

Stocktake of Financial Authorities' Experience in Including Physical and Transition Climate Risks as Part of Their Financial Stability Monitoring

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Table of Contents

Executive summary	1
1. Introduction.....	2
2. The inclusion of climate-related risks in authorities' financial stability monitoring	3
2.1. The degree to which authorities include climate-related risks in their financial stability monitoring	4
2.2. Channels of risks to financial stability that financial authorities consider	7
2.3. The implications of climate-related risks for financial institutions.....	8
2.4. Feedback effects through which climate-related risks on the financial sector can affect the real economy	9
2.5. Potential for cross-border spillovers of climate-related risks.....	10
3. Quantification of climate-related risks to financial stability.....	10
3.1. Existing estimates of climate-related risks	11
3.2. Top-down estimates of climate-related risks	12
3.3. Bottom-up estimates.....	19
4. Supervisory approaches to increasing financial institutions' resilience to climate-related risks.....	23
4.1. Supervisory awareness and expectations.....	23
4.2. Supervisory expectations that financial institutions conduct their own scenario analysis	24
4.3. Disclosure of climate-related risks	25
5. Next steps	26
Annex 1: Survey responses.....	27
Annex 2: Work of international organisations and standard-setting bodies	30
Annex 3: Publications on climate-related risks.....	33
Annex 4: Summary of FSB climate-change workshop	35

Executive summary

- This report **takes stock of financial authorities' experience in including climate-related risks in their financial stability monitoring**. It draws on information provided by FSB Analytical Group on Vulnerabilities (AGV) members, a survey of FSB members and the Network for Greening the Financial System (NGFS), and a workshop with the private sector.
- Financial authorities **vary in terms of whether – and to what degree –** they consider climate-related risks as part of their financial stability monitoring. Around three-quarters of survey respondents consider, or are planning to consider in future, climate-related risks as part of their financial stability monitoring. The majority have also undertaken external outreach and discussions on the subject.
- Those financial authorities considering climate-related risks **generally consider the potential for these risks to affect the financial system via similar channels**. Most focus on the implications of changes in asset prices and credit quality. A minority of authorities also consider the implications for underwriting, legal, liability and operational risks.
- **Authorities also consider the implications of these risks for financial institutions**. Consideration of the implications of credit and market risks faced by banks and insurance firms appears more advanced than that of other risks, or of risks faced by other types of financial institutions.
- Only a small number of authorities consider how climate-related risks to the financial system might (i) **feedback** to the real economy, thereby further affecting the financial system; or (ii) lead to **spillovers across** borders or between financial sectors.
- **Some financial authorities have quantified – or have work underway to quantify – climate-related risks**. Such work is hindered by a lack of consistent data on financial exposures to climate risks, and difficulties translating climate change outcomes into changes in those exposures. Nonetheless, authorities' approaches take two complementary forms:
 - 'Top-down' approaches, where risks are estimated by the authority(s) themselves. These have the advantage of being less resource intensive and allow a high degree of comparability across firms; but they face trade-offs between the granularity of the data on which they are based versus the breadth of their coverage. Many tend to be more static and assess risks at a given point in time.
 - 'Bottom-up' approaches, where the magnitude of risks is calculated by financial institutions themselves, using their own (typically more detailed) proprietary data, based on a quantitative scenario given by the official-sector. Such approaches are generally more resource intensive; but have the advantage of providing a more granular perspective, and covering a large number of firms and/or markets.
- **No approach to quantification provides a holistic assessment of climate-related risks to the global financial system.**

- In some jurisdictions, climate-related risks are being integrated into microprudential supervision of banks and insurance firms (including via requirements for firms' stress testing and disclosure), though such work is generally at an earlier stage than for other types of risk. Some authorities report having set out – or being in the process of setting out – their expectations as to firms' disclosure of climate-related risks. In some cases such expectations explicitly refer to the recommendations of the FSB's Taskforce on Climate-related Financial Disclosures.

1. Introduction

At its conference call on 11 October 2019, the FSB Standing Committee on Assessment of Vulnerabilities (SCAV) approved a proposal from the AGV for its forthcoming work on the financial stability implications of climate change. As a first step in this work, the SCAV agreed that the AGV would provide a stocktake of financial authorities' experience in including (or considerations as to how they might in future include) climate risks as part of their financial stability monitoring.

Existing work at international level on the financial sector implications of climate change has focused on micro risks to individual financial institutions and/or on developing policies to mitigate them. FSB work to date has been to establish the private sector-led Task Force on Climate-related Financial Disclosures (TCFD) to develop voluntary and consistent climate-related financial risk disclosures for use by companies in providing information to lenders, investors and other stakeholders.

This report takes stock of financial authorities' experience in including climate-related risks in their financial stability monitoring.¹ In keeping with the commission from SCAV, such climate-related risks include:

- **Physical risks:** that is, the possibility that the economic costs and financial losses from the increasing severity and frequency of extreme climate-change related weather events might erode the value of financial assets, and/or increase liabilities.
- **Transition risks** that relate to the process of adjustment towards a low-carbon economy, including shifts in policies designed to mitigate and adapt to climate change, which would affect the value of financial assets and liabilities.

To do so, it draws on the results of a survey of FSB members and the Network for Greening the Financial System (NGFS). In total 33 survey responses were received from 31 jurisdictions and international organisations.² Twenty-eight respondents indicated that they had a formal mandate to monitor financial stability.³ A full list of respondents is given in Annex 1. The report

¹ The report also draws on the experience of international organisations that are not financial authorities. Nonetheless, for ease of discussion, the stocktake refers to "financial authorities" as including such international organisations that contributed to the stocktake.

² Survey responses were received from all 24 FSB member jurisdictions. Most – but not all – jurisdictions submitted a consolidated response on behalf of financial authorities in that jurisdiction.

³ 24 of these respondents also included an authority that had supervisory authority over (at least one of) banks, insurers or asset managers. Some financial authorities and bodies without a formal mandate to monitor financial stability had nonetheless undertaken – or were in the process of undertaking – relevant research and analysis of climate-related risks to the financial sector, some of which is included in this stocktake. Some such analysis reflects the official views of the relevant authorities and bodies; others reflects staff views.

was also informed by a 'call for information', in response to which 27 AGV members submitted informal outlines of their recent work on the financial stability implications of climate change.

The AGV also held a workshop with representatives of private sector firms. This aimed to understand the experience of the private sector in considering climate-related risks, as well as the role the official sector might play in ensuring such risks were managed and mitigated appropriately. The workshop was attended by 17 market participants, and included representatives from banks, insurance firms, credit-rating agencies, asset managers and institutional investors, as well as consultancy firms and data vendors. A summary of its key findings is included in Annex 4; key points are given in Box A.

The report does not discuss the possible implications of climate change for the broader economy, or the functions or responsibilities of financial authorities within FSB member jurisdictions beyond those relating to financial stability (e.g. those relating to monetary policy, securities regulation or portfolio management). It does, however, include discussion of approaches taken by some supervisors to increase the resilience of financial institutions to climate-related risks. Such supervisory work did not feature in the survey of FSB members; it did, however, feature in some survey responses.

In light of the findings of this stocktake, the FSB will conduct further work by October 2020 to assess the channels through which physical and transition risks could impact the financial system, and how they might interact. Particular focus will be given to the potential amplification mechanisms and cross-border effects, and to prioritising channels that could materialise in the short-to-medium term. The FSB will also consider the scope for work to assess available data through which climate-related risks can be monitored, as well as any data gaps. This work will build upon, and be coordinated with, that taking place in other relevant international fora.

The report proceeds as follows. The next section discusses the degree to which authorities include climate-related risks in their financial stability monitoring, as well as the channels of risk they consider in doing so. Section 3 discusses attempts made by some authorities to quantify climate-related risks to financial stability, the approaches they take in doing so, as well as their headline conclusions. Section 4 outlines some steps authorities have taken – or are in the process of taking – in incorporating climate-related risks into their approach to the supervision of financial firms. A final section concludes.

2. The inclusion of climate-related risks in authorities' financial stability monitoring

This section discusses the degree to which authorities include climate-related risks in their financial stability monitoring. It also discusses the channels through which authorities consider these risks to affect – as well as the channels through which they could in future affect – the financial system. The majority of such monitoring is qualitative, and amounts to a descriptive assessment of the nature, scope and impact of climate-related risks, along with the channels through which they could affect the financial system.

Some authorities have, however, conducted, or plan to conduct, quantitative assessments of climate-related risks. This is discussed in Section 3.

Box A: Key findings of AGV's workshop with representatives of private sector firms

This box summarises the key takeaways from discussions with the private sector. These do not represent the views of FSB member authorities, nor reflect any consensus views expressed by external stakeholders. Representatives of the private sector were generally from firms whose work on climate change and its associated risks was reasonably advanced relative to their peers.

- Market participants thought that climate-related risks were significant and had the potential to impact their businesses. Most firms were taking steps to better understand and respond to these risks. This involved both attempting to measure and manage risks at the level of individual firms, as well as understanding their consequences for the financial system and global macroeconomy.
- It is unclear whether – and to what degree – financial market prices incorporate climate-related risks. Private sector participants pointed to research suggesting that some asset prices did not reflect physical risks (e.g. the increased frequency and/or magnitude of extreme weather events) or transition risks (perhaps because market participants doubted that governments would commit to policies designed to transition to a low-carbon economy). This might put asset prices at risk of disorderly adjustment.
- It is unclear who would bear some climate-related risks, were they to crystallise in scale. While some market participants held insurance against, for example, physical risks, representatives of the insurance sector told the AGV that some insurance provision may be withdrawn and/or dramatically repriced. This would reduce risks faced by individual insurance firms, but also mean that some risks would be uninsurable. Some workshop participants speculated as to whether governments might have to assume certain risks in the absence of available insurance.
- The workshop included discussion of the channels through which climate-related risks to the financial system may affect the real economy, and, in turn, have further effects on the financial system. Some workshop participants mentioned how transition risks could cause banks to restrict their lending. Transition risks could also put further downward pressure on some asset prices, and trigger a disorderly transition to a low carbon economy.
- Climate-related risks were thought to be global in nature. They were also thought to have the potential to transmit between financial sectors, and between jurisdictions (including via the cross-border operations of some financial institutions).

Market participants spoke to the benefits of alignment and consistency of potential regulatory policies (including those concerning disclosure requirements) and data standards across jurisdictions. Inconsistencies – including those arising from differences in the nature and timing of official-sector responses – hindered the comparability of risks across firms and jurisdictions. Market participants expressed concern that inconsistencies might burden firms unnecessarily and risk fragmenting markets.

A full summary of the workshop's findings is given in Annex 4.

2.1. The degree to which authorities include climate-related risks in their financial stability monitoring

Authorities vary considerably in both whether – and to what degree – they consider climate-related risks as part of their financial stability monitoring. These variations reflect differences in the scope of climate-related work across authorities. They may also reflect differences in

how work is classified. Some authorities have undertaken background work (including, for example, the publication of research) that may support their future monitoring of financial stability risks related to climate change. While some classify such work as monitoring financial stability and so included it in their survey responses, others omitted it. Some authorities also have work under way to assess the financial stability implications of extreme weather events, but vary in whether they explicitly define these as relating to climate change. As such, survey responses – and statistics based upon them – should be interpreted with a degree of caution.

Twenty-four out of 33 survey respondents report that they currently, or are in future planning to, consider climate-related risks in their financial stability monitoring (**see Graph 1**). Of these, 18 survey respondents report including physical risks as part of their monitoring work; 13 survey respondents report including transition risks.⁴ This difference might in part be because there are more data on the crystallisation of physical risks (e.g. that connected to the incidence of extreme-weather events in some jurisdictions), compared to the greater complexity of estimating the magnitude of transition risks.⁵ This issue is discussed further in Section 3. Five survey respondents reported that they considered climate-related risks in their financial stability monitoring, but had yet to consider physical and transition risks specifically. Some plan to do so in future, however.

There is considerable variation in the degree to which authorities include climate-related risks in their monitoring work. Some authorities explicitly report that they consider climate change as part of their regular monitoring of financial stability. They typically discuss climate-related risks in their regular surveillance work, including that published in, for example, their financial stability reports. Other authorities report that they consider climate-related risks, but had not incorporated them into their regular monitoring. Some had undertaken ad hoc analysis of climate-related risks, for example in the form of research or occasional papers or as part of ‘special feature’ boxes in their financial stability reports.⁶ Definitions of what constitutes such ‘regular’ monitoring may, however, differ across authorities.

⁴ Some authorities that classify their work as more preliminary (and not part of that to monitor financial stability) also consider physical and transition risks; see Brainard (2019), *Why Climate Change Matters for Monetary Policy and Financial Stability*, November.

⁵ That said, several authorities reported that a lack of sufficiently granular data on the location of financial sector assets impeded their quantification of physical risks; see Section 3.2.2.

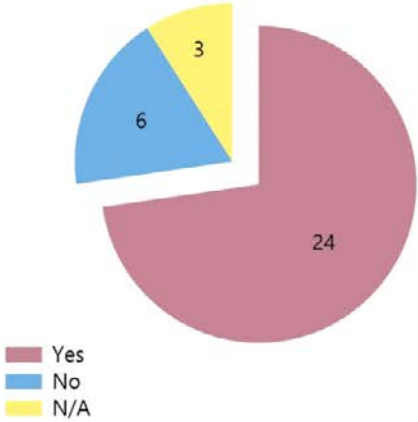
⁶ See Delgado (2019), *Energy transition and financial stability. Implications for the Spanish deposit-taking institutions* published by the Banco de España in the Financial Stability Review (37). See also the South African Reserve Bank (2019), *Financial Stability Review, Box 2: Steering towards a green economy*, November.

Inclusion of climate-related risks in financial stability monitoring

Number of survey respondents

Graph 1

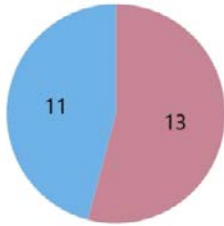
Do you consider risks from climate change as part of your financial stability monitoring?



If so, do you monitor physical risks?



If so, do you monitor transition risks?



Regardless of whether – and to what extent – they include climate-related risk as part of their monitoring of financial stability, the majority of authorities report having undertaken external outreach and discussions on the topic. Many have organised or had their staff attend conferences on the subject.⁷ Others have held discussions with a range of academic, private and public-sector stakeholders. All but two of the six survey respondents who report not considering climate-related risks as part of their financial stability monitoring had nonetheless undertaken external outreach along these lines. Others indicated that such risks featured in discussions with – and publications by – senior staff.⁸ A few noted that some of this outreach and analysis could lead to more systematic monitoring of climate-related risks in future.

⁷ See Federal Reserve (2019) *The Economics of Climate Change*, November.

⁸ See BIS and Banque de France (2020), *The green swan*, and Brainard (2019).

2.2. Channels of risks to financial stability that financial authorities consider

Many authorities have given thought to the channels through which climate-related risks might affect the financial system and/or the real economy.⁹ Those that do so typically refer to (at least some of) a common set of channels.

The channels through which authorities consider **physical risks** to affect the real economy arise from damage and disruption stemming from an increase in the frequency/severity of extreme weather events such as floods and droughts, and/or from gradual change in the climate, such as an increase in sea levels.¹⁰ This includes disruption to business revenue or profitability, as well as reductions in the value of capital as a result of damage to property, land and infrastructure.¹¹

Those authorities that consider **physical risks** to financial stability generally focus on how these could affect the financial system via:¹²

- Market risks: that is, reductions in the value of financial assets that result in losses for banks, asset owners, and other financial institutions (including the financial assets of insurers) and non-bank lenders.
- Credit risks: that is, losses on loans that result both from widespread reductions in the income, or increases in the expenses, of borrowers, either of which could affect their capacity to repay loans. Credit risk could also result from reductions in the value of collateral against which loans are secured.

Other effects of physical risks are considered by a minority of authorities. These include:

- Underwriting losses for insurance and reinsurance firms that could result from more frequent and severe weather events.¹³ This could pose a risk to insurance/reinsurance firms to the extent that the pricing of their liabilities does not account for such risks. If insurers were to raise premia or restrict coverage, this could transfer these risks to households, companies and their lenders.
- Legal/liability risks, which might arise when parties are held liable for losses related to environmental damage that may have been caused by their actions or omissions.

⁹ Only three members reported having considered physical and transition risks to the financial system but not having considered the channels through which these might occur.

¹⁰ See ECB (2019), *Financial Stability Review*, May, p. 120; and IMF (2019), *Global Financial Stability Report*, October, p. 83. In considering physical risks to financial stability, many members do not appear to distinguish between effects on the real economy and those on the financial sector.

¹¹ Some bodies also distinguish between 'acute physical risks', which refer to those that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes or floods.; and 'chronic physical risks', which refer to longer-term shifts in climate patterns (e.g., sustained higher temperatures) that may cause sea level rise or chronic heat waves; see TCFD (2017), *Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures*, June.

¹² For further discussion of the channels through which climate-related risks could affect the financial system, see NGFS (2019), *A call for action - Climate change as a source of financial risk*, April; and IMF (2019), *Global Financial Stability Report*, October and IMF (2020), *Global Financial Stability Report*, April.

¹³ See DNB (2017), *Waterproof - an exploration of climate-related risks for the Dutch financial sector*, p. 19.

Financial institutions and market infrastructure could face operational risks, including from the increased frequency and/or severity of extreme weather events.

Similarly, those authorities that consider **transition risks** to financial stability generally focus on how these could affect the financial system via a common set of channels, or subset thereof.

Authorities recognise that policies or technology designed to mitigate the possible physical risks of climate change – as well as possible shifts in public sentiment or consumer preferences – could lead to a reduction in revenue and/or value of capital, and to a reassessment of the value of assets and/or likely return on investments. This could result, for instance, in assets facing sharp reductions in value (or becoming ‘stranded’) due to reductions in demand or expected revenues, as a result of a shift to a carbon-neutral economy.¹⁴

The channels through which authorities consider that transition risks could affect the financial system are generally narrower in scope than those for physical risks. They include:¹⁵

- Market risks: that is, changes in some financial market prices that could arise through an abrupt decrease in certain assets values, including of financial claims on affected firms and sectors.¹⁶
- Credit risks: that is, credit losses that might, for example, arise if public policy or advances in technology lead to lower profitability and high default risks for firms whose activities are adversely affected by the change in policy. Sovereign credit risk could also increase in the case of those countries with, for instance, carbon-intensive industries.

Legal/liability risks also present a form of transition risk. Recent years have seen an increase in climate-related litigation claims due to the failure of some organisations to adapt to climate change, and the insufficiency of disclosure of material financial risks.¹⁷

2.3. The implications of climate-related risks for financial institutions

The channels through which authorities consider climate-related risks to affect financial stability have bearing on financial institutions. Survey respondents report having considered the effects of such risks on financial institutions (Graph 2). Work to consider the implications of risks to banks and insurance firms appears more advanced than that on asset management firms and other non-bank financial institutions.¹⁸ Such effects include both those on financial institutions themselves (for example via reductions in their solvency caused by the reduction of asset values, or increase in their liabilities), as well as how such effects might have larger

¹⁴ See IMF (2019), *Global Financial Stability Report*, October, p. 83. One authority differentiated between ‘stranded capital’ – that is, transition risk-related losses of capital spending that went into a project (e.g. amounts invested in oil field exploration); and ‘stranded value’, which represents the transition risk related losses of the forward looking financial valuation of a firm or project and the future cash flows it is likely to generate; see NGFS (2019), p. 16.

¹⁵ For further discussion of the channels through which climate-related risks could affect the financial system see NGFS (2019) and IMF (2019).

¹⁶ See Bank of England (2018), *Transition in thinking: The impact of climate change on the UK banking sector*, September.

¹⁷ See TCFD (2017).

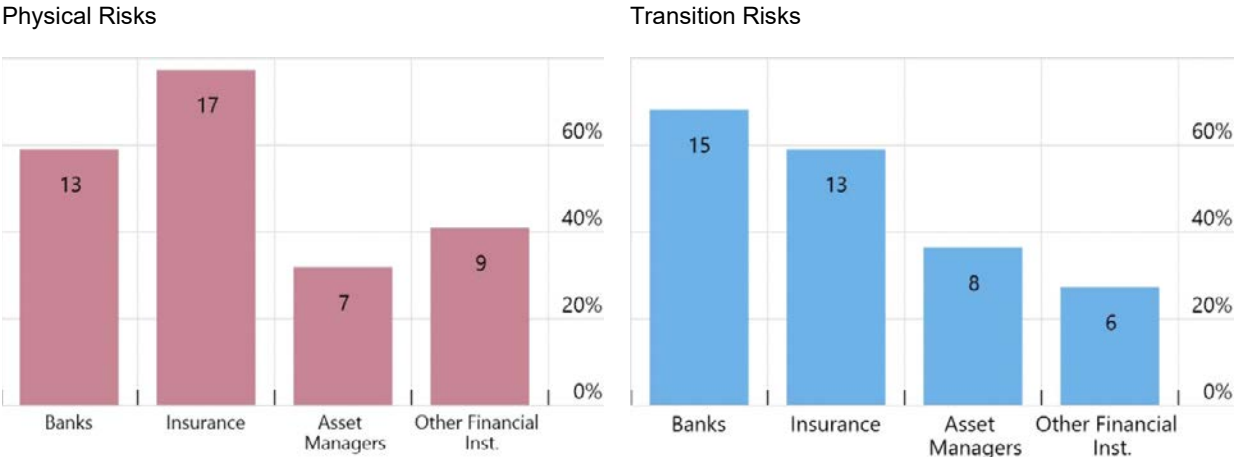
¹⁸ Asset management firms own only limited assets, and so may face different risks to those faced by other types of financial institution.

feedbacks on the financial system (see Section 2.4). A slightly greater number of survey respondents report having considered the effects of physical risks on insurance firms than transition risks. This may be because underwriting physical risks is the core business of some insurance firms.

Work on implications of climate risks relating to financial institutions, by type¹

Percentage of those survey respondents who reported that that they currently (or plan to in the future) monitor climate-related risks to financial stability (see Graph 1). Numbers shown on the chart correspond to the number of respondents

Graph 2



Source: FSB survey.

¹ Asset management firms manage assets on behalf of their clients. Their inclusion here – and in the survey of FSB members – is designed to capture work by financial authorities to assess the effect of climate-related risks on asset owners, as well the effects of measures designed to mitigate these risks that might be developed by those supervising asset management firms (e.g. disclosure requirements so that asset owners are fully informed about the risks to underlying investments).

2.4. Feedback effects through which climate-related risks on the financial sector can affect the real economy

Seven survey respondents report that they also consider the channels through which climate-related risks might then affect the real economy, thereby having further effects on the financial system.¹⁹ This includes consideration, for example, in some authorities’ published work, of how losses faced by lenders might prompt them to restrict their lending, particularly to creditors whose assets or activities are concentrated in certain geographies. This could put further downward pressure on asset values and economic activity, which in turn might exacerbate the impact of further physical risks on the financial sector.²⁰ Some authorities consider how reductions in insurers’ solvency might also prompt a reduction in their underwriting activity (or large increase in its cost), which could also have a depressing effect on economic activity.²¹

¹⁹ Of these seven, five also incorporate risks to financial stability in their regular financial stability monitoring.
²⁰ See NGFS (2019), *Macroeconomic and financial stability: implications of climate change*, July, p. 13; and OECD (2015), *The Economic Consequences of Climate Change*, November.
²¹ For example, according to Carney (2015), *Breaking the tragedy of the horizon - climate change and financial stability*, September, Insurance firms’ rational responses to physical risks can paradoxically trigger new risks: for instance, storm patterns in the Caribbean have left many households unable to obtain private cover, prompting a reduction in mortgage lending and falls in house values.

In general, however, consideration of such feedback effects appears less developed than that of the first-order channels of risk outlined above. It generally consists of qualitative descriptions of feedback effects that are not subject to quantification (see discussion in Section 3).

2.5. Potential for cross-border spillovers of climate-related risks

Climate-related risks might have the potential to transmit between jurisdictions, for example when assets located (physically or legally) in one jurisdiction are held by an investor or financial institution located in another. Only a minority of eight survey respondents report having considered – or recognised the importance of considering in future – such cross-border spillovers. This work is largely qualitative, and includes consideration of the effects of climate-related risks on the foreign exposures of multinational financial institutions and how such effects might potentially be integrated into authorities' future monitoring work.

3. Quantification of climate-related risks to financial stability

Some authorities report having conducted work to quantify climate-related risks to financial stability. Such estimates are generally limited in scope. All focus on the direct effects on the authority's home jurisdiction(s). In the case of physical risks, studies often focus only on those risks that are most pertinent to the jurisdiction in question – for example that of flooding in low-lying countries.²² Many studies also consider a fairly narrow range of the exposures. Those on transition risks typically focus on exposures of financial institutions in a given jurisdiction to high-carbon sectors, or those arising from certain types of corporate loans,²³ or residential mortgages (including those secured on less energy-efficient homes).²⁴

No approach to quantification provides a holistic assessment of climate-related risks to the global financial system. Neither is there currently a consistent methodology for the assessment of climate risks that can assess cross-border spillovers.

Some survey responses indicate that the impact of climate change on the financial system is subject to multiple layers of uncertainty.²⁵ This issue featured strongly in members' discussion with the private sector. The course of climate change is itself subject to considerable scientific uncertainty, as is the degree to which this may lead to an increase in the severity and magnitude of extreme weather events. The nature and relative strength of the channels through which such weather events may impact on the financial system is also uncertain, particularly given that these may involve a mixture of both physical and transition risks. The relative magnitude of these risks are likely to be dependent, for instance, on future official-sector climate policy, as well as the rate of development of technology that may reduce emissions or otherwise curb the effects of climate change.

²² For example, see DNB (2017).

²³ See China Green Finance Committee (2018), *Default and recovery rates for project finance bank loans*.

²⁴ See Bank of England (2018), *Tightening energy efficiency standards and the UK buy-to-let market*.

²⁵ Some of these uncertainties are set out in survey responses. A summary – albeit one that incorporates the views of only a subset of FSB members – is contained in NGFS (2019). See also BIS (2020), Section 3.5.

These uncertainties give rise to a lack of consistent data and methodologies through which to translate potential outcomes for the climate into estimates of financial exposures. For example, several authorities report that estimating the effect of severe weather events on financial exposures (e.g. via estimates of probability of default) is highly complex. Financial firms may be unable to obtain clear estimates of the degree to which climate-change is likely to affect the viability and/or creditworthiness of their clients and borrowers. This task may be made more complex when firms' business models rely on long and complex supply chains. Several authorities also report that these uncertainties lead to a lack of consistent estimates of the degree to which different assets are materially exposed to transition risks, including a commonly accepted view of whether assets are 'green' or 'brown'.

Such difficulties may be exacerbated because exposures depend non-linearly on the severity of climate-related risks and on the capacity of firms to adapt to them,²⁶ and materialise over a long time horizon.²⁷

3.1. Existing estimates of climate-related risks

Despite the difficulties discussed above, attempts to quantify climate-related risks to the financial system typically take one of two forms:

- First, 'top-down' assessments, where the magnitude of risks is estimated by the authority (or authorities) themselves.
 - These have the advantage of being less resource intensive, in part due to their reliance on existing supervisory and/or public data.
 - Such top-down assessments, however, typically face trade-offs between the granularity of the data on which they are based and their coverage. Some also tend to be static in their assessment of risk, in part because they are based on existing data.

Box 1 provides headline results and conclusions of some 'top-down assessments' of climate-related risks performed by some financial authorities.

- Second, 'bottom-up' estimates, where the magnitude of risks is calculated by financial institutions themselves, using their own (typically more detailed) proprietary data.
- Bottom-up estimates are based on a scenario (or scenarios) that specify the future progression of climate change and/or its effect on financial variables. In some cases, a detailed quantitative scenario is given by official-sector authorities. Firms then respond with estimates of their exposures under this scenario. These estimates are generally based at least in part on firms' own models of how their own exposures vary as a function of the financial variables provided by authorities.
 - Such estimates typically have the advantage of better capturing firm-specific dynamics due to more granular data provided by firms themselves. Depending

²⁶ See BIS (2020), Section 3.3 (*Translating a climate-economic scenario into sector- and firm-level risk assessments*).

²⁷ Some authorities report encountering difficulties in modelling climate-related risks given the long-horizon over which such risks may materialise.

on their design, they can also allow for more holistic coverage of the financial system.

- They are, however, generally also more resource intensive because they involve authorities or firms developing a scenario for climate-change, and translating this into an outcome for severe weather events as well as economic variables.

Box 2 provides details of the specific ‘bottom-up’ approaches being developed by two authorities.

The remainder of this section reviews some general considerations related to both approaches in turn. It also outlines the data and methodologies on which they draw, their relative merits, as well as the trade-offs to which they give rise.

3.2. Top-down estimates of climate-related risks

Those authorities that have made top-down estimates of climate-related risks report doing so using a range of different data. These typically differed for physical and transition risks. They incorporate data both used to (i) determine the exposure of the financial sector to different assets or counterparties, and (ii) that used to estimate the *sensitivity* of these exposures to climate-related risks. This section deals with each in turn.

3.2.1. Data used in top-down estimates of physical risks

In the case of physical risks, authorities typically evaluate the exposures of financial institutions by geography. This is because the location of counterparties and/or assets is a key determinant of their susceptibility to extreme weather events. Most authorities report doing so based on regulatory reporting specific to their jurisdiction (e.g. banks’ regulatory reports, or insurers’ reporting under Solvency II).²⁸ Others use data provided by private sector firms.

Authorities use different approaches to estimate the sensitivity of such exposures to physical risks. This generally involves translating outcomes for climate change (and/or the frequency/severity of extreme weather events) into estimates of economic variables that in turn are used to estimate how the value of firms’ exposures changed in responses. Estimates are usually based either on central databases of countries’ vulnerability to physical risks,²⁹ or authorities’ own estimates of such risks within their jurisdiction. One authority, however, employed the services of a specialist private sector firm to calculate the impact of flood scenarios on economic variables, from which it could then determine the impact on financial institutions.³⁰ Some such sensitivity estimates incorporate some recognition of the degree to which different jurisdictions might adapt to physical risks.

²⁸ One authority reported using the *Bank of International Settlements’ cross-border banking statistics* to measure banks’ exposures to different jurisdictions.

²⁹ See, for example the university of Notre Dame Global Adaptation Initiative (ND-GAIN) database; *University of East Anglia Climatic Research Unit data*; and *Maplecroft Climate Change Vulnerability Index*.

³⁰ DNB (2017), p. 35.

3.2.2. Data used in top-down estimates of transition risks

In the case of transition risks, authorities evaluate financial exposures using a combination of official-sector data sets as well as bespoke surveys of financial institutions. Examples of official data sets include that on banks' exposures taken from reporting of their 'large exposures',³¹ or the ECB's Securities Holdings Statistics (SHS), which provide information on a security-by-security basis of securities held by certain categories of euro area investors.^{32, 33} Some authorities combine this data with that from the European Union's NACE database,³⁴ which classifies firms by their economic sector.³⁵ Bespoke surveys of financial institutions are also used to gather more specific exposures data, for example that on bank corporate loans.³⁶

Authorities estimate the sensitivity of such exposures to transition risks both at the level of individual sectors or firms, as well as across the entirety of supply-chains. Data on greenhouse gas emissions at a sectoral level is used to classify the degree to which different sectors are exposed to transition risks, based on their economic activities.³⁷ Other approaches use more granular classification of climate-exposure, including that at the level of individual firms. Some authorities, for example, score individual firms in terms of their environmental, social and governance (ESG) principles as a proxy of firms' ability to manage climate-related risks.³⁸ One authority calculated 'transition vulnerability factors' that estimate the sensitivity of asset prices for industries likely to be affected by policies designed to mitigate climate risks.³⁹ This approach was designed to capture not just the emissions of the producer of final goods and services by the firm in question, but also that by the firms 'upstream' in its value chain.⁴⁰

3.2.3. Strengths and weaknesses of top-down estimates of climate-related risks

Authorities pointed to a number of challenges concerning top-down estimates of climate-related risks.

The first concerns shortcomings as to the available data on the nature and scale of financial institutions' exposures. In the case of physical risks, several authorities reported a lack of sufficiently granular data on the location of the assets underlying financial sector exposures, particularly given the differences within jurisdictions with respect to their vulnerability to extreme weather events. In the case of transition risks, data limitations include a lack of centralised and easily accessible data on financial institutions' exposures, particularly to

³¹ The European Capital Requirements Regulation (CRR) requires that firms report every large exposure, where large exposures are defined as: 'exposures to clients or groups of connected client where its value is equal or exceeds 10 % of the eligible capital of the institution'; see European Banking Authority, *Reporting Large exposures*.

³² For a detailed description, see ECB *Securities Holdings statistics*.

³³ See ECB (2019), *Financial Stability Report*, p. 126. May.

³⁴ *Nomenclature Statistique des activités économiques dans le Communauté européenne (NACE), A European industry standard classification system*.

³⁵ One such methodology for doing so is set out in Battiston, Mandel, Monasterolo, Schutze and Visentine (2017), *A climate stress-test of the financial system*, March.

³⁶ For example see DNB occasional study (2018), *An energy transition risk stress test for the financial system of the Netherlands*.

³⁷ Such data include that by Eurostat in the case of authorities in the European Union.

³⁸ See Faiella I and Lavecchia (2020), *The carbon footprint of Italian loans*, Bank of Italy Occasional Papers No. 557, April.

³⁹ For example, the effective carbon price per quantity of CO₂ emissions See DNB (2018).

⁴⁰ See discussion of Scope 1/2/3 emissions data in TCFD (2017).

smaller counterparties (e.g. those to smaller corporates and households). Some authorities also mentioned a lack of a common key through which to match data on the sensitivity of a given sector or firm to climate outcomes, to data on financial exposures to that sector or firm. One authority also reported difficulties in assessing the underlying exposure to securities held via (particularly more complex) investment fund structures.

Second, top-down estimates also give rise to a trade-off between granularity and scope:

- On the one hand, studies based on aggregate data – for example, by country in the case of physical risks, or by industry in the case of transition risks – allow a useful first approximation of climate-related risks that is quite broad in its coverage.⁴¹

They obscure, however, what can be large differences in the exposures faced by individual firms within a given industry – for example, depending on their precise location (in case of physical risks), or on their production processes and investment in technologies designed to curb climate change (in the case of transition risks).⁴²

- On the other hand, more granular top-down exercises conducted at the level of individual firms allow for a more detailed assessment of risks, but suffer from the drawback that the data on which they are based are typically available for only a relatively small subset of firms, and/or a small subset of assets of those firms.⁴³

Authorities also pointed to **methodological** challenges encountered in top-down estimates of climate-related risks (besides those described above). These included:

- The estimates to which they give rise tend to be static, and offer only limited insight into how risks might change in future.⁴⁴ Exposures could change as a result of actions taken by financial firms and also by their counterparties (e.g. changes to business strategy, geography). This could result in risks being under or over-estimated.⁴⁵
- Difficulties in assessing the linkages between financial institutions or sectors, and the degree to which the actions of one institution or sector might affect climate-related risks faced by others. For example, one respondent reported difficulties in assessing the degree to which banks' exposures to physical risks were insured, and the degree to which such insurance – where it was in place – reduced risks to the financial system as a whole, or just passed it to a different type of institution (e.g. reinsurance firms).

⁴¹ This observation is made in ECB (2019), p. 127.

⁴² For instance, a counterparty whose physical assets are at sea level may face very different risks to a counterparty whose assets are just a metre above sea level, although they may be listed by some databases as being in the same area. Similarly, two firms in, for example, the energy sector, may have very different exposures to transition risks, depending on their reliance on non-renewable versus renewable energy sources.

⁴³ For example, in the case of large exposures data that is used by some authorities to assess transition risks, the European Capital Requirements Regulation (CRR) requires banks to report only exposures to clients (or groups of connected clients) that total at least 10% of the eligible capital of the bank and/or an exposure larger than EUR 300 million. This may understate the exposures in a fragmented banking system, or overstate those of a concentrated system; see ECB (2019), p. 128.

⁴⁴ There are exceptions to this generalisation. For example, some authorities report using estimates of financial firms' exposure to physical risks that incorporate some estimate of the degree to which such exposures may change as a result of firms' adaptation to climate-related risks; see Section 3.1.

⁴⁵ Indeed, some studies suggest that the availability of finance to fund investment in technology to mitigate the effects of climate change (i.e. green bonds) may be heavily concentrated in carbon-intensive sectors; see De Santis, R. A., Hettler, K., Roos, M and Tamburrini, F (2018), *Purchases of green bonds under the Eurosystem's asset purchase programme*, ECB Economic Bulletin, Issue 7.

The potential for self-selection bias in more granular data on some non-financial firms' exposures, due to the fact that – at least in some jurisdictions – some firms report information on climate-related risks on only a voluntary basis. This might mean that authorities based their top-down assessments on data only from those firms who had taken – or were in the process of taking – steps to reduce their exposure to climate-related risks.

Box 1: Examples of financial authorities' top-down analysis of climate-related risks

This Box gives a non-exhaustive summary of top-down work to quantify climate-related risks to financial stability carried out by some financial authorities. Other relevant publications are listed in Annex 3.

- In 2017 De Nederlandsche Bank (DNB) published a study of the impact of flood risk in the Netherlands. Flooding is a key climate-related risk to the financial system in this jurisdiction.⁴⁶ This study estimated that the total economic losses that could result from severe but plausible flood events ranged between €20 and €60 billion. The resulting losses – which could arise from a combination of credit and market risk (see Section 2) for Dutch banks, insurers and pension funds – were estimated to range from EUR 0.9 to €2.3 billion. The analysis also considered how financial institutions may be affected by a deterioration in the perceived credit quality of Dutch sovereign bonds, as well as secondary effects via a deterioration in economic conditions.⁴⁷

In 2018 DNB also published a study that assessed disruptive transition risks to Dutch banks, insurers and pension funds.⁴⁸ This considered stress scenarios with a five-year horizon. This stress test estimated the impact of these risks to range between -1.8 and -4.3 percentage points of the aggregate common equity Tier 1 (CET1) capital ratio of Dutch banks. The impact on the aggregate solvency ratio for insurers was estimated to range between -4.4 and -16.2 percentage points, and that on the aggregate funding ratio of Dutch pension funds was estimated to range between 11.8 and -5.5 percentage points. These results were based on supervisory data, some of which was specifically requested for the purpose of the study.

- The Bank of England (BoE) has undertaken work to assess the exposures of the UK financial sector to both physical and transition risks.

Its research into physical risks suggests that UK mortgage lenders do not account for the risk of prolonged flooding in the pricing or availability of their lending.⁴⁹ Properties in areas that experience prolonged flooding see significant reductions in sales prices relative to unaffected properties in the same area. Valuations used to refinance loans are unaffected by flooding or increases in flood risk, and the effects on mortgage rates and loan amounts are insignificant.

Research has also assessed whether a strengthening of energy efficiency standards for buildings could be a source of transition risks for UK banks, if it became more difficult to let

⁴⁶ See DNB (2017), *Waterproof? An exploration of climate-related risks for the Dutch financial sector*.

⁴⁷ This study was 'top-down' in the sense that its estimates were calculated by the DNB (albeit based on an impact analysis of flood scenarios provided by the Deltares Water Research Institute), rather than by private sector firms; see Deltares (2017), "Standaardmethode 2017: Schade en slachtoffers als gevolg van overstromingen".

⁴⁸ Vermeulen, R., Schets, E., Lohuis, M., Kölbl, B., Jansen, D., Heeringa, W. (2018). *An energy transition risk stress test for the financial system of the Netherlands*. DNB Occasional Studies No 16-7.

⁴⁹ See Nicola Garbarino and Benjamin Guin (2020), *High water, no marks? Biased lending after extreme weather*, March, Bank of England Staff Working Paper No. 856.

properties with low energy efficiency and/or if their market value were to decline. This found that only around 5% of the current buy-to-let properties were affected by current government proposals on energy efficiency standards, but that a tightening of these rules could affect far more (e.g. 72% of) homes. This also found that the energy efficiency of a property is a statistically significant predictor of the credit risk of mortgages secured upon it.⁵⁰

BoE work in 2017 also found that around 30% of global equities, investment-grade corporate bonds, and leveraged loans could be exposed to transition risk.⁵¹ BoE research for July 2019's Financial Stability Report found that, in the UK, loans to fossil fuel producers, energy utilities and emission-intensive sectors amount to around 70% of the largest UK banks' CET1 capital. For UK insurers, around 12% of equity and 8% of corporate bond portfolio exposures are in 'high carbon' sectors.⁵²

In 2018 the BoE published a report that examined financial risks from climate change that impacted UK banks and assessed how banks were responding to and managing these risks.⁵³ This found that 70% of banks recognised that climate change poses financial risks, but only 10% managed these risks comprehensively. The same study estimates that 8.8% of UK banks' mortgage exposures in England are located in areas at risk of flooding.

The BoE is also undertaking a 'bottom-up' assessment of climate-related risks; this is outlined in Section 3.3.

- The European Central Bank (ECB) published a special feature in its November 2019 *Financial Stability Review* that assessed the impact of physical and transition risks.⁵⁴ It found that physical risks had increased in recent years, and that weather-related catastrophe losses accounted for over 80% of insured catastrophe losses in 2018 globally. This was accompanied by a growing frequency of weather-related loss events, of which there were a record number in 2018.

The same publication assessed euro area financial institutions' credit exposures to some transition risks, by measuring their exposures to 'carbon intensive' firms.⁵⁵ It found that banks' exposures to these transition risks, although fairly contained relative to their overall exposures, may be significant for some banks in terms of absolute values.⁵⁶ Non-bank financial sectors were also found to have exposures of around 8%/4%/3% of the assets of investment funds, pension funds and insurance firms respectively. Euro area investment and pension funds were also found to have reduced their relative exposures to securities whose value as exposed to climate-risks in recent years. Exposures of banks and insurance firms remained relatively constant.

The ECB has also tracked how the largest twenty euro-area banks' exposures to certain transition risks has varied over time. Over the last 10 years banks' exposure to transition risks was found to have increased. Although these banks decreased the scale of their

⁵⁰ See Benjamin Guin and Perttu Korhonen (2020), *Does energy efficiency predict mortgage performance?*, January, Bank of England Staff Working Paper No. 852.

⁵¹ Baranova and Noss (2017), *The tip of the iceberg: the implications of climate change on financial markets*, January.

⁵² See Bank of England (2019), *Financial Stability Report*, July.

⁵³ See Bank of England (2018), *Transition in thinking: The impact of climate change on the UK banking sector*, September. The Bank of England has subsequently issued supervisory guidance on how banks should be considering climate-related risks as part of their governance, strategy and risk management.

⁵⁴ See ECB (2019), *Financial Stability Review*, November.

⁵⁵ 'Carbon intensive' firms were defined as the highest quartile of firms as ranked by their volume of emissions or emissions per million of EUR sales.

⁵⁶ Banks' large exposures to the twenty firms with the largest 'carbon intensity' were found to be around 20% of these overall large exposures, or 1.8% of their overall assets.

lending to carbon-intensive firms, the emissions of firms to whom this lending was extended increase by around 19%. In the more recent period between 2015 and 2017, however, similar estimates suggest that such transition risks have decreased.

The European Systemic Risk Board (ESRB) published a report *Positively green – measuring climate change risks to financial stability*, which was prepared by an inter-institutional project team co-led by the ESRB Advisory Technical Committee and Eurosystem Financial Stability Committee.⁵⁷ The report attempts to measure financial stability risks from climate change, leveraging available data and methodologies. In particular, the report draws insights from granular supervisory datasets based on available carbon emissions reporting and makes use of existing economic and financial models to gauge potential near-term risks. It provides three main conclusions: (1) the economic costs associated with climate risk appear inevitable, and yet do not appear to be fully reflected in asset prices so far, perhaps because disclosures are insufficient to allow for a precise quantification of risks; (2) exposures of the banking sector to transition risk are contained on average, but concentrated in a few banks; and (3) exploratory scenario analysis suggests that policy tightening would cause a sharp devaluation of financial assets and a deterioration of economic conditions over a five-year horizon.

- The Bank of Italy analysed Italian banks' lending to firms exposed to risk of flooding. This found that, at end-2014, around 20% of loans were made to firms in geographies at high risk of flooding.⁵⁸ Italian authorities also found that most insurance firms did not explicitly account for climate or sustainability risks in their estimates of technical provisions.

The Bank of Italy also assessed Italian banks' exposure to transition risk in the form of their credit exposures to non-financial corporations with high levels of CO₂ emissions.⁵⁹ This found that exposures to carbon-intensive non-financial corporates ranged between 8 and 10.2% of banks' total assets in 2018.

- The French Prudential Supervision and Resolution Authority (ACPR) has considered physical risks of the French financial sector. One study estimated the effect of extreme weather events on banks and insurers, via both their effects on mortgage collateral and other claims.⁶⁰ Using data gained from a supervisory survey, the ACPR found that no French bank had a level of exposure to countries with high or moderate exposure to physical risks that exceeded 4.6% of their assets (according to a methodology in Standard & Poor's (2014)).^{61, 62} The share of insurers' portfolios exposed to countries with physical risk considered to be 'medium' or 'high' by the methodology of Standard & Poor's represented 1% of their portfolio (or 6% if Dutch securities are considered).

The ACPR has also conducted a sector-based study of banks' and insurers' exposure to transition risk. This exercise revealed that the exposures of the main French banks and

⁵⁷ ESRB (2020), *Positively green: Measuring climate change risks to financial stability*, June 2020

⁵⁸ Areas at high risk of flooding were those municipalities with a share of creditor firms exposed to flood risk greater than the 75th percentile of the overall distribution; for details see Faiella and Natoli (2019), *Climate change and bank lending: the case of flood risk in Italy*, August.

⁵⁹ See Faiella I and Lavecchia (2020).

⁶⁰ ACPR, Analysis and synthesis (2019), *Climate change : which risks for banks and insurers; No. 101: French banking groups facing climate change-related risks; No. 102: French insurers facing climate change risks*, October.

⁶¹ See Standard & Poor's (2014), *Climate Change Is A Global Mega-Trend For Sovereign Risk*, May.

⁶² Vulnerability defined using the Notre Dame University Indiana – Global Adaptation Initiative (ND-GAIN) Climate Change Vulnerability Index, which ranks vulnerability according to exposure, sensitivity, and adaptive capacity of a country to physical risks from climate change.

insurers to transition risks reached 9.5% and 12.2% of security holdings and total credit exposures respectively.

- The World Bank has piloted top-down assessments of climate and environmental risks and opportunities for the financial sector as part of the Financial Sector Assessment Program (FSAP).⁶³ These pilots include assessments of climate risks (e.g., flooding and typhoons) and provide guidance on supervisory response as well as the development of green financial markets. The World Bank also provides technical assistance to emerging market regulators on the greening of their financial systems, including climate risk assessments.
- The International Monetary Fund (IMF) pioneered the use of stress tests for assessing financial stability in the Financial Sector Assessment Program (FSAP) 20 years ago. Every year, under the FSAP, the IMF carries out in-depth financial stability assessments for 12–14 economies. Over the past decade, one in five FSAPs included tests that captured physical risks related to climatic disasters, such as storms, floods, and droughts, whenever relevant. Stress tests for climate-related risks are evolving. The FSAP has already been moving from narrow exercises concentrating on non-life insurance to stress tests that incorporate broader macrofinancial feedback effects. While the focus so far has been on “acute” manifestations of physical risk, future assessments may also consider stability implications of slow-moving consequences of climate change, such as migrations due to water shortages and crop failures. Forthcoming FSAPs that are expected to consider physical risk are, for example, those for the Philippines and South Africa. Ongoing assessments, such as the FSAP for Norway, have started, on a pilot basis, examining consequences of changes in public policy and technology related to the transition to a low-carbon economy. These transition risks are potentially relevant for all economies, with many country authorities recognising that the transition may not be smooth, and that changes in policies and technology may lead to abrupt changes in asset valuations. Leverage and interconnectedness in the financial system could exacerbate these shocks.
- The Bank of Spain has published a paper on the implications of a transition to a low-carbon economy for Spanish deposit-taking institutions. Delgado (2019) found that transition risks may impact the credit quality of exposures to the potentially most affected sectors. In the case of Spain, such exposures represent around 25% of the portfolio of loans for productive activities. A retrospective analysis suggests that, following the global financial crisis, non-performing loans in these sectors have been lower than in others. However, this may be a consequence of specific factors that may not apply under a transition to a low-carbon economy.

The California Department of Insurance has initiated multiple efforts and partnerships since 2015, developing new strategies to test insurer exposures to fossil fuel investments and climate-related transition risks. The Department conducted a comprehensive assessment⁶⁴ of insurers’ exposure to transition risk (2017 year-end data), individually and as a whole, based on their estimated current and future exposure to high-carbon and low-carbon activities. The analysis demonstrated that the average insurer shows *overexposure* — relative to a 2 degree scenario, composing physical and transition risks to asset portfolios — in fixed income and equity to coal and gas power capacity, oil production, and internal combustion engine vehicles; the average insurer shows *underexposure* in fixed income and equity to renewable power capacity and electric vehicle production. In addition to this analysis, the Department hosts a database for insurer investment information related to fossil fuels.⁶⁵ Over the initial 3-year period for which data are available, the total amount of insurer fossil fuel investments

⁶³ Pilots have been concluded in Bangladesh and the Philippines, and several others are ongoing or planned.

⁶⁴ California Department of Insurance, *Assessing Climate Change Transition Risk in Insurer Portfolios*.

⁶⁵ California Department of Insurance, *Climate Risk Initiative Database*.

increased by 11% from \$528 billion at end-2015 to \$586 billion at end-2017, but the total percentage of fossil fuel investments to total assets under management remained within a range of 10.5% to 10.8%, indicating relative stability in strategy relative to fossil fuels. Both the exposure analysis and the searchable database provide a foundation for subsequent stress test efforts.

3.3. Bottom-up estimates

Bottom-up estimates provide an alternative approach to quantifying climate-related risks to financial stability. Such estimates are calculated by financial institutions themselves (typically banks and insurers), albeit based on a common scenario (or scenarios) specified by financial authorities. Such scenarios specify pathways for the future progression of climate change, along with their impact on variables related to the macroeconomy and financial markets. These variables then allow firms to calculate their exposures to financial risks, and report these back to their financial authority.⁶⁶

Bottom-up estimates of climate-related risks to financial stability are currently being developed by the Bank of England and Banque de France/ACPR.⁶⁷ Details of these exercises – and the scenario(s) on which they are based – are given in Box 2.

In some jurisdictions, firms define scenarios themselves. Such estimates are typically used in the context of measuring the resilience of individual firms, in a microprudential context; see discussion in Section 4.

Bottom-up estimates are – in principle – able to overcome some of the short-comings experienced by authorities in carrying out top-down estimates. For example they can:

- Be wider ranging in the scope of firms they include, and encompass all those under the purview of the relevant financial authority carrying out estimate. This may reduce any self-selection bias on the part of financial firms, as all firms involved in the exercise will be required to report relevant exposures (though some such bias may still exist to the extent that only some of their non-financial clients report relevant risks).
- Consider firms' exposures to climate-related risks at more granular level, and are not as bound by the sorts data constraint faced by top-down estimates. This is because estimates of firms' exposures are provided by firms themselves, based on their proprietary knowledge of their counterparties. This may – at least in some jurisdictions – exceed those available to financial authorities
- Better capture firm-specific dynamics, because firms' estimates of their exposure can incorporate assumptions as to how they – and their counterparties – will adapt to climate-related risks (at least to the degree that these factor into firms' calculations).

⁶⁶ The term 'scenario analysis' is closely related to – and is sometimes used interchangeably with – that of 'stress testing'. The International Association of Insurers Supervisors (IAIS) considers stress tests to be a tool that 'measures the financial impact of stressing one or more factors' that could severely affect a firm; while scenario analysis 'considers the impact of a combination of circumstance to reflect historical or other scenarios which are analysed in light of current conditions' (see ICP 16.2.18 in IAIS (2019), *Insurance Core Principles*, November). In practice, the distinction between the two risk quantification techniques is not clear-cut. Nonetheless, 'scenario analysis' is used in this report, in part to reflect the multiple risks incorporated into bottom-up estimates of climate change.

⁶⁷ See Discussion Paper of Bank of England (2019), *The 2021 biennial exploratory scenario on the financial risks from climate change*, December; and Banque de France and ACPR (2020), *Présentation des hypothèses provisoires pour l'exercice pilote climatique*.

In this way, bottom-up estimates may reflect the degree to which climate-related risks may crystallise over a long time horizon.

- Offer some insight into how climate-related risks might transmit between different financial sectors, and feedback on the real economy (see Section 2.4). When the financial authority examines estimates of firms' reported exposures to climate-related risks, it may gain insight into the linkages between institutions and sectors.
- This may also reveal information as to how the effect of climate-related risks on the financial sector may affect the real economy. For example, in its bottom-up exercise (see Box 2), the Bank of England is considering examining the degree to which banks assume themselves to be insured against physical risks, when insurers might in fact assume that their provision of such insurance will be reduced.⁶⁸

That said, bottom-up estimates of climate-related risks are also subject to shortcomings as well as methodological difficulties.

Some such difficulties stem from the need for the financial authority producing the scenario (or set of scenarios) to translate pathways for climate change into those for extreme weather events, as well as for relevant macroeconomic and financial variables.⁶⁹ Such estimates remain subject to considerable uncertainty (see Section 3.1). Their formulation may be very resource intensive, and require skill sets that go beyond the traditional expertise of financial sector authorities. Six survey respondents – including those undertaking bottom-up estimates – report difficulties developing quantitative models to analyse the impact of climate related risks on the economy and financial system (and the need to acquire new technical expertise to do so) as key challenges when monitoring risks from climate change in their financial stability work.

These uncertainties may also give rise to differences in the scenarios used by different authorities, in their interpretation by different firms within a jurisdiction, as well as to inconsistencies in the resulting analysis. This may reduce the comparability of results. Scenarios may differ between financial authorities in both the outcome and the pathways they assume for climate change.⁷⁰ Even when a single scenario (or scenarios) is set by a given financial authority, financial firms participating in the exercise will still have to translate how these affect their individual counterparties. For example, in the exercises being conducted by the Bank of England and the Banque de France/ACPR, the financial authority provides macroeconomic and financial market variables representing the impact of climate-related risks, as well as detailed and granular information on different sectors. Participating firms may still, however, have to extrapolate these to estimate impacts on their individual counterparties and exposures. These too may be a source of inconsistency, given potential differences in the modelling approach of the firms concerned.

⁶⁸ See Bank of England (2019), p. 9.

⁶⁹ See, for example, discussion in Bank of England (2019).

⁷⁰ These issues of comparability have been the subject of extensive discussion in TCFD; see TCFD (2017), *Final Report*, June.

Box 2: Details of bottom-up estimates of climate-related risks by the Bank of England and Banque de France/ACPR

Details of the Bank of England's 2021 'Biennial Exploratory Scenario'

The Bank of England will use its 2021 "Biennial Exploratory Scenario" (BES) to explore the financial risks posed by climate change. Recognising the pioneering nature of this exercise, the Bank published its proposals in a discussion paper in December. The Bank of England will take stock of the responses as well as the evolving situation with a view to announcing the way forward for this exercise in the coming months.

The objectives of the BES are threefold. First, the exercise will provide a comprehensive assessment of the UK financial system's exposure to climate-related risks and therefore the scale of adjustment needed in coming decades for the system to remain resilient. Second, it will examine how major financial firms expect to adjust their business models over this timeframe, and what collective impact these decisions might have for the wider economy. Finally, the BES will provide a vehicle for financial firms to improve their management of climate-related risks, including by sharing best practices and identifying and addressing data gaps.

The proposed design of the BES reflects the distinct challenges posed by climate change.

One such challenge is that physical and transition risks will affect financial firms in distinct ways, and no single scenario will adequately capture both. Recognising this, the Bank of England is proposing three scenarios for the test,⁷¹ each of which will capture different combinations of transition and physical risks:

- The "**early policy action**" scenario assumes early and decisive action to reduce global emissions in a gradual way, consistent with limiting global average temperature increases to below 2°C, in line with the Paris Agreement;
- The "**late policy action**" scenario assumes action to address climate change is delayed by 10 years; as a result, transition risks are larger and the scenario features steep increases in global carbon prices;
- The "**no additional policy action**" assumes governments do not introduce policies to address climate change beyond those already announced. This scenario therefore features limited transition risks, but significant physical risks.

A second challenge is that financial risks from climate change will crystallise over a timeframe much longer than the normal horizon for stress testing. To capture this, the Bank is proposing a 30-year modelling horizon for each scenario.⁷² The Bank will be providing variables for the underlying physical and transition risks for each scenario, alongside consistent paths for macroeconomic and financial variables.

To make this a manageable exercise for participating firms, the Bank is proposing a two-part process: in part one, firms will quantify the risk in their current balance sheets, assuming their balance sheets do not evolve over the scenario; in part two, firms to identify the management responses they would expect to take were the scenario to transpire.

⁷¹ These scenarios will draw on those being developed by the NGFS.

⁷² The no-additional-policy-action scenario will be calibrated assuming that more material physical risks anticipated in the second half of this century occur by 2050.

Third, given the unprecedented nature of these risks, backward-looking analysis based on past data is unlikely to provide a good guide as to the risks the system faces. As a result, assessing the risks requires that participating firms undertake a granular analysis of the vulnerability of individual counterparties' business models in each of the scenarios. The Bank proposes that such counterparty-level assessment should cover 80% of participants' corporate exposures, and that household exposures should be assessed at the household level.

The exercise will be applied concurrently to the UK's largest banks and insurers. This will allow for a broader assessment of climate-driven financial risks across the system, and will yield insights on areas where there are potential spillovers across the financial system, including behaviours that might amplify the impact of the underlying climate shocks. Reflecting the exploratory nature of the exercise, the Bank intends to publish system-level rather than firm-specific losses in the scenarios, and the test will not be used to set capital requirements.

Details of a pilot exercise being undertaken by the Banque de France/ACPR

Since mid-2019, the Banque de France/ACPR have been engaging with banks and insurance firms to develop a pilot exercise to assess the impact of climate-related risks on financial firms. The ACPR has set up working groups with representatives from the main banks and insurers to set out possible options for, and discuss the details of, such an exercise.

The aim of this pilot exercise is to assess the resilience of banks and insurers to climate risks, to speed up the methodological work of financial institutions to support such assessments, and to assist authorities in understanding how financial institutions might react in the face of climate risks (including in terms of the rebalancing of their portfolios). The Banque de France/ACPR have developed a framework to assess financial firms' exposures to climate-related risks.⁷³ This exercise translates the NGFS reference scenarios into economic and financial variables relevant to French firms for both an orderly and disorderly transition.⁷⁴ The approach disaggregates the GDP impact of simulated shocks (through a carbon price and productivity variables) into their impacts on 55 sectors of the economy and associated asset prices. It also generates paths for key macrofinancial variables (interest rates, unemployment etc). In addition, the exposure of the liabilities of the insurance sector to physical risk will be assessed based on the IPCC's RCP8.5 scenario (considered pessimistic but realistic). Insurers will estimate the evolution of property damage claims due to the increased frequency and severity of extreme events such as windstorms, droughts and floods. Many undertakings will rely on the expertise of a common third-party climate model for such estimation, which uses granular data to project geographic impacts within a 20km scope. Increases in health sector claims due to deterioration of air quality or the spread of vector-borne diseases will also be considered.

The scenarios used for this pilot exercise were published in May 2020 for discussion until June 2020.⁷⁵ The exercise will be conducted in the second half of 2020. Insights from this exercise – including the risks it identifies and methodological issues it encounters – will be published by early 2021.

⁷³ See Allen, T., Dees, S., Boissinot, J., Caicedo Graciano, M., Chouard, V., Clerc, L. and Vernet, L. (2020) "Climate-related scenarios for financial stability assessment: An application to France", Banque de France Working paper.

⁷⁴ See NGFS (2020), *Guide for Supervisors: Integrating climate-related and environmental risks into prudential supervision*, May.

⁷⁵ See Banque de France and ACPR (2020).

4. Supervisory approaches to increasing financial institutions' resilience to climate-related risks

The integration of climate-related risks into the supervisory process is at an early stage compared to other types of financial risk and only undertaken in a limited number of jurisdictions.⁷⁶ As discussed in Section 1, supervisory practices were not included as part of the survey of FSB members. Some authorities nonetheless volunteered information on their approach to incorporating climate-related risks into their supervision of banks and insurance firms.

Authorities vary considerably in the nature and extent of such supervisory practices. Some authorities report having focused on building awareness of climate-related risks, both amongst their staff, and amongst firms they supervise, and setting expectations in terms of firms' management of climate-related risks. Twenty-seven survey respondents have undertaken such external outreach, including liaising with firms and experts to improve understanding of issues in this area. Some have also requested that firms conduct stress tests of their resilience to such risks, and set out expectations in terms of their disclosures.

This section examines each of these approaches in turn. More information concerning the integration of climate-related risks into prudential supervision can be found in recent publications by the ECB and NGFS.⁷⁷

4.1. Supervisory awareness and expectations

Several authorities report having taken steps to raise their awareness of climate-related risks.⁷⁸ Initiatives along these lines include those to increase awareness of climate issues within national authorities, including outreach presentations and conferences that sought to bring together expertise across different departments. Other authorities have created fora designed to increase their understanding of financial risks stemming from climate change, and share best practices with industry.⁷⁹

Other authorities reported having raised – or having work in progress to raise – awareness of climate-related risks amongst the financial firms they supervise.⁸⁰ Some such authorities have also undertaken surveys of firms concerning the steps they had taken to manage climate-related risks.⁸¹ Such information gathering was, in some cases, designed to prompt firms to consider climate-related risks more fully and feed into analysis of the approaches to address

⁷⁶ For an example of a study that reaches this conclusion (albeit only in the case of some authorities), see NGFS (2019).

⁷⁷ See ECB (2020), "[Guide on climate-related and environmental risks: supervisory expectations relating to risk management and disclosure](#)", May and NGFS (2020).

⁷⁸ Three authorities reported that they lacked the skills to model climate-related risks to financial stability.

⁷⁹ See, for example, UK Financial Conduct Authority (2019), [Climate Financial Risk Forum](#), August.

⁸⁰ See, for example, Canadian Securities Administrators (2019), [CSA Staff notice 51-358: climate-change related risks](#), August.

⁸¹ See, for example, Appendix A of Bank of England (2015), [The impact of climate change on the UK insurance sector](#), September; and Section 4 of Bank of England (2018), and Banco de México and UNEP (2020), [Climate and environmental risks and opportunities in Mexico's financial system: from diagnosis to action](#), February.

such risks across the industry.⁸² One authority published a guide for consultation that explains how it expects banks to safely and prudently manage climate-related and environmental risks within their business strategy, governance and risk management and disclose such risks under the prudential framework.⁸³

Some authorities have also integrated climate-related risks into their supervisory frameworks. For some authorities this has included setting expectations as to how financial institutions should monitor and manage climate-related financial risks, including how such risks should be integrated into their governance, strategy and risk management.^{84, 85} For example, some authorities report expecting insurers to consider climate risks, if material, in their own risk and solvency assessments (ORSA).⁸⁶

Some of the above work also features prominently in that being advanced by international standard-setting bodies (SSBs). This – and other work of the SSB of relevance to this report – is outlined in Annex 2.

4.2. Supervisory expectations that financial institutions conduct their own scenario analysis

One authority expects banks and insurance firms to – where proportionate – conduct their own scenario analysis to determine the impact of financial risks from climate change on their risk profile and business strategy.⁸⁷ Such scenario analysis is similar in nature to the ‘bottom-up’ assessment of risks conducted by authorities (see Section 3.3). However, instead of drawing on a common quantitative scenario set by authorities, firms are able to set their own scenarios, albeit in line with broad qualitative descriptions set by this authority. Such analysis principally involves the crystallisation of physical risks; some focuses on the crystallisation of transition risks.

Some insurance supervisors expect insurers in their jurisdictions to use similar scenario analysis to assess their climate-related exposures. These supervisors expressed such expectations through regulatory tools such as written guidance or supervisory statements.⁸⁸ Among these insurers that assess climate risks using such scenario analysis, there is evidence that the majority cover only physical risks.⁸⁹

⁸² See Finansinspektionen (2018), *Integration of Sustainability into Corporate Governance, a survey of financial firms’ public sustainability information*, November; and Bank of England (2018).

⁸³ See ECB (2020).

⁸⁴ See Bank of England (2019), *Enhancing banks’ and insurers’ approaches to managing the financial risks from climate change*, April.

⁸⁵ See European Securities and Markets Authority (2019), *Technical Advice to the European Commission on integrating sustainability risks and factors in MIFID II* and *Technical Advice to the European Commission on integrating sustainability risks and factors in the UCITS Directive and AIFMD*, May.

⁸⁶ See also BIS (2019), *Financial Stability Institute Insights on policy implementation No. 20: Turning up the heat – climate risk assessment in the insurance sector*, November.

⁸⁷ See Bank of England (2019), p. 14.

⁸⁸ See BIS (2019), p. 14.

⁸⁹ See BIS (2019), p. 16.

The United Nations Environment Programme Finance Initiative has, together with 16 international banks, also undertaken work to enable firms to conduct more consistent scenario-based analysis. This is designed to equip participating banks to implement the recommendations of the TCFD.⁹⁰

4.3. Disclosure of climate-related risks

Some authorities report having set out – or being in the process of setting out – their expectations as to firms’ disclosure of climate-related risks. A few jurisdictions already have in place, or are planning to implement, some form of climate-related disclosure requirements for financial entities.⁹¹ Some approaches to disclosure are non-mandatory, and involve authorities supporting industry-led or non-binding disclosure guidelines. Other authorities have adopted a ‘comply or explain’ approach under which a firm is considered non-compliant if it does not disclose climate-related risks and fails to provide an adequate explanation.⁹² Other authorities specify a catalogue of data items that firms need to disclose. Non-binding disclosure standards can also support the standardisation of firms’ disclosures.⁹³

Most jurisdictions with disclosure requirements set out the type of information that firms are expected to disclose. While the scope and extent of information disclosure varies across entities and jurisdictions, these reporting components generally include climate-related risks to which a firm is exposed as well as measures it is taking to mitigate such risks.⁹⁴ Such disclosure standards are usually based on the recommendations of the FSB’s TCFD, but this is not always the case.

One authority is consulting on a proposal to introduce rules that require certain listed companies in its jurisdiction to disclose climate-related risks, on a comply-or-explain basis, in line with the recommendations and recommended disclosures of the FSB’s TCFD.⁹⁵ This was motivated by an observation that too few companies were disclosing decision-useful information related to financial risks,⁹⁶ and that this might impede a proper globally consistent assessment of climate-related risks to financial stability.⁹⁷

Based on the evidence it has collected as to the nature of climate-related risks, one securities market authority recommends improvements in issuers’ ESG disclosures.⁹⁸ These recommended disclosures would be designed to respect a minimum level of comparability, relevance and reliability. Its recommendations include amendments to the non-financial

⁹⁰ See UNEP-FI, *Pilot Project on Implementing the TCFD Recommendations for Banks*.

⁹¹ See, for example, Banco de México and UNEP (2020), p. 35-36.

⁹² See, for example, Article 173 of the French Energy Transition Law.

⁹³ For example the EU Commission issues guidelines on non-financial reporting that refine disclosure obligations set out in Directive 2014/95/EU that, as implemented into national law, is mandatory.

⁹⁴ A summary of such requirements – albeit that applying in only a subset of the jurisdictions discussed in this report – is given in NGFS (2019).

⁹⁵ See UK FCA (2020), *CP20/3 Proposals to enhance climate-related disclosures by listed issuers and clarification of existing disclosure obligations*, March.

⁹⁶ See TCFD (2019), *Status Report*, June.

⁹⁷ This observation is also made in NGFS (2019), p. 32.

⁹⁸ See ESMA (2019), *Advise on short-termism*, December.

reporting regulation to establish principles for high quality non-financial information along with a limited set of specific disclosure requirements.⁹⁹

5. Next steps

In light of the findings of this stocktake, the FSB will conduct further work by October 2020 to assess the channels through which physical and transition risks could impact the financial system, and how they might interact. Particular focus will be given to the potential amplification mechanisms and cross-border effects, and to prioritising channels that could materialise in the short-to-medium term. The FSB will also consider the scope for work to assess available data through which climate-related risks can be monitored, as well as any data gaps.

⁹⁹ See ESMA (2019), *Technical Advice to the European Commission on integrating sustainability risks and factors in MIFID II* and *Technical Advice to the European Commission on integrating sustainability risks and factors in the UCITS Directive and AIFMD*, May.

Annex 1: Survey responses

The table below shows responses to the FSB survey of members' (and other relevant official sector bodies') experience in including climate-related risks in financial stability monitoring. Right-hand columns indicate whether one of the financial authorities included in a given response has responsibility for the supervision of banks, insurance firms and/or asset managers, and whether it has a mandate to monitor financial stability.¹⁰⁰

Respondent	Financial authorities and organisations	Bank Supervisor	Insurance Supervisor	Asset Manager Supervisor	Monitor Financial Stability
AR	Securities and Exchange Commission of Argentina (CNV), Central Bank of Argentina (BCRA), National Superintendence of Insurance (SSN).	Yes	Yes	Yes	Yes
AU	Reserve Bank of Australia (RBA), Australian Prudential Regulation Authority (APRA), Australian Securities & Investments Commission (ASIC) and Australian Treasury	Yes	Yes	Yes	Yes
BIS	Bank for International Settlements	No	No	No	No
BR	Central Bank of Brazil	Yes	No	No	Yes
CA	Bank of Canada, OSFI, Department of Finance, Quebec Autorité des Marchés Financiers, Alberta Securities Commission, British Columbia Securities Commission, Ontario Securities Commission	Yes	Yes	Yes	Yes
CH	SNB, FINMA, Swiss Department of Finance	Yes	Yes	Yes	Yes
CL	Banco Central de Chile	No	No	No	Yes
CN	China Banking and Insurance Regulatory Commission, The People's Bank Of China	Yes	Yes	Yes	Yes
DE	BMF, Deutsche Bundesbank, BaFin	Yes	Yes	Yes	Yes

¹⁰⁰ For further details see FSB, "Survey of FSB members' experience in including climate-related risks in their financial stability monitoring".

Respondent	Financial authorities and organisations	Bank Supervisor	Insurance Supervisor	Asset Manager Supervisor	Monitor Financial Stability
ECB	European Central Bank	Yes	No	No	Yes
ES	Banco de España (BdE), Comisión Nacional del Mercado de Valores (CNMV, National Securities Markets Commission), Dirección General de Seguros y Fondos de Pensiones (DGSyFP, Directorate General for Insurance and Pensions Funds), and General Secretariat of the Treasury	Yes	Yes	Yes	Yes
FR	Banque de France, ACPR, AMF, DG Trésor	Yes	Yes	Yes	Yes
ESMA	European Securities Markets Authority	No	No	No	Yes
HK	Hong Kong Monetary Authority (HKMA), Insurance Authority (IA) and Securities and Futures Commission (SFC)	Yes	Yes	Yes	Yes
IMF	International Monetary Fund	No	No	No	Yes
ID	Bank Indonesia, Indonesian Financial Supervisory Authority (OJK)	Yes	Yes	Yes	Yes
IN	Reserve Bank of India	Yes	No	No	Yes
IT	Banca d'Italia, IVASS, Covip, Consob, Ministry of Economy and Finance	Yes	Yes	Yes	Yes
JP	Bank of Japan (BoJ), Japan Financial Services Agency (JFSA)	Yes	Yes	Yes	Yes
KR	Bank of Korea (BoK)	No	No	No	Yes
MX	Banco de México, the Ministry of Finance and the National Banking and Savings Commission.	Yes	No	Yes	Yes
NGFS	Network for Greening the Financial System	No	No	No	No
NL	De Nederlandsche Bank (Ministry of Finance)	Yes	Yes	Yes	Yes
OECD	OECD	No	No	No	Yes

Respondent	Financial authorities and organisations	Bank Supervisor	Insurance Supervisor	Asset Manager Supervisor	Monitor Financial Stability
RU	The Bank of Russia	Yes	Yes	Yes	Yes
SA	SAMA	Yes	Yes	No	Yes
SG	Monetary Authority of Singapore	Yes	Yes	Yes	Yes
TR	The Ministry of Treasury and Finance Insurance Supervision Board, Banking Regulation and Supervision Agency (BRSA) and Capital Markets Board (CMB), The Central Bank of the Republic of Turkey (CBRT)	Yes	Yes	Yes	Yes
UK	Bank of England, FCA	Yes	Yes	Yes	Yes
US	Federal Reserve Board, U.S. Treasury, SEC, CFTC, NAIC	Yes	Yes	Yes	Yes
WB	World Bank	No	No	No	Yes
ZA	South African Reserve Bank (SARB)	Yes	Yes	No	Yes

Annex 2: Work of international organisations and standard-setting bodies

This annex outlines relevant work of the international standard-setting bodies (SSBs). Some of this material was included in presentations made by the SSBs at the AGV workshop on climate-related risks to financial stability in February.

Work of the BCBS

The Basel Committee on Banking Supervision has set up a high-level Task Force on Climate-related Financial Risks (TCFR). The TFCR is charged with undertaking the following initial initiatives on climate-related financial risks:

- A stocktake of members' existing regulatory and supervisory initiatives on climate-related financial risks. A public version of the stocktake report was published in April 2020.¹⁰¹ The report finds that an overwhelmingly large share of BCBS members have conducted research on climate-related financial risks, and that a majority of members have raised the topic with banks and market participants through various channels. The stocktake also notes that about two-fifths of members have issued, or are in the process of issuing, principles-based guidance on climate-related financial risks.
- A set of analytical reports on the transmission channels of climate-related financial risks to the banking system as well as on measurement methodologies; and
- The development of effective supervisory practices in order to mitigate climate-related financial risks.

The BCBS is an observer of the NGFS since June 2019, and is working closely with other SSBs, international fora and international organisations so that our collective efforts are achieved in a coordinated manner.

Work of the IAIS

As part of its 2020-2024 Strategic Plan, the IAIS is increasing its focus on a range of emerging issues that present opportunities, challenges and risks relevant to insurance supervision. This includes sustainability and climate-related risks. This will build on existing foundational work. Since 2017, the IAIS has been partnering with the United Nations Environment Program (UNEP) on a Sustainable Insurance Forum (SIF). The SIF is a body of insurance supervisors who are committed to advancing discussions on the role supervisors can play to understand, assess and take action on climate-related risks.

In July 2018 the IAIS, with the SIF, undertook the first analysis of climate change risk by an SSB, titled the *Issues Paper on Climate Change Risks in the Insurance Sector*. In late February, the IAIS and SIF finalised its Issues Paper, on the Implementation of the Recommendations of the Task Force on Climate-related Financial Disclosures (TCFD

¹⁰¹ Basel Committee on Banking Supervision (2020), *Climate-related financial risks: a survey on current initiatives*, April.

Recommendations). The Issues Paper assesses the level of awareness of the TCFD Recommendations and their implementation within the insurance sector, sets out a range of supervisory approaches to encouraging implementation, and discusses the relevance of the TCFD Framework to IAIS supervisory material. During 2020 the IAIS will also develop an Application Paper on Climate-related Risks in the Insurance Sector, providing guidance to supervisors on how to implement the IAIS Insurance Core Principles (ICPs) from a climate risk perspective. This Paper will cover issues related to the prudential requirements on governance, enterprise risk management, investments and disclosures.

From a financial stability perspective, and as part of its recently adopted global monitoring exercise under the holistic framework for the assessment and mitigation of systemic risk in the insurance sector, the IAIS will also consider emerging risks, including climate-related risks. The global monitoring exercise includes an annual data collection amongst IAIS Members and insurers, as well as annual public reporting. It also includes an annual publication on special topics. The next such publication is planned for early 2021 and will include an analysis into the potential financial stability impacts of climate change.

Lastly, the IAIS became an observer of the NGFS in July 2019.

Work of IOSCO

In February 2017, IOSCO agreed that one of its focus areas would entail an analysis of the role of securities markets in capital-raising and sustainability issues, and the related role of securities regulation. IOSCO has been considering issues and challenges in this area of sustainability and climate-related risks taking into consideration its three main objectives of protecting investors; ensuring that markets are fair, efficient and transparent; and seeking to reduce systemic risk. This work has entailed three main strands.

First, in January 2019, IOSCO published a statement acknowledging the increasing investor interest in environmental, social and governance (ESG) disclosures and setting out the important issues for issuers and investors to consider related to ESG matters when disclosing information that is material to investors' decisions.

Second, in June 2019, the IOSCO Growth and Emerging Markets Committee (GEMC) issued its final report analysing key issues and challenges for developing sustainable capital markets, including recommendations for GEMC member jurisdictions to consider when issuing regulations or guidance regarding sustainable instruments and additional disclosure requirements of sustainability-specific risks.

Finally, in May 2018, IOSCO established its Sustainable Finance Network (SFN) to provide their members with a forum to exchange experiences and gain a better general understanding of sustainability issues from both a regulatory and supervisory point of view. Among other things, the SFN has been focusing on disclosure matters – by issuers and asset managers – and their relevance to investor decision-making; how ESG considerations impact effective capital allocation, and the level of uptake and implementation of industry-lead initiatives. The SFN has conducted a mapping exercise of the sustainability-related initiatives taken or planned by securities regulators, supervisors and market participants as well international initiatives

taken by other organisations. The final report was published on 14 April.¹⁰² The IOSCO Board has also decided to set up a Sustainability Task Force with a mandate to promote the two main objectives identified through the work of the SFN: that is, (i) addressing transparency and (ii) promoting investor protection. Its aim is three-fold: first, to improve sustainability-related disclosures made by issuers and asset managers; second, to work in collaboration with other international organizations and regulators to avoid duplicative efforts and to enhance coordination of relevant regulatory and supervisory approaches; and third, to carry out case studies and analyses of transparency, investor protection – including greenwashing – and other relevant issues for sustainable finance.

IOSCO became an observer of the NGFS in 2019.

Work of the OECD

The OECD assesses risks related to climate change and its impact on economies, financial markets and intermediaries, and develops forms of policy guidance. It does so through various committees, task forces and fora. The Directorates for Environment (ENV) and also Financial and Enterprise Affairs (DAF) develop assessments in their respective bodies, and also jointly convene international policy-makers and private sector participants through their Forum on Green Financial and Investment.

ENV has developed a number of environmental assessments related to economic consequences, aligning policies with a low-carbon economy, sector-specific assessments, and tracking of financial flows to climate transition.¹⁰³

DAF bodies have assessed climate transition and physical risks through its bodies related to global financial markets, infrastructure, insurance and pensions. The Committee on Financial Markets has developed working papers on challenges with ESG investing, and also central banks' ESG integration practices. The OECD 6th annual Forum on Green Finance and Investment included sessions with public and private sector participants with respect to ESG investing, and how central banks were integrating ESG into their investment practices to help support greening of the financial system. Also, housed in DAF is the International Organisation of Pensions Supervisors (IOPS), which in 2019 published its *Supervisory guidelines on the integration of ESG factors in the investment and risk management of pension funds*.

The OECD became an observer of the NGFS in 2018.

¹⁰² IOSCO (2020), *Sustainable Finance and the Role of Securities Regulators and IOSCO: Final Report*, April.

¹⁰³ See [OECD publications on climate change](#).

Annex 3: Publications on climate-related risks

The table below provides links to some of the publications identified by FSB members, analysing climate-related risks both from a supervisory and financial stability perspective.

Jurisdiction	Analysis
Australia	Box C Financial Stability Risks for Climate Change , RBA Financial Stability Review (Oct 2019). Climate Change: Awareness in Action , APRA Information Paper (March 2019).
BIS	The green swan: Central banking and financial stability in the age of climate change , Bolton, Despres, Pereira Da Silva, Samama, and Svartzman (2020). Green bonds: the reserve management perspective , Fender, McMorro, Sahakya, and Zulaica BIS Quarterly Review (2019). Turning up the heat- climate risk assessment in the insurance sector , Clearly, Harding, McDaniels, Svoronos, and Yong. FSI Insights No.20 (2019)
Canada	“Researching the Economic Impacts of Climate Change , Molico (2019). “Scenario analysis and the economic and financial risks of climate change” , Ens and Johnston (2020).
ECB	Special Features A: Climate change and financial stability , ECB Financial Stability Review (May 2019). Box 4: Climate risk-related disclosures of banks and insurers and their market impact , ECB Financial Stability Review (Nov 2019). ECB launches public consultation on its guide on climate-related and environmental risks .
ESMA	ESMA Strategy on Sustainable Finance , ESMA (Feb 2020) ESMA report on Undue short-term pressure on corporations , ESMA (Dec 2019) ESMA report on Trends, Risks and Vulnerabilities , Issue No 1, ESMA, (Feb 2020) ESMA Technical Advice to the European Commission on Sustainability Considerations in the credit rating market , ESMA (Jul 2019) Technical Advice to the European Commission on integrating sustainability risks and factors in MiFID II , ESMA (April 2019) Technical Advice to the European Commission on integrating sustainability risks and factors in the UCITS Directive and AIFMD , ESMA (April 2019)
France	French insurers facing climate change risk , ACPR Analyses et synthèses No.102 (2019). French banking groups facing climate change-related risks , ACPR, Analyses et synthèses No.101 (2019). Présentation des hypothèses provisoires pour l'exercice pilote climatique , Banque de France and ACPR (2020) Climate-related scenarios for financial stability assessment: An application to France (2020).
Germany	Impact of climate-related risks on financial stability , Deutsche Bundesbank Financial Stability Review (2019).
International Monetary Fund	Sustainable Finance: Looking Farther , IMF Global Financial Stability Report (2019).

Jurisdiction	Analysis
	<u>Climate Change: Physical Risk and Equity Prices</u> , IMF Global Financial Stability Report, (2020).
Italy	<u>Climate change and bank lending: the case of flood risk in Italy</u> , Faiella and Natoli (2019). <u>The carbon footprint of Italian loans</u> , Faiella and Lavecchia (2020). <u>The climate risk for finance in Italy</u> , Faiella and Malvolti (2020).
Mexico	<u>Climate and environmental risks and opportunities in Mexico's financial system: from diagnosis to action</u> , Banco de México and UNEP (2020).
OECD	<u>Tracking finance flows towards assessing their consistency with climate objectives</u> , Jachnik, Miarbile and Dobrinevski, OECD Environment Working Papers (2019). <u>IOPS Supervisory Guidelines on the Integration of ESG Factors in the Investment and Risk Management of Pension Funds (2019)</u> , IOPS, OECD. <u>Mobilising Bond Markets for a Low-Carbon Transition</u> , OECD Green Finance and Investment Report (2017). <u>The Economic Consequences of Climate Change (2015)</u> , OECD. <u>OECD Annual Forum on Green Finance and Investment (2019)</u> .
South Africa	<u>Box 2: Steering towards a green economy</u> , SARB Financial Stability Report (Nov 2019)
Spain	<u>Energy transition and financial stability. Implications for the Spanish deposit-taking institutions</u> , Delgado, Banco De Espana Financial Stability Review 37 (Nov 2019). <u>The risk of climate change for financial markets and institutions: challenges, measures adopted, and international initiatives</u> , Marques Sevillano and Romo Gonzalez (2018).
UK	<u>The 2021 biennial exploratory scenario on financials risks from climate change</u> , Bank of England Discussion Paper (Dec 2019)
World Bank	<u>Fiscal Policies for Development and Climate Action</u> Pigato, M. 2019 (ed.). Washington, DC: World Bank <u>Incorporating environmental, social and governance factors into fixed income investment</u> Inderst and Stewart (2020) <u>Macro-Financial Aspects of Climate Change</u> Feyen, Utz, Zuccardi Huertas, Bogdan, and Moon (2020)

Annex 4: Summary of FSB climate-change workshop

In order to engage with external stakeholders, the FSB held a workshop on 19 February 2020 concerning the implications of climate change for financial stability. The workshop explored the experience of the private sector in considering the nature and scale of financial risks from climate change; the channels through which these risks might crystallise; and the difficulties the private sector had faced when attempting to manage and mitigate these risks. The workshop also discussed what role the official sector might play in ensuring such risks were managed and mitigated appropriately.

The workshop was attended by 17 private-sector participants. These included representatives from banks, insurance firms, credit-rating agencies, asset managers, data vendors and think tanks. Private-sector participants were generally those whose work on climate change was reasonably advanced, relative to their peers. Forty-six representatives from official sector institutions also attended the workshop, many of whom represented financial authorities that are members of the AGV.

The workshop comprised four sessions. These focussed on (i) physical risks, (ii) transition risks, (iii) challenges concerning data and (iv) implications of climate-related risks for the wider financial system.

Each session included short introductions from a panel of external stakeholders, followed by open discussion.

This annex begins by summarising the key takeaways from discussions at the workshop. It then explores the key themes of each session. A final section outlines areas where participants believed that official sector action and input might be useful in managing and mitigating climate-related risks. This material does not represent the view of FSB member authorities, nor does it reflect any consensus view(s) expressed by external stakeholders.

Key takeaways (see also Box A in Section 1)

Several overarching key points emerged from the discussions that took place at the workshop:

- Market participants thought that climate-related risks were significant, and had the potential to impact their businesses. Firms were taking steps to better understand and respond to these risks. This involved both attempting to measure and manage risks at the level of individual firms, as well as understanding their consequences for the financial system and global macroeconomy.
- It is unclear whether – and to what degree – financial market prices incorporate climate-related risks. Private-sector participants pointed to research suggesting that some asset prices did not reflect physical risks (e.g. the increased frequency and/or magnitude of extreme weather events) as well as transition risks (perhaps because market participants doubted that governments would commit with policies designed to transition to a low-carbon economy). This might put certain asset prices at risk of disorderly adjustment.
- It is unclear who would bear some climate-related risks, were they to crystallise at scale. While some market participants held insurance against, for example, physical

risks, representatives of the insurance sector told the AGV that some insurance provision may be withdrawn and/or dramatically repriced. This would reduce risks faced by individual insurance firms, but also mean that some risks would be uninsurable. Some workshop participants speculated as to whether governments might have to assume some liabilities. Climate-related risks might also have the potential to transmit between financial sectors, and between jurisdictions (including via the cross-border operations of some financial institutions).

- The workshop included discussion of the channels through which climate-related risks to the financial system may affect the real economy, and, in turn, have further effects on the financial system. Some workshop participants mentioned how banks' exposure to transition risks could put downward pressure on asset prices, thereby causing financial institutions to restrict their lending. This could also trigger a disorderly transition.
- Market participants spoke to the need for alignment and consistency of potential disclosure requirements and data standards across jurisdictions. Inconsistencies – including those arising from differences in the nature and timing of official-sector responses – hindered the comparability of risks across firms and jurisdictions. They might also burden firms unnecessarily and risk fragmenting markets.

Session 1: Physical Risks

In this session, the panel discussed how the increasing severity and frequency of extreme weather events might erode the value of financial assets, and/or increase liabilities. It also discussed analysis that aimed to increase understanding of, and quantify, such risks.

Participants noted that while risk management is central to the business models of many financial firms, climate-related risks have several distinctive characteristics that make them difficult to quantify. Participants pointed out that the impact of climate-change on the financial system is subject to multiple layers of uncertainty. Such uncertainty exists around estimates of the path of climate change, and the degree to which these may lead to an increase in the severity and frequency of extreme weather events. Uncertainties also lead to difficulties in translating these climate outcomes into impacts on financial variables. The panel also highlighted that climate-risks are far reaching and impact economic agents in a correlated fashion. Additionally, the impacts of climate-change are potentially non-linear and subject to tipping points that are hard to estimate based on historical data. Participants also drew attention to how climate-related risks can materialise over a long-horizon, and how this could also be a source of modelling complexity. One participant argued that these features of climate-related risks may limit the usefulness of existing modelling tools in managing climate-related risks.

With regard to the insurance industry, participants reported that physical risks may not have a large impact on the solvency of general insurers, since general insurers' liabilities were generally relatively short term and could be re-priced or withdrawn should the frequency of extreme weather events increase. If such 'deinsurance' or 'protection gap' were to arise, risks could end up being transferred to households, companies and their lenders, or could lead to

governments assuming these liabilities (as has been the case in the UK through 'FloodRe').¹⁰⁴ One participant highlighted that risks to general insurance firms were more likely to be affected via the impact on firms' assets, including the effect of extreme weather events on the broader macroeconomy (and concomitant effects on asset prices).

Participants pointed out that the evidence on whether – and to what degree – financial markets are pricing in potential physical risks is unclear. One presenter outlined analysis conducted on US municipal bonds, Corporate Mortgage Backed Securities (CMBS), and electric utility equities, using geolocation data to ascertain if asset prices reflect the differences of the exposure of the physical assets underlying these securities to potential physical climate risks. They found little evidence that physical risks are reflected in the prices of these assets. The analysis was reported to have required 600,000 hours of CPU (Central Processing Unit) processing time, and to have generated 160 terabytes of data. This was thought to illustrate the current difficulties around quantifying physical risks. Some such difficulties were said to be compounded by a lack of standardised data.

Session 2: Transition Risks

Participants in this session discussed the possibility that the process of adjustment towards a low-carbon economy, including shifts in policies designed to mitigate and adapt to climate risks, could affect the value of financial assets and liabilities.

Participants raised issues concerning the difficulties in understanding, modelling, and quantifying transition risks. One participant highlighted that current modelling methods and individual-firm stress tests provide limited insight on long-term risks. Some participants reflected on the concept of the "Tragedy of Horizons" namely that the impacts of climate change occur over a longer horizon than financial markets and regulators think about. For example, most corporate disclosures do not extend further than three years into the future, making it difficult to quantify the impacts of transition risks on firms. Some participants pointed to innovations they had developed to address these challenges. These included using advances in computing power to run 'bulk stress tests' that utilised hundreds of scenarios and produced a distribution of transition risk impacts. However, it was unclear whether this, and other, work to quantify the effects of transition risks had led to material changes in firms' management of assets and liabilities.

Participants also highlighted the need for a single and consistent set of scenarios for the future path of climate change – and the associated impact on economic variables – that multiple firms can use to quantify the impact of transition risks. One participant pointed out that there are multiple scenarios that were all 'consistent with 2-degree scenario'.¹⁰⁵ These rest on different assumptions around technological innovations and policy responses. Some companies might be pre-disposed to using particular scenarios when disclosing their exposures to transition risk in order to attenuate its impact on the resilience of their business models. The use of different

¹⁰⁴ FloodRe is a joint initiative between the UK government and insurers, which allows insurers to pass the flood risk element of home insurance policies to the government for a fixed price. This ensures high flood risk households continue to have flood cover. FloodRe is planned to be in place until 2039.

¹⁰⁵ A 2-degree scenario refers to a scenario specifying a path of developments (often technological or policy) which is consistent with the goal of limiting the global increase in temperature to 2°C above pre-industrial levels.

scenarios across firms meant that impacts were hard to compare, and frustrated efforts to aggregate impacts across firms' (and sectors') balance sheets.

For these reasons, some market participants thought that most efforts to assess the resilience of business models to transition risks triggered by policy changes or technological innovations were currently largely qualitative in nature.

Several participants also drew attention to the dilemma facing banks as to the degree to which they should support clients to whom they lent 'through the transition' towards a low-carbon economy. This would expose banks to physical risks, and also potential reputational risks; however, withdrawing funding too sharply could trigger a disorderly transition to a low-carbon economy, with unnecessary knock-on impacts on the macroeconomy. Participants stressed the need to strike a careful balance between these considerations.

Session 3: Challenges concerning data

In this session the panel discussed the challenges connected to data availability and the use of this data in monitoring the exposures of financial institutions to climate-related risks.

With regard to data availability, some participants felt that data was of sufficient quality to perform high-level industry-level modelling of climate-related risk exposures, at least in the case of listed companies. However, all participants agreed that there were many respects in which data provision could be improved. Currently data are spread across many different providers, where they take different formats. This makes them hard to compare and aggregate. Greater standardisation and consistency of data across firms as to their exposure to climate-related risks might ultimately create a central data repository that would allow for more consistent analysis across firms, including those that are unlisted, and their supply chains.

Participants also pointed to the importance of establishing a clear taxonomy as to the sensitivity of different assets to climate-related risks. Some argued that establishing basic common definitions (e.g. of 'green' or 'brown assets') would enable firms to more consistently evaluate their asset and liability exposures, and help to integrate climate-related risks into risk management models. Other participants also pointed to a related issue of proliferation of multiple commercial ESG¹⁰⁶ indices that often provided different readings as to the sustainability of firms' operations. Participants believed that a lack of transparency around such indices and how their ratings are derived could lead to confusion among users attempting to quantify their exposure to climate-related risks.

Some participants highlighted opportunities to exploit synergies between firms, and also between firms and the official sector, when improving data availability. In particular, some made reference to the possibility of different sectors within the financial system working together to share expertise and datasets - for example insurers could aid asset managers with locational data when assessing physical risks to their portfolio. One participant also pointed to the Bank of England's Biennial Exploratory Scenario (BES) exercise as having spurred the development of internal working groups to confront data issues. They argued that this may

¹⁰⁶ Environmental, social, and governance factors that aim to capture the sustainability and social impact of a firm.

provide evidence that the work of official sector actors could mandate, and encourage, solutions to some data issues.

Session 4: Implications of climate-related risks for the wider financial system

In this session participants discussed the implications of climate-related risks for the wider financial system, including for those institutions exposed to both physical and transition risks. In general, market participants did not seem to have a clear sense of how the climate-related faced by their individual firms translated to concerns from a financial stability perspective.

Several participants voiced concerns that authorities were moving at different paces in addressing the implications of climate-related financial risks to the financial system. Some pointed to a lack of common standards on reporting, and as well as on inputs to, scenarios used in, and outputs of stress testing. These could lead to an uneven playing field and an onerous regulatory burden on financial institutions that operated in multiple jurisdictions. One participant also highlighted how multiple regulatory approaches might lead to market fragmentation across jurisdictions.

Participants agreed that analysis on the spillover of climate-related risks between sectors and across borders was currently rudimentary. Stronger and more consistent standards around disclosure and data would help address this.

One participant reiterated the risks to financial stability associated with banks' withdrawing finance from projects exposed to climate-related risks. If this were to become too widespread, market participants may begin to anticipate the areas of the economy from which banks would next withdraw funds, which could amplify shocks to credit markets. Some thought that more consistent data on, and indicators of, firms' exposure to such risks might ameliorate this issue.

Potential areas for official sector involvement

Throughout each session participants suggested areas where they believed official sector involvement could help climate-related financial risks to be managed and mitigated more effectively.

Several areas were repeatedly highlighted. These concerned:

- **Disclosures and data.** Participants highlighted that the official sector would be well placed to help drive wider and more consistent disclosures from firms concerning their exposure to physical and transitional risks. One participant suggested mandating the TCFD recommendations¹⁰⁷ in order to achieve this. Participants thought that forcing firms to improve the quality of financial disclosures would also help produce more consistent data for financial firms to use when assessing the risk to their balance sheets.

¹⁰⁷ [Recommendations of the Task Force on Climate-related Financial Disclosures](#) (2017), June.

- **Providing consistent scenarios.** While participants appreciated that it is important for a variety of scenarios to be used when conducting scenario analyses, many felt the sheer variety could potentially prevent comparison of outcomes. Many participants welcomed the planned publishing of reference scenarios by the NGFS and thought this would help firms coordinate analyses. This might help to ensure that their assessment of risks are informative, transparent and comparable.
- **International coordination.** Given the cross-border nature of some financial firms, market participants felt that cooperation between regulators across jurisdictions when it comes to assessing climate-related financial risks, could avoid over-burdening firms and/or fragmenting businesses.