ISDA Safe, Efficient Markets

A Conceptual Framework for Climate Scenario Analysis in the Trading Book

July 2023

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Executive Summary

Understanding the potential impact of climate risk on the financial system is of increasing importance, but the tremendous uncertainty associated with climate change makes it very difficult to build this understanding. Climate risk scenario analysis is a core tool that is being developed and used by financial institutions and regulators to navigate the uncertainty associated with future climate outcomes and ensure the wider financial system can withstand possible climate events in the future.

To date, such analysis has been primarily focused on measuring the long-term effects of climate risk on the banking book. Those exercises have helped to identify gaps and progress has been made in building the industry's capabilities to assess the effects of long-term climate risk scenarios on the banking book. Regulators and financial institutions are now shifting their focus to the shorter-term effects of climate risk on the trading book.

During the first half of 2023, to support the industry and regulators in these efforts, ISDA commissioned Deloitte to conduct research with more than 30 ISDA member banks and develop a conceptual framework together with a set of key considerations to support the design and implementation of climate risk scenarios for the trading book. The framework is novel because it includes explicit consideration of climate risk factors, with the aim of producing a set of corresponding market risk factors consistent with climate risk as an output. The conceptual framework and key considerations have been developed in consultation with the participating banks and are informed by their insights.

Some of the key considerations that underpin the framework include:

- There are many use cases for climate risk scenario analysis in the trading book (eg, regulatory stress tests, internal capital adequacy assessment (ICAAP) processes, internal risk management). It is important that each climate scenario analysis exercise is designed carefully to ensure it meets its specific objectives – there is no one-size-fits-all approach. The primary use case for climate risk scenario analysis in the trading book is currently regulatory compliance. And although more than half of firms are looking to include the integration of climate risk scenario analysis in strategic decision-making and pricing in future, it has not been considered to date.
- To be most useful for the trading book, short-term climate risk scenario narratives will need to include very short-term horizons (eg, days and weeks), but should also be extendable towards more standard three- to five-year stress testing horizons. Shorter-term scenarios should also be consistent with longer-term climate risk scenarios and pathways to allow the banking book and trading book effects to be considered together within a consistent framework.
- As very short-term scenarios are not currently available, banks use existing scenarios (for example, those developed by the Network of Central Banks and Supervisors for Greening the Financial System (NGFS), the European Central Bank (ECB) and the Bank of England) as a starting point and modify existing scenarios to make them more relevant to the trading book. Common modifications to existing scenarios include accelerating the time horizon to reflect an instantaneous shock, as well as adding variables and adjusting the severity of the shock. The primary variables added are market risk variables, sectoral macro-financial variables and country- or region-specific macro-financial variables.
- A key challenge in developing firms' capabilities in terms of modelling and shock calibration continues to be a lack of breadth and depth in the relevant data. For example, historical data on past events is scarce for transition risk, so external data providers or simple proxies have been used to date. In the future, banks plan to make much more use of internal client data, as well as data sourced from disclosures as data availability evolves. This will help firms to develop their modelling capabilities.

Moving into the second half of 2023, ISDA plans to pilot the conceptual framework to test its usefulness as well as to generate some estimates of potential climate risk impacts on a set of hypothetical portfolios.

1. Introduction

1.1. Background

To date, climate scenario analysis has been primarily focused on measuring the long-term effects of climate change, with most work focused on the banking book. But there is now growing recognition that climate-related financial risks could also materialize within much shorter time frames and through a variety of different transmission channels. Regulators and financial institutions are now shifting their attention to the shorter-term effects of climate risk and focusing on other potentially material areas of vulnerability such as the trading book.

Climate scenario analysis approaches for the trading book are still in their infancy. ISDA conducted a survey of its members in 2022 to determine current approaches to trading book climate scenario analysis[1], which concluded that approaches remain in the early stages of development. While various regulatory and industry bodies have made progress on short-term scenarios[2,3,4], their focus has not been on the specific applicability of those scenarios to trading book assets and timescales.

A significant amount of further work is needed across the industry to enhance the applicability of climate scenarios for the trading book, integrate them into traditional market risk models so they can be effectively used in strategic decision-making and ensure a harmonized approach across firms globally.

This whitepaper contributes to the work needed in this space by:

- Providing granular qualitative and quantitative insights into the current and target state of climate scenario analysis in the trading book.
- Setting out a conceptual framework for climate scenario analysis in the trading book and exploring the considerations of such an approach.

Both the insights and the conceptual framework are based on the results of a detailed survey of more than 27 ISDA member banks and are intended to educate the industry and regulators on the needs of financial firms when conducting climate scenario analysis, as well as support the industry in developing a harmonized approach to climate scenario analysis.

1.2. Climate Risk Working Group and Industry Survey

The activities of the climate risk working group (CRWG) included weekly meetings, a detailed survey of the group and bilateral interviews. Participants in the group shared their views and experiences of climate scenario analysis in the trading book and highlighted what they saw as the key challenges, discussing a range of possible approaches. These themes were used as a starting point to identify key features of climate scenario analysis in the trading book.

The core themes[5] set out and discussed in the working group were as follows:

- **Climate scenario narratives**: to capture the key characteristics of scenario narratives that are applicable and relevant to the trading book and can be applied to the various use cases of climate scenario analysis.
- **Climate shocks and their calibration**: to identify the key climate events or 'risk drivers' that underpin climate scenario narratives and the associated data and methodologies required.
- **Applications of climate scenario analysis**: to identify the primary use cases of climate scenario analysis in the trading book (eg, climate stress testing, climate risk management, reporting and disclosures) and explore the extent to which alternative use cases require different approaches.
- **Modelling frameworks and approaches**: to bring together the above themes to explore potential modelling frameworks or approaches that could be used to simulate climate shocks in a climate scenario analysis exercise and apply these to the trading book applications.

These themes informed the development of an end-to-end conceptual framework, which is set out in the next section.

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[1] https://www.isda.org/a/e55gE/Climate-Risk-Scenario-Analysis-for-the-Trading-Book.pdf

[2] https://www.unepfi.org/publications/economic-impacts-of-climate-change-exploring-short-term-climate-related-shocks-with-macroeconomic-models/

[3] https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.climate_stress_test_report.20220708~2e3cc0999f.en.pdf

[4] workstream_scenario_design_and_analysis_mandate.pdf (ngfs.net)

[5] The CRWG discussed a range of topics that were aligned to the short-term scenarios developed by NGFS Workstream 2, currently chaired by the ECB and Bank de France.

2. End-to-end Conceptual Framework for Climate Scenario Analysis in the Trading Book

2.1. Introduction and Approach

The primary goal of the CRWG was to gather insights from the industry and use these to develop a conceptual framework for climate scenario analysis in the trading book. The conceptual framework presented in this section is based on the insights gathered from the CRWG discussions (Figure 1).

The conceptual framework is developed with the objective of providing insights on the necessary steps to conduct climate scenario analysis in the trading book and to ensure the approach is:

- Sufficiently flexible to be applied to a range of different use cases for climate scenario analysis and across a vast majority of trading book asset classes;
- Commensurate with the materiality of climate risks to the trading book and guidance on assessing the materiality of those risks;
- Robust and flexible to incorporate advances, including the ability to incorporate additional risk drivers in future (eg, nature and environmental risks).

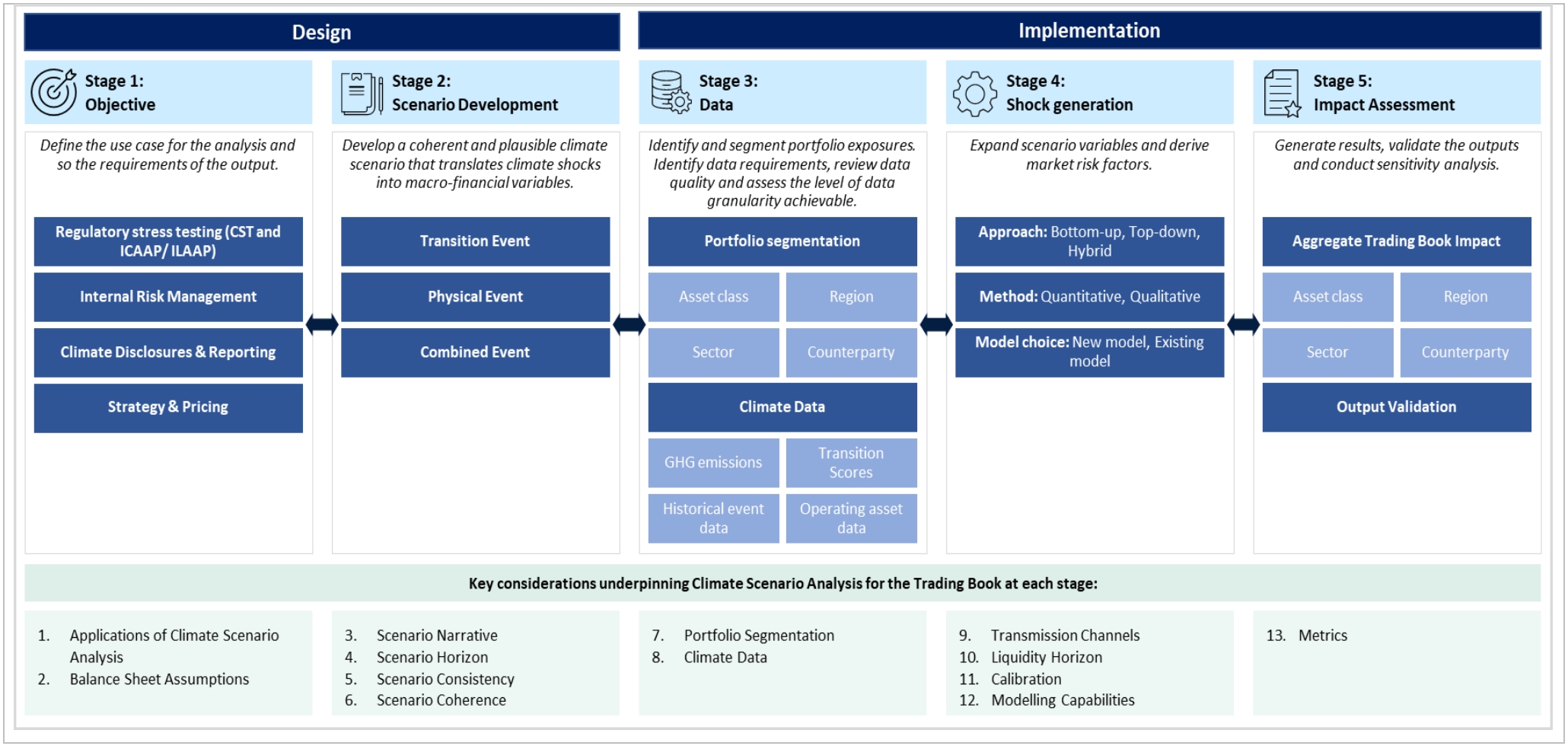
The framework covers two main aspects of climate scenario analysis in the trading book:

1. **Scenario design:** An important feature of scenario design is that it will depend on the objective of the exercise. This may be set by the regulator or the banks themselves and should be defined upfront to inform the approach. Climate scenarios can be developed to suit the chosen use case and explore relevant climate risk driver(s) and how these translate into macro-financial impacts on given regions and sectors. In developing scenarios, banks often use existing climate scenarios as a starting point, which are developed by climate scientists, supervisory bodies such as the NGFS, or regulators. These should then be adapted to ensure they are applicable to the trading book and firm-specific portfolio characteristics when implementing the scenario.
2. **Scenario implementation:** This is undertaken by the banks themselves. Implementing a given climate scenario involves gathering all relevant climate, macro-financial and exposure data, segmenting the portfolio, and mapping out the relevant transmission channels to market risk factors. Banks will need to determine their approach to shock calibration, based on their existing infrastructure, and ensure a robust quantification of the financial effect on the trading book by conducting sensitivity analysis.

Both the scenario design and implementation aspects are split into different stages that define key activities relating to climate scenario analysis in the trading book. At each stage of the approach, several key considerations are highlighted for financial institutions to consider as they progress through the exercise. These represent key judgement calls or decisions that banks will need to make at each stage of the process. These are set out in Figure 1.

The rest of this section of the paper discusses the various stages of the approach in detail and discusses how the detailed survey insights have informed the development of the key considerations underpinning each stage. It is important to note that this is not a linear exercise – banks should revisit earlier stages and considerations as they progress through the exercise and iterate their approach. For example, the sensitivity analysis in Stage 5 might lead institutions to revisit the calibration approach in Stage 4. Likewise, the calibration of shocks in Stage 4 might lead institutions to revisit the data and portfolio segmentation in Stage 3 as new information becomes available.

Figure 1: End-to-end Conceptual Framework for Climate Scenario Analysis in the Trading Book



2.2. Summary of the Five Stages and Key Principles Underpinning the Conceptual Framework

The conceptual framework is set out in stages, with each stage underpinned by a set of key considerations that have been informed by the industry survey and working group insights. The working group discussed a variety of different approaches and the key considerations present the balanced views of participants. As such, it should be read as one recommended approach, recognizing that banks may need to adjust their approach due to multiple factors.

Scenario Design

The design phase covers the objective of the exercise as well as the development of scenarios. It is important to establish the objective for the climate scenario analysis to adequately inform the development of a plausible and coherent climate scenario that translates climate shocks into macro-financial variables. Scenario development defines how climate risk events inform the development of climate scenarios and pathways to deliver a set of macroeconomic variables. This phase could be performed by regulatory bodies, such as the NGFS, or firms can develop these scenarios internally.

Stage 1: Objective

As a first stage of any climate scenario analysis, it is important to establish the use case. Some examples of use cases for climate scenario analysis include: climate stress tests mandated by regulators; internal risk management practices; climate-related disclosures; and informing strategy and business decision making.

Key consideration 1 – Applications: Establishing the use case of climate scenario analysis is required to inform the design of the exercise and ensure it can generate an appropriate set of outputs.

Each application of climate scenario analysis in the trading book differs in scope, objective, approach to materiality, frequency of assessment and the relevant stakeholders that will need to be involved in the exercise (for more details on use cases, see Table 3 in the Appendix).

For example, the purpose of a regulatory stress test is for banks and regulators to assess the impact of climate risk on the financial system and the banks within it. For this use case, banks are more likely to rely on regulatory guidance and variables provided to perform the analysis, with the frequency of the exercise being determined by the relevant supervisory authority. Conversely, for internal risk management, there is likely to be greater flexibility to adjust the approach according to the individual bank's trading book composition and material exposure to vulnerable sectors, regions, or counterparties. Exercises will be completed at various frequencies depending on banks' risk policies and processes.

Among respondents to the industry survey, the primary use case for climate scenario analysis in the trading book is currently regulatory compliance (70%), followed by risk measurement and management (56%). More than a quarter of firms (26%) have already incorporated scenario analysis into their climate-related disclosures, while the majority want to do so in future, likely driven by the Task Force on Climate-related Financial Disclosures and other climate disclosure requirements globally. Notably, while the integration of climate risk scenario analysis into strategic decision-making and pricing has not been considered to date, it remains a key area of focus, with more than half of firms (56%) looking to include this in the future (Figure 2).

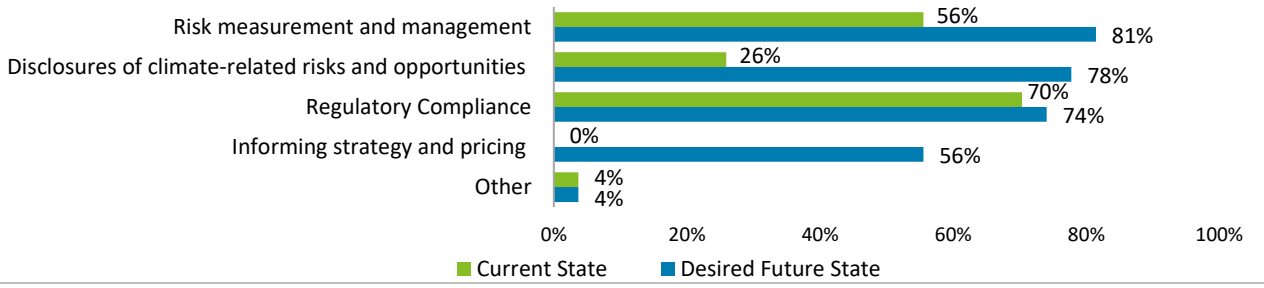


Figure 2: Use cases for climate scenario analysis in the trading book (percentage of total survey respondents, multiple answers permitted)

Each of the use cases necessitates a different approach to ensure the outputs are fit for purpose. The survey results revealed four main differences:

1. A range of scenarios is preferred but some prefer a harmonized approach. In responding to the survey, 63% of respondents suggested alternative scenarios should be considered depending on the use case (Figure 25 in the Appendix). This is mostly driven by a desire to assess different scenario severities. For example, a more severe scenario may be desired to assess capital adequacy when compared to business-as-usual risk management. Some participants also wished to consider different time horizons and scenario likelihoods, or a combination of those factors. Despite this emerging consensus, more than one third of firms prefer a harmonized approach, with standardization and the ability to benchmark being key drivers.
2. Different asset classes may be in scope for each use case. Within the current priority use cases for climate scenario analysis – risk measurement and management and regulatory stress testing – equities, credit and commodities have been the focus to date (Figure 3). Almost all respondents indicated that credit, equities and commodities should be included in a scenario analysis exercise and nearly three quarters indicated that FX (74%) and interest rates (70%) should also be included (Figure 24 in the Appendix). One third of respondents indicated that additional assets such as inflation and securitized products should also be considered.
3. There is, however, greater emphasis on extending the assessment to all asset classes in future, in recognition of various second-order, contagion and feedback effects associated with a given climate shock, with banks looking to extend coverage across all use cases in future (Figure 26 in the Appendix). Commodities, FX and interest rates are particular areas where banks are looking to extend coverage.

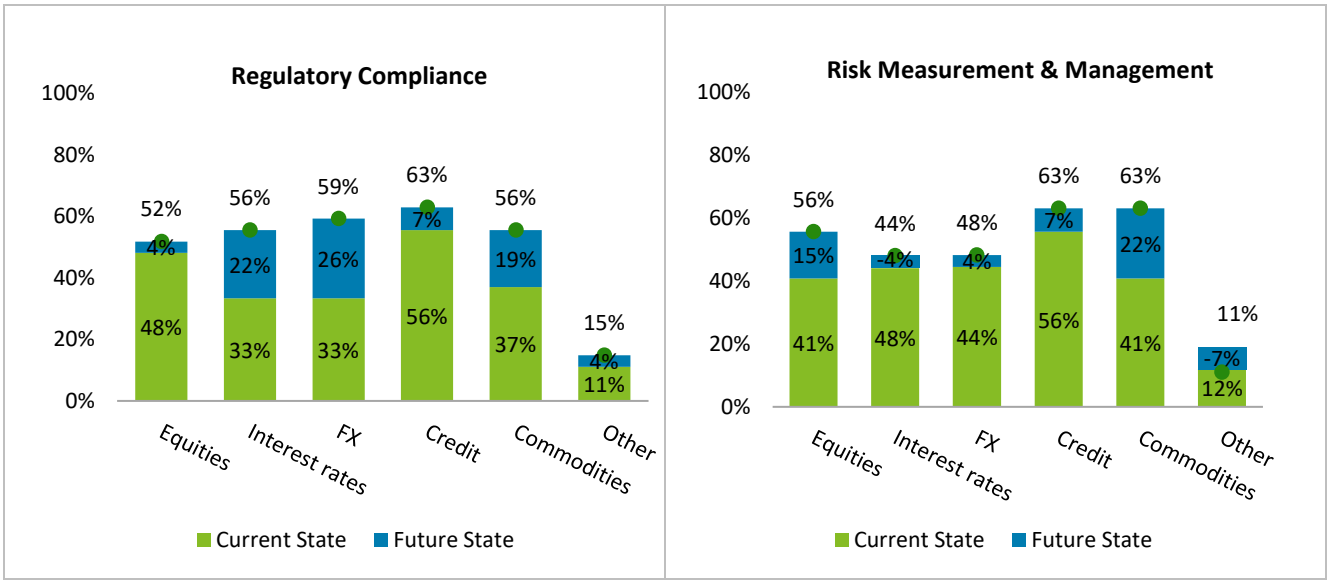


Figure 3: Asset class in scope for regulatory compliance and risk measurement and management exercises (percentage of total survey respondents, multiple answers permitted)

4. Different levels of granularity may be required in the assessment**.** Given the relatively nascent status of climate scenario analysis in the trading book, many firms use qualitative approaches. Where quantitative approaches are employed, banks report the outputs at different levels of granularity depending on the use case. For example, a greater level of granularity is currently required for risk management vs regulatory stress testing in the current state, to adequately identify and assess material climate risk exposures.
5. Different levels of reporting may be required. For risk management purposes (ICAAP/international liquidity adequacy assessment process (ILAAP)), banks find it helpful to distinguish by market risk and counterparty credit risk (CCR), as well as distinguishing between asset class, sector and region. However, where the use case is regulatory compliance, 63% of respondents expect to report at an enterprise-wide

stress test level, while only a third expect to distinguish between market risk and counterparty credit risk (Figure 4).

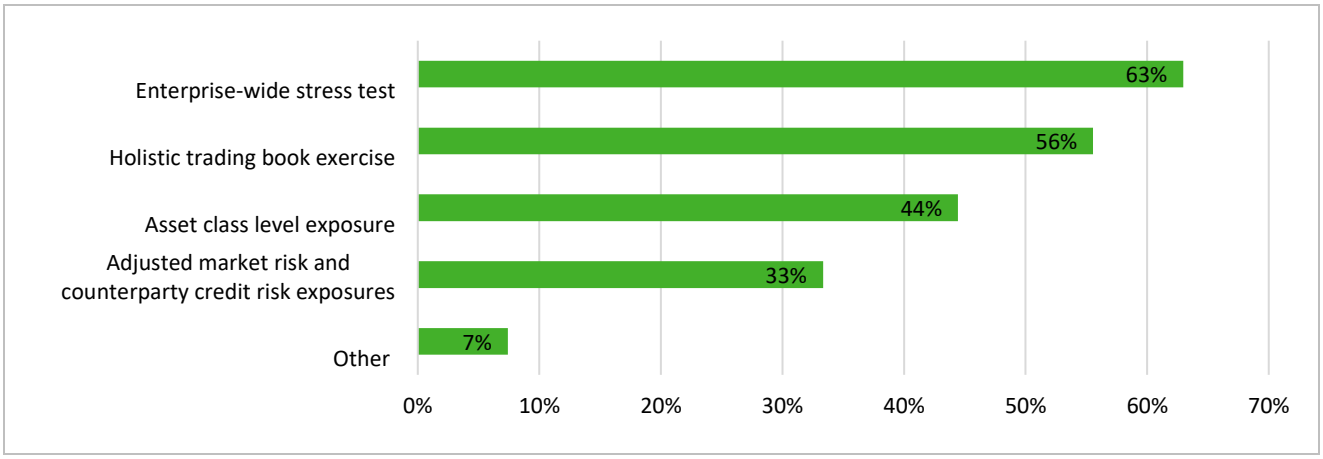


Figure 4: Level of reporting expected for regulatory stress tests (percentage of total survey respondents, multiple answers permitted)

Key consideration 2 – Assumptions: Adopting a static balance sheet is the most appropriate approach for climate scenario analysis in the trading book, given the complexity and uncertainty associated with climate risk. However, firms may wish to consider dynamic approaches based on the use case.

Once the use case has been identified, it is important to set out the required balance sheet assumptions, as these could differ depending on the use case.

Survey respondents generally agreed that a static balance sheet approach is most appropriate for climate scenario analysis purposes, due to the time horizon of the shocks assessed and with a view to creating consistency with traditional stress-testing approaches. In current scenario analysis approaches, 85% of survey respondents assume a static balance sheet, with more than half of these indicating they would not consider a dynamic balance sheet in the future (Figure 5). This view was attributed to the complexity and uncertainty associated with implementing a dynamic balance sheet for trading book shocks. However, it was noted that whether to adopt a static or dynamic balance sheet could be dependent on the use case. For example, a dynamic balance sheet might be preferred for a holistic (trading and banking book) stress testing exercise and capital planning over a three- to five-year horizon, while business-as-usual risk management might prefer a static balance sheet approach.

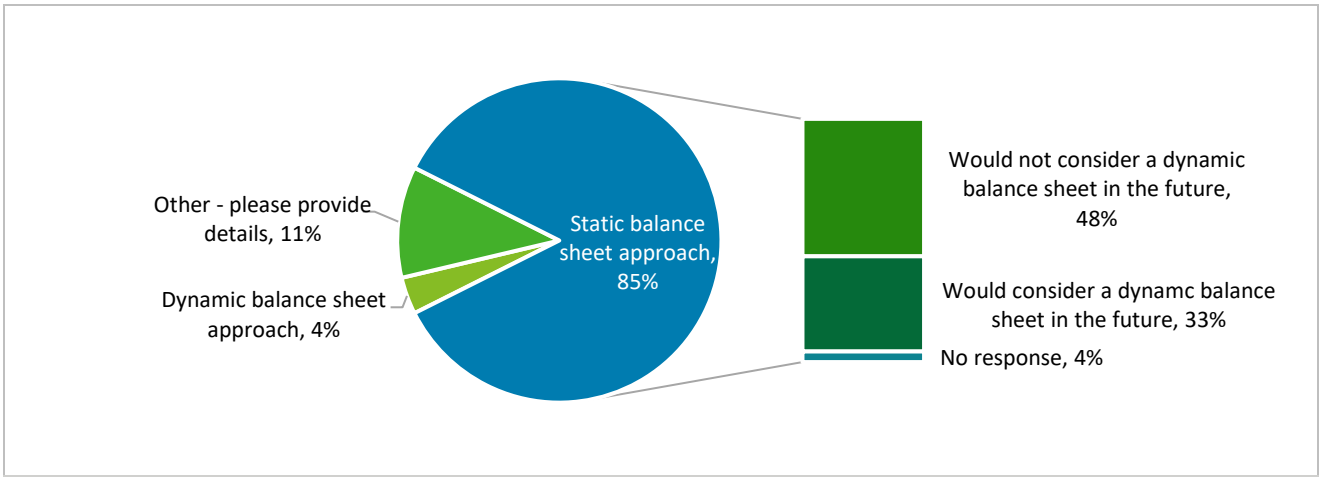


Figure 5: Balance sheet assumptions selected by respondents (percentage of total survey respondents)

Stage 2: Scenario Development

Once the use case has been defined, a scenario or set of scenarios need to be developed that are based on coherent and plausible future climate outcomes under a range of alternative futures and for a range of different risk types. Climate scenarios might be developed by a body such as the NGFS, or internally by the firm. Regardless of which entity is constructing the scenario, there are several features that should be taken into consideration.

Key consideration 3 – Narrative: The scenario narrative is necessary to describe the logic or development of physical or transition risk events and should be consistent with the outcome of the climate risk shock.

The scenario narrative provides the foundation for climate scenario analysis in the trading book, as it defines the relevant climate shock in terms of the anticipated impact on macroeconomic and financial variables and provides additional qualitative context on the event being assessed.

Scenarios for the trading book should be designed to capture specific transition and physical climate risk shocks. Survey respondents regard 'market-based' shocks, such as stranded asset revaluation, or policy and legal risk associated with the transition to a low-carbon economy, as the most material risk drivers across all asset classes for the trading book (Figure 6). Acute physical risks were also considered relevant, particularly for FX and interest rates.

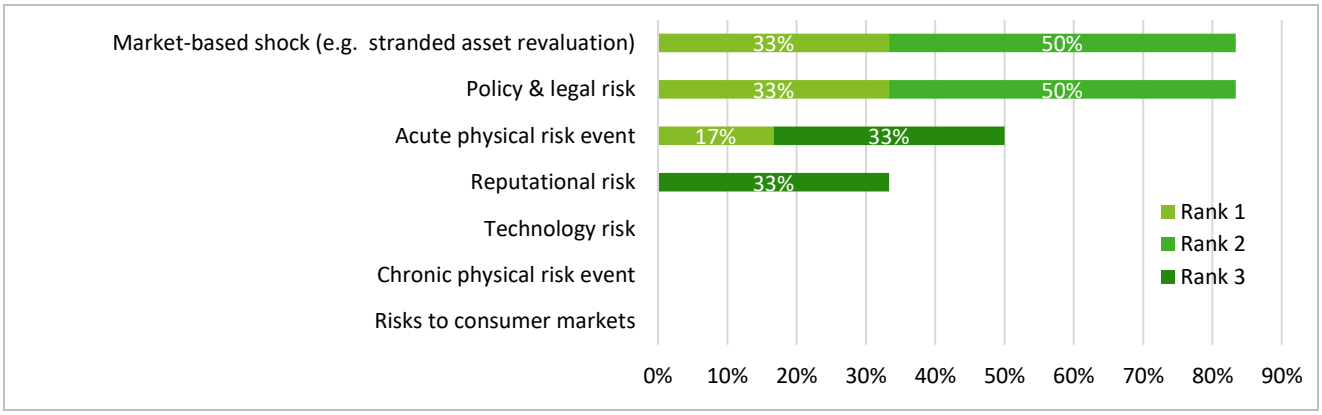


Figure 6: Material climate risk drivers (percentage of asset classes for which each climate risk driver was ranked in the top three most material drivers)

In setting out the scenario narrative, banks should include details of the event trigger(s) and consideration of which sectors and/or regions will be considered part of the stress. The greater level of granularity that is specified at this stage will help with effective risk identification and measurement.

Survey respondents were also keen to see specific detail relating to high transition risk sectors or high physical risk regions in the scenario narrative, as well as narratives that incorporate climate risk shocks impacting significant global trading partners (Figure 7). Some survey respondents that have already undertaken climate scenario analysis in the trading book have incorporated additional detail relating to geopolitical events such as the war in Ukraine, or combined transition and acute physical risk events that were determined to have a more significant impact on their portfolios, to improve the relevance of the exercise.

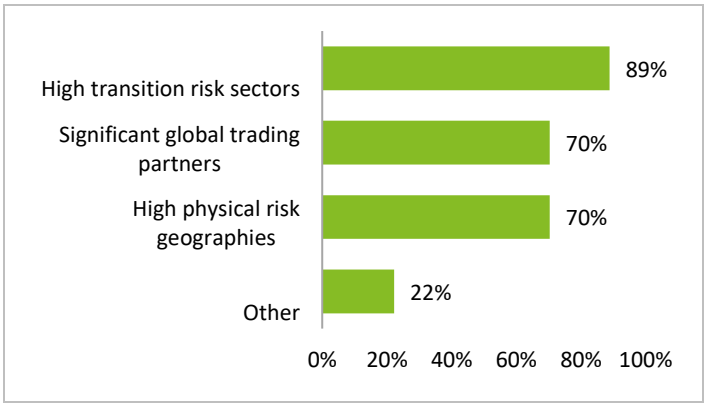


Figure 7: Sectors or geographies to be included in climate scenario analysis (percentage of total survey respondents, multiple answers permitted)

Some aspects of the scenario narrative will not be easily quantifiable. Firstly, there are challenges associated with how to reflect certain technological breakthroughs or other qualitative climate policies for which there are not readily available data points. Secondly, there is considerable uncertainty around a given scenario narrative and the associated variable pathways. This is because they are not a forecast of what will happen, but an illustrative example of what could happen under a given set of assumptions. This uncertainty surrounding climate events and transmission channels specified is also difficult to capture quantitatively. To solve this, survey respondents highlighted the need to explicitly incorporate uncertainty into the scenario narrative to ensure it is captured in the assessment (Figure 8).

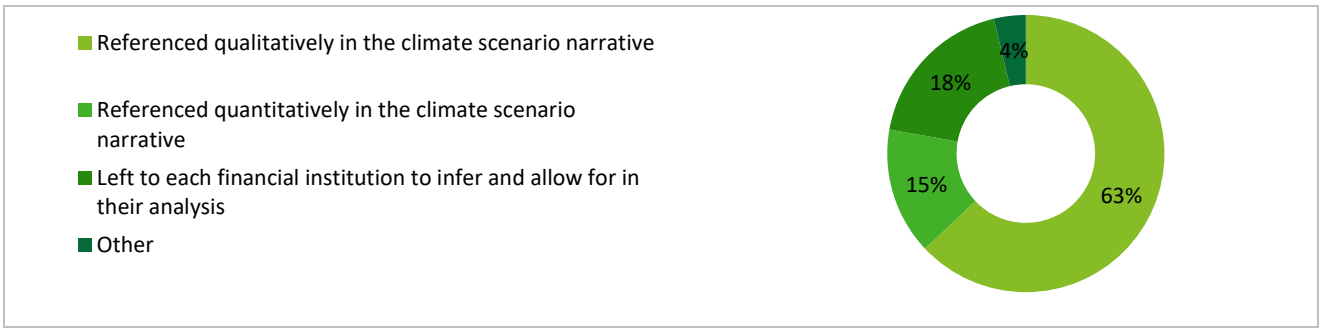


Figure 8: The preferred approach to recognizing uncertainty (percentage of total survey respondents)

Ensuring that the narrative is detailed and complete ensures that all transmission channels and uncertainties associated with a given climate risk shock can be incorporated within the assessment, regardless of whether these are explicitly captured as variables in the quantitative scenario data.

Key consideration 4 – Scenario horizon: The horizon of the climate risk scenario should be sufficiently short-term to be able to capture an instantaneous climate risk event and its effects on financial markets, while also considering the use case and asset class being assessed.

Once the relevant climate shocks have been considered, it is important to determine the relevant scenario horizon over which the events will manifest.

For the purposes of conducting climate scenario analysis in the trading book, almost all firms considered an instantaneous shock (ie, a matter of days or weeks) to be the most relevant time horizon. This enables an assessment of a climate-driven 'Minsky moment'[6], whereby a climate shock results in a sudden adjustment of investor expectations about future climate policies and a potential fire sale of affected assets as the risk is repriced. This ensures it is constructed in such a way that allows it to be calibrated to the relevant liquidity horizon[7] of the portfolios and assets in question. However, a scenario horizon of three to five years was also deemed appropriate by 40% of industry respondents, given the consistency with the horizon of regulatory stress exercises and the ICAAP (Figure 8).

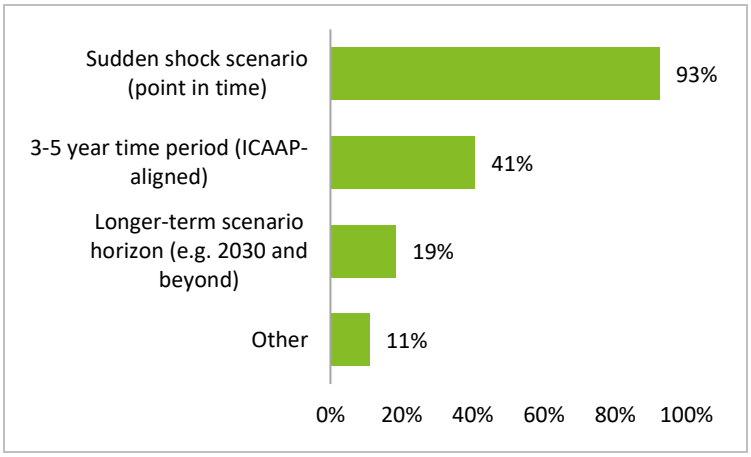


Figure 8: Scenario horizons most relevant for climate scenario analysis in the trading book (percentage of total survey respondents – multiple answers permitted)

[6] Mark Carney: Breaking the tragedy of the horizon - climate change and financial stability (bis.org)

[7] It is important to note that the discussion of scenario horizon is separate and distinct from the liquidity horizon, which relates to the duration of the asset classes being assessed and the calibration of a given climate scenario to make it more specific to the trading book. Please refer to Key consideration 11 – Liquidity horizon

Furthermore, some respondents also acknowledged the need for the horizon to extend beyond the very short term to account for second round or contagion effects following the initial climate shock event.

In practice, while the scenario narrative might detail effects of climate over a multi-year horizon, banks could adopt a 'perfect foresight' approach whereby the effects are reflected in the variables provided as an instantaneous stress impact. The calibration of the shocks in this way ensures they remain relevant and applicable to the trading book, simplifies the exercise and focuses attention on a severe instantaneous shock impact.

An alternative approach is therefore to define a longer-term horizon that is sub-divided into several time steps at shorter-term horizons to reflect the different liquidity horizons of the asset classes in scope and be applied across asset classes and portfolio profiles.

Key consideration 5 - Scenario coherence: Consideration should be given to the plausibility of multiple occurring events and how this would affect the ability to isolate the effects of one climate event when conducting scenario analysis.

When developing climate scenarios, it is important to consider the potential occurrence of multiple interconnected events, instead of focusing on one individual risk driver at a time. This reflects that both physical risk and transition risk events could happen simultaneously, either as unrelated simultaneous events or due to some causality between events (eg, acute physical risk event resulting in urgent climate transition policies). Furthermore, a climate risk event will have an initial macro-financial impact that could magnify over time, resulting in further secondary macroeconomic effects via contagion effects and feedback loops. These secondary effects could be of significant magnitude compared to the initial shock but would be less directly relevant to the climate risk event itself.

Survey respondents noted that it would be beneficial to distinguish between impacts driven by climate and non-climate shocks and to isolate individual climate risk drivers, to determine the materiality of each individual event (Figure 9). However, they recognized significant difficulties in separating out different climate-related risk effects, making this challenging in practice.

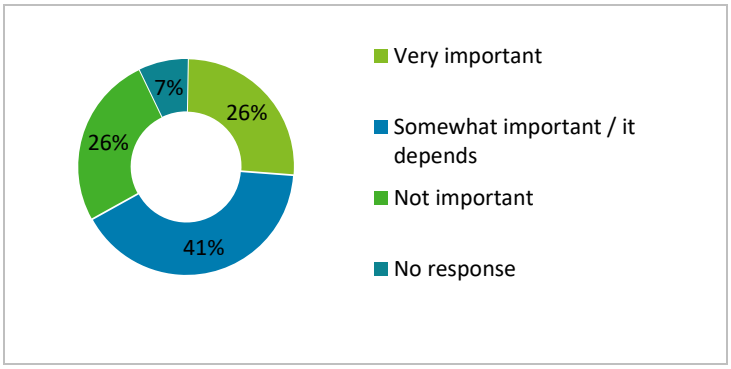


Figure 9: Percentage of respondents indicating the importance of isolating climate risk impact

Key consideration 6 – Scenario consistency: Short-term trading book scenario narratives should be consistent with and easily comparable to existing longer-term scenario narratives, such as those provided by the NGFS.

Despite the necessary focus on the short term, banks should consider how any climate event being assessed corresponds to an existing longer-term narrative and ensure there is consistency between them. 75% of survey respondents agreed with the importance of aligning short-term scenarios with long-term scenarios. As per Figure 10 below, 44% have already aligned them in existing climate scenario analysis exercises, while a further 19% indicated this is a consideration for the future state.

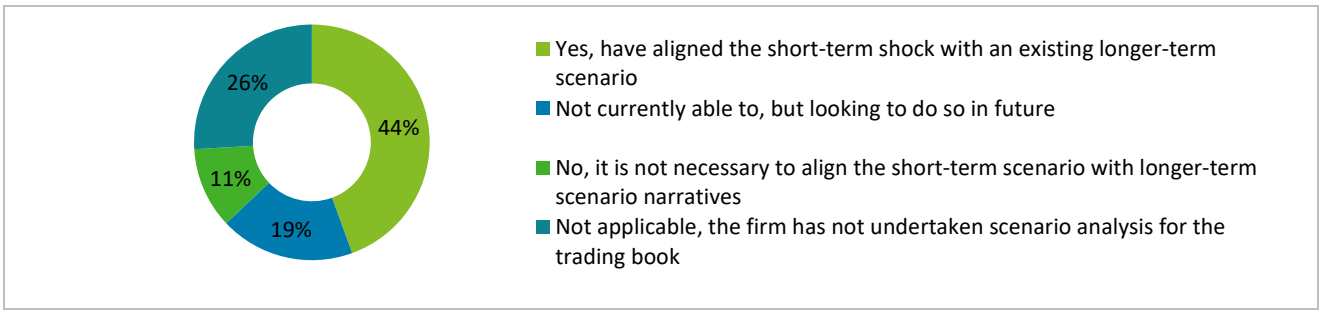


Figure 10: Percentage of respondents aligning short-term scenarios to long-term scenarios

Consistency with long-term scenarios is mostly achieved by linking the narrative of the short-term trading shocks with long-term narratives. For example, an acute physical risk shock such as a major flood event in the UK, or the expectation of future events, is consistent with the increased frequency and severity of physical risk events that may take place in a scenario in which global surface temperatures increase to more than 2°C. A high transition risk event such as a large increase in the price of carbon due to delayed policy announcement or inconsistent implementation across jurisdictions is consistent with a longer-term 'disorderly transition' scenario.

As very short-term scenarios are not currently available, banks use existing scenarios as a starting point and modify these to make them more relevant to the trading book. For transition risk, the NGFS Delayed Transition scenario and the ECB's short-term disorderly transition scenario are the most common scenarios used**,** followed by the Bank of England's Late Action scenario (with the latter two both based on NGFS scenario pathways).

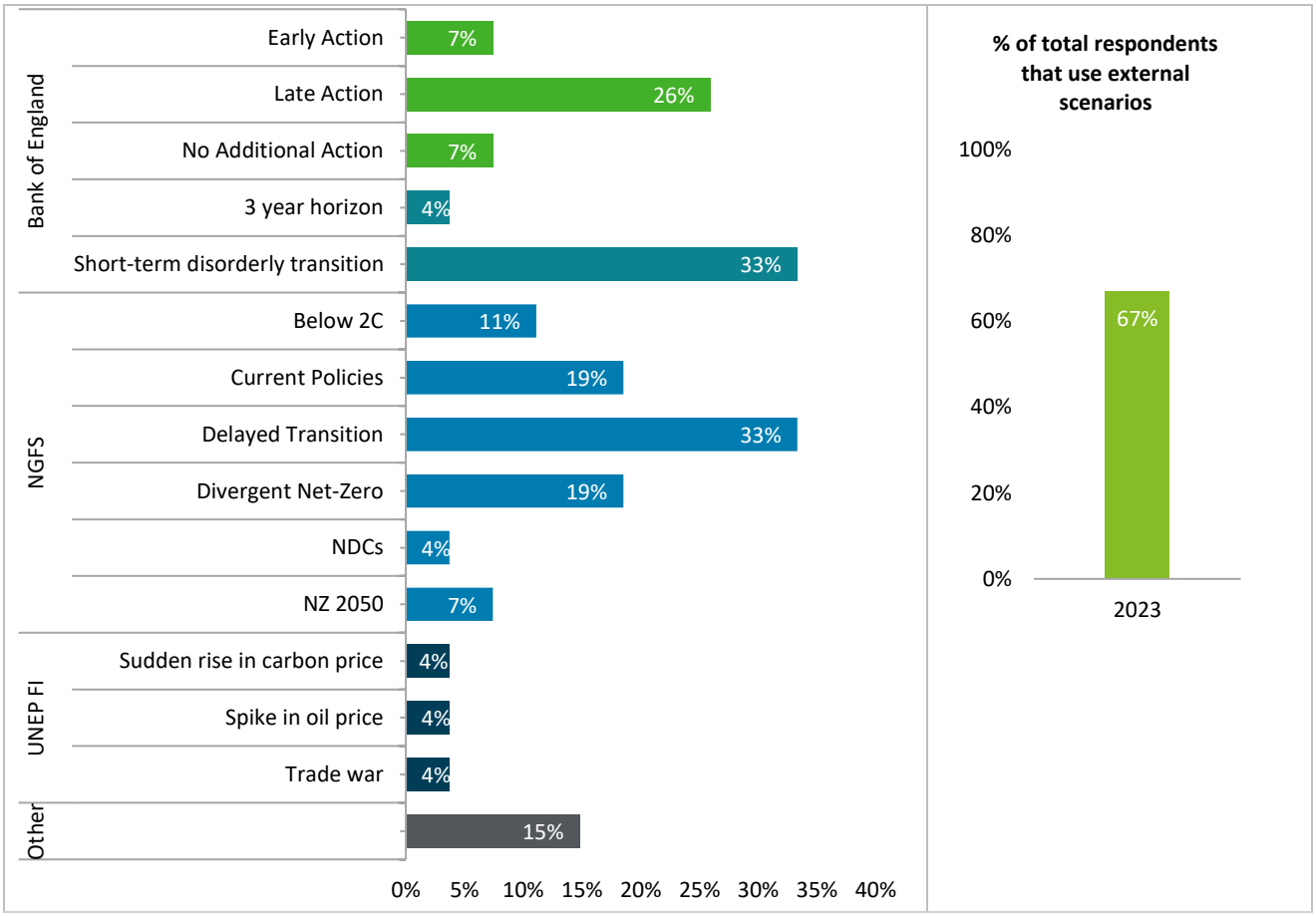


Figure 11: Existing climate scenarios used as a starting point (percentage of survey respondents, multiple answers permitted on left-hand chart)

Common modifications to existing scenarios include accelerating the time horizon to reflect an instantaneous shock (as discussed in 'scenario horizon'), as well as adding additional variables**.** These variables might include more granular sector or regional variables, as well as additional features of the narrative geopolitics (eg, the Ukraine war) and transition policy risk (eg, the EU 'Green Deal' carbon tax). Other changes to scenarios include adjusting the severity of the shock. The exercise of aligning the short-term scenario development with existing longer-term scenarios helps to promote consistency with other climate scenario analysis that is being undertaken for the banking book and ensures alignment with any bank goals relating to the climate transition (eg, greenhouse gas emissions reductions).

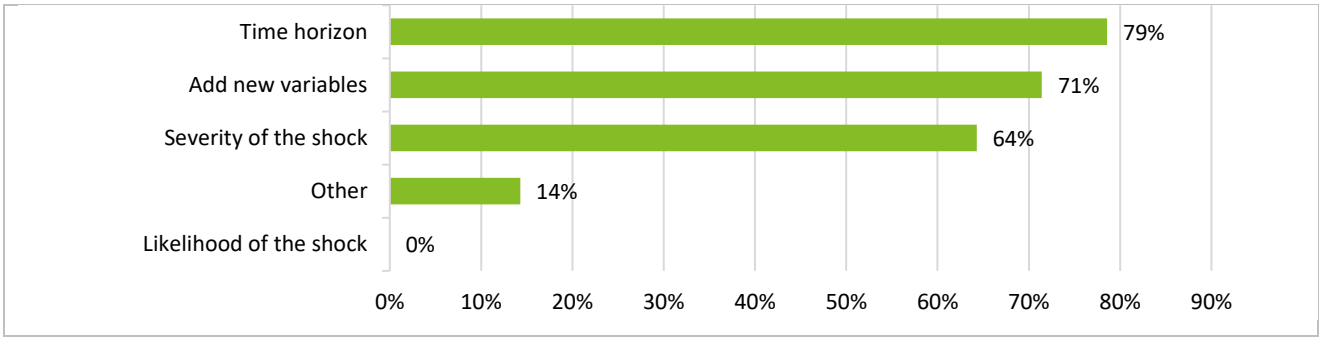


Figure 11: Modifications to existing scenarios indicated by the percentage of respondents that currently modify scenarios to be more relevant to the trading book

Scenario Implementation

Scenario implementation by financial institutions largely involves translating macro-financial variable outputs implied by climate scenarios into market risk factors and applied to firm-specific trading book portfolios. This includes identifying data requirements and segmenting portfolio exposures to the required level of granularity, expanding scenario variables to generate market risk factor shocks and performing an impact assessment to validate results and conduct a sensitivity analysis.

Stage 3: Data – Exposures

To generate useful and meaningful results, banks will need to identify and break down their trading book exposures to ensure the relevant shocks are applied to the relevant assets at an appropriate level of granularity. A climate data gathering exercise is then required. Sourcing the appropriate data is undoubtedly the most challenging component of any climate scenario analysis exercise. In the absence of prescriptive guidance, the industry currently uses a range of quantitative and qualitative approaches to inform climate risk shocks.

Key consideration 7 – Portfolio segmentation: Portfolio segmentation should be undertaken to identify the most vulnerable and material sectors in the chosen portfolio(s). This will help to prioritize the climate scenario analysis in the trading book. Banks should challenge themselves to achieve the greatest level of portfolio granularity possible to enable a robust assessment of climate risk.

Banks need to segment their trading book to effectively identify their most material exposures. Segmenting the portfolio to granular levels results in enhanced identification of risk vulnerabilities across the trading book, leading to better insights that can inform decision-making (eg, hedging and pricing strategies). However, there will be a trade-off as data quality and availability vary across sector, geography and counterparty size, making it difficult to harmonize the approach across a global multi-asset trading portfolio.

The asset classes considered as part of scenario analysis could be driven by materiality, exposure type or defined by the nature of the exercise and desired outcome. For example, for a regulatory stress test exercise, asset class coverage is likely to be aligned to a traditional stress test exercise (ie, covering the entire regulatory trading book). On the other hand, for more ad-hoc scenario analysis exercises for internal risk management practices, banks might want to focus on the asset classes to which they are most exposed, both from a financial and climate materiality perspective.

Currently, banks are largely segmenting their book by asset class (see key consideration 1 – Applications) and by risk sensitivity (Figure 13). Adopting an asset-class specific approach would make it easier to customize the stress to the specific portfolio characteristics and prioritize sizing the effects that banks think is likely to be largest. However, restricting the exercise to a subset of asset classes could mean that cross-asset class dependencies may not be captured, therefore risks could be left unassessed (eg, contagion).

Banks wish to further segment their portfolios by sector and/or region in future, depending on whether transition risk or physical risk shocks are being assessed and the specific scenario narrative chosen. Sector and regional segmentation are appropriate to understand how transition risks might affect different portfolio segments, as different policies (eg, to curb fossil fuels) could be applied across specific geographies or

industries. Differentiating by region is more appropriate for physical risks, as acute weather events are location-based.

Banks also wish to segment at counterparty level to enable firm-specific assessment. One way of achieving this is to introduce counterparty-level transition readiness considerations, which could include both mitigation and adaptation activities, to identify the 'leaders' and 'laggards' in the transition to net zero within each sector. Counterparty-level granularity is also desired for the future. Respondents noted that counterparty-level information is more commonly used to assess CCR.

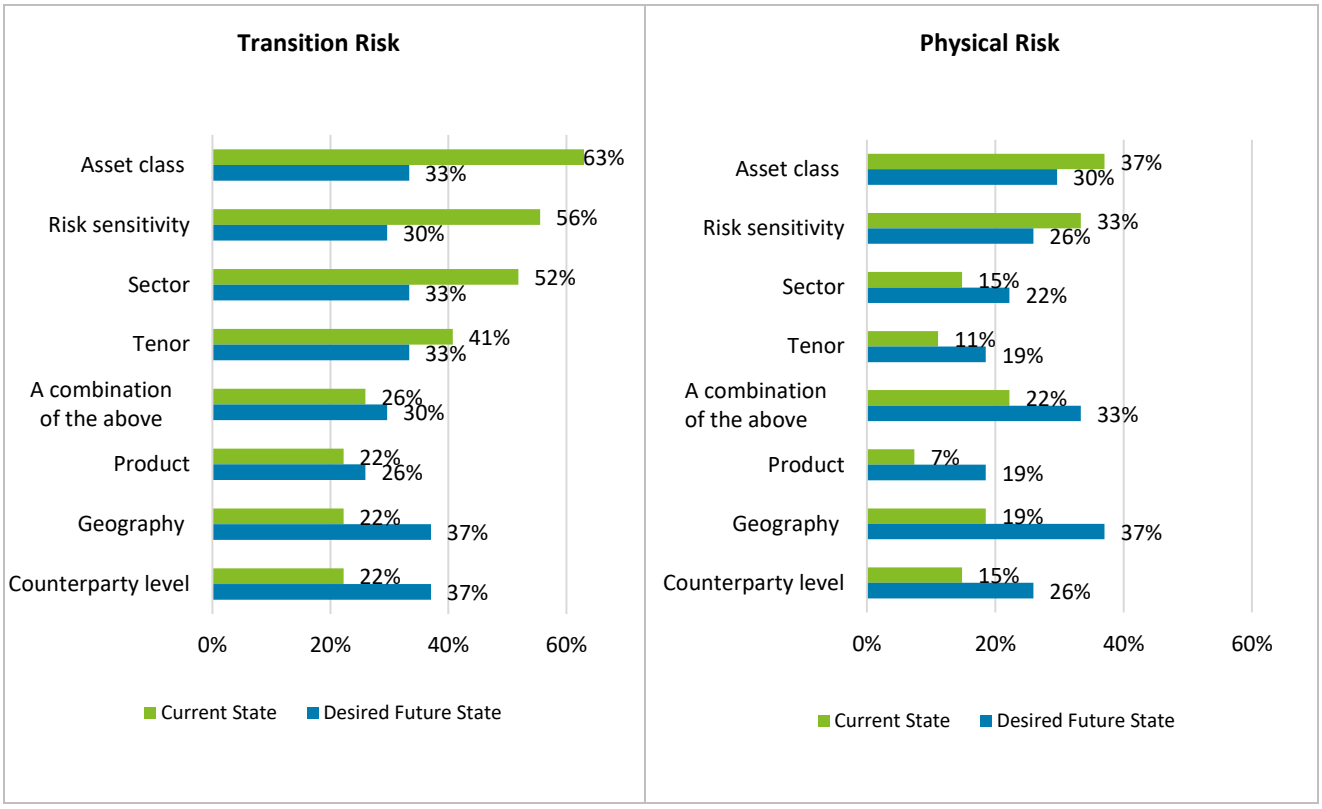


Figure 14: Segmentation of the trading book for physical and transition risk (percentage of total survey respondents, multiple answers permitted)

59% of respondents indicated that counterparty-level analysis should be conducted across all sectors for transition risk, where the materiality of exposure to a given sector determines the granularity of analysis performed (Figure 26 in Appendix). Respondents noted another possible determinant for which sectors are analyzed includes using general sector-level climate risk ratings. For physical risk, 48% of respondents suggested that counterparty-level analysis should be performed across all sectors, followed by the power generation sector (22%) and agriculture (19%). Other sectors highlighted for physical risk included tourism, food and beverages and services.

Key consideration 8 – Climate data: Reflecting the current challenges around gathering appropriate data to conduct climate scenario analysis, the industry should consider a quantitative assessment where feasible and supplement this using qualitative approaches and expert judgement to inform climate risk shocks.

Based on the desired approach to portfolio segmentation, firms will need to carry out a data exercise in which they identify their data requirements, review existing data quality and assess the level of data granularity that is desirable or achievable when carrying out climate scenario analysis. This data exercise will be key in determining the approach to generating shocks in the next stage (

Stage 4: Generating Shocks), such as the extent to which a data-driven approach could be used.

Sourcing the appropriate data remains one of the most challenging components of a climate scenario analysis exercise and the CRWG discussed how additional guidance from the regulator on the appropriate data and sources of that data would be desirable. In the absence of such guidance to date, the industry uses a range of quantitative and qualitative approaches to inform climate risk shocks and identify transmission channels.

30% of respondents indicated they use company-specific transition data to inform counterparty-level assessments, generally through a scorecard approach, and 52% indicated they plan to do so in the future (Figure 12). Assessment is typically undertaken at a sectoral or country level, with plans in the future to expand this with company-specific data or sovereign data regarding counterparty exposure or vulnerability to climate-related risks and transition readiness.

Historical data on past events is scarce for transition risk, so external data providers (48%) or simple proxies (48%) are the preferred data sources, followed by regulatory data (41%) (Figure 13). In the future, banks plan to make much more use of client internal data (56%), as well as data sourced from disclosures (30%) as data availability evolves, to assess the impact of climate risk events on institutions. For physical risk data, the use of external data providers is the most common (30%) due to the lack of internal data, but as data availability evolves, banks plan to make more use of a range of data sources in the future. Compared to transition risk, physical risk is not as widely measured in the trading book as some respondents consider physical risk to be immaterial for the trading book given the shorter holding periods and the nature of physical events being idiosyncratic.

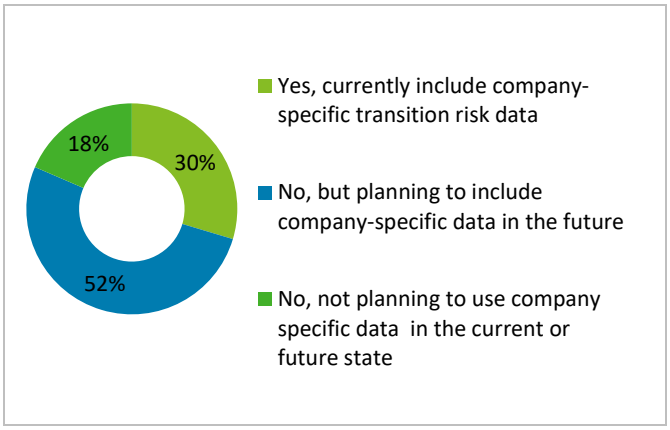


Figure 12: Including company-specific transition data for counterparty-level assessments (percentage of total survey respondents)

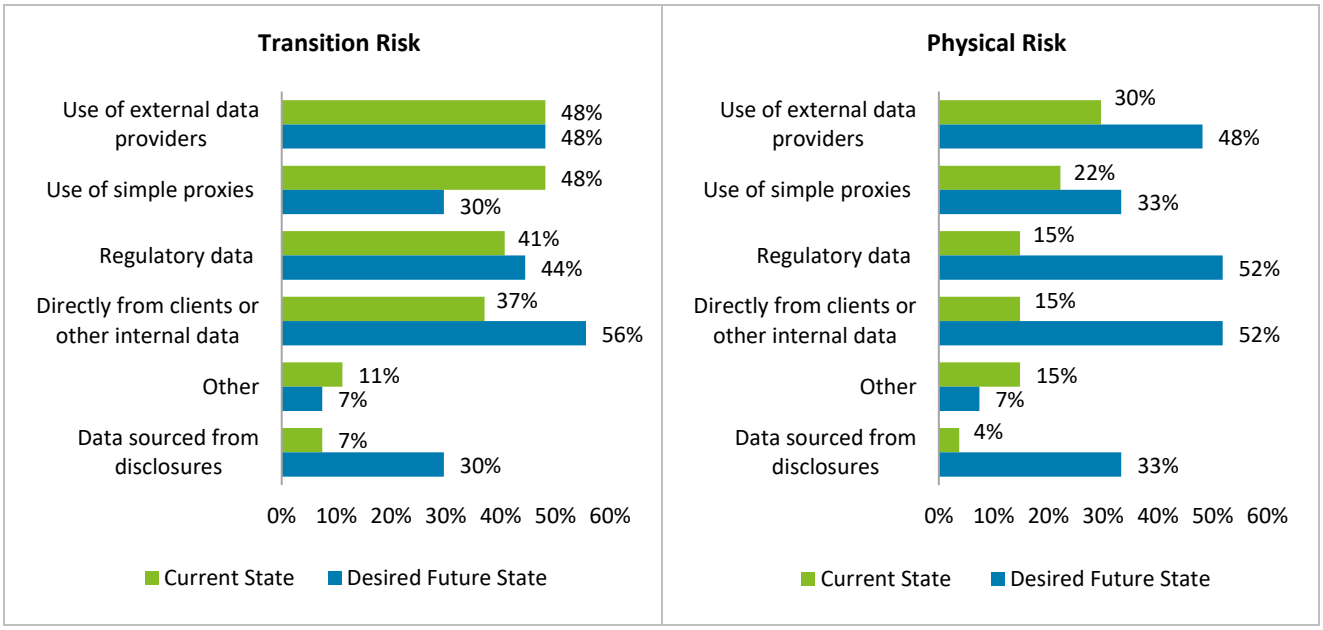


Figure 13: Data sources for transition and physical risk (percentage of total survey respondents, multiple answers permitted)

Stage 4: Generating Shocks

It is important to consider what calibration approach will be taken, and this is heavily informed by the decisions made in Stages 1-3. Firms need to develop the capability to adequately identify transmission channels, which would inform the approach taken to calibrating corresponding market risk shocks and give thought to how liquidity horizons would be affected by these shocks. At this stage, firms should take stock of their existing modelling infrastructure and determine what calibration approach is most appropriate to enable the derivation of market risk factors for stressing their portfolios.

Key consideration 9 – Transmission channels: Identifying relevant transmission channels for climate shocks and their associated market impact is an important step in determining the appropriate calibration approach and assessing the resulting trading book effect.

Transmission channels represent the process through which climate risk events materialize and translate into a financial impact on the trading book and firms should develop the capability to adequately identify transmission channels.

As part of the design phase described in this paper, a climate shock event will have been macroeconomic defined and developed into climate scenario pathways and an associated set of effects. Institutions can decide if they want to use climate scenario pathways and macroeconomic variables set out by regulatory bodies as a starting point or design these scenarios internally when looking to conduct climate scenario analysis in the trading book. Whichever approach is used, those macroeconomic climate scenarios will need to be translated into market risk factors through firms' preferred calibration approach to ultimately assess the impact on the trading book exposures. A key determinant of the scenarios and market risk factors will be mapping out the relevant transmission channels, which would also be useful for decisions on risk mitigation and management actions.

These channels will be different depending on whether a physical risk or transition risk event (or a combined event) is being assessed and whether the bank is choosing to assess market risk, CCR or both. For example, it may be that market risk and CCR effects occur in different time periods and via different channels. Box A sets out some illustrative transmission channels from climate risk shocks to trading book risks.

Most respondents indicated they have limited (44%) or somewhat limited (36%) confidence in their ability to adequately identify transmission channels, emphasizing the gap in firms' climate risk assessment capabilities.

The consideration of different risk types (market risk, CCR, XVA) is driven by the transmission channels assumed, the nature of trade position and materiality of the exposure to market risk factors or the creditworthiness of the counterparty. 96% of survey respondents agreed that market risk and CCR should be assessed as part of climate scenario analysis for the trading book. Likely due to the current lack of available data and consensus on methodologies to assess CCR, only 41% of respondents include CCR in their existing scenario analysis and nearly twice as many respondents are looking to include this in the future state. In contrast, while XVA risk is considered to a greater extent than CCR in the current state, it is not as much of an area of focus in the future (Figure 14).

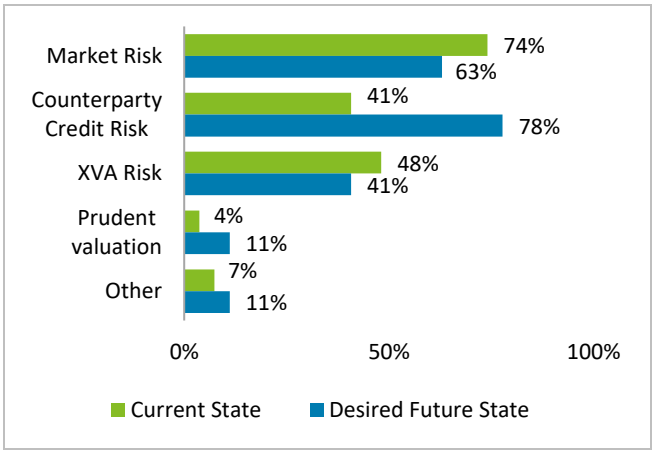


Figure 14: Current and future state risk types included in climate scenario analysis in the trading book (percentage of total survey respondents, multiple answers permitted)

Another key aspect of transmission channels will be whether first- and second-round effects are both being considered. First-round effects may be more company-, sector- or region-specific. Second-round effects are typically more dispersive and apply more widely, aggregating across the economy beyond individual asset

classes, reflecting systemic contagion risk in other asset classes (eg, FX, interest rates)[8]. In other words, first-round effects define the instantaneous and direct impact from a given climate shock, while second-round effects generally refer to contagion effects and feedback loops stemming from that initial shock.

37% of respondents indicated it is very important and a further 33% indicated it is somewhat important for scenario narratives to cover second-round effects and feedback loops. In practice, focusing purely on capturing first-round effects is the most popular choice for participants conducting climate scenario analysis, with some suggesting that second-round effects may disguise the true effects of climate risk (Figure 15).

Consideration of whether to include both first-round and second-round effects has implications for (i) the shock generation approach (eg, use of models versus expert judgement); (ii) the coverage of specific risk classes (ie, market risk, CCR and XVA). 74% of respondents suggested the incorporation of second-round effects was not considered to affect the choice of climate scenario horizon.

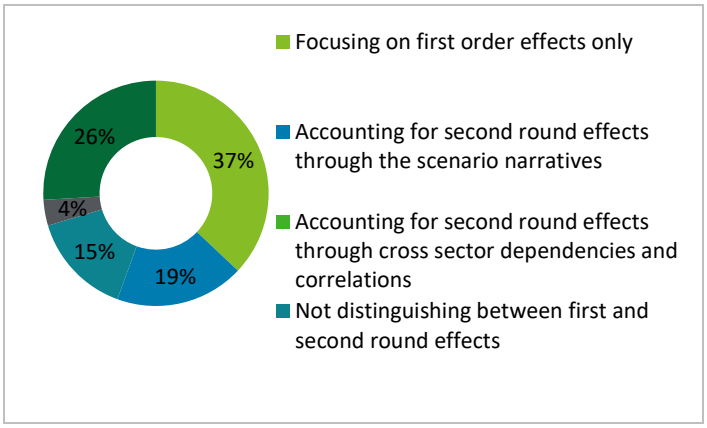


Figure 15: Current and future state risk types included in climate scenario analysis in the trading book (percentage of total survey respondents)

Explicit consideration of how scenario analysis assumptions should be adapted for climate-related risks can inform a sense check of exactly what is captured within the analysis and the associated weaknesses. This allows for clarity for the purposes of review and challenge of the resulting approach. Furthermore, clear documentation of scenario analysis assumptions and limitations will be beneficial when it comes to regulatory correspondence.

[8] Macro-financial feedback loops could be considered as part of the second-round effects and can be articulated as part of the macroeconomic scenario

Box A: Illustrative Transmission Channels from Climate Risk Shocks to Trading Book Risks

Climate risk shocks such as the sudden introduction of a carbon tax or an acute physical event such as a flood, could affect trading book asset classes through various economic transmission channels at different time horizons, as illustrated below.

Transmission channels for transition shocks, such as the introduction of a carbon tax, could include newly stranded assets, increased capital requirements, price and valuation shifts which may result in equity, commodity and possibly currency shocks, depending on the carbon intensity of the country. The extent of these manifesting to financial risks will depend on the magnitude and extent of the carbon tax and the time horizon of the scenario.

Similarly, transmission channels for physical shocks such as a flood event could include property damage and business disruption, resulting in loss of income, capital depreciation and supply chain shocks. These could also result in equity price shocks as well as interest rate increases to reflect higher insurance premiums. The extent of these manifesting to financial risk will depend on the flood severity and damage caused to different sectors and the time horizon of the scenario.

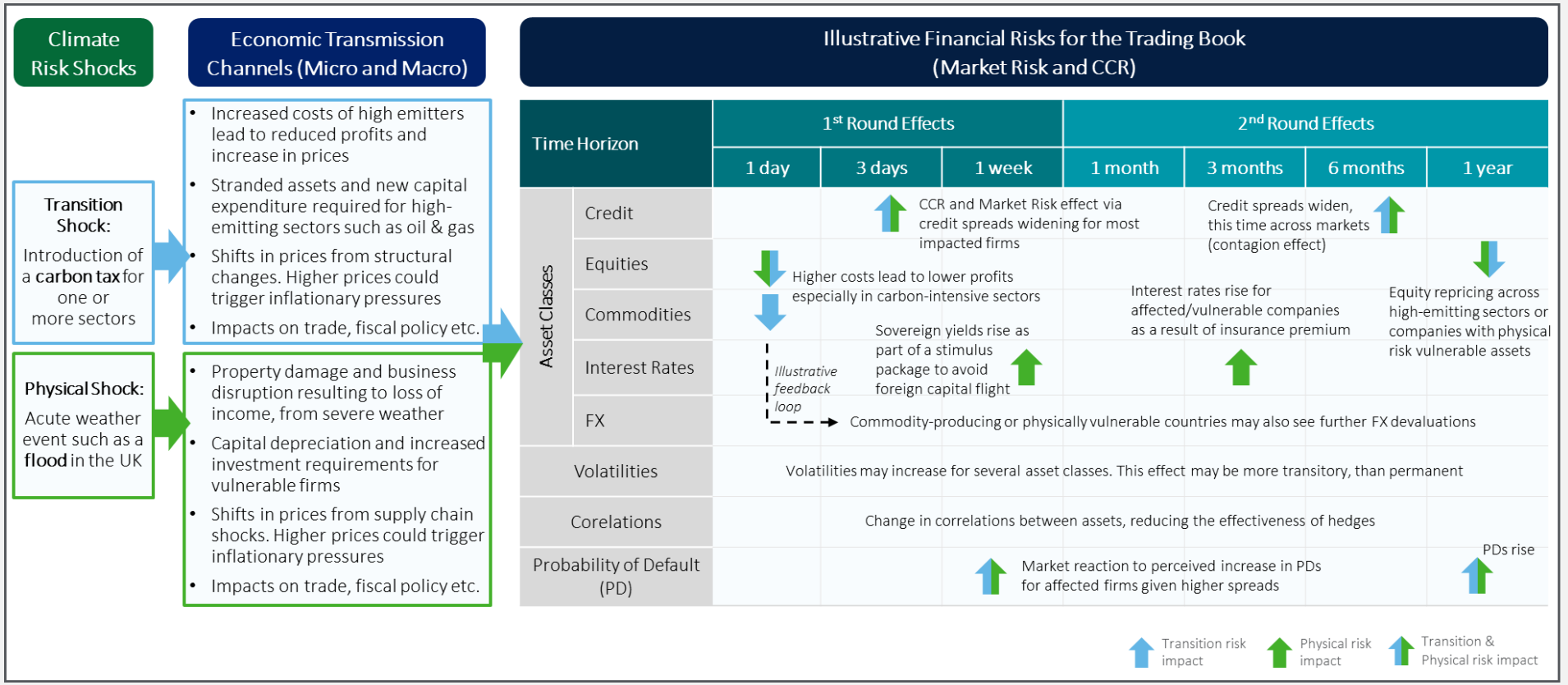


Figure 16: Illustrative climate risk transmission channels to trading book risks

Key consideration 10 – Liquidity horizon: A given climate shock could affect the ability to liquidate positions in each sector or market in the short term and may subsequently affect hedging strategies. Attention should be given to liquidity horizons when considering the effect of a climate scenario on the trading book.

Liquidity horizons will be affected by climate risk events and firms may need to adjust their hedging strategies accordingly. The magnitude of climate shocks and the transmission channels associated with those shocks could have an effect on liquidity horizons for a given trade position, portfolio or asset class. Consideration should be given to the extent to which a climate event would affect the corresponding liquidity horizon.

For transition risk, a wide range of liquidity horizons up to one year were specified by respondents as relevant across each asset class, with the most relevant horizon being one day and two weeks, due to the short-term nature of trading book balance sheets. The liquidity horizons selected for physical risk are consistent with transition risk, with marginally shorter horizons. For credit, the liquidity horizons are slightly longer, with one month being the preferred liquidity horizon (Figure 19).

Respondents consider liquidity horizons to remain the same or perhaps increase to some degree for climate scenario analysis. In adjusting the liquidity horizons, banks can ensure they have customized the stress to specific portfolio characteristics to better inform hedging strategies.

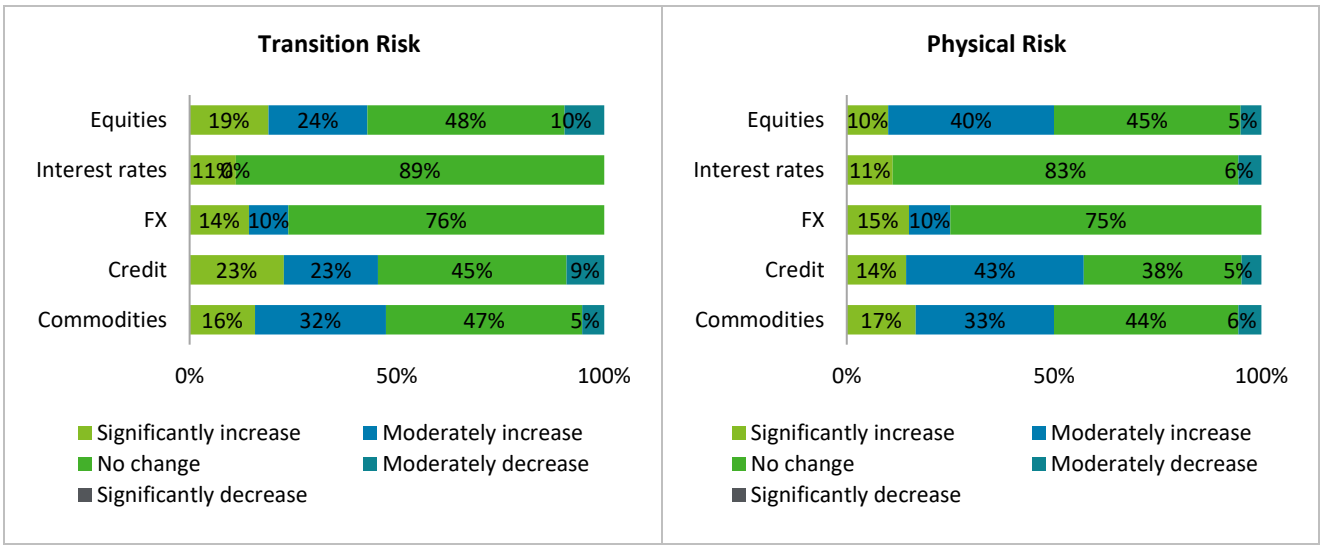


Figure 20: The effect of climate risk shocks on asset class liquidity horizons (percentage of total survey respondents)

Box B: Existing use of longer-term NGFS scenarios in climate scenario analysis in the trading book

Although 60% of respondents noted that they use NGFS scenarios indirectly as a starting point, only 37% reported using NGFS scenarios directly. However, these respondents have provided useful insight into specific NGFS models and variables used.

Respondents using existing longer-term NGFS scenarios for their trading book climate scenario analysis as a starting point suggested that macro-financial variables provided by NiGEM and transition variables provided by integrated assessment models are the most relevant variables for their assessment (Figure 17).

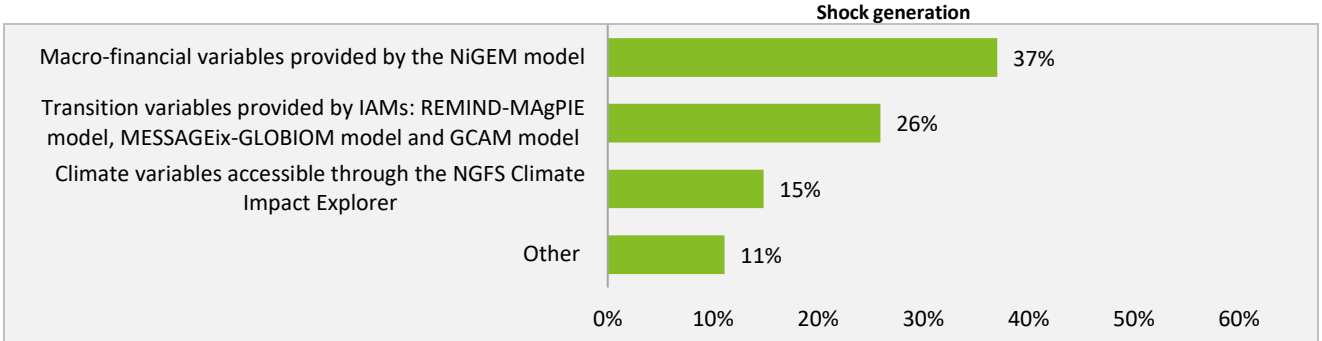


Figure 17: Variables most relevant when using existing NGFS scenarios (percentage of total survey respondents, multiple answers permitted)

37% of respondents selected macro-variables from NiGEM and indicated that inflation and interest rates, followed by energy prices and gross domestic product are the most relevant variables. Additional variables recommended by respondents included FX rates, policy rates (eg, central bank base rates) and house prices.

Where transition variables from integrated assessment models have been used, most respondents use the energy variables (energy prices, energy mix including renewables, investment in energy sectors) and greenhouse gas emissions data at aggregate/sectoral level. Only a small number of respondents (15%) have stated that they have used physical risk data from the NGFS Climate Impact Explorer.

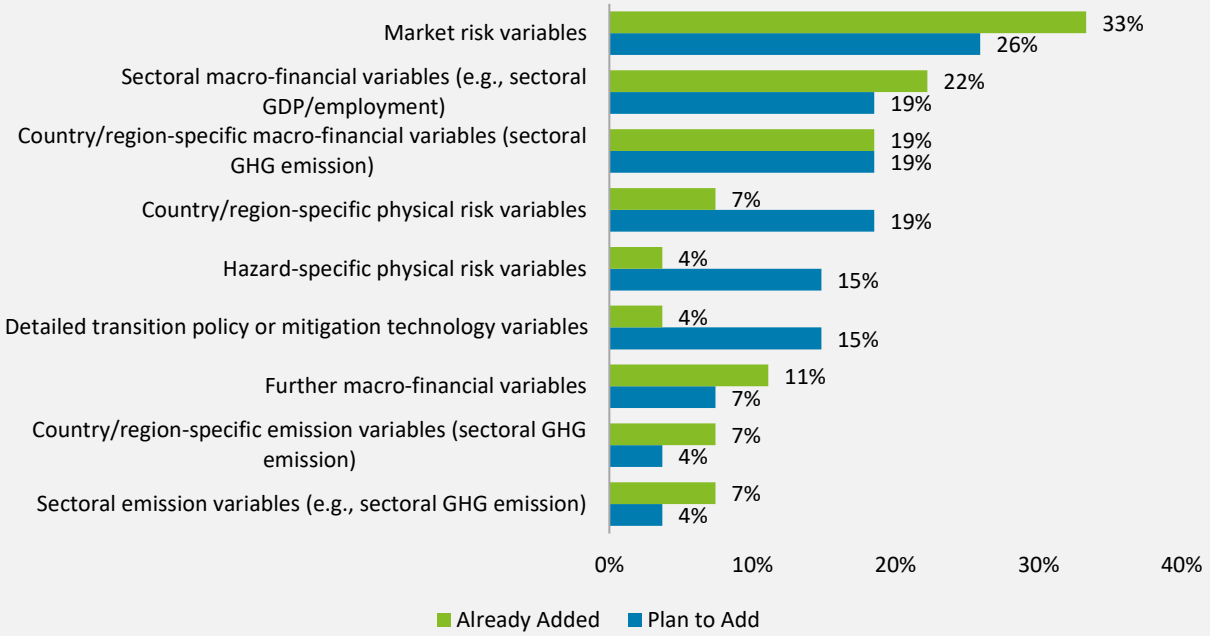


Figure 18: Additional variables to maintain relevance to the trading book when using existing NGFS scenarios (percentage of total survey respondents, multiple answers permitted)

Firms noted that the use of NGFS scenarios does have some limitations in terms of the relevant variables available to support the assessment. Where firms concluded that variables are missing, they have added or plan to add existing variables. The primary variables either added or planned to be added are market risk variables, sectoral macro-financial variables and country- or region-specific macro-financial variables. Variables such as sector ratings or illiquid risk factors are recognized as being additional variables needed to modify scenarios for the trading book. A further focus area is on country- or region-specific physical risk, or hazard-specific variables (Figure 18).

Key consideration 11 – Calibration: Firms should select the most appropriate method to calibrate market risk factors for the trading book and decide if a quantitative or qualitative approach is more suitable for the given use case and scenario pathway. Firms should consider alternative approaches that might be required for transition and physical risks. Firms should take care to evidence and justify their choices.

Irrespective of the calibration approach, it is important to ensure that the approach and underlying assumptions are supported by evidence, the assumptions around the approach are documented and that the choice of a specific approach is explained and justified in comparison to the alternatives.

A range of quantitative and qualitative approaches to climate shock calibration is currently being taken across the industry, with many banks relying on qualitative 'expert judgement' approaches to calibrate market risk shocks. Other banks use more data-driven granular approaches where they have been able to source emissions data, company-specific transition readiness data and historical extreme weather events to inform the calibration of the corresponding climate shock (Figure 23).

There may also be differences in the calibration approach according to whether transition risk or physical risk events are being assessed. For transition risks, 50% of respondents prefer a bottom-up calibration approach to account for company-specific transition data, whereas for physical risk respondents are more divided on their approach (Figure 22). For example, where acute physical risk shocks could be based on historical events and calibrated to reflect the severity of future events, transition risk events pose a greater challenge with no historical data to inform macroeconomic expansion or the calibration of market risk factors.

Some hesitance for including second-round effects stems from the concern that these effects tend to be larger, macroeconomic impacts that might overshadow the true climate risk associated with the initial shock. For this reason, second-round effects might also be addressed by management actions, rather than being explicitly calibrated.

Once the relevant market risk factors have been calibrated from the macro-financial and climate data, these should be sense checked to consider whether they adequately capture a range of severities of climate events consistent with the firm's risk appetite, while remaining relevant and plausible. This will help stakeholders to understand the relevance of the results and consider how the impacts might affect the business, informing strategic decision making. The severity of the market risk shocks associated with a given climate scenario is likely to be dependent on the use case. The resulting calibration should be based on both a data-driven and/or judgement-based assessment of the potential future risks that might materialize.

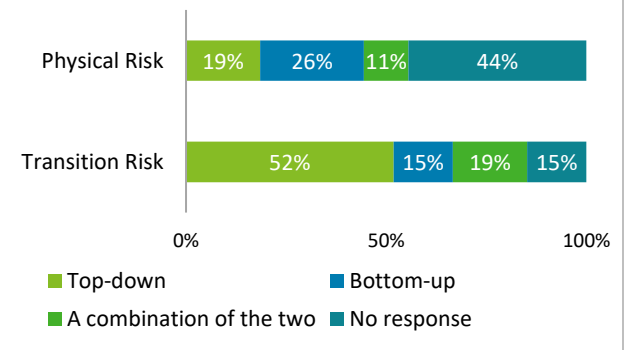


Figure 19: Calibration approach selected for climate scenario analysis in the trading book (percentage of total survey respondents)

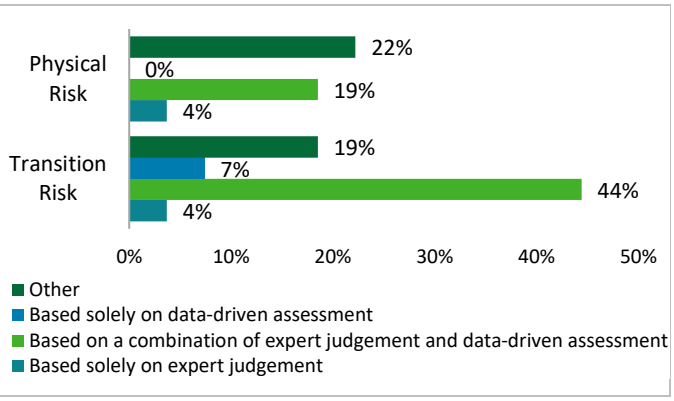


Figure 20: Modifying scenarios to be more relevant to the trading book (percentage of total survey respondents)

Key consideration 12 – Modelling capabilities: Institutions should consider undertaking a stocktake of existing modelling capabilities to generate market risk factors and look to develop these for climate scenario analysis in the trading book with other approaches such as data-driven assessment or expert judgement. Any development of a new model should be commensurate with materiality and consider the model risk associated with the approach.

Stage 4: Shock generation

Adopting a model(s) to perform climate scenario analysis is only one of the approaches followed to assess climate risk in the trading book. When carrying out climate scenario analysis, different approaches can be taken to map macro-financial climate scenarios to firm-specific trading book exposures. Currently climate scenario analysis is mainly undertaken using existing bank infrastructure or is heavily dependent on expert judgement when translating climate impacted macroeconomic variables into market risk shocks.

It is important to consider whether the effort associated with a given method is commensurate with the perceived materiality of the risks and to consider the degree of model risk associated with a given approach. In particular, any development of an approach needs to consider the robustness of statistical methods in modelling the impact on firm-specific traded exposures.

Banks were asked if they currently use or plan to use an integrated model to link climate pathways and macroeconomic variables with the associated transmission channels and market risk factors. A very small number of respondents (7%) have a model already in place and only for transition risk. Most respondents do not currently have a model in their framework, but a significant proportion of these would consider this in future (63% for physical risk and 48% for transition risk – see Figure 24). Furthermore, when asked what their preferred approach is when developing an integrated model, 37% of respondents prefer to have a combination of internally and externally developed models (Figure 28 in the Appendix).

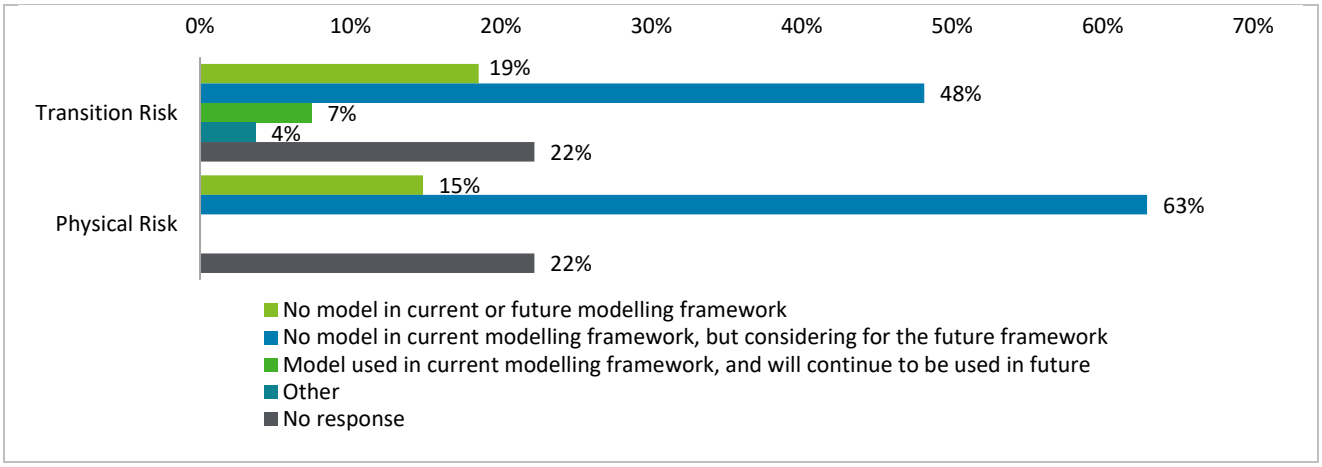


Figure 25: Percentage of survey respondents using an integrated model to link climate shocks with associated transmission channels

Respondents cited a number of challenges in using integrated models:

- 70% of respondents cited lack of appropriate data to inform such a model;
- Half of respondents also cited modelling complexity; and
- The lack of guidance on how to use macroeconomic models in the short-term (Figure 25).

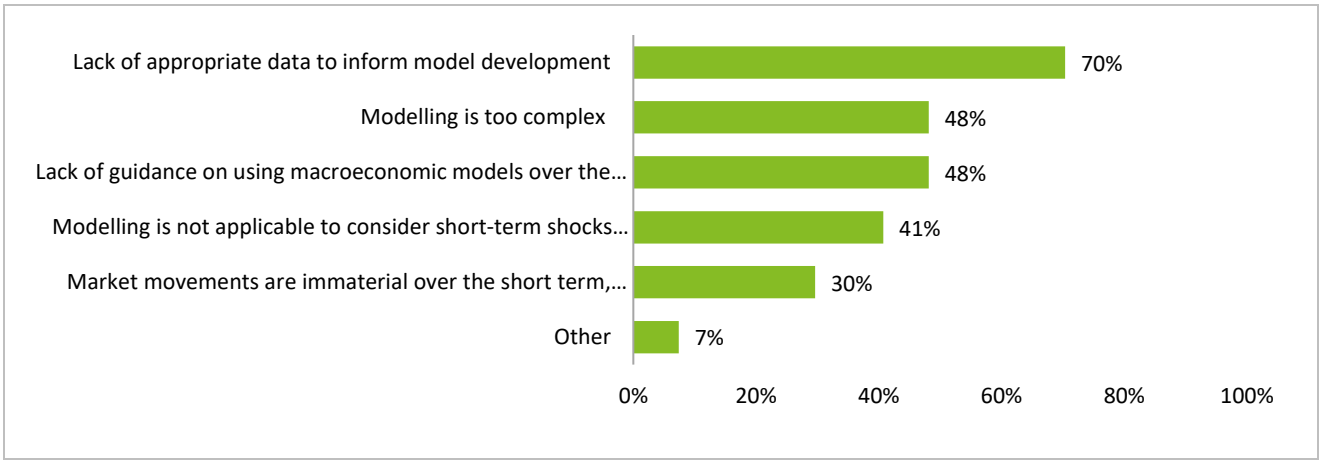


Figure 26: Challenges institutions face in using an integrated model (percentage of total survey respondents, multiple answers permitted)

Stage 5: Impact assessment

The results of the climate scenario analysis need to be expressed in terms of existing risk metrics for the trading book (eg, profit and loss (P&L)). Once the results have been generated, it is important to perform internal validation of the outputs, including sensitivity analysis.

Key consideration 13 – Metrics: A range of metrics, such as P&L or risk-weighted assets, should be used to assess the financial impact of climate risk shocks in the trading book and the most appropriate metric could differ depending on the use case or a firm's level of maturity in scenario analysis.

In the current absence of climate-specific metrics, the effects of climate are being integrated into traditional risk measures. Stressed P&L is regarded as the preferred impact metric to measure climate risk in the trading book. Where the effect is measured at an overall trading book level, there is a desire to have a more granular view at a sector, regional or counterparty level to assess the associated risk at each level (Figure 21).

In future, as data availability improves and firms have a better understanding of how to measure climate risk in the trading book, climate-specific risk metrics might be produced to isolate the specific climate shock impact, for example a climate delta or climate value-at-risk.

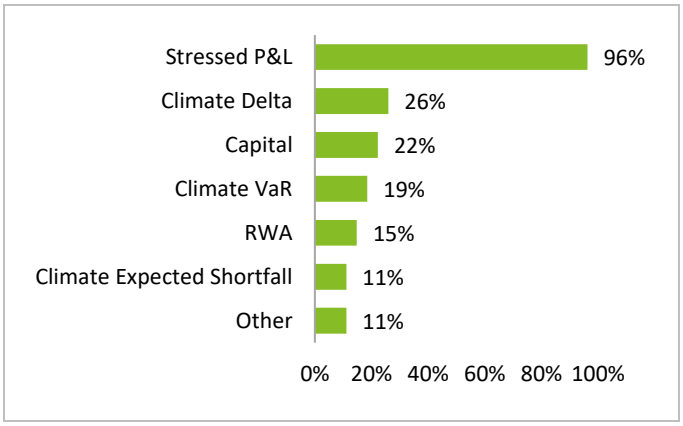


Figure 21: Preferred impact metrics (percentage of total survey respondents - multiple answers permitted)

Once the results have been produced, firms should undertake internal validation of the outputs, including sensitivity analysis, to ensure the robustness of the results. Performing validation or back-testing is complex for climate risk given the lack of data and in reality, the severity and frequency of climate events, location of potential effects and speed of crystallization could all manifest in different ways than predicted climate scenarios. For example, when considering physical risk, there is uncertainty around the exact location, timing and severity of an acute weather event. For transition risk there may be uncertainties around the timing and severity of policy announcements, rate of technology innovation or changes to consumer preferences.

Sensitivity analysis allows firms to understand and interpret the results for use in strategic decision-making. It also helps to identify the portion of the shock that relates to specific climate risk driver(s) vs other macroeconomic effects. Quantitative assumptions of likelihood (eg, probabilities) of different climate events could also be applied to further interpret the results. This elevated level of uncertainty versus traditional stress tests should be explicitly acknowledged when conducting climate scenario analysis.

The type of sensitivity analysis or model validation that takes place will depend on the calibration approach taken. As discussed, some firms are considering building an integrated model to conduct climate scenario analysis in the trading book. However, 59% of respondents are unclear how the results should be validated, while the remainder have no plans to develop an internal model (Figure 22).

Figure 22: Validation of outputs from integrated model (percentage of total survey respondents)

3. Conclusion and Next Steps

Climate scenario analysis is a core tool being developed and used by financial institutions and regulators to understand the climate-related risks faced in the financial sector. To date, climate scenario analysis has been primarily focused on measuring the long-term effects of climate change, with most work undertaken for the banking book. This paper instead focuses specifically on the short-term effects of climate change and how these could impact trading book assets.

Drawing heavily on an industry working group and the results from a detailed survey of working group members, this paper provides a stocktake of the approaches currently used or in development at financial institutions to undertake climate scenario analysis in the trading book. It uses these insights to develop a blueprint for an end-to-end conceptual framework for climate scenario analysis in the trading book. In doing so, it educates industry and regulators on the needs of financial firms when conducting climate scenario analysis and supports the industry in developing a harmonized approach to climate scenario analysis that is consistent with the aims and objectives of both industry and regulators.

Finally, it identifies the following key areas of focus for both financial institutions and regulators in developing approaches to climate scenario analysis:

- The quality and quantity of available macro-financial data continues to represent a key barrier to the bottom-up, data-driven assessment of climate-related risks to trading book assets. Industry, regulators and academia should work together to improve the availability and applicability of climate and macro-financial data to be used for climate scenario analysis in the trading book, including developing guidance on how this data should be used.
- Given that climate scenario analysis in the trading book remains in nascent stages, a range of qualitative and quantitative calibration approaches are being used across the industry. Further work should be done to develop a consensus view on relevant and robust approaches to the calibration and modelling of climate-related shocks and the impact these have on trading book assets.

In relation to the latter, ISDA plans to build on the work done during the development of this paper in a next phase of this work to be conducted in the second half of 2023, to develop approaches to climate scenario analysis in the trading book and provide support in the practical implementation of those approaches across the industry.

This further phase of work will involve the conceptual framework for climate scenario analysis in the trading book outlined in this paper to develop a suite of scenarios for the trading book. ISDA will work with industry participants that have expressed an interest in this pilot phase to develop and implement climate scenario analysis approaches, ensuring that these exercises can be leveraged across the various use cases for such analysis, be it regulatory stress exercises, internal risk management or to inform strategy and pricing.

4. Appendix A

A.1. Literature Review

This section summarizes the key resources covering the current state of short-term climate scenarios development and the incorporation of climate risk into the trading book across the industry. The resources are set out in order of publication.

Hong Kong Monetary Authority (HKMA) (2023) – Guidelines for Banking Sector Climate Risk Stress Test
The latest HKMA banking sector climate risk stress test (CRST) includes a new short-term (five-year horizon) scenario to assess the potential effects arising from simultaneous economic and climate-related shocks. The exercise will also include three long-term scenarios developed by the NGFS. A broader set of scenario variables and assumptions will be provided to all participating banks to support more granular assessments. The first round of the CRST will focus on exposures highly vulnerable to climate-related shocks and the second round will extend to exposures that are usually considered less susceptible to climate change. Banks are required to use Global Industry Classification Standards codes when classifying their corporate exposures, based on business activities.

The HKMA has developed a set of granular metrics that should be generated under each of the scenarios to facilitate comparability of financial performance across banks. Key metrics include capital adequacy ratios, expected credit losses, risk-weighted assets, probability of default of their corporate obligors, fair value of assets and operational losses.

Deutsche Bank Research (2023) – Climate Stress Tests: Are banks fit for the green transition?
This report explores the readiness of banks to manage climate risks. In the short term, shocks may stem from extreme weather events, as well as sudden and sharp hikes in carbon prices. According to a joint report from the ECB and the European Systemic Risk Board (ESRB), a sudden carbon price shock would hit banks much harder (projected losses of 0.7% of outstanding corporate loans) than a shock caused by an extreme weather event (0.004%). In the long term, however, if global warming continues unabated, physical risk effects will become more severe as the likelihood of extreme weather events increases and higher temperatures affect the economy on a larger scale (eg, decline in labour productivity due to high temperatures).

ISDA – EY (2022) – Climate Risk Scenario Analysis for the Trading Book
18 banks participated in a survey to determine the maturity of firms' approaches to climate risk scenario analysis for the trading book. It included an introduction on firms' scenario capabilities in the trading book and how this compares with the banking book. The report details how firms aim to use scenario analysis for the trading book and design choices such as scenario narrative, asset class coverage and considerations for different trading book risk types (eg, market risk, CCR). It highlights the challenges firms are facing such as data availability and lack of consensus on approach.

UNEP FI (2022) – Economic Impacts of Climate Change: Exploring Short-Term Climate-Related Shocks with Macroeconomic Models
The most progress made in using macroeconomic models to generate shorter-term scenarios has been by the United Nations Environment Programme's Finance Initiative (UNEP FI). UNEP FI partnered with the UK's National Institute of Economic and Social Research and consulted with 48 participating financial institutions to develop three new short-term macroeconomic scenarios for users to explore (five-year horizon). The three scenarios are linked to existing longer-term NGFS scenarios and capture the following: (i) a sudden rise in carbon price; (ii) a spike in oil price; and (iii) a trade war.

UK Finance (2022) – Integrating Climate Risk into the Prudential Capital Framework
UK Finance held a series of roundtables with the six UK banks in scope of the Bank of England's Climate Biennial Exploratory Scenario to discuss the appropriateness of capital for climate-related financial risks. The report suggested that capturing climate within the internal models approach for market risk is challenging given the short-term nature of the trading book.

European Banking Authority (EBA) (2022) – The Role of Environmental Risks in the Prudential Framework
This discussion paper highlights the role of environmental risks in the prudential framework. The report outlined that climate risks could materialize through market risk via multiple channels, including commodity markets. Physical risks could cause market price fluctuations, causing equity price losses due to the destruction of firms' assets or capacity to produce.

While climate risk may not lead to the introduction of new risk factors, it may affect the magnitude of their shocks. Also, climate risks could cause market risk factors (eg, an equity price, FX) to fluctuate more than historically observed or to be subject to severe jumps. Since the available data do not include sufficient or comparable information about losses due to climate-related events or transition trends, it is difficult to identify relevant risk drivers and uncertainties on transforming these risk drivers into financial risk indicators.

ECB (2021) – 2022 Supervisory Climate Risk Stress Test
The ECB incorporated near-term transition and physical risks into their 2022 supervisory climate risk stress test. Transition risk is modelled using three-year horizon scenarios, whereas physical risk scenarios are designed as instantaneous shocks. The exercise assesses the vulnerability to the effects of the entirety of Europe being hit by a heatwave and a severe flood. The CRST also includes a 'severe but plausible' scenario assessing a three-year disorderly transition due to a rapid increase in carbon prices.

The 41 participating banks estimated overall credit and market risk losses of EUR 70 billion for three short-term stress scenarios combined. For market risk, banks report a very small drop in the net fair value of their trading portfolios from a one-year materialization of an instantaneous transition risk shock. However, the market risk methodology adopted was simplified as it had less comprehensive and less severe market risk shocks compared to adverse scenarios of the regular EU-wide EBA stress tests.

Basel Committee on Banking Supervision (2021) – Climate-related Risk Drivers and their Transmission Channels
This report explores how climate-related financial risks can arise and how they affect both banks and the banking system. Physical and transition climate risk drivers can affect banks' financial risks via micro- and macro-economic transmission channels. Climate risk drivers can have a significant effect on the value of financial assets, including downward price shocks and an increase in market volatility in traded assets. The paper welcomed further work on the impact of climate risk drivers on price correlations as well as market liquidity.

NGFS (2020) – Guide to Climate Scenario Analysis for Central Banks and Supervisors
This report provides general, practical guidance to the industry on using scenario analysis to assess the impact of climate risks on the economy and the financial system. The report adopts a four-step process that includes: (i) identification of objectives and exposures; (ii) selecting climate scenarios; (iii) assessing economic and financial impacts; (iv) communicating and using results.

Banque de France / Autorité de Contrôle Prudentiel et de Résolution (2020) – Climate-Related Scenarios for Financial Stability Assessment in France
The first bottom-up climate-related risk assessment for financial stability in France. The exercise proposed an analytical framework to quantify the impacts of climate policy and transition narratives on economic and financial variables. For transition risks, the NGFS-calibrated scenarios and models considered unexpected increases in carbon prices and productivity shocks to reflect disorderly transition processes. For market risk only, the trading portfolio was considered for the portfolio revaluation and a static balance sheet assumption was followed. The market shocks used for this exercise were significant but applied to a small portion of the portfolio (equity and corporate credit spreads in sensitive sectors as well as to sovereign risk).

De Nederlandsche Bank (DNB) (2018) – An Energy Transition Risk Stress Test for the Financial System of the Netherlands
In its transition risk stress test, DNB explored four short-term disruptive energy transition scenarios. In line with common stress testing practice, the four stress scenarios were chosen to be 'severe but plausible', capturing tail risks over a five-year horizon. Unlike the NGFS scenarios, the DNB scenarios are not explicitly tied to a temperature outcome and focus on transition risk.

A.2. Challenges of Using Existing Frameworks for Short-term Climate Scenario Analysis in the Trading Book

Existing traditional stress testing frameworks are not designed for the purpose of climate scenario analysis in the trading book and so will require varying degrees of modification to enable the application of climate-specific shocks and the generation of corresponding market risk factors. The two main types of climate risk shocks that need to be considered in climate scenario analysis are:

- Transition risks arising from the transition to a lower-carbon economy, which can result from additional policies (eg, carbon taxes), legal risks, technology disruption, preference shifts and reputational effects;
- Physical risks arising from acute weather events such as hurricanes and wildfires, and/or chronic shifts in weather patterns, such as gradual increase in surface temperatures.

For regular stress tests, scenarios are chosen based on expert knowledge and historical experience, and so the impact on financial institutions has been tested with some degree of confidence. Conversely, climate change is inherently uncertain and past events do not necessarily provide an accurate guide to potential future outcomes. This means that, for an accurate assessment of climate risks, models instead need to be based on a forward-looking view of the interaction between climate and the economy. However, the data and methodologies available to map out the transmission channels of climate-related risks into economic and financial risks, and forecast these into the future, are incomplete and incredibly complex. Table 1 summarizes the distinction between traditional stress testing frameworks and frameworks specific to climate risk scenario analysis in the trading book.

Table 1: Climate vs traditional trading book scenario analysis

	Climate Risk Trading Book Scenario Analysis	**Traditional Trading Book Scenario Analysis**
Transmission Channels	Based on a climate risk event – eg, natural disaster or transition risk shock	Based on a purely market risk event – eg, a macroeconomic shock
Calibration approach	Greater reliance on expert judgement given climate data constraints. Models and expert-judgement need to incorporate climate-adjusted data	Greater reliance on historical data-driven assessment, supported by expert judgement and models
Granularity	Granular regional and sector level – linked to vulnerability to climate risks based on climate data regarding asset-specific locations, particularly for physical risk	Some sector / regional granularity, but not required at same level

Industry progress so far has been primarily on climate scenario analysis for longer-term horizons. These are more relevant to the banking book. Climate scenario analysis in the trading book requires an alternative approach that explicitly considers the characteristics of specific trading book assets that would be affected by climate risks in different ways. For example, the relevant scenario horizons, liquidity horizons and transmission channels would be very specific for trading book assets and assumptions would necessarily differ from the assumptions around these factors in the banking book. Table 2 summarizes the distinction between climate scenario analysis in the trading book compared to the banking book. The conceptual framework, which is core to this paper, aims to identify and draw out these differences, illustrating how existing stress testing frameworks can be leveraged and modified to incorporate climate-related factors.

Table 2: Trading book vs banking book climate scenario analysis

	Typical Trading Book Climate Scenario Analysis	Typical Banking Book Climate Scenario Analysis
Scenario Horizon	Very short term – up to 1 year	Short- to medium-term – 3-5 years Longer term - up to 30 years
Risk Types	Market Risk, Counterparty Credit Risk	Credit Risk focused
Asset Classes	Equities, Commodities, FX, Interest Rates, Credit, Vulnerable Counterparties	Credit-focused – eg, retail products (eg, mortgages), Wholesale corporate products, Sovereign Loans
Risk Factors	Equity Indices, Commodity prices, Rates, Credit spreads	Probability of Default, Loss Given Default, Exposure at Default
Transmission Channels	Immediate impacts on macro-financial variables and market risk factors	Short- to medium-term movements in macro-financial variables
Assumptions	Static balance sheet favoured in short term	Dynamic balance sheet appropriate for medium term horizon

A.3. Case Studies

Case studies were provided by industry participants to demonstrate different firm-specific calibration approaches currently applied in practice.

Box C: Case Study 1 – Calibrating firm-specific shocks in a transition scenario

One bank provided a case study on how it supplements sector-average shocks with firm-specific scores in order to generate transition shocks. These feed into a transition scenario, producing equity price sell-offs and credit spreads at a company level (where granular data is available).

Methodology

Figure 23: The use of sector-specific risk assessments supplemented by firm-specific scores to generate transition shocks Sector average shock

1. The transition scenario uses an existing internal stress framework to apply average sector shocks. Shocks are defined using a combination of internal analysis and expert judgement, and through collaboration with asset class specialists. Certain carbon-intensive sectors (such as oil & gas) see a larger sell-off in equity prices and credit spreads. In sectors where there is a clear decarbonization pathway, there is a larger variance in the size of the sell-off.

2. **Transition score shock breakdown**
   There is a significant range of Paris Agreement transition preparedness by companies within each sector – therefore the aim is to ultimately define shocks at name level based on a waterfall approach, prioritized by materiality. Company-specific scores aim to measure preparedness for Paris Agreement / net-zero transition whereby a 'waterfall logic' is applied to rank the sources and apply the highest-ranked available score for each company. If a scoring provider isn't available, the next in the list is used, before finally reverting back to the sector average shock.

Sourcing Transition Scores

The sources of scores range from external providers, such as Bloomberg Climate Transition Scores and BNEF scores, to an internal scoring methodology that incorporates carbon emissions (present and projected), and

governance, to internal scores based on the aggregation of external vendor scores covering slow-moving environmental outlook and fast-moving news flow datasets.

Scores of external data providers are prioritized as they offer both scope and comparability, especially when considering the time and effort required to develop internal scores. As and when improved climate reporting leads to a wider and more established body of transition scores, this approach may be subject to change.

Box D: Case Study 2 - Qualitative calibration of transition risk events in the trading book

One bank provided a qualitative approach to calibrating a transition risk shock – a net-zero technology breakthrough. This involves collecting historical data, leveraging expert judgement to assess impacts and aggregating both to produce scores that represent the scale of macroeconomic movements.

Background

- Bank XYZ's Risk Committee asks its risk department to design a scenario that would estimate the potential vulnerability to a significant transition risk involving a technology shock.
- Considering that there is no historic precedent for a similar event, the risk department approaches the scenario analysis through a multi-step approach, relying on a combination of historical data and expert judgement.

Scenario Analysis in practice

1. **Scenario Design**
   - There has been a technology breakthrough related to the transition to net zero that leads to an immediate market reaction – a large move in global oil prices;
   - Senior experts at the Bank XYZ expect this to impact FX rates in fossil fuel exporting countries almost instantaneously;
   - The bank assumes the selling pressure will last for a period of one month.
2. **Calibration of Shocks**
   - Historical market data is collected to estimate the amplitude of the currency moves;
   - These include previous instances of abrupt global geopolitical events that impacted oil prices and in turn the oil industry of a given country – eg, elections with expectations of material policy changes, or military conflicts;
   - The currency movements are then sorted by magnitude per event;
   - Expert judgement is used to assess to what extent the historical market moves would need to be scaled up or down.
3. **Assessment of Impact**
   - Bank XYZ's research department uses vendor and publicly available data (corporate disclosures and nationally determined contributions) to establish a view on the long-term impact on national income from loss of oil exports;
   - Simultaneously, the business unit is assessing what the market perception may be on a given currency's sensitivity to a large drop in oil prices, including mitigating factors – interest rate differentials or other non-climate related factors influencing demand for the currency.
4. **Aggregation**
   - The research department and the business unit's qualitative assessment is summarized into a set of scores determining the scalar to be applied on historical moves.

A.4. Charts and Tables

Table 3: Applications of climate scenario analysis

	Stress Testing, ICAAP and ILAAP	Internal risk measurement and management	Disclosures and reporting	Strategy
Scope	The regulatory trading book	Only some parts of the trading book, determined by materiality	Guidance by reporting standards, based on materiality and industry best practice	Asset class, sector or select counterparties
Objective	Helps banks and regulators assess climate risk impacts for the bank or financial system Informs ICAAP/ILAAP submission	Form the basis of the institution's climate risk identification and management	For compliance with mandatory/ voluntary reporting standards, especially around any targets or forward commitments made transition planning.	Ensure business model resilience to climate change on a forward-looking basis, strategic decision-making considering both risks and opportunities
Materiality	Guided by the regulators	Self-identified by bank (eg, exposure, vulnerability etc.)	Driven by external reporting bodies and/or regulators or internal business MI	Driven by business' expectations around supporting climate transition and related actions (eg, targets) as well as risks faced
Frequency	As determined by supervisory authorities	Driven by internal timelines (eg, annually) and ad-hoc (eg, sensitivity runs)	Driven by annual external reporting requirements (eg, ISSB)	Driven by internal business requirements
Stakeholders	**CRO and Board Risk Committee:** Sign-off on risk posed by the trading book **ERM Team:** Stress test embedding	**Local regulator and CRO:** Agreement on material risks and actions **Head of Traded Risk and CRO:** Agree on traded risk's contribution to climate risk	**Head of Financial reporting / CFO:** Meeting regulatory disclosure requirements **Investors and clients:** buy-in from stakeholders	**Head of Strategy / CFO:** Dynamic view of trading book strategy **Head of Sustainability:** Overview of climate risk embedded in firm strategy

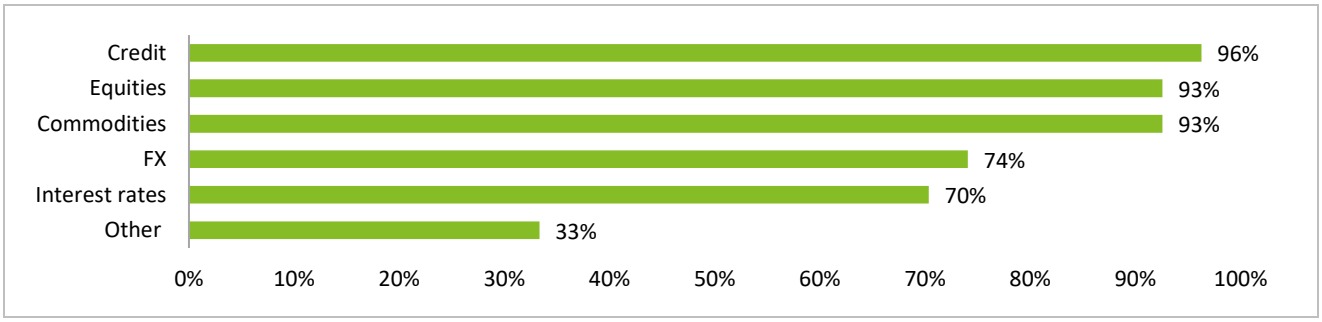


Figure 24: Asset class coverage for climate scenario analysis in the trading book (Percentage of total survey respondents, multiple answers permitted)

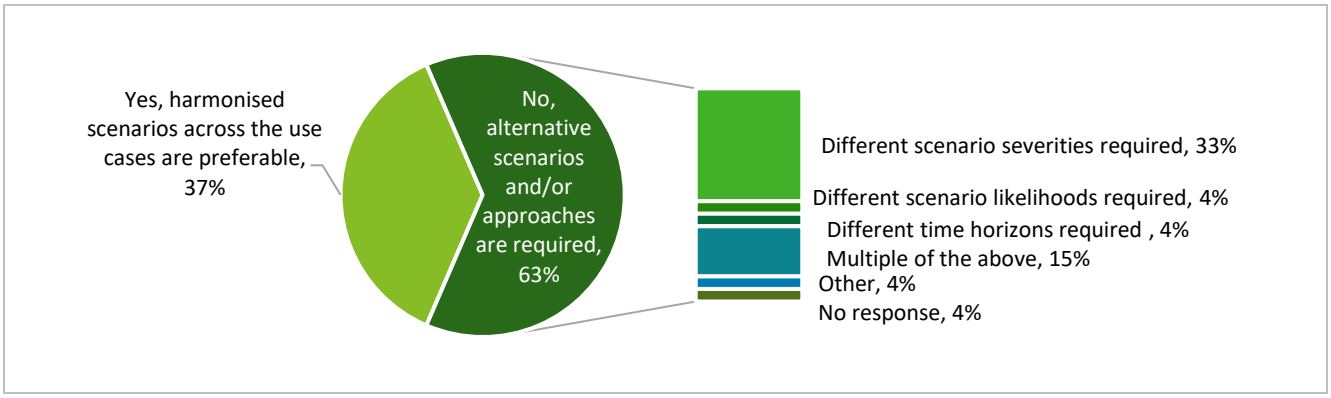


Figure 25: Percentage of survey respondents preferring consistency in scenarios across use cases

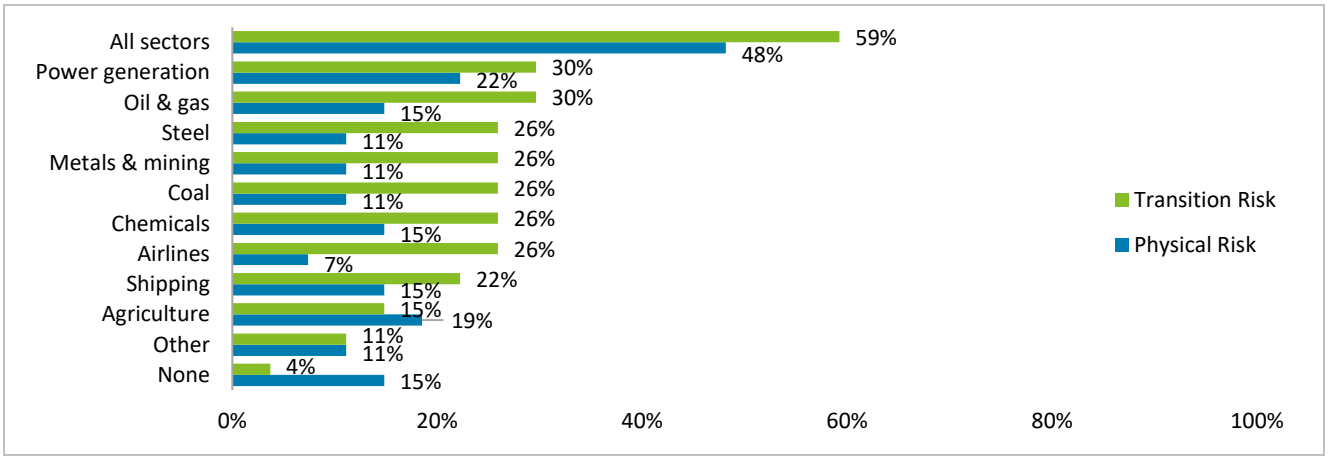


Figure 26: Sectors listed where counterparty-level analysis is most useful

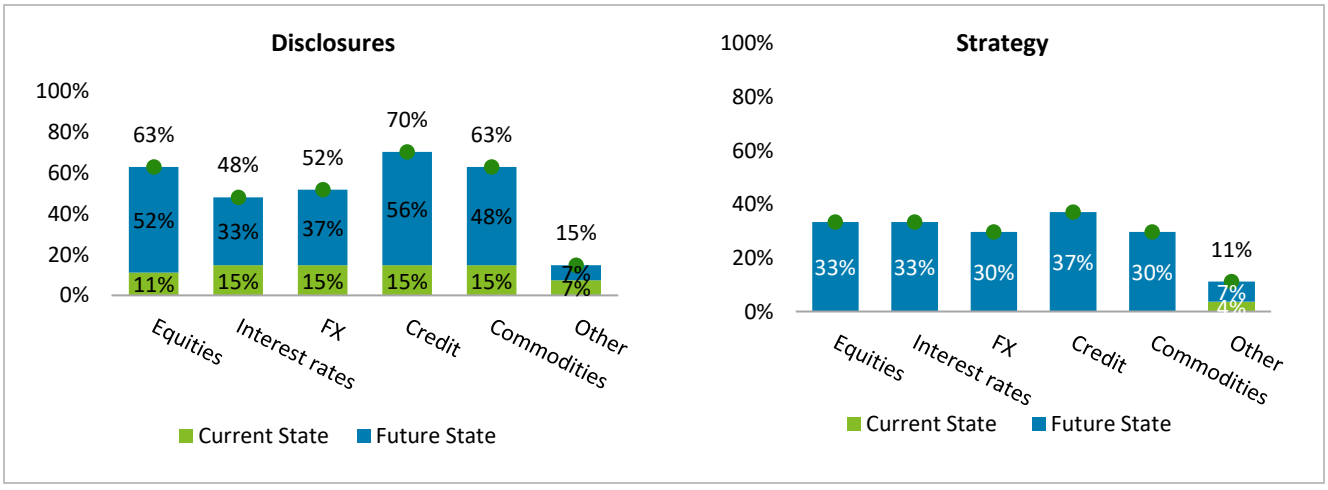


Figure 27: Asset class in scope for regulatory compliance exercises (Percentage of total survey respondents, multiple answers permitted)

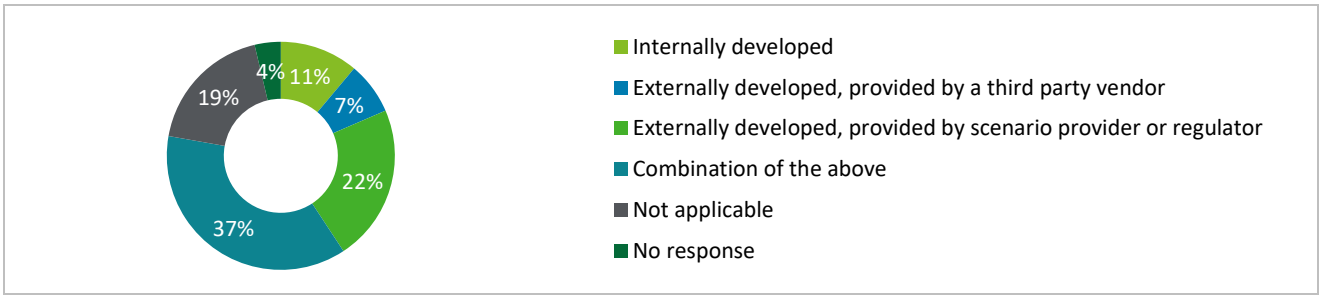


Figure 28: Preferred approach to develop an integrated model (Percentage of total survey respondents)

Appendix B

B.1. Summary of Key Considerations

Key consideration 1 – Applications: Establishing the use case of climate scenario analysis is required to inform the design of the exercise and ensure it can generate an appropriate set of outputs.

Key consideration 2 – Assumptions: Adopting a static balance sheet is the most appropriate approach for climate scenario analysis in the trading book, given the complexity and uncertainty associated with climate risk. However, firms may wish to consider dynamic approaches based on the use case.

Key consideration 3 – Narrative: The scenario narrative is necessary to describe the logic or development of physical or transition risk events and should be consistent with the outcome of the climate risk shock.

Key consideration 4 – Scenario horizon: The horizon of the climate risk scenario should be sufficiently short-term to be able to capture an instantaneous climate risk event and its effects on financial markets, while also considering use case and asset class being assessed.

Key consideration 5 - Scenario coherence: Consideration should be given to the plausibility of multiple occurring events and how this would affect the ability to isolate the effects of one climate event when conducting scenario analysis.

Key consideration 6 – Scenario consistency: Short-term trading book scenario narratives should be consistent with and easily comparable to existing longer-term scenario narratives, such as those provided by the NGFS.

Key consideration 7 – Portfolio segmentation: Portfolio segmentation should be undertaken to identify the most vulnerable and material sectors in the chosen portfolio(s). This will help to prioritize the climate scenario analysis in the trading book. Banks should challenge themselves to achieve the greatest level of portfolio granularity possible to enable a robust assessment of climate risk.

Key consideration 8 – Climate data: Reflecting the current challenges around gathering appropriate data to conduct climate scenario analysis, the industry should consider a quantitative assessment where feasible and supplement this using qualitative approaches and expert judgement to inform climate risk shocks.

Key consideration 9 – Transmission channels: Identifying relevant transmission channels for climate shocks and their associated market impact is an important step in determining the appropriate calibration approach and assessing the resulting trading book effect.

Key consideration 10 – Liquidity horizon: A given climate shock could affect the ability to liquidate positions in each sector or market in the short term and may subsequently affect hedging strategies. Attention should be given to liquidity horizons when considering the effect of a climate scenario on the trading book.

Key consideration 11 – Calibration: Firms should select the most appropriate method to calibrate market risk factors for the trading book and decide if a quantitative or qualitative approach is more suitable for the given use case and scenario pathway. Firms should consider alternative approaches that might be required for transition and physical risks. Firms should take care to evidence and justify their choices.

Key consideration 12 – Modelling capabilities: Institutions should consider undertaking a stocktake of existing modelling capabilities to generate market risk factors and look to develop these for climate scenario analysis in the trading book with other approaches such as data-driven assessment or expert judgement. Any development of a new model should be commensurate with materiality and consider the model risk associated with the approach.

Key consideration 13 – Metrics: A range of metrics, such as P&L or risk-weighted assets, should be used to assess the financial impact of climate risk shocks in the trading book and the most appropriate metric could differ depending on the use case or a firm's level of maturity in scenario analysis.

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Contributing Authors

Deloitte was commissioned by ISDA to conduct research for this report and summarise the findings from the survey. Deloitte was also asked to conduct in-depth interviews to develop a conceptual framework together with a set of key considerations to support the design and implementation of climate risk scenarios for the trading book.

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