collateral framework incorporates insights gained from the outcomes of its climate stress testing.

Fourth, *strengthening the enabling environment for transition finance to help scale up clean energy and reduce climate risks over time*. In this respect, taxonomies and collateral rules must be attuned to the credibility of transition plans, not just current emissions intensity metrics.

Central banks have started to incorporate climate-related risks into their monetary operations and are currently widening their approaches. Greening central bank portfolios is no longer only about tilting corporate asset purchases and disclosures. It increasingly concerns collateral policy, taking action to address data challenges, determining appropriate transition metrics and moving beyond corporate bond portfolios to other asset classes. Nature-related topics, too, represent new and important considerations.

To overcome associated challenges, the discussants highlighted the importance of peer learning. Collective analysis and case study development through the NGFS, ongoing Eurosystem cooperation, and common disclosure practices were presented as essential mechanisms for spreading knowledge and good practice. In particular, a highlighted strength of the NGFS has been its emphasis on sharing experiences and practical examples rather than advocating one-size-fits-all solutions

The next phase will depend on better data, iterative processes, more credible forward-looking methods and continued international cooperation. The panel's practical conclusion was clear: central banks already have scope to act and should focus on doing what is feasible and consistent with their mandates.

3. DEVELOPMENTS IN FACTORING CLIMATE RISKS INTO MONETARY OPERATIONS PRACTICES

Over the past decade, central banks have made notable progress in developing and implementing approaches to factor climate risks into monetary operations. These approaches primarily rely on forms of asset purchase facilities, climate-related refinancing or targeted lending operations; and, through the incorporation of climate risks into central banks' collateral valuation practices. While the asset purchase facilities were very active at major central banks during periods of extraordinary monetary policies following crises (e.g. Global Financial Crisis, Covid Crisis), more recently the collateral approaches are being contemplated and utilized by several central banks during normal monetary conditions.

3.1. Greening of asset purchase programmes

Asset purchase programmes are central bank programmes that serve to purchase market securities, such as sovereign or other public sector bonds, corporate bonds, covered bonds, or asset backed securities, to provide liquidity that reduces stress and improves the efficacy of monetary policy transmission across markets. In this regard, the asset purchasing signals higher asset demand and helps lower the yield on eligible assets, which facilitates positive market conditions even for similar securities that are not eligible for purchase.⁵ Benefitting from a growing body of research on climate risks, certain central banks sought to apply climate-risk analytical tools to help rebalance asset-purchase portfolios and tilt towards assets that have lower climate-related physical and transition risks.

The Bank of England's climate methodology for its £20bn Corporate Bond Purchase Scheme (CBPS), introduced in 2021, used a climate scorecard to tilt reinvestments toward greener

⁵ A number of research papers have reviewed the efficacy of central bank asset purchase programmes, with generally positive results in terms of lowering yields and risk premia. See Andrade et al. (2016).

issuers within sectors. This enabled the Bank to reduce exposure to climate transition risks and incentivise the transition to net zero while also maintaining market neutrality. The Bank also set a portfolio-level target to reach net zero by 2050 and excluded purchases of corporates that mine thermal coal. The extent to which purchases were tilted depended upon the strength of corporates' climate performance, assessed against four metrics: their emission intensity; progress in reducing emissions; having published a climate disclosure; and having a verified emissions reduction target (Bank of England, 2021).

The ECB incorporated climate risk methodologies to help tilt its purchases of corporate sector securities within two of its asset purchase portfolios, the Corporate Sector Purchase Programme and the Pandemic Emergency Purchase Programme (ECB, 2022). The ECB employed a multi-pronged methodology composed of backward-looking metrics assessing company emissions, forward-looking metrics of companies' future emissions; and the robustness of climate disclosures. With these measures, the Eurosystem sought to mitigate climate-related financial risks and, without prejudice to the mandate of price stability, gradually decarbonise its corporate bond holdings to improve the weighted average climate score of the holdings over time, thereby aligning the portfolio with the goals of the Paris Agreement (ECB, 2025). In doing so, it also sought to support the green transition of the economy in line with the EU's climate neutrality objectives.

Overall, the greening of central bank portfolios in this manner has three benefits: (i) during the announcement and asset purchasing phase, it shifts the demand and therefore cost of capital to modestly benefit securities with relatively lower transition or physical risk; (ii) during the wind-down, it maintains the positive tilt toward assets with lower climate risk; and (iii) after the wind-down, aspects of the methodologies may continue to be utilised by market participants.⁶

Assessments of the efficacy of climate-aligned asset purchase programmes indicate, to varying degrees, that they contribute to decarbonisation. The ECB's assessment of the decarbonisation in its own climate-aligned asset purchase programmes is that it contributed to about 25% of decarbonisation of the corporate portfolios from 2021-2024, and corporate holdings remain on track to meet their interim decarbonisation targets based on carbon-intensity metrics (ECB, 2025). There is evidence that the ECB's asset purchase programmes contributed to significantly improving financing conditions for eligible green bonds, thereby increasing the attractiveness of these instruments to issuers and of the euro area as a location of issuance (Bremus et al., 2021). However, due to the limited size of ECB holdings relative to the broader corporate debt outstanding and the relatively short time frame, there is little evidence that this

⁶ Anecdotally, the author received feedback from London-based market participants that the benefits of the Bank of England's climate scoring include better educating market participants of ways to utilise quantitative methodologies to assess climate risk in portfolios in a systematic manner.

alone had a material impact on accelerating decarbonisation. Nevertheless, the combination of these and numerous other central banking, supervisory, and EU green spending programmes is widely credited with the acceleration of financial and corporate sector decarbonisation in the European Union.

3.2. Climate-related refinancing operations

Several central banks have engaged in direct climate-related refinancing or direct lending operations to channel financing to entities that are decarbonising. Unlike asset-purchase programmes that buy securities on the secondary market, these operations are intended to refinance central bank counterparties, such as commercial banks, on preferential terms that incentivise them to extend lower-cost lending to customers that are demonstrating reductions in their emissions.

The Bank of Japan (BOJ) supports green refinancing through its Climate Response Financing Operations, providing low- or zero-interest funds to financial institutions that invest in or lend to projects and firms demonstrating a sufficient level of transitioning to lower their net emissions. For example, the BOJ provides one-year, zero-interest funds to commercial banks matching the volume of their internal green or transition financing lending (Bank of Japan, 2025). One of the eligibility criteria for counterparties is that they disclose particular information about their efforts to address climate change and about the green and sustainability-linked loans, bonds, and transition finance they provide to customers or issue to markets. The outstanding climate-related preferential lending under this program reached roughly US\$155 billion in July (Bank of Japan, 2026) which is more than 30% of BOJ lending to counterparties in 2026.⁷

The People's Bank of China (PBOC) also conducts green lending to counterparties, in a similar manner yet with distinct operational features, to encourage decarbonisation of the real economy. In 2021, the PBOC launched a Carbon Emission Reduction Facility, which provides to banks, at a lending rate of 1.75%, 60% of the principal of qualifying loans for clean energy, energy conservation, and carbon reduction activities (Caswell, 2021). At the same time, financial institutions that received the low-cost funds from the PBOC were required to disclose information about the outstanding balance and interest rates of carbon emission reduction loans as well as their effects on carbon emission reduction, and to be subject to verification by independent third-party agencies (Yi, 2023). By mid-2023, over \$120bn had been disbursed to carbon reduction projects under the programme, according to the disclosures of 21 major banks in China, driving the reduction of an estimated 215 million tonnes of CO₂ (Green Central Banking, 2024). Given its usage and impact, PBOC extended the programme through 2027.

⁷ Authors' calculations from data on the Bank of Japan Accounts, July 31, 2026.

Overall, the purpose of central bank green lending schemes is to help accelerate decarbonisation through incentives, and in turn to foster a conducive macrofinancial environment over the medium-term by making financial systems and the real economy more resilient to climate. Notwithstanding progress, central banks face a number of operational challenges, including technical expertise, data availability, selection criteria, counterparty practices, etc.

The research on efficacy toward these objectives is mixed. Some research suggests measurable impact on lending volumes, and correlation with reduction in emissions; however, there is some evidence that this is accompanied by higher Non-Performing Loans (NPLs) and weaker bank profitability (Wang et al., 2026). It is not clear, however, whether this relates to green investments, as greater lending volumes and looser lending standards are typically associated with subsequent higher NPLs.⁸ Climate-aligned lending facilities are not without criticism, including concern over the extent to which counterparties pass on the rate benefits, and over inadequate disclosure. Nevertheless, these programmes have provided clear evidence that — within their mandates — central banks can provide incentives via advantageous cost-of-capital for counterparties and their borrowers to decarbonise. Looking ahead, there is room for greater application across central banks, and room for improvement in terms of standards of implementation. Doing so within a broader integrated strategy for greening monetary policy and operations would more effectively contribute to shaping financial sector and real economic incentives to accelerate decarbonisation.

3.3. Including climate risks in collateral frameworks

The consideration of embedding climate risk in central bank collateral frameworks gained acceptance over the last decade. This shift in mindset was aided by assessments that such measures could contribute meaningfully within central bank toolkits to help green the financial system, either based on sound risk management or environmental considerations (Grantham Research Institute, 2022). In its 2022 membership survey, the NGFS found that almost a third (mostly from euro area) of responding central banks had taken some steps to introduce climate considerations in their collateral frameworks, including adjustments to haircuts for green assets, as well as limiting eligibility of carbon-intensive collateral (NGFS, 2023). Yet, genuine progress has been gradual due in part to operational challenges including data gaps and measurement challenges. Since then, three central banks have made substantial changes to their collateral policies to measure climate transition risks and adjust haircuts accordingly.

⁸ See Foos et al. (2009). Based on an assessment of 16 countries, it suggests that bank loan growth leads to an increase in loan loss provisions during the subsequent three years, to a decrease in relative interest income, and to lower capital ratios.

Hungary

Hungary's central bank, the Magyar Nemzeti Bank (MNB), issued an innovative sustainability-aligned monetary policy toolkit in 2021, in which it noted that greening of collateral management would be one important step to help encourage sustainability markets. It highlighted that the introduction of a green haircut could effectively contribute to the development of a sustainable bond market through the preferential treatment of green securities (MNB, 2021). As such, in 2021 the MNB introduced a 20 percent discount on green securities' haircuts, with a maximum value of 5 percentage points. To further develop the domestic green securities market, the use of preferential haircuts for green securities has been made conditional on the fulfilment of transparency conditions, and the central bank subsequently introduced preferential haircuts for non-green assets if the issuer publishes relevant climate reports (MNB, 2024). In addition to these collateral measures, the MNB also launched a Green Mortgage Bond Purchase Programme (MNB, 2026a) and a preferential refinancing programme for green homes (ended in 2022) (MNB, 2026b). It also introduced preferential capital requirements for loans financing the construction or renovation of energy-efficient housing. Similar capital requirement discounts are available for qualifying green corporate and municipal loans and bonds (MNB, 206c). These measures show MNB's efforts to promote green financing within its jurisdiction.

European Central Bank

The ECB's consideration of climate risk in its collateral framework evolved substantially. Initially, the central bank considered concentration limits on collateral pools for securities issued by companies exposed to high levels of transition risk (ECB, 2022). However, in 2025 the ECB's Governing Council decided to introduce a climate factor instead, implemented in June 2026, which reduces the value assigned to eligible assets pledged as collateral, depending on the extent to which an asset can be impacted by transition risks (ECB, 2025b). The climate factor applies to individual assets, and its calibration is based on three components: sector-level data on non-financial corporations from the Eurosystem's climate stress test, the issuer's climate score, and the asset's residual maturity (ECB, 2025b). The maximum additional reduction in the final collateral value will be 5% (ECB, 2026).

While this announcement was important to demonstrate the central bank's commitment to sound risk management and to protect the balance sheet against transition risks in the corporate sector, the application of this measure initially focused on collateral issued by non-financial corporations, representing a limited subset of the broader collateral universe.

In July 2026, the ECB announced an extension of this climate factor to non-financial corporate credit claims (non-marketable debt instruments such as bank loans) by end-2027

(ECB, 2026). This announcement was important, both for risk management and as a signal to markets, as it has the potential to affect up to nearly 30% of used collateral at the ECB.

Bank of England

In June 2026, the Bank of England similarly announced that it would update, starting in October 2026, its corporate bond collateral framework to account for climate-related risks. The Bank's new criteria include: (i) bonds issued by companies active in thermal coal mining would no longer be eligible collateral, in line with its previous approach to its Corporate Bond Purchase Scheme; and (ii) new corporate bond haircuts in sectors exposed to risks from the transition to a green economy (Bank of England, 2026a). This adds to the Bank's existing practice of mitigating physical and transition risks to residential mortgage collateral, which represented 60% of all pledged collateral in 2025 (Bank of England, 2026b). In particular, the Bank chose to exclude mortgages, which represent the majority of pledged collateral, that were not compliant with the minimum energy efficiency standards, and to adjust mortgage haircuts based on their energy efficiency label and exposure to flood and subsidence-related risks. According to CETEx calculations, nearly two-thirds of the Bank of England's collateral holdings are now subject to climate-related collateral rules (Serrano, 2026).

A comparison of these approaches offers a range of tools for central bank collateral management:

- Incentives such as a reduction of haircuts on green bonds, based on the premise that green bonds reduce the climate transition risks associated with standard bonds. This approach provides a direct benefit, thereby financially incentivizing markets and entities to issue green or otherwise sustainability-linked bonds.
- Direct disincentives to issuers with higher transition risk, by increasing collateral haircuts, which indirectly raises the cost of financing for the affected issuers.
- Stronger disincentives to issuers, by excluding their collateral from being pledged in central bank operations. This affects the cost of capital and the liquidity of excluded issuers.

These factors, in combination with other measures to embed transition risk into asset purchase schemes, have the potential to shift cost of financing and liquidity over time, to provide material incentives to transition leaders and disincentives to laggards. In this manner, they should materially influence the funding practices of financial institutions as counterparties to central banking operations. As none of the major central banks provide combined climate transition disincentives and incentives in their collateral policies, there is room for improvement to strengthen risk management of transition risks, and to better align central bank policies with transition objectives where doing so is within their primary or secondary mandates.

4. FURTHER CONSIDERATIONS — BUILDING ON GOOD PRACTICES AND ADVANCING NEW PRACTICES

Insights from the Banco de España panel discussion and our review of areas of progress on embedding climate practices into monetary operations suggest that — notwithstanding welcome developments to implement emerging green practices — much more progress can be made. While such progress would need to assess and overcome operational and reputational risks, primary mandates offer ample room for considerably more incorporation of a range of green operations.

An NGFS review of these policy operations provided a comparative assessment of options to green credit operations, asset purchases and collateral frameworks (NGFS, 2021). Based on survey and judgement, the assessment illustrated that its members considered each of the approaches to have a positive to strongly positive impact on climate change mitigation, and generally a minimal to positive effect on risk mitigation. However, at the time, some questions were raised over the impact on monetary policy efficacy, and complexities with respect to the operational feasibility of haircut adjustments, tilting, and aligning collateral pools frameworks (NGFS, 2021). Several of these challenges, such as those related to expertise and data gaps, are being overcome, while others are more reflective of structural operational constraints, and would benefit from additional analysis.

Advancements can come in the forms of: (i) strengthening good practices — including incentives and disincentives — across asset purchase schemes and collateral frameworks; (ii) extending the application of the climate risk input to haircuts of additional asset classes; (iii) capturing physical risks; and, (iv) including nature degradation, which is already acknowledged to have the potential to erode asset valuations under adverse circumstances.

4.1. Strengthening good practices

The good practices outlined across five institutions in this article — ECB, BoE, MNB, BOJ and PBOC— highlight a wealth of operationalised initiatives to better embed climate transition risks into central bank operations. Yet not one of them incorporates all the good practices. This is not because the practices are conflicting; rather, they could be seen to be more coherent and mutually reinforcing. The calibration of haircut reductions for green bonds and loans, haircut increases for higher transition risk, portfolio tilting and exclusion, and targeted lower-cost lending could all be achieved through a common risk management framework. Adverse effects of stricter eligibility criteria and higher haircuts on liquidity and monetary policy transmission could be counterbalanced by parallel haircut discounts and eligibility status for green securities.

Asian central banks appear to have made the most progress in greening their credit operations. In addition to PBOC and BOJ, central banks of India, Malaysia, and Bangladesh have also made considerable progress in implementing various forms of green lending operations. Yet, the ECB, BoE and the Federal Reserve have not done so, even though certain members of the ECB Executive Committee have signalled that green targeted lending operations could be an instrument worth considering (Schnabel, 2023). As the Federal Reserve overcame operational challenges to utilise a wide array of direct credit operations during the Covid crisis (Milstein and Wessel, 2024) (including direct lending to SMEs, non-profits, and state and local governments), equally such operations could be employed during a climate crisis, such as a severe weather event or disorderly climate transition that creates acute liquidity and credit stress and inhibits monetary policy transmission. This would be well within the Federal Reserve's mandate.⁹

If major central banks in advanced and emerging markets were to incorporate transition risks in their collateral frameworks, asset purchasing and targeted refinancing practices, this would send a strong signal to the corporate sector across industries that there would be financial reward for increasing transition ambition and accelerating decarbonisation, while laggards would face measurably higher costs of capital. Such costs, as well as the growing cost differential between fossil fuels and renewable energy, would in turn raise questions of corporate competitiveness, strategy and leadership.¹⁰ These incentives and disincentives would help shape the growing use of sectoral transition plans and financing plans — such as those being developed in the UK through the Net Zero Council— to help bridge the gap between NDCs and corporate transition plans.

4.2. Extending methodologies to additional asset classes

With the extension of the climate factor to credit claims, the ECB has recognised that the risk-based logic underpinning the factor is not limited to corporate bonds. The Bank of England's haircut adjustments for mortgages similarly show how this asset class is vulnerable to transition and physical risks. But the remainder of the collateral pool of both central banks, comprising sovereign bonds, covered bonds and asset-backed securities, is similarly exposed to climate-related financial risks. These three asset classes account for 60% of the total collateral pledged to the Eurosystem in recent periods. Therefore, the natural next step would be to extend existing measures such as the climate factor across these classes to gain comprehensive climate risk coverage (Serrano et al., 2026).

⁹ The Federal Reserve's dual mandate includes maximum employment and price stability. Note that the Federal Reserve's Financial Stability Report, 2020, highlighted that climate change poses various risks to the stability of the US financial system. See Federal Reserve, "Financial Stability Report", 2020, which can threaten price stability.

¹⁰ For example, see Klein et al. (2026). The authors note that stronger alignment between capital expenditure and climate objectives, alongside lower financing costs, is associated with more credible transition strategies.

For the ECB, this requires adapting the climate factor's methodology to the specific features of each asset class. Some components, such as the asset-specific residual maturity of the climate factor, may be easily translatable across different asset classes. Issuer and sector-specific components may require deeper rethinking in each case.

Asset-backed securities, mainly composed of mortgages and vehicle loans, could rely on a pool-level component measuring the exposure of underlying loans to transition-related energy shocks. This exposure could be assessed from data such as energy performance certificates (EPC) or emissions of vehicles. Although data coverage may be patchy and uneven across Eurosystem countries, interim solutions could look at estimating missing energy efficiency data from available information such as property or vehicle characteristics.

Covered bank bonds would need a component assessing the exposure of the issuing bank to climate-related financial risks. Relevant data may be obtained from existing supervisory assessments, which could then be analysed through the many emerging frameworks that are used in financial markets to analyse banks' financed emissions, transition targets and climate governance.¹¹ Underlying mortgages in the cover pool could follow the treatment suggested for ABS, building on good transparency practices such as the European Covered Bond Council (ECBC)'s Harmonised Transparency Template (HTT), which offers a well-established framework for incorporating GHG emissions, EPC (Energy Performance Certificates) and other climate-related metrics for the underlying mortgage assets. Public exposures in the cover pool, on the other hand, may prove more challenging to include.

Sovereign bonds are a more sensitive case, due to the effects that adjustments could have on the country's borrowing capacity or in the perceived impartiality of the central bank. In addition, climate performance is largely driven by fiscal, regulatory and structural policies, suggesting that fiscal should remain the key instrument for achieving decarbonisation objectives. Where central banks choose to support these objectives, preferential treatment for strong climate performers and green sovereign bonds may prove more feasible than penalties for laggards, drawing on transparent and open-access assessments of countries' emissions trends, targets and policy frameworks, through existing market-based methodologies such as ASCOR.¹²

A careful calibration must be done to preserve risk equivalence across different asset types. A phased approach, beginning with the components where data is strongest and within an architecture designed to absorb later improvements, would allow central banks to act without waiting for full data harmonisation, an approach the NGFS has also identified as a priority for widening the scope of asset-side measures. The ECB's extension of the climate factor to

11 See Net Zero Banking Assessment Framework (NZBAF) and Carbon Performance, TPI Centre.

12 See Assessing Sovereign Climate-related Opportunities and Risks (ASCOR), TPI Centre.

credit claims provides a practical example of this approach, relying on available sector-level information where granular data remains limited.

4.3. Capturing physical risks

Many central banks have started addressing climate-related risks by focusing on the uncertainties of the low-carbon transition. However, transition risk represents only one dimension of climate change. Global warming also generates physical risks through acute natural hazards and chronic shifts in weather patterns, which can damage firms' operations and their capacity to sustain their debt obligations. Floods, wildfires and droughts can also erode the value of collateral, particularly in the case of mortgages and mortgage-backed securities. These effects can create material risks for both the financial system and central bank balance sheets. It is recognised that acute and chronic physical hazards are increasing in frequency and intensity, and that their effects may turn catastrophic beyond geophysical thresholds known as "tipping points" (Broeders and Mongelli, 2026). Excluding physical risks from central bank frameworks may therefore leave a significant gap in climate-related risk coverage.

The Bank of England's approach has shown feasibility in incorporating physical risk into the valuation of collateral, given the predominance of mortgages in posted collateral. Physical risk, in the form of flood and subsidence risk, is calibrated into the haircut adjustments of eligible mortgages using scenario analysis (Bank of England, 2026b). Other central banks can follow this example and model physical risks in their stress test scenarios to assess the vulnerability of collateral. Since the timing and intensity of physical hazards is highly difficult to predict, forward-looking scenarios may rely on a precautionary approach, assuming high tail risks.

Physical risk also raises equity questions that transition risk does not. Exposure may concentrate geographically, often falling on lower-income households and on regions that have contributed least to climate change. Adjusting collateral values on the basis of location could raise the cost of borrowing precisely where adaptation investment is most needed. Fiscal policies can guarantee fairness by redistribution mechanisms, but this type of support lies outside the scope of central banks and may only be achieved with coordinated action with governments (Claeys et al., 2024).

4.4. Including material risks to asset valuations from nature degradation

Central banks increasingly acknowledge the macroeconomic and financial sector impacts of nature-related risks and are striving to better incorporate them into their frameworks. In an ECB-CETEx joint conference in 2026 focused on Climate, Nature and Monetary Policy, President Christine Lagarde highlighted that last year's ECB strategy assessment was a commitment not

only to incorporating climate change considerations systematically into its monetary policy and central banking, but also to extend that commitment to nature (Lagarde, 2026).

Nature degradation is closely interconnected with climate-related risks, with both reinforcing one another through feedback loops. For instance, rising temperatures allow pests and invasive species to survive and spread, degrading the forests and agricultural systems that both sequester carbon and form a natural buffer against extreme weather events (Almeida et al., 2025). Biodiversity and ecosystem services underpin a wide range of economic activities, many of which, such as agriculture and food production, are highly dependent on natural systems. Nature is also inherently multidimensional. Early work in the euro area has concentrated on one of those dimensions: water. It finds that water-related risks are highly material for the euro area economy, with surface water scarcity alone estimated to place up to 15% of the Eurozone's economic output at risk (Elderson, 2025).

Translating this risk into monetary policy frameworks is perceived to be harder than it is for climate (Serrano et al., 2026). There is no single metric capturing nature loss comparable to carbon emissions, ecosystem dependencies or impacts are highly location-specific, and disclosure frameworks remain voluntary and unevenly adopted. While better data, analytical and modelling practices are needed, a realistic route can follow the approach favoured in the conference discussion: begin where action is possible.

Central banks have already begun assessing financial system exposure to nature degradation. The central banks of the Netherlands, France, Malaysia and Mexico, as well as the ECB (Ceglar, 2025), have all published analyses of dependencies of economic activities and financial institutions on ecosystem services. The next step is to translate exposure into measurable financial risk metrics that can identify the most material sources of nature-related risk (Gallet et al., 2024). From there, nature-related considerations could be integrated into existing climate scenarios¹³ and stress tests, allowing them to inform existing measures, such as the Eurosystem's climate factor or the Bank of England's collateral haircuts. Building on the architecture of existing climate risk frameworks to pragmatically integrate nature risk would keep the operational burden proportionate while maintaining methodological consistency across risk types.

5. CONCLUSION

Central banks have come a long way over the past decade from concept to practice, and a number of initiatives outlined in this article highlight the efficacy of such good practices.

13 For instance, the NGFS's Nature Taskforce is spearheading the development of nature-related scenarios for central banks and supervisors, and the ECB has conducted an initial integrated climate-nature scenario exercise in collaboration with the Potsdam Institute for Climate Impact Research (PIK).

However, given the extensive assessment by NGFS, central banks and research centres to determine how greening of operations can be developed and implemented, there is clearly room for improvement well within central banks' mandates and operational competencies. Combining such practices — incentives, disincentives, and other risk-based measures— across asset purchase programmes, collateral frameworks, and other aspects of operations, both within and across central banks, could send a powerful signal to financial systems and the real economy of the tangible economic value of climate and nature transitions.

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