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Net-zero central banking:
A new phase in greening the financial system

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Policy report

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Key messages and summary recommendations

Reaching net-zero greenhouse gas emissions is a critical goal of climate policy. Across the world, growing numbers of governments are introducing targets and plans to achieve net-zero around the middle of this century. Alongside this, leading banks and investors are committing to align their portfolios with net-zero by 2050. As guardians of the financial system, central banks and supervisors also need to introduce explicit strategies to support the transition to net-zero as the next stage in confronting the risks of climate change.

The rationale for central banks and supervisors is two-fold: first, achieving a net-zero economy is the best way of minimising the risks of climate change to the stability of the financial system and the macroeconomy; and second, central banks and supervisors need to ensure that their activities are coherent with net-zero government policy. The first signs of financial authorities starting to align their operations with net-zero are beginning to emerge; a systematic approach is now required.

Recommendations for central banks and supervisors to adjust current approaches and measures in line with net-zero

i. **Strategy:** Central banks and supervisors need to develop a net-zero roadmap including long-term expectations and near-term actions. This would include the promotion of liaison and coordination between central banks, supervisors and policymakers on net-zero.

ii. **Prudential regulation:** Prudential supervisors should make net-zero a core element of supervisory practice at micro and macro levels, aligning supervisory expectations and prudential instruments with net-zero. This could involve requiring all regulated financial institutions to submit net-zero transition plans, as well as addressing climate risks in regulatory ratios. Disclosure frameworks such as that of the Task Force on Climate-related Financial Disclosures (TCFD) will also need to include net-zero.

iii. **Scenarios:** Forward-looking scenarios need to become more consistent with a net-zero pathway to limiting warming to 1.5°C. Central banks and supervisors need to signal clearly that they are not indifferent to the outcome (e.g. whether net-zero is achieved or not) and complement long-term scenarios with short-term outlooks.

iv. **Monetary policy:** Central banks need to consistently integrate climate change into monetary frameworks and models to adequately account for the impacts of climate change on macroeconomic outcomes. In addition, central bank instruments and policy portfolios need to become operationally aligned with net-zero.

v. **Portfolio management:** Sustainable and responsible investment practices for central banks' portfolios should include a net-zero target and central banks should each publish a transition plan to achieve this.

vi. **Just transition:** Central banks should explore the implications of net-zero for jobs and livelihoods to mitigate potential downside sectoral and regional consequences.

vii. **International cooperation:** Net-zero needs to be incorporated into key international financial and regulatory frameworks and processes. There is also potential for partnerships with multilateral development banks in developing and emerging economies.

1. Introduction: The race to net-zero finance

Achieving net-zero[1] greenhouse gas emissions is a critical goal of climate policy, alongside strengthening resilience to physical shocks and ensuring that the transition process is fair and just. Limiting global warming to 1.5°C with no or limited overshoot requires global CO_2 emissions to reach net-zero by 2050 and other non-CO_2 emissions to decline substantially. To deliver this, credible emission reduction pathways are needed at the level of individual institutions as well as at the whole-economy level. Accelerating the shift to this 1.5°C net-zero economy by mid-century is emerging not only as a desired core outcome for the COP26 climate summit scheduled for November 2021, but also as a way of delivering a successful recovery from the COVID-19 pandemic.

Finance is critical to achieving this transition. Indeed, Article 2.i.c of the 2015 Paris Agreement set out the goal of "making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development" (UNFCCC, 2016). Across the financial system, a small but growing number of banks and investors are committing to align their portfolios with net-zero by 2050. However, as highlighted by Mark Carney, the UN Special Envoy on Climate Action and Finance, current calculations suggest that "the financial system as a whole is funding temperature increases of over three degrees centigrade" and there is "a striking gap between what society wants and what the market values" (Carney, 2020a).

Central banks and financial supervisors continue to deepen their work to respond to the risks of climate change. Membership of the Network for Greening the Financial System (NGFS) has grown more than tenfold from eight institutions since its launch in December 2017. Increasing efforts are being taken by these authorities to manage the risks posed by climate change to financial and monetary stability. This report identifies the early steps that some financial authorities have taken. However, few, if any, have so far set out the role that they will play in building a net-zero financial system. With 127 countries adopting or considering a net-zero target (CAT, 2020), it is becoming imperative for central banks and supervisors to establish their approach to net-zero. A clear net-zero strategy will be crucial for central banks to deliver on their mandated goal of safeguarding macrofinancial stability and ensuring policy coherence.

Net-zero is clearly only one part of the wider agenda of greening the financial system. Nonetheless, it is a priority that requires a strategic response from monetary and financial authorities.

This report is a first attempt to examine the role that central banks and financial supervisors could play in supporting the transition to net-zero. It will be followed by a second report focused specifically on European institutions and we plan for further work to examine how net-zero can be adopted in other parts of the world and as part of international financial frameworks.

The report starts by reviewing the steps taken by private financial institutions to align their lending and investment portfolios with net-zero. We then present the case for net-zero central banking before providing recommendations for action across seven areas of central bank and supervisory practice.

[1] The term 'net-zero' refers to the target of reducing the greenhouse gas emissions that cause global warming to zero by balancing the amount released into the atmosphere from sources with the amount removed and stored by carbon sinks. This is also described as 'carbon neutrality' and sometimes 'climate neutrality'. See www.lse.ac.uk/granthaminstitute/explainers/why-is-net-zero-so-important-in-the-fight-against-climate-change/ for a full 'Explainer' about net-zero.

2. The growing financial momentum for net-zero

Impetus from the *Special Report on 1.5 Degrees*

The scientific evidence contained in the *Special Report on 1.5 Degrees* published by the Intergovernmental Panel on Climate Change (IPCC) in 2018 was pivotal in directing the world – and the financial sector with it – onto a path to net-zero. The IPCC report revealed the severe consequences of allowing planetary temperatures to rise beyond a threshold of 1.5°C above pre-industrial levels (IPCC, 2018) and led to a growing recognition that net-zero emissions would need to be achieved by 2050 to limit global warming to this level.

A quantitative target for banks and investors

For banks and investors, net-zero has translated the high-level climate ambition of the 2015 Paris Agreement into a quantitative target against which institutions can measure and manage their portfolios. Rising public pressure on financial institutions to respond at a level commensurate with the urgency of the climate crisis has prompted leading investors and banks to recognise that the only way in which they can deliver their long-term promise to savers, beneficiaries, clients and society at large is through a strategy aligned with 1.5°C.

In light of this, investors and banks are making both individual and collective commitments to net-zero. The UN-convened Net-Zero Asset Owners Alliance has led the way, bringing together more than 30 pension funds and insurers with over US$5 trillion in assets (UNEP FI and PRI, 2020a). One survey suggests that by the end of 2020, 44% of insurance firms and 33% of pension funds had a 2050 goal, up from none at the beginning of the year (Flood, 2020).

Banks have followed, often prompted by the self-same investors to take action. Nearly 40 banks with over $15 trillion in assets have supported a collective commitment to action and started to report on progress (CCCA, 2020). Asset managers have also established their own net-zero coalition to support the goal of net-zero emissions by 2050 or sooner, in line with global efforts to limit warming to 1.5°C (NZAM, 2020). What is striking is that these commitments are made by institutions governed by fiduciary duty and pursuing shareholder value.

Short-term actions and benchmarks

Intensive work is underway to translate these crucial but distant targets into the operational steps that drive carbon out of global financial flows (IIGCC, 2020). Investors are supplementing their high-level goals with the development of a net-zero benchmark they will use to assess the adequacy of measures taken in the largest carbon-intensive firms (Climate Action 100+, 2020). As part of this, a critical step is for financial institutions to identify the short-term actions that they will take – in the next five years, for example – to bend the curve of emissions through to 2050 (UNEP FI and PRI, 2020b).

Approaches for measuring, evaluating and reporting net-zero alignment are under development, but remain relatively new and at an early stage of evolution (Portfolio Alignment Team, 2020; Science Based Targets, 2020). And the adequacy and integrity of the measures taken by financial institutions is receiving scrutiny (Hay, 2020).

Finally, in the run-up to COP26, Mark Carney, in his role as UN Special Envoy on Climate Action and Finance, has outlined key priorities for intensifying action on net-zero alignment, particularly as part of the Returns pillar of his strategy for private finance (Carney, 2020b).

Matching national-level commitments with net-zero finance plans

A critical driver for financial sector action is the credibility and ambition of the net-zero targets and policies of governments. Two years ago, none of the world's major economies were committed to net-zero, even though the target is an implicit part of the Paris Agreement. In June 2019, the UK was the first G20 country to set a legally binding target of net-zero emissions by 2050, a step that was followed by commitments to achieve net-zero by 2050 by the European Union, Japan and South Korea. In September

2020, China pledged to achieving net-zero by 2060 in a potentially transformational step, signalling how the world's current largest emitter and the economy that will be the largest by mid-century intends to rise to the challenge. Equally significant is the new commitment made by President Biden to commit the USA to climate neutrality by 2050. In total, 127 countries responsible for around 63% of emissions are considering or have adopted net-zero targets (CAT, 2020).

These net-zero commitments at the national economy level need to be matched by defined plans to build net-zero financial systems (Robins, 2020). Importantly, to meet 2050 goals, capital investment in net-zero technologies needs to be frontloaded in the 2020s and early 2030s. In the UK, for example, extra investment needs to grow five-fold from around £10bn per year in 2020 to around £50bn in 2030, before peaking in 2035 (ibid.). Financial system actions are needed to complement real economy measures by governments. This is where central banks and financial supervisors need to consider the role they can play in supporting the transition to net-zero.

3. Why should central banks and financial supervisors act on net-zero?

Over the past five years, central banks and supervisors have become increasingly involved in responding to the threat that climate change poses to the financial system. This has involved both catching up with financial sector leaders in terms of acknowledging and responding to climate-related financial risks and stimulating far broader consideration of climate factors across the financial system. Financial authorities are now signalling an array of new expectations in terms of micro- and macroprudential management, and, increasingly, are considering how to adjust monetary policy and the management of their own portfolios. Central banks and supervisors have been clear that responding to the catastrophic threats of climate change is fully in line with their existing mandates. Much of the current generation of actions taken by central banks and supervisors was, however, framed without a clear positioning on net-zero and the 1.5°C target.

Central banks and supervisors now need to take a strategic stance on net-zero. These institutions have specific mandates and the net-zero target will need to be calibrated to reflect these policy and institutional frameworks. While there is significant variation in central bank mandates, our view is that no change in legal mandate is required for net-zero central banking. Conventions and interpretations will, however, have to be rethought in light of the challenges posed by achieving net-zero.

While action by banks and investors is primarily driven by their fiduciary duties and aims to deliver returns for key stakeholders (including their shareholders), central banks and supervisors will need to take a systemic perspective, addressing both micro- and macroprudential risks, and, by implication, working to ensure that all financial flows become aligned with net-zero. They also need to 'walk the talk' so that their own policies and operations are consistent with net-zero.

A dual rationale

The rationale for doing this is two-fold: first, net-zero is the best way of minimising the risks of climate change to stability of the financial system and the macroeconomy; and second, central banks and supervisors need to ensure that their activities are coherent with net-zero government policy.

i) Macroeconomic and financial stability

For central banks and supervisors, the pursuit of their core financial and price stability objectives provides a strong rationale for aligning their own operations as well as the financial systems they oversee with net-zero.

To start with, a net-zero economy should cease being regarded as simply one option among many in terms of potential climate outcomes. Instead, net-zero needs to be seen as the outcome that will best enable central banks and supervisors to deliver their prudential and monetary goals over time. The ability of central banks and supervisors to mitigate climate risks and safeguard macroeconomic stability will become progressively impaired, especially so in a beyond-1.5°C scenario, threatening the functioning of the financial system and the macroeconomy (Van Tilburg and Simić, 2021).

The fact that achieving net-zero in ways that are aligned with 1.5°C of warming is the best outcome for the stability of the financial system does not make it the most likely – far from it. Doing all that they can to ensure that the financial system becomes aligned with 1.5°C becomes a way for central banks and supervisors to provide a quantitative target around which to organise climate interventions. This requires central banks and supervisors to focus on the prudential issues that arise from delivering as smooth a transition to net-zero as possible across financial markets. Vigilance is needed to respond to both potential issues of 'stranded assets' in high-carbon sectors and possible 'green bubbles' in growing clean economy sectors (Semieniuk et al., 2021). Setting a clear strategy for net-zero would greatly enhance the chance of realising an 'orderly' scenario, in contrast to a 'disorderly' scenario or even 'hot house world' or 'too little, too late' scenarios, as described by the NGFS (2019).

With their oversight of the financial sector and the macroeconomy, central banks and supervisors are also well placed to identify macrofinancial risks stemming from the net-zero transition and can provide advice to governments on addressing these risks (Volz, Beirne et al., 2020). Using their role as guardians of the financial system, central banks need to ensure that the financial sector at large aligns with net-zero targets, which would also accelerate the transition in the real economy and help to avoid macroeconomic and financial instability in the future.

Furthermore, there are specific challenges that can only be addressed at the system level, not least the 'tragedy of the horizon' – the lag between the actions of financial institutions and the impacts in terms of catastrophic and irreversible climate damage (Carney, 2015). To date, climate scenarios have been developed as a way to bring the future into today's financial decision-making. But given the front-loaded nature of the net-zero investment challenge, the next task for businesses, financial institutions and also financial authorities is to supplement these long-term perspectives with tools focused on the action that is needed in the near term. The shape of the decarbonisation curve is critical to climate success and understanding how this is delivered in reasonable increments of time that link to the business cycle is key. UK policymakers, for example, have found that setting five-yearly carbon budgets is an effective tool for translating long-term climate goals into tangible action. A similar approach is now needed from financial authorities, building on the initial work from leading financial institutions, to ensure credible and consistent strategies for translating 2050 targets into 2025 and 2030 plans by regulated firms.

Clearly stating that central bank climate policies are oriented around the goal of net-zero from a stability perspective has a number of systemic advantages. It would help to provide clarity and predictability in the marketplace. It would also serve to prevent the possibility for firms to game narrowly defined risk-based strategies. It also builds on the concept of double materiality, which is gaining increasing traction in financial decision-making. This means that financial institutions need to understand and manage not only the risks that environmental factors pose for their balance sheets and operations, but also the risks that their activities create in terms of intensifying climate change. Double materiality is highly relevant for the way in which monetary and financial authorities can consider their role in achieving net-zero. For example, in terms of monetary policy operations, central banks should take care to avoid providing liquidity to operations that are inconsistent with net-zero; failing to do so would intensify carbon risk on central bank balance sheets and in the wider financial system that could then reverberate back in the future.

As a result, in order to fulfil their core stability objectives in the long term, central banks must take a more proactive stance to foster the needed net-zero transition. Doing this would mark a material shift in emphasis from current approaches, but one that would be fully consistent with their mandate.

ii) Policy coherence

In addition to their core mandates for price and financial stability, many, but not all, central bank mandates include a secondary objective to support the economic policies of their government, provided this does not interfere with the achievement of their primary goals (Dikau and Volz, 2021). In countries where governments have set a net-zero target, this means that central banks ought to make net-zero their baseline assumption when assessing future macroeconomic and financial risks to ensure consistency of their activities with government policies and targets. As Frank Elderson, member of the European Central Bank's Executive Board, has highlighted: "The Treaties [the Treaty of the European Union and Treaty of the Functioning of the European Union] gave the ECB the – sometimes overlooked – obligation 'to support the general economic policies in the Union'" (Elderson, 2021). These policies include, as stated in the Treaties, sustainable development and environmental protection. This support should be provided "without prejudice to the primary objective of price stability", Elderson adds, and should not encroach on the competences of other authorities responsible for environmental policy.

Central banks with a secondary mandate to support government economic policies in a jurisdiction where the government has committed to net-zero should therefore play a catalytic role in supporting the zero-carbon transition. Making this happen can require governments as well as central banks to define the new focus on net-zero. In the UK, for example, this has been done by adjusting the annual remit letters sent by the Government to the Bank of England's Financial Policy and Monetary Policy Committees: the 2021 letters make clear that the Government's economic policy includes "structural

reform ... to transition to an environmentally sustainable and resilient net-zero economy" (HM Treasury, 2021a & b). In Sweden, the Sveriges Riksbank has stated that its goal to support the general economic policy of the Swedish government tasks it to support achieving sustainable growth and high employment, assuming that these targets are compatible with its other objectives (Sveriges Riksbank, 2020). In the EU, the European Central Bank needs to explicitly identify how it can support the delivery of the Union's commitment to climate neutrality by 2050 throughout its operations in a way that does not impair the delivery of its other objectives (see Elderson, 2021). In the context of the Eurosystem, monetary policy tools have to be delivered in the context of the Union's goal of climate neutrality.

The imperative of net-zero policy coherence has been accentuated by the COVID-19 crisis, which has produced a broad-based consensus from policymakers and leading central banks on the need to support a green and inclusive recovery from the pandemic (Hepburn et al., 2020). So far, however, few central banks have explicitly incorporated climate factors into their crisis response measures (Dikau et al., 2020). Committing to aligning their activities with net-zero therefore will be an essential early step during 2021 to support a green recovery that fast-tracks climate action this year and over the decade ahead.

Signalling expectations

Taken together, the dual rationale of safeguarding macroeconomic and financial stability and ensuring policy coherence provides a strong foundation for central banks and financial supervisors to take a proactive stance on the net-zero transition. In this context, it is important to highlight that the actions – as well as inactions – of central banks and supervisors inevitably have an impact on expectations and behaviour in financial markets and can indeed shape markets. Markets respond to signals from central banks, and the seriousness of intent with which they consider net-zero targets is likely to have a profound bearing on financial market decisions that will ultimately determine capital formation and, thus, the carbon trajectory of the economy. As a result, there is a path dependency to actions taken today by central banks and market actors alike. It is crucial to avoid path dependency in financial markets and the economy that inhibits an orderly transition to net-zero.

4. Recommendations

Developing a credible and effective approach to net-zero will involve actions from central banks and supervisors at a number of levels. To take this agenda forward, we have identified seven recommendations to make net-zero a reality across central bank and supervisory practice, summarised in Figure 1 and detailed below.

Figure 1. Implementing net-zero central banking – seven action areas

i) Strategy and policy coordination

- Develop a net-zero strategy, with a roadmap of actions including long-term expectations and near-term actions
- Promote liaison and coordination between central banks, supervisors and policymakers on net-zero

ii) Prudential regulation

- Require all regulated financial institutions to submit net-zero transition plans
- Upgrade TCFD disclosure to include net-zero

iii) Scenarios

- Adjust long-term scenarios to be 1.5°C aligned and complementary with short-term outlooks

iv) Monetary policy

- Incorporate net-zero into monetary policy frameworks and operations
- Set clear net-zero crtieria for collateral, refinancing and asset purchase programmes

v) Portfolio management

- Adopt a net-zero target for own portfolios and publish a transition plan detailing how to achieve it

vi) Just transition

- Explore the implications of net-zero for jobs and well-being
- Connect central banks' macrofinancial stability and employment objectives to the climate risk and net-zero agenda

vii) International cooperation

- Incorporate net-zero into international frameworks, including the integration of climate-related considerations into the IMF's surveillance function, technical assistance and lending facilities
- Coordinate with multilateral development banks, especially in emerging and developing economies where central banks and supervisors face particular challenges around net-zero
- Build on networks such as the NGFS to develop common strategies

i) Strategy and policy coordination: introduce a net-zero roadmap

First and foremost, central banks and supervisors need to formally signal the evolution of their climate strategy so that the financial institutions and systems they oversee are aligned with net-zero by 2050. Setting out the direction and speed for climate action of the financial industry and systems they oversee is crucial. This could be done by developing a roadmap that takes a sequential approach to the role of central banks and supervisors in achieving net-zero. Such a roadmap could include the rationale for action, long-term expectations and near-term actions, including steps to achieve alignment of their own operations, as well as wider capital flows within the financial system. The example of the UK's remit letters highlights the importance of clear and accountable communication for citizens and markets: formal statements could reinforce operational cooperation between financial regulators and policymakers (De Boer and Van 'T Klooster, 2020; Van 'T Klooster, 2021).

In many regards, financial institutions need clear signals from central banks and supervisors concerning expectations on net-zero pathways, including transition scenarios, alignment targets and timeframes. In

addition, central banks and supervisors will need to play a key role in shaping the tools, methodologies, data systems and taxonomies required for net-zero. Financial authorities can help to consolidate trusted and efficient approaches that both support the net-zero transition plans at the institutional level and ensure that these contribute to overall system stability and effective capital deployment in the real economy.

Central banks receive their mandates from governments and close liaison in delivering net-zero will be crucial to deliver the shift at speed and scale, and with stability. Providing independent advice to governments on what the financial system needs to do to facilitate the transition will be a vitally important role for central banks and supervisors, in terms of real economy policies (e.g. carbon pricing), but also in terms of financial system reforms to achieve an effective intermediation of net-zero investment. Retrofitting Europe's building stock is a case in point, where building regulations, public finance as well as the prudential supervision of mortgage portfolios need to be aligned.

ii) Prudential regulation: make net-zero a core element at micro and macro levels

Prudential supervisors across banking, investment, insurance and capital markets have played an important role in setting broad expectations for regulated firms in terms of managing physical and transition risks. A growing number of central banks and supervisors are making clear the levels of competence they expect from regulated firms in terms of managing these risks (Bank of England, 2019a). This setting of expectations needs to be extended to net-zero.

One way of implementing a net-zero approach through supervisory policy would be to require all regulated financial institutions (banks, insurance firms, pension funds, asset managers) to submit net-zero transition plans (Caldecott, 2020; Robins, 2020). Transition plans can serve as an important risk management tool and should be required by supervisors from financial institutions as evidence of the ability to manage the risks from a net-zero transition. Transition plans are important for microprudential supervision as they help to establish a strategic approach to climate risk management. As well as setting out long-term targets, net-zero transition plans from financial institutions would need to include shorter-term outlooks on the positioning of firms over five-year periods (including steps to reduce fossil fuel exposure and increase green assets). Alongside the prudential purpose, there is a strong financial conduct case for supervisors to ensure the credibility of transition plans to ensure that users of financial services are treated fairly. Importantly, central banks and supervisors will not only need to understand the alignment of individual institutions, but also develop an aggregate assessment of the financial system as a whole (Bank of England, 2020a).

Authorities would then act to manage the financially-related risks of these exposures and signal the need for action by misaligned firms, for example through the use of adjustments to capital requirements and risk buffers. In effect, supervisors would be focusing on the risk of *not* achieving net-zero and the consequences that this will have for both micro- and macrofinancial stability. Ultimately, a net-zero approach would require prudential policy to put a higher risk weight on assets that are not compatible with net-zero for prudential reasons.

Strengthening disclosure standards

In terms of disclosure requirements, which provide the basis for numerous prudential measures, the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) are the most widely accepted framework. The TCFD's most recent guidance on scenario analysis (TCFD, 2020a) and its consultation on forward-looking metrics (TCFD, 2020b) acknowledge the relevance of net-zero due to growing demand from investors. However, to make the TCFD an adequate disclosure framework for net-zero prudential policy and for helping manage systemic climate risk in the financial system, net-zero needs to be made a core component of all four pillars of the TCFD recommendations.

Furthermore, the concept of 'double materiality' needs to be incorporated into the TCFD. This concept has been introduced by the European Commission as part of the Non-Binding Guidelines on Non-Financial Reporting Update (NFRD) to address financial as well as environmental and social materiality and account for the fact that an organisation's impact on environmental and social outcomes can have financially material consequences over time (European Commission, 2019). While there is an ongoing

debate about how to utilise climate risk disclosure as a foundation to directly support the transition to net-zero, further coordinated efforts by central banks and supervisors are needed "to create internationally consistent, comparable, and decision-useful reporting that the financial system needs" (Schapiro, 2021). On a global level, the strengthening of disclosure and sustainability standards is key and the announcement by the International Financial Reporting Standards (IFRS) Foundation to possibly establish a sustainability standards board at COP26 in November 2021 is an important step.

The nature of climate risks and the difficulty of modelling the financial stability implications is making it difficult but not impossible for central banks and supervisors to move from acknowledgment to concrete policy action (Finance Watch, 2020). Central banks and financial regulators are increasingly discussing the systemic financial stability implications of climate change, relating to both physical risks and the financial risks of transition. As a result, it is necessary for the 'standard' macroprudential policy framework to address relevant climate-related risks (Gruenewald, 2020). Policy needs to build on comprehensive disclosure frameworks to enable the identification of risks and on forward-looking, scenario-based methodologies for risk analysis, such as stress-tests.

Based on the classical differentiation between the time and cross-sectional dimensions, instruments such as climate-risk-adjusted capital and liquidity requirements, countercyclical capital buffer, and a sectoral leverage ratio for lending to carbon-intensive industries could be employed to address the time dimension and a potential 'carbon cycle' (Schoenmaker and Van Tilburg, 2016). Concerning the cross-sectional dimension of systemic risk, where it is imperative to limit common exposures and interlinkages and create rules for systemically relevant financial institutions, exposure limits to carbon-intensive sectors could, for example, reduce the risks associated with the transition to a net-zero economy. Furthermore, the recognition of the 'radical uncertainty' involved in climate-related financial risks and the information gaps and shortcomings of disclosure, transparency, scenario analysis and stress-testing have led to calls for a 'precautionary' policy and for a role of central banks in actively steering market actors towards a managed transition in order to ensure a scenario that minimises harm to the financial system and the wider economy in the future (Chenet et al., 2019).

iii) Scenarios: adjust long-term scenarios and develop short-term outlooks

Central banks and supervisors should continue to develop, deploy and refine a suite of climate scenarios, but with a change in focus. The climate scenarios recently developed by the NGFS (2020a) mark a major step forward for climate risk analysis. These now need to become more consistent with a net-zero pathway to limiting temperature rise to 1.5°C. Currently, the 'orderly' (representative) scenario assumes a 2°C trajectory with carbon dioxide removal (CDR) technologies.

Building on the current NGFS climate scenarios, scenarios could be deployed to highlight the implications of alternative routes to net-zero, which are more or less disruptive for the financial system (e.g. early or late action). Scenarios that do not deliver net-zero by 2050 could of course be maintained, but as a way of exploring the physical risks in terms of climate damage, as well as the potential for disorderly asset stranding. Climate stress testing exercises, which should be a regular feature of prudential regulation, should be centred on net-zero scenarios that represent an orderly transition. In addition, central banks and supervisors designing and deploying these scenarios need to signal clearly that they are not indifferent to the outcome (e.g. whether net-zero is achieved or not).

Finally, these long-term scenarios could be usefully supplemented with short-term outlooks that can be used to test the positioning of both regulated firms and the system as a whole over five-year periods. This would be an important way of connecting efforts to future-proof the financial system with key policy milestones (such as 2025 and 2030).

iv) Monetary policy: integrate net-zero into frameworks and operations

Net-zero alignment for monetary policy means: first, taking the net-zero transition into account within monetary frameworks and models to ensure effective price and financial stability targeting; and second, making sure that central bank instruments and policy portfolios become operationally aligned.

Central banks are increasingly prepared to take account of climate-related risks in monetary policy (NGFS, 2020b). Climate change can influence key macroeconomic variables, including output,

consumption, investment, productivity, employment, wages, international trade, exchange rates, inflation and inflation expectations (NGFS, 2020c). One observer has suggested that the net-zero transition is set to have potentially profound implications for prices, with indications that the expansion of renewable energy could have a significant deflationary effect (Lewis, 2020).

In terms of monetary operations, there is growing recognition that the traditional 'market neutrality' approach needs to be updated in light of the climate crisis (Matikainen et al., 2017). The traditional market-neutral stance fails to recognise the double materiality of climate-related financial risks: central banks themselves would contribute to climate-related risks by not aligning their monetary policies and accepting exposition to transition risks (Oustry et al., 2020). In the context of the persistent market failures that have caused the climate crisis, the traditional market-neutral approach to asset purchase and refinancing simply reproduces a high-carbon status quo. This inadvertently provides liquidity and improved funding/cheaper conditions to firms and assets that are not aligned with net-zero, thereby locking in high-carbon business models and exacerbating climate-related financial risks in the system. According to De Nederlandsche Bank governor Klaas Knot, "central banks can also help to correct the carbon bias in capital markets" and can "explore how [...] they can redesign their monetary policy instruments to prevent such biases from occurring, and instead contribute to unlocking more green investments" (Knot, 2021).

The resurgence in monetary activism in the response to COVID-19 has highlighted the need for central banks to make their monetary operations and portfolios consistent with the goals of the Paris Agreement. Banque de France Governor Francois Villeroy de Galhau has set out the need for "decarbonizing the ECB's balance sheet in a pragmatic, gradual and targeted manner for all corporate assets, whether they are held on the central bank's balance sheet or taken as collateral", and the need to define decarbonisation methods and targets (Villeroy de Galhau, 2021a). A number of proposals have been made to bring monetary operations into line with net-zero including, in the EU context, the design of green 'targeted longer-term refinancing operations' (TLTROs) (Senni, 2021; van 't Klooster and van Tilburg, 2020), the greening of corporate bond purchases (Dafermos et al., 2020) and the greening of collateral frameworks (Monnin, 2020; Oustry et al., 2020). These proposals are increasingly recognised by European central bankers.

Implementing a modernised version of market neutrality would embed the principle of double materiality, thereby taking into account the risks affecting the central bank's balance sheet as well as the impact of its operations on the climate. This would mean incorporating net-zero into collateral frameworks, refinancing, asset purchase programmes and foreign exchange reserve management. As a starting point, and building on a double materiality approach, assets that are clearly incompatible with net-zero under any scenario and are associated with high transition risk, as well as a negative impact on the climate (e.g. coal), could be excluded from central banking operations. However, an exclusion criterion might only have a limited, short-term effect on shaping incentives for issuers and banks to start moving on an alignment pathway. To support the reallocation of capital that is needed, access to monetary operations could be made contingent on companies committing to a credible net-zero transition plan, to give net-zero monetary policy operations a clear forward-looking approach (Oustry et al., 2020). Introducing such a requirement would also deliver clear alignment with the investment and engagement activities of institutional investors.

At a strategic level, central banks will also need to design a strategy for making their monetary policy portfolios (for example, for asset purchases) net-zero by 2050. To credibly ask private businesses to disclose their exposure, central banks are starting to 'walk the talk' by issuing their own TCFD reports and disclosing the carbon intensity and temperature alignment of their portfolios (Bank of England, 2020b). The inclusion of the 'net-zero transition' as a government priority in the Bank of England's March 2021 MPC Remit Letter (HM Treasury, 2021b) prompted an immediate response from the Bank, signalling action "to adjusting the Corporate Bond Purchase Scheme (CBPS) to account for the climate impact of the issuers of the bonds" (Bank of England, 2021). As central bank monetary policy portfolios also have significant holdings of sovereign bonds, this will require close cooperation with finance ministries and debt management offices.

v) Portfolio management: implement net-zero targets and plans

Central banks also manage other portfolios, notably their own assets, foreign exchange reserves (which are effectively 'policy portfolios' for exchange rate targeting central banks) as well as pension funds. Here, like other long-term asset owners, central banks should adopt a net-zero target and publish a transition plan to achieve this. However, for the assets held on behalf of the government, this is often not a decision that can be taken independently by the central banks and therefore requires clear guidance and targets from the government.

The recent NGFS progress report on the implementation of sustainable and responsible investment practices in central banks' portfolio management shows that considerable progress has been made by some central banks in aligning their own portfolios, followed by the policy portfolios held for foreign exchange intervention and/or financial returns, and pension portfolios (NGFS, 2020d). For example, two Eurosystem central banks are considering aligning one or more of their portfolios with the EU's climate benchmark framework. In order for the system as a whole to be net-zero by 2050, some portfolios clearly will need to become aligned much earlier. The long-term nature of some of their portfolios provides a strong basis for central banks to set targets in advance of 2050 to show market leadership. In the UK, for example, leading fiduciary investors are already setting net-zero targets for the 2030s: these include the South Yorkshire Pension Fund (with a 2030 target), BT Pension Fund (2035) and Cambridge University (2038).

The work of the Banque de France (BdF) over recent years shows how a net-zero-aligned approach can be developed as part of an investment strategy. The BdF adopted a Responsible Investment Charter in March 2018, an innovative initiative at the time (Banque de France, 2018). The charter applies to the BdF's own fund and pension portfolios, for both of which the BdF is solely and fully responsible. Based on the charter, the BdF published a first annual Responsible Investment Report in 2020 (Banque de France, 2020). The report outlines its responsible investment strategy, as well as an analysis of its portfolios following the provisions of Article 173 of the French law on Energy Transition for Green Growth (LTECV) and the recommendations of the TCFD. It also outlines the changes in the BdF's investment policy to align with the objective of a trajectory that limits global warming to 2°C above pre-industrial levels, as per the commitment set out in the Paris Agreement. The BdF also established a Responsible Investment Committee in 2020, which regularly reviews the responsible investment strategy in light of emerging issues, such as fossil fuel exclusions, biodiversity and broader social aspects (NGFS, 2020d).

Within this framework, coal mining companies or coal-based energy producers with thermal coal accounting for more than 20% of turnover have been excluded by the Banque de France from its own investments. In January 2021, the BdF announced that it would further lower the threshold to 2% at end-2021 before reducing it to 0% at end-2024, thus excluding all companies with a coal-related activity, however small, by the end of that year (Villeroy de Galhau, 2021b). On oil and gas, the BdF will align itself with European benchmarks in 2024 and start to withdraw from non-conventional hydrocarbons from 2021. Furthermore, on fossil fuel projects in general, the BdF will build on its voting policy to check that companies do not engage in new projects to develop fossil fuels (Banque de France, 2021).

Another bank that has taken a leading stance is Sweden's Riksbank. In November 2019, the Riskbank took the step of excluding bonds from Western Australia and Queensland, as well as the oil-rich Canadian province of Alberta, due to the high greenhouse gas emissions from these regions (Flodén, 2019). The exclusion of these assets from the Riksbank's foreign exchange reserves is based on its policy, introduced in 2019, to analyse the composition of foreign exchange reserves based not only on a risk and yield assessment, but also on how much the assets contribute to greenhouse gas emissions (Sveriges Riksbank, 2020). Under this policy, the Riskbank sold and excluded assets such as the Australian and Canadian bonds. Starting in 2021, the Riskbank will also assess and report the carbon footprint of the corporate bond portfolio to promote the reporting of climate pollutant factors in general.

vi) Just transition: explore the implications of net-zero for jobs and regions

Central banks also have a role to understand the socioeconomic implications of achieving net-zero and the role that the financial system could play to ensure that the process is inclusive in terms of employment and regional development. The just transition is included in the Paris Agreement and is

increasingly recognised as a critical success factor in delivering climate action (Robins, 2020b). In the EU, for example, the just transition is a core part of the Green Deal with dedicated financing mechanisms designed to ensure that no one is left behind in the drive to net-zero. In the USA, President Biden's new climate strategy stresses the importance of climate action creating good-paying union jobs and promoting environmental justice for disadvantaged communities (U.S. President, 2021). Similarly, investors are starting to incorporate the just transition into their shareholder engagement, capital allocation and policy dialogue on climate change (Robins et al., 2020).

Many central banks have employment objectives or are tasked with supporting the economic priorities and policy of their governments. For central banks and supervisors, the just transition connects climate risk and net-zero with long-established roles in economic surveillance, notably in terms of monitoring the economy in terms of output, employment and well-being as well as the performance of key sectors and regions. The COVID-19 crisis has underscored the importance of addressing inequality across the economy, and central banks need to account for the potential effects of their policies on inequality. The pandemic has also prompted governments and central banks to commit to supporting a green recovery.

Central banks should begin to explore their role in enabling the financial system to support the just transition. Placing net-zero within the broader context of inclusive growth and socioeconomic development potentially could help to address some of the understandable hesitancy in central banks over the implications that applying carbon screens in their COVID-19 crisis response measures could have for jobs and regional development. One place to start would be to use the results of planned climate scenario and stress-testing exercises to identify at the aggregate level sectors and regions that could have pronounced concentration risk in terms of the net-zero transition (Robins et al., 2020). In addition, where the mandate allows, central banks and supervisors could explore the ways in which vulnerable low-income communities could be supported (for example, through the Community Reinvestment Act in the USA). Moreover, central banks and supervisors can play an important role in facilitating a just transition by supporting inclusive green finance (Volz, Knaack et al., 2020).

vii) International cooperation: incorporate net-zero into international frameworks

Net-zero is a global imperative, and monetary and financial authorities in all parts of the world will need to develop their own strategies for net-zero that combine a stability focus along with policy coherence, calibrated to national legal and institutional frameworks. This is particularly important for large emitters, including the USA and China and other G20 economies. Central banks and supervisors in emerging and developing economies could face particular challenges around net-zero due to a high level of climate change vulnerability, less developed institutions and capacity constraints. This points to a role for international organisations in supporting the monetary and financial authorities of their member countries to bring their policy frameworks in line with net-zero, but also in mainstreaming net-zero across their own operations. For instance, the International Monetary Fund (IMF) ought to align its operational work – comprising surveillance, technical assistance and training, and emergency lending and crisis support – with net-zero. Among other things, the IMF should adopt a consistent, systematic and universal appraisal and treatment of physical and transition risks for all countries in Article IV consultations and Financial Sector Assessment Programmes (FSAP) (Volz and Ahmed, 2020). In addition, multilateral development banks can support monetary and financial authorities in the design and delivery of net-zero strategies.

Net-zero will also need a more explicit focus in the key financial system standard-setting and oversight bodies, such as the Bank for International Settlements, the Financial Stability Board, the International Association of Insurance Supervisors, the International Organisation of Securities Commissions, and the Organisation for Economic Co-operation and Development. These organisations can play an important role in advancing the net-zero agenda by issuing supervisory recommendations, supporting disclosures and endorsing common approaches (for example to reference scenarios). Regional associations of central banks and supervisors can play an important role in sharing experience and developing approaches fine-tuned to specific circumstances. The NGFS, as the preeminent forum for central banks and supervisors seeking to address climate change, could take the lead in developing an international approach to net-zero for central banks and supervisors.

5. Conclusions

Central banks and supervisors have been clear that responding to the catastrophic threats of climate change is fully in line with their existing mandates. As guardians of macroeconomic and financial stability, central banks and supervisors now need to introduce explicit strategies to support the transition to net-zero. As more and more governments adopt net-zero policies, prudential and monetary authorities will have a crucial role in translating financial sector leadership into universal practice across the financial system.

There is a dual rationale for action: first, recognising that achieving a net-zero economy is the best way of minimising the risks of climate change to stability of the financial system and the macroeconomy; and second, making sure that central bank and supervisory activities are coherent with net-zero government policy.

Central banks and supervisors will need to take a systemic perspective, addressing both micro- and macroprudential risks over a much longer time horizon than they do now, and work to ensure that financial flows become aligned with net-zero. Markets respond to signals from central banks, and the seriousness of intent with which they consider net-zero targets is likely to have a profound bearing on financial market decisions that will ultimately determine capital formation and, thus, the carbon trajectory of the economy. As part of this, monetary and financial authorities will need to play a pivotal role in shaping the tools, methodologies, data systems and taxonomies required for net-zero. Crucially, they also need to align their own policies and operations with net-zero.

The run-up to the COP26 climate summit in November 2021 is the moment for leading central banks and supervisors to signal that they are embarking on a new phase in greening the financial system. Now is the time for net-zero central banking.

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