

Results of the 2021 Climate Biennial Exploratory Scenario (CBES)

The Bank of England (Bank) has today published the results of the Climate Biennial Exploratory Scenario to explore the financial risks posed by climate change for the largest UK banks and insurers (participants).

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1: Executive Summary

- Climate change, and the transition to net zero, create risks for businesses and households globally, and so for the financial system.
- The stylised scenarios used in this exercise are illustrations of possible paths for climate policy and global warming, not forecasts.
- Climate risks captured in the CBES scenarios are likely to create a drag on the profitability of UK banks and insurers.
- Projections made by banks and insurers suggest overall costs will be lowest with early, well-managed action to reduce greenhouse gas emissions and so limit climate change.
- Some climate costs that initially fall on banks and insurers may ultimately be passed on to their customers. In particular, in the No Additional Action scenario, households and businesses vulnerable to physical risks would be especially hard hit.
- Governments set public climate policy, which will be a key determinant of the speed and shape of the transition in the global economy. Banks and insurers have a collective interest in managing climate-related financial risks in a way that supports that transition over time. They will need to improve their management of climate risks in order to be able to do so.
- Projections of climate losses are uncertain; scenario analysis is still in its infancy and there are several notable data gaps. But the CBES has already helped drive improvements in these areas.
- The Bank will continue to work on this important topic, in support of its objective to protect and enhance the stability of the UK financial system. This will include continuing to work with banks and insurers to improve climate risk management, for example by disseminating best practice, and supporting initiatives to help fill data gaps.

The Bank of England (the Bank) has run its first exploratory scenario exercise on climate risk, involving the largest UK banks and insurers.

This exercise supports the Financial Policy Committee (FPC) and Prudential Regulation Committee (PRC) in the pursuit of their statutory objectives (set out more fully in Annex 1). The financial risks from the physical effects of climate change and the transition to a net-zero economy have the potential to affect the vulnerability of banks and insurers to shocks, and the stability of the wider financial system.

The Prudential Regulation Authority's (PRA's) primary objectives are to promote the safety and soundness of firms that it regulates, and to contribute to the protection of insurance policyholders. The FPC's primary objective is to protect and enhance the stability of the financial system of the United Kingdom. The FPC also has a secondary objective to support the economic policy of Her Majesty's Government, which includes ensuring the financial system can support the transition to a net-zero economy.[1]

The Climate Biennial Exploratory Scenario (CBES) includes three scenarios exploring both transition and physical risks, to different degrees. The exercise considered two possible routes to net-zero UK greenhouse gas emissions by 2050: an 'Early Action' (EA) scenario and a 'Late Action' (LA) scenario. A third 'No Additional Action' (NAA) scenario explores the physical risks that would begin to materialise if governments around the world fail to enact policy responses to global warming.

The CBES scenarios are not forecasts of the most likely future outcomes. Instead, they are plausible representations of what might happen based on different future paths of climate policies, technological developments and consumer behaviour, aimed at limiting the rise in global temperatures. Each scenario is assumed to take place over a period of 30 years.

In line with the stated aims of the exercise, the CBES has:

- Assisted participants in enhancing their management of climate-related financial risks (hereafter 'climate risks'), including by fostering engagement with their large corporate customers to understand their vulnerability to climate risks.

The CBES has shown that UK banks and insurers are making good progress in some aspects of their climate risk management, and this exercise has spurred on their efforts further. But the Bank's assessment is that UK banks and insurers still need to do much more to understand and manage their exposure to climate risks. The lack of available data on corporates' current emissions and future transition plans is a collective issue affecting all participating firms. The Bank will give firm-specific feedback to participants, and will use findings from the CBES to help target their efforts.

- Sized the financial exposures of participants to climate risks.

Climate risks captured in the CBES are likely to create a drag on the profitability of banks and insurers, particularly if they are unable to manage these risks effectively. But there is substantial uncertainty around the true magnitude of these risks. And climate risks outside the scope of the CBES (such as trading losses for banks and mortality risk for life insurers) could be material.

- Allowed policy makers to gauge challenges to banks' and insurers' business models from

climate risk, to understand their likely responses, and to analyse the implications of those responses for the system as a whole.

All participating banks and insurers have published climate strategies or net-zero transition plans, which they broadly followed in their responses to all three of the CBES scenarios. Individual plans involve reducing finance, and in some cases insurance, to the most carbon-intensive industries, as well as engaging with corporate clients and counterparties to help facilitate their transition to net zero. There is a risk, however, that the collective impact of such plans could have negative consequences for the wider economy. For example, there could be economic consequences if limits on lending and insurance to corporates involved in the supply of more carbon-intensive energy run ahead of the expansion of renewable energy supply and other measures to improve energy efficiency.

A transition to net zero would materially impact a number of sectors that banks and insurers are exposed to, forcing those in such sectors to adapt their business models or potentially risk becoming unviable over time. It will be in banks' and insurers' collective interests both to support the adaptation of those counterparties across the economy that have credible transition plans, and to gradually reduce their exposures to sectors of the economy that become less economically viable as a result of the transition to net zero. Banks and insurers noted that they will be better able to prepare and plan for the transition if the evolution of climate policy is clear and well communicated.

Some responses – to the NAA scenario in particular – implied a material reduction in access to lending and insurance for sectors and households which were most exposed to physical risks. In the NAA scenario, banks would reduce lending to properties facing greater physical risks, and insurers would substantially increase the premiums they charge to insure against such risks, making insurance coverage unaffordable for many of these households.

Key lessons and next steps

One recurrent theme across participants' submissions was a lack of data on many key factors that participants need to understand to manage climate risks. Another was the range in the quality of different approaches taken across organisations to the assessment and modelling of these risks. All participating firms have more work to do to improve their climate risk management capabilities. The Bank will engage with firms individually and collectively to help them target their efforts, and share good practices identified in this exercise.

Inside the Bank, the findings from this exercise will inform the FPC's thinking around system-wide policy issues related to climate risk and the Committee's work in supporting the financial

system's role in the economy's transition to net zero. The findings will also inform the PRA's supervisory policy and approach. Outside the Bank, key lessons and themes emerging from the exercise will be shared with the UK Government and the Bank's international peers, helping to advance global thinking on how to manage climate-related financial risks, including around the appropriate role of bank and insurer capital requirements.^[2]

Scope

Given the focus of the exercise on driving improvements in risk management and understanding how firms may respond to the risks they could face, the CBES incorporated some key differences in design relative to climate stress tests run elsewhere. The exercise required participants to make granular assessments of their largest counterparties; particular emphasis was placed on banks' and insurers' ability to evaluate the net-zero transition plans of their corporate counterparties; and the exercise focussed on participants' responses to climate risks to a greater extent.

For banks, loss projections were focussed on the credit risk associated with their lending activities, with an emphasis on detailed analysis of risks to large corporate counterparties. For insurers, the focus was on changes in the value of invested assets and the impact on insurance claims. Given the difficulties inherent in accurately assessing climate risk, and the fact that this was the first detailed climate exercise involving both banks and insurers that the Bank has run, the CBES did not aim to evaluate the full impact on participants' income and capital positions. Some factors were not included in the CBES. Examples of omissions include potential trading losses, and detailed projections of the impact of climate risks on banks' risk-weighted assets.

Loss projections for the CBES scenarios are based on the balance sheets of participants as they stood at the end of 2020. So they represent an expectation of losses that might materialise if banks and insurers do not act to reduce the climate risks they face. This design feature makes interpretation of the results more straightforward and allows a clear, separate focus on specific actions that participants might take in response to the scenarios. But it is also likely to push projected losses upwards, as over the thirty year horizon of the CBES participants would likely be able to adjust their business models, and may reduce or mitigate some of the risks they face.

Scenarios

There are two key types of risk associated with climate change: the risks that arise as the economy moves from a carbon-intensive one to net-zero emissions, known as transition risks; and risks associated with the higher global temperatures likely to result from taking no further policy action, known as physical risks. The CBES includes three scenarios exploring both transition and physical risks, to different degrees. These scenarios build on the climate scenarios developed by the Network for Greening the Financial System (NGFS). The CBES also includes an exercise to explore climate litigation risk facing general insurers, separate from these three scenarios.

The exercise considered two possible routes to net-zero carbon dioxide emissions globally by 2050: an Early Action scenario and a Late Action scenario (Figure 2.2). These scenarios primarily explore transition risks from climate change:

- **Early Action (EA):** Under this scenario, climate policy is ambitious from the beginning, with a gradual intensification of carbon taxes and other policies over time. Global carbon dioxide emissions are reduced to net-zero by around 2050 and global warming (relative to pre-industrial levels) is successfully limited to 1.8°C by the end of the scenario, falling to around 1.5°C by the end of century. The required adjustment in the economy creates a temporary headwind to growth but this dissipates in the latter half of the scenario once a significant portion of the required transition has occurred, and the productivity benefits of green technology investments begin to be realised.
- **Late Action (LA):** The implementation of policy to drive the transition to a net-zero economy is assumed to be delayed by a decade under this scenario. Policy measures are then more sudden and disorderly as a result of the delay. Global warming is limited to 1.8°C by the end of the scenario (2050) relative to pre-industrial levels, but then remains around this level at the end of the century. The more compressed nature of the reduction in emissions also results in material short-term macroeconomic and financial markets disruption. UK unemployment rises to 8.5% and the economy goes into recession for a short period. Falls in output are particularly concentrated in emissions-intensive sectors.

In both these scenarios, climate risks have been managed by 2050. In reality, however, the effectiveness of climate policy is not certain. Based on climate simulations and modelling of the impact of policy, the early action policy path has the highest probability of success in terms of limiting climate change.^[3] From a practical perspective, acting late would leave less time to fine-tune policy as its effectiveness was revealed, and leave governments more exposed to the risk of policy co-ordination failure.

A third scenario explores the physical risks that would begin to materialise if governments around the world fail to enact policy responses to global warming and no additional action is taken to address climate change. In contrast to the two transition scenarios, risks in the NAA scenario continue to build beyond the end of the scenario, making it more difficult to compare the effects of such a scenario. Furthermore the scenario does not factor in other potential geopolitical impacts of severe climate change such as increases in migration and conflict, which alongside their enormous human costs, are likely also to result in further financial losses.

No Additional Action (NAA): This scenario primarily explores physical risks from climate change. It is a deliberately severe scenario, being based on climate outcomes that would only occur later this century under the assumption that no additional action is taken to address climate change, and represents a worse than expected outcome even under such conditions. The absence of transition policies in this scenario leads to a growing concentration of greenhouse gas emissions in the atmosphere and, as a result, global temperature levels continue to increase, reaching 3.3°C higher relative to pre-industrial levels by the end of the scenario. This leads to chronic changes in precipitation, ecosystems and sea-levels, which are unevenly distributed globally, and in some cases irreversible. There is also a rise in the frequency and severity of

extreme weather events. There are permanent impacts on living and working conditions, buildings and infrastructure. As a result, UK and global GDP growth is permanently lower and macroeconomic uncertainty increases. Reflecting the fact that the future looks materially worse at the end of the scenario, with the adverse effects of climate change set to worsen further, UK and US equity prices are respectively just under 20 and 25% lower than they might otherwise be.^[4]

Further detail on headline findings

Climate Risk Management

UK banks' and insurers' approaches to projecting losses in the CBES, taken together with other qualitative information provided, suggest that participants are making good progress in some aspects of climate risk management. And there is evidence that this exercise has spurred on participating firms to develop their risk management capabilities further (See Box B for examples of good practice identified through the CBES). But the Bank's assessment is that UK banks and insurers still need to do much more fully to understand and manage their exposure to climate risks, including through getting data on and understanding their counterparties' and customers' transition plans. The findings are consistent with the PRA's assessments in relation to firms' progress against a Supervisory Statement the PRA issued in 2019 ([SS3/19](#)), which sets expectations for how banks and insurers should incorporate climate risks into their risk management practices and governance arrangements, which were set out in the PRA's [Climate Change Adaptation Report 2021](#).

In order to produce better estimates of climate risks in their portfolios, banks and insurers will need to prioritise investment in their climate risk assessment capabilities, both by focusing on their internal modelling and data capabilities and doing more to scrutinise data and projections supplied by third-party providers (upon which participants have relied heavily to compile CBES submissions). The inability to capture appropriate and robust data in certain areas is a common limitation, which means many climate risks are only being partially measured. Examples of gaps include information about the location of corporate assets to permit physical risk assessment, and a lack of standardised information about value chain emissions relating to corporate counterparties.^[5] Banks and insurers will need to prioritise progress on data and will need to put in place interim measures to inform risk management until these data challenges are resolved. The Bank will continue to be supportive of co-ordinated initiatives to fill such data gaps (See Section 6).

A more developed and nuanced approach to risk management would allow banks and insurers to reflect climate risks more accurately in their business decisions (for example by explicitly incorporating possible future carbon prices and their impact on counterparties in pricing, lending and investment decisions). This is important for their own long-term profitability and hence financial resilience. And it is also important to ensure that banks and insurers can support the economy in the transition to net zero. Absent these improvements, there is a risk that banks and insurers may resort to actions that do not appropriately reflect climate risks, such as withdrawing finance to those carbon-intensive businesses in need of external finance to support their transition to less carbon-intensive production. This could give rise to wider macroeconomic risks.

The Bank will help the banks and insurers it regulates to use the results of the CBES to improve their climate risk management capabilities, both through individual firm supervisory dialogue and

by sharing and discussing key thematic findings with the banking and insurance industry more broadly (including through the [**Climate Financial Risk Forum \(CFRF\)**](#)).

Exposures to climate risks

The loss estimates presented here are based on the simplifying assumption that banks' and insurers' balance sheets stay fixed over the scenario horizon, remaining as they stood at end-2020. In reality, banks and insurers business models are likely to respond to climate risks over time. These responses may act to mitigate some of the losses projected.

Across scenarios, participants' projections show that if banks and insurers do not respond effectively, climate risks could cause a persistent and material drag on their profitability. Loss projections vary across participants and scenarios, but are equivalent to an annual drag on profits of around 10-15% on average. Losses of this magnitude could make individual firms, and the financial system overall, more vulnerable to other future shocks.

Due to the relative immaturity of firms' approaches and the complexity of modelling the impact of these risks, the uncertainty bands around projected losses are very large. For example, participating firms' estimated loss rates on the same corporate customers can differ substantially, with the most conservative estimates for losses around ten times higher on average than the least conservative. The impact of climate-related losses will depend on the time horizon over which they occur, which is also uncertain in reality. More clustered losses would have a bigger impact on banks and insurers.

Based on banks' and insurers' projections in this exercise, the overall costs to these firms from the transition to net zero should be bearable without substantial impacts on firms' capital positions – for example through a combination of lower retained earnings and increases in lending rates to sectors where risks increase, and also because not all of the losses on insurers' investments would ultimately fall on shareholders (Section 4). Firms' projections suggest that these costs will be lower if early, well ordered action is taken.

In the case of banks, for which projections were focused on realised credit losses only, as opposed to forward-looking asset prices, loss rates were projected to rise appreciably in all three scenarios.

Banks' projected climate-related credit losses were 30% higher in the Late Action (LA) scenario than the Early Action (EA) scenario. Loss rates in the LA scenario were projected to more than double as a result of climate risks – equivalent to an extra c.£110 billion of losses for participating banks over the period. Around 40% of these losses were realised during the first five years of transition. Key drivers were the large increase in carbon prices contained in this scenario, which leads to large corporate loan losses across energy users and energy producers, and the economy-wide recession, including a rise in unemployment and fall in house prices caused by the

sharp adjustment process, leading to significant mortgage impairments. These household losses were particularly heavily concentrated in the first five years after the delayed start of the transition.

At a corporate sectoral level, the industries in which banks projected the highest loss rates in the two transition scenarios were mining (including extraction of petroleum and natural gas), manufacturing, transport and wholesale & retail trade. On average these sectors were projected by banks to have cumulative impairment rates of 35%, more than twice the aggregate projected impairment rate on corporate portfolios. Insurers projected heavy corporate bond and equity losses in similar sectors, with assets in the mining of gas and oil sector suffering by far the largest losses. These sectoral results were in line with expectations given the carbon intensity of these industries' supply chains.

The NAA scenario also results in significant costs for banks and insurers during the scenario horizon, as the intensification of physical risks leads to higher losses on lending and insurance activities, and lowers the return on financial assets.

In contrast to the two transition scenarios, the NAA scenario only captures a subset of the costs of climate change, which would build far into the future beyond the 30-year horizon of the exercise and persist indefinitely. And the scenario does not factor in other potential geopolitical impacts of severe climate change such as increases in migration and conflict, which alongside the enormous human cost, are likely also to result in further financial losses.

Under the NAA scenario, impairments rates projected by banks were just over 50% higher than normal levels. But these estimates are particularly uncertain. In part that is because banks appeared less well equipped to assess thoroughly the impact of physical risks prominent in the NAA scenario, particularly those arising from corporate vulnerabilities.

The aggregate results show that, for life and general insurers, the NAA scenario would be likely to have a more significant impact than either of the transition scenarios, even within the 30-year window of the exercise. For life insurers, this was because forward-looking asset price impacts are greatest at the end of that scenario with an overall impact worth just over 15% of total market value. Such falls in asset prices would of course affect all holders of assets and participants in these markets. For general insurers, the key way that losses materialised was via a build-up in physical risks, which resulted in higher claims for perils such as flood and wind-related damage. UK and international general insurers, respectively, projected a rise in average annualised losses of around 50% and 70% by the end of the NAA scenario. Staff analysis on UK insurance losses suggests increases could be as much four times higher than firms submitted. Insurers reported that the impact of these increased domestic and international insurance claims would fall, ultimately, on households and businesses through higher insurance premiums or through lower availability of insurance cover.

Projected loss rates from individual banks and insurers spanned a wide range. This suggests

significant uncertainty around the true magnitude of these risks, reflecting the fact that participants' climate risk assessment techniques are still developing, as well as the wide range of approaches taken by participants. The significant degree of uncertainty is corroborated by sensitivity analysis conducted by the Bank.

This exercise also highlighted data gaps and potential risks to international general insurers from climate-related litigation, which could impact the cost and availability of Directors' & Officers' liability insurance cover (Box C). An increase in climate litigation risk would clearly also affect those businesses being litigated against beyond the insurance sector.

Challenges to business models and participants' responses to scenarios

By examining jointly the potential responses of banks and insurers to climate risk, the results of the CBES shed light on the possible collective impact of participants' behaviours, including whether they may give rise to unintended or undesirable system-wide consequences (see Box E).

UK banks and insurers typically expected to respond to the scenarios in this exercise by following their existing plans around the transition to net-zero emissions, including in this instance by increasing counterparty engagement to support the transition. In this exercise, banks and insurers planned to reduce their exposure to carbon-intensive sectors, with banks projecting the largest reductions in the petroleum and gas extraction, petroleum manufacturing, and mining and quarrying sectors. The sectors that banks and insurers planned to reduce their exposure to were broadly similar across all three scenarios. These strategies raise the possibility that some corporate sectors (particularly some carbon-intensive ones) may struggle to access finance as the transition progresses, especially from banks. Unless the transition is carefully managed, this could have significant impacts on businesses and consumers, and through them the financial sector. For example there could be potential macroeconomic consequences if limits in the supply of finance and insurance to fossil fuel producers could outpace the new investment in sustainable energy alternatives and improvements in energy efficiency.

Participating firms identified more business opportunities in the transition scenarios than in the NAA scenario. And banks were able to quantify more new opportunities than life insurers in this exercise. Life insurers noted that their ability to seize some investment opportunities would be dependent upon improvements in disclosures. Some insurers expressed a concern that a surge in 'green' investment could unduly raise asset prices.

In the two transition scenarios, banks planned to increase lending substantially to some components of the gas and electricity supply sector, specifically to renewable energy firms and those developing technology for electric vehicle batteries. At the same time, banks planned to reduce lending to firms within this sector that were particularly reliant on revenues from fossil fuels. They also envisaged increasing lending to the construction sector, reflecting greater investment in retrofitting and flood defence improvements.

Banks also planned to expand into retail lending opportunities created by the transition, including offering green mortgages, and providing financing products for home energy efficiency improvements. General insurers also planned to expand further into opportunities that would be created by a net-zero transition, for example by providing insurance to renewable energy projects, and to companies developing battery and fuel cell technology.

In the NAA scenario, banks and insurers generally sought to reduce their exposures to similar sectors as in the transition scenarios. General insurers planned to increase the price of insurance to reflect the increases in physical risk in the scenario. These firms' insurance contracts are typically written to cover one year, allowing them to alter pricing relatively quickly as risks change. And insurers noted that UK household flood insurance coverage could fall sharply in such a scenario, particularly as insurance on some properties would become unaffordable once the Flood Re scheme ended as per current legislation in 2039, though the vast majority of households would still be able to afford insurance.

In the NAA scenario participants' responses indicated that around 7% of UK households that they currently cover could be forced to go without insurance – because their properties become uninsurable, or because they cannot afford insurance at the prices offered. The share of households affected could be greater than this, to the extent that general insurers have underestimated the physical risk impact of the NAA scenario (see Section 4).

Households and corporates that insurers become unwilling to insure, or where insurance premiums become unaffordable, may face difficulty in accessing finance from banks. UK households in regions most exposed to physical risk would face challenges re-mortgaging their properties in the NAA scenario because they would fall in value due to severe flooding and/or become uninsurable. 45% of the mortgage impairments in the scenario are accounted for by just 10% of the 4-digit postcode areas analysed. Affected households may find themselves stranded on the more expensive Standard Variable Rate mortgages.

Both banks and insurers noted that these risks could be in part mitigated by investment in flood defences, increasing flood resilience measures for properties, and encouraging flood-resilient repairs. They also noted their support for a continuation of a publicly supported UK flood reinsurance pool in such a scenario, and an extension to include properties built after 2009.

The Bank will work with the Government and the FCA to support greater understanding of risks to the provision of financial services highlighted by the CBES exercise.

Actions and next steps

The findings of this CBES relating to individual participants will inform ongoing dialogue about the management of climate risks between banks and insurers and their supervisors. For example, evidence gathered through the CBES will help the PRA to assess firms' progress against the

PRA's expectations in this area set out in [SS3/19](#), and help to reveal where more intensive action is needed by firms (both individually and collectively) to address the issues identified.

More broadly the findings will inform the FPC's thinking around financial stability policy issues related to climate risk and the PRA's supervisory policy in this area. The Bank is working to understand how the management of these risks, or the failure to do so, might affect the provision of financial services to the real economy.

The FPC is supportive of wider work to develop standards and frameworks for net-zero transition. Examples include: government climate policy and transition plan standards, industry net-zero target-setting frameworks, and sustainability disclosure standards and requirements put in place by the International Sustainability Standards Board (ISSB). These standards, and the improved data they are designed to provide, are critical foundations to help banks and insurers better understand their customers' current exposure to climate risks, and their plans to transition towards a net-zero economy.

The Bank is working closely with Government and other regulators to improve its understanding of the future path of climate policy, how the transition will unfold across the real economy, and the ability of the financial system to support a sustainable transition. It is important to note that while the financial system has a crucial role to play in helping finance the transition, it is the real economy where the reductions in greenhouse gas emissions ultimately need to take place. In addition, reductions in the supply of finance to carbon-intensive energy producers will need to be balanced with increases in investment in sustainable energy producers and reductions in energy demand if potential macroeconomic consequences are to be avoided. The FPC will monitor the risks that may arise to the financial system as a result of possible large scale withdrawals of credit to particular sectors. The Bank's work on climate scenario analysis, including the CBES exercise, is a key tool in supporting firms and policymakers as they navigate the uncertainty over the future path for climate policy and climate change by enabling assessment against a range of possible outcomes. In highlighting the macro level impacts of climate change and the transition to net zero, the FPC will also in time be better able to determine whether system-wide capital levels provide a sufficient level of resilience against climate risks. That is one way in which the Bank's work on the CBES and climate scenario analysis more broadly could help inform future work on regulatory capital requirements.

This exercise will not be used to set capital requirements related to climate risk. As set out in the PRA's October 2021 Climate Change Adaptation Report, the PRA and the Bank are undertaking further analysis to determine whether changes need to be made to the design, use, or calibration of the regulatory capital frameworks. Such changes would be aimed at ensuring appropriate resilience to the financial consequences of climate change, consistent with the PRA's and FPC's objectives. However, regulatory capital is not an appropriate tool to address the underlying causes of climate change (ie greenhouse gas emissions across the economy). It would likely be both less effective than other possible direct climate policy interventions, and could potentially

give rise to unintended consequences for firms' safety and soundness. The responsibility for addressing the causes of climate change ultimately lies with governments, businesses and households. The Bank will also continue to actively support a co-ordinated international approach to climate change, including by engaging in the Basel Committee on Banking Supervision's (BCBS's) Task Force on Climate-related Financial Risks.[6]

To support this work on the capital framework, the Bank will host a Research Conference on the interaction between climate change and capital in Q4 2022, and has already put out a 'Call for Papers'. [7] The Bank will publish follow-up material on the use of capital including on the role of any future scenario exercises, informed by the conference and the findings of the CBES.

The CBES has built on our work with central banks, supervisors, and climate scientists around the world to develop climate scenarios for use by financial firms and policymakers. The Bank will share the key thematic lessons learned from this exercise with its peers, helping to advance understanding of the risks that climate change poses to the global financial system. This collaboration also helps to reduce the level of fragmentation across jurisdictions as they address climate risks that are global in nature.

Given that this was the Bank's first detailed climate exercise involving both banks and insurers, it has revealed several insights for the appropriate design and execution of climate stress scenarios and exercises. For example, the CBES exercise has driven improvements in firms' risk management approaches, and helped to expose data and modelling gaps. The Bank has also learned that participants find it difficult to consider their responses to these scenarios in depth, in part reflecting uncertainty about aspects of climate policy which meant participants had to make assumptions about the precise form such policy would take. Loss projections for the CBES scenarios are based on the balance sheets of participants as they stood at the end of 2020. This design feature makes interpretation of the results more straightforward and allows a clear, separate focus on specific actions that participants might take in response to the scenarios. But it is also likely to push projected losses upwards, as over the thirty year horizon of the CBES participants would be likely to adjust their business models and may reduce or mitigate some of the risks they face. In particular, general insurers writing relatively short-term cover are likely to be able to respond relatively quickly to the evolution of climate risks. But the exercise has highlighted clearly how insurers might respond in terms of pricing and coverage as risks materialise and the consequences of those decisions for households and businesses.

2: Background to the CBES

While the primary levers for driving an orderly economy-wide transition to net-zero emissions are government climate policy and business innovation and investment, the Bank – consistent with its objectives – has a key supporting role to play as the Government develops and sets out its plans. The CBES contributes to this role.

The CBES is just one of the Bank’s workstreams aiming to assist in ensuring the financial system is resilient to climate-related financial risks. More detail on the Bank’s wider approach to managing climate-related risks can be found on its [climate change webpage](#).

2.1: Aims

As set out in the CBES ‘Key Elements’ published in June 2021, the exercise was designed to:

- Present a fully coherent set of scenarios that could be used to assess climate risks facing key UK firms.
- Assist participants in enhancing their management of climate-related financial risks, consistent with expectations set out in Supervisory Statement 3/19, including embedding these risks in business as usual risk management, engaging counterparties to understand their vulnerability to transition and physical climate risks, and encouraging boards to take a strategic, long-term approach to managing these risks.
- Size the financial exposures of participants and the financial system more broadly to climate-related risks.
- Understand the challenges to participants’ business models from these risks; and gauge their likely responses and the implications for the provision of financial services.

These aims support both the PRA’s objectives to ensure the safety and soundness of firms and to contribute to the protection of insurance policyholders, as well as the FPC’s objective to enhance the resilience of the financial system. Notably, the CBES also supports the FPC’s objective support the Government’s wider economic policy, which includes ensuring that the financial system is able to support the transition to a net-zero economy.

Table 2.A lists the CBES participants. The exercise covered the global activities of the listed participants within the scope of the exercise. For example, for banking groups both UK and non-UK credit exposures were covered.

Table 2.A: CBES participation and coverage

Large UK banking groups and building societies	Large UK life insurers	UK general insurers	International general insurers
Participation:			
Barclays	Aviva	Allianz Holdings plc (UK entities only)	AIG (UK entities only)
HSBC	Legal & General	Aviva	Society of Lloyd's (Ten selected Syndicates)
Lloyds Banking Group	M&G	AXA (UK entities only)	
Nationwide Building Society	Phoenix	Direct Line	
NatWest Group	Scottish Widows	RSA (UK entities only)	
Santander UK			
Standard Chartered			
Coverage in key markets:			
Around 70% of UK bank lending to UK households and businesses.	Around 65% of the UK life insurance market by asset size. A range of business models (annuities, with-profits, unit-linked).	Around 60% of the UK general insurance market by Gross Written Premium.	The ten selected Syndicates account for around 40% of the Society of Lloyd's property and liability insurance market by premium.

2.2: Scenarios

There are two key types of risk associated with climate change: the risks that arise as the economy moves from a carbon-intensive one to net-zero emissions, known as transition risks; and risks associated with an increase in global temperatures, known as physical risks.

The CBES includes three scenarios exploring both transition and physical risks, to different degrees. The exercise considered two possible routes to net-zero UK greenhouse gas

emissions by 2050: an 'early action' scenario and a 'late action' scenario. A third 'no addition action' scenario explores the physical risks that would begin to materialise if governments around the world fail to enact policy responses to global warming.

The CBES scenarios are not forecasts of the most likely future outcomes. Instead, they are plausible representations of what might happen based on different future paths of climate policies, technological developments and consumer behaviour, aimed at limiting the rise in global temperatures. There are many possible alternative paths for these drivers of emissions. Each scenario is assumed to take place over a period of 30 years.

The CBES scenarios are based on a subset of NGFS climate scenarios.^[8] Building on the NGFS climate scenarios ensures that the CBES scenarios are grounded in a consistent set of pathways for physical climate change, the energy system, land-use and the wider economy. Specifically, the CBES scenarios take the NGFS Net Zero 2050, Delayed Transition and Current Policies scenarios as a starting point. The Bank has expanded on the NGFS scenarios by including additional risk transmission channels and adding additional variables (working with climate scientists, academics and industry experts).^[9] As a result, the Climate BES scenarios are not identical to those produced by the NGFS, but they are consistent across many variables.

Since the launch of the CBES in June 2021, carbon prices appear to have risen by slightly more than in the first year of the early action scenario.^[10] Fossil fuel prices are also much higher, but in large part this is due to Russia's invasion of Ukraine. Meanwhile the Intergovernmental Panel on Climate Change's (IPCC's) latest report suggests global emissions need to be reduced even more aggressively to prevent global warming above 1.5°C by the end of century.

The exercise considered two routes to net-zero carbon dioxide emissions globally (and net-zero greenhouse gas emissions for the UK) by 2050: an Early Action scenario and a Late Action scenario (Table 2.A). These scenarios primarily explore transition risks from climate change:

- **Early Action (EA):** Under this scenario, climate policy is ambitious from the beginning, with a gradual intensification of carbon taxes and other policies over time. Global carbon dioxide emissions are reduced to net-zero by around 2050 and global warming (relative to pre-industrial levels) is successfully limited to 1.8°C by the end of the scenario, falling to around 1.5°C by the end of century. The required adjustment in the economy creates a temporary headwind to growth but this dissipates in the latter half of the scenario once a significant portion of the required transition has occurred, and the productivity benefits of green technology investments begin to be realised. It is the lowest risk path in terms of the probability of limiting global warming in line with international commitments.
- **Late Action (LA):** The implementation of policy to drive the transition to a net-zero economy is assumed to be delayed by a decade under this scenario. Policy measures are then more sudden and disorderly as a result of the delay. Global warming is limited to 1.8°C by the end of the scenario (2050) relative to pre-industrial levels, but then remains around this level at the

end of the century. The more compressed nature of the transition to lower emissions also results in material short-term macroeconomic and financial markets disruption. Unemployment rises to 8.5% and the economy goes into recession for a short period. Falls in output are particularly concentrated in emissions-intensive sectors.

In both these scenarios climate risks have been managed by 2050.

An important indicator of the level of transition risks in these scenarios is the carbon price.^[11] Transitioning away from fossil fuels and carbon-intensive modes of production requires significant investment in low-carbon alternatives in all sectors of the economy. Policymakers can induce this transition by increasing the implicit cost of emissions. The carbon price can be thought of as a summary of these policies, and so is closely linked to the extent of transition risk.

In the Early Action scenario, carbon prices increase from roughly US\$30 per tonne of carbon dioxide-equivalent as at end-2020, to just under US\$900 by 2050 in the UK and EU (abstracting from general inflation over the time period).^[12] In the Late Action scenario, carbon prices remain at US\$30 until 2030, and then rise steeply to over US\$1,000 in 2050.

Changes in emissions, and the atmospheric concentration of greenhouse gases, translate through to changes in global mean temperatures. Global mean temperatures have already increased by around 1.1°C from pre-industrial levels.^[13] In the Early and Late Action scenarios, carbon dioxide emissions globally (and greenhouse gas emissions in the UK) reach net zero. Because of the significant lag between emissions and warming levels, temperatures continue to rise, reaching a global warming level of 1.8°C by this point (Figure 2.2). The degree of warming is then projected to fall slightly from its peak in these scenarios by the end of the century, due to actions that help to remove some greenhouse gases from the atmosphere (eg changes in land-use).

Taking policy action sooner, as in the Early Action Scenario, would mean that there was more chance of a lower peak temperature than in the Late Action Scenario, although consistent with past emissions remaining in the atmosphere for many years, the likely peak temperature in scenarios such as these is broadly similar.^[14] As a prudent and simplifying assumption, the peak level of warming is the same in the Early and Late Action scenarios.

A third scenario explores the physical risks that would begin to materialise if governments around the world fail to enact policy responses to global warming and no additional action is taken to address climate change. In contrast to the two transition scenarios, risks in the NAA scenario continue to build beyond the end of the scenario, making it more difficult to compare the effects of such a scenario. The scenario does not factor in other potential geopolitical impacts of severe climate change such as increases in migration and conflict, which alongside their enormous human costs, are likely also to result in further financial losses. Nor does the macroeconomic scenario explicitly factor in the potential second round impact of a reduction in the availability of

credit and insurance for households and businesses most exposed to increases in physical risk (See section 5).

No Additional Action (NAA): This scenario primarily explores physical risks from climate change. It is a deliberately severe scenario, being based on climate outcomes that would only occur later this century under the assumption that no additional action is taken to address climate change, and represents a worse than expected outcome even under such conditions. The scenario features chronic changes in precipitation, ecosystems and sea-levels, which are unevenly distributed globally, and in some cases irreversible. There is also a rise in the frequency and severity of extreme weather events. There are permanent impacts on living and working conditions, buildings and infrastructure. UK and global GDP growth are permanently lower and macroeconomic uncertainty increases. UK equity prices are just under 20% lower as a result, and the S&P 500 is 25% lower, reflecting the fact that the future looks materially worse at the end of the scenario, with the adverse effects of climate change set to worsen further.

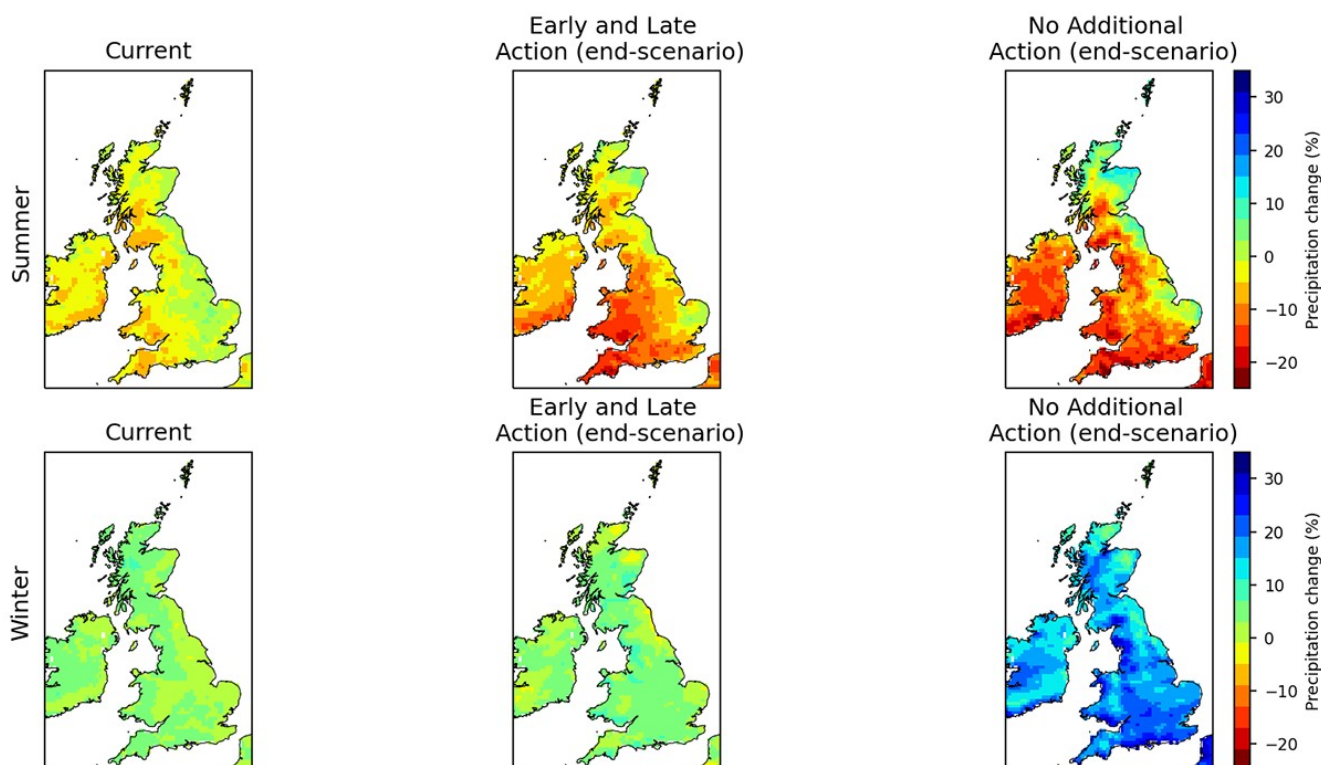
In the No Additional Action scenario, carbon prices do not rise.^[15] The absence of transition policies mean the concentration of emissions in the atmosphere grows, and global warming relative to pre-industrial times reaches 3.3°C by 2050. Climate scientists' projections conditioned on no further policy action suggest, however, that temperature increases as significant as these would only be likely to occur later in the century. The shifting forward in time of these more severe temperature rises – and associated physical risks – is deliberate, as it allows the Bank to explore the impact of these more extreme risks within the 30-year time horizon of the exercise. Specifically, the calibration is based on climate outcomes that could materialise between 2050 and 2080 in the absence of further policy action, consistent with warming reaching 4.1°C by the end of the century.

The temperature pathway used in this scenario is based on the 90th percentile of the projected distribution of warming outcomes conditional on further policy inaction. The Bank has made this calibration choice in recognition of the large degree of uncertainty surrounding temperature pathways, as well as the modelling uncertainty related to physical risks, including the difficulty of modelling potential developments such as conflict and mass migration, which do not feature in the calibration.

The combination of climate change effects incorporated in the No Additional Action scenario leads to an increased risk of flooding in the UK. By the end of the No Additional Action scenario, average winter precipitation in the UK increases by 25% compared to the late 20th century (Figure 2.1).

Figure 2.1: In the No Additional Action scenario, average winter precipitation in the UK rises by nearly 25% compared to the late 20th century

Change in the average summer and winter precipitation since the late 20th century








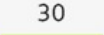












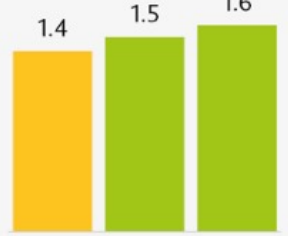
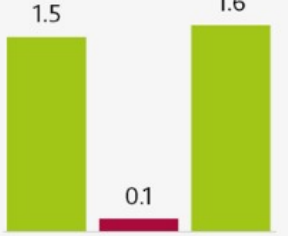
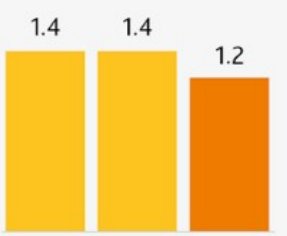
Sources: Met Office and Bank calculations.

The degree of exposure to climate risks varies across different sectors of the UK economy. This is reflected in the calibration of Gross Value Added (GVA) paths for individual sectors within the CBES scenarios. For instance, sectors relying on carbon-intensive production processes are more vulnerable to transition risks than the economy as a whole. And sectors that are highly dependent on physical infrastructure in certain areas could be more vulnerable to physical risks. The magnitude of a sector's exposure also depends on factors such as its core activity, supply chain structure, and the extent of emissions associated with the final consumption of its goods and services. To aid participants with their sectoral analysis, CBES scenario variable paths provide sectoral GVA paths for 59 UK sectors, spanning the entire economy, in each scenario. These paths reflect the value of goods and services produced by each sector.

Figure 2.2 provides an overview of the three scenarios described above, as well as the transition and physical risks they give rise to. More detail on the scenarios used can be found in the 'Key Elements' publication.^[16] The CBES scenario variable paths are available at the [Bank's stress testing webpage](#).


Figure 2.2: The CBES explores transition and physical risks from climate change

Summary of impacts in the CBES scenarios

	Early Action	Late Action	No Additional Action
Transition risks	 Medium	 High	 Limited
Transition begins in	2021	2031	n.a.
Nature of transition	Early and orderly	Late and disorderly	Only policies that were in place before 2021
Peak UK shadow carbon price (carbon tax and other policies) (2010 US\$/tonne carbon dioxide equivalent)	900 	1,100 	30 
Physical risks	 Limited	 Limited	 High
Mean global warming relative to pre-industrial times by the end of scenario (°C)	1.8 	1.8 	3.3 
Mean sea level rise in the UK (m)	0.16 	0.16 	0.39 
Impact on output	 Temporarily lower growth	 Sudden contraction (recession)	 Permanently lower growth and higher uncertainty
Average annual output growth in the UK (per cent)	 Year 6–10 Year 11–15 Year 26–30	 Year 6–10 Year 11–15 Year 26–30	 Year 6–10 Year 11–15 Year 26–30

Sources: Met Office, Network for Greening the Financial System and Bank calculations.

Box A: Comparison of assumptions on government policy across CBES scenarios

Differences in assumed international government climate policy drive the differences between the three CBES scenarios. Largely, the stance (or relative urgency) of climate policy is expressed through the paths of carbon prices in the different scenarios. But to help explore some specific climate risks in particular, the Bank also published certain other hypothetical UK climate policy related assumptions for use in each scenario. In these cases, the assumptions should not be taken to represent intended Government policy; however, the path for policy specified is designed to be broadly consistent with policy changes already announced by the UK Government, and to be in line with the spirit of scenario concerned. This box describes those specific policy-related assumptions (further details can be found in the [Guidance issued to CBES participants](#) ).

End 2020 UK government Policy	EA Policy Assumptions	LA Policy Assumptions	NAA Policy Assumptions
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EPC ratings (a)	Government set aspiration that all fuel poor homes to be upgraded to Energy Performance Certificate (EPC) Band C by 2030 and for as many existing homes as possible to be EPC Band C by 2035 where practical, cost effective and affordable. (b) Interim milestone has been set to raise as many fuel poor homes as is reasonably practicable to Band D by 2025.	Energy efficiency improvements gradually carried out over 30 years. From 2035, all domestic properties and commercial real estate in the UK must have an EPC band E or higher. CRE: Properties that cannot be improved to an EPC band E or higher then become unmarketable. There is a rollout of heat pumps. Government offers subsidy scheme supporting implementation of energy efficiency improvements.	Energy efficiency improvements carried out from 2030 onwards. From 2035, all domestic properties and commercial real estate in the UK must have an EPC band E or higher. CRE: Properties that cannot be improved to EPC band E or higher become unmarketable. There is a rollout of heat pumps. Government offers subsidy scheme supporting implementation of energy efficiency improvements.	No further policy changes assumed.
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	End 2020 UK government Policy	EA Policy Assumptions	LA Policy Assumptions	NAA Policy Assumptions
Cars	On 18 November 2020, the UK government announced the end of the sale of new petrol and diesel cars in the UK by 2030, and hybrid vehicles by 2035.	<p>Government acts promptly to encourage a smooth transition to electric vehicles.</p> <p>The proportion of new vehicles accounted for by internal combustion engine vehicles gradually falls and policies are introduced to remove used internal combustion engine vehicles from the road.</p>	There are substantial government policies to manage the transition to electric vehicles beginning in 2026 rather than 2021.	<p>Paths for vehicle prices, sales and vehicles on the road mirror LA scenario to 2030. Thereafter transition stops – announced policies not subsequently introduced.</p>

	End 2020 UK government Policy	EA Policy Assumptions	LA Policy Assumptions	NAA Policy Assumptions
Flood Re	<p>Flood Re is a joint initiative between the Government and insurers which makes flood cover more affordable and widely available for the highest risk households. When consumers buy home insurance cover, their insurer can choose to cede the flood risk element of the policy to Flood Re for a fixed price.</p> <p>Flood Re ends in 2039 as per current legislation, at which point insurers should be offering policies based on actual risk to property.</p>	<p>Flood Re ends in 2039 as per current legislation and affordable flood risk reflective pricing is achieved before its end.</p> <p>The market gradually transitions, starting well before 2039.</p> <p>Risks that are currently ceded to Flood Re will not be ceded in the future because the insurance market has found its equilibrium without Flood Re's subsidy.</p>	<p>Flood Re ends in 2039 as per current legislation; due to disruption created by the late transition the market has not yet transitioned to affordable risk reflective pricing (ie the objective of Flood Re has not been met). Insurers refuse risks previously ceded to Flood Re at renewal.</p>	<p>Flood Re ends in 2039 as per current legislation; the market has not transitioned to affordable risk reflective pricing. Insurers refuse risks previously ceded to Flood Re as well as any additional physical risks materialising under NAA.</p>

(a) Domestic Energy Performance Certificates (EPCs) are banded from 'A' to 'G', where 'A' is the most energy efficient in terms of likely fuel costs and CO2 emissions, and G is the least energy efficient. Properties are categorised into these seven bands based on their Standard Assessment Procedure (SAP) rating. Such ratings take into account the performance potential of the building itself (the fabric) and its services (such as heating, insulation ventilation and fuels used). More information can be found [here](#).

(b) The Government has consulted on exemptions for particular property types in its policies to date.

3: Firms' climate risk management capabilities

The Bank's assessment is that UK banks and insurers need to do much more to understand and manage their exposure to climate risks. The CBES has shown that UK banks and insurers are making good progress in some aspects of their climate risk management, and this exercise has spurred on their efforts further. But more needs to be done. The findings are consistent with the PRA's assessments in relation to firms' progress against a Supervisory Statement the PRA issued in 2019 ([SS3/19](#)), as set out in the PRA's [Climate Change Adaptation Report 2021](#).^[17]


In order to produce better estimates of climate risks in their portfolios, banks and insurers will need to prioritise investment in their climate risk assessment capabilities, both by focusing on their internal modelling and data capabilities and doing more to scrutinise data and projections supplied by third-parties (upon which participants have relied heavily to compile CBES submissions). The inability to capture appropriate and robust data in certain areas is a common limitation, which means many climate risks are only being partially measured. Examples of gaps include information about the location of corporate assets to permit physical risk assessment, and a lack of standardised information about value chain emissions relating to corporate counterparties.^[18] Banks and insurers will need to prioritise progress on data and will need to put in place interim measures to inform risk management until these data challenges are resolved. The Bank will continue to support co-ordinated initiatives to fill such data gaps (see Section 6).

Without further improvement in their capabilities, banks and insurers will not be able to reflect accurately climate risks in their business decisions (eg on pricing, lending and investment). This is important for their own long-term financial resilience. But it is also important to ensure that banks and insurers can support the economy in the transition to net zero. Absent a more developed approach to risk management, they may resort to actions such as withdrawing lending to carbon-intensive sectors that need finance to support their transition to less carbon-intensive production. This could give rise to wider macroeconomic risks.

The Bank will help the banks and insurers it regulates to use the results of the CBES to improve their climate risk management capabilities, both through individual firm supervisory dialogue, and by sharing and discussing key thematic findings with the banking and insurance industry more broadly (including through the Climate Financial Risk Forum (CFRF)).

3.1: Assessing participants' risk management capabilities

Firms' climate risk management capabilities were assessed based on their CBES qualitative questionnaire responses and their approaches to modelling and quantifying risks in the scenarios

given. This assessment was carried out along four key dimensions consistent with the topics covered in the [Climate Financial Risk Forum \(CFRF\) Guide 2020 Risk Management Chapter](#) . While there is no direct read across to the PRA's expectations in SS3/19, this assessment will help to inform the PRA's views on participants' progress against meeting SS3/19. The four dimensions are:

- **Governance** arrangements
- The **framework** for internal reporting of climate risk
- The way risk **appetite** for climate-related risks is set
- Capability to **assess** climate risks.

Broadly speaking, banks and insurers have made progress implementing arrangements for the governance and stewardship of climate risks, having been able to slot climate risk into existing risk governance practices. Other aspects of climate risk management are less advanced. A particular challenge for firms is the availability of timely and comprehensive data that can be used, alongside expectations of future climate policy, to inform the assessment of climate risk. Box B sets out what banks and insurers would need to be able to do to more fully assess climate risks on their key portfolios, together with examples of good practices seen to date.

3.2: Banks

Banks have made good progress in integrating climate risk into their existing risk governance structures and reporting frameworks.

This includes clearly allocating accountability for climate risk to senior managers, setting up appropriate internal committees to oversee climate risk, and providing climate risk reporting to such committees.^[19] Banks have largely integrated climate risk as a cross-cutting risk within their existing risk frameworks. And they are beginning to embed it into their existing ‘three lines of defence’ models which allocate responsibility and accountability for risks between business lines, risk management, and internal audit. But such frameworks are not as effective as they could be at present because of the challenges firms face in assessing climate risk, which are outlined below.

Banks have also made good progress in identifying their portfolios which may be most sensitive to climate risks, but face challenges in accurately quantifying the level of risk they are exposed to. Their overall ability to model climate risk is at an early stage.

Banks have tended to focus on building their capabilities in the most material aspects of their business – for example, wholesale-focussed banks generally showed greater sophistication in their approach to assessing the impact of climate risks on corporate lending.

Few banks have developed in-house modelling capability, with many reliant on a small number of third parties.

Banks varied in their ability to scrutinise and understand the strengths and weaknesses of third-party models, and adapt them appropriately to the CBES scenario. As set out below, insurers who were able to do this typically projected materially larger losses. Banks will need to decide to what extent they will continue to rely on third parties, or instead build their own models, as they further develop their ability to assess climate risks.

Progress in relation to risk appetite and risk assessment has been significantly hampered by a lack of standardised data of sufficient quality to underpin the measurement, assessment, and modelling of climate-related risks.

The absence of some tools to measure climate risk and the inability to capture appropriate and robust data in certain areas are common limitations, which means many climate risks are only being partially measured. Examples of gaps include information about the location of corporate assets to permit physical risk assessment, which is important in light of global supply chains, and a lack of standardised information about value chain emissions relating to corporate counterparties. Banks also struggled consistently to assign their large corporate customers to industrial sectors, which limits the reliability of even their sectoral assessments of potential losses. And the assessment of physical risks was hampered by a lack of readily available modelling solutions, with few firms assessing risks beyond those from inland floods and tropical cyclones.

While banks invested in enhancing their data collation as part of this exercise, overall, data were incomplete, and banks had to make estimates and assumptions for some of their exposures where data were unavailable or missing. Remediation of data limitations and gaps will help firms meet the PRA's supervisory expectations, as set out in [SS3/19](#). Firms' efforts in this area will be supported by initiatives currently in train to resolve some of these data gaps (see Section 6 for further detail).

Banks' climate loss projections associated with lending to their largest corporate customers were subject to various approximations as a result of the data issues described above. And in some cases these loss projections were then extrapolated to estimate results for a wider set of smaller companies, exacerbating the impact of such weaknesses. Firms' submitted projections may have benefitted from more consistent application of cross-checks or other validations.

Banks' ability to accurately estimate potential losses on their retail lending was hampered by: the absence of up-to-date EPC ratings for much of the UK's housing stock; and the limited availability and sophistication of modelling tools with which to assess non-flood risks at a property level over long horizons. Banks were particularly reliant on third party providers in this area.

As a result of the challenges with assessment discussed above, banks are still in the early stages of developing their climate risk appetite framework. Most firms have a qualitative statement of risk appetite, but few have developed quantitative metrics.

A more developed and nuanced approach to risk management would allow banks and insurers to reflect climate risks more accurately in their business decisions (for example by explicitly incorporating possible future carbon prices and their impact on counterparties in pricing, lending and investment decisions).

Absent these improvements, there is a risk that banks and insurers may resort to actions that do not accurately reflect climate risks, such as abruptly withdrawing finance to those carbon-intensive businesses in need of external finance to support their transition to less carbon-intensive production. This could give rise to wider macroeconomic risks (see Section 5 for further detail).

3.3: Insurers

Insurers have also made good progress in incorporating climate risk into their existing risk governance frameworks.

UK life and general insurers have generally made good progress in embedding climate risk management into their three lines of defence frameworks, though international general insurers' progress is more mixed. Insurers differ in their framework for addressing climate risk – with some treating it as a cross-cutting risk, and others as a separate principal risk.

Many insurers have set target dates for their investment portfolios to be net-zero carbon emitting

(see Box D). And some insurers have begun tracking their current portfolios against these targets using available in-house Environmental, Social and Corporate Governance (ESG) data. Most general insurers have not set qualitative or quantitative risk appetites for their underwriting activities, though some insurers have begun to avoid insuring certain businesses in sectors that are particularly carbon intensive.

Around half of the participating insurers have integrated climate scenarios into the stress and scenario tests included in their Own Risk and Solvency Assessment (ORSA) reports.

Life insurers faced many of the same issues as banks in modelling corporate exposures, and like banks, life insurance firms varied in the overall strength of their approaches to modelling losses on their assets and their ability to validate their results. Although life insurers also relied heavily on third-party modelling, some are now investing in their own in-house capability or alternative tools, to replace or test these models.

Insurers also noted numerous data challenges that they faced in estimating potential losses on their invested assets.

In particular, data on companies' emissions, and their geographical locations and those of their supply chains, was incomplete. Firms used a variety of approaches in modelling these losses, with the trade-off that more sophisticated approaches typically required more input data and more effort to calibrate.

A material proportion of investment assets are in the form of securities issued by other financial institutions and collective investments. In both cases it is difficult to see through to the underlying securities and assess their climate vulnerabilities. Life insurers were generally able to look through to the underlying securities held by these structures, though in some cases they did not.

Models employed by insurers typically struggled to account properly for the impact of corporate leverage on the value of financial assets. For example, many firms used simple, linear models which mapped from projected net income to equity prices, abstracting away from the fact that corporate leverage would likely amplify the impact of changes in income on equity prices. These were likely to understate both positive and negative impacts on equity prices from corporate income shocks, compared to models which do account for leverage.

General insurers' ability to model expected losses from insurance claims is also limited by similar challenges, particularly on the flexibility of third-party models. A large proportion of firms were unable to match the physical risk parameters prescribed in the CBES scenarios in their models.

The ability to assess and model physical risks in the CBES varied across firms, largely reflecting their varying capability to modify existing models.

Insurers were able to model UK inland and coastal flood at a high level of geographical granularity. More sophisticated firms were able to identify the limitations of their chosen third party

models, and made adjustments to address them. They were also able more closely to match the inputs of such models with the prescribed CBES scenarios. Firms that were able to carry out such adjustments and better match the CBES scenarios typically arrived at significantly higher loss estimates. Section 4 includes some estimates for the level of aggregate general insurance losses had these better approaches been adopted across all firms when producing their projections.

Box B: Observed examples of good practice in assessing climate risks

Participants' submissions have shown that UK banks and insurers are making welcome progress in some aspects of their climate risk management, but still need to do much more to understand, and manage, their exposure to climate risks. This box outlines some of the things that banks and insurers would ultimately need to do to fully understand their key climate risk exposures covered by the CBES. Related to that, the box also highlights some specific examples of good practice observed on the part of CBES participants (Table 1). Over time, the Bank expects firms to go beyond the examples of good practice identified here.

Table 1: Capabilities required to fully understand climate risks, and examples of good practice seen in the CBES

Risks to	Capabilities to develop/Observed good practices
Banks – corporate lending	<p>In general, banks with material corporate exposures would need to be able to model the impact of both transition and physical risks on their counterparties, and understand how these may affect counterparties' financial health and hence their ability to repay outstanding loans.</p> <p>Assessment of corporate loan books would be considered at both a sectoral and geographical level. Banks would model sector-geography combinations in different ways, reflecting their specific features. Analysis would also be completed at an individual company level for particularly vulnerable companies, or those they have large exposures to.</p> <p>Example of good practice: Modelling sectors in a differentiated way to reflect sector-specific features, for example relating to particular climate-risk vulnerabilities, as in the oil and gas extraction sector.</p> <p>Banks would need to understand how vulnerable their corporate customers are to transition risk – including to changes in carbon prices, as well as other potential policy or regulatory action. When modelling the impact of transition policies on the</p>

Risks to	Capabilities to develop/Observed good practices
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financial performance of a counterparty, banks would ideally account for several factors, including: (i) the capital investment required to transition and (ii) whether demand would accommodate any changes in the price of their products.

Example of good practice: Considering wider market dynamics, including price elasticities of demand and so the extent to which increases in production costs (eg from increases in carbon prices) could be passed on to consumers. This informed analysis of the likely consequences for revenues and profits.

Banks would need to understand what companies can and have done to mitigate the climate risks they face, including the credibility of their transition plans. Banks may need to assemble both publicly available data and private data directly from their counterparties in order to reach robust conclusions.

Example of good practice: engaging in thorough outreach with counterparties to assess their climate vulnerability and the feasibility of their adaptation plans – eg through pre-populated surveys sent to key counterparties. Better approaches included expert credit reviews of modelled results, and applying conservative overrides when modelled results were inconsistent with expectations for individual counterparties.

Banks would need to understand how vulnerable their counterparties are to a wide range of physical risks, through a variety of channels. To do this robustly, they would need to consider both average and severe (or 'tail-risk') weather events.

Example of good practice: calculating potential damages by counterparty arising from a wide range of acute and chronic physical risks, as well as wider factors such as changes in labour productivity and costs, and potential operational disruptions in the wider market. Better approaches also took into account wider market dynamics (eg the impact on competitor companies).

Banks would need to be able to classify which sectors their customers are operating in, and are dependent upon. And for larger customers, banks would ideally understand both the location of their operations, as well as those of their distribution and supply chains, in order to assess how physical risks might ultimately affect them. They would also need to understand the extent to which their customers have insurance, or other measures, in place to protect them from physical risks, and consider the level of climate vulnerability of specific assets which have been used as collateral against loans.

Example of good practice: Assessing potential counterparty vulnerabilities using both bottom-up approaches, based on individual counterparty assessments, and top-down ones, based on sector-country assessments.

Risks to	Capabilities to develop/Observed good practices
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**Banks –
household
lending**

Banks with significant household lending would need to understand how retail lending may become more vulnerable in various climate scenarios. To achieve this, they would need to consider numerous channels by which transition or physical risk could affect households – for example, if they affect households' disposable income and so their capacity to repay loans, or if they affect the value of collateral held against lending (most notably, residential housing). They would need to consider this both at a macro level (eg impacts from unemployment and house prices) as well as on a granular level (eg across both geographies and borrower characteristics).

Household transition risk primarily emanates from the costs associated with improving the energy efficiency of the housing stock and its interaction with rising energy prices on consumers. Banks would need to understand the costs to households of retro-fitting required to meet proposed efficiency standards, and the consequences for property prices and borrowers' ability to afford loan repayments.

Examples of good practice:

- **Considering and modelling as appropriate transition risk impacts on property prices and borrower income. This included considering the impact on property values and loan affordability arising from the interaction between energy efficiency improvements on the one hand, and potential increases in energy prices on the other.**
- **Addressing gaps in data on properties' EPC ratings by using information from other comparable properties to reach informed judgements on estimated EPC ratings (eg by comparing properties by the date they were built and their building type).**

Banks would need to be able to model the financial impact to their retail book from a wide range of both acute and chronic physical risks. Banks would consider the primary impacts of such risks on property prices, as well as possible secondary impacts, including those stemming from higher insurance premiums or remediation costs on households' disposable income. Banks would be able to review and revise their estimates of physical risk vulnerability on an on-going basis: for example, property valuations should be routinely re-assessed after a physical climate risk event. They would also factor into their modelling adaptation and mitigation strategies, such as flood defences (at both regional and property-level).

Examples of good practice:

- **Capturing the impact of physical risks at a high level of granularity – for example, by using flood scores to reflect the likelihood and severity of different types of flood risk events for mortgages at an individual property level.**
- **Considering how a variety of risk factors, including the availability and**

Risks to	Capabilities to develop/Observed good practices
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cost of insurance, and the impact on house prices of physical risk events, impacted both the probability of default and potential losses in the event of default.

- Clear plans for the development of their physical risk modelling, including developing internal research capabilities and models to account for physical climate risks, reviewing scientific and academic research, and challenging third party modelling.

Insurers – investment portfolios Insurers would need to be able to project how the value of their bonds, equity holdings and other assets change in response to transition or physical risk. When modelling at an individual counterparty-level, the first step is to project the financial performance of the company. Insurers would then need to supplement this by modelling the response of market prices and/or credit ratings to company financials.

Examples of good practice:

- Using bespoke modelling approaches for sectors with specific climate vulnerabilities such as power, oil and gas, and transport. This allowed firms to capture the interaction between public policy, demand elasticity and capital expenditure to fund transition or adaptation. Better approaches made explicit the assumptions embedded in these models, for example, assumptions on evolving energy mix in the electricity generation sector.
- For large holdings: explicitly linking bond and equity valuation on the same counterparty, or including a reconciliation to check the consistency of results.
- For less material holdings: comparing and contrasting the two alternative approaches that firms used: either extrapolating results from larger counterparties who were modelled in more detail, or using sectoral approaches based on the gross value added (GVA) paths provided as part of the CBES scenarios.
- Adjusting pricing models to account for the fact that expected future changes in physical or transition risks may affect market prices in the near-term, not just when they eventually materialise.

Risks to	Capabilities to develop/Observed good practices
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Insurers - liabilities	<p>Insurers would need to be able to assess losses arising from a wide range of physical perils under future climate conditions. They would need to develop new tools, or increase their ability to identify and address the limitations of existing third party models, and be better able to adapt them in order to flexibly incorporate a range of physical risk variables. They would also need to develop research capabilities to better inform their physical risk modelling.</p> <p>Examples of good practice:</p> <ul style="list-style-type: none"> • Modelling a wide range of physical perils, beyond those of the most readily available catastrophe models. Using a range of tools in order to better incorporate and expand the physical risk variables provided in the scenario, and providing justification for instances where values used materially deviated from those that the Bank provided. • Identifying limitations of the third party models used, and making adjustments to address these limitations. Specific examples include allowing for UK west coast storm surge losses, and explicitly considering the impact of flood defences. In addition, considering additional factors that could amplify the modelled losses, such as litigation, social inflation and loss adjustment expenses. • Reviewing academic research to inform physical risk modelling by: improving abilities to challenge and adjust third party models; and developing in-house approaches for perils or territories where a third party model was unavailable. Demonstrating validation and review of results, including by comparing such results to alternative internal models, or the outcomes from scientific research and publications. • Demonstrating validation and review of results by comparing them to alternative models, and through engagement with internal and external specialists, and developing a clear plan of how to address gaps that they identified in their physical risk modelling process. Undertaking explicit sensitivity analysis in order to consider a range a possible outcomes.
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4: Firms' exposure to climate-related risks

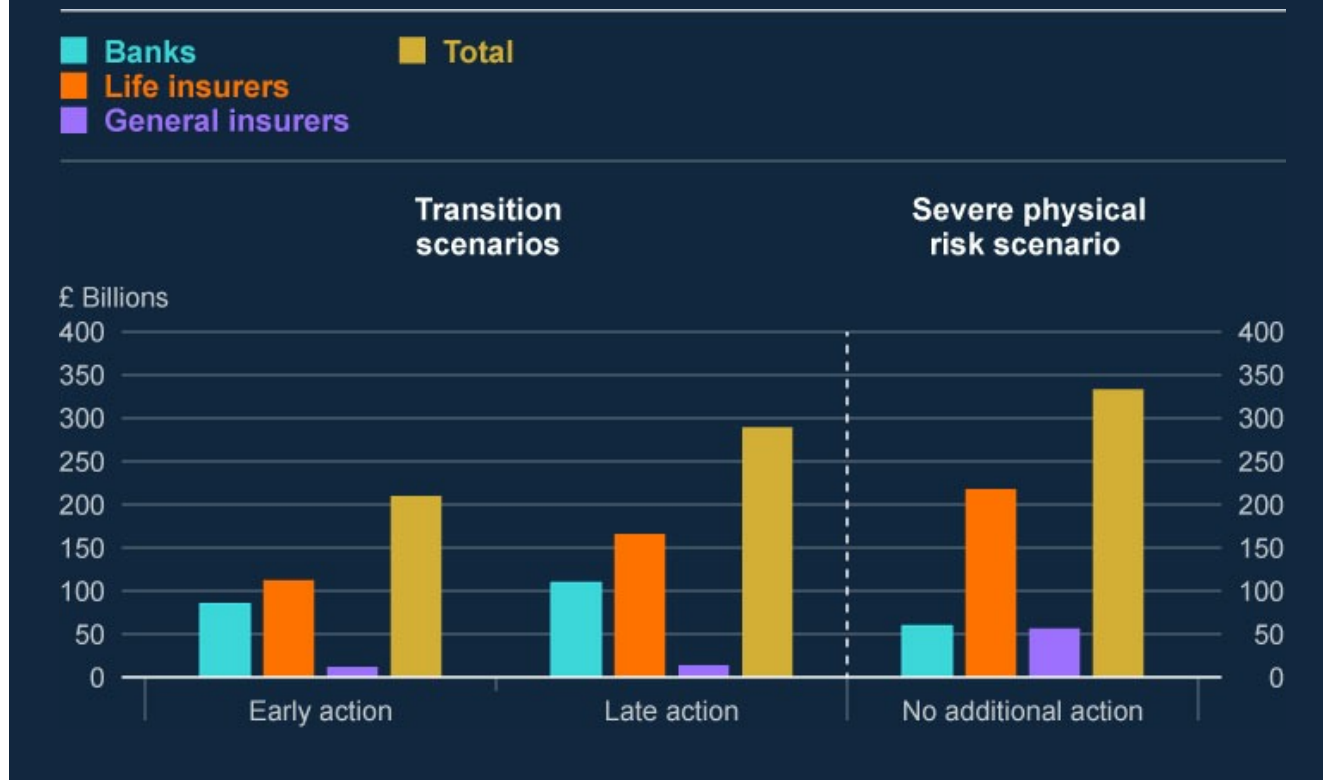
The loss estimates presented here are based on the simplifying assumption that banks' and insurers' balance sheets stay fixed over the scenario horizon, remaining as they stood at end-2020.^[20] In reality, banks' and insurers' business models are likely to respond to climate risks over time (See Section 5). These responses may act to mitigate some of the losses projected.

Based on banks' and insurers' projections in this exercise, the overall costs to these firms from the transition to net zero should be bearable without substantial impacts on firms' solvency positions, for example through a combination of lower retained earnings and increases in margins on lending to higher risk sectors, and also because not all of the losses on insurers' investments would ultimately fall on shareholders. Firms' projections suggest that these costs will be lower if early, well-ordered action is taken (Chart 4.1).

Projected loss rates from individual banks and insurers spanned a wide range. This suggests significant uncertainty around the true magnitude of these risks, reflecting the fact that participants' climate risk assessment techniques are still developing, as well as the wide range of approaches taken by participants. The significant degree of uncertainty is corroborated by sensitivity analysis conducted by the Bank.

Chart 4.1: Climate-related losses are larger in the late action and no additional action scenarios

Additional cumulative climate losses over scenario (a) (b)



Sources: Participating firms' submissions and Bank calculations.

(a) Incremental additional losses compared with losses that would be expected to occur in a hypothetical counterfactual scenario in which there are no additional headwinds from climate risks.

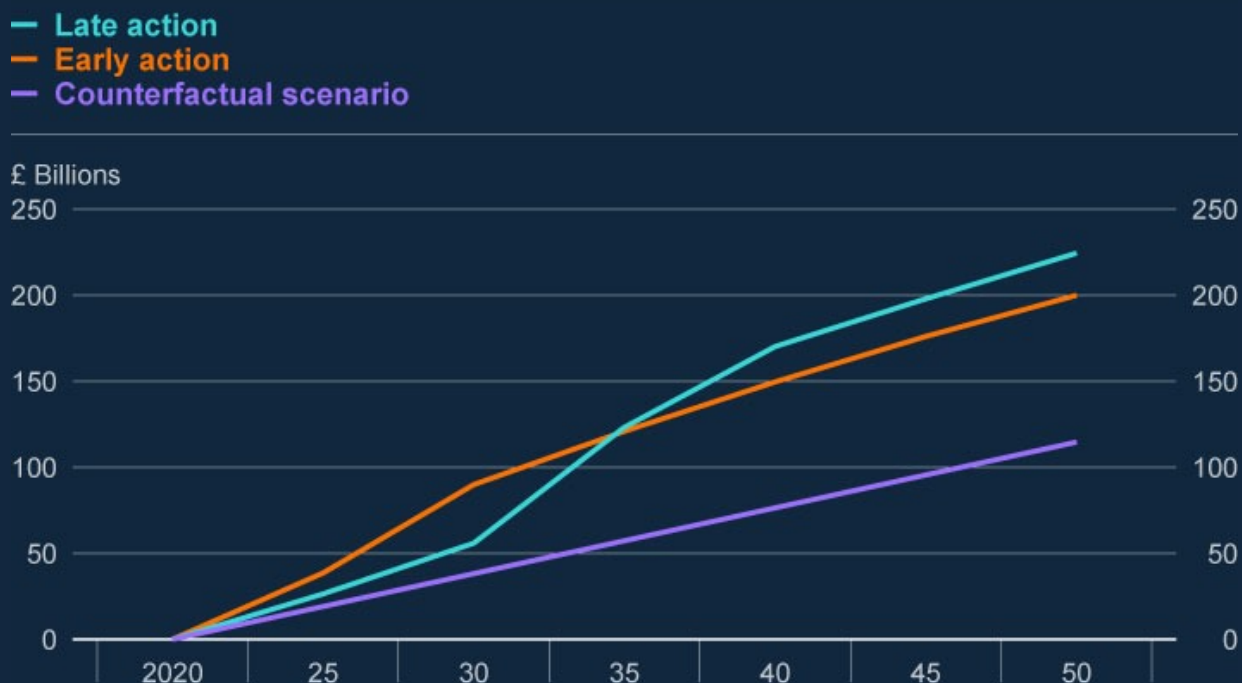
(b) For banks, chart shows cumulative 30-year impairment losses on bank lending. For life insurers it shows additional investment losses at year 30. For general insurers it shows additional investment losses at year 30, plus the cumulative increase in average annual loss over 30 years relative to year zero.

4.1: Impact on Banks

For banks, projections were focused on realised credit losses only. Loss rates are projected to rise appreciably in all three scenarios. Projected bank credit losses were greatest in the Late Action scenario, with loss rates more than doubling as a result of climate risks. That is equivalent to an extra c.£110 billion of losses over the period, of which around 40% is realised during the first five years of transition (Chart 4.2).

Chart 4.2: Projected bank losses were highest in the late action scenario

Banks' total losses in the transition scenarios versus expected losses in hypothetical counterfactual scenario (a) (b)



Sources: Participating firms' submissions and Bank calculations.

(a) Cumulative impairment losses on bank lending.

(b) Estimated counterfactual losses are based on a hypothetical scenario in which there are no additional headwinds from climate risks. Bank staff estimates based on firm submissions and Bank calculations.

Projected climate risk impacts were highest for banks' wholesale and mortgage exposures (Chart 4.3).

The drivers of these losses differ across scenarios. Corporate losses increase substantially as a result of the impact of higher carbon prices in both of the transition scenarios. By contrast, mortgage losses are relatively muted in the early action scenario, but increase substantially in the late action scenario as a result of rising unemployment together with falling house prices and the general macroeconomic downturn.

In contrast to the two transition scenarios, the climate-related impacts associated with the NAA scenario are expected to persist beyond the scenario horizon, and worsen beyond the 30-year timeframe analysed by the CBES, incurring substantial and permanent human and economic costs. Within the scenario horizon, projected impairments rates for banks are just over 50% higher as a result of climate risks, but banks' confidence around these estimates is particularly low.

In the NAA scenario, projected corporate losses were substantially lower than in the transition scenarios. In part, this may reflect the fact that insurance is assumed to mitigate the impact on corporate counterparties from physical perils. But there is evidence that banks were less well equipped to assess thoroughly the impact of physical risks prominent in this scenario. Staff analysis suggests that correcting for some of the gaps in firms' modelling could imply corporate impairment rates 40% higher than those submitted, which would bring aggregate losses in the NAA scenario to around the same level as in the LA scenario. Higher mortgage losses in the NAA scenario are driven in large part by an intensification of flood risks, the effects of which are described in more detail below.

Chart 4.3: Climate impacts are highest for banks' wholesale and mortgage portfolios

Banks' climate losses as a proportion of counterfactual losses (a) (b)



Sources: Participating firms' submissions and Bank calculations.

(a) Cumulative impairment losses on bank lending relative to estimated counterfactual losses based on a hypothetical scenario in which there are no additional headwinds from climate risks.

(b) The No Additional Action 'illustrative adjustment' is a Bank staff adjustment to participants' submitted projections. It accounts for gaps in the modelling of losses in this scenario acknowledged by participants.

4.1.1: Impact on corporate exposures

At a corporate sectoral level, the industries with the highest projected bank loss rates in the two

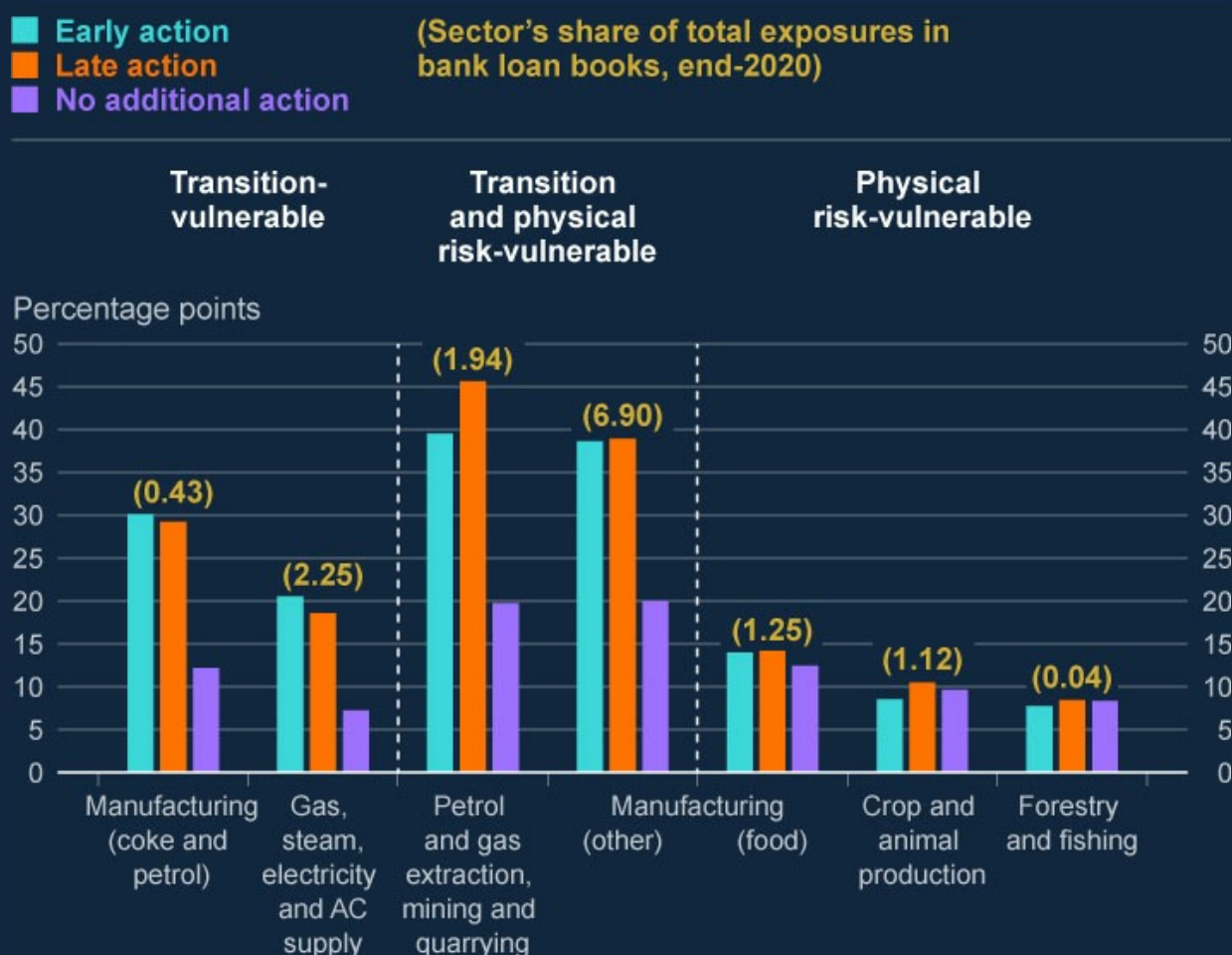
transition scenarios were mining (including extraction of petroleum and natural gas); manufacturing; transport; and wholesale & retail trade (Chart 4.4). On average these sectors were projected by banks to have cumulative impairment rates of 35%, more than twice the aggregate projected impairment rate on corporate portfolios. Insurers projected material losses on corporate bonds and equities in similar sectors, with assets in the mining of gas and oil sector suffering by far the largest losses. These sectoral results were in line with expectations, given the carbon intensity of these industries' supply chains.

Unsurprisingly, some of the most carbon-intensive industrial sectors, and those most exposed to physical risks, account for a disproportionate share of projected corporate credit losses.

The sectors most affected by transition risks account for around a third of banks' total provisions in the transition scenarios, despite these sectors only accounting for around 14% of banks' total corporate exposures. Though overall the losses across corporate sectors are similar in these two scenarios, they are significantly more concentrated in time in the late action scenario, and would therefore present a greater potential risk to banks' profitability and capital positions. Around a quarter of provisions in the NAA scenario are accounted for by the sectors which are most exposed to physical risks, including manufacturing, crop and animal production, and forestry and fishing.

Chart 4.4: Climate-vulnerable sectors account for a large proportion of total losses on bank lending

Percentage point changes in impairment rates for bank lending to more climate-vulnerable sectors
(a)



Sources: Participating firms' submissions and Bank calculations.

(a) Cumulative thirty year impairment rate on bank lending to selected sectors over the CBES scenarios, minus year 0 impairment rate. Sectors shown here are those whose contribution to Gross Value Added (GVA) falls significantly in the CBES scenarios. Impairments include both those that might have been expected in a hypothetical counterfactual scenario in which climate risks did not worsen further, and those related to climate risks materialising in the CBES scenario.

Large corporate impairment rates also differed across jurisdictions. Projected impairment rates were higher in the US than in the UK or in Hong Kong and China. This pattern is driven by the larger share of transition vulnerable sectors in US corporate lending portfolios, and by the country's material susceptibility to increasing physical risks in the NAA scenario (as discussed in section 4.2 below). By contrast, the UK is relatively less susceptible to physical risks in the NAA scenario. And lower impairments in Hong Kong and China in the NAA scenario are in part a

reflection of the fact that banks' exposures in these regions are concentrated in industrial sectors which are less vulnerable to physical risk. In general, for the NAA scenario, most banks assumed that part of the impact of greater physical risk on their corporate borrowers would be mitigated by insurance.

Projected total corporate loss rates from individual banks spanned a wide range, with the highest estimates typically being around twice as large as the lowest across scenarios.

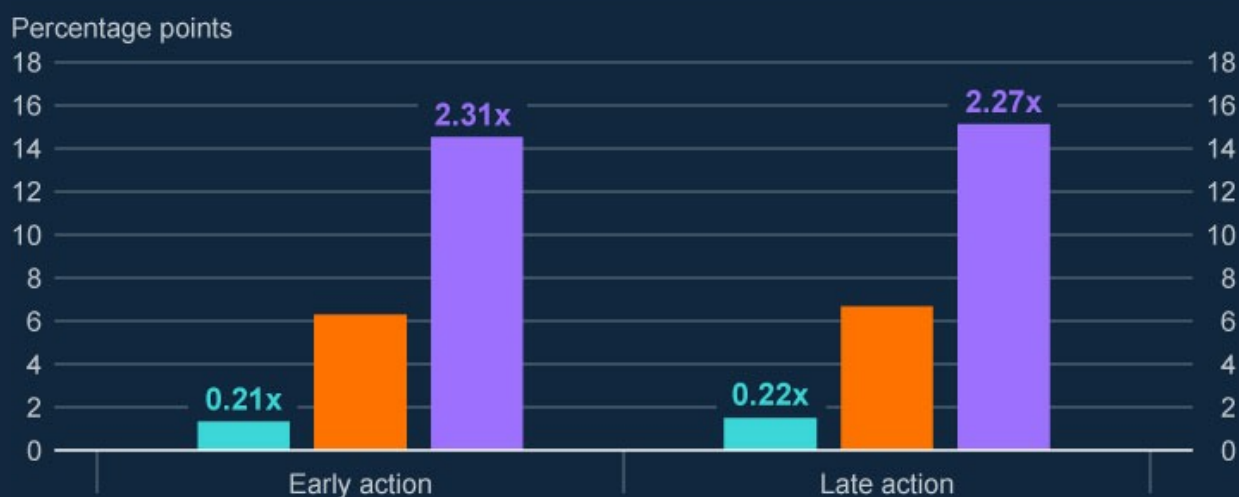
This suggests significant uncertainty around the true magnitude of these risks, reflecting the fact that participants' climate risk assessment techniques are still developing. To encourage participants to improve their thinking in this area and build their capability, the Bank deliberately set the exercise up in a way that enabled participants to take a range of approaches.

Around one fifth of participating banks' most significant corporate exposures are to counterparties which another participating bank also had a lending exposure to. Banks projected substantially different loss rates on such shared counterparties. The differences in individual firms' views of losses for the same counterparties were driven in part by differences in their views on how successfully these counterparties would be able to implement their transition plans, and differences in the nature of their exposures (eg around the type of loan). As an illustration, Chart 4.5 below shows how much higher or lower shared counterparty corporate losses would be in each scenario if the maximum and minimum loss rates projected by individual banks for specific counterparties were applied to all banks with that counterparty. These differences may narrow over time as banks apply the lessons learnt from the CBES exercise, and their ability to assess climate risks improves.

Chart 4.5: Projected losses on shared counterparties spanned a wide range

Change in impairment rate on banks' lending to shared corporate counterparties (a)

■ Minimum ■ Average ■ Maximum



Sources: Participating firms' submissions, Bank analysis and calculations.

(a) Minimum and maximum bars constructed by applying respectively the minimum and maximum loss rates across firms' submissions for each counterparty to all firms' exposures to that counterparty.

4.1.2: Impact on retail lending

Mortgage losses are significantly higher in the LA scenario than in the EA scenario. That is a result of the sharp macroeconomic downturn in the LA scenario, which leads to higher unemployment and a general fall in UK house prices. In both of the transition scenarios, households are assumed to bear the cost of improving the energy efficiency of homes, whether they borrow further from banks to do so or not (see Box A on assumed standards). This extra household liability affects the ability of some borrowers to afford mortgage repayments. Staff estimate that the aggregate costs of such energy efficiency improvements for participating firms' UK mortgage customers may be around £75 billion.^[21] And impairment rates are particularly high for properties whose potential energy efficiency (EPC) ratings are in the lowest two brackets (F and G), as banks assume these properties become unmarketable. That said, such properties represent only a small fraction of banks' total mortgage portfolios (<1%). Figure 4.6 shows how projected mortgage impairment rates differ across EPC ratings, and are highest for properties with the lowest potential energy efficiency ratings.


Figure 4.6: Impairment rates were much higher for properties with the lowest potential EPC ratings

Aggregate impairment rates by current and estimated EPC ratings (EA) (a) (b)

Potential EPC rating	Current EPC rating		
	A–C	D and E	F and G
A–C	1.4%	1.4%	1.9%
D and E		1.1%	1.6%
F and G			35.8%

Sources: Participating firms' submissions and Bank calculations.

(a) Cumulative 30-year impairment rate on banks mortgage lending in the Early Action scenario. Impairments include both those that might have been expected in a hypothetical counterfactual scenario in which climate risks did not worsen further, and those related to climate risks materialising in the CBES scenario.

(b) Domestic Energy Performance Certificates (EPCs) are banded from 'A' to 'G', where 'A' is the most energy efficient in terms of likely fuel costs and CO₂ emissions, and G is the least energy efficient. Properties are categorised into these seven bands based on their Standard Assessment Procedure (SAP) rating. Such ratings take into account the performance potential of the building itself (the fabric) and its services (such as heating, insulation ventilation and fuels used). More information can be found [here](#) .

Mortgage losses are highest in the NAA scenario, and these losses are geographically concentrated.

UK mortgage impairments are concentrated in areas predicted to be most heavily impacted by flooding, with nearly half of all projected mortgage losses arising from just one tenth of postcode districts. The areas banks identified as likely to be responsible for the greatest credit losses in the NAA scenario were broadly similar, but not identical to those identified by insurers as most likely to flood. The discrepancy may in part be due to banks assuming that a large proportion of properties remain insured, reducing the direct impact of flooding on bank losses. The insurance coverage assumption underlying these projections is that coverage would fall from 95% to 90% by the end of the NAA scenario, in line with the Bank's guidance. In all scenarios, Flood Re is assumed to end in 2039 as per current legislation (See Box A). And this causes a sharp uptick in provisions in the NAA scenario, as banks assume some properties facing high levels of flood risk become uninsurable.

There was considerable variation in banks' approaches and modelling assumptions for the impact of physical risk on mortgage impairments. In particular, some banks did not consider physical risks beyond flooding, such as coastal erosion or subsidence.

| Projected climate-related consumer credit losses were relatively low.

Such losses occur primarily as a result of contagion from higher mortgage and other costs in the scenarios, as well as – for the late action scenario – increases in unemployment. The assumption that firms' balance sheets are fixed over the CBES scenario horizons serves to depress estimated losses later in the scenario as higher risk borrowers default earlier on, and so because this lending is not replaced, the average quality of the remaining pool of borrowers increases. This effect is particularly pronounced for consumer credit, which has a higher baseline default rate than other types of lending.

4.2: Impact on Insurers

The aggregate results show that, for life and general insurers, the NAA scenario would be likely to have a more significant impact than either of the transition scenarios, even within the 30-year window of the exercise. For life insurers, this was because forward-looking asset price impacts are greatest at the end of that scenario, with an overall impact worth just over 15% of total market value. Such falls in asset prices would of course affect all holders of assets and participants in such markets. For general insurers, the key way that losses materialised was via a build-up in physical risks, which resulted in higher claims for perils such as flood and wind related damage. UK and international general insurers, respectively, projected a rise in average annualised losses of around 50% and 70% by the end of the NAA scenario. Staff analysis on UK insurance losses suggests increases could be as much as four times higher than firms submitted. Insurers reported that the impact of these increased domestic and international insurance claims would fall, ultimately, on households and businesses through higher insurance premiums or through lower availability of insurance cover.

This exercise also highlighted data gaps and potential risks to international general insurers from climate-related litigation (see Box C), which could impact the cost and availability of Directors' & Officers' liability insurance cover.

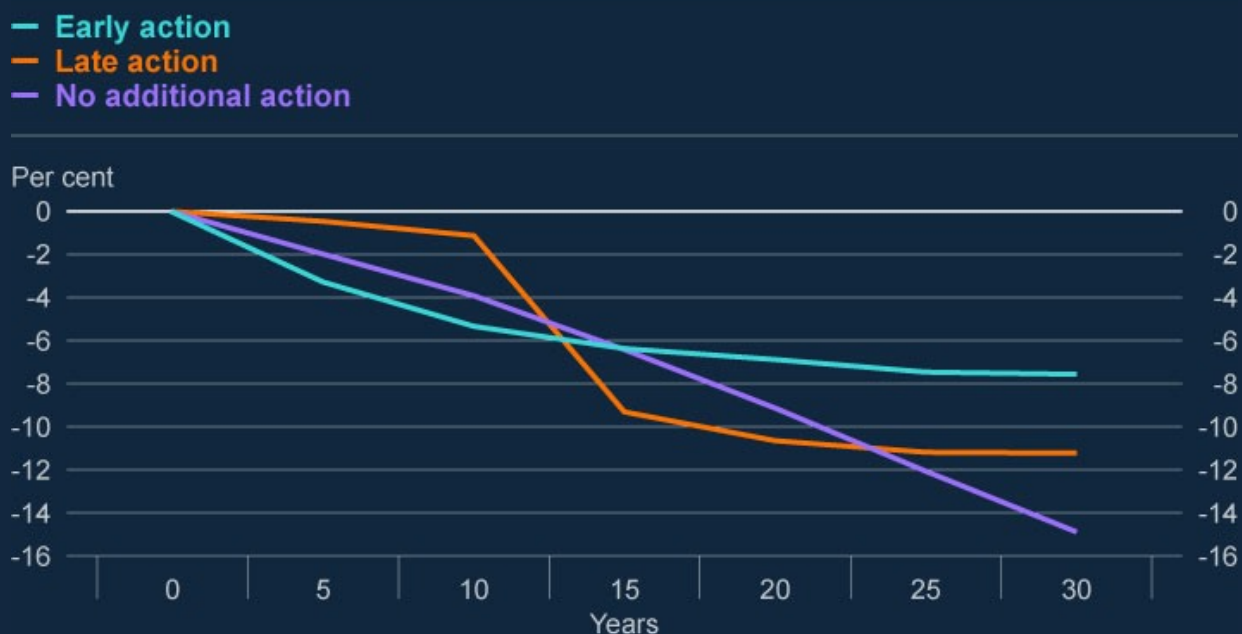
4.2.1: Impact on insurers' assets

| Losses on insurers' investment assets were largest in the No Additional Action scenario.

Insurers' asset values fall by 15% in the NAA scenario, compared with 8% and 11% in the early and late action scenarios, respectively (Chart 4.7). The two key drivers of these investment losses are falls in the value of equity holdings, and increases in credit downgrades and defaults in life insurers' corporate bond portfolios. There is also a fall in bond prices consistent with specified changes in the yield curve. Investment losses are initially highest for the early action scenario, where the impact of transition policies on corporate profits begins to be felt sooner than in the late action scenario. Financial markets are assumed not to be able to anticipate the impact of policy changes in the late action scenario before they occur.

Chart 4.7: Projected investment losses are largest in the NAA scenario

Change in Market Value of insurers' invested assets (a)



Sources: Participating firms' submissions and Bank calculations.

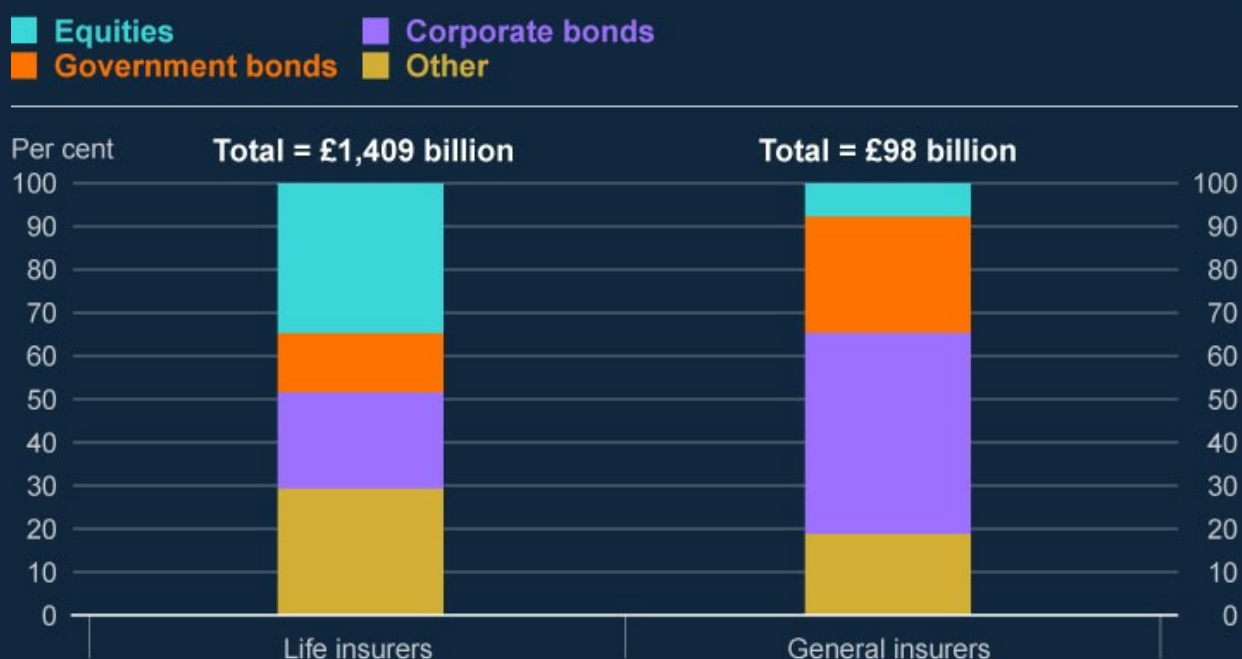
(a) Change in aggregate market value for both life and general insurers' invested assets over the CBES scenarios, relative to a hypothetical counterfactual scenario in which there are no additional headwinds from climate risks.

Life insurers account for the majority of projected investment losses.

Life insurers portfolios account for the majority of total invested assets across participating insurers, and their investments are typically weighted more towards equities and longer duration bonds, which experience greater falls in value (Chart 4.8).

Chart 4.8: Life insurers account for the vast majority of total invested assets

Invested assets by insurer type (a)



Sources: Participating firms' submissions and Bank calculations.

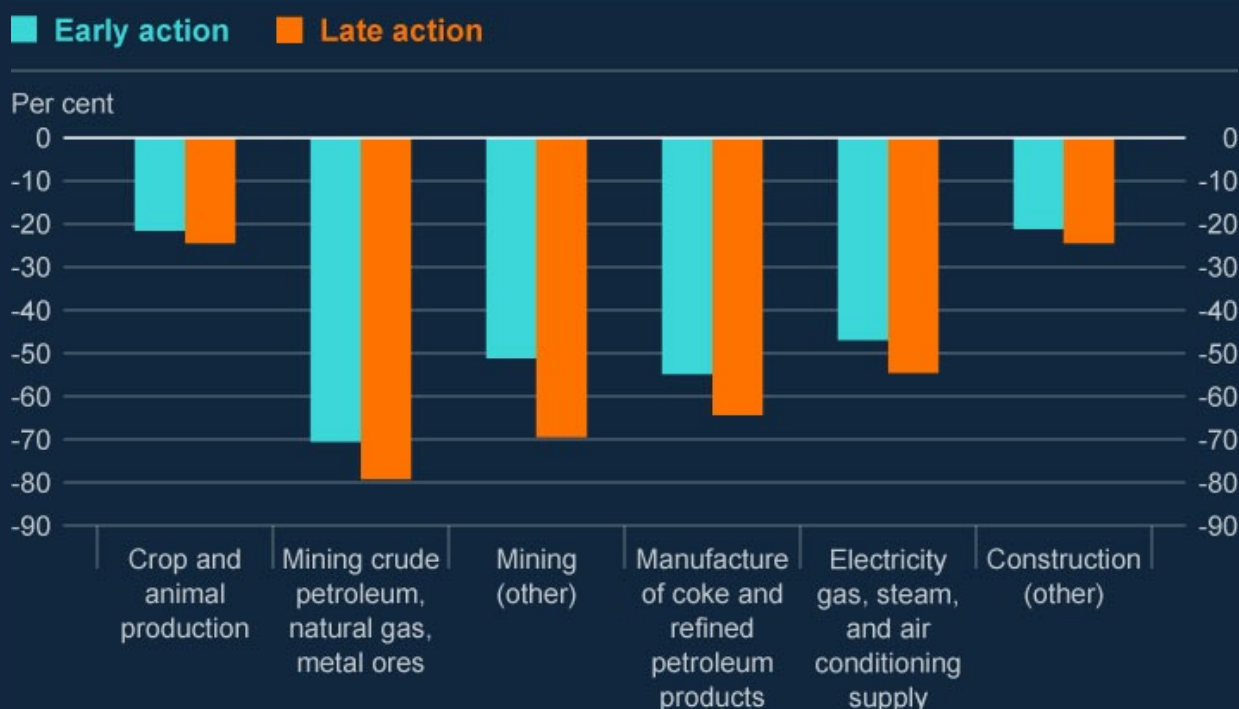
(a) Other assets include property, derivatives, and other bonds.

Insurers and banks identify similar corporate sectors as being most at risk to transition and physical risks.

In the transition scenarios, insurers' losses were particularly concentrated in some more carbon-intensive industries such as the mining and manufacture of petroleum, and electricity supply (Chart 4.9). In the NAA scenario, losses were highest for the forestry & fishing and food manufacturing sectors, which are particularly exposed to higher physical risks.

Chart 4.9: Losses are concentrated in some more carbon-intensive sectors

Insurers' equity investment losses at Year 30 (a)



Sources: Participating firms' submissions and Bank calculations.

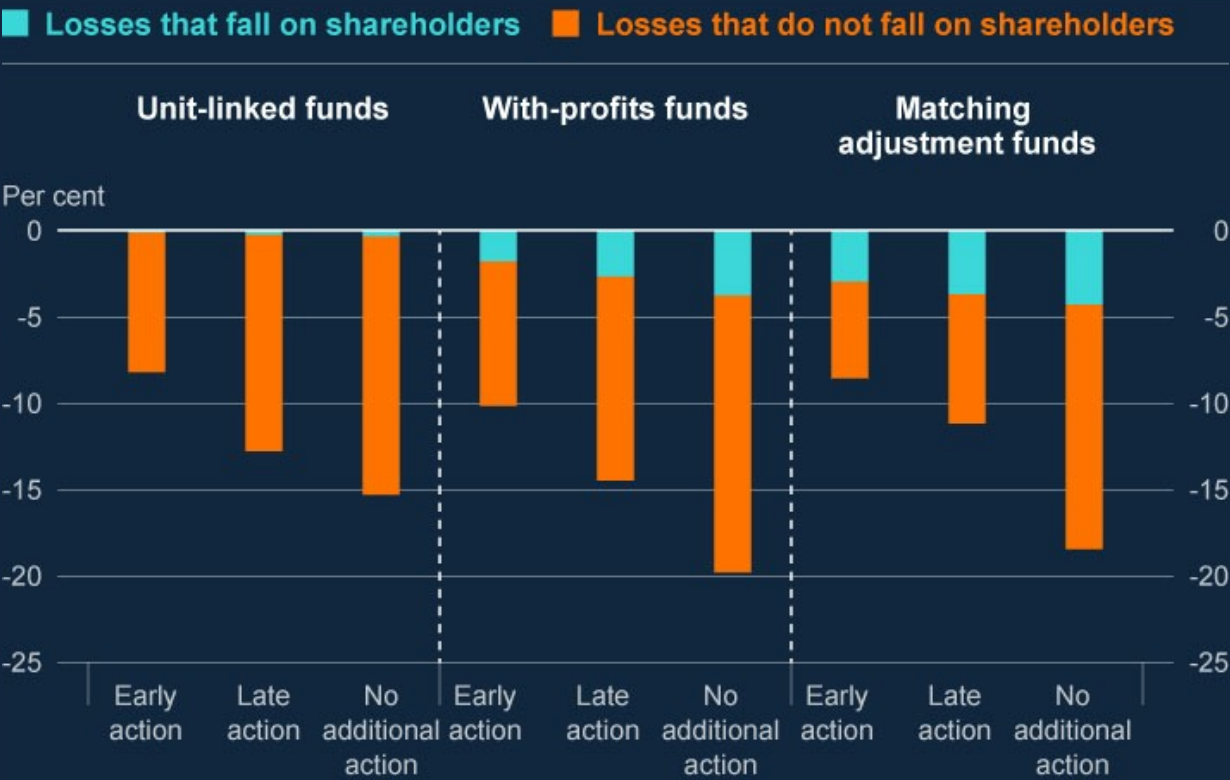
(a) Chart shows sectors for which equity losses are highest in the early and late action scenarios.

Not all investment losses fall on shareholder funds, and as a result the impact on insurers' solvency positions is likely to be manageable

The share of losses that is passed through to policyholders differs by insurance product – for example, in unit-linked funds, the policyholder bears most of the investment risk, and 'with profits' funds have a risk-sharing feature. In addition, annuity funds use a regulatory mechanism called matching adjustment (MA). The MA acts to absorb losses caused by a rise in spreads on the backing assets, increasing the importance of this measure on the regulatory balance sheet (Chart 4.10). In aggregate in the NAA scenario, around 90% of the £200 billion total of life insurers' investment losses (worth 15% of their total market value) is passed through to policyholders or absorbed by other features of the balance sheet. These figures are indicative of the likely scale of losses which could be borne by other investors.

Chart 4.10: Only a small fraction of life insurers’ total investment losses fall on shareholders

Proportion of life insurers' investment losses that fall on shareholders (a) (b)



Sources: Participating firms' submissions and Bank calculations.

(a) Chart shows estimated fraction of losses which fall on insurers' shareholders for three types of insurance funds. In unit-linked funds the policyholder generally bears the risks associated with the underlying investments. With-profit funds are a type of 'pooled investment' fund. The risk from changes in the underlying investments is shared between policyholders, with support from shareholder funds.

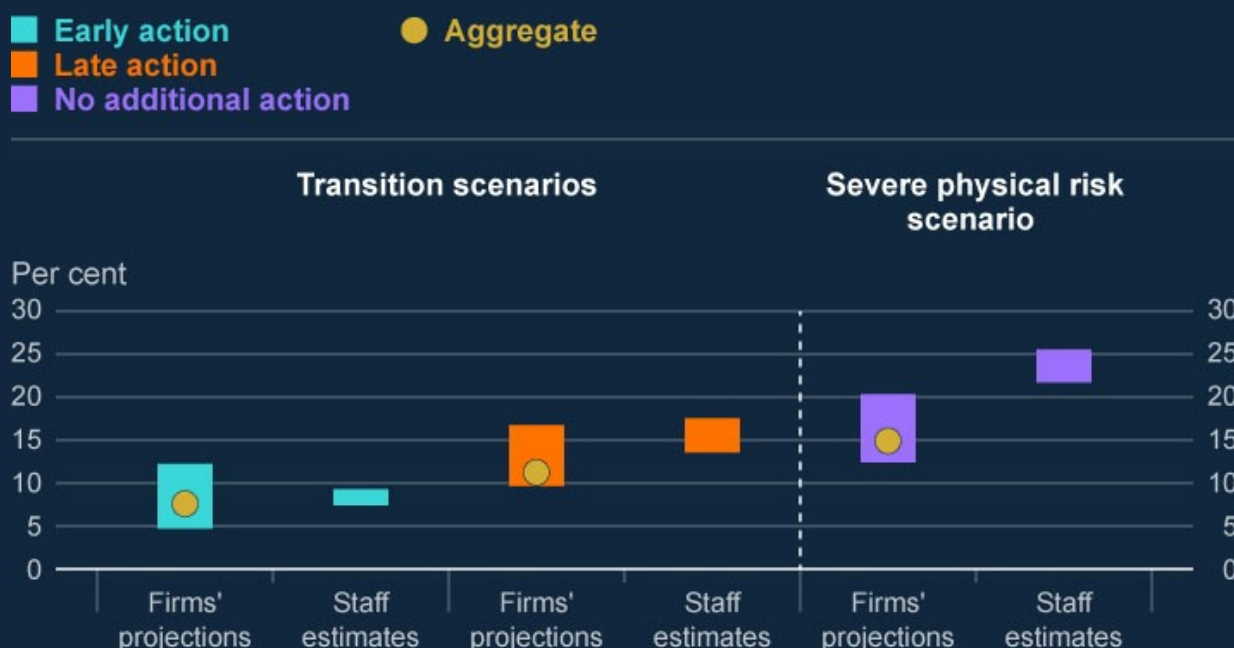
(b) The matching adjustment recognises that insurers who match certain long-term liabilities, such as annuities, with assets that they can hold to maturity, are not materially exposed to the risk of having to realise those assets in unfavourable market conditions. It permits those insurers to discount their liability cash flows at a higher rate than the basic risk-free rate, resulting in a lower liability value. Consequently, the matching adjustment is a mechanism to allow insurers to recognise upfront, as loss-absorbing capital resources, a proportion of the spread they hope to earn over the lifetime of their investments.

| Insurers' projected losses spanned a wide range, in common with those of banks.

Chart 4.11 below shows the aggregate projected loss in each scenario, together with the range submitted by individual firms. Staff analysis suggests that losses could be around 50% higher than submitted in the LA and NAA scenarios. This analysis uses a common methodology for estimating losses across firms, which suggests that differences in firms' asset mix and the sectoral split of their exposures can account for some, but not all, of the differences in firms' projections.

Chart 4.11: Life insurers' submitted losses spanned a wide range

Submitted and estimated investment loss ranges for life insurers in each scenario (a) (b)



Sources: Participating firms' submissions, Bank analysis and calculations.

(a) Firms' projections: the range of submitted investment losses across individual life insurers.

(b) Staff estimates: the range of estimated investment losses across individual life insurers based on applying a common methodology to all firms, accounting for differences in asset types and the sectoral mix of exposures.

4.2.2: Impact on general insurers' liabilities

Insurers projected a rise in average annualised losses of around 50% on UK exposures, and 70% on US exposures, by the end of the NAA scenario, although staff analysis suggests these losses could be significantly higher.

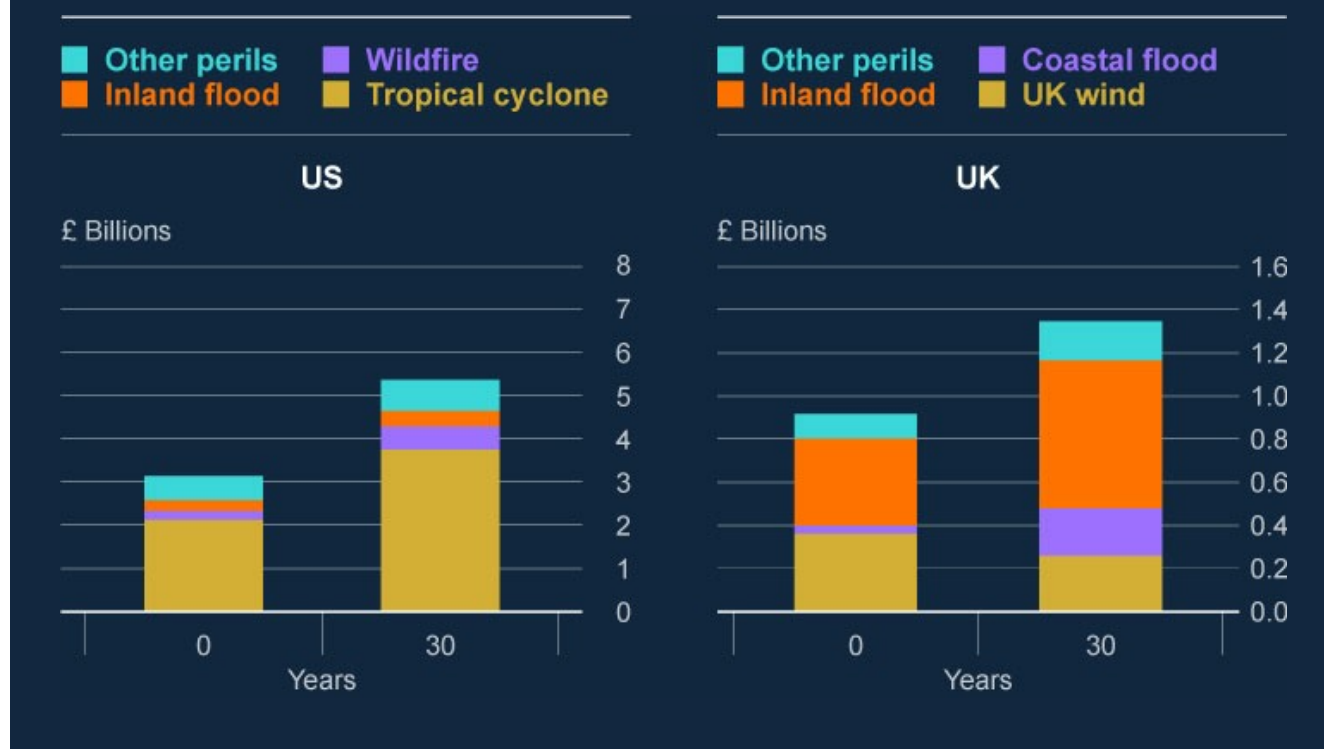
Insurers reported that the impact of these increased domestic and international insurance claims would fall, ultimately, on households and businesses through higher insurance premiums or through lower availability of insurance cover (see Section 5).

The physical risks driving increased losses differ across countries. In the United States, the expected intensification of tropical cyclones is the largest contributor to increased losses (Chart 4.12). For UK exposures, most of the increase in projected average annual losses come from the heightened risks of inland and coastal flooding. Almost half of participating insurers' gross written premium (the total amount their customers pay for insurance coverage) comes from US markets, and nearly a third from UK ones.

Firms focused their analysis primarily on the perils and territories that are currently most material. Where firms did assess a wider range of perils and territories, their estimates indicated that some perils could become significantly more material in the future. In the United States for example, wildfire losses experience the greatest percentage increase over the scenario horizon. These results show the potential benefit to firms' of monitoring exposures to perils and territories where physical risk could become more material under future conditions.

Chart 4.12: The largest increases in projected insurance losses are a result of the intensification of tropical cyclones in the US, and flooding in the UK

Average annual losses on liabilities in the NAA scenario. Left: US. Right: UK (a)



Sources: Participating firms' submissions and Bank calculations.

(a) Chart shows most material three perils in terms of their impact on US and UK general insurance losses. 'Other Perils' includes winterstorms and severe convective storms (US); freeze-thaw weathering and subsidence (UK).

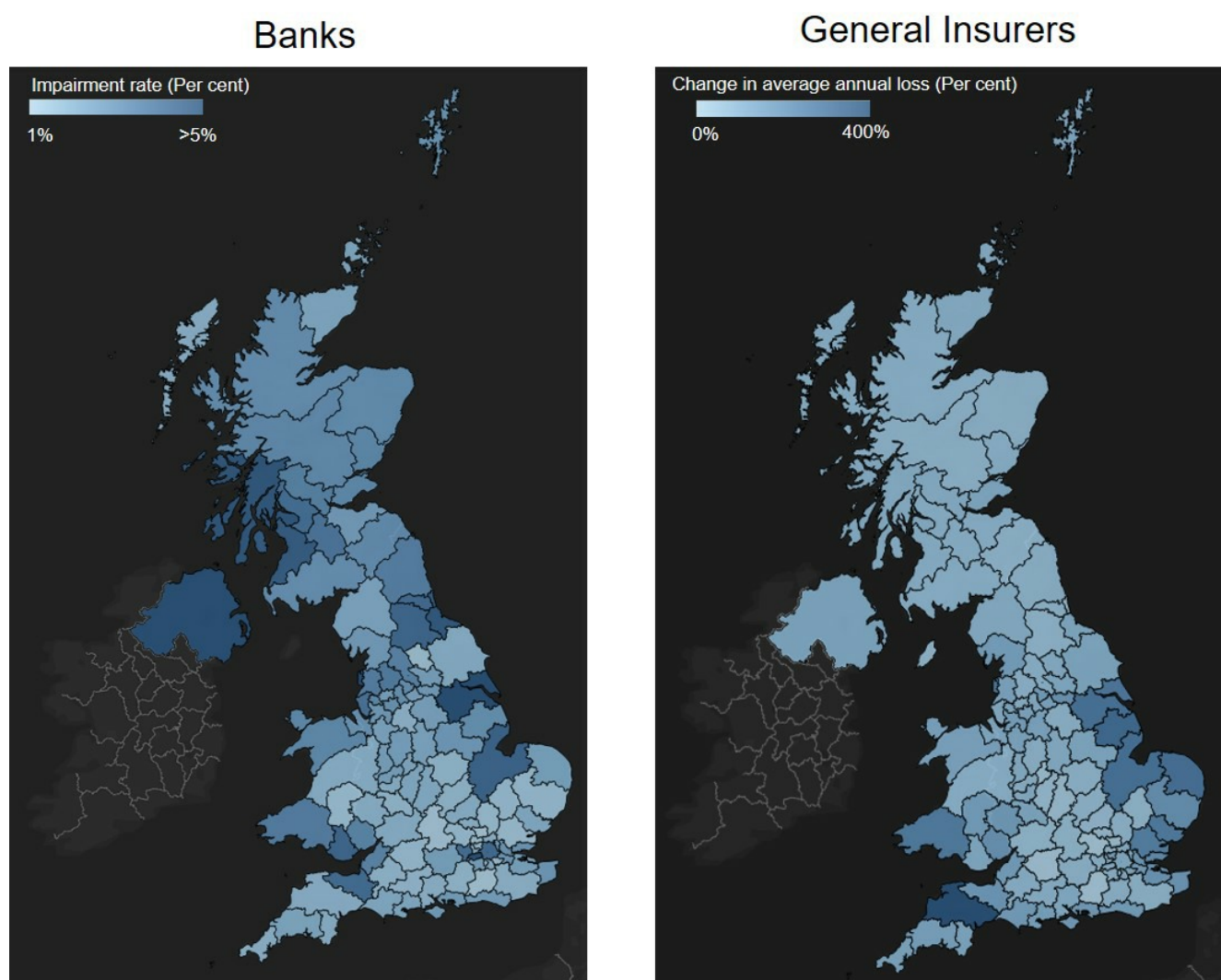
Insurers' projected UK general insurance losses in the NAA scenario were highly geographically concentrated

Just 10% of four-digit postcode districts accounted for two thirds of the total increase in annual UK retail insurance losses in the NAA scenario. For the 5% of postcodes most affected, the increase in average annual losses is 548%. When combined with other (non-climate sensitive) risks, this could equate to a doubling of insurance premiums. Chart 4.13 shows the most impacted areas, which are particularly concentrated in the Yorkshire & the Humber, East, and

East Midland regions.

Chart 4.13: Banks and insurers identified broadly similar areas as being at risk in the NAA scenario

Increase in banks' aggregate impairment rate and insurers' average annual losses (NAA scenario) (a) (b)



Sources: Participating firms' submissions and Bank calculations.

(a) For banks, chart shows cumulative thirty year impairment rate on mortgage lending, including both impairments that might have been expected in a hypothetical counterfactual scenario in which climate risks did not worsen further, and those related to climate risks materialising in the CBES scenario.

(b) For general insurers, chart shows the percentage increase in average annual losses from year 0 to year 30 arising from coastal and inland flooding only.

| Some firms under-calibrated physical risks compared to prescribed benchmarks.

Some firms were unable to adapt their models to provide a close fit to the physical variables in the scenario (see Section 3), and sensitivity testing by staff suggests that firm results in aggregate understate the impact of UK flood risk. As an illustration of the sensitivity of firms' results to methodological choices, staff undertook analysis using more conservative assumptions across a number of dimensions. This analysis suggested that estimated increase in annual losses from UK liabilities could be up to four times higher than firms' projections. It also suggested that technical premiums for the insured could rise by an average of around a third, and by almost four times for the most impacted postcodes.

Box C: Climate litigation risk

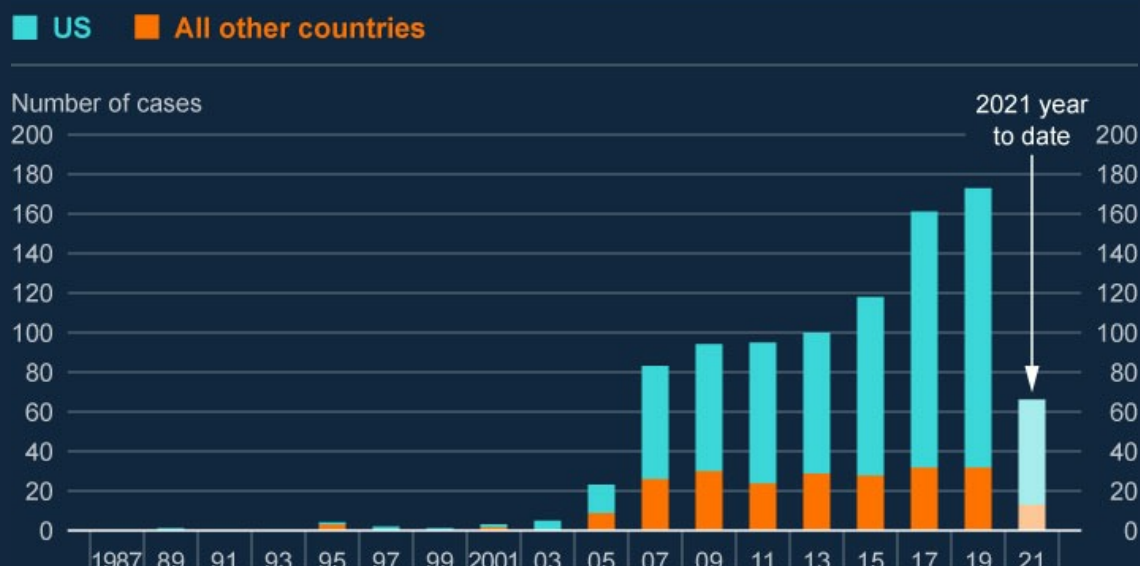
Climate-related litigation is increasing globally (Chart A). London Market general insurers provide insurance to businesses (and their directors), which protect them from financial losses arising from legal claims and the costs of mounting a legal defence, regardless of whether the claims are successful.^[22] Claims are being initiated with the aim of changing corporate behaviour, or seeking compensation for consumer or investment losses. If this trend continues it could present a potential exposure and risk management challenge for some insurers.

As a result, the Bank, working with members of the London Market, launched an exercise on climate litigation as part of the CBES. As explained in this box, the aim of this novel exercise was to illustrate the potential scale of climate litigation risks, and help firms develop processes to monitor and manage such risks.

The exercise asked participants to consider seven hypothetical legal cases to explore possible exposures to the London Market from climate-related litigation (Table 1). The cases cover a broad spectrum, such as: assessing whether insurance policies cover a corporation that is being sued for their direct contribution to climate change or for mislabelling products as 'environmentally friendly'; through to the targeting of financiers that support the funding of carbon-intensive activities.

Chart A: Instances of climate litigation have been increasing in recent years

Climate-related litigation cases over time (a) (b)



Source: Global trends in climate litigation: 2021 snapshot, J. Setzer and C. Higham.

(a) Based on data from the Climate Change Laws of the World database, maintained by the Grantham Research Institute in partnership with the Sabin Center for Climate Change Law, and the US Climate Case Chart, maintained by the Sabin Center.

(b) Due to difficulties in compiling global data on climate change litigation across jurisdictions and languages, these figures may be partially incomplete.

Firms' capabilities to assess climate litigation

For many participating insurers this exercise was the first time that they had attempted to draw together information in order to assess the potential for climate-related litigation across several product lines. Consequently, in the absence of established processes, several insurers struggled to collate and aggregate the information necessary for a robust assessment of potential exposures. For example, firms faced difficulty identifying and aggregating policy exposures according to specific contract wording and industry sector classifications.

Examples of better practices included: (1) using a multi-disciplinary team (including, for example, underwriters and claims handlers, as well as legal, risk management and actuarial staff); (2) submitting initial results to robust internal challenge; (3) considering of a wide range of legal interpretations; (4) using findings from the exercise to inform existing risk management practices; and (5) applying technical rigour in considering policy exposures (eg risk differentiation within sub-sectors, consideration of differing geographical and legislative environments).

Firms varied in their areas of strength, and no participant demonstrated these better practices consistently across all areas.

Firms' exposure to climate litigation

This exercise highlights that some insurance products may be exposed to climate-related litigation where stakeholders seek financial redress (as opposed to seeking behavioural changes from firms), and if courts find in favour of claimants.

Specialist insurance policies covering corporate Directors' and Officers' liabilities were the most likely to pay out. These policies were considered particularly vulnerable to three of the hypothetical legal cases: the greenwashing claim, the claim based on a breach of fiduciary duties, and the claim based on the indirect financing of carbon emissions. Professional indemnity policies could respond to the indirect financing case, and the scope for professionals to be drawn into many kinds of litigation brought against businesses was also noted. If real-world cases led to payouts, the possible financial costs that could be borne by businesses or insurers are large. Directors' & Officers' insurance policy limits for large global firms typically exceed £100 million. These policies are syndicated across multiple insurers, with individual insurers typically providing between £2 million and £7.5 million of coverage towards these limits. Around 8,500 such policies were written by insurers covered in the CBES exercise.

Several insurers noted that they often also cover insureds' legal defence costs whether or not litigation against their insureds is ultimately unsuccessful, and that such defence costs could be sizeable.

Chart B: Professional Indemnity and Directors' & Officers' insurance policies were likely to pay out in response to some hypothetical legal cases

Estimated share of policies which may pay out in response if selected hypothetical legal cases were successful (a) (b)



Sources: Participating firms' submissions and Bank calculations.

(a) Data from ten participating general insurers. For seven hypothetical legal cases brought against their insureds, Insurers were asked what percentage of their directors & officers, professional indemnity, and general liability insurance policies would be likely to pay out in the event that these legal claims were successful. Table 1 provides an overview of the hypothetical legal cases.

(b) General liability figures not shown as a smaller number of firms submitted figures for this category.

Firms' potential responses to climate litigation

Liability insurance contracts typically provide cover for periods of 12 months, allowing insurers to annually reassess, amend, and re-price products to reflect any changes in risk. Annual re-pricing mitigates some but not all the risk of increasing climate litigation – new contracts could be at risk from a rapid shift in the legislative environment and expected professional standards.

Under such circumstances, future insurance cover could become prohibitively expensive for businesses, or in extremis not available at all, particularly if insurers feel they can no longer accurately calibrate the risks. Potential difficulties in securing insurance coverage for directors, officers and professional advisors would have a substantial impact on businesses. And though it could incentivise firms to focus on developing and implementing credible climate transition plans, it may also make firms more risk averse,

and reduce innovation.

Insurers noted that these risks may lessen as market disclosure standards on climate risks become more consistent and embedded across jurisdictions, as firms become more certain around their application, and if insured firms develop clear transition plans within guidelines set by central bodies and/or industry associations. Insurers also highlighted the potential need for, in extremis, the development of a reinsurance pool to ensure they could continue to offer such insurance in the face of a sudden increase in successful climate-related litigation cases.

Next steps

The Bank encourages all London Market insurers to develop appropriate data extraction and modelling techniques to enable regular scenario testing that test whether coverage intent (from the perspective of the policyholder and (re)insurer) is aligned to current contract wording. Such information can also assist the market in adapting to the challenges posed by climate litigation, and contribute to its continued integrity.

The Bank will explore the implications of contract certainty and the size of possible risks through its regular biennial insurance stress tests.

Table 1: Summary of hypothetical legal cases

Case	Summary of legal case raised
1	Direct causal contribution: a corporate is found liable for their representative contribution to manmade climate change.
2	Violation of fundamental rights resulting in cessation or reduction of operations: a corporate is prevented from practising carbon-intensive activities that violate fundamental human and dignity rights, this has a significant impact on financial revenues.
3	Greenwashing: a corporate is found to be misleading customers (eg false advertising, mislabelling as 'environmentally friendly', underreporting disclosures) and must pay out compensation to customers/investors.
4	Misreading the transition: a corporate is sued on the basis that it continued to sell a carbon-intensive product while in knowledge it would become redundant due to government net-zero policy, they must refund and compensate customers.
5	Indirect casual contribution (related to exposure to Utilities sector only): utilities are sued for their indirect contribution to climate change which amplifies physical risks due to inadequate or negligent preparation.
6	Directors' breach of fiduciary duties (related to cover against asset managers only): investors of an asset manager allege that the entity's directors have understated the physical and/or transition risk to their assets in their disclosures. Investors seek payment for damages from the directors' breach of fiduciary duty.
7	Indirect causal contribution (financing): a case is brought against financiers of carbon-intensive activities, as they have contributed indirectly to manmade climate change through financing activities of carbon majors.

5: Firms' responses to climate-related risks

Firms provided both quantitative and qualitative information on how they would respond to the evolution of climate risks in each of the three CBES scenarios. These responses were explored further through a second round of submissions.^[23]

This part of the CBES exercise was designed to explore the implications of firms' responses to climate risk for the provision of financial services, and to assess firms' ability to take a strategic, long-term approach to managing climate risks and adapting their business models.

By examining the potential responses of banks and insurers to climate risk jointly, the results of the CBES shed light on the possible collective impact of participants' behaviours, including whether they may give rise to unintended or undesirable system-wide consequences (see Box E).

UK banks and insurers typically responded to all three scenarios in this exercise by following their existing plans around the transition to net-zero emissions.

These plans include increasing counterparty engagement to support businesses to transition. Box D gives further detail around firms' existing climate strategies. The sophistication of firms' strategic thinking was mixed, and in general firms did not tailor their responses to the specific CBES scenarios.

In this exercise, banks and insurers also reported plans to reduce their exposure to carbon-intensive sectors, with banks projecting large reductions in exposure to the petroleum & gas extraction, petroleum manufacturing, and mining & quarrying sectors.

These strategies raise the possibility that some corporate sectors (particularly some carbon-intensive ones) may struggle to access finance as the transition progresses, especially from banks.

Participating firms identified more business opportunities in the transition scenarios than in the NAA scenario.

And banks were able to quantify more new opportunities than life insurers in this exercise. Life insurers noted that their ability to seize some opportunities would be dependent upon improvements in disclosures. Some insurers expressed a concern that a surge in 'green' investment could unduly raise asset prices.

5.1: Transition scenarios

In the two transition scenarios, banks planned to increase lending substantially to some components of the gas and electricity supply sector, specifically to renewable energy firms and

those developing technology for electric vehicle batteries. At the same time, banks planned to reduce lending to those corporates in that sector which were particularly reliant on revenues from fossil fuels. They also envisaged increasing lending to the construction sector, related to greater assumed investment in retrofitting and flood defence improvements.

On the retail side, banks planned to offer green mortgages, and provide financing products for home energy efficiency improvements.^[24] Some firms' strategic thinking was relatively more sophisticated, demonstrated for example by identifying unique opportunities based on their areas of existing expertise, and by assessing the credibility of these opportunities in light of possible demand and supply limitations.

General insurers also planned to expand further into opportunities that would be created by a net-zero transition, for example by providing insurance to renewable energy projects, and to companies developing battery and fuel cell technology.

Participating life insurers quantified fewer concrete new opportunities as part of the shift in their investment portfolios in this exercise.

Life insurers planned to invest in green assets and renewable energy, as well as in the decarbonisation of UK real estate. But they noted their ability to seize these opportunities would be dependent on the disclosure of appropriate metrics to distinguish which assets were genuinely green. Some insurers also expressed a concern that a surge in green investment could unduly raise asset prices, potentially reducing the attractiveness of this type of investment.

In response to the scenarios, banks planned to reduce lending to some of the most carbon-intensive corporate sectors, in line with existing commitments to reach net-zero financed emissions by 2050.

As a result of the fact that firms' submitted actions were largely drawn from existing plans, the sectors that banks planned to reduce lending to were broadly similar across all three scenarios. The biggest projected reductions in exposures were in the mining and quarrying, petroleum and natural gas extraction, and the petroleum manufacturing sectors (Chart 5.1), though these exposures collectively account for a small share of banks' overall corporate lending portfolios.

Banks planned to assess the credibility of individual large corporates' transition plans using qualitative information on company strategies, as well as available quantitative information on emissions, when deciding whether to continue providing finance. Some banks also used the information gained from assessing these plans in their everyday risk management.

Insurers planned to reduce their exposures to similar sectors to those cited by banks, though expected changes in their portfolios were much more modest (Chart 5.2).

This reflected a strategic emphasis on engagement with counterparties to support transition, as opposed to active divestment before assets mature. Some general insurers envisaged reducing their coverage or increasing the premiums they charged for some of the most carbon-intensive

industries under these scenarios.

Approaches that were more sophisticated involved considering both opportunities and potential divestments in the same sector. For example, several banks outlined both withdrawals and possible opportunities in the 'gas and electricity' and 'manufacturing' sectors. And more sophisticated insurers have detailed plans for counterparty engagement already in place.

Though banks recognised that exiting from certain industries or clients could be particularly challenging if their peers were attempting to do so simultaneously, few firms specified how they would adapt to such a situation. More sophisticated responses considered the reputational and conduct risk that could occur from exiting certain exposures or customer groups if lots of other banks were also doing so, and noted there may be a need to amend divestments accordingly. For example, some banks considered using limit management rather than rapid divestment for clients where exit could be difficult. Some banks also noted that these reductions in exposure would necessarily be weighted towards larger corporates, who would be more able to turn to other forms of finance.

Banks also noted that they would seek to reduce lending to carbon-intensive industries at a faster pace if climate-related losses proved higher than expected. Accelerating planned reductions in lending could be difficult to do in practice given they could push individual firms into default, and potentially lead to reputational damage to lenders.

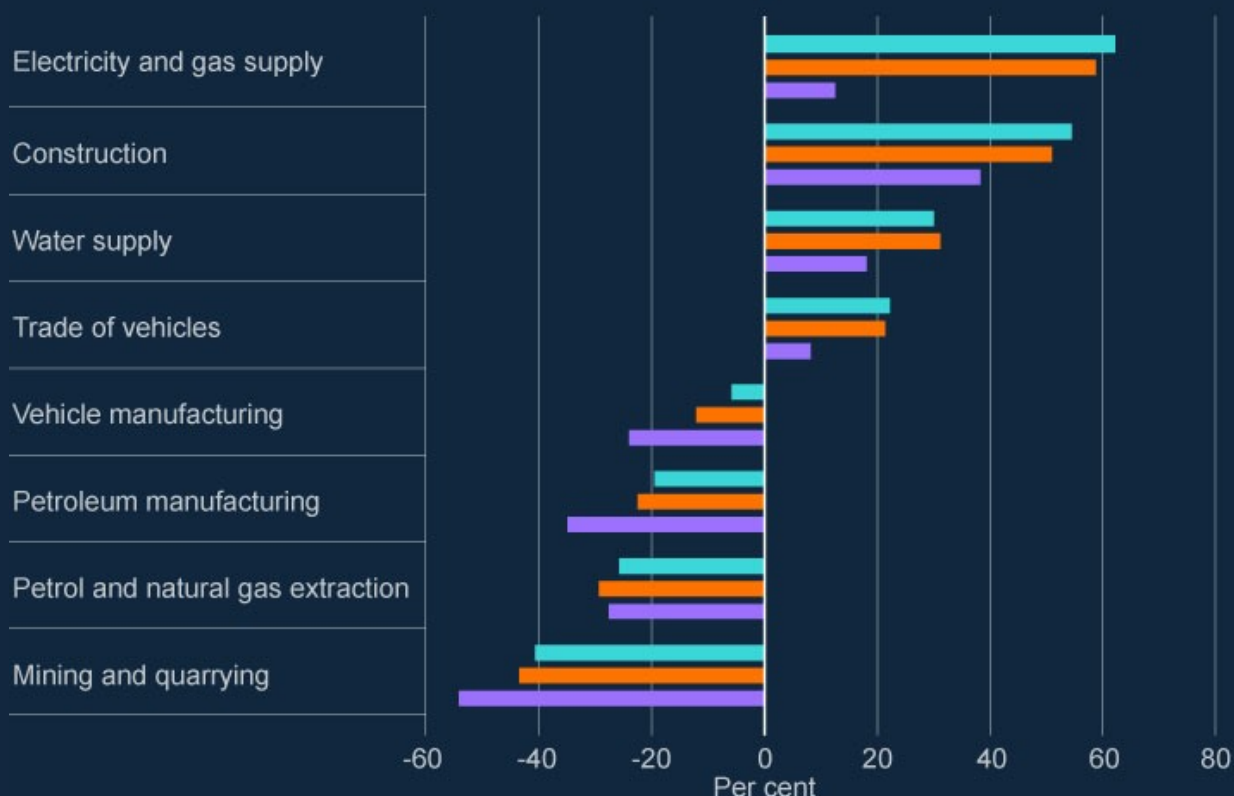
Considering responses from banks and insurers together, these strategies raise the possibility that some corporate sectors (particularly some carbon-intensive ones) may struggle to access finance as the transition progresses, especially from banks.

Limits in the supply of credit to fossil fuel producers could outpace the new investment in sustainable energy alternatives and improvements in energy efficiency. Unless this transition is managed carefully, this could have significant impacts on businesses and consumers, and through them the financial sector.

Chart 5.1: Banks plan to reduce lending to carbon-intensive industries

Indicative net changes in banks' drawn balances to selected sectors in the CBES scenarios (a)

■ Early action
■ Late action
■ No additional action



Sources: Participating firms' submissions and Bank calculations.

(a) Indicative net change in drawn balance from year 0 to year 30 based on firms' submissions, abstracting from the impact of underlying trends in growth and inflation over the scenario. Chart shows sectors for which banks submitted the largest changes in drawn balances. All banks quantified potential reductions in exposure in response to the CBES scenarios, though some did not quantify potential increases.

5.2: No Additional Action scenario

Banks and insurers envisaged far fewer new opportunities in the NAA scenario relative to the two transition scenarios, in line with the fact that macroeconomic prospects at the end of the scenario are much worse.

For example, banks projected much smaller increases in lending to the electricity and gas sector to support the development of renewable energy in this scenario (Chart 5.1). That said, both banks and insurers identified opportunities to support repairs in the aftermath of flood and storm

damage.

The relative lack of reported opportunities for firms in this scenario may result in more significant challenges to firms' business models and profitability. Firms noted that if losses were significantly higher than they projected, they might seek to reduce dividends and take other actions to restore their capital positions.

Banks planned to reduce new lending secured on properties facing higher physical risk in the NAA scenario. Meanwhile, general insurers planned to increase the price of insurance in line with the increases in physical risk in the scenario.

General insurance contracts are typically written to cover one year, allowing firms to alter pricing relatively quickly as risks change. And insurers noted that UK household flood insurance coverage could fall sharply, as insurance on some properties would become unaffordable once the Flood Re scheme ended as per current legislation in 2039. That said, the vast majority of households would still be able to afford insurance.

Both banks and insurers noted that increased flood risks in the UK could be mitigated, in part, by investment in flood defences, increasing flood resilience measures for properties, and encouraging flood-resilient repairs. They also noted their support for a continuation of a publicly supported UK flood reinsurance pool in such a scenario, and a widening of eligibility criteria to include properties built after 2009.^[25]

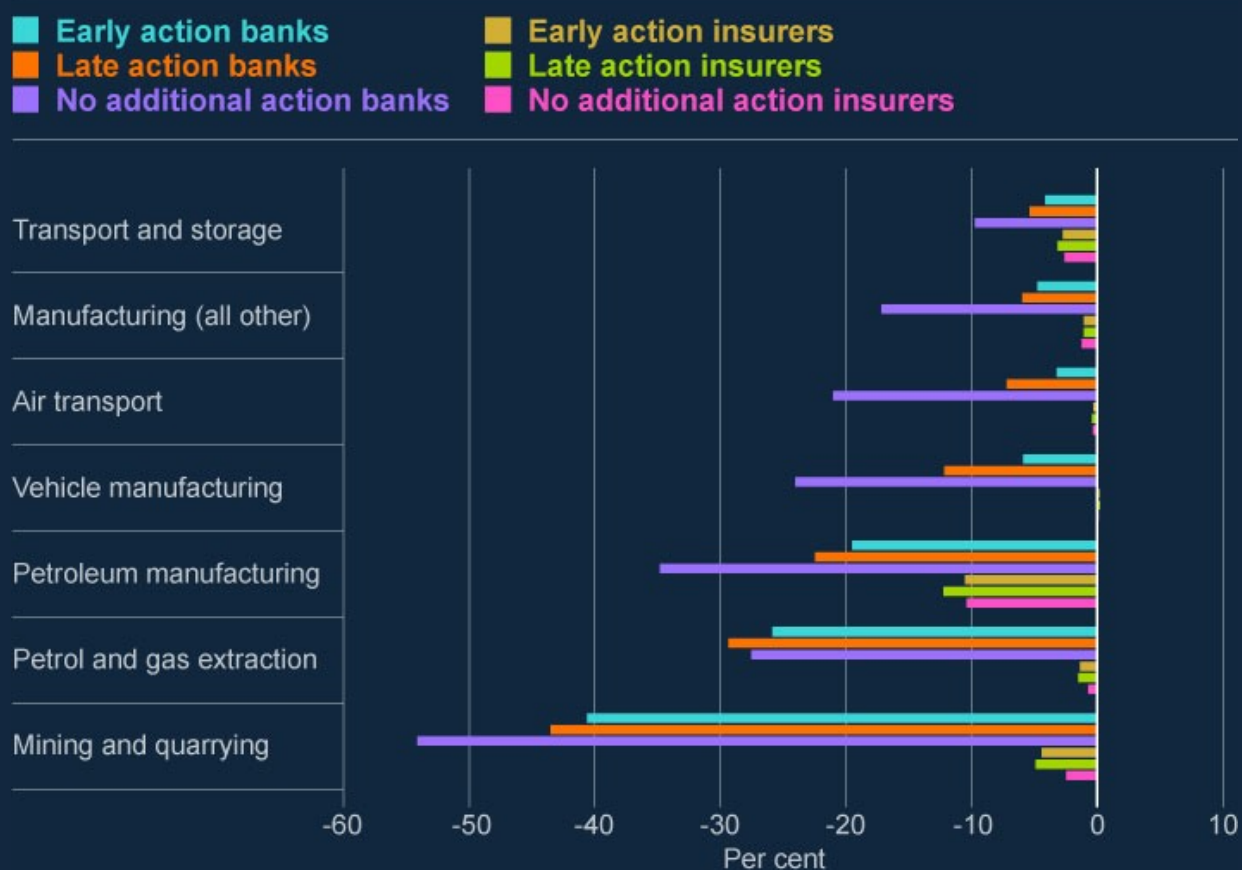
In the NAA scenario participants' responses indicated that around 7% of UK households that they currently cover could be forced to go without insurance – because their properties become uninsurable, or because they cannot afford insurance at the prices offered. This portion of affected households could be greater to the extent that general insurers have underestimated the physical risk impact of the NAA scenario (see Section 4).

Households and corporates who are unable to obtain or to afford insurance may also face difficulty in accessing finance from banks. For example, UK households in regions most exposed to physical risk would face challenges re-mortgaging their properties in the NAA scenario because they would fall in value due to severe flooding and/or become uninsurable. 45% of the mortgage impairments in the scenario are accounted for by just 10% of the four-digit postcode areas analysed. Affected households may find themselves stranded on more expensive Standard Variable Rate mortgages.

The Bank will work with the Government and the FCA to ensure that any risks to the provision of financial services highlighted by the CBES exercise are well understood.

Chart 5.2: Reductions in exposure are broadly similar across scenarios, and more pronounced for banks

Indicative net changes in banks' and insurers' exposure to highly impacted sectors (a) (b) (c)



Sources: Participating firms' submissions and Bank calculations.

(a) Indicative net changes in exposure based on firms' submissions, abstracting from the impact of underlying trends in growth and inflation over the scenario. Chart shows sectors for which participants submitted the greatest reductions in exposure.

(b) For banks, figures show net change in drawn balance from year 0 to year 30. All banks quantified potential reductions in exposure, whereas some did not quantify potential increases.

(c) For life insurers, figures show implied changes in market value of invested assets, excluding the impact of valuation changes over the scenario. Figures are based on a small number of firms, as not all life insurers submitted quantitative projections for potential changes in their asset allocation.

Box D: Firms' existing transition plans

Banks and insurers drew heavily on their existing published transition plans and climate strategies when formulating responses to the three CBES scenarios. This box explains

some of the key features of those transition plans.

Most CBES participants currently have a climate strategy in place that supports the transition to a net-zero greenhouse gas emission economy by 2050. These plans vary in their level of granularity.

In practical terms, that means these institutions have plans to cut financed carbon emissions to net zero by that date.^[26] Banks and insurers are also committed to making their internal operations carbon neutral well before then (Chart A). They have already reported integrating climate risk in their governance structures, strategy, risk management and TCFD disclosures. Most firms have also decided to report annual progress against their climate transition plans in their annual reports and accounts.

Chart A: CBES participants' public target dates for net-zero transition goals (a) (b) (c)



Sources: Information published on participating firms' websites.

(a) Each cell represents a single CBES participating firm. The Society of Lloyd's is depicted as a single firm, with individual syndicates not shown.

(b) Net zero in own operations refers to firms' targets for becoming net zero in their own operations by reducing or offsetting generated emissions.

(c) Net zero financed emissions refers to firms' targets for achieving net zero emissions across all activities they finance via investment or lending, including through the use of carbon offsetting.

Some firms have publically committed to help clients and customers navigate the transition by offering new products and consumer education, which will partially help address reputational and conduct risks.

On the retail side, some banks are already offering green mortgages, or plan to begin

doing so.^[27] They are also offering discounted financing for retrofitting, electric vehicles and solar panels to improve EPC ratings on properties. And banks are gradually increasing the energy efficiency of their mortgage books as existing assets mature. On the corporate lending side, they are increasingly requiring clients to have credible transition plans, and supporting their customers' alignment to green transition regulations by providing advisory services. Banks are considering sustainability risk for all new and renewing lending facilities, and setting targets to phase out financing to highly carbon-intensive sectors, as well as repricing exposures or including debt covenant adjustments.

Similarly, insurers are providing green investment options to their customers, and most are publicly committed to achieving a 30% to 50% reduction in carbon emissions. They are also reducing their exposures to counterparties vulnerable to transition risks. General insurers have highlighted growth areas for specialist types of insurance products they have developed to support new technologies for greening the economy, in particular to cover: electric vehicles, lithium and cobalt batteries, hydrogen-powered fuel cells, warranty products for solar panels and battery systems, renewable energy sectors, and carbon offsetting for travel insurance.

Box E: What we learned from running the CBES in two rounds

The first round of the CBES was launched in June 2021. Participating banks and insurers were required to produce loss projections under the three published scenarios, as well as responses to a qualitative questionnaire covering several aspects of their approach to climate risks, including questions on overall strategy, risk management and modelling approaches. Participants also submitted prospective management actions in response to the scenarios. The Bank launched a second round in February 2022. This focussed exclusively on exploring in greater depth banks' and insurers' prospective responses to climate risks.

This box explains the rationale for running exploratory exercises such as this one in more than one round. It also explains the specific insights this approach has generated with respect to firms' responses in the CBES.

Rationale for running an exploratory exercise with more than one round

A common objective of the biennial exploratory scenario exercises the Bank has run since 2017 has been to better understand the behavioural responses of participants to stress scenarios. It is likely, however, that such behavioural responses will be sensitive to a

number of factors. Examples include the estimated extent of losses in a given scenario, assumptions around public sector support, and assumptions about the behaviour of participants' competitors. Discrepancies between participants on key assumptions can therefore lead to an incoherent set of responses when considered in aggregate.

Running exercises like the CBES in two rounds allows stress testing authorities to test how firms' behavioural responses could differ under alternative assumptions. These alternative assumptions might take into account the collective impact of participants' initially proposed responses, or a Bank staff view that losses in the scenarios provided may be being underestimated, for example. A second round also allows any key data gaps that emerge to be filled, and areas of particular interest to be explored in more depth.

Specific insights from the second round of the CBES

For the CBES Round 2, the Bank asked CBES participants to:

- Spell out the opportunities they would seek to exploit in further detail (without assuming they are able to get a 'first mover' advantage from entering these opportunities before other firms).
- Assume that their competitors were taking similar actions to them and explain the impact on their responses to the scenarios.
- Assume that losses would be double their initial central projections and explain the impact on their responses to the scenarios.
- Provide further detail on how they judged the credibility of counterparties' net-zero transition plans.
- Provide further detail on the need or otherwise for a continuing role for public sector support, with respect to providing financial services to climate-vulnerable households.

Insights gathered included:

- Banks in particular were able to outline more potential opportunities than they did in Round 1 and in more detail. This made it more apparent that the size of potential opportunities for banks was larger in the transition scenarios than in the no additional action scenario.
- Participants recognised that their desired management actions may be more difficult to execute if their peers were also attempting to undertake similar actions. For example, without the assumption that finance would be available from elsewhere, banks recognised that they might not be able to withdraw credit from smaller borrowers without causing insolvencies. There was also a recognition that opportunities would likely be less profitable if peers were all competing to invest in greener assets.

- If losses were much larger than projected, participants reported that they would attempt to speed up actions, though the overall magnitude of desired divestment from carbon-intensive industries was broadly unchanged. General insurers reported that they would seek to employ more and different forms of re-insurance, as well as passing on the impact of higher claims to customers, in the form of higher premiums.
- Participants used a mixture of qualitative information on corporate strategies and quantitative information on emissions to judge which corporates to support through transition. Not all banks were able to demonstrate how they used this information systematically though, for example in broader models used to assess corporate credit risk.
- Participants made several suggestions about the need for and potential form of further public sector involvement to maintain similar levels of insurability in the event of an NAA style physical scenario materialising (discussed in Section 5).
- Participants' ability to articulate how their responses to the scenarios might vary under different potential assumptions was mixed. Some answers were well thought out and credible, while others appeared less coherent.

6: Actions and next steps

The CBES is one of the Bank's workstreams aiming to ensure the financial system is resilient to climate-related financial risks. The lessons from the CBES will help inform the Bank's wider work on climate change.

The financial risks from climate change affect businesses and households and so the safety and soundness of firms the PRA regulates and the stability of the wider financial system that the Bank oversees. Climate-related financial risks therefore have a direct impact on the delivery of the Bank's macroprudential and microprudential policy objectives, as set out in relevant legislation and the remit and recommendation letters (remit letters) from the Government to the Financial Policy Committee (FPC) and Prudential Regulation Committee (PRC).

The UK Government's March 2021 FPC and PRC remit letters set out each committee's responsibility to have regard to the Government's commitment to achieve a net-zero economy when considering how to advance their respective objectives. As set out in the Government's April 2022 FPC and PRC remit letters, this should include, where practical and relevant, having regard to the Government's energy security strategy and the important role that the financial system will play in supporting the UK's energy security – including through investment in transitional hydrocarbons like gas. Findings from the CBES relating to the impact of participants' planned responses will be shared with the Government to support its work in this area.

Firms will be given feedback on the quality of their CBES submissions and areas for improvement, and findings on climate risk management will feed into the assessment of firms against our supervisory expectations (as set out in SS3/19). The CBES will also inform ongoing work around further appropriate policy tools to capitalise climate risks.

The FPC is supportive of wider work to develop standards and frameworks for net-zero transition. Examples include: government climate policy and transition plan standards, industry net-zero target-setting frameworks, and sustainability disclosure standards and requirements put in place by the International Sustainability Standards Board (ISSB). These standards, and the improved data they are designed to provide, are critical foundations to help banks and insurers better understand their customers' current exposure to climate risks, and their plans to transition towards a net zero economy.

6.1: Informing the Bank's wider work on climate

The findings from the CBES exercise will feed into the FPC's thinking around financial stability policy issues related to climate risk. The Bank is working to understand how the management of these risks, or the failure to do so, might affect the resilience of the financial system.

In addition, the Bank is working closely with Government and other regulators to improve its understanding of: the future path of climate policy; how the transition will unfold across the real economy; and the ability of the financial system to support a sustainable transition. It is important to note that while the financial system has a crucial role to play in helping finance the transition, it is the real economy where the reductions in greenhouse gas emissions ultimately need to take place. In this context, reductions in the supply of finance to carbon-intensive energy producers will need to be balanced with increases in investment in sustainable energy producers and reductions in energy demand, if potential macroeconomic consequences are to be avoided. The FPC will monitor any risks to the financial system as a result of possible large-scale withdrawals of credit from particular sectors.

6.2: Supervisory strategy and policy

The Bank will help the banks and insurers it regulates to use the results of the CBES to improve their climate risk management capabilities, both through individual firm supervisory dialogue and by sharing and discussing key thematic findings with the banking and insurance industry more broadly (including through the Climate Financial Risk Forum (CFRF)).^[28]

The firm-specific findings of the exercise will inform ongoing dialogue about the management of climate risks between participating firms and their supervisors. For example, evidence gathered through the CBES will help the PRA to assess firms' progress against the PRA's expectations in this area (as set out in SS3/19), and help to reveal where more intensive action is needed by firms to address the issues identified.

The Bank's work on climate scenario analysis, including that done as part of the CBES, provides a key tool supporting firms and policymakers as they navigate uncertainty over future climate policy and climate change, enabling assessment against a range of possible outcomes. By highlighting the macro level impacts of climate change and the transition to net zero, the CBES will assist the FPC in determining whether system-wide capital levels continue to provide a sufficient level of resilience against climate risks. That is one way in which the Bank's work on the CBES, together with other climate scenario analysis, could help inform future work on regulatory capital requirements.

This exercise will not be used to set capital requirements related to climate risk. As set out in the PRA's October 2021 Climate Change Adaptation Report, the PRA and the Bank are undertaking further analysis to determine whether changes need to be made to the design, use, or calibration of the regulatory capital frameworks. Such changes would be aimed at ensuring appropriate resilience to the financial consequences of climate change, consistent with the PRA's and FPC's objectives. However, regulatory capital is not an appropriate tool to address the underlying causes of climate change (ie greenhouse gas emissions across the economy). It would likely be both less effective than other possible direct climate policy interventions, and could potentially give rise to unintended consequences for firms' safety and soundness. The responsibility for

addressing the causes of climate change ultimately lies with governments, businesses and households. The Bank will also continue to actively support a co-ordinated international approach to climate change, including by engaging in the Basel Committee on Banking Supervision's (BCBS's) Task Force on Climate-related Financial Risks.^[29]

To support this work on the capital framework, the Bank will host a research conference on the interaction between climate change and capital in Q4 2022, and has already put out a 'Call for Papers'.^[30] The Bank will publish follow-up material on the use of capital, including on the role of any future scenario exercises, informed by the conference and the findings of the CBES.

6.3: Lessons for future climate stress tests

The Bank intended for the CBES to be a learning exercise. Expertise in modelling climate-related risks is in its infancy, so this exercise was designed to develop the capabilities of both the Bank and CBES participants.

The CBES has built on our work with central banks, supervisors, and climate scientists around the world to develop climate scenarios for use by financial firms and policymakers. The Bank will share the key themes and lessons learned from this exercise with its peers, helping to advance understanding of the risks that climate change poses to the global financial system. This collaboration should also help to reduce the level of fragmentation across jurisdictions as they each address climate risks that are global in nature.

Given that this was the Bank's first detailed climate exercise involving both banks and insurers, there are several lessons for the appropriate design and execution of climate stress scenarios and exercises. For example, allowing participants to exercise flexibility rather than being prescriptive in approaches to modelling, and asking them to liaise directly on climate risks with their counterparties has driven improvements in banks' and insurers' risk management approaches, and helped to expose data and modelling gaps. The Bank also learned that participants found it difficult to consider their responses to the CBES scenarios in depth, in part reflecting uncertainty about aspects of climate policy. This uncertainty meant participants had to make assumptions about the precise form such policy would take.

Finally, the fixed balance sheet assumption has had both costs and benefits. It makes interpretation of the results more straightforward, and allows a clear, separate focus on specific actions that participants might take in response to the scenarios. But for general insurers writing one or two year contracts, this assumption is less appropriate. And all participants would be likely to adjust their business models to some extent over a thirty year period in order to reduce or manage the risks they face, so overall the fixed balance sheet assumption may have pushed up projected losses.

Annex 1: The Prudential Regulation Authority's and Financial Policy Committee's objectives and remit




The Prudential Regulation Authority (PRA) has a general objective of promoting the safety and soundness of the firms it regulates, including through ensuring that firms' business is carried on in a way which avoids any adverse effect on the stability of the UK financial system and minimising the risk that firm failure could pose to financial stability. In relation to insurers, the PRA has an additional primary objective of contributing to the securing of an appropriate degree of protection for those who are or may become policyholders. When seeking to advance its primary objectives it must, so far as reasonably possible, act in a way which, as a secondary objective, facilitates effective competition in the markets for services in which regulated firms operate. And there are certain matters to which it must have regard in the exercise of its general functions, including the government's economic policy to achieve strong, sustainable and balanced growth.


The Financial Policy Committee's (FPC's) primary objective is to contribute to the achievement by the Bank of its financial stability objective, through the identification and monitoring of, and taking action to remove or reduce, systemic risks with a view to protecting and enhancing the stability of the financial system of the United Kingdom. The FPC has a secondary objective to support the economic policy of Her Majesty's Government..

The PRA should have regard to, and the FPC has a secondary objective to support, HM Government's objective to deliver a financial system that supports and enables a net zero economy by mobilising private finance towards sustainable and resilient growth, and that is resilient to the physical and transition risks that climate change presents.^[31] In addition, where practical and relevant, the PRA and FPC should have regard to the Government's energy security strategy and the important role that the financial system will play in supporting the UK's energy security as part of the UK's pathway to net zero.

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1. As set out in the Government's April 2022 FPC remit letter, this should include, where practical and relevant, having regard to the Government's energy security strategy.
 2. The Bank does not intend to disclose any firm-specific results.
 3. See [Key Elements of the 2021 Biennial Exploratory Scenario](#).
 4. Relative to a counterfactual scenario in which there are no additional headwinds from climate risks. Even though the exact size and nature of risks from climate change is uncertain, some combination of physical and transition risks will materialise in the future with a high degree of certainty. The counterfactual pathways that might be expected in the absence of climate risks are therefore purely hypothetical. These counterfactual pathways do not represent the Bank's view of the long-run path for the economy. Summary statistics for counterfactual paths of key variables can be found in

the published variable paths.

5. Value chain or “Scope 3” emissions as defined by the Greenhouse Gas Protocol are indirect emissions resulting from value chain activities, such as emissions from investments and use of sold products. Scope 3 emissions can be significant in some sectors, even representing the majority of a firm’s emissions profile, for example in the financials and energy sectors.
6. As part of this international effort the Bank supports the work of the Network for Greening the Financial System, the recommendations of the Financial Stability Board’s Task Force on Climate-related Financial Disclosures (TCFD), and is co-founder of the Sustainable Insurance Forum. More details can be found on the Bank’s [climate change webpage](#).
7. The call for papers for the Bank’s research conference on the interaction between climate change and capital can be found [here](#).
8. The NGFS climate scenarios have been developed by the NGFS Macrofinancial workstream. They aim to provide users, including central banks and supervisors, with a common starting point for analysing climate risks under different future pathways. They are produced in partnership with leading climate scientists, leveraging climate-economy models that have been widely used to inform policymakers, and have been used in key reports such as the IPCC Special Report on Global Warming of 1.5°C. The NGFS climate scenarios can be found in the [NGFS Climate Scenarios for central banks and supervisors](#) .
9. The CBES scenarios were generated using the NiGEM model. The NiGEM economic model is the property of the National Institute of Economic and Social Research and NiGEM is a trade mark of the Institute.
10. The carbon price at the end of 2021 in the early action CBES scenario is US\$70 per tonne, up from \$30 at the end of 2020 in the UK and EU. All carbon prices in the CBES are real prices based on 2010 US dollar. The carbon price in the EU Emissions Trading Scheme (ETS) – based on prevailing nominal exchange rates – was around US\$102 per tonne at the end of 2021, up from around US\$27 per tonne at the end of 2020. Carbon prices based on the ETS are volatile and not directly comparable to the CBES carbon price variable, which is intended as a proxy for government policies affecting the cost of carbon emissions including but not limited to carbon taxes.
11. Throughout this document, the term carbon price is used to refer to a shadow price of all greenhouse gas emissions, ie the marginal abatement cost of an incremental tonne of emissions. The higher shadow price of emissions indicates the existence of more stringent transition policies. This is a simplification, intended to capture a range of different transition policies. In reality, governments can adopt a mix of policies to reduce greenhouse gas emissions, which may include, for example, carbon taxes, cap-and-trade schemes, green subsidies and environmental regulations.
12. Real carbon prices based on 2010 US dollar.
13. This is an estimate of the current warming levels incorporated as a starting point in the [NGFS scenarios](#) . There is, however, a natural variability in warming levels observed each year. For example, according to [a study by the World Meteorological Organization](#)  there is about a 40% chance of the annual average global temperature temporarily reaching 1.5°C above the pre-industrial level in at least one of the next five years.
14. Based on projections at the time the CBES was launched in June 2021, the path of emissions in the Early Action scenario would be consistent with around a 50% chance of limiting global warming to below 1.5°C by the end of the century.
15. Because the carbon price is defined as an implicit price on emissions, not all of the modelled carbon price results in tax revenue available for use by governments. The CBES scenarios assume only 50% of the carbon price leads to tax revenues. This assumption is not intended to reflect or predict current or future climate policies in the UK or abroad. Different combinations of tax and non-tax policies could be used to achieve a given reduction in emissions.
16. **‘Key elements of the 2021 Biennial Exploratory Scenario: Financial risks from climate change’.**
17. SS3/19 sets expectations for how banks and insurers should incorporate climate risks into their risk management practices and governance arrangements.
18. Value chain or “Scope 3” emissions as defined by the Greenhouse Gas Protocol are indirect emissions resulting from value chain activities, such as emissions from investments and use of sold products. Scope 3 emissions can be significant in some sectors, even representing the majority of a firm’s emissions profile, for example in the financials and energy sectors.
19. As set out in the PRA’s supervisory statement SS3/19, firms’ should allocate responsibility of climate change to appropriate Senior Management Function(s).

20. In general, the nominal size and composition of balance sheets of participants were assumed to be fixed, though they were updated to account for mitigation and adaptation plans of large counterparties, provided those plans were already under way, and were judged highly likely to be completed. For smaller counterparties, participants were asked to infer an amount of adaptation based on the relevant sectoral GVA paths provided in the scenarios. More detail can be found in the published [Guidance for participants of the 2021 Biennial Exploratory Scenario](#) .
21. Estimated based on participating firms' data on total mortgage balances for each current and potential EPC rating combination, and an estimated average retrofitting cost for each combination.
22. The London Market is the largest global hub for commercial and speciality (re)insurance. In 2018 it wrote c.\$110 billion of Gross Written Premium, of which \$7.5 billion related to Financial Lines insurance – providing cover to businesses and their executives in the event of lawsuits.
23. As outlined in Section 4 above, loss projections were submitted on a fixed balance sheet basis so participants did not factor in the potential impact of their responses to the scenarios.
24. Green mortgages are secured loans offered on already more energy efficient properties, or with the aim of improving a property's energy efficiency, typically with preferential terms.
25. Properties built after 2009 are not currently eligible for Flood Re. The exclusion of newer properties is so as not to incentivise home-building in high flood risk areas.
26. Including investment portfolios, as well as direct lending for banks.
27. Green mortgages are secured loans offered on already more energy efficient properties, or with the aim of improving a property's energy efficiency, typically with preferential terms.
28. The Bank does not intend to disclose any firm-specific results.
29. As part of this international effort the Bank supports the work of the Network for Greening the Financial System, the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD), and is co-founder of the Sustainable Insurance Forum. More details can be found on the Bank's [climate change webpage](#).
30. The call for papers for the Bank's research conference on the interaction between climate change and capital can be found [here](#).
31. See also Section 6 for further discussion of the remit letters received annually by the FPC and PRC from HM Government.