

Network for Greening the Financial System
Technical document

Adapting central bank operations to a hotter world: current progress and insights from practical examples

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Foreword



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Climate change – and the policies to mitigate it – affect the economy and the financial system and, in turn, have implications for central banks' operations. In 2021, in its report [Adapting central bank operations to a hotter world: Reviewing some options](#), the NGFS set out a range of options for central banks to take climate considerations into account in their monetary policy operations. Since then, many central banks have made some climate-related adjustments to their operational frameworks.

The extent to which central banks reflect climate considerations in their monetary policy operations depends on their respective mandates. The NGFS aims to share the experience of central banks that have chosen to adapt their operational frameworks, providing inspiration and guidance for other central banks, so that they are able to follow suit.

The NGFS Workstream on Monetary Policy carried out a [survey](#) and compiled several case studies of NGFS members that have adjusted their monetary policy operations. This work offers practical insights into the experiences that central banks have gained along the way, including in dealing with challenges, such as data limitations.

There are two main reasons for central banks to incorporate climate-related considerations into their operational frameworks. First, central banks ought to identify, assess and manage the financial risks that their own balance sheets are exposed to, including those stemming from climate change and climate policies. Second, some central banks have an explicit mandate to support the transition to a low-carbon economy in line with policies and climate targets of their governments.

The scope of climate-related adjustments to the operational framework depends on the scope of central bank mandates in this area. Some central banks, whose climate-related remits are broader, have made adjustments to credit operations, asset purchase schemes and collateral policies. Other central banks that primarily focus on financial risk management have so far typically restricted their measures to collateral frameworks.

We are, as ever, grateful to the NGFS members and observers for sharing their learnings and to the Secretariat for contributing to this work. We would particularly like to thank the co-leads of the subgroup on monetary policy operations – Daniel Gybas (European Central Bank) and Caspar Siegert (Bank of England) – for putting together this report. We hope this publication will contribute to deepening central banks' understanding of how monetary policy frameworks can account for climate factors in line with their mandates.

Executive summary

Over the past years, a number of NGFS member institutions have gathered experience with considering climate-related factors in their monetary policy operations. Actions that central banks have taken span across all of the high-level options set out in a report that the NGFS published in 2021¹ – that is credit operations, asset purchases, and collateral policies. Some actions are intended to protect central banks' balance sheets against financial risks stemming from climate change, while others are intended to contribute to an orderly transition towards a low-carbon economy.

This document reviews eight case studies from Europe and Asia and discusses the practical insights that can be gained from these. While the list of case studies considered is not exhaustive, it does include a significant share of the measures that central banks around the world have taken. It includes reviews of three cases of central banks having adjusted credit operations, three cases of central banks having adjusted asset purchase schemes, and two cases of central banks having adjusted their respective collateral policies.

The case studies demonstrate that while practical challenges remain, they can be overcome. Many of the measures that central banks have taken over the last years were originally deemed to face meaningful operational challenges (see 2021 report). The fact that several central banks have managed to implement a wide range of measures suggests that operational challenges may be more manageable than initially expected. That said, the number of central banks having taken action is still limited, in particular in the context of actively protecting their own balance sheet against climate-related financial risks.

The case studies also show that central banks have typically prioritised actions based on materiality considerations, as well as data availability. Central banks that aim to limit climate-related financial risks to their own balance sheet prioritised action based on the size of their own exposures, while central banks that aim to support the transition to a low-carbon economy were more focused

on the importance of the targeted asset class in the wider economy. In addition, central banks have considered data availability when determining areas of strategic focus.

Recognising the challenges associated with calibrating their action, central banks that have taken action have initially followed a cautious and gradual approach, although some of these central banks have signalled that their action will “escalate” over time. Climate-based adjustments to monetary policy operations typically give rise to trade-offs. Given that the materiality of these trade-offs is uncertain, many central banks have taken a cautious and gradual approach. It would be expected that central banks learn more about these trade-offs over time, and start to take more robust action. In fact, some central banks signalled explicitly to the market that they expect to “escalate” action over time.

Central banks found pragmatic solutions to overcome data availability issues, and the multitude of approaches developed so far offer significant flexibility. For example, central banks that assess the greenhouse gas (GHG) emissions of corporate issuers can use a “waterfall” approach of filling in missing data². Central banks have also constructed climate scores for issuers to capture several dimensions of an issuer's climate performance. And where central banks are unable to obtain GHG emissions or other forms of raw climate data for a given type of assets, they may be able to rely on third-party assessments (such as green bond labels) or self-assessments by their counterparty.

However, country-specific factors exist that may make it more difficult for some countries to take similar action. Indeed, certain countries may face challenges around the operational burden of integrating climate factors into risk management frameworks, managing external dependencies, or dealing with potential cross-border leakage. Central bank mandates may also limit the actions that central banks may take, in particular where these actions are aimed at contributing to the transition rather than managing risks.

1 Thoughtout this report, the term “2021 report” refers to the NGFS publication *Adapting central bank operations to a hotter world – Reviewing some options*.

2 A waterfall approach to data imputation follows a specified series of steps to impute missing data based on availability. For example, it might initially seek to impute missing time series data with data from the previous year. If that data is unavailable, the backstop for imputation could be to impute with a summary statistic from a similar population (e.g. mean for firms within the same sector).

In addition, many of the measures have been implemented during a period when interest rates were historically low, and may be less applicable during times when interest rates are above the zero lower bound (ZLB). When interest rates are within the ZLB, central banks often conduct operations that expand the size of their balance sheet – for example asset purchase schemes or long-term lending operations. Many of the climate measures seen in recent years have therefore focused on adjusting such tools. However, when interest rates are above the ZLB, central banks may put more weight on other aspects of their monetary policy operations, such as collateral policy, that are relevant even as central banks shrink their balance sheets.

There are three specific areas that may warrant further analysis. First, central banks could develop frameworks for assessing the effectiveness of existing measures in managing risks or supporting the transition, as well as the impact of such measures on the effectiveness of monetary policy transmission. Second, central banks have not yet considered how to incorporate climate considerations into liquidity management tools that focus on the liability side of their balance sheet. Finally, further work may be needed to better understand how to best integrate climate considerations into monetary policy operations during periods when interest rates are above the ZLB.

Introduction

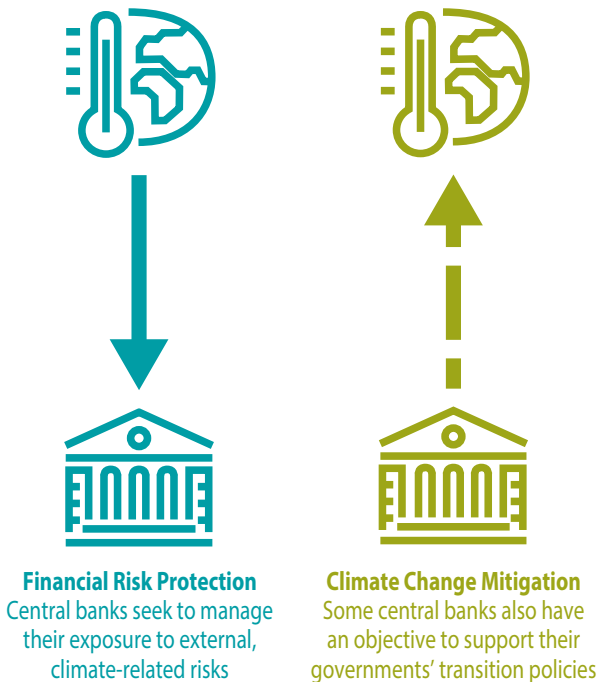
Climate change adversely impacts economic activity and exposes the value of some financial assets to substantial risks. Climate-related financial risks arise through two main channels. Transition risks arise from the significant structural changes as economies adjust towards a low-carbon economy. These are largely determined by the interaction of policy choices, the impact of disruptive innovations and technological progress, and changes in the preferences of economic agents. Physical risks stem from the increasing severity, frequency and geographic spread of extreme climate and weather-related events (e.g. floods, hurricanes, droughts) and chronic shifts in weather patterns (e.g. temperature increases, sea level rise). The materialisation of either risk type can yield large financial losses and impair asset values, in particular if such risks are not yet reflected in current asset prices. Investors will hence want to take climate factors into consideration as part of their regular risk management processes.

There is also a growing recognition that while governments and legislators are leading on providing the conditions for an orderly transition to a low-carbon economy, the financial sector plays an important role in supporting this transition. The International Energy Agency (IEA) estimates that over 2.5 trillion USD of additional clean energy investments per year (by 2030) are needed to support the transition towards a low-carbon economy, and much of this will need to be provided by private finance³. The extent to which investors are willing to provide such funding and invest in green⁴ assets depends on financial incentives provided by public policy, as well as investors' investment objectives (including whether they would be willing to accept higher financial risks or lower financial returns to contribute to the mitigation of climate change).

The NGFS has provided a forum for central banks to consider the relevance of these considerations in their monetary policy operations. The assets that central banks hold as part of their monetary policy operations typically involve collateralised lending to eligible financial institutions, and/or outright purchases of financial assets.

These assets may be exposed to climate-related financial risks in the same way as the financial assets held by private institutions. And, depending on central banks' mandates, monetary policy operations can also support the transition to a low-carbon economy (Figure 1). While we refer to "monetary policy operations" throughout this report, many of these considerations are equally relevant for market operations that central banks may conduct pursuing objectives other than monetary policy implementation (e.g. financial stability).

Figure 1 **Central bank objectives in connection with climate change**



Managing material financial risks to their own balance sheet, including climate-related financial risk ("risk protection"), is a core responsibility of every central bank. Central banks can be exposed to climate-related financial risks that affect the credit worthiness of their counterparties, the value of collateral provided by counterparties, or the value of financial assets held as part of asset purchase schemes. The materiality of these risks will

³ See IEA (2023).

⁴ "Green" in this context refers to activities which are more closely aligned with the transition to a net zero economy. This may include low-carbon assets, as well as assets that help with the "greening" of traditionally carbon-intensive activities (as part of the provision of transition finance). "Non-green" refers to activities that do not meet the definition given for "green" activities.

depend on the nature of individual central banks' exposures. For example, central banks that only lend against a narrow set of high-quality collateral and/or apply very conservative haircuts may be less exposed to climate-related financial risks than central banks that conduct a wide range of asset purchases (given the "double layer of risk protection"⁵ that the collateral provides). But to the extent that risks are deemed material, central banks should include them in their risk management frameworks.

Conversely, whether and/or the extent to which central banks should consider to modify their behaviours to support the transition towards a low-carbon economy ("climate change mitigation") depends on their mandate. By favouring counterparties, collateral, or assets that are more aligned with the transition to a low-carbon economy, central banks may support the transition to a low-carbon economy (see Box 1).

However, unless this also reduces the financial risks that central banks are exposed to, taking such action is not necessarily within all central banks' remit. The mandates of central banks are generally set out in their statutory frameworks and central banks with mandates that explicitly include climate-related objectives are currently an exception. Some central banks may judge that their statutory objective of maintaining price stability can provide the legal basis for action, provided that climate change is judged to impact their ability to achieve their price stability objective. Other central banks infer a mandate to support the transition from other statutory objectives, such as an objective to support government economic policy⁶.

In 2021, the NGFS set out a framework for how to consider both climate-related financial risks as well as environmental objectives in central banks' monetary policy operations. The report on *Adapting central*

bank operations to a hotter world: Reviewing some options (NGFS, 2021) set out a range of stylised options for adjusting operational frameworks, and assessed to what extent these can help protect central banks' balance sheets from climate-related financial risks or contribute to mitigating climate change. These considerations are still relevant and can help inform central banks' overall approach to climate-related factors. The report also dives deeper into wider conceptual and design considerations.

Since 2021, several NGFS members have gathered experience putting these options into practice – showing that while practical challenges remain, there has been considerable progress in addressing them. The purpose of this short companion piece to the 2021 report is to share these experiences. This will help central banks in better understanding the practical challenges involved in considering climate-related factors and how these can be overcome. In line with the scope of the 2021 report, this report is focused on the asset side of the central bank balance sheet and hence does not consider how climate considerations may be integrated into liability-side tools such as reserve requirements and sterilisation operations.

This document is primarily meant to share the practical insights from these case studies with other central banks. But it may also be of interest to other market participants. The audience at which this report is aimed includes primarily central banks that may want to better understand how to incorporate climate change considerations into their monetary policy operations. But some of these considerations may also be relevant for other market participants, as there may be a read-across to sustainable investing and/or climate risk management more generally.

5 The "double layer of risk protection" generally refers to operations that are conducted with financial sound counterparties (first layer) against adequate collateral (second layer).

6 See NGFS (2023).

How adjustments to central bank operations can help mitigate climate change?

When conducting market operations, central banks often use the concept of “market neutrality” as an important guiding principle. However, central banks may choose to aim off this guiding principle for a range of reasons, including in light of climate factors.

Adjusting central banks’ monetary policy operations to reflect climate-related financial risks can help protect central banks’ balance sheets from climate-related financial risks. The way in which adjustments to counterparty eligibility, collateral eligibility and haircuts, and asset purchases can limit traditional sources of credit, liquidity or market risk is well understood and can serve as a useful starting point for also addressing climate-related sources of risk.

Some central banks may also adjust monetary policy operations to help mitigate climate change. The way in which these adjustments can support the transition to a low-carbon economy is less obvious. The common idea is that adjustments to monetary policy operations can lower the relative funding costs for green investment opportunities and increase the relative funding cost of non-green investment opportunities. This should help support investments in areas aligned with a low-carbon economy. However, how this works in practice depends on the elements of the monetary policy operations that central banks adjust.

Credit operations

Some central banks may choose to provide refinancing to financial institutions which finance low-carbon projects at more advantageous rates.

Cheaper refinancing may induce financial institutions to grow their low-carbon lending activities and provide more generous terms to real economy borrowers that are aligned with the transition to a low-carbon economy. This may reduce these real economy borrowers’ funding costs. Again, this will allow the borrower to invest in growth and compete more successfully in the product markets the borrower is active in.

Collateral policies

Other central banks may choose to provide preferential treatment for green collateral – for example by applying lower haircuts to green corporate bonds or loans. This will increase the amount of central bank liquidity that financial institutions can obtain for a given amount of eligible collateral.

This preferential treatment for green collateral may induce financial institutions to pay a higher price for these specific corporate bonds, and may help increase the liquidity of green bond markets. In turn, this may translate into lower funding costs for corporates issuing green bonds, incentivising more investment into green projects.

However, the size of this effect is uncertain and depends on the scarcity of collateral as well as the availability of surplus liquidity in the banking system. If financial institutions have ample liquidity and/or have more than enough collateral to access central bank facilities, it is unlikely that they will be willing to pay a premium for assets that face lower haircuts. As a result, the issuers of these assets might not materially benefit from the changes in the central bank’s collateral policy¹.

Asset purchases

As part of their asset purchase programmes, central banks may choose to hold larger amounts of bonds from issuers that are aligned with a low-carbon economy. This may reduce the outstanding amount of bonds available for purchase in the market and drive-up prices in the secondary market.

Higher prices in the secondary market may in turn affect the price that investors are willing to pay for any new bonds issued by low-carbon issuers. This reduces these issuers’ funding costs relative to peers who are less aligned with a low-carbon economy, allowing them to invest in growth and compete more successfully in the (real economy) product markets they operate in. It may also incentivise other issuers to become more aligned with the transition to a low-carbon economy.

¹ See Giovanardi *et al.* (2023).

Many of the measures covered in this report have been implemented during a period where interest rates were historically low. The measures central banks may want to take in periods when rates are above the ZLB may be different. In many economies, the period up to 2021 was characterised by low growth and inflation – which meant that the monetary policy stance was generally accommodative, and in many countries short-term rates were at the effective lower bound. In this period many central banks conducted operations that expanded the size of their balance sheets – for example increasing the size of asset purchase schemes or long-term lending operations. Many of the climate adjustments to monetary policy operations in recent years have focused on adjusting such operations (e.g. the tilting of new asset purchases towards better-performing issuers or assets according to climate-related criteria). In principle, these climate-related adjustments do not depend on the exact monetary policy stance. Their impact, however, is expected to be greater in times of more accommodative policy and of larger central bank balance sheets (i.e. their impact is cyclical). Given the sharp increases in inflation as of mid-2021, many central banks started tightening monetary policy and these climate adjustments have probably become less impactful. In periods when interest rates are above the ZLB, central banks may instead put more weight on other aspects of their monetary policy operations, such as collateral policy, that are relevant even as central banks shrink their balance sheets. This report touches on some of these questions. A more detailed discussion of the tools that central banks may want to use when interest rates are above the ZLB is beyond the scope of this report, but may be a useful focus for future work.

Climate factors may also affect the appropriate monetary policy stance. However, this is outside of the scope of this report. In addition to the aforementioned considerations on how the monetary policy cycle can render certain types of monetary policy operations more or less relevant, climate factors can also shape the appropriate monetary policy stance. Carbon pricing, for example, and its effect on energy prices can have a material impact on economic activity and inflationary pressures. Similarly, the increased frequency of extreme weather events can affect both the supply and demand sides of the economy. Monetary policymakers need to be aware of these effects in order to choose an appropriate monetary policy stance and meet their price stability objectives. The analytical foundations for doing so will be discussed in forthcoming NGFS publications. However, these issues are largely separate from the appropriate design of monetary policy operations and, therefore, are outside of the scope of this report⁷.

This report also does not discuss the extent to which climate-related factors should be considered in other asset portfolios that central banks manage. Many central banks hold assets for reasons that are not directly linked to the implementation of monetary policy. This may include asset portfolios used to fund central banks' own operations and/or meet their pension obligations. Some of the practical considerations set out in this report are also applicable to these portfolios. However, central bank mandates are typically less constraining in the context of non-monetary policy portfolios and central banks may hence behave in a way that more closely resembles the behaviour of other financial investors. Considerations in the context of non-policy portfolios are set out in an NGFS report on sustainable and responsible investment in central banks' portfolio management (NGFS, 2024).

⁷ Note that any climate-related changes to the appropriate monetary policy stance may have an indirect effect on the impactfulness of different climate adjustments to monetary policy operations. This could in theory affect which climate adjustments to monetary policy operations central banks want to prioritise.

1. Practical examples and experiences

1.1 Scenario analysis can provide useful lessons for adjusting monetary policy operations...

Since 2021, a few central banks amongst the NGFS membership have completed climate scenario analysis of their own balance sheets (NGFS, 2023). While the exact scope and focus of the exercises depended on each central bank's institutional and financial environment, the common objective of these exercises was to quantify the potential overall financial impact of various climate scenarios on the central bank's balance sheet. This allows central banks to assess the potential impact of unprecedented risks that are not reflected in historical data.

Scenario analysis can provide insights into how central banks can adjust their monetary policy operations.

As part of this scenario analysis, central banks had to assess the climate characteristics – and any associated risks – of many of their exposures. This can provide insights into what adjustments central banks may need to make to their monetary policy operations to manage climate-related financial risks. Moreover, while the assessments were focused on the exposure to climate-related financial risks, they also yield useful insights into how central banks may be able to adjust monetary policy operations to help mitigate climate change. The exercises revealed that while it is possible to obtain relevant climate data for many asset classes, there are significant challenges in obtaining data for some asset classes such as asset-backed securities or covered bonds.

1.2 ... and a number of central banks have already started accounting for climate factors in their monetary policy operations

A number of central banks have already started to account for climate factors in their monetary policy operations. The NGFS reviewed eight examples of central banks that have incorporated climate change considerations

into some aspects of their monetary policy operations. These case studies cover central banks across Europe and Asia. They include both advanced economies and emerging market and developing economies within these regions, and are summarised in Boxes 2 to 4. This group of case studies is not exhaustive and only includes cases for which the NGFS was able to retrieve sufficiently detailed public information. However, to the best of the NGFS' knowledge, it includes a significant share of the measures that central banks around the world have taken.

There is significant heterogeneity in the type of adjustments that these central banks have made.

When drawing up a taxonomy of potential climate-related adjustments to monetary policy operations, the 2021 report distinguished between:

- 1) Changes to the pricing/counterparty eligibility for credit operations ("credit operations");
- 2) Adjustments to collateral haircuts and/or eligibility ("collateral"), and;
- 3) Changes to asset purchases ("asset purchases").

Within each of these categories, the 2021 report distinguished different levers that central banks could focus on. The eight case studies reviewed as part of this update span a large number of these categories and levers (see Table 1).

Some of this heterogeneity may be driven by institutional and country-specific factors.

To some extent, the heterogeneity of practices may reflect the fact that all these measures have different strengths and weaknesses, as set out in the 2021 report⁸. For example, some measures are more suitable for managing climate-related financial risks to central banks' balance sheets, while others are more suitable for contributing to the mitigation of climate change. But the range of practices observed may also point towards important country-specific factors – including the structure of the financial system and central banks' mandates, operational frameworks and balance sheets – which ultimately drove central banks' decision making process.

⁸ See Table 2 in NGFS (2021).

Table 1 Number of case studies in different categories and across objectives

| | | Credit operations | | | Collateral | | | | Asset purchases | | |
|-----------|---------------------------|--|---------------------------------|---------------------------------------|---------------------|--------------------|--------------------|---------------------------|-----------------|--------------------|--------------------|
| | | Adjusting pricing based on type of lending | Adjusting pricing to collateral | Adjusting counterparties' eligibility | Haircut adjustments | Negative screening | Positive screening | Aligning collateral pools | Tilting | Negative screening | Positive screening |
| Objective | Climate change mitigation | 3 | | | 1 | | | | 1 | | 1 |
| | Financial risk protection | | | | | 1 | | | | | |
| | Both | | | | | | | | 1 | | |

Note: "Credit operations" include measures taken by the Magyar Nemzeti Bank, the People's Bank of China, and the Bank of Japan; "collateral" includes measures taken by the Magyar Nemzeti Bank and European Central Bank; "asset purchases" includes measures taken by the Magyar Nemzeti Bank, the European Central Bank, and the Bank of England.

While risk-based considerations remain relevant for all central banks, in six of the eight case studies, adjustments were primarily motivated by the objective of mitigating climate change.

A given measure can serve overlapping purposes, and different central banks might motivate the same measure by referring to different objectives⁹. Nonetheless, it is striking that most measures were motivated by the aim of mitigating climate change. This applies across all categories considered in this review (asset purchase schemes, credit operations and collateral policies). Conversely, measures with a primary focus on financial risk management are currently restricted to collateral frameworks.

There are a number of potential reasons for why only two of the case studies were motivated by risk protection objectives.

First, as part of their usual operations, central banks take a range of mitigating measures to reduce the financial risks they are exposed to as much as possible (e.g. by only accepting high-quality collateral and/or applying conservative valuation haircuts). Central banks may judge that these steps are sufficient to protect them against a wide range of financial risks, including climate-related risks. Second, some central banks consider climate-related financial risks as part of their internal risk management processes, and have not publicly described such considerations as a specific climate risk protection measure. Our case studies have been selected based on publicly available material and may hence understate the prevalence of such climate risk protection considerations. Third, there are still a number

of methodological challenges to accurately measure and quantify climate-related financial risks in a comprehensive manner, and to coherently integrate these findings into traditional risk management frameworks. Many central banks have a high bar for adjusting their quantitative risk management tools, and try to limit the role of judgement-based decisions in their risk management frameworks as much as possible (given the importance of clear accountability)¹⁰. This may be another reason why there are for now relatively few publicly mentioned risk-based actions. Nonetheless, to the extent that some central banks have started to take risk-based actions, they will contribute to enhancing our collective knowledge in this field and may encourage further action.

1.3 These case studies illustrate how central banks can operationalise changes to credit operations...

Three central banks have focused on considering climate factors as part of their credit operations (see Box 2). The 2021 report identified different options for adjusting credit operations in the light of climate-related factors. These included (i) adjusting pricing to reflect counterparties' climate-related lending; (ii) adjusting pricing to reflect the composition of pledged collateral; and (iii) adjusting counterparties' eligibility. Central banks that have taken action in the area of credit operations have focused on the first option. In all cases, these central banks

⁹ This overlap is particularly pronounced in the context of managing transition risks: actions that are intended to guard against transition risk tend to reduce central banks' exposures to non-green assets, which may lower the relative cost of funding green investment opportunities (see Box 1).

¹⁰ The fact that in light of the radical uncertainty around climate change central banks may want to initially only take gradual action was also discussed in NGFS (2021).

had an explicit objective to incentivise specific types of lending to mitigate climate change.

When determining whether lending is green, these central banks did not typically rely on any taxonomies.

Some central banks initially considered using “green taxonomies” to assess whether a real-economy borrower that the financial institution had lent to was supporting the transition to a low-carbon economy, and whether the financial institution should therefore qualify for preferential access to central bank facilities. However, none of the measures reviewed in the case studies ended up being based on such taxonomies. This may reflect the absence of comprehensive taxonomies in many jurisdictions. It may also reflect a desire to go beyond a binary, activities-based classification into green and non-green assets, and instead form a more nuanced view on the climate characteristics of an individual borrower.

Instead, some of these central banks relied on financial institutions developing their own criteria for defining “green lending”. By doing so, they effectively outsourced the task of assessing the climate characteristics of a real-economy borrower to their counterparty.

Counterparties were required to publicly disclose the criteria they had applied in order to provide transparency and support market discipline.

Other central banks linked the assessment of whether a financial institution’s lending was green to detailed loan-level data on energy performance. In one of the case studies, the central bank linked eligibility for preferential lending rates to the Energy Performance Certificate (EPC) rating and primary energy consumption of the residential mortgages that were being refinanced. This was intended to support the development of a green housing loan market, the awareness of environmental sustainability issues and the building of green residential properties.

The incentives provided for such green lending were non-negligible. In two cases, central banks refinanced green assets at an interest rate of 0%. However, these interest rates must be seen in the light of the low interest rate environment that prevailed at the time. In one case, the central bank provided additional incentives for green lending by exempting central bank reserves worth twice the volume of green lending from negative interest rates on excess reserve balances.

Box 2

Greening credit operations – examples from the NGFS membership

Green Home Programme

In October 2021, the Magyar Nemzeti Bank launched the “Green Home Programme” as a part of the wider “Funding for Growth Scheme” (FGS). In the Green Home Programme, the Magyar Nemzeti Bank provided 300 billion HUF (c. 825 million USD) refinancing to credit institutions at 0% interest on the condition of this funding being lent to households for the construction or purchases of new, energy-efficient residential real estates. Properties had to have a minimum energy efficiency label of

“BB” and a maximum primary energy consumption of 90 (later 80) kWh/m²/year to be eligible.

The aim of this programme was to boost green mortgage lending, in order to support the transition towards a sustainable economic transformation.

Details on the programme and its utilisation can be found in Magyar Nemzeti Bank (2022) and Magyar Nemzeti Bank (2023).

Climate Response Financing Operations

In September 2021, the Bank of Japan introduced the “Funds Supplying Operations to Support Financing for Climate Change Responses” (Climate Response Financing Operations) that provides loans to eligible financial institutions. As part of this programme, the Bank of Japan provides loans at an interest rate of 0% (as of 12th February 2024) to fund the financial institution’s investments or loans that contribute to Japan’s action to address climate change. In addition, twice this amount is exempted from negative interest rate on excess reserve balances. To avoid getting involved in micro-level resource allocation, the Bank of Japan leaves it to financial institutions to determine which of their investments or loans contribute to addressing climate change. The Bank of Japan requires financial institutions to disclose the criteria they used so as to ensure that market discipline will be exercised.

The aim of this programme is to support private sector efforts on climate change, which will also contribute to stabilising the macroeconomy in the long run.

Details on the programme can be found in Bank of Japan (2021).

Structural Facilities for Green Transition

In November 2021, the People’s Bank of China launched two targeted lending facilities: the Carbon Emission Reduction Facility (CERF) and the Special Central Bank Lending Facility for Clean and Efficient Use of Coal. Under these facilities, the People’s Bank of China provides loans to eligible financial institutions at a preferential interest rate of 1.75%, to motivate them to lend to carbon emissions reductions projects and projects to support the “clean and efficient” use of coal. Financial institutions that used the CERF are asked to disclose information such as the amount of carbon reductions financed by such loans.

The aim of these operations was to mobilise private capital to support the transition towards a low-carbon economy.

Details on the operations can be found in People’s Bank of China (2022).

1.4 ... as well as changes to collateral policies...

In its 2022 membership survey, the NGFS found that almost a third of responding central banks had implemented adjustments to their collateral framework, a majority of which were from euro area central banks (NGFS, 2023). Two of the case studies focus on central banks that have started to conduct work in this area.

This includes adjustments to haircuts for green assets, as well as restrictions around the eligibility of carbon-intensive collateral.

In one case study, preferential haircuts for green bonds have been used as a tool to contribute to the mitigation of climate change. This central bank started offering preferential haircuts for green bonds (i.e. bonds where proceeds are being used to fund green expenditure), subject to these bonds being compliant with common green bond standards and the issuer publishing annual impact reports.

In addition, the central bank also offered somewhat lower preferential haircuts for non-green assets provided the issuer stepped up climate-related disclosures including, the Task Force on Climate-Related Financial Disclosures (TCFD) reporting standards¹¹. In both cases, the motivation was to contribute to the mitigation of climate change and to increase the transparency of the green bond market rather than to manage climate-related risks to the central bank’s balance sheet.

In another case study, the central bank started to adjust collateral eligibility to manage climate-related financial risks to their balance sheet. In one of the reviewed case studies, the central bank had announced plans to limit the share of assets issued by certain entities with a high carbon footprint that can be pledged as collateral by a counterparty. This reflects the fact that, all else equal, issuers with a higher carbon footprint may be more exposed to transition risks. Another central bank noted that it had started to use scenario analysis to quantify the impact that climate factors could

¹¹ Following the establishment of the International Sustainability Standards Board (ISSB) standards, the TCFD has been disbanded in October 2023. Future reporting requirements will likely also be linked to other reporting frameworks.

have on the probability of default and loss given default of loans that it accepts as collateral. However, at the time of writing this analysis has not led to any changes to their collateral policy yet and is therefore not included in the eight case studies.

In other cases, central banks have concluded that they do not need to adjust haircuts to account for climate risks. The analysis of one central bank suggested that

existing theoretical valuation models continue to be fit for purpose, and that current haircuts are sufficiently conservative to provide for appropriate risk protection against climate-related risks over the relevant time horizon. These judgements have focused on specific classes of collateral, and do not necessarily indicate that the same is true for other classes of collateral where climate-related financial risks may be less transparent and more difficult to quantify.

Box 3

Greening collateral management – examples from the NGFS membership

Green Collateral Management

In 2021, the Magyar Nemzeti Bank took steps to integrate green considerations into its collateral management practices. This included a preferential haircut for green securities that was set at 80% of the haircut that would otherwise apply (up to a maximum “haircut discount” of five percentage points). Preferential haircuts could only be maintained if the issuer continued to published all necessary climate-related documentation (e.g. impact report, allocation report). The Magyar Nemzeti Bank also introduced more limited preferential haircuts for non-green assets if the issuer published relevant climate reports. The Magyar Nemzeti Bank implemented a transparency template for green covered bonds for reporting the characteristics of the structure of the bonds, the mortgage pool and describing the green aspects of the programme.

The strategic goal of these preferential haircuts was to contribute to the development of green securities markets, increase transparency and foster standardisation.

Details on the preferential haircuts can be found in Magyar Nemzeti Bank (2023a).

Collateral pool limits

In July 2022, the European Central Bank announced that the Eurosystem would limit the share of assets issued by entities with a high carbon footprint that could be pledged as collateral by individual counterparties when borrowing from the Eurosystem. The measure would apply before the end of 2024, provided that the necessary technical preconditions are in place. While the scope of this “cap” was initially going to be limited to marketable debt instruments by non-financial corporates, the European Central Bank indicated that it might be extended to other asset classes as the quality of climate-related data improved.

The primary aim of these measures is to reduce financial risk related to climate change on the Eurosystem’s balance sheet. The measure further provides incentives for issuers to align with a low-carbon economy.

Details on these measures can be found in European Central Bank (2022) and European Central Bank (2023).

1.5 ... or asset purchases

In the context of central bank's asset purchases, central banks have typically focused on tilting their asset purchase schemes (NGFS, 2023). The common principle of the tilting measures used by the two central banks that feature in the case studies is to balance asset holdings away from bonds with negative climate characteristics, and towards those with more positive climate characteristics (relative to a climate-agnostic benchmark allocation).

To do so, these central banks developed methodologies to assign climate scores based on issuer-level data.

These climate scores determined the price that central banks were willing to pay for different bonds and/or resulted in issuers with good climate characteristics constituting a larger part of the portfolio. Conceptually, assigning scores to individual issuers based on issuer-level data is not the only approach to tilting the asset purchases. Central banks could alternatively choose to tilt based on instrument-level data (e.g. favouring green bonds over traditional bonds), or based on the sector that a corporate issuer belongs to. However, such practices appear to be less common.

The climate scores that these central banks used were designed to capture several dimensions of an issuer's climate performance. These dimensions included backward-looking carbon intensity, forward-looking decarbonisation targets, and the quality of climate-related disclosures by the issuer. Data on these dimensions were then aggregated into an overall score. Using such a "balanced scorecard" approach may reflect the fact that there are no individual metrics that would reliably capture all elements of an issuer's exposure to climate-related financial risks and/or an issuer's contribution to mitigating climate change.

These central banks have followed a "flow-based" approach to tilting. As part of these flow-based approaches, central banks applied the tilts only to new asset purchases rather than proactively divesting from assets with poor climate characteristics¹².

The central banks that chose to tilt their asset purchase schemes accompanied this with other measures. This included imposing maturity limits for issuers with unfavourable climate characteristics, or excluding issuers involved in certain economic activities such as coal mining (a type of negative screening).

The examples for tilting seen so far are all focused on corporate bond purchase schemes. The fact that these central banks have focused on corporate rather than sovereign bond purchase programmes may reflect the fact that, in the context of corporate bonds, central banks have considerable leeway to adjust the weight of different issuers without negatively affecting monetary policy objectives. Conversely, for sovereign bond purchase programmes, the issuer(s) that central banks are exposed to are determined by monetary policy objectives.

Separately, asset purchases with positive screening have also been successfully implemented. In one case study, the central bank launched an asset purchase scheme that exclusively purchased Green Mortgage Bonds. This measure was designed to create a liquid market for green mortgage bonds that did not previously exist, and to encourage green mortgage loan activities.

¹² These new purchases can either be the result of an expansion of the asset purchase scheme, or can occur when central banks reinvest the proceeds from maturing bonds.

Greening of central bank asset purchases – examples from the NGFS membership

Green Mortgage Bond Purchase Programme

In September 2021, the Magyar Nemzeti Bank launched a Green Mortgage Bond Purchase Programme. The central bank purchased Forint-denominated, fixed-rate mortgage bonds that complied with widely recognised standards for green bonds. Under the programme, the issuer was required to issue an annual impact report that contained information on the main characteristics of the underlying lending activity, and the progress in reducing carbon dioxide emissions (amongst other indicators).

The strategic goal of the Green Mortgage Bond Purchase Programme is to contribute to the development of a domestic green mortgage bond market through targeted purchases and, through this, encourage green mortgage loan activities.

Details on the programme and its utilisation can be found in Magyar Nemzeti Bank (2021).

Tilting of corporate bond purchases

In November 2021, the Bank of England published a comprehensive framework for greening its 20 billion GBP (c. 25 billion USD) corporate bond purchased programme. The Corporate Bond Purchase Scheme (CBPS) was introduced in 2016, and purchased investment grade sterling corporate bonds issued by companies judged to make a material contribution to U.K. economic activity. One key component of this greening was the tilting of purchases towards stronger climate performers in any given sector. Stronger climate performers were defined as corporates with lower carbon intensities, larger historical reductions in absolute emissions, climate-related financial disclosures, and emissions reduction targets verified

by a third-party. The tilting was applied to reinvestment rounds between November 2021 and February 2022, when the decision was taken to stop any reinvestments in the light of monetary policy considerations.

The primary aim of this measure was to incentivise firms to take decisive actions that support an orderly transition to net zero.

Details on this measure can be found in Bank of England (2021).

In October 2022, the Eurosystem started to tilt the corporate bond purchases of both its Corporate Sector Purchase Programme (CSPP) and its Pandemic Emergency Purchase Programme (PEPP) towards issuers with a better climate performance. Stronger climate performers were defined as corporates with lower past greenhouse gas emissions intensities (combining a best-in-class and best-in-universe approach), ambitious and science-based decarbonisation targets, and high-quality disclosures verified by third-parties. Both the CSPP and PEPP had stopped making any net purchases by October 2022. As such, the tilting was applied to reinvestments only. Following a decision to reduce the scale of reinvestments, the European Central Bank's Governing Council decided in February 2023 to tilt the remaining reinvestments more strongly towards issuers with a better climate performance.

These measures aimed to reduce financial risk related to climate change on the Eurosystem's balance sheet, encourage transparency, and support the green transition of the economy.

Details on these measures can be found in European Central Bank (2023a).

2. Cross-cutting practical challenges and how to address them

Central banks’ practical experiences have highlighted a number of cross-cutting implementation challenges, as well as ways of successfully overcoming them. Many of the challenges that central banks have encountered while making these adjustments apply to all of the case studies previously discussed. Against this background, this section is focused on reviewing three cross-cutting challenges: determining what operations to focus on (“Strategic focus”), deciding on the appropriate calibration of any climate measures (“Calibration”),

and overcoming challenges around data availability (“Data limitations”). These challenges determine how the success criteria for climate actions that were set out in the 2021 report can be met: while Data limitations primarily affect the operational feasibility, the Strategic focus and Calibration of tools have a direct impact on central banks’ ability to meet the objectives of risk protection and/or mitigating climate change, without adversely impacting the effectiveness of monetary policy (see Table 2).

Table 2 **The three cross-cutting challenges discussed in this section and the “success criteria” set out in 2021 that each of these challenges has a material impact on**

| | | Success criteria | | | |
|------------|------------------|---|---|--|--|
| | | Objective 1: Contribute to climate change mitigation | Objective 2: Contribute to risk protection | Constraint 1: Limit any impact on monetary policy effectiveness | Constraint 2: Support operational feasibility |
| Challenges | Strategic focus | | | | |
| | Calibration | | | | |
| | Data limitations | | | | |

Note: Grey cells denote success criteria that are materially affected by a given cross-cutting challenge.

2.1 Challenge #1: Strategic focus – Determining which measures should be prioritised in the light of local circumstances

Many central banks are still building up in-house climate expertise and have to identify and prioritise areas of strategic focus. This challenge is not limited to central banks and applies to many commercial financial institutions too. But given the specificities of monetary policy operations, and the more limited scope to learn from peers, central banks may find this particularly challenging.

The measures that central banks prioritise tend to depend on local circumstances. For example, in countries with more bank-based financial systems and small capital markets, options that focus on the treatment of securities may have a smaller impact on mitigating climate change or protecting central banks from climate-related financial risks than in countries with deep and liquid capital markets.

Furthermore, the asset classes that are most relevant in a particular market may not necessarily be those for which climate data are readily available, affecting the operational feasibility of any adjustments that could have a material impact.

Central banks have typically focused on measures that are most material – either from the perspective of the wider economy and/or their balance sheet – and where decision-useful climate-related metrics are more readily available. Central banks that aim to contribute to the mitigation of climate change often focused on operations linked to parts of the economy that were in particular need of decarbonisation (e.g. loans to the coal industry, residential real estate). As a result, they would adjust the way in which claims on these parts of the economy are treated in their monetary policy operations. Central banks that aim to limit climate-related financial risks to their own balance sheet were more likely to prioritise based on the size of their own exposures rather than based on the importance of the asset

class in the wider economy. Where a range of operations was considered to be materially impacted by climate considerations, central banks sometimes prioritised those where decision-useful climate-related metrics were most readily available (e.g. corporate bond purchase schemes).

The availability of decision-useful metrics depends heavily on the type of entity that a central bank is trying to assess. When adjusting the pricing of their credit facilities, central banks may want to consider either the climate characteristics of their counterparty (e.g. a commercial bank) or the real-economy borrower that the counterparty lends to (e.g. a corporate). When adjusting collateral policies, the central bank may want to assess the climate characteristics of the issuer of the collateral (e.g. the corporate that has issued a bond). And when adjusting asset purchase schemes, the central bank would typically want to assess the climate characteristics of the issuer of these assets (e.g. a sovereign that has issued a bond). The availability of decision-useful metrics varies significantly across these different types of entities.

As a result, central banks have focused on specific types of exposures. Table 3 below demonstrates that measures taken so far have typically relied on assessing non-financial corporates and real estate. For example, rather than adjusting the haircuts and/or eligibility of all types of collateral, central banks have focused on collateral linked to real estate or non-financial corporates. Conversely, there are no

prominent examples for central banks assessing sovereigns or financial institutions, and adjusting their operations in a way that reflects these assessments. This might reflect the fact that central banks have less scope to adjust exposures to sovereigns or financial institutions (e.g. by limiting the eligibility of certain sovereign issuers in their asset purchase schemes, or restricting the eligibility of certain financial counterparties in their credit operations) without negatively impacting their monetary policy objectives.

But it may also be an indication of the lack of decision-useful metrics for assessing sovereigns and financial institutions. This lack of decision-useful metrics can either reflect a lack of raw data (e.g. reliable Scope 3 emissions for financial institutions) or a lack of analytical work (e.g. quantitative estimates of the financial impact of climate factors on sovereigns) and in the case of sovereigns, an additional important element is that the compliance with the climate targets depends on the climate policies put in place by governments.

Early experiences also demonstrate that certain measures may become more or less relevant as a central bank's monetary policy stance changes. Central banks need to adjust their monetary policy stance depending on the macroeconomic environment. When interest rates move away from the ZLB, central banks would typically reduce the size of their balance sheet, which reduces the scope for green lending operations and tilting asset purchases¹³.

Table 3 Measures taken so far by type of exposure being assessed

| | | Credit operations | | | Collateral | | | | Asset purchases | | |
|-------------------------|--------------------------|--|---------------------------------|---------------------------------------|---------------------|--------------------|--------------------|---------------------------|-----------------|--------------------|--------------------|
| | | Adjusting pricing based on type of lending | Adjusting pricing to collateral | Adjusting counterparties' eligibility | Haircut adjustments | Negative screening | Positive screening | Aligning collateral pools | Tilting | Negative screening | Positive screening |
| Exposure being assessed | Non-financial corporates | 1 | | | 1 | 1 | | | 2 | | |
| | Real estate | 1 | | | | | | | | | 1 |
| | Sovereigns | | | | | | | | | | |
| | Financials | | | | | | | | | | |

Note: Table excludes measures taken by the Bank of Japan as the Bank of Japan leaves it to financial institutions to assess exposures. Exposures deemed "green" could include a wide range of different exposures, including exposures to real estate, non-financial corporates, other financial institutions, or sovereigns.

13 Central banks may want to review whether to withdraw certain climate measures in an environment where interest rates are above the ZLB, given their reduced relevance and any fixed costs of maintaining them throughout the monetary policy cycle.

Conversely, central banks may have meaningful scope to make changes to their collateral policy regardless of the monetary policy environment. Such measures are likely to become more relevant in the context of a tightening cycle, as liquidity provided via non-standard instruments is withdrawn and financial institutions become more reliant on accessing liquidity via central banks' collateralised lending operations. This notwithstanding, there may also be a cyclical element as central banks may choose to unwind non-standard collateral policies and return to using a narrower set of collateral.

2.2 Challenge #2: Calibration – How much weight to put on climate factors, relative to other considerations?

Most central banks surveyed by the NGFS judge that, in principle, considering climate-related factors as part of their monetary policy and/or risk management frameworks is covered by their mandates. Up to 70% of central banks surveyed by the NGFS in 2022¹⁴ judged that their mandates provide scope for adjusting their operational frameworks to integrate climate-related issues¹⁵.

But central banks still need to determine how much weight they should put on these climate-related factors – and what this implies for the calibration of any climate-related adjustments to their monetary policy operations. For instance, central banks need to determine how aggressively to tilt asset purchase schemes towards low-carbon issuers; or the preferential lending rate that they offer as part of any green lending operations.

Where central banks try to protect their own balance sheet from climate-related financial risks, the appropriate calibration of tools depends in part on the complex trade-off between managing climate-related financial risks, any potential impact on the effectiveness of monetary policy, and any potential increase in the exposure to other financial risks. As discussed in the 2021 report, there can be trade-offs between risk management and a central bank's monetary policy objectives. For example, large adjustment to valuation haircuts or heavy

restrictions on collateral eligibility to account for climate-related financial risks could reduce financial institutions' ability to draw on central bank facilities, and could impair the monetary transmission mechanism. The extent to which this constitutes a risk will depend on whether there is enough collateral that is not materially exposed to climate risks and that banks could pledge. There can also be trade-offs between managing climate-related and other financial risks. For example, tilting asset purchases towards greener issuers may reduce a central bank's exposure to transition risks. But excessive tilting could lead to significant increases in concentration risk. Both of these trade-offs may inform how central banks calibrate any climate adjustments in their monetary policy operations.

Where central banks intend to contribute to the mitigation of climate change, considering the potential trade-offs between climate objectives, monetary policy effectiveness and exposure to financial risk may be particularly relevant. Central banks that aim to contribute to mitigating climate change have often done so by providing concessionary lending rates and/or haircuts for green assets, rather than by penalising less climate-friendly assets. This can expose central banks to additional financial risks and reduces their ability to replenish financial resources. This may also have an impact on the effectiveness of monetary policy operations. Central banks need to carefully consider these trade-offs when deciding on the calibration of any "concessionary" rates or haircuts. This is in addition to the monetary policy trade-offs and communication challenges that any "concessionary" lending rates would pose during a tightening cycle.

It is not always possible to fully quantify these trade-offs. Central banks have addressed this challenge by initially taking a cautious approach, while signalling that they may "escalate" actions over time. Many of the actions seen so far have been designed to minimise the impact on monetary policy objectives and/or other sources of financial risk. For example, even after starting to tilt their corporate bond purchase schemes, central banks have typically continued to invest in a wide range of issuers. This has helped limit any increase in concentration risk, while preferential haircuts for green bonds have tended to be moderate. At the same time, a number of central banks indicated that they would be inclined to "escalate" actions over time, as they conduct regular reviews

14 See NGFS (2023).

15 See Chart 5 in NGFS (2023).

and gain experience on the effectiveness and any unintended consequences of their measures. Often, central banks have also tied escalation to developments in public policy.

2.3 Challenge #3: Data limitations – How to deal with imperfect and incomplete data?

2.3.1 Data granularity

In the context of scenario analysis exercises, central banks have put significant weight on top-down analysis that is informed by macroeconomic scenarios, such as the NGFS scenarios. Where possible, scenario pathways have been downscaled (e.g. to the level of individual countries) to more closely capture the specific exposures that central banks have. Grounding the analysis in clear macro scenarios helps ensure that it is consistent across different asset classes, while also providing a good level of granularity.

When it comes to adjusting their monetary policy operations, central banks have tended to put more weight on bottom-up assessments of specific assets.

In particular, central banks relied on asset/issuer-specific data such as GHG emissions, green bond labels, or energy efficiency ratings for residential properties to distinguish between green and non-green assets and treat these assets differently. This approach helps central banks compare the climate characteristics of specific assets within the same asset class, and to adjust their operations without fundamentally rethinking the asset classes they want to be exposed to. This sort of approach has been crucial in allowing central banks to make meaningful near-term progress in terms of greening their monetary policy operations. This is particularly true in advanced economies where asset/issuer-specific data is more likely to be available.

This approach has allowed central banks to adjust monetary policy operations in a robust and pragmatic way. But it can make it more difficult to ensure coherence across different tools and interventions. For example, central banks that aim to reduce climate-related financial

risks to their balance sheets may decide to limit the eligibility of corporate bonds of carbon-intensive issuers as collateral. But to the extent that these adjustments are exclusively based on asset-class specific bottom-up analysis, it can be difficult to judge what steps a central bank should take with respect to other types of collateral to ensure a similar level of climate resiliency.

The practices reviewed as part of this report suggest that some central banks have taken steps to address these challenges by combining bottom-up and top-down assessments. For example, some central banks that performed scenario analysis on their balance sheet have started with top-down scenarios, but then used asset-specific data on corporates to extrapolate impacts to the individual issuer level (e.g. using data on the carbon-intensity of a specific issuer). Other central banks have started with bottom-up assessments of the climate characteristics of specific assets (e.g. of the energy efficiency of residential properties), and then combined this with top-down NGFS scenarios¹⁶ to translate these characteristics into financial risks. However, while such hybrid approaches have been used in the context of scenario analysis and early exploratory work, they have not been used in any of the eight case studies of central banks having adjusted their monetary policy operations.

While combining bottom-up and top-down assessments can ensure a high level of robustness and coherence, such an approach requires significant, asset-class specific investments into data and modelling skills. As such, central banks that have not yet built significant in-house capacity may want to start with conducting individual bottom-up analysis across different monetary policy operations, before starting to systematically link them to consistent macro scenarios.

2.3.2 Choosing the right type of asset-level data

While there is broad consensus to rely on granular, asset/issuer-specific data when adjusting monetary policy operations, central banks have opted for a range of different types of data. These differences largely reflect heterogeneity in the types of data that are available for different markets and/or asset classes.

¹⁶ For example, a central bank might start with a qualitative review of the Energy Performance Certificates (EPCs) of residential properties that it accepts as collateral. This allows for an assessment of which properties are most exposed to energy price shocks. But to translate this qualitative assessment into changes in the probability of default of a mortgage, it may use the NGFS scenarios to consider plausible energy price shocks and the impact that these would have on households' disposable income.

In the context of credit operations, some central banks have asked counterparties to self-certify which assets they consider green. This can be particularly useful in markets where quantitative data on climate performance (such as GHG emissions) are less widely available. And it can limit the extent to which central banks affect the allocation of credit based on their own, judgement-based assessments. However, this approach can give counterparties scope to overstate green credentials and can lead to greenwashing risk. One way of mitigating this risk is to require that counterparties publish their assessment criteria. This would expose counterparties that apply excessively lenient criteria to reputational risk.

Other central banks have relied on third-party assessments of whether an asset is “green”. In a number of cases, central banks provided special treatment for green or sustainability-linked bonds, as long as the bond met a set of clear, transparent criteria of, for example, the Climate Bond Initiative or the International Capital Market Association (ICMA) Green Bond Principles, and where compliance with these criteria was verified via a second-party opinion. This approach is another way of avoiding the need for central banks to apply their own judgement-based criteria, while substantially reducing the risk of greenwashing. One limitation is that these assessments tend to be binary in nature – i.e. they only distinguish between green assets and non-green assets. As such, they provide little nuance. Moreover, the classification of a bond as “green” is generally based on the use of proceeds rather than the issuer’s overall climate characteristics. As such, it may be less relevant for central banks that aim to limit their exposure to climate-related financial risks as there is no reason to think that a green bond is less risky than a conventional bond when both are issued by the same issuer.

Central banks that have already built sufficient in-house expertise would often use raw data that is disclosed by companies to assess climate characteristics. This would often include data on issuers’ current GHG emissions, recent trends for GHG emissions, forward-looking targets, or the extent to which issuers comply with disclosure recommendations and requirements. Central banks typically use a “balanced scorecard approach” that considers a range of different factors in order to approximate the overall climate characteristics of an asset. In the context of risk management objectives, this can be a useful interim step while central banks are still developing

tools to fully translate these metrics into impacts on an exposure’s probability of default or loss given default.

An increasing number of third-party data providers allow central banks to access such raw data at scale. Even when central banks rely on raw data, third-party providers play an important role in gathering and distributing the information disclosed by issuers. This reduces the need for central banks to review each issuer’s disclosures individually and mirrors the role of third-party data providers in the delivery of traditional financial data. However, given the less mature state of the market for climate data, central banks often encounter instances where data provided by third-parties do not accurately capture all disclosed information. Hence, central banks with sufficient in-house resources and expertise may want to check for outliers, and check whether any missing data can be retrieved manually from the issuer’s public disclosures.

In the context of corporate exposures, relying on raw data is inherently easier when conducting “within-sector comparisons” than for “cross-sector comparison”. This is because metrics such as “percentage of electricity generation capacity by renewables” can be extremely useful to assess climate credential in one sector (e.g. electric utilities) but may be meaningless for other sectors.

Central banks have been reluctant to rely on third-parties to provide summary metrics that are based on third-parties’ own, proprietary models. These summary metrics are designed to provide a comprehensive view of the climate-related financial risks that an asset is exposed to (e.g. “Climate Value at Risk”) or the contribution that it makes to mitigating climate change (e.g. “Implied Temperature Rise”). But these metrics are subject to various assumptions, methodologies are not always fully transparent, and the metrics may not be available for all asset classes or individual assets. The trade-offs between comprehensiveness and complexity may explain why central banks have so far been reluctant to put too much weight on these metrics when adjusting their monetary policy operations.

Overall, the case studies suggest that central banks can choose from a range of practical options for assessing an asset’s climate characteristics. For example, where central banks are unable to obtain raw climate data for a given type of assets, they may be able to rely on third-party assessments (such as green bond labels) or self-assessments by their counterparty.

2.3.3 Completeness of asset-level data

When using raw data, central banks often encounter issues regarding data availability. While metrics such as Scope 1¹⁷ and Scope 2¹⁸ GHG emissions are now widely disclosed, there are still notable gaps and data will not be available for every single issuer or assets. These gaps tend to be even larger in emerging market and developing economies.

In the reviewed case studies, central banks have successfully used pragmatic solutions for dealing with missing data. For example, central banks that assessed the GHG emissions of corporate issuers used a “waterfall” approach of filling in missing data. Missing emissions data was imputed using (i) data providers’ estimates of emissions where available; (ii) then data from previous periods

where available; and (iii) then sectoral and/or regional summary statistics, such as averages. It may also be possible for central banks to estimate climate metrics by using their own predictive models. In this context, central banks need to be conscious of the risk of selective non-disclosure – i.e. the fact that issuers that choose not to disclose data may have worse climate characteristics. This can to some extent be mitigated by making more conservative assumptions if no data are available.

Central banks are also commonly using their monetary policy operations to actively contribute to increases in data availability. For example, the publication of climate disclosures is a common requirement for entities to be eligible as part of green lending operations, asset purchase programmes, or collateral frameworks.

17 Scope 1 emissions are direct GHG emissions that occur from sources that are controlled or owned by an organisation (e.g. emissions associated with fuel combustion in boilers, furnaces, vehicles).

18 Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling.

3. Country- and institution-specific challenges and constraints

In addition to the universal challenges set out above, there are a number of complexities and constraints that individual central banks may face as a result of country- or institution-specific factors. Some of these are particularly relevant for emerging market and developing economies. These complexities and constraints did not necessarily feature in the context of the eight aforementioned case studies, but they may nonetheless affect (other) central banks' willingness and ability to incorporate climate considerations into their monetary policy operations.

3.1 Integration into risk management models

Some central banks that want to reflect climate-related financial risks into their monetary policy operations will have to integrate these into their existing quantitative risk models. For example, central banks' collateral haircuts may be a function of a loan's modelled probability of default (PD) and loss given default (LGD). This means that climate-related risks have to be captured in the models that are being used to estimate PD and LGD in order to be reflected in the haircuts.

Depending on the nature of these models, this can pose significant challenges. For example, PD and LGD estimates may be determined using backward-looking data that does not account for climate risks that may be seen in the future. Adjusting these models to account for unprecedented risks is not always straightforward and may require technical expertise that is not easily available. Incorporating additional risk parameters might also entail significant changes in the operational infrastructure, and make it more difficult to formulate a coherent risk appetite. In particular, central banks outside of advanced economies may face resource constraints in terms of making the necessary investments.

That said, some central banks have found ways of overcoming these challenges. This includes the use of different "satellite models" that can translate climate factors into traditional risk factors. For example, a satellite model might be used to assess the impact of a severe transition risk

scenario on a corporate's stressed interest coverage ratio. This can then be fed into traditional models that estimate PD and LGD based on interest coverage ratios. Central banks that are unable to invest into such models may instead opt for alternative approaches, such as judgement-based overlays, to manage climate risks.

3.2 Reliance on external parties

Many smaller central banks rely heavily on external providers and their systems to conduct monetary policy operations. Central banks outside of advanced economies in particular tend to rely on external providers to offer a wide range of services such as collateral valuation, risk assessment, custodial arrangements, and operational support. By outsourcing collateral management functions to external providers, central banks can manage operational complexity, access specialised expertise, and ensure efficient collateral utilisation.

However, this can constrain their ability to implement climate-specific aspects in their operational framework. For example, capturing the climate characteristics of an asset may be constrained by an external provider's systems or technical expertise and the lack of direct interaction with the mobilising counterparty or issuer. Similarly, it may not be possible to translate these characteristics into granular haircut adjustments or eligibility criteria.

To address these challenges, central banks may want to work with external providers to relax these external constraints over time. Given that an increasing number of financial institutions are interested in reflecting climate-related financial risks in their processes, there may be scope to work with external providers to relax various technical and operational constraints on the side of the external provider. In the meantime, taking less targeted approaches – such as setting sufficiently conservative haircuts that are likely to encompass the potential impact of climate risks – can allow central banks to be resilient to climate-related financial risks even if these are not explicitly captured in their risk management frameworks.

3.3 In-house expertise

Some central banks may also face constraints limiting their ability to rely on third-parties to provide climate solutions. The reliance on third-party assessments to determine the terms of monetary policy operations may expose central banks to reputational or legal risks. In addition, unless central banks invest in in-house expertise, reliance on external parties might also create lock-in effects and reduce future strategic flexibility for central banks.

This may be the reason why central banks that have taken action have tended to follow their own, in-house approaches. As set out above, central banks have typically not relied on third-parties to provide comprehensive assessments of climate-related financial risks that assets are exposed to, or of assets' contributions to mitigating climate change. Instead, they have tended to put more weight on in-house assessments.

However, the need to build in-house expertise may affect the speed at which central banks are willing to move.

Some central banks may be prepared to outsource climate assessments to external parties in order to move more quickly. Others may want to build up in-house expertise to make these judgements within the institution itself. Should central banks have sufficient resources to do so, they may still be able to move quickly. However, central banks with less resources may face a trade-off between the need to ensure accountability and the need to move quickly in the light of rapidly increasing climate risks.

3.4 Cross-border leakage

Many assets are eligible for central bank operations in more than one country. While asset purchase schemes tend to be focused on domestic assets denominated in the local currency, many central banks accept a much wider range of assets as collateral. This means that globally active financial institutions have some flexibility around which central bank(s) they post collateral with.

This could risk undermining the effectiveness of climate policies pursued by individual central banks. For example, if one central bank were to charge higher interest rates when lending against collateral with poor climate characteristics, then globally active financial institutions might attempt to use this collateral in jurisdictions that they consider to be more lenient.

However, those central banks that have already taken action appear to have avoided such “leakage” effects.

This may have been achieved by focusing on domestic assets that are unlikely to be eligible in other central banks operations (e.g. corporate bond purchase schemes primarily purchase bonds issued by domestic issuers and denominated in the local currency)¹⁹. Concerns around potential “leakage” may also explain why central banks have so far been more likely to provide concessionary conditions for green assets than to apply a penalty treatment for less climate-friendly ones.

3.5 Others

There are a range of other challenges that are particularly relevant for emerging market and developing economies.

This includes, but is not limited to, challenges around managing any interaction between climate-related factors and broader development mandates or the management of fixed exchange rate regimes.

¹⁹ A related reason for focussing on domestic assets is that relevant climate data may be less readily available for foreign assets, given cross-country differences in disclosure requirements and data availability.

Conclusion

Central banks have made material progress in addressing many of the challenges associated with considering climate-related factors in their monetary policy operations. Many of the measures that central banks have taken over the last years were originally deemed to face meaningful operational challenges (see 2021 report). While it is too early to fully assess the effectiveness of the steps that central banks have taken, the fact that some central banks have managed to implement a wide range of measures spanning across all categories identified in the 2021 report suggests that operational challenges may be more manageable than initially expected.

Central banks have prioritised climate-based actions considering factors such as materiality and data availability. Central banks that aim to limit climate-related financial risks to their own balance sheet prioritised based on the size of their own exposures, while central banks that aim to support the transition to a low-carbon economy focused on the importance of the targeted asset class in the wider economy. In addition, central banks have considered data availability when determining areas of strategic focus.

While central banks have initially followed a cautious and gradual approach, some central banks have signalled that policies will “escalate” over time. Climate-based adjustments to monetary policy operations typically give rise to trade-offs. Given that the materiality of these trade-offs is uncertain, many central banks have taken a cautious and gradual approach. It would be expected that central banks learn more about these trade-offs over time, and start taking more robust action.

Central banks found pragmatic solutions to overcome data availability issues, and the multitude of approaches developed so far offer significant flexibility. For example, central banks that assess the GHG emissions of corporate issuers used a “waterfall” approach of filling in missing data. Central banks have also constructed climate scores for issuers to capture several dimensions of an issuer’s climate performance. These typically include an issuer’s backward-looking carbon intensity, forward-looking decarbonisation targets and the quality of an issuer’s climate-related disclosures. And where central banks are unable to obtain GHG emissions or other forms

of raw climate data for a given type of assets, they may be able to rely on third-party assessments (such as green bond labels) or self-assessments by their counterparty. However, assessing the climate characteristics of sovereign and financial bonds remains challenging.

Based on the experiences so far, there appears to be no reason to revise the 2021 assessment of the relative effectiveness or simplicity of different adjustments.

The 2021 NGFS report laid out a number of challenges and trade-offs faced by central banks willing to take action. Based on reviewing a number of case studies, some of the operational challenges that were anticipated in 2021 can be overcome. As such, the operational feasibility of taking action may be higher than initially expected. When comparing the different types of measures that central banks can take, the experiences gathered over the past years do not appear to warrant a reassessment of the relative ease of making adjustments to, for example, asset purchases vs. credit operations. Hence, central banks will likely continue to prioritise different measures based on their mandates, as well as local circumstances.

That said, the case studies reviewed in this report also point to the need for further analysis going forward.

Three specific areas that warrant further analysis have been identified:

- **First, central banks may want to develop frameworks for assessing the effectiveness of existing measures.** These impact assessments will allow these central banks to continuously adapt and refine their current methodologies in the light of their effectiveness. It will also help ensuring that any newly introduced measures do not only leverage latest developments in data availability and scientific knowledge, but also the practical experiences with previous measures.
- **Second, central banks may in the future consider how to incorporate climate change considerations into liquidity management tools that focus on the liability side of central banks’ balance sheets.** This could be particularly relevant for central banks that operate in an environment of a structural liquidity surplus and could constitute a fourth channel of potential future central bank action alongside asset purchases, credit operations and collateral.

- **Finally, further work may be needed to better understand how to best integrate climate change considerations into monetary policy operations during periods when interest rates are above the ZLB.**

Many of the case studies analysed involve measures that are most appropriate during periods when the central bank embarks on non-standard monetary policy measures that typically increase the size of the balance sheet. This includes tilting asset purchase schemes towards greener issuers, or introducing new green lending

schemes. But in periods when interest rates are above the ZLB and central bank balance sheets shrink there is less scope for such measures. Future work by the NGFS may hence want to put more weight on other, more structural aspects of monetary policy operational frameworks, such as collateral policies or the composition of permanent monetary policy portfolios. That said, some central banks have indicated that they expect to continue to hold meaningful “structural” asset portfolios, the composition of which may reflect climate considerations.

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