Network for Greening the Financial System

First comprehensive report

A call for action

Climate change as a source of financial risk

April 2019

NGFS

Central Banks and Supervisors
Network for Greening the Financial System

Foreword by Frank Elderson, Chair of the NGFS

We collectively face the effects of climate change, as it reaches beyond economies, borders, cultures, and languages. In 2017, air pollution was a cause of almost 5 million deaths worldwide while 62 million people in 2018 were affected by natural hazards, with 2 million needing to move elsewhere due to climate events. A transition to a green and low-carbon economy is not a niche nor is it a "nice to have" for the happy few. It is crucial for our own survival. There is no alternative. Therefore, we need to come together and take action to create a bright, sustainable future.

Understanding what the magnitude of climate change heralds for financial stability, at the initiative of Banque de France, eight central banks and supervisors established a Network of Central Banks and Supervisors for Greening the Financial System (NGFS) at the Paris "One Planet Summit" in December 2017. Since then, the NGFS has grown to 34 Members and 5 Observers from all over the globe.

Climate-related risks are a source of financial risk and it therefore falls squarely within the mandates of central banks and supervisors to ensure the financial system is resilient to these risks. This significant breakthrough was already acknowledged in the NGFS progress report, published in October 2018. With this first NGFS comprehensive report, we build upon this insight to issue six recommendations: the first four apply to the work of central banks and supervisors while the last two address policymakers. However, all six call for collective action and draw a focus to integrating and implementing previously identified needs and best practices for a smooth transition towards a low-carbon economy. These recommendations are aimed at inspiring central banks and supervisors– NGFS members and non-members – to take the necessary measures to foster a greener financial system. We need to take action and we cannot and will not do this alone. We will globally cooperate with policy makers, the financial sector, academia and other stakeholders to distill best practices in addressing climate-related risks.

The achievements of the NGFS and the rapid expansion of its membership within a year have exceeded my expectations. However, we are not there yet. These recommendations represent only the Network's beginnings, as there is much work to be done in order to equip these aforementioned actors with appropriate tools and methodologies to identify, quantify and mitigate climate risks in the financial system. Future deliverables include a handbook on climate and environmental risk management, voluntary guidelines on scenario-based risk analysis and best practices for incorporating sustainability criteria into central banks' portfolio management. Going forward, the NGFS also expects to dedicate more resources to the analysis of environmental risks.

I am confident that the brain trust of the NGFS will continue to grow and evolve, keeping in mind the aim of having the financial sector worldwide contribute toward a greener future. As chair, I am very proud of what the NGFS has accomplished in only 16 months since its creation, and I look forward to consolidating our work during the coming years.

Finally, I would like to extend my thanks to the tremendous amount of work done by everyone involved in this endeavour, the chairs and members of the three working groups and my team at De Nederlandsche Bank. In particular I would like to thank the secretariat at the Banque de France, without whom we would not have stood where we stand today.

Contents

Executive summary

In the October 2018 progress report, NGFS members acknowledged that ***"climate-related risks are a source of financial risk. It is therefore within the mandates of central banks and supervisors to ensure the financial system is resilient to these risks."*** The legal mandates of central banks and financial supervisors vary throughout the NGFS membership, but they typically include responsibility for price stability, financial stability and the safety and soundness of financial institutions. Even though the prime responsibility for ensuring the success of the Paris Agreement rests with governments, it is up to central banks and supervisors to shape and deliver on their substantial role in addressing climate-related risks within the remit of their mandates. Understanding how structural changes affect the financial system and the economy is core to fulfilling these responsibilities.

Climate change is one of many sources of structural change affecting the financial system.[1] However, it has distinctive characteristics that mean it needs to be considered and managed differently. These include:

- **Far-reaching impact in breadth and magnitude:** climate change will affect all agents in the economy (households, businesses, governments), across all sectors and geographies. The risks will likely be correlated with and potentially aggravated by tipping points, in a non-linear fashion. This means the impacts could be much larger, and more widespread and diverse than those of other structural changes.
- **Foreseeable nature:** while the exact outcomes, time horizon and future pathway are uncertain, there is a high degree of certainty that some combination of physical and transition risks will materialise in the future.
- **Irreversibility:** the impact of climate change is determined by the concentration of greenhouse gas (GHG) emissions in the atmosphere and there is currently no mature technology to reverse the process. Above a certain threshold, scientists have shown with a high degree of confidence that climate change will have irreversible consequences on our planet, though uncertainty remains about the exact severity and time horizon.
- **Dependency on short-term actions:** the magnitude and nature of the future impacts will be determined by actions taken today, which thus need to follow a credible and forward-looking policy path. This includes actions by governments, central banks and supervisors, financial market participants, firms and households.

While today's macroeconomic models may not be able to accurately predict the economic and financial impact of climate change, climate science leaves little doubt: action to mitigate and adapt to climate change is needed now. The NGFS recognises that there is **a strong risk that climate-related financial risks are not fully reflected in asset valuations**. There is **a need for collective leadership and globally coordinated action** and, therefore, the role of international organisations and platforms is critical.

The NGFS, as a coalition of the willing and a voluntary, consensus-based forum provides **six recommendations** for central banks, supervisors, policymakers and financial institutions to enhance their role in the greening of the financial system and the managing of environment and climate-related risks. The recommendations are not binding and reflect the best practices identified by NGFS members to facilitate the role of the financial sector in achieving the objectives of the Paris Agreement.

Recommendations n°1 to 4 *are aimed at inspiring central banks and supervisors – NGFS members and non-members – to take these best practices on board when it fits within their mandate. Parts of these recommendations may also be applicable to financial institutions.*

Recommendation n°1: Integrating climate-related risks into financial stability monitoring and micro-supervision.

Important steps in this regard include:

a) Assessing climate-related financial risks in the financial system by:

- mapping physical and transition risk transmission channels within the financial system and adopting key risk indicators to monitor these risks;

1 The report focuses on climate-related risks rather than environment-related risks.

• conducting quantitative climate-related risk analysis to size the risks across the financial system, using a consistent and comparable set of data-driven scenarios encompassing a range of different plausible future states of the world;
• considering how the physical and transition impact of climate change can be included in macroeconomic forecasting and financial stability monitoring.

b) Integrating climate-related risks into prudential supervision, including:
• Engaging with financial firms:
  – to ensure that climate-related risks are understood and discussed at board level, considered in risk management and investment decisions and embedded into firms' strategy;
  – to ensure the identification, analysis, and, as applicable, management and reporting of climate-related financial risks.
• Setting supervisory expectations to provide guidance to financial firms as understanding evolves.

Recommendation n°2: Integrating sustainability factors into own-portfolio management.

Acknowledging the different institutional arrangements in each jurisdiction, the NGFS encourages central banks to lead by example in their own operations. Without prejudice to their mandates and status, this includes integrating sustainability factors into the management of some of the portfolios at hand (own funds, pension funds and reserves to the extent possible).

Notwithstanding that the focus of central banks incorporating environmental, social and governance (ESG) aspects into their portfolio management has been on own funds and pension portfolios, some voices have called for an extension of this approach to monetary policy. Going forward, the NGFS considers exploring the interaction between climate change and central banks' mandates (beyond financial stability) and the effects of climate-related risks on the monetary policy frameworks, paying due regard to their respective legal mandates.

Recommendation n°3: Bridging the data gaps.

The NGFS recommends that the appropriate public authorities share data of relevance to Climate Risk Assessment (CRA) and, whenever possible, make them publicly available in a data repository. In that respect, the NGFS sees merit in setting up a joint working group with interested parties to bridge the existing data gaps.

Recommendation n°4: Building awareness and intellectual capacity and encouraging technical assistance and knowledge sharing.

The NGFS encourages central banks, supervisors and financial institutions to build in-house capacity and to collaborate within their institutions, with each other and with wider stakeholders to improve their understanding of how climate-related factors translate into financial risks and opportunities. The NGFS also encourages relevant parties to offer technical assistance to raise awareness and build capacity in emerging and developing economies.

Recommendations n°5 and 6 *do not fall directly within the remit of central banks and supervisors but point to actions that can be taken by policymakers to facilitate the work of central banks and supervisors. Parts of these recommendations may also be applicable to the private sector.*

Recommendation n°5: Achieving robust and internationally consistent climate and environment-related disclosure.

The NGFS emphasises the importance of a robust and internationally consistent climate and environmental disclosure framework. NGFS members collectively pledge their support for the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). The NGFS encourages all companies issuing public debt or equity as well as financial sector institutions to disclose in line with the TCFD recommendations. The NGFS recommends that policymakers and supervisors consider further actions to

foster a broader adoption of the TCFD recommendations and the development of an internationally consistent environmental disclosure framework.

Recommendation n°6: Supporting the development of a taxonomy of economic activities.

The NGFS encourages policymakers to bring together the relevant stakeholders and experts to develop a taxonomy that enhances the transparency around which economic activities (i) contribute to the transition to a green and low-carbon economy and (ii) are more exposed to climate and environment-related risks (both physical and transition). Such a taxonomy would:

- facilitate financial institutions' identification, assessment and management of climate and environment-related risks;
- help gain a better understanding of potential risk differentials between different types of assets;
- mobilise capital for green and low-carbon investments consistent with the Paris Agreement.

To some extent, recommendations n°1-4 require the implementation of recommendations n°5-6, but this does not preclude central banks and supervisors from acting now.

Going forward, the NGFS will continue its work as long as its members deem it necessary and useful. The lesson drawn from the first sixteen months of NGFS activity is that climate change presents significant financial risks that are best mitigated through an early and orderly transition.

To ensure such a smooth transition, there is still a significant amount of analytical work to be done in order to equip central banks and supervisors with appropriate tools and methodologies to identify, quantify and mitigate climate risks in the financial system. This calls for a close and specific dialogue with academia and for further technical work to translate the NGFS recommendations or observations into operational policies and processes.

More precisely, the NGFS is planning to develop:
(i) a handbook on climate and environment-related risk management for supervisory authorities and financial institutions;
(ii) voluntary guidelines on scenario-based risk analysis;
(iii) best practices for incorporating sustainability criteria into central banks' portfolio management (particularly with regard to climate-friendly investments).

This report has been coordinated by the NGFS Secretariat/Banque de France.
For more details, go to *https://www.banque-france.fr*
or contact the NGFS Secretariat *sec.ngfs@banque-france.fr*

BANQUE DE FRANCE
EUROSYSTÈME
NGFS Secretariat

Origin of the NGFS

8 central banks and supervisors
established a Network
of Central Banks and Supervisors
for Greening the Financial System.

Since then, the NGFS has grown to
34 Members **5 Observers**
representing 5 continents.

The NGFS is a coalition of the willing.
It is a voluntary, consensus-based forum whose purpose is to share best practices, contribute to the development of climate –and environment– related risk management in the financial sector and mobilise mainstream finance to support the transition toward a sustainable economy.

The NGFS issues recommendations
which are not binding
but are aimed at inspiring
all central banks and supervisors
and relevant stakeholders
to take the necessary
measures to foster
a greener financial system.

NGFS composition and governance

DeNederlandscheBank
EUROSYSTEEM

Chair
Frank Elderson

Secretariat
Morgan Després

BANQUE DE FRANCE
EUROSYSTÈME

Plenary Members and Observers

NGFS members' jurisdictions cover:

31%
of the global population

Source: United Nations, 2017.

Supervision of **2/3**
of the global systemically important banks and insurers

Source: Financial Stability Board, 2018.

45%
of global greenhouse gas emissions

Source: Global Carbon Budget, 2017.

44%
of the global GDP

Source: World Bank, 2017.

Functioning of the NGFS

The NGFS aims to accelerate the work of central banks and supervisors on climate and environmental risk and on scaling up green finance. The NGFS' work could feed into the work of existing international regulatory bodies. It does not aim to replicate the work conducted elsewhere, but to build on and enrich it where necessary. The NGFS' diverse membership allows for close coordination between the various ongoing international initiatives on issues of common interest. To this end, the NGFS has kept close contact with the Sustainable Banking Network (SBN), the Sustainable Insurance Forum (SIF) and the recently created Sustainable Finance Network (SFN), initiated by IOSCO, and the UNEP Financial Initiative.

The NGFS has structured its work into **three workstreams** dedicated to:

- **supervising of climate and environmental risks** (WS1, chaired by Ma Jun from the People's Bank of China);
- **analysing the macrofinancial impact of climate change** (WS2, chaired by Sarah Breeden from the Bank of England);
- **scaling up green finance** (WS3, chaired by Joachim Wuermeling from the Deutsche Bundesbank).[2]

2 Joachim Wuermeling will be replaced by Sabine Mauderer, Member of the Executive Board of the Deutsche Bundesbank, as chair of the WS3 as of April 2019.

1 Climate change as a source of economic and financial risks

The Intergovernmental Panel on Climate Change (IPCC) has concluded that anthropogenic emissions have increased since the pre-industrial era, driven largely by economic and population growth. This has led to increased concentrations of GHGs which are unprecedented in at least 800,000 years.[3] This is extremely likely to have been the dominant cause of the observed warming since the mid-20th century. Temperatures are now at least 1°C above pre-industrial levels.

Climate scientists have concluded that continued emissions in line with historical rates would lead to warming of 1.5°C between 2030 and 2052.[4] This would cause long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems.

BOX 1

Distinguishing between climate and environment-related risks

The NGFS aims to contribute to the development of environment and climate-related risk management in the financial sector. By **environment-related risks**, this report refers to risks (credit, market, operational and legal risks, etc.) posed by the exposure of financial firms and/or the financial sector to activities that may potentially cause or be affected by environmental degradation (such as air pollution, water pollution and scarcity of fresh water, land contamination, reduced biodiversity and deforestation). By **climate-related risks**, the report refers to risks posed by the exposure of financial firms and/or the financial sector to physical or transition risks caused by or related to climate change (such as damage caused by extreme weather events or a decline of asset value in carbon-intensive sectors).

This report focuses on climate-related risks rather than environmental risks for two main reasons: first, the transition to a low-carbon economy consistent with the objectives of the Paris Agreement requires a radical shift of resource allocation and, thus, a seminal response by the financial sector. It was first against this background that the NGFS was founded. Second, climate change itself poses a major challenge – if not the major challenge – of our time and its impact will be felt globally, thus demanding a strong international response and multilateral cooperation, particularly given that the impacts of climate change may only be felt many years into the future, and yet are determined by the actions we take today.

Nevertheless, there are compelling reasons why the NGFS should also look at environmental risks relevant to the financial system. For instance, environmental degradation could cascade to risks for financial institutions, as reduced availability of fresh water or a lack of biodiversity could limit the operations of businesses in a specific region. These could turn into drivers of financial risks and affect financial institutions' exposures to those businesses.[1] Also, it is important to be aware of potential greater impacts due to the combined effects of climate and environmental risks. Against this background, the NGFS expects to dedicate more resources to the analysis of environmental risks going forward.

1 Schellekens, Van Toor (DNB), *Values at risk? Sustainability risks and goals in the Dutch financial sector*, 2019.

3 IPCC, *Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 2014.

4 IPCC, *Global Warming of 1.5°C, Summary for Policymakers*, 2018.

1.1 Climate change is a source of structural change in the economy and financial system and therefore falls within the mandate of central banks and supervisors

The legal mandates of central banks and financial supervisors vary throughout the NGFS membership, but they typically include responsibility for price stability, financial stability and the safety and soundness of financial institutions. Understanding structural changes to the financial system and the economy is core to fulfilling these responsibilities. Climate change is one source of structural change.[5] As highlighted by the NGFS October 2018 progress report, climate change may result in physical and transition risks that can have system-wide impacts on financial stability and might adversely affect macroeconomic conditions.

Physical impacts include the economic costs and financial losses resulting from the increasing severity and frequency of extreme climate change-related weather events (such as heat waves, landslides, floods, wildfires and storms) as well as longer term progressive shifts of the climate (such as changes in precipitation, extreme weather variability, ocean acidification, and rising sea levels and average temperatures).

Transition impacts relate to the process of adjustment towards a low-carbon economy.[6] Emissions must eventually reach "net zero" to prevent further climate change. The process of reducing emissions is likely to have significant impact on all sectors of the economy affecting financial assets values. While urgent action is desirable, an abrupt transition could also have an impact on financial stability and the economy more broadly.

These risks might have persistent impacts on macroeconomic and financial variables (for instance, growth, productivity, food and energy prices, inflation expectations and insurance costs) **that are fundamental to achieving central banks' monetary policy mandates**.[7]

Nevertheless, the prime responsibility for ensuring the success of the Paris Agreement rests with governments. Yet, it is up to the central banks and supervisors to shape and deliver on their substantial role in addressing climate-related risks, although the NGFS remains mindful that not all its member-central banks have the same mandates for action. An understanding of the links between broader climate policy and the mandates of central banks and supervisors is therefore necessary.

1.2 Climate change is different from other sources of structural change

Climate change is one of many sources of structural change. However, it has distinctive characteristics that mean it needs to be considered and managed differently.

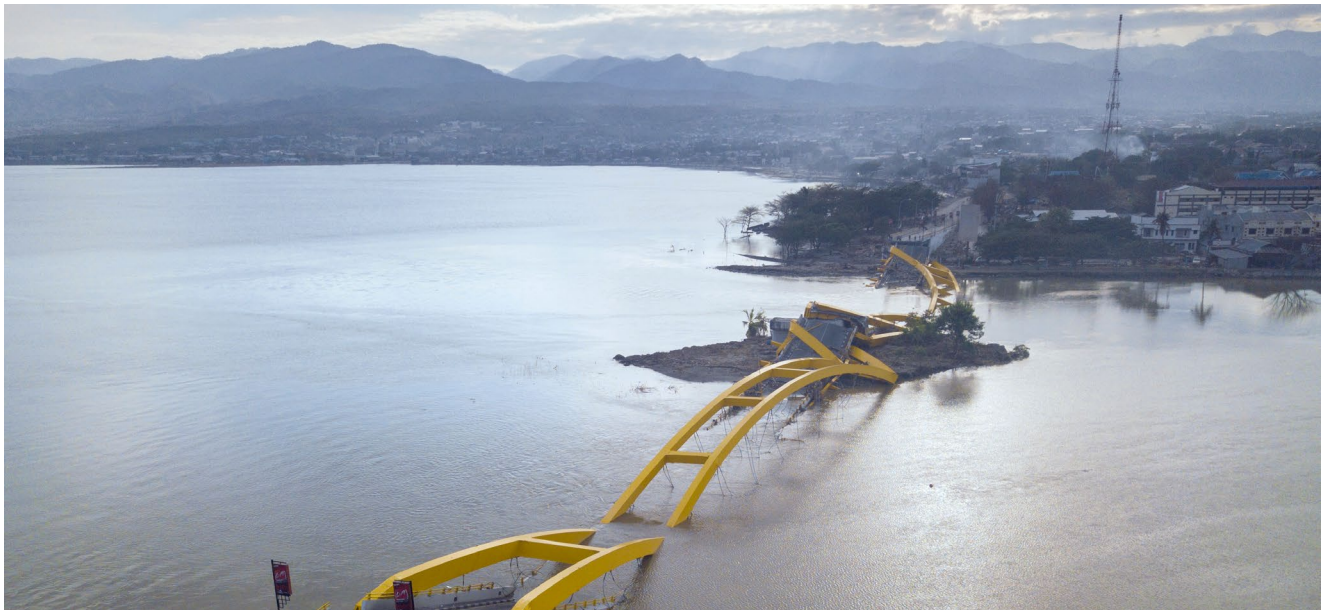
These include:

- **Far-reaching impact in breadth and magnitude:** climate change will affect all agents in the economy (households, businesses, governments), across all sectors and geographies. The risks will likely be correlated and, potentially aggravated by tipping points, in a non-linear fashion. This means the impacts could be much larger, and more widespread and diverse than those of other structural changes.
- **Foreseeable nature:** while the exact outcomes, time horizon and future pathway are uncertain, there is a high degree of certainty that some combination of increasing physical and transition risks will materialise in the future.
- **Irreversibility:** the impact of climate change is determined by the concentration of greenhouse gas (GHG) emissions in the atmosphere and there is currently no mature technology to reverse the process. Above a certain threshold, scientists have shown with a high degree of confidence that climate change will have irreversible consequences on our planet, though uncertainty remains about the exact severity and time horizon.
- **Dependency on short-term actions:** the magnitude and nature of the future impacts will be determined by

5 Some NGFS members have extended this analysis to broader environmental risks, which are also considered within supervisory and financial stability mandates.

6 In its work, the NGFS has incorporated the risk associated with emerging legal cases related to climate change for governments, firms and investors, e.g. liability risks, as a subset of physical and transition risks.

7 See, for instance, the speech by Benoît Cœuré, Member of the Executive Board of the European Central Bank, at a conference on "Scaling up Green Finance: The Role of Central Banks", organised by the Network for Greening the Financial System, the Deutsche Bundesbank and the Council on Economic Policies, Berlin, 8 November 2018.



actions taken today which thus need to follow a credible and forward-looking policy path. This includes actions by governments, central banks and supervisors, financial market participants, firms and households.

1.3 How climate change might affect the economy and financial stability

1.3.1 Understanding the possible impacts of physical risks

Extreme weather events impact health and damage infrastructure and private property, reducing wealth and decreasing productivity. These events can disrupt economic activity and trade, creating resource shortages and diverting capital from more productive uses (e.g. technology and innovation) to reconstruction and replacement. Uncertainty about future losses could also lead to higher precautionary savings and lower investment.

Physical impacts are not just risks for the future; they are already impacting the economy and financial system today. Overall, worldwide economic costs from natural disasters have exceeded the 30-year average of USD 140 billion per annum in 7 of the last 10 years.[8] Since the 1980s, the number of extreme weather events has more than tripled.[9]

Over a longer time horizon, progressive changes in the natural environment will impact the liveability of different regions, particularly if mean temperatures rise by more than 1.5 to 2°C compared to pre-industrial levels. This is due to the significant risks related to human health, food security, water resources, heat exposure and sea level rise.[10]

Estimates suggest that absent action to reduce emissions, the physical impact of climate change on the global economy in the second half of the century will be substantial. The more sophisticated studies suggest average global incomes may be reduced by up to a quarter by the end of the century.[11] In addition, the increased probability of disruptive events such as mass migration, political instability and conflict in these scenarios means that economic estimates are likely to understate the size and timing of the associated risks.

8 Munich Reinsurance Company (2019), "Natural Catastrophe Review 2018" *Geo Risks Research*, NatCatSERVICE.

9 Munich Reinsurance Company (2018), "A stormy year: Natural catastrophe 2017" *Geo Risks Research*, NatCatSERVICE.

10 IPCC (2018), Chapter 3.

11 See, for example, Burke, Hsiang and Miguel, "Global Non-Linear Effect of Temperature on Economic Production", *Nature* Vol. 527, pp. 235-239 (12 November 2015).

There have been fewer attempts to quantify the physical risks to financial stability rather than for the economy as a whole, but again losses are likely to be significant. Studies estimate that the financial value at risk could be up to 17% depending on the mean average temperature rise.[12]

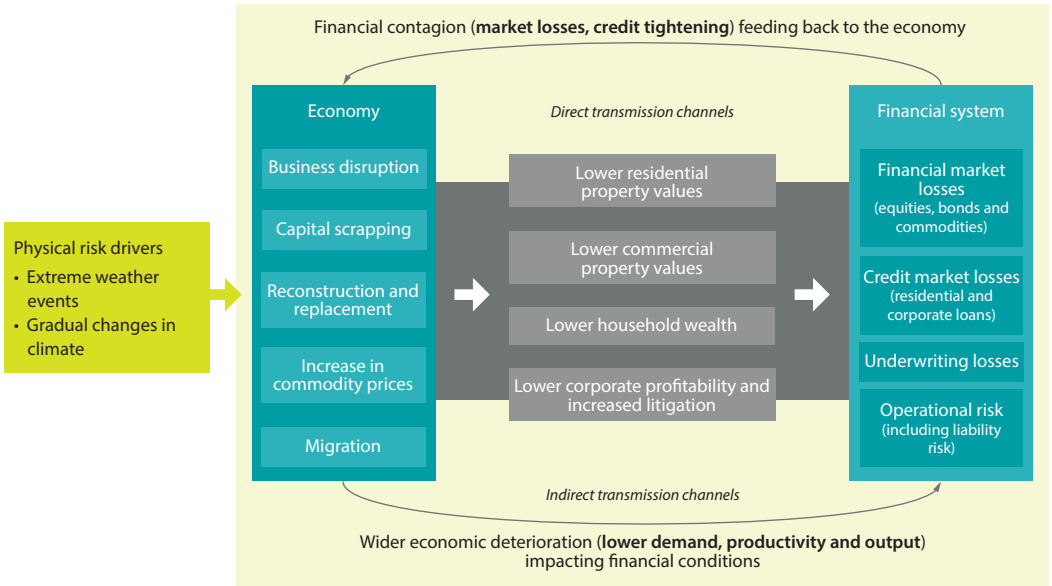
If losses are insured, more frequent and severe weather events affect insurance firms directly through higher claims and their customers indirectly via higher premiums. If losses are uninsured, the burden falls on households, companies and ultimately governments' budgets. A change in the debt repayment capacity of borrowers or a fall in collateral values can increase credit risks for banks and other lenders. A change in lenders' projected earnings would also be reflected in financial markets, impacting investors and asset owners.

Feedback loops between the financial system and the macroeconomy could further exacerbate these impacts and risks. For example, damage to assets serving as collateral could create losses that prompt banks to restrict their lending in certain regions, reducing the financing available for reconstruction in affected areas. At the same time, these losses weaken household wealth and could in turn reduce consumption.

The broad, global averages referenced above mask significant differences in the distribution of economic impacts and financial risks across regions and sectors. This variation is driven not only by differences in the gross exposure to physical risks, but also by the level of resilience and adaptation (action taken to prevent or minimise damage). Countries with less economic diversification, less climate resilient public infrastructure, less capital market flexibility and lower capacity to adapt will be at greater risk. Particular sectors could be at greater risk too, depending on their regional footprint.

These estimates represent a lower bound. Currently, physical impact models for both the economy and financial stability are partial. They typically cover only a handful of the possible transmission channels in order to make them tractable and neglect wider socio-economic impacts. Non-modelled impacts are also often estimated separately. A more holistic approach is needed to understand the relationship between different levels of risks, resilience and adaptation. The non-linearities stemming from the increasing risk of tipping points, and the potential for these to accelerate in the near term, are a core part of climate modelling that need to be better captured in economic and financial risk models.

Figure 1 **From physical risk to financial stability risks**



12 One study found that almost 2% of the world's financial assets are at risk if the global mean surface temperature rises by 2.5°C compared to pre-industrial levels (Dietz, Bowen, Dixon and Gradwell "Climate value at risk' of global financial assets" *Nature Climate Change*, 2016). Warming of 5°C could result in losses equal to 5% of the global stock of manageable assets ("The cost of inaction: Recognising the value at risk from climate change", *The Economist Intelligence Unit*, 2015).

1.3.2 Understanding the possible impacts of transition risks

The potential severity of the physical impacts of climate change and the direct correlation with the concentration of greenhouse gases (GHG) motivated the international community to commit to reducing emissions in Paris in December 2015. The Paris Agreement aims to limit the rise in global average temperatures to well below 2°C above pre-industrial levels, and to pursue efforts to limit the temperature increase to 1.5°C. Signatories agreed to reach global peaking of GHG emissions as soon as possible and to undertake rapid reductions thereafter, so as to achieve net zero emissions in the second half of this century.

The transition to a low GHG economy requires rapid and far-reaching transitions in energy, land, urban, infrastructure and industrial systems. **The scale of the economic and financial transformation related to this transition is significant, bringing both risks and opportunities for the economy and the financial system.** The Intergovernmental Panel on Climate Change (IPCC) projects the necessary additional energy-related investments compatible with a 1.5°C scenario for the period 2016-2050 to reach USD 830 billion annually.[13] The European Union alone has identified an annual investment gap amounting to almost EUR 180 billion to achieve its climate and energy targets.[14] Although the incremental change in total investment is not large, it would require a significant redirection of capital toward green finance.[15] For example, the OECD estimates that to achieve the 2°C target, bonds financing and refinancing in the renewable energy, energy efficiency and low-emission vehicle sectors have the potential to reach USD 620 billion to USD 720 billion in annual issuance and USD 4.7 trillion to USD 5.6 trillion in outstanding securities by 2035.[16]

Despite its rapid growth in the last few years, this is well beyond what the green bond market amounts to nowadays, namely an issuance volume of about USD 168 billion in 2018 after USD 162 billion in 2017 and USD 85 billion in 2016.[17] Although the green bond market does not account for all green investments, it provides a signal of the scaling up of green finance. The increase in volume has spurred the development of new green financial assets: for example, in addition to the already dynamic green bond market, new products have emerged such as green covered bonds and green securities.

This shift in investment would result in significant structural changes in the economy compared to today and some studies have sought to quantify the impacts of such a transition. Summarising the results of 31 models, the IPCC (2014) concluded that the costs of limiting warming to 2°C (with a 66% probability) would be between 1-4% of global aggregate consumption by 2030 compared to current economic forecasts.

Intuitively, the economic costs of the transition would stem from a disruptive transition and the need to switch to – initially more expensive – low-carbon technologies in some sectors, for instance, aviation or cement and steel production. However, these costs and the precise transition pathways will vary from country to country depending on the existing capital stock and may be more or less likely due to different political, technological and socioeconomic conditions. Moreover the costs and pathway for the transition can change over time depending on future choices made (e.g. infrastructure investment, a sudden decision by policy makers to cut subsidies for renewables energy or a sudden shift of consumers towards greener choices). **Nevertheless, the estimated costs are likely to be small compared to the costs of no climate action.**

In addition, these cost estimates are not universally accepted and **some argue that the economic costs of the transition to a low-carbon economy would be offset by a positive "green growth" effect.** According to this theory, ambitious climate policies aimed at achieving structural reforms would boost innovation and job creation and lower production costs.[18]

13 IPCC, *Global Warming of 1.5°C, Summary for Policymakers* 2018.

14 European Commission, *Action Plan: Financing Sustainable Growth*, 2018.

15 The G20 Green Finance Study Group (GFSG, 2016) defines "green finance" as "financing of investments that provide [climate and] environmental benefits in the broader context of environmentally sustainable development".

16 OECD, *Mobilising Bond Markets for a Low-Carbon Transition*, Paris, 2017.

17 Sustainable Banking Network, *Creating green bond markets-insight, innovations and tools from the emerging markets*, October 2018. Green bond issuances have been stable in 2018, but the sustainable bond universe grew steadily (Climate Bonds Initiative, *Green bonds: The state of the market 2018*, 2019).

18 ESRB, *Too late, too sudden: Transition to a low-carbon economy and systemic risk*, 2016; Finansinspektionen, *Climate change and financial stability*, 2016.

This would benefit the global economy in the short and medium term in aggregate.[19] This notion is called the **"Porter Hypothesis"**.[20] However, empirical evidence of this effect, focusing on smaller scale case studies, is mixed.[21]

What the literature does show is that, firstly, while the transition would result in a significant structural change in the economy – and some regions and sectors will fare better than others – the overall costs of the transition would be much lower than those that would arise absent action, i.e. in a "hot house world". Secondly, infrastructure decisions today affect choices in the future. Delaying the transition to a low-carbon stock means that sharper (and more costly) emissions cuts would be required in the future to meet a given policy target. The speed and timing of the transition is crucial: an orderly scenario, with clear policy signalling, would allow adequate time for existing infrastructure to be replaced and for technological progress to keep energy costs at a reasonable level.[22] In contrast, a disorderly, sudden, uncoordinated, unanticipated or discontinuous transition would be disruptive and costly, particularly for those sectors and regions that are more vulnerable to structural change.

Comparing economic estimates is, however, difficult because the models define a wide range of possible values for employment, investment, population, productivity and growth. Further research is needed to narrow the range of plausible values to be incorporated into economic models, particularly taking into account country and sectoral differences.

The potential risks to the financial system from the transition are greatest in scenarios where the redirection of capital and policy measures such as the introduction of a carbon tax occur in an unexpected or otherwise disorderly way. So far, scenarios have largely focussed on the potential for assets to become stranded when infrastructure has to be retired before the end of its useful life in order to meet emissions reduction targets. Stranded assets will fall in value leading to losses of both capital and

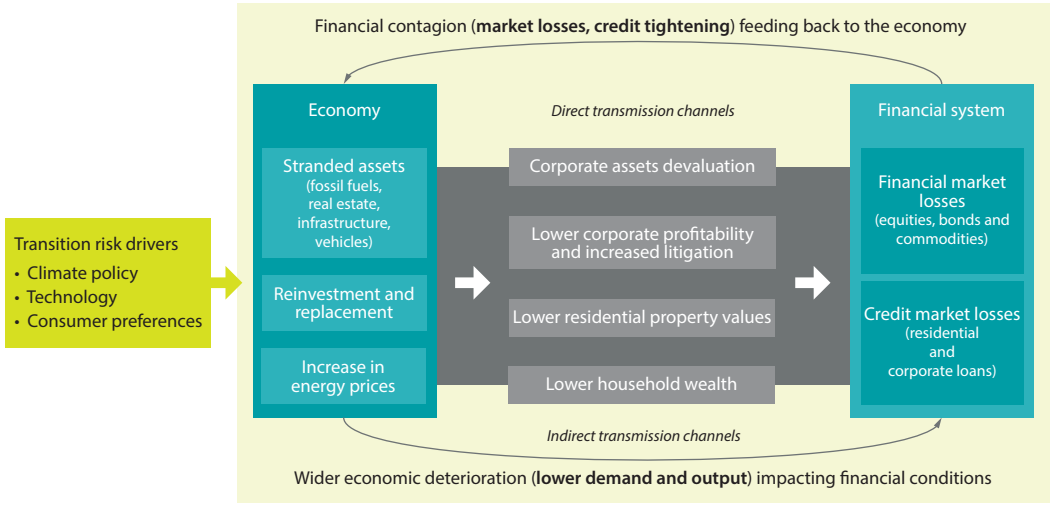
19 OECD, *Investing in Climate, Investing in Growth*, 2017.

20 Porter and van der Linde, "Toward a New Conception of the Environment-Competitiveness Relationship" *Journal of Economic Perspectives*, Vol. 9 (4): pp. 97-118, 1995.

21 Jaffe, Newell and Stavins, "Technological Change and the Environment", *Working Paper* No. 7970, National Bureau of Economic Research, 2000; Berman and Bui, "Environmental Regulation and Productivity: Evidence from Oil Refineries", *NBER Working Paper* No. 6776, November 1998; Gray and Shadbegian, "Environmental Regulation, Investment Timing, and Technology Choice", *Working Paper* No. 6036, National Bureau of Economic Research, May 1997.

22 ESRB, *Too late, too sudden: Transition to a low-carbon economy and systemic risk*, 2016; Finansinspektionen, *Climate change and financial stability*, 2016.

Figure 2 **From transition risk to financial stability risks**



income for owners but also to increased market and credit risks for lenders and investors.

Many of these studies on the transition risks of climate change are partial and often focus on the energy sector. A smaller number of studies are broader in scope, covering transition impacts to entire economic segments. **Estimates of losses in these studies are large and range from USD 1 trillion to USD 4 trillion when considering the energy sector alone,[23] or up to USD 20 trillion when looking at the economy more broadly.[24]** More research is needed to understand how these impacts translate into systemic risks for financial markets, particularly taking second order effects into account. A wholesale reassessment could destabilise markets, spark a pro-cyclical crystallisation of losses and lead to a persistent tightening of financial conditions, which would constitute a climate Minsky moment.[25]

Translating economic transition loss estimates into financial risks is challenging because often the macroeconomic models used were developed for a different purpose, such as calculating the social cost of carbon or the cost of meeting a particular emissions target. Linking these macroeconomic models to financial portfolios requires granular and holistic outputs at a firm, regional and sectoral level to better support bottom-up analysis.

1.4 The future impacts provide a loud wake-up call

If we continue along our current global emissions trajectory, the physical risks from climate change are likely to significantly change where and how we live in the second half of the century. Even though considerable effects of climate change on the economy are widely expected, due to various limitations in our economic models, quantitative estimates today can only give an indication of how big the impacts on the economy and the financial system might be.

Measures to smooth the climate-related structural changes towards a low GHG economy would minimise these risks. As mentioned before, the overall costs of the transition would be much lower than those in a "hot-house world". The size and nature of the risks will therefore be dependent on actions today.

23 See IEA and IRENA, *Perspectives for the Energy Transition*, 2017.

24 See IEA and IRENA (2017). There is also a difference in the methodology used. The IEA estimates stranded *capital* while IRENA estimates stranded *value*. For instance, in the upstream oil and gas sector, the IEA considers investments that oil & gas firms have made into exploration, which may not be recouped. IRENA, on the other hand, considers the potential priced-in market value of explored reserves, which, as one might expect, is higher than the cost of exploration.

25 Bank of England Prudential Regulation Authority (2018), *Transition in Thinking: The impact of climate change on the UK banking sector*.

2 A call for action: what central banks and supervisors can do and how policymakers can facilitate our work

While today's macroeconomic models may not be able to accurately predict the economic and financial impact of climate change, **climate science leaves little doubt: action to mitigate and adapt to climate change is needed now**. At the country level, governments and agencies should step up their efforts to implement effective policies that incentivise sustainable practices, while firms should develop business strategies and risk management controls that achieve sustainability in the long term.

There is a need for global collective leadership and coordinated action and, therefore, the role of international organisations and fora is critical. The NGFS, as a coalition of the willing and a voluntary, consensus-based forum, acknowledges this fact. **It is within this context that we set out a number of recommendations for central banks, supervisors and policymakers to do more.**

The following six non-binding recommendations reflect the best practices identified so far by NGFS members to facilitate the role of the financial sector in achieving the objectives of the Paris Agreement.

- **Recommendations n°1 to 4 are aimed at inspiring central banks and supervisors** – NGFS members and non-members – to take these best practices on board as it fits within their mandate. Parts of these recommendations may also be applicable to financial institutions.

- **Recommendations n°5 and 6 do not fall directly within the remit of central banks and supervisors** but point to actions that can be taken by policymakers to facilitate the work of central banks and supervisors. Parts of these recommendations may also be applicable to the private sector.

2.1 Recommendation n°1 Integrating climate-related risks into financial stability monitoring and micro-supervision

The NGFS acknowledges that climate-related risks are a source of financial risk and therefore calls on central banks and supervisors to start integrating climate-related risks into micro-supervision and financial stability monitoring. Important steps in this regard include:

1) Assessing climate-related financial risks in the financial system by:
- **mapping physical and transition risk transmission channels within the financial system and adopting key risk indicators to monitor these risks;**
- **conducting quantitative climate-related risk analysis to size the risks across the financial system, using a consistent and comparable set of data-driven scenarios encompassing a range of different plausible future states of the world;**
- **considering how the physical and transition impact of climate change can be included in macroeconomic forecasting and financial stability monitoring.**

2) Integrating climate-related risks into prudential supervision, including:
- **engaging with financial firms:**
  - **to ensure that climate-related risks are understood and discussed at board level, considered in risk management and investment decisions and embedded into firms' strategy;**
  - **to ensure the identification, analysis, and, as applicable, management and reporting of climate-related financial risks.**
- **setting supervisory expectations to provide guidance to financial firms, as understanding evolves.**

2.1.1 Assessing climate-related financial risks in the financial system

Scenario analysis is an important tool to help central banks and supervisors assess how climate change will impact the macroeconomy, financial system and safety and soundness of financial firms. The NGFS has therefore been considering how it could be implemented into authorities' toolkits.

There are several challenges that need to be highlighted in the development of workable scenarios for the financial impact of climate change. Assessing the impacts of climate change can be challenging because of the uncertainties around the course of climate change itself, the breadth and complexity of transmission channels, the primary and secondary impacts and the need to consider, in aggregate, some combination of both physical and transition risks. Even if all these challenges were addressed, over long time horizons, estimates will be highly dependent on the assumptions made about how climate policy and technology will evolve.

The future of climate policy is highly uncertain especially given the extended time horizons and political economy considerations. Policies must be initiated far in advance of the benefits being realised, while costs typically occur more immediately. Furthermore, the rate of progress in low-carbon technologies will be instrumental in determining the emissions reductions that are technically and economically feasible. It will also determine the extent of disruption to current business models in various sectors. Scenario analysis requires assumptions about whether emissions targets are met and when and how policymakers choose to act. These decisions may of course not be uniform in every region.

Given the sensitivity of results to these underlying assumptions, **hypothetical transition scenarios can be used to explore the direction and broad scale of outcomes**.

BOX 2

Designing a scenario analysis framework for central banks and supervisors

To contribute to central banks' and supervisors' ongoing work in this area, **the NGFS is developing an analytical framework for assessing climate-related risks, in order to size the impact of climate-related risks on the economy and the financial stability**. This includes looking at the different possible outcomes for climate change and the policies to mitigate it, assessing the financial impact and determining the timeframes during which risks could materialise.

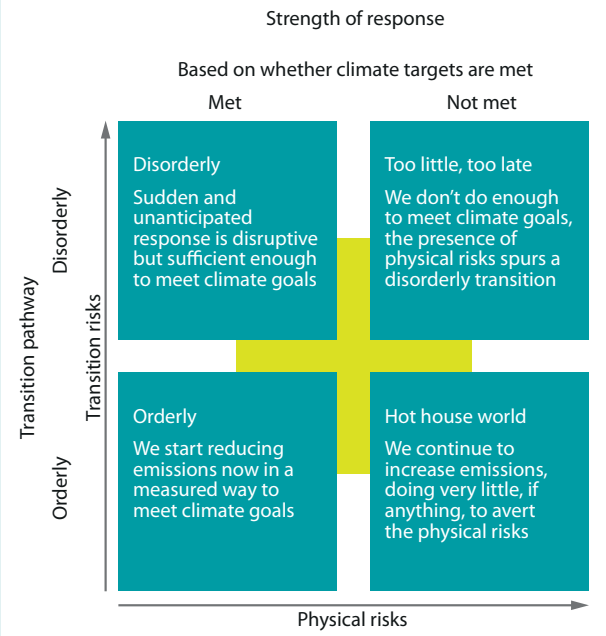
In its work so far, the NGFS has undertaken a **literature review** of existing scenarios to consider the most important design decisions when sizing macrofinancial risks. The NGFS has concluded that there are two important dimensions to consider when assessing the impact of physical risks and transition risks on the economy and the financial system.

- The total level of mitigation or, in other words, **how much action is taken** to reduce greenhouse gas emissions (leading to a particular climate outcome).
- Whether the transition occurs in an orderly or disorderly way, i.e. **how smoothly and foreseeably the actions are taken**.

Across these two dimensions there is a continuum of different outcomes and transition pathways to achieve them. However, to simplify the analytical exercise, four representative **high-level scenarios** have been developed that take both these dimensions into consideration.

The bottom-right scenario can help central banks and supervisors consider the long-term physical risks to the economy and financial system if we continue on our current "hot house world" pathway. The bottom-left orderly scenario can help us understand how climate policy (such as a carbon price) and other shifts in technology and sentiment to reduce emissions would affect the economy and the financial system.

The two scenarios at the top can help central banks and supervisors consider how physical and transition risks could crystallise in the economy and the financial system over a short time period (for example, in response to extreme weather events or a shift in climate policy leading to a sudden reassessment of future developments).



In the next phase, **the NGFS will develop a more detailed data-driven narrative and quantitative parameters as a foundation to these scenarios** and enable central banks and supervisors to explore some of these questions in their own jurisdictions. This will include proposing key assumptions for policy and technological change. During this design phase, the NGFS will work with academic experts, scenario designers and financial firms to ensure the scenarios are fit for purpose.

Looking ahead, NGFS members may incorporate these scenarios into their domestic work programmes. This would provide a case study for other central banks and supervisors that are considering running similar exercises and provide some feedback for the calibration of the scenarios.

Although these scenarios are primarily being developed by central banks and supervisors in support of their own work and objectives, these scenarios may provide a useful input for other stakeholders, such as financial and non-financial firms, in considering how they may be impacted by climate change.

These scenarios should have a clear, plausible, qualitative narrative but also be data-driven and provide quantitative parameters to help anchor assessments of economic costs and financial risks. They can help identify sectors or geographies which are particularly vulnerable either to physical or transition risks or a combination thereof. Ultimately, they should be suitable to help explore materially different plausible future states of the world over different time horizons.

The different states of the world that feature prominently in the existing literature on scenario analysis (and are key determinants of risk) include those where international climate targets are either met or not, and those where the transition to a low-carbon economy occurs in an orderly or disorderly way.

Using a consistent set of transition scenarios can help to enhance the comparability of different analyses. Work to standardise some of the macroeconomic assumptions in transition scenarios is already underway and could be developed further.[26] However, it is vital that common scenarios do not unduly constrain or narrow the analysis and results.

Further work is also required to translate these economic scenarios into financial risk parameters for financial stability analysis. This would help supervisors assess the financial stability risks across the system. Key risk indicators allow us to track which future scenarios are most likely to materialise and whether the economy and financial system need to adjust to minimise the potential risks.

Common scenarios should only provide a starting point for supervisors and firms to carry out bespoke analyses on the risks to their balance sheet. Financial firms should not wait for central banks or supervisors (or others) to deliver some kind of universal, perfect model. Rather, they should initiate their own structured analytical work to identify risks and vulnerabilities, which, successively, can become more and more quantified and sophisticated.

2.1.2 Integrating climate-related risks into prudential supervision

The NGFS stock-taking exercise on national supervisory frameworks and practices concluded that **the integration of climate-related factors into prudential supervision is at an early stage.** However, it also shows that over the last few years, many authorities have made significant progress within this area, and methods and tools to assess the financial risks of climate change from both physical and transition risks are gradually developing.

To contribute to central banks' and supervisors' ongoing work to integrate these issues into their operations, and based on the experiences and best practices identified within its membership, the NGFS proposes a high-level framework summarised in Figure 3.

Raising awareness and building capacity

The first step is for national and supra-national competent authorities **to build in-house capacity and to collaborate within their institutions**.

This in-house capacity building needs to happen concurrently with integration of climate change into risk assessment to ensure engagement with firms is effective. Initiatives to achieve this include:

- **Increasing awareness of climate issues within institutions** through outreach presentations and bringing together expertise from multiple departments.
- **Providing training courses for frontline supervisors** and financial stability experts. Training can provide an understanding of both the financial risks stemming from climate change, as well as the distinct characteristics of climate issues, e.g. regarding the timing mismatch between action and impact.

Collaboration with other supervisors and with wider stakeholders (think-tanks, NGOs, government departments, environment and climate science experts, and industry bodies from the financial sector) is also important.

26 See the Shared Socioeconomic Pathways (SSPs) project by the International Institute for Applied Systems Analysis (IIASA).

Figure 3 **High-level framework for the integration of climate-related factors into prudential supervision**

Courses of action	Possible measures by supervisors
Raising awareness and building capacity among firms	• Raise awareness of the relevance of climate-related risks publicly and during bilateral meetings; survey firms on the impact of these risks; lay out a strategic roadmap for the handling of climate-related risks. • Build capacity by convening events to progress the translation of scientific findings to financial analysis; set up working groups with firms, for example, on incorporating climate issues into risk management or scenario analysis.
Assessing climate-related risks	• Develop analytical tools and methods for assessing physical and transition risks related to climate change both at a micro- (financial institutions) and macro-level (i.e. the financial system). • Conduct and publish an assessment of these risks at a macro- and micro-level. • Analyse potential underlying risk differentials of "green" and "brown" assets. This pre-supposes that the supervisor and/or jurisdiction have agreed on definitions and classifications for "green" and "brown" activities.
Setting supervisory expectations	• Issue guidance on the appropriate governance, strategy and risk management of climate-related risks by regulated firms. • Train supervisors to assess firms' management of these risks.
Requiring transparency to promote market discipline	• Set out expectations for firms' climate-related disclosures in line with the TCFD recommendations. • Consider integrating climate-related disclosures into Pillar 3.
Mitigating risk through financial resources	• Consider applying capital measures in Pillar 2 for firms that do not meet supervisory expectations or with concentrated exposures. • Based on the risk assessment outlined above, possibly consider integrating it into Pillar 1 capital requirements.

As a next step, most authorities are focusing on engaging with firms to raise awareness and foster capacity building and discussing how the governance structure and strategy of the firm ensures a proper identification, assessment, management and reporting of climate and environment-related risks. In this regard, some central banks and supervisors have undertaken formal information gathering by sending out surveys to regulated firms.[27] Such a survey process can prompt firms to consider the risks more fully and then feed into an analysis of the approaches to address climate-related risks across the industry.[28]

27 See Appendix A of *The impact of climate change on the UK insurance sector A Climate Change Adaptation* Report by the Bank of England Prudential Regulation Authority (PRA), September 2015 and Section 4 of *Transition in thinking: The impact of climate change on the UK banking sector*, PRA, September 2018.

28 See e.g. Bank of England PRA, *Transition in thinking: The impact of climate change on the UK banking sector*, September 2018 and Finansinspektionen, *Integration of Sustainability into Corporate Governance, A survey of financial firms' public sustainability information*, 7 November 2018.

Developing tools and methods to identify and assess climate-related financial risks

Climate Risk Assessment

Climate Risk Assessment (CRA) refers to the methods and practices used to size the financial impact of climate-related risks to micro-prudential objectives, including:

- **Qualitative CRA** explores the longer-term impacts of different scenarios and provides a descriptive assessment, for example of risk transmission channels to the financial sector. Most member supervisors have undertaken some form of qualitative analysis.
- **Quantitative CRA** represents a numerical approach to sizing the financial risks. It is most effective at assessing the shorter-term financial exposures to physical and transition risks. Fewer authorities have performed quantitative analysis and in general, these studies have been partial, focusing on narrow channels of impact although wider methodologies are being developed.

Over the last few years, there has been significant progress on attempts to size the financial risks from both physical and transition risks. When combined, qualitative and quantitative assessments can provide a fuller picture of the risks the financial sector faces. The list below provides some examples of quantitative CRA.

On the transition risk side:

- Assessing financial institutions' exposures to high-carbon sectors.[29]
- Estimating the impact of a bank's exposure at risk to energy inefficient homes against the background of tightening energy efficiency regulation.
- Incorporating climate-related stresses into sector – or even market – wide stress tests.[30,31]

On the physical risk side:

- Developing climate scenarios based on specific temperature rises and estimating the climate-related claims burden for insurers (see the case studies in Box 3).
- Analysing the consequences of flood scenarios by linking estimated damage to residential and commercial buildings to financial institutions' exposures.
- Calculating a vulnerability index for firms' assets based on their geographical distribution.[32]

29 Regelink, Reinders, Vleeschhouwer, van de Wiel (DNB), *Waterproof? An exploration of climate-related risks for the Dutch financial sector*, 2017.

30 According to a stress test conducted by DNB, transition risk could lead to substantial losses for banks, leading to a reduction in the banks' CET-1 capital ratios of up to 4.3 percentage points. Vermeulen, Schets, Lohuis, Kölbl, Jansen, Heeringa, *An energy transition risk stress test for the financial system of the Netherlands*, 2018.

31 Bank of England PRA, *General Insurance Stress Test 2017, Scenario Specification, Guidelines and Instructions*, 11 April 2017.

32 Regelink, Reinders, Vleeschhouwer, van de Wiel (DNB), *Waterproof? An exploration of climate-related risks for the Dutch financial sector*, 2017.

BOX 3

Case study of quantitative analysis – DNB physical risk CRA tool

Dutch non-life insurers cover most of the economic damage caused by storms, hail and rain. Therefore, changing weather patterns are an important consideration for the insurance sector. In the Netherlands, more than 95% of all non-life insurance policies cover objects within domestic borders. Hence, insurers' claims are heavily related to regional climate change.

The 2017 Waterproof report explored the potential of a changing climate on climate-related claims. Based on scenarios from the Intergovernmental Panel on Climate Change (IPCC), the Dutch Meteorological Institute (KNMI) developed climate scenarios for the Netherlands for a 1.5°C and 3.5°C temperature rise in 2085. These scenarios include more frequent and severe hail and thunder, an increase in the intensity of rainfall and sea level rise. Based on these scenarios, the De Nederlandsche Bank (DNB) calculated the climate-related claims burden in 2085. Lower and higher estimates reflect the substantial uncertainty about the impact of changes in frequency and intensity of weather.

.../...

All scenarios showed an increase in climate-related claims as a result of climate change.

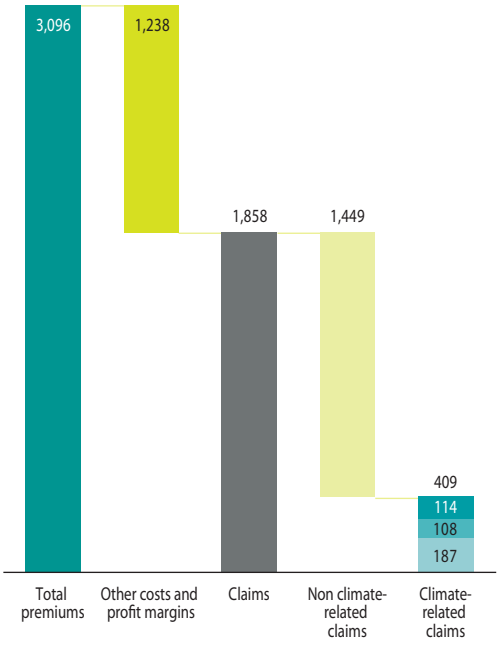
Since products of non-life insurance companies are typically on a one-year horizon, the sector might be able to adapt to the new circumstances on a relatively short notice. However, this would lead to additional pressure on premiums. Supervisors can use these scenario analyses to challenge insurance firms' risk model and climate strategies.

Other institutions have performed CRA exercises as well. According to an internal study by the Deutsche Bundesbank, in early 2018, **German banks' credit exposure to a limited set of carbon intensive industries was relatively small** (with an aggregated exposure of around EUR 157 billion or 4.7% of total loans to domestic households and non-financial corporations). According to a study by the ACPR, **in France, 13% of banks' total net credit was exposed to sectors vulnerable to transition risks** in 2016.[1]

Increase in climate-related claims in 1.5°C and 3.5°C scenarios

C1 **Estimated climate-related claims burden as a proportion of premiums in 2016**

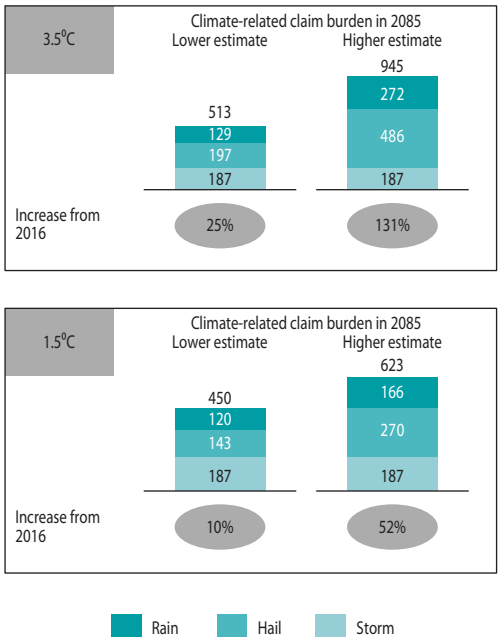
Homeowner's insurance policies *(in EUR millions)*



Source: DNB, 2017 Waterproof Report.

C2 **Estimated climate-related claims burden in 2085**

Homeowner's insurance policies *(in EUR millions)*



Source: DNB, 2017 Waterproof Report.

1 French Treasury, ACPR, Banque de France, *Evaluating Climate Change Risks in the Banking Sector*, April 2017.

Analysis of the potential risk differentials between profiles of green, non-green, brown and non-brown assets

From a supervisory perspective, there is a need to understand the potential risk differentials between green, non-green, brown and non-brown assets. If risk differentials are detected, further analysis needs to be performed to assess if the differentials can be attributed to (non-) green or (non-) brown characteristics, or if they are driven by other factors. Important prerequisites for this are clear definitions of which assets can be considered green or brown. Owing to the lack of taxonomies elsewhere, the default rates of these types of assets have not been evaluated in any jurisdiction, except for China.

BOX 4

The China Banking and Insurance Regulatory Commission analysis of default rates of green loans compared to the overall loan portfolio[1]

Data from the China Banking and Insurance Regulatory Commission (CBIRC, formerly the CBRC)[2] showed that, for the **21 largest banks in China as of June 2017, green loans had a non-performing loan (NPL) ratio that is 1.32 percentage points lower on average (at 0.37%) than that of all loans**. CBIRC data also showed that the NPL ratios of green loans were consistently lower than those of all loans for each of the previous four years (2013-16). However, further work is needed to assess whether the differences in performance can be attributed purely to the green/brown characteristics of the related loans.[3]

China was able to conduct this study following the introduction of official definitions for green loans in 2012, and official definitions for green bonds in 2015.[4] Other than China, Brazil is the only other G20 country to have adopted a green loan definition, but no data has been collected in Brazil.

1 This simple statistical analysis does provide first insights about the relative performances of green and brown assets, but it does not allow inferring broader conclusions about their relative intrinsic riskiness. The study does not indeed control for other factors which influence NPL ratios (different states of the sectoral cycle, average characteristics of counterparties or the loan, etc.). Further data analysis is therefore warranted.

2 *www.cbrc.gov.cn/*

3 As an example, borrowers with high profitability and cash flow (i.e. low PD) may be the same borrowers who have the means to invest in modern, "green" production capacity.

4 In China, the definition of green loans could be traced back to July 2007 in the *Opinions on Implementing Environmental Protection Policies and Regulations to Prevent Credit Risks* (MEP Document No. 108 2007) issued by the Ministry of Environment Protection (MEP), CBRC (the banking regulator) and the PBC, and has been further improved in the *Guidelines on Green Loans* (CBRC Document No. 4 2012) issued in February 2012.

Under prudential frameworks, risk weights are allocated to different asset classes or each individual exposure based on the riskiness of the underlying asset(s), in accordance with local supervisory requirements, usually based on BCBS and IAIS standards.[33] **No jurisdiction, however, has thus far explicitly taken into account the (non-) green or (non-) brown nature of the underlying assets when computing their perceived riskiness.**

The NGFS has performed a preliminary stock-take of studies conducted by market participants on credit risk differentials between green and non-green assets. These studies used either international or local definitions of "green". The preliminary finding of the stock-take is that **it is currently impossible to draw general conclusions on potential risk differentials.** Some studies, based on national and sectoral data found that green loans had lower default and non-performing[34] ratios than non-green loans while others did not.

The studies have covered several types of assets:

- Several studies point to a lower arrears frequency for **residential mortgages** on energy-efficient properties, although borrowers' financial ability and thus repayment capacity is only one of the factors controlled for.[35,36]
- There are fewer studies on **corporate loans**. The China Green Finance Committee (CGFC) found lower NPL ratios for green corporate loans across most corporate industry portfolios. Moody´s carried out a study in 2018 on infrastructure transactions from 1983 to 2016 in both

33 The definition of "non-performing" in these studies is based only on arrears, which differs from other definitions such as in the EU, where the NPL definition includes loans where the borrower has been assessed as "unlikely to pay" by the lender.

34 The Basel Committee on Banking Supervision (BCBS) is the primary global standard setter for the prudential regulation of banks. The International Association of Insurance Supervisors (IAIS) is responsible for the regulatory cooperation regarding the supervision of the insurance sector.

35 "Home Energy Efficiency and Mortgage Risks" (2013), by the Institute for Market Transformation (IMT).

36 E.g. "Impact of energy use and price variations on default risk in commercial mortgages: Case studies" (2017) by Mathew et al., "Insulated from risk? The relationship between energy efficiency of properties and mortgage defaults" (2018), by Guin and Korhonen and *Transition in Thinking: The impact of climate change on the UK banking sector*, case study 1: "Tightening energy efficiency standards and the UK buy-to-let market" (2018), by the Bank of England.

advanced and developing economies.[37] It found that green use-of-proceeds projects exhibit lower cumulative default risk (5.7%) than non-green use-of-proceeds projects (8.5%) in advanced economies. However, Moody´s suggests that the difference is likely to be due to subsample characteristics other than greenness.

- Some studies assess the default implications **from the perspective of loan/bond pricing**, on the basis that companies with lower default probabilities tend to enjoy lower funding costs. One study, based on data of 5,600 loans from the Thomson Reuters DealScan Database, finds that borrowers with better green management have more stable income streams. This makes them less likely to default on loans, violate covenants or file bankruptcy. As a result, the borrowing costs for "greener" companies tend to be lower than those of other companies.[38]
- Two studies found that a premium (ranging from 1 to 7 basis points) exists for **green bonds**. However, the study that found a larger premium has not isolated the "green factor".[39] Another study found no systematic evidence that green bonds would be issued or traded at lower yields than comparable non-green bonds. It highlighted the excess of demand for green bonds as the main driver behind the perceived premium of 1-2 basis points, rather than the explicit "greenness".[40]

However, the number of these studies is small and they typically have three types of limitations:

- most do not fully take into account other variables on borrower characteristics that may affect the default probability;
- country and sectoral coverage is limited;
- the definitions of green/non-green and brown/non-brown assets are not harmonised across the studies, therefore it is not possible to draw a general conclusion on their risk profiles.

The stock-take points to the need for a more thorough examination of existing studies as well as further fact-gathering and analyses. This should pay due regard to non-climate variables that might affect the default rates and performance of green assets. The NGFS intends to perform an exploratory data collection from selected banks in 2019. The objective is to analyse the collected data and assess if there is a risk differential between green and non-green assets (loans and bonds), taking into account the above mentioned constraints. The NGFS is aware that historical data is not always a good indicator of future performances, in particular given the likelihood of unprecedented disruptions to the economy caused by climate change. Therefore, as a possible next step after the collection and analysis of historical data, it may be expedient to introduce a more forward-looking perspective into the analysis, for example, through scenario analysis and/or stress tests.

Setting supervisory expectations

Some central banks and supervisors have further integrated climate-related risks into the supervisory framework by adjusting and communicating their supervisory expectations.[41] These expectations can set out how financial institutions should monitor and manage the financial risks associated with their climate exposures, anchored in the qualitative aspects of Pillar 2. This includes ensuring that consideration of these risks is integrated into governance, strategy and risk management assessments. The majority of authorities plan to assess climate-related financial risks through established financial risk categories, rather than to introduce new policy or frameworks.

Promoting transparency to enhance market discipline

In addition, authorities can set out their expectations when it comes to financial firms' transparency on climate-related issues. Through the promotion of climate-related disclosure via Pillar 3, for example in line with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations (see recommendation n°5); authorities can contribute to an improvement of the pricing mechanisms for climate-related risks and a more efficient allocation of capital.

37 "Default and recovery rates for project finance bank loans, 1983-2016: Green projects demonstrate lower default risk" (2018).

38 Dawei Jin, Jun Ma, Liuling Liu, Haizhi Wang, Desheng Yin. "Are green companies less risky and getting lower cost bank loans? A stakeholder-management perspective." *Working Paper*, 2018.

39 "Is there a Green Bond Premium?" (2018), by O D Zerbib and "The Pricing and Ownership of U.S. Green Bonds" (2018), by Baker et al.

40 UBS Wealth Management Sustainable Investing – Green Bonds (2018).

41 See e.g. *https://www.bankofengland.co.uk/*

Mitigating climate-related risks through financial resources

Climate-related risks could be integrated further via the quantitative aspects of the prudential framework. In particular, the Pillar 2 framework could be enhanced to assess the adequateness of firms' governance and risk management processes for dealing with climate and environment-related risks, or with concentrated exposures. If a risk differential and causation is established, it might be appropriate to include it in Pillar 1 capital requirements.

2.2 Recommendation n°2 Integrating sustainability factors into own-portfolio management

Acknowledging the different institutional arrangements in each jurisdiction, the NGFS encourages central banks to lead by example in their own operations. Without prejudice to their mandates and status, this includes integrating sustainability factors into the management of some of the portfolios at hand (own funds, pension funds and reserves to the extent possible).

NGFS members may lead by example by integrating sustainable investment criteria into their portfolio management (pension funds, own accounts and foreign reserves), without prejudice to their mandates.[42] **This approach could have several benefits:**

- The assessment of sustainability factors, in addition to traditional financial factors, can **improve investors' understanding of long-term risks and opportunities** and thereby enhance the risk-return profile of long-term investments. To the extent that sustainability factors, such as the exposure of a security to climate change, can pose financial risks, it is natural for investors to seek to capture them.

- **Central banks can reduce reputational risks** by acknowledging financial risks related to the transition towards a carbon-neutral economy and by addressing these risks proactively in their own (risk) frameworks. Against this backdrop, central banks could be scrutinised for not "walking the talk" if they fail to appropriately address climate-related risks in their own (risk) frameworks. Reputational risk could also arise when central banks invest in companies that are exposed to these risks.

- Central banks may decide to employ part of their investments to pursue non-financial sustainability goals in order to **generate positive (societal) impacts**, in addition to traditional financial return goals. In this way, central banks can also actively support the development of the market for green and sustainable assets.

Many NGFS members are, however, limited by their mandates and/or investment objectives, such that, overall, sustainability criteria currently still play a minor role in most central banks' portfolio management. **Nevertheless, a number of central banks have established themselves as frontrunners** in this field and have adopted sustainability strategies for all or at least part of their investments.

If other central banks were to follow, it seems expedient for them to first establish their fundamental strategy based on their motivation and rationale, then to establish sustainability policies for their different given portfolios and finally decide on the necessary implementation measures and how to evaluate and report on their progress towards achieving their set objectives. As central banks are not a homogeneous group of investors with one shared doctrine, it is up to each central bank to set the appropriate goals and scope for their respective sustainable investment approach.

42 NGFS members' efforts to work towards mainstreaming green finance also include various steps they take as corporates to green their core business activities and to reduce their environmental impact. There is broad consensus among NGFS members that leadership also requires dedicated environmental strategies, well-defined sustainability targets – such as reducing resource, water and energy use as well as waste production – and transparency regarding the measures taken and the degree to which these targets have been met.

BOX 5

Sustainable investment at the Banque de France

In March 2018, the Banque de France (BdF) released its responsible investment charter for its portfolios backed to own funds and to the pension liability. This investment charter is in line with the BdF's corporate social responsibility (CSR) charter and its fiduciary duty as a long-term investor.

One year later, **the BdF released its first responsible investment report** based on the provisions of Article 173 of the French Law on the energy transition for green growth (LTECV) and recommendations from the Task Force on Climate-related Financial Disclosures (TCFD).[1] It describes the extra-financial performance of its portfolios and sets up the objectives of the BdF responsible investment strategy. The BdF committed to harmonise its investments with France's climate targets by getting aligned with a 2°C trajectory and by financing the energy and ecological transition through green bonds and dedicated funds. Moreover, the BdF will include environmental, social and governance (ESG) criteria in its asset management and a best-in-class approach based on firms' ESG score and climate performance will be applied. Lastly, the BdF will adopt a voting policy that includes provisions on non-financial transparency and will increase its general meeting attendance rate.

1 *https://www.banque-france.fr/sites/*

Notwithstanding that the focus of central banks incorporating ESG aspects into their portfolio management has been on own funds and pension liability portfolios, **some voices have called for an extension of this approach to monetary policy.** Among NGFS members, so far only one central bank, the People's Bank of China, has a dedicated policy to promote green finance via monetary policy.

Going forward, the NGFS will consider exploring the interaction between climate change and central banks' mandates (other than financial stability) and the effects of climate-related risks on the monetary policy frameworks, paying due respect to their respective legal mandates.

2.3 Recommendation n°3 Bridging the data gaps

Building on the G20 GFSG/UNEP initiatives, the NGFS recommends that the appropriate public authorities share data of relevance to Climate Risk Assessment (CRA) and, whenever possible, make them publicly available in a data repository.

In that respect, the NGFS sees merit in setting up a joint working group with interested parties to bridge existing data gaps. The deliverable of this group would be a detailed list of data items that are currently lacking but which are needed by authorities and financial institutions to enhance the assessment of climate-related risks and opportunities – for example, physical asset level data, physical and transition risk data or financial assets data.

In the course of its work, the NGFS observed, like other institutions and academic papers before, that **data scarcity and inconsistency are substantial obstacles to the development of analytical work on climate risk**. The associated challenges include:

- **Data availability**: data covering the exposure to climate-related risks, risk-return profiles of green financial products as well as "brown" assets (loans, bonds and equity instruments) are critical to undertaking risk assessment and carrying out climate disclosure. Granular data is also needed to conduct bottom-up, quantitative analysis of the macrofinancial impacts of climate-related risks. Finally, such data is also needed to assess and quantify the development of green asset markets, which is of particular interest in a portfolio management context.
- **Time horizon**: the period covered by available data is currently too short. Risk-weighted assets, for example, are calculated on a one-year forward-looking basis only.
- **Lack of expertise**: there is a need to bring together the relevant expertise to gain a complete and integrated understanding of data needs, covering climate, environmental and financial data.

In order to move from observation to action, the NGFS is ready to initiate work with interested parties on setting out a detailed list of currently lacking data items, which authorities and financial institutions would need to enhance the assessment of climate-related risks and opportunities such as physical asset level data, physical and transition risk data and financial assets data. The aim of this initiative is to allow data providers to mine the relevant data and progressively bridge the gaps.

2.4 Recommendation n°4 Building awareness and intellectual capacity and encouraging technical assistance and knowledge sharing

The NGFS encourages central banks, supervisors and financial institutions to build in-house capacity and to collaborate within their institutions, with each other and with wider stakeholders to improve their understanding of how climate-related factors translate into financial risks and opportunities.

The NGFS therefore encourages central banks, supervisors and financial institutions to:

- **allocate sufficient internal resources to address climate-related risks and opportunities;**
- **develop training to equip employees with the necessary skills and knowledge;**
- **work closely together with academics and think-tanks to inform thinking;**
- **raise awareness by sharing knowledge within the financial system.**

The NGFS also encourages relevant parties to offer technical assistance to raise awareness and build capacity in emerging and developing economies when possible.

A key element to achieving effective consideration of climate risks across the financial system is to support internal and external collaboration. Internally, the distinct cross-cutting nature of climate-related risks has led to innovative ways of working across supervisory institutions. Central banks and supervisors have typically formed internal "hubs" or "networks" to bring together the relevant expertise within their organisations.

Externally, there are examples of collaboration with academia, think-tanks, NGOs, government departments, other local supervisors, climate science experts, and financial industry bodies. Examples of international collaboration include:

- ESRB – European Systemic Risk Board and the Analysis Working Group (AWG) Project Team on Sustainable Finance;
- G20 – the G20 Sustainable Finance Study Group;
- IOSCO – Sustainable Finance Network;
- OECD – Centre on Green Finance and Investment, including its annual Forum on Green Finance and Investment;
- SBN – Sustainable Banking Network supported by the IFC;
- SIF – Sustainable Insurance Forum;
- TCFD – Task Force on Climate-related Financial Disclosures.

NGFS members also promote market growth as facilitators between the financial industry and legislators. Many are involved in various national and/or international private sector or public-private initiatives such as the Network of Financial Centres for Sustainability, the Prudential Regulation Authority (PRA)-Financial Conduct Authority (FCA) Climate Financial Risk Forum, Finance for Tomorrow in Paris, the DNB's sustainable finance platform, and the Chinese Green Finance Committee. Participating in such initiatives allows for continuous dialogue with market participants and enables central banks and supervisors to contribute to the improvement of existing green market infrastructure and the development of new green financial instruments.

To foster international exchange on the topic, the NGFS organised an industry dialogue in Singapore in June 2018 which was instrumental in understanding the expectations of the private sector with regards to the role of the NGFS and its members in scaling up green finance. Some participants called for policymakers to set minimum transparency standards regarding the methodologies of second opinion providers for green assets, to provide guidelines (for example, for green bonds) or to simplify approval processes (facilitating green issuances).

Furthermore, the NGFS hosted a conference at the Bank of England in January 2019 bringing together academia, think-tanks, central banks and supervisors and financial institutions to better understand how to size the risks.

Going forward, NGFS members will scale up their efforts for capacity building and technical assistance in emerging economies. Emerging economies are often disproportionately affected by the effects of climate change and they often lack the resources to assess the associated risks. During its work, the NGFS has therefore initiated a dialogue with authorities in developing and emerging countries outside of its membership, and will continue to do so. The NGFS also encourages other relevant parties, such as multilateral institutions, to offer technical assistance to raise awareness and build capacity in emerging and developing economies when possible.

2.5 Recommendation n°5 Achieving robust and internationally consistent climate and environment-related disclosure

The NGFS emphasises the importance of a robust and internationally consistent climate and environmental disclosure framework.

NGFS members collectively pledge their support for the recommendations of the Task Force on Climate-related Financial Disclosures (TCFD). The TCFD recommendations provide a framework for consistent, comparable and decision-useful disclosure of firms' exposures to climate-related risks and opportunities. The NGFS encourages all companies issuing public debt or equity as well as financial sector institutions to disclose in line with the TCFD recommendations.

The NGFS recommends that policymakers and supervisors consider further actions to foster a broader adoption of the TCFD recommendations and the development of an internationally consistent environment disclosure framework. This includes authorities engaging with financial institutions on the topic of environment and climate-related information disclosures, aligning expectations regarding the type of information to be disclosed and sharing good disclosure practices.

As stated in the NGFS October 2018 progress report, **robust disclosure of climate-related information by financial institutions has a number of important benefits:**

- It is integral to an efficient, well-functioning capital market, as it can improve the pricing mechanisms for climate-related risks. It also facilitates the surveillance of the financial system.
- Better disclosure can lead to better risk management. The discipline of public disclosure requires financial institutions to establish the necessary data collection and procedures to better identify and manage their risks.
- It enables market players and policymakers to quickly identify and capitalise on sustainable opportunities, thereby contributing to the continued growth of the green finance ecosystem.

Climate-related disclosure practices differ across jurisdictions, both in terms of what and how to disclose.

The majority of jurisdictions surveyed by the NGFS already have in place, or are planning to implement, some form of climate-related disclosure requirements for their entities. **There are various approaches to encourage disclosure**, including:

- **Non-mandatory approaches**: supporting industry-led or non-binding disclosure guidelines, including cross-border collaboration[43] and surveying disclosure practices. This approach can help financial institutions comply with broader disclosure requirements applied to listed entities and/or entities considered to be of significant public relevance within the jurisdiction.
- **A "comply or explain" approach**: a firm would be considered non-compliant if it does not disclose and fails to provide an adequate explanation.[44] This approach provides firms with clarity and guidance on disclosure requirements but with greater flexibility and possibly reduced compliance costs compared to a one-size-fits-all disclosure rule. Additional non-binding recommendations can support the standardisation of firms' disclosure.[45]
- **A mandatory approach**, specifying a catalogue of data items detailing the quantitative and qualitative data that need to be disclosed.

Most jurisdictions with disclosure requirements set out the type of information that entities must disclose, but allow flexibility on how to comply with the requirements. While the scope and extent of information disclosed varies across entities and jurisdictions, the reporting components broadly include:

- the firm's policies and practices in relation to climate matters;
- climate targets, metrics and performance (including the impact of their activities on the environment);
- material climate risk exposures as well as measures taken to mitigate such risks. In some entities and jurisdictions, this may include the entity's environmental impacts, and how it seeks to identify, prevent and mitigate those impacts.

The absence of a global standardised framework for disclosures results in two main drawbacks:

- the lack of comparability and consistency across jurisdictions, especially on the level of granularity and transparency;
- the lack of a level playing field across jurisdictions, which may lead to increased and skewed compliance costs.

This impedes the proper and globally consistent assessment of climate risks at a firm level as well as the analysis of financial stability risks.

A common international standard on climate information disclosure would foster comparable high-quality disclosures and provide greater clarity to the industry on how to align their reporting internationally. **The recommendations provided by the TCFD with support from the Financial Stability Board (FSB) are an obvious avenue of convergence for a global standardised framework on climate disclosures.** Unlike existing disclosure requirements, the TCFD proposal mainly focuses on climate rather than more broadly on sustainability.

There is a significant level of awareness amongst central banks, supervisors and regulated entities of the TCFD

43 Led by the China Green Finance Committee and the City of London Green Finance Initiative, and in collaboration with the Principles for Responsible Investment, the China-UK Pilot TCFD group, comprising ten Chinese and UK financial institutions, launched a pilot TCFD reporting programme and developed templates for disclosure by banks. The three-year action plan of this pilot exercise was published in November 2018.

44 An example of this is Article 173 of the French Energy Transition Law.

45 EU law requires large companies to disclose certain information on the way they operate and manage social and environmental challenges. While Directive 2014/95/EU, as implemented into national law, is mandatory, the EU Commission issues non-binding guidelines on non-financial reporting which refine the disclosure obligation set out in the Directive.

recommendations, and support from the private sector has grown rapidly, particularly considering that the recommendations were only released in mid-2017. As of February 2019, the TCFD had the support of over 580 firms, with market capitalisations of over USD 7.9 trillion, and including financial firms responsible for assets of nearly USD 100 trillion. The most recent status report, from September 2018, highlighted that many firms are already disclosing in line with the recommendations, but there is still a need for progress in key areas, including scenario analysis and disclosing the financial impacts of climate change on the firms' operations. Increasing awareness and sharing best practices can help encourage wider implementation of the recommendations. For example, the United Nations Environment Programme Finance Initiative (UNEP FI)/TCFD pilot project involves 16 global banks working to assess how they can best adopt key elements of the recommendations.

Supervisors could support the development of a disclosure framework by proposing additional standardised metrics for the financial sector. This includes:

- engaging with financial institutions on the topic of environment and climate-related information disclosures to align expectations regarding the type of information to be disclosed and share good disclosure practices;
- issuing additional guidance on materiality assessment for their respective financial institutions and jurisdictions in order to help firms' comprehensively capture the climate-related risk factors to be considered and disclosed.

In jurisdictions where prudential and market supervision are conducted by different authorities, collaboration on disclosure is also very important.

The NGFS considers that disclosure of climate-related information and enhanced market discipline cannot emerge rapidly enough without action by policymakers or supervisory authorities. While acknowledging the need to move forward on this issue, the NGFS is also mindful of the remaining challenges, including the current lack of data, the scope of reporting, and methodological issues.

2.6 Recommendation n°6 Supporting the development of a taxonomy of economic activities

The NGFS encourages policymakers to bring together the relevant stakeholders and experts to develop a taxonomy that enhances the transparency around which economic activities (i) contribute to the transition to a green and low-carbon economy and (ii) are more exposed to climate and environment-related risks (both physical and transition). Such a taxonomy would:

- **facilitate financial institutions' identification, assessment and management of climate and environment-related risks;**
- **help gain a better understanding of potential risk differentials between different types of assets;**
- **mobilise capital for green and low-carbon investments consistent with the Paris Agreement.**

Policymakers would thus need to:

- **ensure that the taxonomy is robust and detailed enough to (i) prevent green washing, (ii) allow for the certification of green assets and investments projects and (iii) facilitate risk analysis;**
- **leverage existing taxonomies available in other jurisdictions and in the market and ensure that the taxonomy is dynamic and reviewed regularly to account for technological changes and international policy developments;**
- **make the taxonomy publicly available and underline the commonalities with other available taxonomies. Eventually, it should strengthen global harmonisation to ensure a level playing field and prevent the dilution of green labelling.**

BOX 6

Green taxonomies and the cases of China and Europe

Green finance taxonomies provide the basis for defining and classifying green financial assets (e.g., green loans, green bonds and green funds). **In China, the definition of green loans was introduced as early as 2013 by the China Banking and Insurance Regulatory Commission** (CBIRC, formerly CBRC) **in the *Guidance on Green Loans***. This green loan definition included 12 categories, such as renewable energy, green transportation, green building, etc. Since then, the CBIRC has requested all major banks to report on a semi-annual basis the balance of green loans and the environmental benefits these loans delivered. Green loan default data are also collected by the CBIRC. As of end-2018, the outstanding amount of green loans held by the 21 largest commercial banks in China reached RMB 8.23 trillion, accounting for about 10% of their total aggregate loan balance.

In 2015, China introduced the world's first national-level green bond taxonomy, the Green Bond Endorsed Project Catalogue (2015), which was published by the Green Finance Committee of China Society for Finance and Banking, an institution under the People's Bank of China (PBoC). The Catalogue defined six main categories and 31 sub-categories of projects as eligible for green bond financing. The six main categories included (i) energy saving, (ii) pollution prevention and control, (iii) resource conservation and recycling, (iv) clean transport, (v) clean energy, and (vi) ecological protection and climate change adaptation. The Catalogue was used by virtually all issuers, investors and verifiers in China, even though it was not intended to be "mandatory". Based on the green bond taxonomy, Chinese regulators have also introduced rules and guidelines on green bond verification, as well as environmental information disclosure by green bond issuers. The Catalogue is now under revision and a new version is expected to be released in 2019. Thanks in part to the green taxonomies and the green bond eco-system developed on the basis of the taxonomy, Chinese institutions have issued over USD 100 billion in green bonds from 2016 to 2018, becoming one of the largest green bond markets in the world.

In Europe, the European Commission has tabled a legislative proposal to develop a unified EU classification system – or taxonomy – to determine which economic activities can be regarded as environmentally sustainable for investment purposes. Such a list of environmentally sustainable economic activities would be a useful tool to help financial market participants identify sustainable companies and assets. The proposal identifies six environmental objectives. For an economic activity to be environmentally sustainable, it needs to (i) substantially contribute to at least one of the environmental objectives, (ii) do no significant harm to any of these objectives, (iii) comply with minimum safeguards, and (iv) comply with technical screening criteria. These criteria are meant to determine when an activity can be considered to "substantially contribute" to the objectives, while doing "no significant harm". The Commission has set-up a Technical Expert Group on Sustainable Finance to advise the Commission on the technical screening criteria. The taxonomy will be instrumental to many other actions that the Commission plans to take to move towards more sustainable growth. For example, the Technical Expert Group is also working on a potential EU Green Bond Standard, which will build on the EU Sustainability Taxonomy.

It is important to exploit potential synergies between taxonomies in different jurisdictions. For example, the China Green Finance Committee and the European Investment Bank (EIB) have already made such an attempt by publishing a White Paper called "The Need for a Common Language in Green Finance" in November 2017, followed by a second edition in December 2018. The White Papers compared and mapped the differences and similarities between different green bond taxonomies and highlighted the need for and a potential pathway towards harmonisation of green taxonomies.

The NGFS identified a clear taxonomy around green, non-green, brown and non-brown products as a prerequisite for deepening its analytical work.

- **A taxonomy of "brown" assets** based on clearly defined criteria is important to identify **which assets will be impacted by the Paris Agreement** and the low-carbon and climate-resilient transition. It is a preliminary step to better assess the risk profile of "brown" assets and ensure that disclosures by financial institutions are consistent and comprehensive.
- **A taxonomy of "green" assets** enables policymakers and supervisors to **assess their risk** profile. Like any other investor, central banks will benefit from these taxonomies when implementing sustainable investment strategies.
- **A taxonomy of "green" assets is also of particular use for scaling up green finance**, as it provides financial markets with more transparency, consistency and uniformity and, therefore, confidence in green characteristics. It provides the basis for labelling green financial assets and verifying the "green" feature of the underlying activities, for collecting statistics in green financial flows and stocks, such as green loans or bonds extended or issued during a certain period of time as well as the outstanding volume of green loans and green bonds at any point in time.

The practical challenge is for all affected stakeholders to come together and implement this taxonomy. This calls for policymakers to bring together the relevant stakeholders and experts and to structure and facilitate the debate.

Until now, no regulatory taxonomy has been implemented globally, except market-driven taxonomies which are, by definition, not binding. The NGFS acknowledges the trade-off between, on the one hand, the fragmentation of regional or national approaches, diversity of jurisdictions' collective preference and differing stages of development and, on the other hand, harmonisation in order to avoid level-playing-field problems and to facilitate global assessment of risk profiles. **Although the space for a global taxonomy is limited, the NGFS is supportive of ensuring comparability and consistency across different taxonomies.**

3 Looking forward: operationalising the work and strengthening the dialogue

The NGFS is an open-ended initiative and will continue its work as long as its members deem it necessary and useful. The lesson drawn from the first sixteen months of NGFS activity is that climate change presents significant financial risks that can only be mitigated through an early and orderly transition.

To ensure such a smooth transition, there is still a significant amount of analytical work to be done in order to equip central banks and supervisors with appropriate tools and methodologies to identify, quantify and mitigate climate risks in the financial system. This calls for a close and specific dialogue with academia and for further technical work to translate the NGFS recommendations or observations into operational policies and processes.

The NGFS will continue to leverage the best practices identified within its membership to help central banks and supervisors to better assess and mitigate climate-related risks.

More precisely, in terms of concrete deliverables, the NGFS is planning to develop:

- **A handbook on climate and environmental risk management for supervisory authorities and financial institutions:** this document would set out some detailed and concrete steps to be taken by supervisors and financial institutions to better understand, measure and mitigate exposures to climate and environmental risks. The handbook will build on the recommendations of this report. It would also provide some detailed case studies of climate/environmental risk analyses carried out by financial institutions and/or supervisory authorities. The focus will be primarily on climate-related risks but will also cover environmental risks.
- **Voluntary guidelines on scenario-based risk analysis:** scenario-based risk analysis is complex, requiring further research and analytical input. The NGFS is working to develop data-driven scenarios for use by central banks and supervisors in assessing climate-related risks. The next step will consist in providing practical advice and guidelines for authorities willing to conduct their own analyses.
- **Best practices for incorporating sustainability criteria into central banks' portfolio management (particularly with regard to climate-friendly investments):** building on some concrete case studies, NGFS members will further delve into the topic and develop a hands-on practical guide for central banks to integrate sustainability principles into their portfolio management.

The NGFS is also aware that addressing climate-related risks calls for a collective response with the relevant stakeholders, namely:

- **With non-NGFS central banks or supervisors, regional and/or international supervisory authorities and standard setting bodies and international organisations, governments and policymakers** in order to contribute to developing the appropriate policy framework. International standard setting bodies could consider how the NGFS recommendations could feed into their work and assess their current set of standards/best practices with respect to the relevance of climate-related risks. To this end, the NGFS will present this report to the BCBS in 2019. Specific regional outreach exercises, following the example of the Mexico Green Finance Conference in January 2019, will be arranged to strengthen the global reach of the NGFS.
- **With academia** in order to identify analytical blind spots and gaps in our collective knowledge. In 2019, the NGFS will set up a specific dialogue with academia and hold periodic academic events to discuss the most pressing research questions.
- **With the financial industry and NGOs** in order to ensure a mutually beneficial exchange of experience and information. To that end, the NGFS has entered into a close dialogue with a number of stakeholders relevant to its work.

Conclusion

Over barely sixteen months of existence, the NGFS has grown from eight founding members to more than thirty members from five continents including emerging and developed countries alike. **As time is running out to ensure a smooth transition to a low-carbon economy, and to mitigate climate change impacts on the world's economy and the global financial system, the momentum among the central bank and supervisory community to respond to this challenge is growing rapidly.** This first comprehensive report lays the foundations for the more technical deliverables the NGFS is going to produce in the coming months. The NGFS membership is collectively determined to develop practical tools and methodologies for its membership and beyond, while continuing to raise awareness and to reach out to the various stakeholders relevant to its work.

List of acronyms

BCBS	The Basel Committee on Banking Supervision is the primary global standard setter for the prudential regulation of banks.
CRA	Climate Risk Assessment refers to the methods and practices used to size the financial impact of climate-related risks to micro-prudential objectives, including qualitative and quantitative analysis.
CSR	Corporate social responsibility.
ESG	Environmental, social and governance criteria are used by responsible investors and can be financially material.
GFSG/SFSG	The G20 Green/Sustainable Finance Study Group was launched under China's Presidency of the G20 in 2016. The Study Group is co-chaired by China and the United Kingdom and has published three reports in 2016, 2017 and 2018.
GHG	According to the IPCC[1] the greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and by clouds.
IAIS	The International Association of Insurance Supervisors is responsible for regulatory cooperation regarding the supervision of the insurance sector.
IPCC	The Intergovernmental Panel on Climate Change is the United Nations body for assessing the science related to climate change.
NGFS	Network for Greening the Financial System.
NPL	A non-performing loan is a loan for which the debtor has not met the scheduled payments for a defined period.
PD	The probability of default refers to the likelihood of default on a financial asset over a defined time horizon.
SFN	The Sustainable Finance Network is an initiative of the International Organization of Securities Commissions (IOSCO) bringing together securities and markets authorities. The Network is currently chaired by Erik Thedéen, Director General, Finansinspektionen (Swedish Financial Supervisory Authority).
TCFD	The Task Force on Climate-related Financial Disclosures is a private-sector led task force, chaired by Michael R. Bloomberg with support from the Financial Stability Board, which provides a global standardised framework on climate disclosures.
UNEP FI	The United Nations Environment Programme – Finance Initiative is a partnership between UNEP and the global financial sector created in the wake of the 1992 Earth Summit with a mission to promote sustainable finance.

1 IPCC, Special Report: Global Warming of 1.5°C, Glossary, 2018.


BANQUE DE FRANCE
EUROSYSTÈME
NGFS
Secretariat