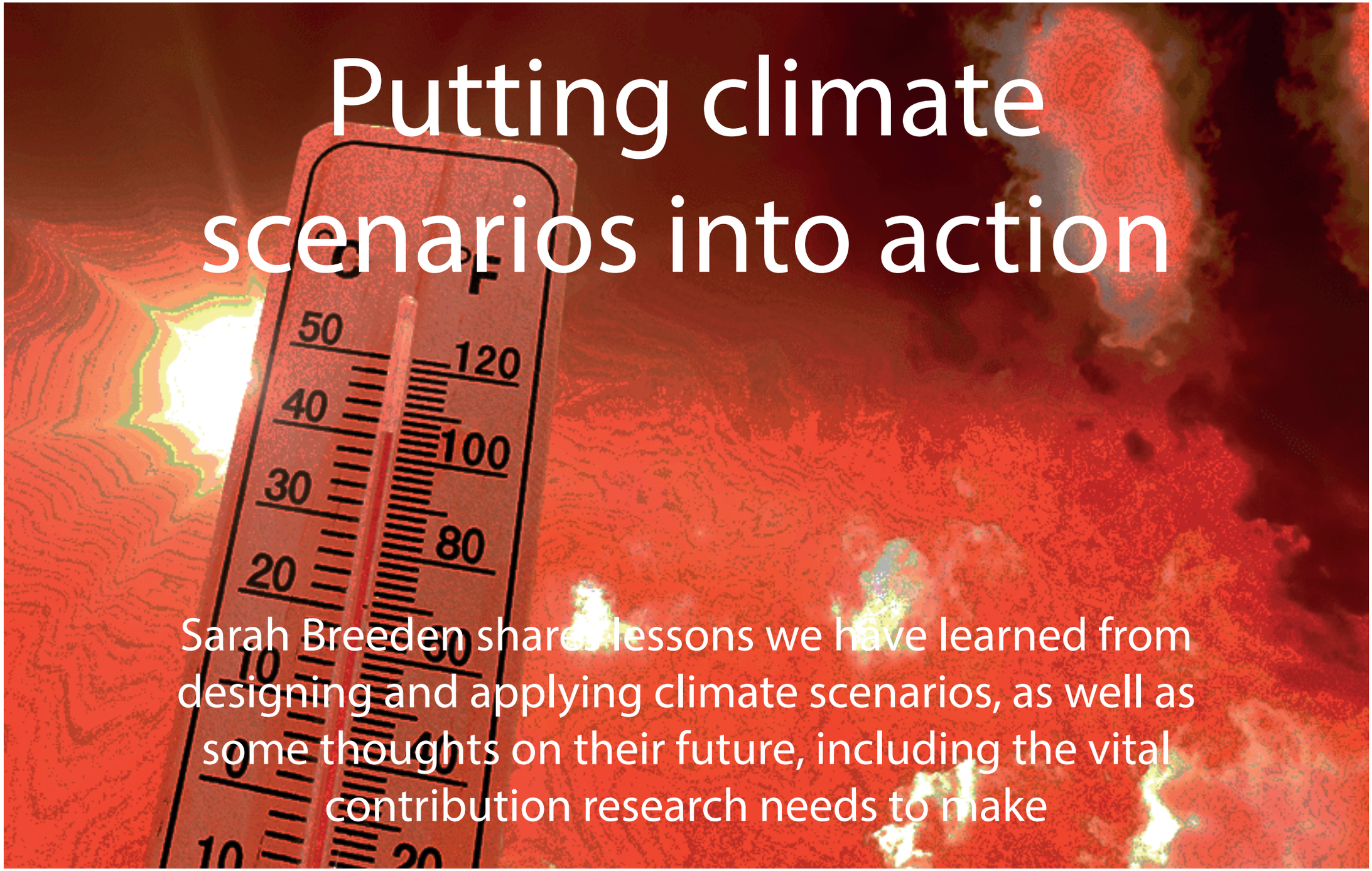
Putting climate scenarios into action



Sarah Breeden shares lessons we have learned from designing and applying climate scenarios, as well as some thoughts on their future, including the vital contribution research needs to make

Climate science tells us that the planet has already warmed by about 1.1 degree Celsius since pre-industrial times[1]. Indeed, the news is full of the devastating effects of physical changes already taking place around us. And existing commitments from countries to reduce greenhouse gas emissions are not enough to keep warming to well below 2 degrees, let alone 1.5[2].

The United Nations Intergovernmental Panel on Climate Change (IPCC) estimates we will reach 1.5 degrees by 2040 even under their 'very low emissions' scenario[3]. Failure to formulate more ambitious commitments and deliver against them this decade will mean we miss the last opportunity significantly to deter the course of climate change.

The case for action is clear - the question is whether our actions will match that case, in particular whether we turn aspiration into action on the scale required. Delivering a path to net zero requires all of us to take necessary steps – governments and business, investors and individuals, as well as central banks and financial regulators.

Here at the Bank of England, we have taken a range of actions in line with our objectives – including setting expectations for banks and insurance companies on their approaches to managing climate-related financial risks, running a system wide climate scenario exercise, and setting out how to green our corporate bond purchase scheme[4] – to play our part in the transition to a net zero economy.

Through all this work, one thing has become abundantly clear – that the actions we take today will determine the consequences we face in the years to come. And so if we are to take the right decisions, we must stretch our horizons, taking different decisions today well before the consequences of inaction manifest at scale.

This needs to occur across the entire economy. And the financial system needs to be a key enabler. As central bank and financial regulator, these implications put climate change squarely within our remit. We cannot solve climate

change and drive the transition – those with the responsibility and tools to do this sit elsewhere in government and industry. But we must ensure that the financial system is resilient to climate-related financial risks, that it can support the transition, and that we understand its macroeconomic impacts.

I want to speak specifically on the system-wide and economy-wide impacts of climate change, using insights from the most recent work we have done on climate scenarios through the central banks and supervisors Network for Greening the Financial System (NGFS).

... climate scenario analysis is of fundamental importance in managing the risks from climate change, helping us to chart the course to net-zero and to drive different decisions today

I will cover three things: first, lessons we've learned from designing climate scenarios? second, lessons we've learned from applying them? and third, I will share some thoughts on the future of scenario analysis – including the vital contribution research needs to make.

Scenario analysis

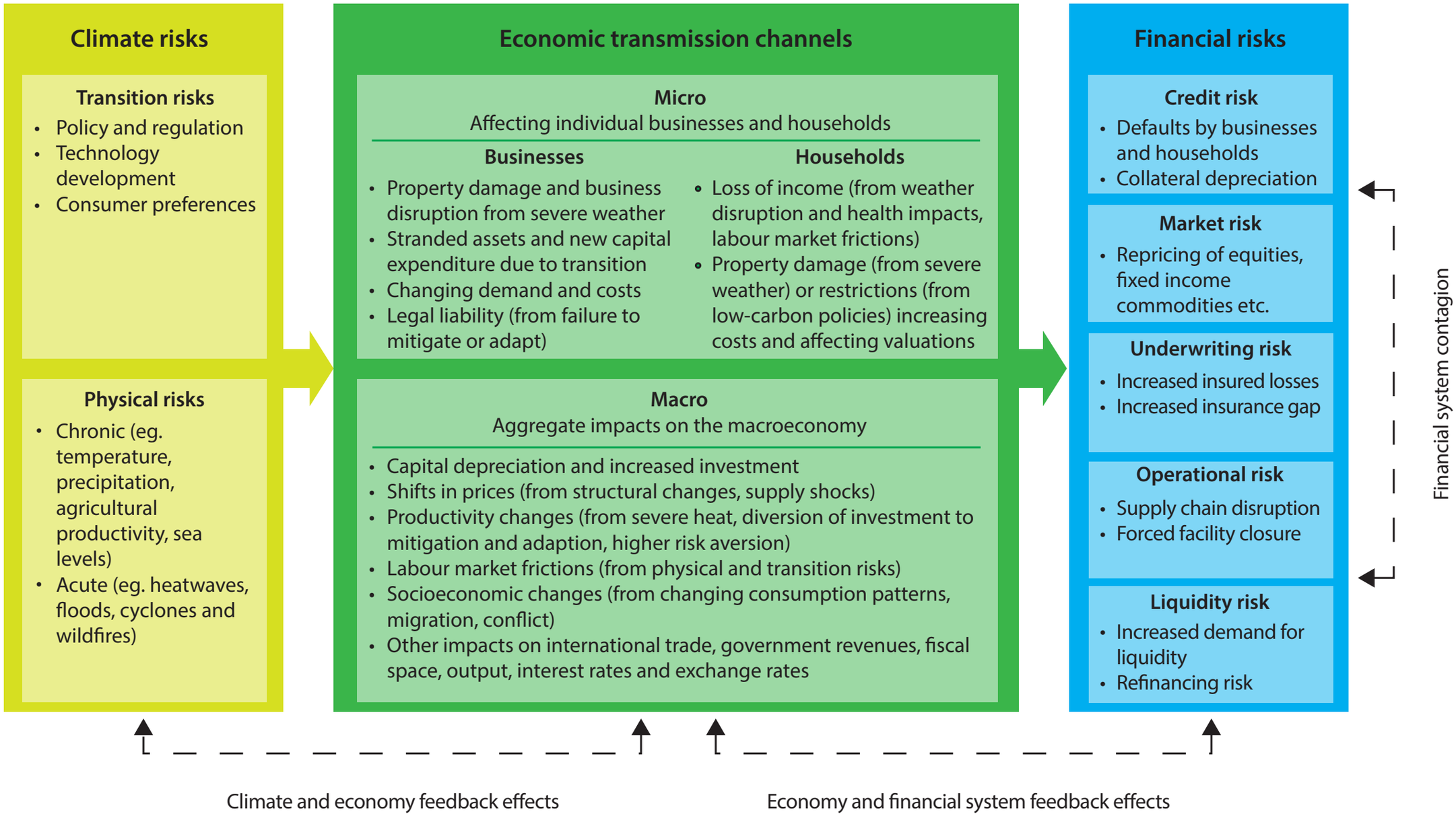
The first step in understanding the impact of climate change to the macroeconomy and the financial system is to recognise that we must look forwards not backwards.

The risks from climate change are unprecedented. They cannot be assessed solely by looking at past data. And depending on our actions today, we could see fundamentally different future outcomes – from a hot house world with extreme physical risks, to futures where we limit the worst effects of climate change but with potentially high transition risks.

While it is certain that a combination of these risks will materialise, it is not clear which path we are on. To navigate these various future pathways, and to understand what future financial risks and economic costs we may see, central banks and financial regulators have turned to scenario analysis.

Scenario analysis is fiendishly complicated. Figure 1 highlights that the transmission channels from climate risks to economic and financial risks are numerous, with significant interdependencies. A holistic analysis therefore requires macroeconomic and top-down approaches to be complemented and augmented by granular and bottom-up risk assessments. A major challenge to doing this is that the prerequisite data and methodologies to translate climate outcomes into macroeconomic and financial risks are incomplete and inadequate. And of course the future path of climate risks themselves is subject to huge uncertainty. Any such exercise is complex and complicated.

Figure 1. Transmission channels



NGFS Climate Scenarios for central banks and supervisors'

To support central banks, supervisors and the financial system with the assessment of these risks, and to bridge some of these modelling and data gaps, in 2019 we launched a project to co-design climate scenarios with a consortium of world-leading climate scientists and close to 60 other central banks and supervisors under the Macrofinancial workstream of the NGFS. In June of this year we published the most recent version of our scenarios[5]. As chair of this workstream, I am proud of the progress we have made in just a few years, and the lessons we have learned along the way. Let me share a few.

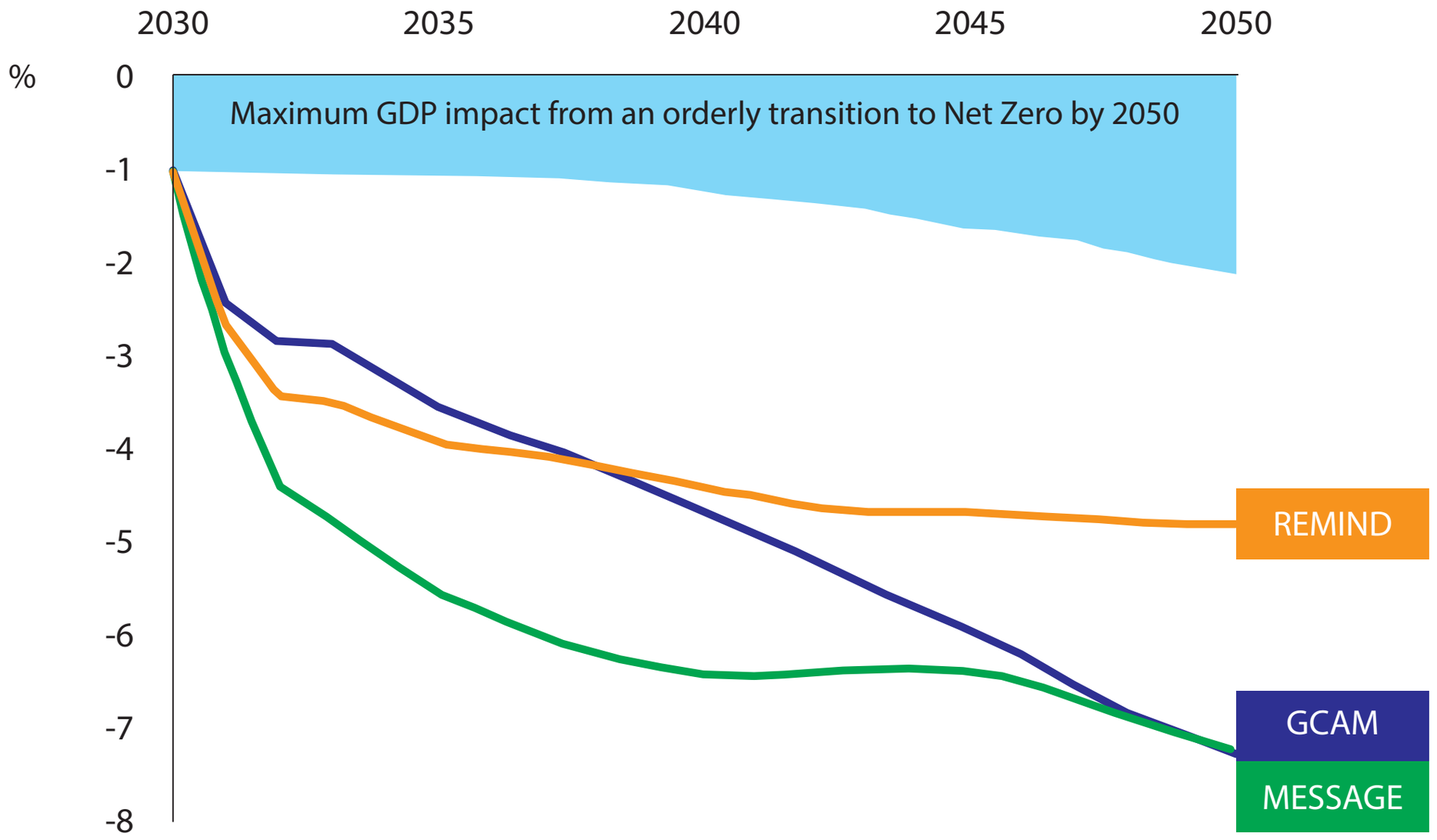
1. Lessons from designing the NGFS climate scenarios

Although we often emphasise the uncertainties inherent in climate projections, it is worth emphasising how much we already know. The scientific basis is unequivocal.

We also have a clear picture of where our emissions come from and how they can be reduced, so we know what the building blocks of the transition are – from increasing the share of renewables in the energy mix to more sustainable buildings and agriculture, alongside carbon capturing and offsetting where possible whether through new technologies or nature-based solutions like afforestation. A number of different types of policy measures can help us get there.

We have also learned that the cost to the economy in aggregate of getting to net zero need not be substantial. Our latest economic modelling shown in Figure 2 suggests that reaching net zero, if the transition is managed well, might have a small or negligible effect on economic aggregates such as GDP, unemployment and inflation. The Sixth Carbon Budget produced by the UK Committee on Climate Change estimates the net costs of the transition will be equivalent to less than 1% of GDP over 2020-2050[6].

Figure 2. GDP impact from delaying the transition across models



Based on the NGFS scenarios 'delayed transition' and 'Net Zero 2050'. Modelled with NiGEM, using transition pathways from three integrated assessment models: GCAM, MESSAGE-GLOBIOM, REMIND-MAgPIE.

But we also know that those costs depend on whether the transition is orderly or disorderly. And that it takes time to implement policy and for markets to adapt to the changes. That means that if meaningful action is delayed by another ten years, the transition would need to be much sharper.

The NGFS estimate that GDP in 2050 would be more than 5 percentage points lower than it would have been if we acted today – even before accounting for possible feedback loops, for example if losses in the financial sector amplify the slowdown in the real economy. And of course the longer we leave meaningful adjustment, the greater the physical risks, leading to higher costs particularly later in the century.

Third those impacts from physical risks will be significant (Figure 3). Analysis by the NGFS indicates that even if we limit the rise in global mean temperatures to 1.5 degrees, physical risks are likely to dominate the potential impacts of transition[7]. And if instead we continue on our current trajectory well above Paris goals, global losses just from the impact of physical risks on labour and agricultural productivity could be as high as 13% of GDP by the end of the century – and that is before accounting for sea level rise, more extreme weather events, food insecurity, migration and displacement of people[8].

This number is therefore very much a lower estimate. And as high levels of warming are unprecedented, we should remain cognisant that we are unlikely to be able fully to capture the delicate balance between the climate, living conditions, ecosystems and the economy with the models at our disposal.

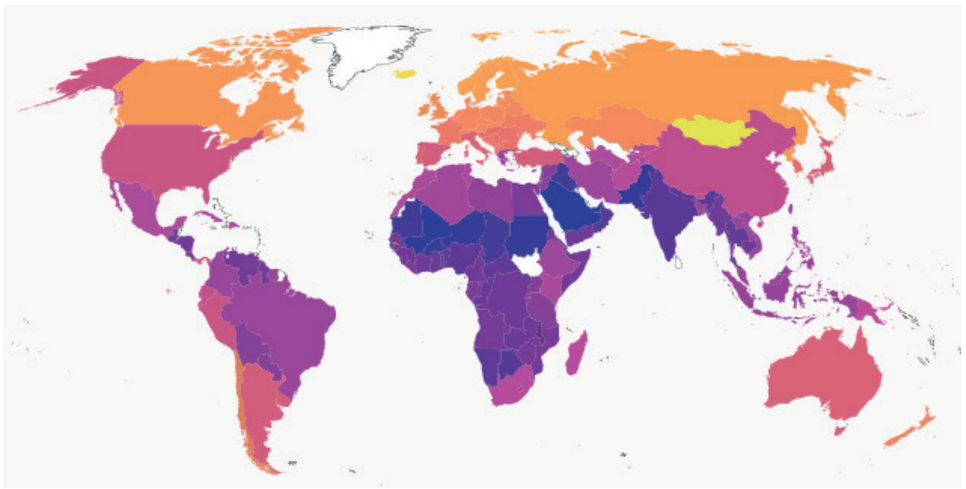
Clearly, investment is needed to help adapt to these inevitable physical changes, which in turn should reduce damages. The Global Commission on Adaptation estimates that $1.8 trillion of global investment in adaptation this decade could generate $7.1 trillion in net benefits[9]. In our focus on the transition to net zero, we must not forget the need to build resilience and to adapt to these physical risks.

Figure 3. Physical risk GDP losses

Physical risk GDP losses by country

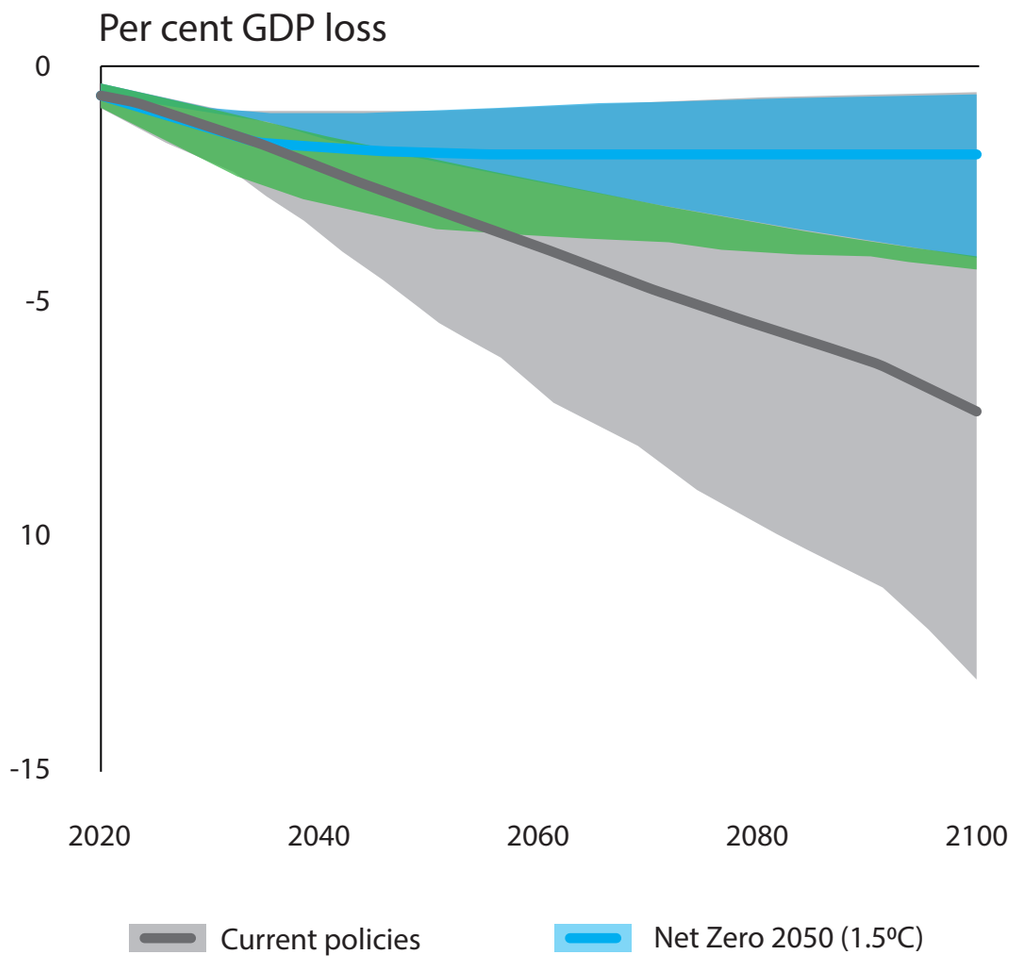
Current policies (95th percentile damages)

Per cent GDP loss relative to prior trends



Source: Calculations by PIK based on scenario temperature outcomes and damage estimates from Kalkuhl and Wenz (2020). Base year for warming is 2005.

Physical risk GDP losses



Source: IIASA NGFS Climate Scenarios Database, REMIND model. 2005 used as the base year.

So what do I take from all this? The cold hard climate physics could not be clearer in underlining the importance of early action. And the returns to investment in mitigating and adapting to climate change now are high.

2. Lessons from applying climate scenarios: findings from the NGFS Scenarios in Action report

So far, I have spoken about some of the key lessons learned while designing the NGFS scenarios. I will now speak about what we have learned from applying these scenarios to macroeconomic and financial risk assessment.

Many central banks and financial supervisors are already using climate scenarios to assess the risks to their economies and financial systems. The NGFS published a report surveying the climate scenario exercises of 30 NGFS members.

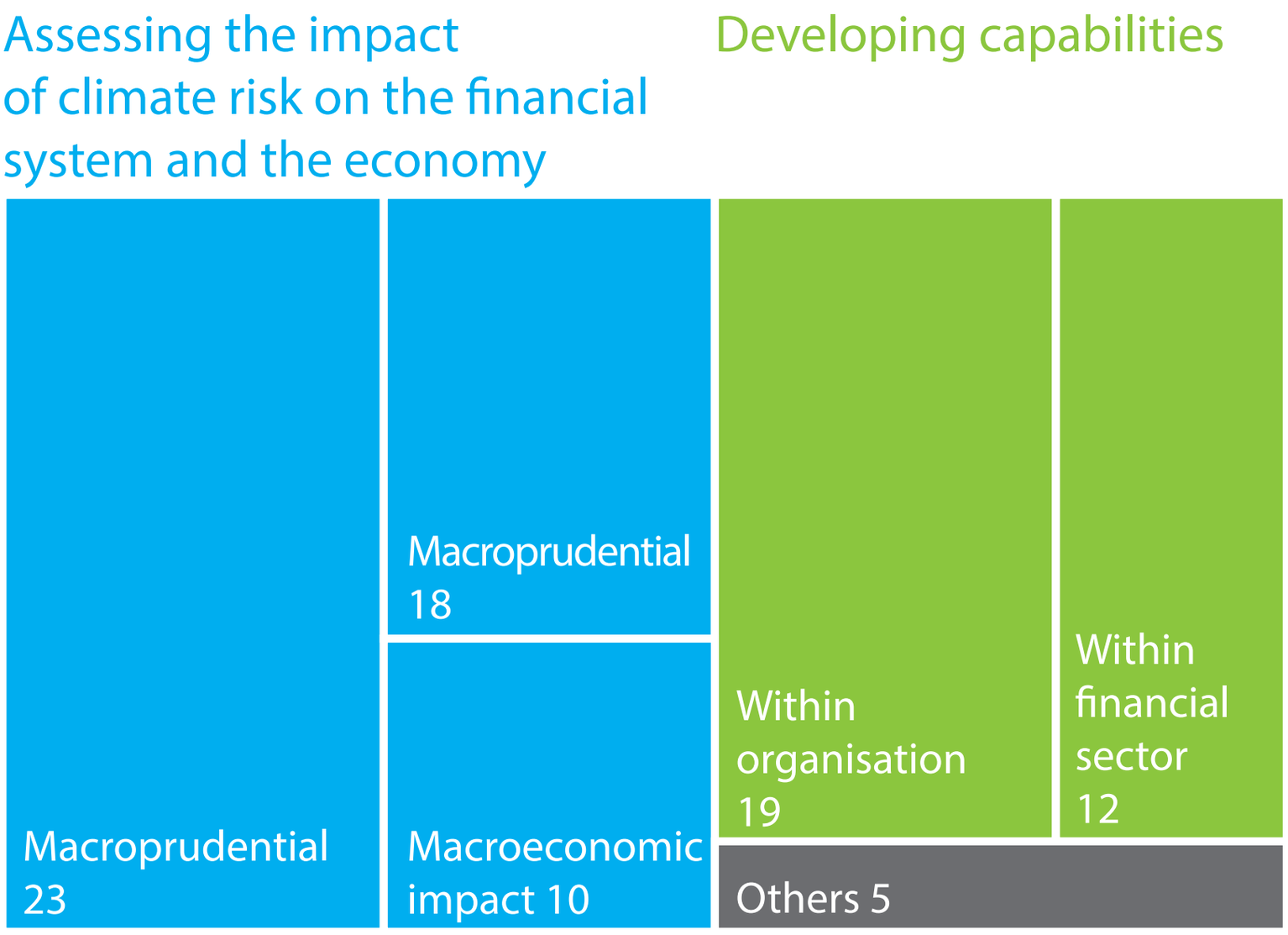
At the moment, only four of these exercises have been completed and their results published, but things are developing rapidly in this field, with another 21 exercises scheduled to be completed within the next 12 months. It has been thrilling to see that the NGFS scenarios serve as a foundational component in the significant majority of these exercises.

Objectives

The objectives of the climate scenario exercises undertaken by NGFS members vary (Figure 4). While all exercises aim to assess risks, the focus of this assessment ranges from risks to individual institutions, to risks to the wider financial system, to risks to the broader economy.

Moreover, as most of us are doing this type of climate scenario analysis for the first time, it is often equally as important to promote an awareness of the risks and to develop capabilities for assessing these risks, as it is to quantify the risks – learning by doing you might say.

Figure 4. Objectives of climate scenario exercises



Many members attributed more than one objective to their exercises, hence why the number of objectives (87) is larger than the total number of members (30).

Scope

The scope of exercises varies as well (Figure 5). All exercises surveyed in the report cover the banking sector, and about half of them include additional financial firms such as insurers and pension funds.

All but one exercise includes transition risks, and about half of the exercises cover the physical risks from climate change. This might seem strange but there are two key reasons some exercises have chosen not to cover physical risks – firstly, transition risks are seen as a more pressing matter for certain sectors such as banking, and secondly, transition risks are comparatively easier to model.

However, a comprehensive risk assessment will require us to look at both types of risk. I expect this will increasingly happen as our methodologies for analysing these risks improve.

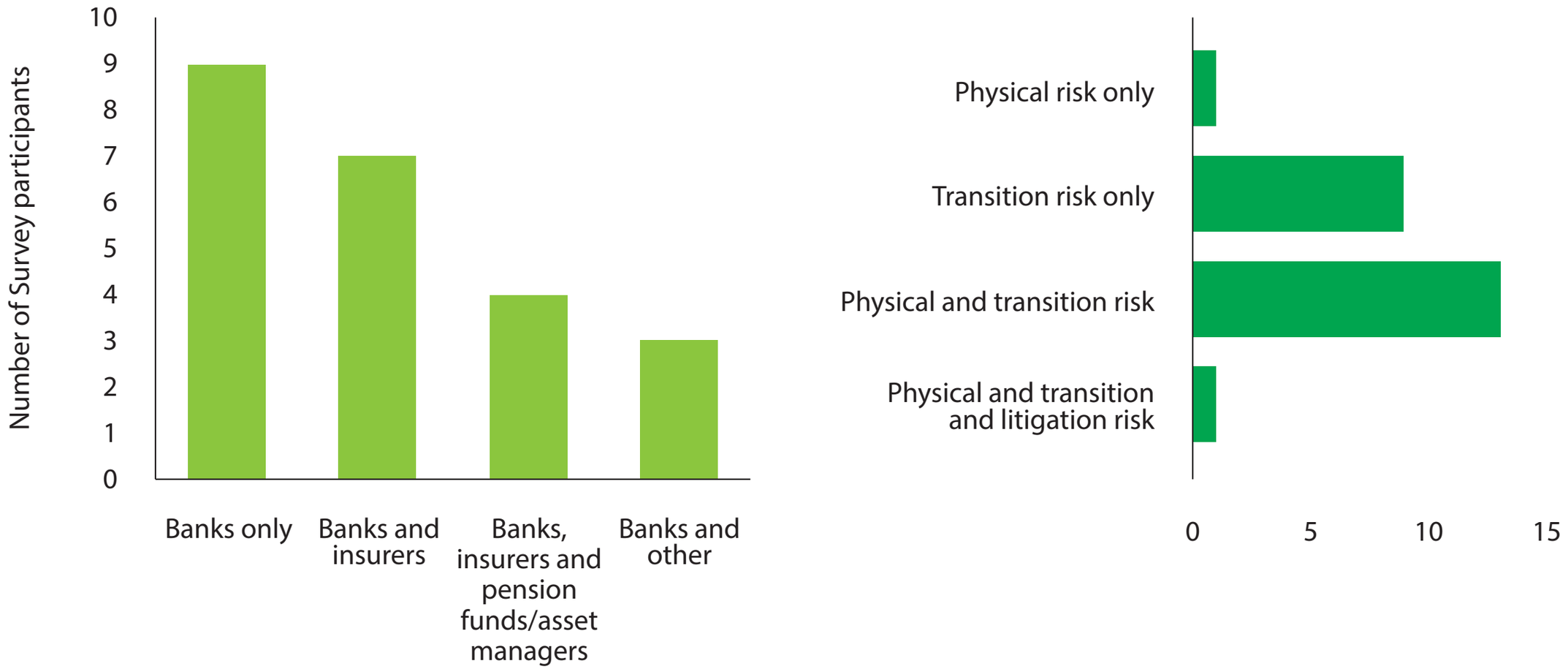
To date, only one of the exercises surveyed includes climate litigation, the Bank of England's own Climate Biennial Exploratory Scenario (CBES), reflecting the complexities associated with modelling this risk. Across the world, there are increasing numbers of climate-related cases[10] being litigated.

The impacts of such litigation can pose material financial risks to firms and create uncertainty over their operating environment[11]. This could have a material impact on the stability of defendant companies, creating risks for investors, insurers, and the wider financial system, so we need to continue to adapt future scenario analyses to capture as many of these interactions as possible.

Challenges

The report also highlights a number of challenges that central banks and supervisors encountered when applying climate scenario exercises.

Figure 5. Scope of climate scenario exercises



- First, immaturity in this complex field means further enhancements are needed. The NGFS scenarios are a critical component in the significant majority of the climate scenario exercises that we surveyed.

  The scenarios have been designed to be flexible, and indeed, we are seeing NGFS members build on these in their own exercises by tailoring them to the specific needs of their jurisdiction. In the last two years we have made huge strides in adding country-level data for hundreds of variables which can support jurisdiction specific assessment. But even so more development is needed.

- Second, data challenges take time to resolve. Even though scenario analysis helps generate relevant data that can help build the full picture, it is a gradual process and getting the right data to undertake scenario analysis remains a key challenge.

- Third, uncertainties remain around the estimates of macroeconomic and financial impacts. Although we have a good sense of the direction of the impacts from climate change, there is still much uncertainty around their exact size and composition – and this begins with the underlying physics.

  For example, projections of future temperature rises are subject to considerable uncertainty bands, especially in scenarios with high emissions[12]. There's also uncertainty about the pace and composition of the transition. So it's important to make our methodologies robust considering multiple scenarios and outcomes rather than single estimates.

In light of these challenges, no members as of yet envisage specifically calibrating regulatory capital requirements on the basis of their exercise. However, some members expressed interest in this topic and indicated that they may include it as an objective for future exercises.

Technical design features

Technical design features can be useful in dealing with the challenges I just described. Let me draw out two points:

i. Firstly on the type of scenario exercise being undertaken.
Some climate scenario exercises are conducted entirely by the central bank or supervisor, where they use existing datasets at their disposal to make scenario-based calculations – often referred to as desk-based exercises.

Others have opted for an approach where financial firms themselves are responsible for calculating the scenario impacts, based on a scenario that the regulator has provided them with – similar to how we conduct traditional stress tests.

Exercises are split evenly between these two types, highlighting that each approach is useful for different reasons. If financial firms make the calculations, they are forced to collect relevant data and build up internal risk management capabilities and awareness of climate-related risks.

But this can make comparability tricky as firms will take different approaches. If the regulator leads the exercise, the methodology applied can be consistent across firms. This is also often a simpler and quicker approach.

ii. Secondly, on time horizons and assumptions.
Most exercises look at a time horizon of 30 years, consistent with the fact that most emissions reductions must take place over the next three decades to meet the Paris goals[13].

Some exercises look further into the future to include the more extreme physical risks that could arise later in the century. There are also exercises that look at shorter horizons of just a few years.

An issue when looking at longer time horizons is that exposures change over time. Financial firms continuously adjust their exposures to manage risks while aiming to profit from new opportunities. If we assumed that they can do this perfectly, we would by definition find that the direct risks they face are very small.

But of course firms would continue to face indirect risks as temperatures rise – it is not possible to diversify away from exposure to the planet. And we know perfect management of even firms' own direct exposures does not always happen, especially in stress, as might occur with a sudden adjustment in asset prices – a so called climate Minsky moment. And we are of course interested in what would happen if firms failed to adjust their business model or manage the risks adequately.

To assess the full size of the risks, three quarters of climate scenario exercises assume that financial firms' balance sheets are frozen in time. This is a huge simplification but it allows the climate specific impacts through the course of the exercise to be more easily identified. Others have instead allowed for changes to balance sheet to be modelled, sometimes subject to restrictions.

Understanding these technical aspects of climate scenario exercises is crucial properly to appreciate and contextualise the results. The Bank of England is also dealing with these complex challenges and design choices through the CBES, which launched this summer, the results of which are due to be published next year.

3. The future of climate scenarios

As I hope you have appreciated, we have learned a lot from designing and applying climate scenarios. But this is just the beginning. There is more we need to do, iteratively adjusting the nuts and bolts in the models – and even when we think we have got it right, we will find further room for improvement.

Central banks and supervisors have a lot to gain from these improvements – as this will help us better understand how climate risks affect the financial system and the economic outlook in order to consider our potential policy responses. We will therefore continue to share our experiences, and plan to publish further reports in the future to summarise the progress we have made.

We will also continue to improve the NGFS scenarios themselves. We are working on adding more sectoral detail to the scenarios so the distribution of risk across the economy becomes more apparent, and to include more physical risks so the cost of inaction becomes clearer.

But we need your help too. Let me highlight a handful of areas where more research is needed, and where scenario analysis can be usefully applied.

First, on policy levers. Our NGFS scenarios use a shadow carbon price, which serves as a proxy for a range of different potential climate policies – whether carbon taxes, business regulation or investment in research.

In aggregate, climate policies will need to create the relative price shift that internalises the costs of emissions and drives an economy-wide shift to net zero. Our NGFS analysis suggests that these will need to add up to an equivalent global shadow carbon price of over $150 a tonne within a decade if we are to reach net zero by 2050 in an orderly way. Estimates of the average global price of carbon today are nowhere near that[14], meaning that investments being made today lack crucial pricing signals that could fundamentally change investors' decisions.

In this context, further research to anticipate the challenges and opportunities that come with different approaches to climate policy and carbon pricing, to further understand the right mix of policy tools to support a swift yet

smooth transition to net zero and to develop comprehensive frameworks to better capture the impact of this mix of tools on the economy, are essential.

Second, on macroeconomic implications, we have identified three key areas where we think there is a need for further work and research:

- further integrating climate and macro modelling – climate models typically don't model the economy in much detail, and macro models don't capture climate risks well, so we need to do more work on integrating models across the different disciplines if we are to do a better job of understanding what might happen?

- understanding and sizing different transmission channels and improving our understanding of how they interact? and

- going beyond the aggregate impacts to understand distributional implications, for example across sectors and geographies.

Finally, research around the monetary policy implications of climate change and the transition to net zero have only recently started to emerge.

We know that domestic and international climate policy will have an impact on inflation, growth, and labour markets[15]. It is also clear that the physical risks from climate change will impact macro variables – for example, changes in weather patterns and increased reliance on bioenergy could increase the volatility of food and energy prices, and hence the volatility of headline inflation rates[16]. And we know too that the impacts will become larger if we fail to act at all.

We also know that to meet climate goals, we need a structural shift across the economy. And that will affect expected long-run steady state variables, such as the natural rate of interest (r*) and the natural rate of unemployment (u*). All of which matter for monetary policy makers.

The unknowns I have just talked through – policy levers, macroeconomic impacts, and monetary policy impacts – are all ripe areas for further research.

These efforts will not only help central banks and supervisors, but will also ensure that the NGFS scenarios can continue to be used by financial institutions in the private sector, industry and policymakers for their own purposes. We will continue our dialogue with these stakeholders and take on their feedback as we determine where to take the NGFS scenarios next.

Conclusion

To conclude, climate scenario analysis is of fundamental importance in managing the risks from climate change, helping us to chart the course to net-zero and to drive different decisions today.

As stewards of the financial system, scenario analysis must remain a core component of the central bank and supervisory toolkit. Indeed, our supervisory work has also indicated that scenario analysis is an area where our regulated firms need to do more.

Our case study report shows the extent to which these scenarios are being applied. And our international engagement this year, including through the NGFS, the G7, the G20 and the FSB, has shown us that scenario analysis is becoming an increasingly important tool for academia, financial institutions, businesses and policymakers around the globe.

The science tells us we are fast approaching a point of no return for the planet. That means we all need to work together to understand the risks, develop the analytical capabilities, and formulate the solutions.

It's an ambitious ask but humanity is best placed to achieve the impossible when there is a will and a way. Let's get to work. ■

Sarah Breeden is Executive Director, UK Deposit Takers Supervision, at the Bank of England

Endnotes

1. IPCC *'AR6 Climate Change 2021: The Physical Science Basis'*
2. UNFCCC *'Nationally determined contributions under the Paris Agreement'*
3. IPCC *'AR6 Climate Change 2021: The Physical Science Basis'*
4. *Options for greening the Bank of England's CBPS discussion paper*
5. See *NGFS Scenarios Portal*
6. Climate Change Committee *'The Sixth Carbon Budget: The UK's path to Net Zero'*
7. *This is true for an orderly transition. In a very disorderly scenario, transition risks will outweigh physical risks.*
8. See *Quiggin, et al 2021 for an overview of how these additional risk factors might play out.*
9. Global Commission on Adaptation *'Adapt now: A global call for leadership on climate resilience'*
10. For example, see *Milieudefensie et al. v Shell* or *Neubauer et al v Germany*
11. *S&P Global Ratings, 2021: Climate Change Litigation: The Case for Better Disclosure and Targets*
12. IPCC *'AR6 Climate Change 2021: The Physical Science Basis'*
13. IPCC *'Global Warming of 1.5 ºC' report*

14. IMF 'A Proposal to Scale Up Global Carbon Pricing'
15. NGFS 'Climate Change and Monetary Policy: Initial takeaways'
16. Batten, S et al 'Climate change: Macroeconomic impact and implications for monetary policy'

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