SECOND DISCUSSION PAPER ON METHODOLOGICAL PRINCIPLES OF INSURANCE STRESS TESTING

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European Insurance and Occupational Pensions Authority

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[1] Regulation (EC) No 1049/2001 of the European Parliament and of the Council of 30 May 2001 regarding public access to European Parliament, Council and Commission documents (OJ L 145, 31.5.2001, p. 43).
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[3] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC (OJ L 295, 21.11.2018, p. 39).

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Abbreviations

BCBS	Basel Committee for Banking Supervision
BE	best estimate
BS	balance sheet
CIC	complementary identification code
CQS	credit quality step
D&A	deduction and aggregation
DTA	deferred tax asset
DTL	deferred tax liability
EBA	European Banking Authority
EIOPA	European Insurance and Occupational Pensions Authority
ESRB	European Systemic Risk Board
GDP	gross domestic product
GWP	gross written premium
IAIS	International Association of Insurance Supervisors
ICP	(IAIS) insurance core principle
EU	European Union
LTG	long-term guarantees
NACE	nomenclature of economic activities
Nat-Cat	natural catastrophe
NCA	national competent authority
OF	own funds
ORSA	own risk and solvency assessment
RFR	risk-free rate
RM	risk margin
SII	Solvency II
SCR	solvency capital requirement
ST	stress test
TA	total assets
TP	technical provisions
UL/IL	unit-linked and index-linked

Introduction

1. In the process of enhancing its bottom-up stress test framework EIOPA issued in the beginning of 2020 a first methodological paper focused on the financial and traditional insurance specific risks. The drafting process of the paper was since the beginning designed to strengthen the cooperation among practitioners, insurance associations, National Competent Authorities and EIOPA. The work, benefitting from the stakeholders' comments and inputs, produced a first toolbox for the design and the implementation of future European capital stress test exercises.
2. The first paper elaborated the key constituent of a bottom-up stress test exercise such as the objectives, the scope, the definition of the scenarios and of the shocks including approaches to the calibration and the application to the balance sheet and to the solvency position of the participants. The focus was mainly on the financial shocks and traditional shocks to liabilities such as lapses, longevity, cost of claims.
3. The paper also opened to the introduction of emerging risks in the design of stress test scenarios with specific reference to the risks stemming from the climate change. Additionally, the paper introduced the potential evolution of the framework from instantaneous to multi-period scenarios.
4. The two topics, together with the approach to liquidity stress tests are extensively treated in this second methodological paper which is structured on three self-contained sections as follows:
   - Section 1: A stress test framework on climate change;
   - Section 2: An approach to liquidity stress testing;
   - Section 3: A multi-period framework for the bottom-up insurance stress testing.
5. Compared to the first methodological paper, the three sections elaborate the topics from a theoretical perspective. The first methodological paper presented stress test aspects which were partly already applied in former ST exercises, therefore subject to extensive discussions. Against this, the theoretical framework was complemented by concrete technical elements for the design of the scenarios, the definition of the shocks and their application as well as the specifications and simplifications for their application.
6. This second paper proposes approaches, challenges and open points related to the three topics. In particular:
7. The climate change section covers transition and physical risks. Given the forward looking, long term, and explorative nature of the exercise the proposal is based on a step-by step approach initiating from the assessment of the vulnerability of the insurers based on their current exposures (micro-dimension), complemented by a forward looking assessment of the potential changes in the business models and their implications to policyholders and potential spill-over to other markets (macro- dimension). Technically the proposed approach is based on a medium-to-long-term time horizon, with end-of-modelling horizon impacts evaluated as an instantaneous shock without reactive management actions. The main challenges in modeling the transition risk are the granularity of the asset classification and the calibration of the shocks. Given the long term nature of the risks the proposed metrics are mainly based on the Solvency II balance sheet (e.g. excess of assets over liabilities). No post-stress solvency position will be requested.

8. Liquidity stress test cannot build over a robust and commonly applied framework for the assessment of the liquidity risk. In the absence of a reference framework the section proposes a step-by-step approach starting from the micro- objective of assessing the vulnerability of the insurers to liquidity shocks, complemented by a quali- quantitative questionnaire on the potential reactions (e.g. disinvestment) to the adverse scenario. The stress test builds over the definition of the liquidity sources and of the liquidity needs for an insurance company. Sources and needs are defined based on the bucketing of assets and liabilities according to their implied liquidity and eventually shocked according to the time horizon covered by the scenario. The metrics are specifically designed for liquidity purposes, hence no standard Solvency II capital based indicators are requested.

9. On the multi-period approach to stress testing the focus is on the main theoretical and operational challenges to be faced in such a framework. The theoretical endeavor is the definition of the guidelines on how to treat the future business and the reactive management actions over the periods of the exercise. Process-wise the discussion covers the limitation of the process applied so far by EIOPA in its bottom-up stress test exercises and suggests a new approach based on iterative calculation / validation process. As a final remark the multi-period approach is considered doable but at a high costs, hence an accurate cost-benefit analysis would be requested before initiating such an exercise.

10. In line with the spirit of the Discussion Paper, the aim is to collect concrete stakeholder feedback on the different methodologies presented, in particular regarding feasibility and appropriateness of the assumptions and of the approaches proposed.

1 Climate Change stress tests

1.1 Introduction

11. The main purpose of this chapter is to set out methodological principles to incorporate climate change-related risks in a stress testing framework, which can be used when developing future EIOPA bottom-up stress test (ST) on climate change risks. As such, it can be seen as a methodological tool-box which can inform the design and calibration of future supervisory climate STs and is part of EIOPA's broader strategy on integrating sustainability and climate-related assessment into its various supervisory processes and framework.

12. While there are clear similarities between traditional stress testing in the financial sector and climate change stress testing, several specific challenges related to assessing climate change vulnerabilities exist. First, as climate change risk is a relatively **new and long-term risk**, standardized methodologies are not widely available at this stage. Indeed, one of the main challenges regarding climate change stress testing is that it requires close cooperation among different disciplines and the combination of various different tools and data sources to understand the potential implications of climate change for the financial sector and insurers.

13. Another challenging aspect relates to the **uncertainty, nature and time horizon** of any climate change scenario, as the impact of climate change is likely to be structural, irreversible and non-linear and the impacts may only manifest themselves beyond the typical short term time horizon for stress testing.[4] As such, the consideration of adaptation strategies, technological advances and responses (management actions) to climate change also become relevant (see Table 1-1 for an overview of several key assumptions and uncertainties that can affect climate scenarios).

[4] The structural, non-linear and irreversible impact of climate change in the long run has also been referred to as the Tragedy of the Horizons (Mark Carney, Breaking the Tragedy of the Horizon – Climate Change and Financial Stability, 2015): while the physical impacts of climate change will be felt over a long-term horizon, the time horizon in which financial, economic and political players plan and act is much shorter.

Table 1-1 Key assumptions and uncertainties surrounding climate change scenarios

Key assumptions and uncertainties	Macroeconomic physical	Macroeconomic transition	Financial stability physical	Financial stability transition
Future climate policy	Determine the extent of warming	Determine the speed and timing of transition	Determine the extent of warming	Determines the speed and timing of transition, and also may have diffuse impacts on different sectors (for example, a widespread carbon tax)
Rate of progress in carbon-neutral technology	Determine the extent of warming	Could reduce costs or actually result in an increase in GDP	Determine the extent of warming	Key technologies (for example carbon capture and storage) will be particularly important for some sectors, and result in less disruption to existing business models
Feedback loops within the model	Key assumptions (e.g. about GDP) are often taken as external in the model	Economy may be affected indirectly through second-round effects	Financial stability risks could be exacerbated by second-round impacts	Financial stability risks could be exacerbated by second-round impacts
Level of adaption and adaptive capacity	Higher level of adaption could lower the long-term physical damages but might entail higher adaption costs in the short-term	More diversified economies, adaptive firms, and resilient financial systems could reduce transition costs	Higher level of adaption could lower the long-term physical damages but might entail higher adaption costs in the short-term	More diversified economies, adaptive firms, and resilient financial systems could reduce transition costs
Non-linear impacts / uncertainties in climate modelling	Damages may be higher than expected, either through direct losses to particular sectors or through general macroeconomic channels	Higher-than-expected damages could impacts the speed and timing of climate policy	Damages may be higher than expected, either through direct losses to particular sectors or through general macroeconomic channels	Higher-than-expected damages could impacts the speed and timing of climate policy

Source: NGFS (2019)

14. Moreover, **historical data and experience are scarce**, which means that climate change scenarios are inherently more forward-looking and rely heavily on assumptions about possible future equilibria and interactions between physical, transition and liability risks. In light of these challenges, EIOPA acknowledges that its first climate change STs should be seen as an important learning process with a more explorative nature, where each ST exercise will evolve as expertise and capacity is built over time. An important element of climate stress testing is therefore about raising awareness, enhancing risk management capabilities and understanding how insurers assess climate related risks themselves and evaluate potential spillover effects to other financial sectors and the real economy.

15. Finally, it should be noted that this paper focuses solely on climate change related risks and does not consider other environmental and sustainability risks for insurers. This is in line with the current focus within the global supervisory community on climate change as a wide-ranging and potentially large-scale transformation compared with other aspects of sustainability. Furthermore, this paper is mainly concerned with the financial impact of

climate change related risks and does not look at specific liquidity risk stemming from climate change (approaches to liquidity stress testing for insurers in general are discussed in Chapter 2).

1.1.1 Climate change risk and transmission channels

16. Climate change is by now widely recognized as an important source of financial risk for the financial sector and for insurers in particular.[5] Climate change related risks can not only adversely affect the safety and soundness of individual firms and the wider financial sector, but also affect the insurability of risks, impacting the affordability and availability of insurance products with potential implications for the insurance protection gap (difference between total economic losses and insured losses). It is therefore increasingly relevant to EIOPA's mandate to monitor and assess the resilience of the European insurance sector to adverse climate developments. In particular, stress testing and scenario analysis are seen as important tools to better understand and assess potential financial and economic risks stemming from climate change given the high-level of uncertainty involved and the more forward-looking nature of climate scenarios, to ensure that the financial system is resilient to these risks.

17. The financial risks stemming from climate change for insurers are typically divided into three different channels: physical risks, transition risk and legal liability/litigation risk. [6]

18. **Physical risk** refers to the risk faced by financial institutions due to the economic costs and financial losses resulting from the direct physical impact of increasing severity and frequency of extreme climate change-related weather events (such as heat waves, landslides, floods, wildfires and storms) as well as longer term progressive shifts of the climate (such as changes in precipitation, extreme weather variability, ocean acidification, and rising sea levels and average temperatures). For insurers, this could not only affect their own physical assets and investments, but also their insurance liabilities (through higher claims). For life insurers, increased morbidity (ill-health and specifically the rate of incidence of ill-health) and mortality from severe heat waves and other indirect impacts of rising temperatures may affect life insurance liabilities.

19. **Transition risk** refers to the risk related to the process of adjustment towards a low-carbon economy to meet the objectives of the Paris climate agreement, which may lead to a reassessment of a wide range of asset values, in particular for climate-sensitive sectors (for instance carbon/GHG intensive sectors such as fossil fuels). The transition to a carbon-neutral economy also presents some opportunities for the financial sector, for example, financing investments in building energy efficiency, renewable energy and carbon-neutral transportation. A range of factors influence the adjustment process to a low-carbon economy, including: climate change-related developments in policy and regulation, the emergence of disruptive technology or business models, shifting sentiment and societal preferences. Transition risks are particularly pronounced for abrupt and disorderly transitions to a low-carbon economy.

[5] See for instance SIF-IAIS Issues Paper on Climate Risk (2018) or NGFS Comprehensive Report (2019) among many others.
[6] https://www.iaisweb.org/page/supervisory-material/issues-papers/file/76026/sif-iais-issues-paper-on-climate-changes-risk

20. **Legal liability/litigation risk** refers to the risk of climate-related claims under legal liability policies, as well as direct claims against insurers for failing to manage climate risks. Liability risk may arise when parties who have suffered losses from climate change seek compensation from those they believe may have been responsible (for instance through failure to mitigate, adapt or disclose climate change-related risks). Liability risks are of particular relevance to insurance undertakings as these risks can be transferred by means of third-party liability protection, such as professional indemnity or directors' and officers' insurance.

21. **Going forward, this paper considers only climate change-related risks stemming from <u>physical</u> and <u>transition</u> risks.** While *legal liability/litigation risk* is also important in the context of climate change, it is not addressed further in the paper as there is currently very little information available in the literature on methodologies to incorporate this in stress testing frameworks (also in the absence of jurisprudence and/or settlements related to climate change lawsuits). [7]

22. Many studies have found that climate change-related risks can have a significant impact on the economy, in particular in the medium to long term, and is likely to affect different economic sectors and geographic regions differently.[8] Climate change risks also have direct implications for both the asset side and liability side of insurers. The table below provides an overview of the main transmission channels for insurers and highlights which ones are covered in this paper.

[7] This does not mean that insurers and supervisors should ignore potential legal liability risks within their risk management and supervisory frameworks beyond stress testing.

[8] See for instance OECD Economic Consequence of Climate Change (2015), The Cost of Inaction (The Economist Intelligence Unit 2015), NGFS First Comprehensive Report: A Call for Action (2019) or The Green Swan: Central banking and financial stability in the age of climate change (BIS/Banque de France 2020).

Table 1-2 Overview of main transmission channels for climate change-related risks

Type of risk	Transmission channel	Balance sheet impact	Example	Covered in this paper?
Physical risk	Underwriting risk	Liabilities	Higher than expected insurance claims on damaged insured assets (non-life) or higher than expected mortality or morbidity rates (life/health)	Yes
	Market risk	Assets	Impairing of asset values due to financial losses affecting profitability of firms, due to for instance business interruptions, or damage to real estate. Specific example: equity price shocks	Yes
	Credit risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties/reinsurers due to financial losses stemming from climate change Specific example: bond price/yield shock	Yes
	Operational risk	Assets	Disruption of own insurance activities and/or assets, such as damage to own property	No
	Liquidity risk[9]	Assets / Liabilities	Unexpected higher payouts and/or lapses as broader economic environment deteriorates	No (not as part of climate ST)
Transition risk	Market risk	Assets	Impairment of financial asset values due to low-carbon transition, for instance stranded assets, 'brown' real estate and/or decrease in value of carbon/GHG intensive sectors. Specific example: equity price shock	Yes
	Credit risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties as entities that fail to properly address transition risk may suffer losses Specific example: bond price/yield shock	Yes
	Underwriting risk	Liabilities	Decrease of underwriting business due to increase of insurance prices in response to higher than expected insurance claims (non-life) or changes in policyholders' expectations and behavior related to sustainability factors (e.g. green reputation) (life)	No
Legal liability risk	Underwriting risk	Liabilities	Higher than expected claims on professional indemnity cover, as parties are held accountable for losses related to environmental damages caused by their activities	No
	Legal/reputational risk	Assets/ Liabilities	Insurers could be held responsible for climate change and/or not doing enough to mitigate/adapt	No

[9] This concerns liquidity risk specifically stemming from climate change related risks, which is not considered further in this chapter. However, please note that Chapter 2 discusses the general approach to liquidity risk stress testing for insurers.

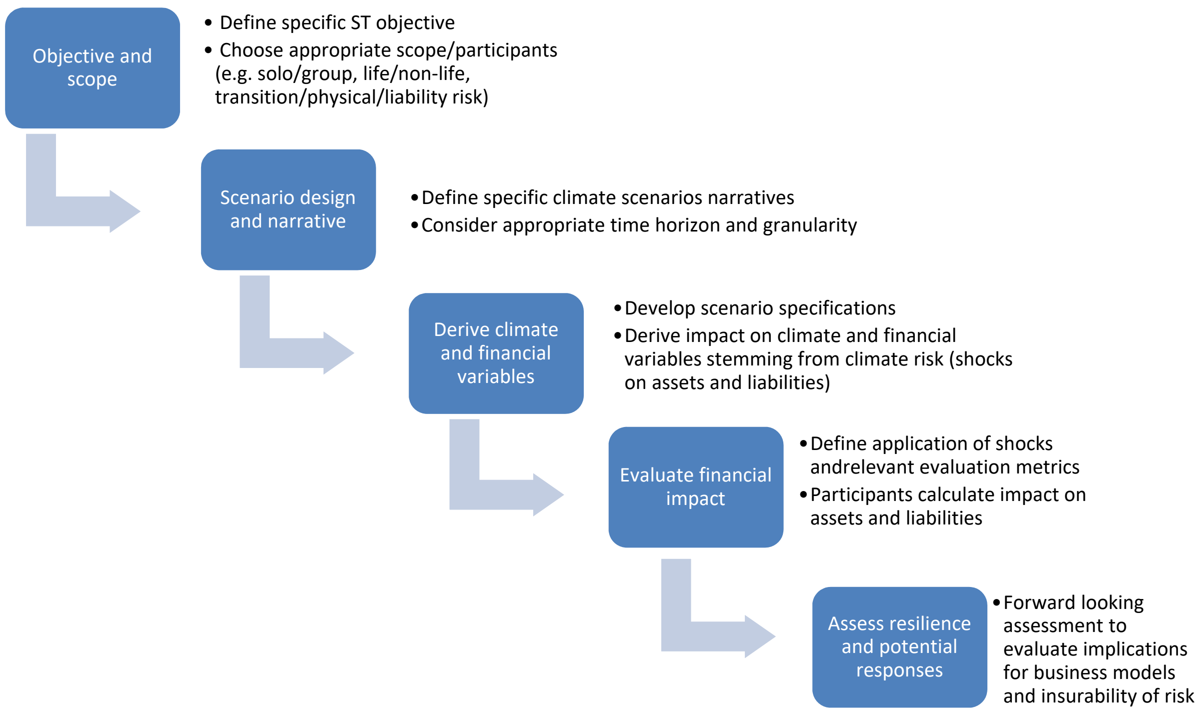
23.On top of these direct transmission channels on insurers' business and balance sheet (BS), there may also be important second-round effects and feedback loops (indirect effects), as climate change may lead to a wider worsening of macroeconomic conditions further affecting insurance business, while there might also be indirect exposures stemming from other financial institutions. Depending on the modelling approach, these second round effects could also be taken into account for calibrating a ST scenario.

Questions:
Q 1 What are your views on the main climate change related risks and transmission channels? Are there any other climate change related risks or transmission channels that should be considered?

1.1.2 Elements of a Climate Change Stress Test exercise

24.The overall process of a climate change ST exercise is similar to a traditional ST, though its aim and design may differ. The figure below provides a stylized overview of the different elements of a climate ST exercise that are covered in this paper. In particular, different scenarios and modelling approaches for assessing the impact on both assets and liabilities of insurers stemming from *physical* and *transition* risk will be considered, for both non-life and life business (including health).

Figure 1-1 Stylized overview of climate change stress test elements



25.The rest of this chapter is structured as follows: the possible objective(s) of a climate ST exercise are discussed in section 1.2. The principles of climate change scenario design and specification are discussed in section 1.3. The modelling approaches for deriving specific shocks to assets and liabilities are discussed in section 1.4.1 (for transition risk) and in section 1.4.2 (for physical risk). The metrics for evaluating the financial impact are presented in section

0, while the possible approaches to a forward looking assessment, including responses and adaptation strategies to infer implications for business models, are discussed in section 1.6. In each section, different options are explored with a discussion of the pros and cons, with the aim of collecting concrete stakeholder feedback on the different methodologies presented.

1.2 Objective of Climate Change stress test

26. ST exercises can be designed to pursue micro- or macroprudential purposes.[10] The design of a climate change-related exercise, despite its specificities, follows the same logic and should have its objectives clearly defined at inception, which will inform the design and scope of any climate change ST.

27. In particular, given the forward-looking and long-term nature of climate change risks, a climate change ST exercise is expected to be more explorative compared to traditional financial stress testing (i.e. no prudential capital ST exercise in the traditional sense). Furthermore, it is important to consider the type of risks that will be assessed, as a climate ST can incorporate all types of climate change risks (transition, physical, liability) separately, in conjunction or focus on one particular source of risk. Finally, a climate ST can also provide information about potential issues regarding affordability and availability of insurance products in the future (more macroprudential objective to assess potential spillovers and implications for protection gap / forward looking aspects). Against this, a climate ST can be designed to cover microprudential or macroprudential objectives. As for any type of ST exercise it is key that the objectives are defined upfront and the other elements designed accordingly[11]. Table 1-3 below provides an overview of the main micro- and macroprudential objectives of a climate change ST.

Table 1-3 Overview of possible objectives for a climate ST

Microprudential objectives	Macroprudential objectives
• Assess vulnerabilities and resilience of individual (re)insurers to climate change risks and assess size of potential financial exposures/losses to adverse climate scenarios • Enhance understanding of potentially long-term climate change risks and implications for business models • Enhance risk management capabilities to assess and mitigate climate change risks	• Assess vulnerabilities and resilience of overall (re)insurance sector and potential systemic climate change risks • Assess potential spill-overs to other financial sectors and the real economy of climate change risks • Assess potential implications for future insurability of risks and potential protection gap for the real economy related to climate change risks/perils

28. EIOPA acknowledges that the first climate change ST will be more explorative and part of an important learning process to better understand the potential implications of climate change risks for the insurance sector. As such, a step-by-step approach is considered, starting with a more microprudential exercise to assess individual vulnerabilities given the current BS exposures, complemented with a separate forward-looking assessment (mostly via

[10] For a thorough discussion on the objective of a ST exercise refer to Chapter 2 of the 1st EIOPA publication on the Methodological Principles of Insurance Stress Testing available at https://www.eiopa.europa.eu/content/methodological-principles-insurance-stress-testing_en

[11] For a description of the key constituent of a ST exercise refer to Chapter 2 of EIOPA (2020) Methodological principles of insurance stress testing. Available at: *https://www.eiopa.europa.eu/sites/default/files/publications/methodological-principles-insurance-stress-testing.pdf*

qualitative questionnaire) to assess the implications for insurers' business models and potential spillover effects stemming from reactive management actions/responses. At a later stage, more comprehensive macroprudential exercises can be considered, but even after experience is gained, climate change stress testing is expected to be more explorative in nature given the uncertainty and long-term risks involved.

Questions:

Q 2 What are your views on the objectives of a climate change ST? Should any additional objectives be considered?

1.3 Scenario design

29. Selecting and designing suitable climate change scenarios in line with the ST objective(s) is an important element of a climate ST exercise and requires addressing a couple of key questions related to risk coverage, time horizon and granularity of scenario specifications.

30. To begin with, physical and transition risks are interlinked and affect financial firms in distinct ways. The initial approaches taken by supervisors to better understand the impact of climate change tend to treat the two risks separately. The same approach is taken by the academia where much of the existing production focuses on one element or the other in insulation. Although approaching the two risks separately might help from a theoretical and operational perspective, by simplifying the analysis and enhancing transparency, it neglects to understand the interplay between both risks. The complex dynamic between physical and transition risks can generate both mitigating and mutually reinforcing effects which need to be analyzed in a ST scenario in order to create more multi-dimensional approaches for forward-looking stress testing..[12] Any climate scenario shall therefore involve a trade-off across both risks given their interrelated nature: continued emissions in the absence of strong climate policy will lead to rising temperatures that increase physical risks, whereas limiting these impacts requires substantial emissions reductions that may increase transition risks.

31. This section aims to further set out methodological principles to develop climate change risk related stress scenarios, looking at general principles, scenario specification, granularity and time horizon considerations.

1.3.1 General principles and scenario narratives

32. ST scenarios are intended to assess vulnerabilities to severe, but plausible adverse scenarios. In light of the complexity, uncertainty and long-term nature of climate change related risks, it is useful to define certain general principles to help inform the design of climate stress scenario and narratives. In particular, the following principles can be defined for a climate change stress scenario for the insurance sector:

- **Principle 1:** given their distinct but interlinked nature, both transition risk and physical risk should ideally be assessed in conjunction in a climate change stress test. In any climate change scenario there is a trade-off across both risks;

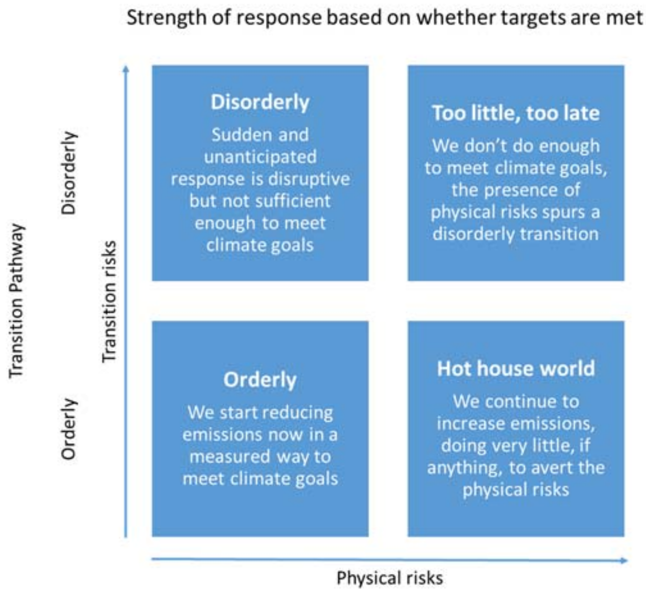
[12] See Annex 3 of The Green Swan (BIS and Banque de France 2020) for more details on the interactions between physical and transition risk.

- **Principle 2:** given the wide range of possible future climate paths, it is important to consider a range of climate change scenarios and transition pathways that capture different combinations of physical and transition risk. Applying multiple scenarios also allows to take into account different key dimensions, such as the role of climate policy;
- **Principle 3:** ST scenarios should focus both on a central path climate projection and on adverse tail events, to assess whether the financial system and insurers are resilient in case of disruptive climate and transition scenarios;
- **Principle 4:** scenarios should entail information (ideally quantitative) about climate pathways (key changes in climate factors) and associated financial impacts at a sufficiently granular level. The scenarios should also allow for the identification of key variables/assumptions that affect scenario pathways;
- **Principle 5:** scenarios should cover appropriate time horizons to assess the long-term impact of climate change related risks, given the more long-term nature of climate scenarios, while allowing flexibility to derive short-term stress periods from long-term scenarios.

33.When designing the different scenarios, it can be particularly useful to focus on adverse outcomes along two dimensions as proposed by the NGFS (see Figure 1-2):

- The total level of mitigation of climate change risks or, in other words, how much action is taken to achieve Paris agreement goals and reduce greenhouse gas emissions (leading to a particular climate outcome);
- Whether the transition occurs in an orderly or disorderly way, i.e. are the actions sudden and unanticipated.

Figure 1-2 Stylized climate scenarios with transition and physical risks



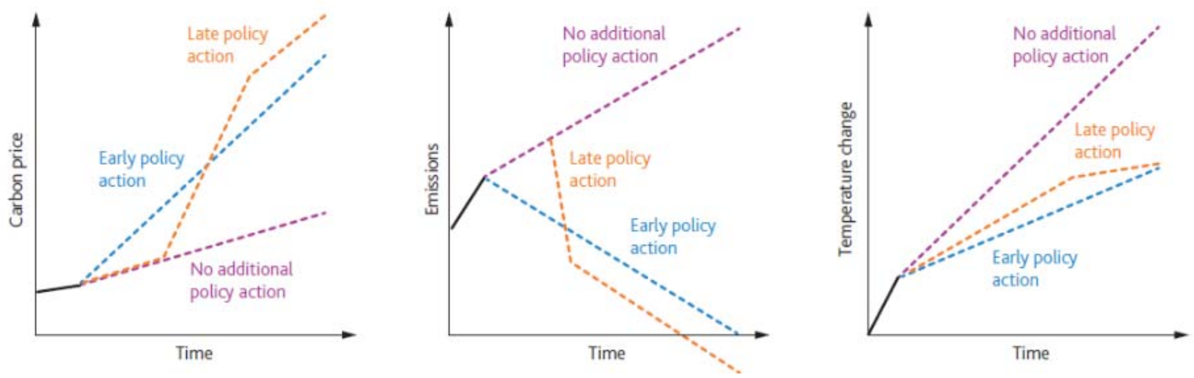
Source: NGFS Comprehensive report "A call for action: Climate change as a source of financial risk.

34. As such, the following scenario narratives seem particularly relevant for climate change related risks:

- **Early policy action, orderly transition** scenario where the transition to a carbon-neutral economy starts early and the increase in global temperature stays below 2ºC, in line with the Paris Agreement. Physical and transition risks are minimized in this scenario;
- **Late policy action, disorderly transition** scenario where the global climate goal is met but the transition is delayed and must be more severe to compensate for the late start. In this scenario, physical risks arise more quickly early on in the scenario and transition risks are particularly pronounced compared to the early policy action scenario;
- **Too little, too late** scenario**,** where the manifestation of physical risks spurs disorderly transition, but not enough to meet Paris agreement goals. Physical and transition risks are both high and severe;
- **Business as usual, no additional policy action** scenario ('Hot house world') where no policy action which has already been announced is delivered. Therefore, the transition is insufficient for the world to meet the Paris agreement climate goal and physical risks will be particularly pronounced.

35. Figure 1-3 provides an illustration of what the different scenario narratives/pathways could look like in terms of emissions, temperature and carbon prices. It should be noted that these scenario pathways would not explicitly incorporate social and political feedback effects, such as migration or political upheaval, in its specification or calibration, given the high degree of uncertainty related to these feedback effects.

Figure 1-3 Stylized pathways for possible climate scenario narratives



Source: Bank of England (2019): The 2021 biennial exploratory scenario on the financial risks from climate change

1.3.2 Scenario specification and granularity of technical specifications

36. Following the selection of scenario narratives, another important consideration relates to scenario granularity, as climate scenarios can be specified at different aggregation levels.

37. At the highest level, **the scenario narrative** discussed above would only describe the key assumptions about the climate transition, the timing of the shocks and climate outcomes.

38. As a next step, the scenario narratives can be translated into **specific climate outputs**, with pathways for specific climate factors related to physical and transition risk: global and regional temperature pathways, severity and frequency of perils, emissions, carbon price, energy prices and energy mix. Potential inputs for this can be the IPCC RCPs[13], IEA reference scenarios, General Circulation Models (RCMs) and expert judgment.

39. The climate scenario and factors can be further translated into **broad economic outputs** such as Gross Domestic Product (GDP), inflation and interest rate pathways. Potential tools for estimating these impacts are Integrated Assessment Models (IAMs), structural models, the LIMITs database or other macroeconomic models such as NiGem or DSGE models.

40. Going one step further, **impacts can be disaggregated across economic sectors and countries** using appropriate industry classifiers, based on sensitivity to climate-related risks of specific economic sectors (for instance carbon/GHG intensities). Impacts could be classified using either NACE (4 digits where needed), GICS or GLEIF code classifiers or other classifiers, such as the Climate Policy Relevant Sectors (CPRS) developed by Battiston et al. (2017).[14]

41. Even more granular scenario specifications could derive **individual firm implications** (based on climate sensitivity of underlying activities of individual firms). This would require a highly granular mapping of the portfolio at individual asset level (ISIN) to calculate the impact of the specified shocks. A potential tool for this is the PACTA model[15] or similar approaches.

42. Finally, the most granular level of specification would derive **economic activity-level implications**. This would require participants of a ST exercise to identify and map the economic activities of their individual counterparties/individual asset level to calculate the impact.

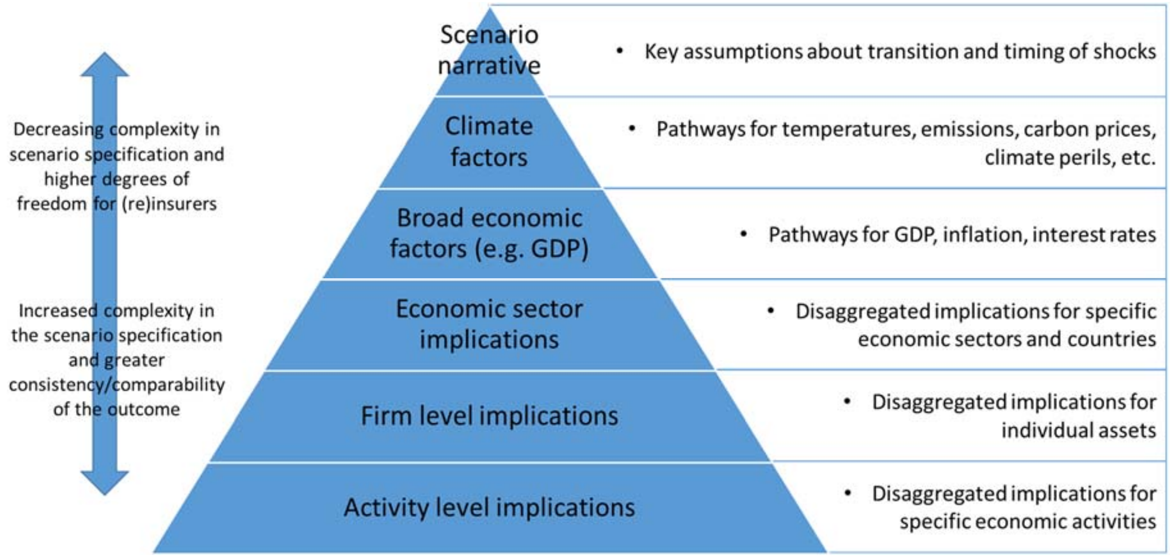
43. In general, the higher the level of aggregation/specification, the more degrees of freedom there are for participating firms to calculate and assess the (financial) impact of the climate scenario for their portfolio/business, but the results would be less comparable and more difficult to validate. Conversely, the more granular the scenario specification, the greater the complexity of the technical specifications and the exercise, but this would lead to greater consistency and comparability of the ST outcomes and could allow for more validation of the results. Figure 1-4 summarizes the different aggregation levels of scenario specification.

[13] Detlef P. van Vuuren et al. (2011) The Representative Concentration Pathways: An overview. Climatic Change, 109(5).

[14] Battiston, S., Mandel, A., Monasterolo, I., Schuetze, F., Visentin, G. (2017) A climate stress-test of the financial system. Nature Climate Change 7, 283–288.

[15] https://2degrees-investing.org/resource/pacta/

Figure 1-4 Granularity of scenario specification



Source: EIOPA adapted from Bank of England.

44. The different levels of scenario granularity come with different advantages and disadvantages, which are summarized in the table below. These mainly relate to the trade-off between complexity, comparability and incentives for building risk management capacity.

Table 1-4 Advantages and disadvantages of different scenario granularity for bottom-up stress testing

Aggregation level	Advantages	Disadvantages
Scenario narrative	• Simplicity: requires less detail in the specifications and can be clearly linked to climate research • Allows flexibility for firms to use different models • Forces firms to enhance modelling/risk management capacity to assess impact of high-level climate scenarios	• Greater flexibility reduces modelling consistency and comparability across firms • More difficult for participants to calculate impact on financial metrics • Results can be difficult to validate
Climate factors	• Only climate variables would have to be specified, which can be clearly linked to climate research • Allows flexibility for firms to use different models, but achieves more consistency concerning the impact on key climate factors • Forces firms to enhance modelling/risk management capacity in order to translate climate factors into financial impacts	• Greater flexibility reduces modelling consistency and comparability across firms • More difficult for participants to calculate the impact on financial metrics • Results can be difficult to validate
Broad economic factors	• Ensures consistency not only on climate factors, but also on the macroeconomic impact and key economic variables • Macroeconomic models can be used to estimate broad economic impacts	• Firms would still have to model implications from broad economic factors to their specific portfolio (reducing consistency/ comparability) • Uncertainty regarding model calibration • Broad economic factors do not distinguish between economic sectors, which could be impacted quite differently
Sectoral	• Provides clarity on the implications for different economic sectors and takes into account different impacts across economic sectors • Classifications are readily available (for instance NACE 2, GICS or GLEIF) • Results can be compared against similar studies	• No commonly accepted methodology yet to estimate sectoral impacts of climate scenarios (challenging to bridge climate models to economic sector impact) • Sectoral impacts do not take into account firm's heterogeneity within sectors • Requires mapping of the portfolio to economic sectors
Firm	• Takes into account firm-heterogeneity and specifies firm-specific impacts based on underlying activities based on activity • Ensures comparability /consistency as impacts are provided at individual asset level • Promotes risk awareness at counterparty level	• Very complex specification and requires extensive mapping of the portfolio to individual assets calculate impact • Relevant climate data at individual firm level data is often incomplete and only provides a partial view on consolidated firm activities • Less incentives for capacity/risk management building for firms to assess exposures of individual assets/counterparties, as impacts would be provided to them at a very granular level
Activity	• Specifies impacts at the most granular level • Incentives firms to assess climate exposures of assets based on the underlying activity	• Requires highly granular information on underlying economic activities of firms and how these activities would be impacted by climate change • Data on underlying activities is often not available and only provides a partial view on consolidated firm activities

45. Based on these advantages and disadvantages, EIOPA considers the most appropriate aggregation level for a bottom-up ST at this stage to be, at least,

a specification that includes impacts at an economic sector whose shocks shall be calibrated, where applicable, at country and regional level:

- Sectoral level for corporate bonds, equities and real estate exposures. For specific sectors a higher granularity may be explored if needed (for instance based on technology used in energy production, e.g. coal, gas, oil or renewables);
- Country level for government bonds exposures;
- Regional level for climate related factors, such as temperature and emission pathways and intra-country regional level for climate-related perils.

46. This approach aims to strike a balance between complexity and comparability. A more granular specification (for instance with scenario outputs and shocks at individual firm-level) would be seen as too complex and burdensome at this stage for a bottom-up ST exercise, but can be considered further on as part of top-down approaches and sensitivity analysis on climate risks.

1.3.3 Time horizon and treatment of balance sheets

47. One of the challenges of designing climate change stress scenarios, is to define an appropriate time horizon that captures the relevant climate risk dynamics over time, while balancing this with modelling feasibility to ensure meaningful, consistent and comparable outcomes. In previous EIOPA STs on insurers and pension funds, the shocks had been applied on an instantaneous basis to the BS at the reference date without allowing for reactive management actions[16]. However, the full extent of climate change-related risks are expected to only manifest themselves fully over a considerable time period in the medium to long term (see Table 1-5), beyond the time horizon typically used for stress testing (1-3 years), which makes the approach and the assumptions therein less plausible. At the same time, EIOPA acknowledges the difficulty in establishing the shocks to be applied for long term scenarios, which will be more hypothesis-driven.

[16] The EIOPA Discussion Paper on Methodological Principles for Insurance Stress Testing distinguishes between embedded management actions and reactive management actions (Box 2.1 in the respective paper). In the context of climate change, the focus is on reactive management actions: actions that would be taken by undertakings in direct response to a climate change scenario and that are not assumed to be applied in the baseline scenario.

Table 1-5 Overview of climate change related risks and expected timing of effects

Type of risk		Timing of effects	Financial impact
Physical risk	Extreme climate events	Short to medium term	Unanticipated shocks to physical assets, economic distress, possible systemic disruption
	Gradual warming	Medium to long term	Anticipated shocks to physical and financial assets Anticipated shocks to financial and non-financial (e.g. long-term impacts on profitability of climate sensitive sectors)
Transition risk		Short to medium term	Unanticipated shocks to financial assets and potential stranded assets

Source: Adapted from NGFS Technical Supplement to First Comprehensive Report (2019)

48. In light of these challenges, Table 1-6 provides an overview of possible different approaches to the time horizon along three dimensions:

- The reporting frequency (i.e. whether calculations are required at intermittent intervals within the modelling horizon);
- Static/Fixed reference BS without reactive management actions or dynamic BS with reactive management actions (instantaneous shocks to reference BS versus dynamic BS).

Table 1-6 Possible approaches for the fixed/dynamic balance sheet

Reporting frequency	Fixed / Dynamic balance sheet	Outcome	Pros	Cons
At end of modelling horizon only	Fixed, impact on reference date balance sheet	Climate scenario modelled over short, medium, or long term with instantaneous shocks to balance sheet at reference date, no reactive management actions allowed	• Relatively easy to implement • Enhanced comparability • Allows to assess the potential impact given current business/balance sheets	• Reactive management actions/responses not considered which could overstate the impact
	Dynamic, balance sheet allowed to change	Climate scenario modelled over short, medium, or long term with instantaneous shocks to balance sheet at with reactive management actions allowed	• Reactive management actions/responses taken into account, more realistic, notably for long-term impacts • Allows to assess impact of reactive management actions/responses	• Reduces comparability, as reactive management actions can vary and may be hard to validate • Impact of reactive management actions difficult to assess depending on time horizon
At intermittent intervals (for instance 1 year or 5 year intervals)	Fixed, impact on reference date balance sheet	Climate scenario modelled over short, medium, or long term with instantaneous shocks to balance sheet at reference date for specific intervals, no reactive management actions allowed	• Medium complexity • Allows assessing impacts on current balance sheet over time	• Reactive management actions/responses not considered which could overstate the impact • Adds additional scenario specification and computational burden compared to only end-of period impact
	Dynamic, balance sheet allowed to change	Climate scenario modelled over short, medium, or long term with shocks to balance sheet at reference date for specific intervals, with reactive management actions allowed at each interval (e.g. shock T=10 compared to balance sheet at T=5)	• Reactive management actions and responses taken into at each interval, more realistic • Allows to assess reactive management actions and responses	• Highly complex both in terms of scenario specification and computational burden, full blown multi-period ST • Reduced comparability as results will be very hard to validate

49.At this stage, EIOPA is considering as a first step to assess individual vulnerabilities to climate change risks a ST approach based on:

- a medium-to-long term horizon (e.g. 30 years),
- with shocks modelled as instantaneous,
- to the reference date BS,
- without allowance for reactive management actions (fixed BS assumption),
- to be assessed at the end of the modelling horizon.

This approach balances the long-term climate dynamics with operational feasibility and comparability and allows for the assessment of the potential impact of climate change-related risks given current BSs/business models (i.e. sizing the potential exposures in different climate scenarios). While for climate change-related risks a multi-period approach with reactive management actions may be more appropriate, this would add considerable complexity to the design of a stress exercise, for which no common tools and methods are available yet.

50. The proposed approach could be combined with a separate forward-looking assessment of the reactive management actions/responses to climate change-related risks to identify the risk mitigation responses that are considered by insurers in response to climate change. This approach would help to better understand the resilience of insurers to climate change and the implications of these responses on insurers' business models, for instance with regards to asset allocation, underwriting risk coverage, Gross Written Premium (GWP) and/or protection gap and allow to assess potential spillovers effects to other financial sectors and the real economy (see also section 1.6).

51. Going forward, further extensions could be considered as part of a step-by-step approach to enhance the ST framework for climate change related risks, also incorporating more dynamic approaches with the use of (reactive) management actions (multi-period ST).

1.3.4 Conclusion

52. To summarize, and in light of the considerations above, EIOPA considers the following approach for a first climate change ST, recognizing that it is an important learning process:

- **Multiple climate scenarios** to be evaluated focusing on different climate outcomes/scenario narratives, given the uncertainty of future climate outcomes and to allow a range of different combinations of physical and transition risks. While this would add operational and computational burden to the ST exercise (as participants would have to calculate the impact of multiple, distinct climate scenarios), using multiple scenarios allows to take into account different key dimensions of climate change risks and better assess vulnerabilities and resilience to adverse climate scenarios.
- **Scenario and technical specifications** with specific climate variables at regional (intra-country) level for perils and financial impacts at a sectoral level (for corporate bonds, equities and real estate)[17] and country level (for government bonds), to ensure a balance between complexity and comparability. Methodologies for deriving, specifying and calibrating these variables will be discussed in more detail in sections 1.4.1 (for transition risk) and 1.4.2 (for physical risks). A more granular scenario specification, for instance at individual asset/firm level, would be seen as too complex and burdensome at this stage for a bottom-up ST exercise, but will be considered further as part of EIOPA's work on top-down methodologies and sensitivity analysis on climate risks.
- **A medium-to-long-term time horizon**, with end-of-modelling horizon scenario impact evaluated as an **instantaneous shock (without reactive management actions) to the reference BS**. This allows assessing the potential long-term financial impact of climate change related risks given

[17] For specific sectors a higher granularity may be explored if needed (for instance based on technology used in energy production, e.g. coal, gas, oil or renewables)

current business models and BSs. As such it can give an important indication of the size of potential exposures, and hence the required transformation given current business models, should a specific climate scenario materialize, given the more long-term nature of climate scenarios.
- A **separate forward-looking assessment** to capture the reactive management actions/responses to climate change-related risks to identify the risk mitigation responses that are considered by insurers in response to climate change and better understand the implications of these responses on insurers' business models, their resilience and the potential spill-over effects (see section 1.6).

Questions:

Q 3 Are there any other scenario narratives that should be considered as part of a climate change stress test exercise?

Q 4 What is your view on the appropriate scenario specification granularity? Would the proposed granularity be compatible with your modelling to calculate the stressed impact?

Q 5 What is your view on the appropriate time horizon for a climate change ST?

Q 6 What is your view on modelling the long-term shocks on a fixed reference date balance sheet (without reactive management actions)? Would this approach strike a right balance between allowing an assessment of the potential risk, modelling feasibility, complexity and comparability?

Q 7 What is your view on having a separate forward-looking to assess reactive management actions, implications for business models and potential spill-over effects?

1.4 Modelling approaches

53. This section discusses different possible modelling approaches to derive and calibrate the physical and financial impact on insurers' asset and liabilities in a climate change scenario. Section 1.4.1 discusses modelling approaches for transition risk, whereas section 1.4.2 discusses approaches for physical risk. Section 0 subsequently discusses general principles regarding the specification and application of the shocks.

1.4.1 Transition risk

54. This section discusses modelling approaches that serve for the derivation of the shocks stemming from transition risk on the asset-side (see the excerpt in Table 1-7 with an overview of the main transmission channels and asset classes affected).

Table 1-7 Overview of the main transmission channels on the asset-side

Type of risk	Transmission Channel	Balance Sheet impact	Example	Asset classes affected
Transition risk	Market risk	Assets	Impairment of financial asset values due to low-carbon transition, for instance stranded assets, 'brown' real estate and/or decrease in value of carbon/GHG intensive sectors. Specific example: equity price shock	Equity Property Infrastructure
	Credit risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties as entities that fail to properly address transition risk may suffer losses Specific example: bond price/yield shock	Government bonds Corporate bonds Mortgages/Loans

55. The relevant asset classes considered are based on the main asset categories in Solvency II[18], i.e. government bonds (Complementaty Identification Code - CIC 1), corporate bonds (CIC 2), equity (CIC 3), property/real estate (mortgages/loans) (CIC 8-9) and infrastructure investments (CIC 0). The focus would be to calibrate the severity of the negative shocks according to the climate sensitivity of the assets, in line with the adverse scenario approach of STs. Although the transition to a low-carbon economy can potentially also lead to positive shocks for certain assets, for instance in the case of "green" assets or technologies, this can only be considered in a stress testing framework if they can be duly justified.[19] The methodologies discussed below potentially allow for the integration of positive shocks, but the inclusion of these would have to be carefully considered in light of the ST objective with a focus on adverse scenarios.

56. Each of the sub-section below is devoted to a modelling approach and focuses on the asset classes that are treated in the method, including the discussion on methodologies and data sources to calibrate the shocks (more details about the modelling approaches can be found in the Annex 4.1). The criteria for the calibration refer to the level of the shock (asset level, industry/sector level or geographical level), the future economic trajectories and forward-looking climate policy shock scenarios. In particular, the derivation of impacts from climate policy shocks are considered. Climate policy shocks negatively affect high carbon firms and sector's profitability. One example for climate policy shocks is the introduction of a carbon tax. Table 1-8 provides an overview of the main asset classes and list several methodologies that could be used to derive the financial impact of transition risk (including the level of granularity the methodology would allow the shock to be specified).

57. The list of methodologies is by no means exhaustive and EIOPA welcomes stakeholder feedback regarding other modelling approaches to consider.[20] The aim is to give a flavor of the different modelling approaches available. EIOPA intends to liaise with the academic community, practitioners and model vendors for the exact calibration of the shocks. Furthermore, given the data limitations and reliance on assumptions of the methods presented, the results

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[18] As laid out in the Commission Implementing Regulation (EU) 2015/2450, Official Journal of the European Union, L 347, 31 December 2015 (p. 1208).
[19] For instance, CARIMA, the stress testing module of the PACTA tool and others emphasize that risks are two-sided and therefore, positive shocks should be considered in stress-testing.
[20] The overview focuses on open-source and publicly available methodologies. EIOPA is aware that commercial model vendors have also developed specific climate change risk models, but these are excluded from the list.

give only an approximation of the possible future development of assets in the light of climate change scenarios. Depending on the assumptions and limitations of the methods, it is crucial to bear in mind that the results might change over time with varying assumptions or parameters and should therefore not be seen as a forecast.

Table 1-8 Overview of the main asset classes and methodologies that could be used to derive the financial impact of transition risk

Assets	Methodology	Granularity
Government bonds	CLIMAFIN (Battiston and Monasterolo,2019)	Country-level
Corporate bonds	CARIMA (Gorgen et al.)	Asset level, sector level or country level
	CLIMAFIN (Battiston et al.)	Asset or Sector level
	NiGEM (DNB and BdF)	Sector level
	PACTA (2dii)	Asset or technology level
Equity	CARIMA (Gorgen et al.)	Asset level, sector level or country level
	CLIMAFIN Battiston et al. (2019)	Asset or Sector level
	NiGEM (DNB and BdF)	Sector level
	PACTA Model (2dii)	Asset or technology level
Property/real estate (mortgages)	CARIMA (Gorgen et al.) PACTA (2dii)	Firm-level Individual Property level
Infrastructure investments	See corporate bonds or equity (depending on the type of infrastructure exposure)	

58. Finally, due to the high degree of uncertainty, assumptions and the limitations of climate modelling and the uncertainty of future (political, economic, or societal) developments, any of the methodologies discussed below will ultimately have to be complemented with expert judgment based on review of available literature/estimates on climate impacts to validate the shocks in terms of severity and plausibility.

1.4.1.1 CLIMAFIN

Government bonds

59. Government bonds are not immune to climate change risks. A climate policy shock might affect the coupon rate and the expected value of a sovereign bond, through the channel of its intermediate impact on the sovereign net fiscal assets and its default probability (Battiston and Monasterolo, 2019).[21] However, due to the interconnectedness of the capital markets, the competitiveness of the real economy and financial stability, the impact of climate change on government bonds is more complex than, e.g., for equities or corporate bonds.

60. The approach by Battiston and Monasterolo (2019) is based on the CLIMAFIN model developed by Battiston, Mandel and Monasterolo (2019)[22] and focuses on the analysis of a disorderly policy transition on sovereign bonds, through the channel of firms' profitability to sectors' Gross Value Added (GVA). This approach prices forward-looking climate transition risks in the value of individual sovereign bonds, by including the characteristics of climate risks (i.e. uncertainty, non-linearity and endogeneity of risk) in financial valuation,

[21] Battiston, S. & Monasterolo, I. (2019). A Climate Risk Assessment of Sovereign Bonds' Portfolio Working paper, available at SSRN: https://ssrn.com/abstract=3376218

[22] Battiston S., Mandel A., Monasterolo I. (2019): CLIMAFIN handbook: pricing forward-looking climate risks under uncertainty". Working Paper, Climate Finance Alpha.

using policy-relevant 2°C-aligned climate mitigation scenarios from the LIMITS project database (Kriegler et al. 2013).[23] The model first analyses the impact of the shock on firms and sectors' profitability and subsequently calculates the change in market share and GVA for sectors and firms in fossil fuels and renewable energy sectors, using two Integrated Assessment Models (IAM) (GCAM and WITCH). This serves as a basis to calculate the impact on fiscal revenues of sovereigns and finally on sovereign fiscal assets and default probability, which affects the value of sovereign bonds.[24]

61. The study uses different data sources. The Nomenclature of Economic Activities (NACE) Rev2 classification of economic sectors allows to associate the exposure of a specific financial instrument to a specific sector of economic activity which allows, by remapping the subsectors in five climate-relevant sectors, to distinguish carbon-intensive and low-carbon sectors. Lastly, using data on energy and electricity production and proxies by fossil fuel, nuclear and renewable energy technology, by British Petroleum (BP), Statistical Review of World Energy 2018 and by the IEAs World Energy outlook (2018), Battiston and Monasterolo (2019) estimate the gross value added of each technology and its share on total electricity production by country. More detailed information on their findings can be found and its application to insurers' sovereign bonds can be found in Annex 5.1.2.[25]

Corporate bonds and equity holdings

62. The method which is used for government bonds, i.e. the CLIMAFIN approach developed by Battiston et al. (2019), can also be extended for the analysis of transition risk on corporate bonds and equity holdings.

63. The approach embeds climate scenarios in adjusted financial pricing models and allows forward-looking transition risk shocks obtained from climate economic models (e.g. IPCC). As such, it allows embedding forward-looking risk scenarios in the valuation of counterparty risk, in the probability of default of bonds and largest losses on investors' portfolios (Battiston et al., 2019).

64. The CLIMAFIN approach would allow asset shocks to be specified for climate-sensitive sectors (for corporate bonds and equities) and climate-sensitive countries (government bonds), but could also be used to derive more granular shocks at individual issuer level.

65. However, one drawback is that IAMs have limitations relating to the model structure and behavior which, in turn, may affect the policy relevance of the outcomes and hence may not be suitable for scenario analyses (see IMF, 2019).

[23] Kriegler E, Tavoni M, Aboumahboub T, Luderer G, Calvin K, De Maere G, Krey V, Riahi K, et al. (2013) What does the 2 C target imply for a global climate agreement in 2020? The LIMITS study on Durban Platform scenarios. Climate Change Economics 4(4), 1340008.

[24] According to Battiston et al. (2019), the climate spread metric introduces climate as a source of risk in 10-years' bond yields. Shocks are potential gains (positive) or losses (negative) on individual sovereign bonds associated to countries disordered transition to a 2°C-aligned economy by 2030.

[25] The application to insurers' sovereign bonds is also described by Battiston, S., Jakubik, P., Monasterolo, I., Riahi, K. & van Ruijven, B. (2019). Climate risk assessment of sovereign bonds portfolio of European insurers, EIOPA Financial Stability Report December 2019, available at: https://www.eiopa.europa.eu/content/eiopa-financial-stability-report-december-2019

1.4.1.2 CARIMA

66. Görgen et al. (2019)[26] build on previous work Fama and French (1993)[27] and Elton et al. (1995)[28] to capture the sensitivity of carbon risks on assets such as corporate bonds among other asset classes. Their work, named "Carbon Risk Management" (CARIMA) aims at measuring, quantifying, and managing carbon risks and financed emissions.

67. The authors develop a factor model approach to capture the sensitivity of carbon risks on corporate bonds among other asset classes, by introducing a Carbon Risk Factor BMG ("Brown-Minus-Green"), which can be used to derive a 'Carbon Beta'. This Carbon Beta measures the effect of unexpected changes in the transition process of the economy towards a green economy.

68. The CARIMA approach is a fundamental approach to analyze the drivers of returns of assets and the range of the application of the Carbon Beta is wide as it can be determined for several asset classes such as stocks, corporate bonds, loans, portfolios and funds.[29] Moreover, the Carbon Beta can be aggregated to country or sector level and thus allows country and sector analyses. For the purpose of stress testing, the Carbon Beta can be used for generating scenarios. However, one of the most important limitations of this and similar methods is that the "real" market portfolio is unknown.

<u>Corporate bonds</u>

69. For the purpose of measuring the effect of Carbon Risk on corporate bonds, the authors estimate a factor model including the Carbon Risk Factor BMG. In the context of corporate bonds, a high positive value of Carbon Beta means that the value of the asset will fall compared to the entire market, given a transition process. If, analogously, the Carbon Beta takes a high negative value, it implies the opposite, i.e. the value of the asset will increase compared to an average asset, given a transition process. Carbon Betas close to zero imply that the asset moves to an average extent by the transition process.

<u>Equities</u>

70. For equities, transition risk impacts share prices through revenues and capital charges with varying effects across sectors. By affecting the market value of a company, the CARIMA approach allows to derive shocks to individual assets and climate sensitive sectors.

<u>Property/real estate (mortgages) and loans</u>

71. In the case of loans and mortgages real estate projects, Carbon Risk emerges from credit risk, in particular default risk. Transition risk on real estate can be linked to higher energy efficiency standards or lower household wealth due to increased energy costs and expected price development of properties will, in turn, lead to changes in the valuation of mortgages associated to the property. By calculating the Carbon beta of loans related to real estate projects, one is able to build a proxy for transition risk on property and real estate projects.

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[26] Görgen, M., Jacob, A., Nerlinger, M., Riordan, R., Rohleder, M., Wilkens, M. (2019) Carbon Risk. Working Paper.

[27] Fama, E. F., French, K. R. (1993) Common risk factors in the returns on stocks and bonds. Journal of Financial Economics, 33 (1), 3–56.

[28] Elton, E.J., Gruber, M.J., Blake, C.R. (1995) Fundamental Economic Variables, Expected Returns, and Bond Fund Performance. Journal of Finance, 50(4), 1229-56.

[29] The freely available Excel-tool provides an intuitive starting point for investment professionals to quantifying Carbon Risk and its effect on investments.

72.In general, the CARIMA method measures the impact of Carbon Risks on financial assets using historical return time series. For loans, however, such historical return time series or historical time series of (present) values are not available. Hence, the Carbon Beta can only be measured indirectly by using the Carbon Beta of corporate bonds and stocks. There are several possibilities to indirectly determine the Carbon Beta for loans.

73.First, if a firm issues corporate bonds and the Carbon Beta can be calculated, the Carbon Beta of that firm's loans can be also be determined. This may be relevant for non-listed firms, where no times series of stock returns are available. Second, if a firm issues stocks and the Carbon Beta can be calculated, the Carbon Beta of that firm's loans can be also be determined. This may be relevant for listed firms that do not issue corporate bonds. Third, if a firm issues corporate bonds and stocks, the Carbon Beta of that firm's loans can be estimated by the Carbon Beta of comparable firms. This may be relevant for listed firms that are financed by stocks and corporate bonds. Finally, if a firm issues neither corporate bonds nor stocks, the Carbon Beta of that firm's loans can be estimated by the Carbon Beta of comparable firms. This may be relevant for non-listed firms that are financed with capital market instruments.

Infrastructure investments

74.Infrastructure investments usually have bond or equity exposure. Building on the Carbon Betas of equity and corporate bonds, one can consider whether infrastructures investments have a different risk profile. Otherwise, it is possible to consider infrastructure investments as part of the bond and equity shocks depending on the underlying industry.

75.One major issue is that in order to calculate Carbon betas, the CARIMA models rely on historic returns. Especially in the case of alternative investments such as real estate, underlying returns are often unavailable or only provide recent data. One solution is to consider proxies for missing historic returns.

1.4.1.3 NiGEM model

76.De Nederlandsche Bank (DNB) and Banque de France designed their energy transition risk ST using the multi-country macroeconomic model NiGEM. DNB considers risks related to a delayed policy response (with a sudden and sharp increase in the carbon price) to climate-risk and asymmetric technology shocks.[30] Banque de France studies the impact of different transition pathways (in terms of timing, level of carbon taxation, and distribution channels) to reach the Paris agreement goals. In both approaches, the macro-financial impacts of the climate scenarios are derived within the NiGEM model (i.e. the climate shocks – carbon price in particular - are inputs into the model which generates broader economic and financial shocks).

77.As not all industries are equally vulnerable to scenario conditions, DNB computes Transition Vulnerability Factors (TVFs) to account for the heterogeneous reactions of different industrial sectors, depending on their carbon footprint. The TVFs take into account not only an industry's own emissions, but also the emissions of the supplying firms throughout the entire production chain. Differently from the binary measures often used (green vs.

[30] Vermeulen, R., Schets, E., Lohuis, M., Kölbl, B., Jansen, D., Heeringa, W., 2018. An energy transition risk stress test for the financial system of the Netherlands. DNB Occasional Studies No 16-7. Available at: https://www.dnb.nl/en/binaries/OS_Transition%20risk%20stress%20test%20versie_web_tcm47-379397.pdf.

brown industry), the TVFs capture a more granular distribution of sensitivities across 56 sectors. In order to capture interactions effects related to the production chain and sector-specific emissions intensities, Banque de France connects NiGEM with a sectorial model and obtains impacts of an increase in carbon price on sectoral value added and turnover. Furthermore, to disentangle the effect between winners and losers, the Banque de France connects the sectorial model to a firm-level credit risk rating model, in order to address the intra-sectoral (firm-level) heterogeneities.

78. DNB translates the NiGEM forecast of stock price indices and government bond yields into industry specific equity and bond returns. To derive equity returns by industry, the equity losses incurred in a given scenario and based on excess market returns are transposed at the sectoral level through the TVFs. Bond prices are instead derived according to changes in the risk free interest rate (when it increases, bond prices decrease) and in industry-specific credit risk spreads (when they increase, bond prices decrease). Banque de France and L'Autorité de contrôle prudentiel et de résolution (ACPR) aim at determining the sensitivities of industry specific stock returns to climate risk by means of the following two approaches: a) the NiGEM-based projections of stock price indices are translated into associated industry level stock returns by means of a previously estimated CAPM-like relationship; b) the NiGEM-and-Sectorial-Model-based projections of industry specific value added (or sales revenues) and associated dividend flows are linked to the industry level stock return using a Dividend Discount Model with discount factors given by credit-risk-adjusted EIOPA Risk Free Rates (RFR) with proper maturity. As far as industry specific bond returns are concerned, they are determined by adding to the NiGEM-based sovereign yield projections an industry specific credit spread component.

79. As such, the financial shocks are provided both as broad economic factors (such as GDP, inflation and interest rates movements) and sector specific shocks (based on carbon intensity). The benefit of this approach is that it takes into account different vulnerabilities across industries and the impacts can be readily calculated using a combination of macroeconomic models and input-output tables on carbon footprints. The limitations of specifying shocks at a sectoral level using the NiGEM model are that it does not allow for firm-level heterogeneity within industries for the financial shocks and that the climate shocks have to fit the specifications of the macroeconomic model (to be used as inputs). Banque de France tries to address this issue subsequently with a firm-level credit rating model, using the sectorial model outputs. A second challenge concerns the ability to generate a term structure of risk-free rates (instead for short-term and long-term maturity only) with nominal term premia across the maturity spectrum. A third challenge relates to the combination of an interest rate shock (consistent with the climate scenario and modelled on the climate policy shock) and a sector specific credit spread shock for bonds.

1.4.1.4 PACTA model

80. The PACTA model assesses the alignment of firms' investments portfolios with respect to a 2°C scenario. The goal of this approach is to analyze the current exposure of the portfolio to economic activities affected by the transition to a low-carbon economy, to illustrate the alignment with a 2°C transition within a period of five years and to assess the expected future exposure to high- and low-carbon economic activities.

81. The PACTA model calculates the expected benchmark exposure for each technology in the specific asset class. Current and planned production (fossil fuel and automotive sector) and current installed capacity as well as new capacity additions (power sector) are sourced from business intelligence databases[31]. Using this forward-looking production and capacity data at the physical asset level, the model maps this data to their immediate owners and parent company to generate an aggregate "current production profile" for each technology.

82. Linking these production plans to the financial assets (equity and fixed income) issued by the company, it is possible to derive the current exposure in the respective asset class and geography and adding a trend scenario line, e.g. International Energy Agency - IEA's 2°C compatible sustainable development scenario, to each technology. The models time horizon is five years, which reflects the time horizon of capital expenditure planning for which meaningful data is available, across all sectors.[32] The chosen scenarios reflect potential technologies pathways to meet climate goals and are subject to uncertainty. The providers of the climate technology pathways are the IEA, Greenpeace, Bloomberg, among others.

83. For stress testing purposes, the PACTA approach can be used to derive individual asset shocks ("stressed values") based on the adjustment in physical production that would be needed to align with a 2 degree scenario (for instance based on a 'late and sudden' type of adjustment). The sensitivity could be measured depending on a) when policy action is taken and b) how strong the policy measures are (i.e. how fast does the economy move to decarbonize).

84. This detailed assessment would require physical production to be linked to the IEA scenarios. For assets where this information is available, shocks will be based on the required change in production necessary to meet the targets in a 2 degree scenario. An advantage of this approach is that it takes into account firm-level heterogeneity and shocks are based on actual physical production. However, a drawback of this approach for bottom-up stress-testing is that it would require highly granular individual asset level specifications for the shocks (only available for those assets that can be linked to physical production, which are mostly listed equity and corporate bonds) and participants would have to map their portfolio to the individual shocks.

Corporate bonds

85. For corporate bonds, the re-pricing would be based on a calculation of the expected change of net income due to the required adjustment to align physical production with the 2 degree target in a specific scenario. This can be run though the Zmijewski default probability model[33]. The re-evaluation of the bond value is then given by the net present value (NPV) of the expected returns until maturity, weighted by the default probability.

Listed equity

86. For equity, the shocks rely on the calculation of the expected change of net income and in turn the expected NPV of future dividends and market price of

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[31] The data sources of the PACTA model are derived from Global data, WardsAuto, RightShip, FlightGlobal as well as other sectors databases, Bloomberg and Morningstar.

[32] 2° Investing Initiative (2019). 2° SCENARIO ANALYSIS Report - Background Information, available at https://www.transitionmonitor.com/wp-

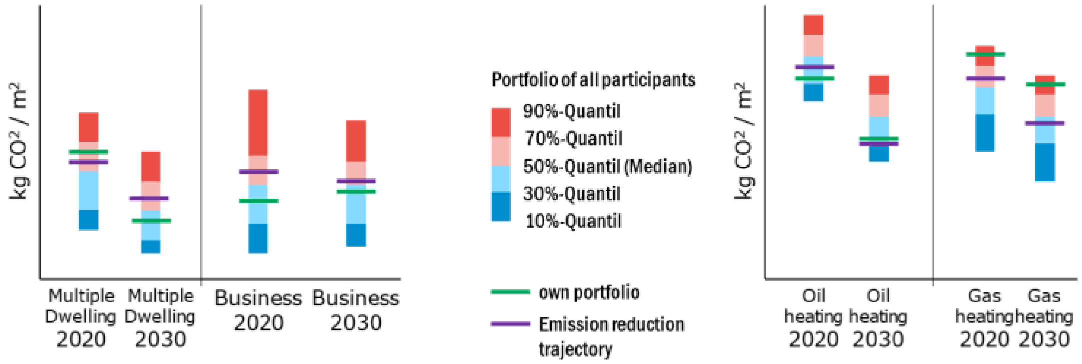
[33] Zmijewski, M. E. (1984) Methodological Issues Related to the Estimation of Financial Distress Prediction Models. Journal of Accounting Research 22, 59-82.

equity. In detail, this follows Gordon's dividend discount model, i.e. the net present value of dividends, assuming the ratio dividends to net income stays constant in time and that change in volume of dividend moves proportionally with the change in expected net income. This value will be calculated in „late and sudden"-type transition scenario(s), which can be compared to the current market value (or to values in other scenarios).

Real estate

87. In the application of the PACTA model to Swiss pension funds, 2 degree initiative has developed a method to analyze the CO_2 emissions of a building or a real estate/mortgage portfolio, to compare it to peers and to assess the alignment with climate objectives for the real estate sector.[34] Given the location of the property, information on the heating system, energy consumption area or refurbishment details, the model calculates the CO_2 emissions for each property. A visual sample is given in Figure 1-5.

Figure 1-5 CO2 emissions for selected Swiss real estate portfolio



Source: 2° Investing Initiative (2019). CLIMATE ALIGNMENT ASSESSMENT 2020 BRIEFING FOR INVESTORS

Limitation

88. An important limitation is that due to the fact that the mapping of physical assets to financial securities is based on the ISIN of the underlying security, coverage may be limited. Although previous reports on PACTA's scenario analysis, e.g. California insurance companies (see Annex 5.1.2 for more information), report a coverage of only 28% for fixed income and equity investments, the authors argue that within the portfolio, i.e. investments that are covered, account for 90% of energy-related CO_2-emissions in a typical portfolio.

89. Moreover, forward-looking data is subject to uncertainty as it is based on current public plans from companies. With respect to the time horizon of five years, this the companies' plans will certainly change.

[34] 2° Investing Initiative (2017). OUT OF THE FOG: Quantifying the alignment of Swiss pension funds and insurances with the Paris Agreement and 2° Investing Initiative (2019). CLIMATE ALIGNMENT ASSESSMENT 2020 BRIEFING FOR INVESTORS.

1.4.1.5 Conclusion

90. The number of modelling approaches that can be considered in a stress-testing framework for climate change risks in insurance companies is vast. This section has illustrated the heterogeneity in assumptions, data sources and methodological approaches. For the calibration of future climate ST scenario it is therefore important to carefully consider:

- **Multiple modelling approaches** to compare and validate the shocks to be included in the scenario specifications;
- **Granularity of the model output** and whether they fit with the objective of the ST exercise and allow the shocks to be specified in such a way they can be implemented by stress test participants;
- **Data challenges** and issues related to the consistency of data sources, in obtaining time series which are long enough, the lack of forward-looking data, comparability of data, which may all result in low data coverage;
- **Complexity of models**, which lead to difficulties in implementing such models in bottom-up stress testing. Moreover, models such as Integrated Assessment Models show that they may not be suitable for stress testing frameworks. Finally, stress testing assumptions should consider expert judgement in defining material stresses;
- Due to variety of assumptions and respective data requirements in modelling approaches, it is challenging to find a model which captures risks for the derivation of stress in one unified model. This leads to "**patchwork models**" which are difficult to interpret.

91. Going forward, EIOPA intends to liaise with the academic community, practitioners and model vendors for the exact calibration of the shocks.

Questions:

Q 8 What are your views on the different modelling approaches presented? Are there any other modelling approaches for transition risk that should be considered?

Q 9 Are there particular external sources to calibrate transition risks for assets that should be considered?

1.4.2 Physical risks

92. This section looks at the methodologies and approaches to derive the impact on assets and liabilities of insurers stemming from physical risk. Section 1.4.2.1 will consider the impact on the liability side and section 1.4.2.2 will consider the impact on the asset side.

Table 1-9 Transmission channels on the balance sheet stemming from physical risks

Type of risk	Transmission channel	Balance sheet impact	Example
Physical risk	Underwriting risk	Liabilities	Higher than expected insurance claims on damaged insured assets (non-life) or higher than expected mortality rates (life)
	Market risk	Assets	Impairing of asset values due to financial losses affecting profitability of firms, due to for instance business interruptions, or damage to real estate. Specific example: equity price shocks
	Credit risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties/reinsurers due to financial losses stemming from climate change Specific example: bond price/yield shock

1.4.2.1 Impact on insurance liabilities

93. Physical risks from climate change are expected to mainly impact the liabilities of insurance companies through higher claims, manifesting themselves in

- changes to the frequency, severity and correlation of specific weather-related events such as heatwaves, floods, wildfires and storms, and
- in the longer term, broader shifts in climate such as changes in precipitation and extreme weather variability, sea level change and rising average temperatures.

94. This section discusses the shocks stemming from physical risks on the liability-side. The sub-sections are respectively devoted to non-Life risk, Life risk and Health risk.

1.4.2.1.1 Non-life shocks

95. As presented in the Prudential Regulation Authority of the Bank of England (PRA)'s framework for assessing financial impacts of physical climate change (PRA May 2019)[35], there is a wide range of possible impacts from climate change on general insurance firms' liabilities. Consequently, there is no single climate change scenario that can assess this impact effectively across all firms and across all business decisions. Nevertheless, it is generally agreed that the frequency, severity and correlation of natural catastrophic event are expected to increase with climate change. This paper considers windstorm (including hail), floods (coastal, inland, or flash flood), heatwaves, wildfires and droughts as the more material perils amplified by climate change.

96. Given the relatively short-term nature of non-life (re)insurance liabilities, the impact of climate change on catastrophe perils may be difficult to distinguish from natural variability. As such, over a short horizon the impact of climate change may be dwarfed by other factors such as interest rate movements, natural climate variability or changes in exposure. Shocks over a longer time horizon can pick up trends and can serve to illustrate any costs of inaction, in particular as medium term to long term shocks are therefore expected for physical risks in non-life (PRA May 2019).

97. To define the shocks, EIOPA is considering two approaches:

[35] A framework for assessing financial impacts of physical climate change, BoE, May 2019.

- Prescribing specific Nat-Cat events linked to climate change evidence ('event-based scenario' similar to the approach in the EIOPA 2018 ST exercise for Nat-Cat);[36]
- Prescribing changes to frequency, severity and correlation of specific (regional) perils linked to climate change evidence (but not prescribing the specific events).

98. Table 1-10 provides an overview of the pros and cons of the different approaches.

Table 1-10 Advantages and disadvantages of event-based scenario vs. Changes to severity, frequency and correlation parameters for perils

Approach	Advantages	Disadvantages
Event-based scenario	• The approach will allow for the evaluation of the impact of a specific set of catastrophic events on the European insurance sector linked to climate change (e.g. specific windstorm or flood event) providing additional insights into the resilience of the sector to such physical risks	• Challenging to link specific events to explicitly to climate change • The approach could be expensive and challenging for undertakings/groups that do not have an internal model for computing catastrophic losses and might rely on external consultants / data provides. This is particularly true for medium-sized/small non-life solo undertakings • The approach doesn't allow for a similar severity of shocks for all participants (depending on the specific Nat-Cat events in the scenario) • The comparability of results could be hampered by the fact that current modelling tools allow for customisation by participant groups that may lower the estimations of the final losses
Changes to severity, frequency and correlation parameters for perils	• The approach will allow for the evaluation of the impact of changing severity, frequency and correlation of specific (regional) perils linked to climate change, providing additional insights into the resilience of the insurance sector to such physical risks • The approach would allow more similar severity of the shocks for all participants, as they are not tied to specific events, but broader perils	• Challenging to link increasing severity and frequency of specific perils to climate change and even more for the correlation • It may be difficult to translate shocks to parameters into specific financial losses (requires granular data on the type of coverages provided and how they would be impacted by different perils). • The comparability of results could be hampered as participating groups may use different modelling tools to estimate financial impact

99. EIOPA is considering **prescribing changes to severity, frequency and correlation of parameter for specific (regional) perils** (in particular windstorm, floods, heatwaves, wildfires and droughts). This could help ensure for more comparable severity across participants as impacts are not tied to specific events prescribed, but broader Nat-Cat perils linked to climate change.

100. For the calibration of the shocks, EIOPA intends to consult external data providers and climate scientists, as it needs to be closely linked to scientific evidence on the expected impact of climate change on different perils. For instance, one can refer to various climate scenarios, such as the IPCC's

[36] See also the EIOPA Discussion Paper on Methodological Principles (section 5.2.2.2)

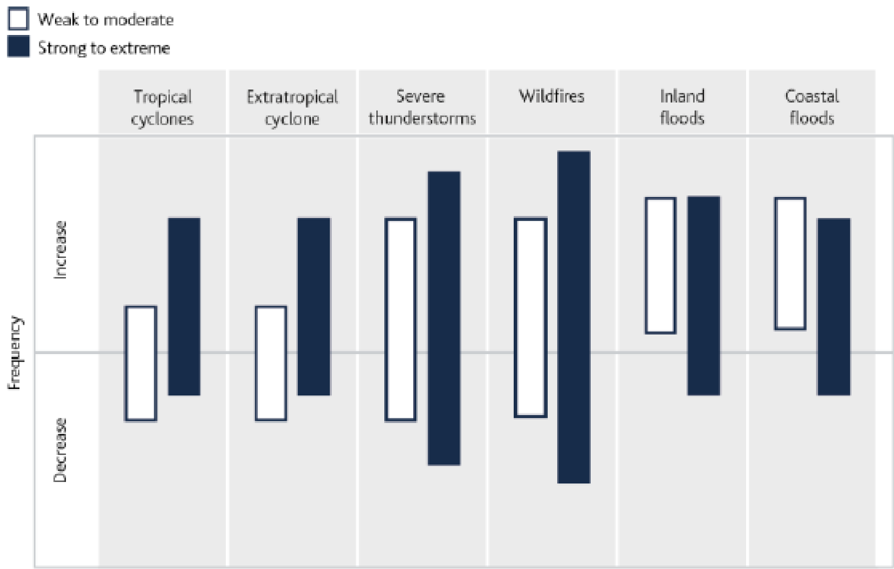
Representative Concentration Pathways (RCPs), and for a range of assumptions used to translate hazard impacts into potential loss impacts. As part of its work the IPCC creates optimistic and pessimistic emission scenarios which are used in future projections.

101. The definition of shocks for a specific peril and/or region of interest, could include determining:

- key drivers influencing the severity of a given peril;
- impact of climate change on those drivers;
- historic trends and/or potential future trends impacting these drivers;
- a measure of uncertainty in the current climate and the strength of climate change signal that will be distinct from inherent natural variability in today's climate;
- change in likelihood of events (or event drivers) of a given severity;
- change in geographic areas impacted by a given peril; and
- the relation of the information above to greenhouse gas emission projection(s), recognizing that research outcomes are based on a range of IPCC model outputs.

102. To develop those shocks one could use as example, the climate change impacts from AIR (2017) as summarized in Figure 1-6, showing a likelihood of increases or decreases in frequency of weak-to-moderate intensity events (with a 2- to 10-year return period) and strong to extreme events (50 to 1-in-250 year return period) for different weather-related phenomena by the end of the 21st century. Length of bar indicates degree of uncertainty. Note that the relative positions of the bars represent globally-averaged estimates; significant regional differences may exist and would need to be considered separately.

Figure 1-6 Likelihood of increases or decreases in frequency of weak-to-moderate intensity events



Source: AIR (2017)

Questions:

Q 10 Do you agree that windstorm, floods, heatwaves, wildfires and droughts are the more material perils amplified by climate change which are relevant for non-life risks?

Q 11 Do you agree that prescribing changes to frequency, severity and correlation of specific perils linked to climate change evidence (but not prescribing the specific events) should be the preferred approach? Would this type of specification allow you to calculate the stressed impact for your portfolio?

Q 12 Would you have suggestions of a methodology to define the changes to frequency, severity and correlation of specific perils in light of climate change? Are there particular external sources to calibrate physical risk impacts on insurance liabilities should be considered when calibrating the scenario variables?

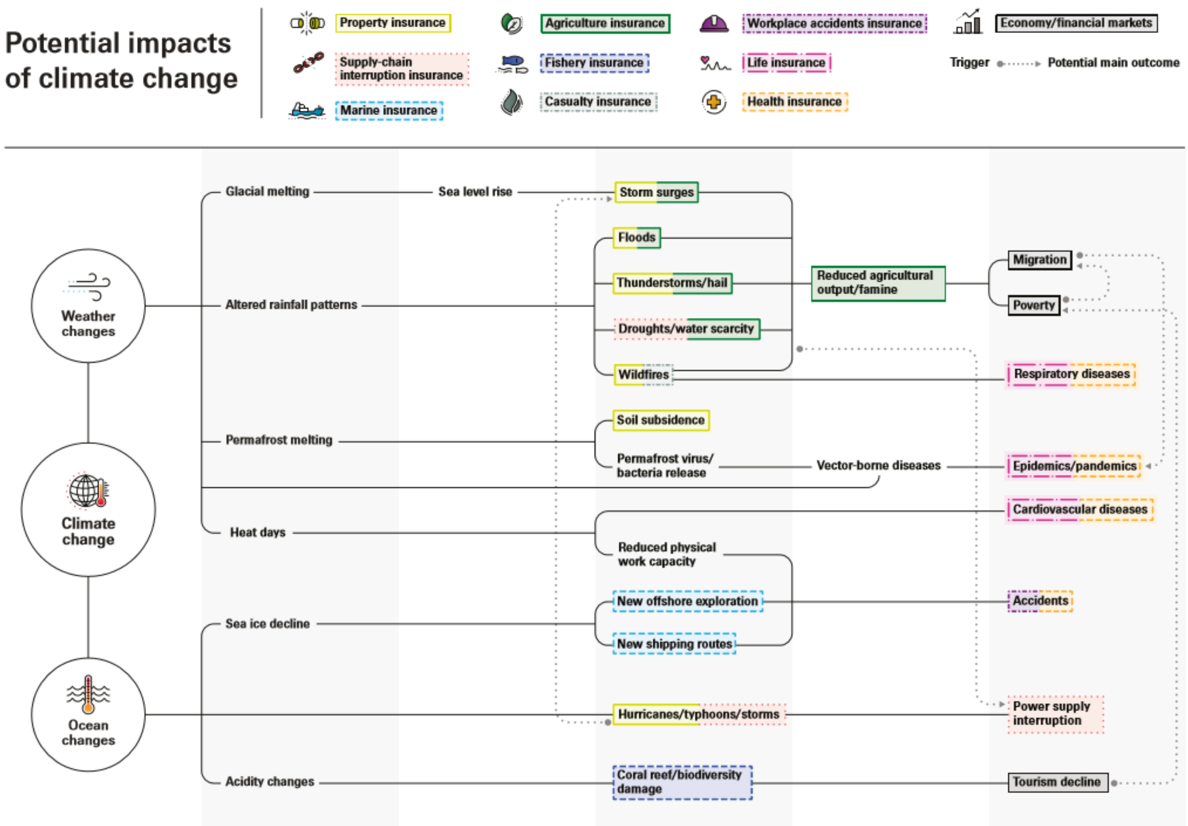
1.4.2.1.2 Life and health shocks

Direct impacts

103. EIOPA would consult both climate scientists and health experts to calibrate potential life & health sector climate change shocks. Preliminary evidence suggests that the most pronounced risks affecting human health stem from heatwaves, floods, droughts wildfires and vector-borne diseases. As temperatures warm and wildfires become more frequent, air quality may also deteriorate, potentially accelerating costs related to the health, and life insurance lines of businessIt is the cascading risks related to climate change, such as the increased threat of pandemics because of warming temperatures and air pollution due to more frequent wildfires that will have significant effects on human life and health.

104. Swiss Re has elaborated the transition graphic identifying the potential impact of climate change on human life and health as reported in Figure 1-7.

Figure 1-7 Potential impact from climate change on life and health



Source: Swiss Re SONAR 2019 New emerging risk insight

105. One of the main factors expected to impact mortality is extreme heatwaves, particularly in populous areas which previously haven't been heavily affected. An example of one such event is the 2003 heatwave in Europe, which is estimated to have caused 70,000 deaths. As temperatures rise, the frequency and severity of such events will likely increase.

106. IPCC report on Impacts of 1.5°C of Global Warming on Natural and Human Systems shows that increasing temperatures and high humidity due to climate change is another area of concern. This combination enables vector-borne diseases to conquer new ground, such as the Zika epidemics. Climate change will extend the transmission season and geographical range for many infectious diseases.

107. UN studies on human health and adaptation to understand climate impacts on health shows for example Lyme disease, avian influenza, meningitis, dengue fever and tropical bacterial and viral infections are projected to increase with global warming, including potential shifts in their geographic range.

108. The California wildfires of 2018 and the Australian ones of December 2019 shows that severe drought conditions can lead to increased wildfires, which in turn lead to air pollution.

Questions:

Q 13 Do you agree that heatwaves, floods, droughts, fires and vector-borne diseases are the more material perils amplified by climate change which are relevant for life and health risks?

Q 14 Do you agree that shocking mortality and morbidity rates as part of a climate stress test is relevant? Are there further risks beyond mortality and morbidity that should be specified as part of climate change ST?

Q 15 Could you suggest a methodology to calibrate such a shock?

1.4.2.2 Impact on insurance assets

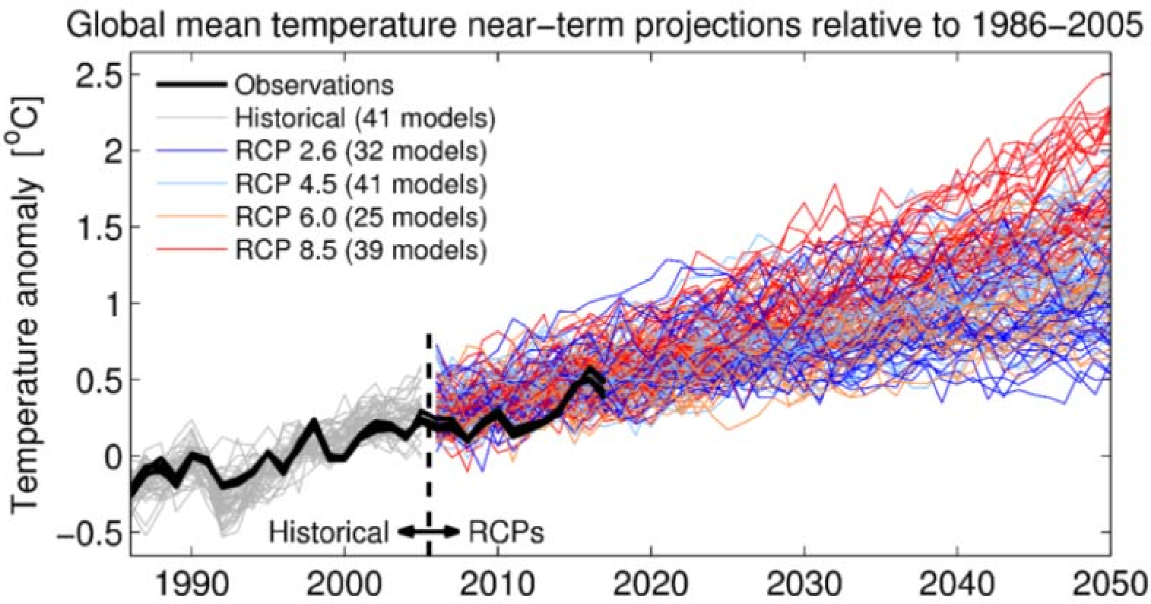
109. On the asset side, scenario analysis for physical risk is fundamentally different from transition risk in its assumptions. While a financially adverse transition shock is predicated on an abrupt or drastic reduction in carbon emissions, physical risk is assumed to increase with the frequency and severity of weather events, and consequently with the emission of carbon. Calibration of an asset shock that includes both transition risk and physical risk is therefore challenging, as the business-as-usual scenarios that most amplify physical risk are those in which the manifestation of transition risk is minimal.

110. Further, there are several challenges to quantifying the repercussions of physical risks on asset prices. Firstly, it is the uncertainty regarding the speed at which relatively long-term climate scenarios would ultimately be transmitted to asset prices. It is not clear how to make assumptions on how, if at all, market players discount[37] the future losses of an asset whose present profitability helps generate such losses by contributing to future systemic volatility. Moreover, physical risks over the next 10-20 years are largely independent from current policy decisions and emission pathways given the strong inertia of climate systems and the past 150 years of GHG emissions[38].

[37] See http://eprints.whiterose.ac.uk/125845/1/Actual_resubmission_DiscountingDisentangled_AEJP_2017_R2.pdf for a survey on the so-called Social Discount Rate (SDR) is used by economists and policy experts (Drupp, Moritz A., et al, AER 2018). A positive discount rate reduces the present value given to projects which benefit future generations.

[38] See http://427mt.com/2019/06/17/scenario-analysis-for-physical-climate-risk-part-1-foundations/ for a review of scenario analysis for physical climate risk.

Figure 1-8 Global mean temperature near-term projections relative to 1986-2005



Source: Climate Lab Book (2019) Comparing CMIP5 & observations. Available at: https://www.climate-lab-book.ac.uk/comparing-cmip5-observations/

111. Secondly, it is the difficulty approximating a given company's exposure at the sectorial or even geographical level. Unlike transition risk, to which most players of certain sectors of activity are commonly exposed, more granular information is likely necessary to calibrate meaningful shocks linked to physical risk. While certain components of physical risk, such as heat stress, may be assumed to materialize at a regional level, exposure to other components, such as hurricanes or sea level rise, cannot easily be captured at broad geographical levels (e.g., the country level). Physical damage can occur with different severity at two production plants from the same sector and same approximate geographical area. Further, physical damage leave a firm's home market untouched while devastating firms essential in its supply chain.

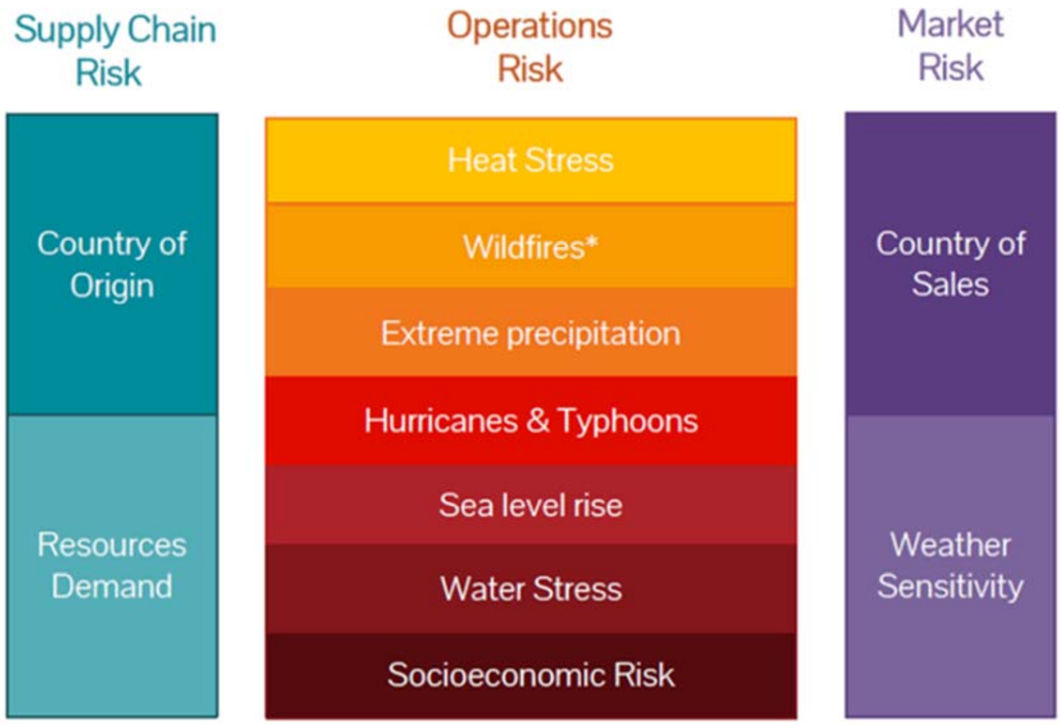
112. Lastly, it is worth mentioning the difficulties in using an empirical approach for this type of exercise. First, academic research on the relationship between climate events and corporate bond and stock performance is still very limited. Further, while market players in the past may have reacted sluggishly to a publicly-traded company that has suffered an adverse weather event, reactions in the future may become more pronounced as investors begin to better apprehend underlying climate trends and their implications on future economic conditions.

113. In a June 2019 post, the publisher and provider of data, market intelligence and analysis related to physical climate and environmental risks Four Twenty Seven outlined a methodology[39] for a score that measures an equity or fixed-income security's exposure to physical climate risks. While the purpose of this scoring tool is to help investors identify and mitigate risk in their portfolios, Four Twenty Seven suggests that "differentiated impacts by sectors can lay the foundations for a stress test, as industry risk levels can be used to set initial assumptions on sector-wide impacts."

[39] http://427mt.com/2019/06/18/scenario-analysis-for-physical-climate-risk-equity-markets/

114. Risks are broken down into three categories: supply chain risk, operations risk and market risk as shown in Figure 1-9.

Figure 1-9 Risks broken down into supply chain risk, operations risk and market risk



Source: Four Twenty Seven (2019) Scenario Analysis for physical Climate Risk: Equity Markets. Available at: http://427mt.com/2019/06/18/scenario-analysis-for-physical-climate-risk-equity-markets/

115. Scores for Operations Risk are produced by screening each corporate site for its exposure and sensitivity to a set of climate hazards including extreme precipitation, sea level rise, hurricanes, heat stress, water stress and wildfires. At present, 2,000 companies have been scored in this category. Market Risk and Supply Chain scores are given based solely on financial data, and are available for 10,000 companies.

116. Despite its difficulties, it is conceivable to apply shocks more broadly at the industry level, by applying stresses based on the average exposures of companies in that industry. For example, manufacturing firms in the technology sector rely on complex supply chains in Southeast Asia that can be disrupted by extreme weather events, such as typhoons and extreme precipitation as depicted in Table 1-11.

Table 1-11 Sector exposures to physical risk

		427 data-derived estimates of exposure to select climate hazards			
GICS Sector	**GICS Industry Group**	**Average score**	**Operations Risk Score**	**Market Risk Score**	**Supply Chain Risk Score**
Information Technology	Semiconductors & Semiconductor Equipment	56	43	70	62
Information Technology	Technology Hardware & Equipment	54	44	64	57
Utilities	Utilities	53	46	37	70
Health Care	Pharmaceuticals, Biotechnology & Life Sciences	52	42	63	57
Consumer Staples	Household & Personal Products	50	40	65	57
Materials	Materials	50	42	60	51
Industrials	Transportation	50	43	41	63
Consumer Staples	Food & Staples Retailing	48	41	57	52
Consumer Discretionary	Automobiles & Components	48	42	66	34
Industrials	Capital Goods	47	42	57	40
Consumer Discretionary	Consumer Durables & Apparel	46	40	54	46
Energy	Energy	45	39	48	51

Source: Four Twenty Seven (2019) Scenario Analysis for physical Climate Risk: Equity Markets. Available at: http://427mt.com/2019/06/18/scenario-analysis-for-physical-climate-risk-equity-markets/

117. More precise analysis at the security level would require data on the location of a company's main production plants, the location of its suppliers and the location of their main customer base where sales are conducted. Applying weights to the relative importance of these three considerations at the (e.g., at the industry level) would yield a total exposure to physical risk per security. Finally, to conduct an asset-side ST, assumptions need to be made which link asset price movements to each climate scenario considered (RCP 2.6, RCP 4.5, RCP 8.5, etc.), although as mentioned above, the choice of scenario is unlikely to drastically alter the path of climate outcomes in the near (10-20 year) term.

118. Impacts to sovereign bonds are considered to be negligible in advanced economies[40], ratings on certain emerging regions (such as Southeast Asia or the Caribbean) will require additional scrutiny, particularly if significant shares of their economies are concentrated in sectors which are exposed to physical damage.

119. While EIOPA acknowledges that physical risks can also have an impact on insurers' assets and investment, currently no reliable methodology or data source seems available to estimate and calibrate this impact reliably. As such, the first EIOPA climate stress test is expected to focus on insurance liabilities when it comes to physical risks. Methodologies to also integrate shocks to assets stemming from physical risk will be explored further in the future.

Questions:

Q 16 What are your views on the risk posed by physical risk on your assets and investments?

Q 17 Are you already trying to assess impact on assets from physical risk? Do you have any other indicators or methodologies to do so?

Q 18 Do you have a methodology to disentangle physical and transition risk on the asset side?

[40] https://www.spratings.com/documents/20184/1634005/How+does+sandp+incorporate+ESG+Risks+into+its+ratings/6a0a08e2-d0b2-443b-bb1a-e54b354ac6a5

1.4.3 Specification and Application of shocks

120. In light of the above discussion, EIOPA envisages the following variables to be specified in a climate ST scenario, noting that the exact specification would also build on the Network for Greening the Financial System's reference scenarios due to be published in April 2020. The financial variables would reflect the macroeconomic and financial impact of the combination of climate-related risks (the climate variables) in each scenario; they would not layer on an additional macroeconomic shock that is unrelated to climate change.

Table 1-12 Overview of key variables to be specified in climate ST scenario

Climate variables		Financial variables	
Physical risk	**Transition risk**	**Macroeconomic**	**Financial markets**
• Global and regional temperature pathways • Frequency, severity and correlation of specific and material climate-related perils for different regions (for non-life) • Mortality / morbidity parameters (for life)	• Emission pathways (aggregate and disaggregate across world regions and economic sectors) • Carbon price pathways • Commodity and energy prices, by energy source • Energy mix	• GDP (aggregate and disaggregated by economic sector and country) • Interest rates (RFR)[41] • Inflation • Residential and commercial real estate prices	• Government bond yields • Corporate bond yields, disaggregated by economic sector • Equity indices/shocks, disaggregated by economic sector

121. In any scenario covering both transition and physical risk, the shocks across both risks would have to combined to derive the total financial impact (i.e. the ultimate financial impact would be a combination of both risks).

122. In general, the same principles apply regarding the application of shocks as discussed in EIOPA's Discussion Paper on Methodological principle of insurance stress testing (and in particular Chapter 5 thereof). Where a positive marginal impact arises from the application of the scenario shocks, these would in principle be allowed (no capping of impact). The topic will be nevertheless further considered in the definition of the technical specification of future ST exercises.

123. In case of a fixed BS approach, the shocks would be applied to the reference date BS as an instantaneous shock, without the use of reactive management actions.

Treatment of reinsurance

124. Insurers typically have risk mitigation techniques in place at the reference date related to Nat-Cat risk, in particular proportional and non-proportional reinsurance treaties.

125. For the purpose of climate change ST and to assess the resilience of the (re)insurance sector, the treatment of reinsurance is of particular importance. The following approaches can be considered in this regard:

- Impact calculated gross of reinsurance (i.e. reinsurance treaties are not taken into account for the calculation of the financial impact);

[41] Shocks to interest rates only stemming from climate change shocks if they can be justified by the model (i.e. additional macroeconomic shocks are not considered).

- Impact calculated both gross of reinsurance and net of reinsurance;
- Impact calculated net of reinsurance, but with shock to reinsurance recoverables;
- Impact calculated net of reinsurance.

126. Given the importance of reinsurance for physical risks, the preferred approach would be to ask the **impact both gross and net of reinsurance**. For the calculation of the net impact, in case reinsurance treaties in force at the reference date allow for reinstatement, reinstatements (including potential related costs) should be taken into account. However, any change in the treaties, including changes in the reinstatement regime against the prescribed shocks, should be treated as post-stress reactive management actions and therefore not allowed if not differently specified.

127. With regard to the reinsurance recoverables, the following could also be applied in addition: recoverables are accounted for as a credit to be received from reinsurers. In a more complex catastrophe scenario the recoverability of insurance losses through reinsurance treaties could also be shocked. To this end an additional shock considering the default of some reinsurers (e.g. the largest ones) or their ability to fully repay the claims could be considered. To do so, the largest counterparty could be selected and their recovery rate could be shocked according to the Credit Quality Step (CQS) of the reinsurer (using as a reference the probability of default prescribed in the SII standard formula).

128. With regard to national guarantee schemes (Nat-cat schemes) for Nat-cat events, which may exist in some jurisdictions, these may only be taken into account if they are already implemented in the best estimate at the reference date, are clearly enforceable and lead to 'automatic' – (based on pre-defined triggers rather than ex-post decision) risk transfer similar to reinsurance (i.e. they are not dependent on an action by a third-party/government to declare a national emergency). Where feasible, both the gross and net of amount can be requested. The aim is to ensure a comparability of the gross financial impact across countries in light of the heterogeneous nat-cat schemes coverage across countries.

Questions:

Q 19 What are your views on the proposed specification of the shocks? Do you foresee any challenges regarding the proposed specification of the variables for your modelling of the impact?

Q 20 What are your views on the application of shocks? Do you foresee any challenges regarding the proposed treatment of reinsurance and nat-cat schemes?

Q 21 Are there alternative approaches to capturing the interactions between physical and transition risks in climate change scenarios?

Q 22 What are views on the treatment of Nat-Cat schemes?

1.5 Metrics for evaluation

129. In order to assess the impact of a scenario, depending on the type of risks that are evaluated (physical, transition or both), a set of indicators based on key figures computed under baseline and stressed scenarios could be considered. The aim of those indicators is to provide a comprehensive picture of the major drivers behind the impact of the prescribed scenarios on the BS and on the profitability of the participants. These two groups of indicators are considered key metrics for climate change stress test. Moreover, a set of technical indicators are provided with the purpose of complementing the analysis (especially for the assessment of the impact of the physical risks). Indicators on the capital position (Solvency Ratio, Total Own Funds) are not deemed suitable at least for the first climate change stress test exercise due to its macro objectives and to the (ideally) longer time horizon. In the future, in case of exercises more focused on micro aspects, EIOPA may consider to include also capital indicators in this type of ST.

1.5.1 Balance sheet indicators

Table 1-13 Balance sheet indicators by type of risk

Indicator	Type of risks	Notes
Excess of Asset over Liabilities (change of)	Physical and transition	
Asset over Liabilities (change of)	Physical and transition	
Stressed value or price change for each of the identified assets (or class of asset) or change in portfolio market evaluation	Only transition	Only for assets mapped to climate relevant sectors, physical assets and their related technologies.
Relative change of total technical provision	Only physical	Only non-life business could be considered unless the scenario include also the impact of a change in mortality/morbidity

1.5.2 Profitability indicators

Table 1-14 Profitability indicators by type of risk

Indicator	Type of risks	Notes
Loss Ratio	Only physical	Overall or split by relevant lines of business
Overall impact on the firm's profit and loss	Physical and transition	
Impact on the firm's technical result	Only physical (for non-life insurers); both (for life insurers)	Overall or split by relevant lines of business

1.5.3 Technical indicators

130. With reference to the potential loss metrics that can be used in assessing the physical risk deriving from the climate change, depending on the purpose of the analysis, the following distinction should be considered:

- **expected losses** – typically average annual losses (AAL) or median losses to show how average losses might change due to the impact of climate change;
- **tail losses** – showing how the losses that might be expected in an extreme year could move as a result of climate change.

131. Table 1-15 provides a list of potential technical indicators for complementing the assessment of the climate change impact.

Table 1-15 Technical indicators by types of risks

Indicator	Type of risks	Notes
Gross/ceded/net aggregated losses	Only physical	
Exposures (Sum Assured)	Only phiyical	Baseline figures. Overall or split by event[42]/geographical area
Total assets subject to transitional risks	Only transition	Baseline figures. Overall or split by sector or technology
Return period of gross losses	Only physical	
1 in X years AEP (aggregate exceedance probability)	Only physical	It shows the maximum amount of losses caused by all the events over a period of one year, corresponding to the given probability level
Annual Average Loss (AAL)	Only physical	It shows the average losses from property damage experienced by a portfolio per year[43].
Probable maximum loss (PML)	Only physical	It shows the value of the largest loss that is considered likely to result from an event
Annual Probability of occurrence	Only physical	It shows the probability that, over a period of one year, an event of a given magnitude occurs.
1 in X years Return period	Only physical	It shows the magnitude of an extreme event (for instance an event with a 1-in-100 year return period has a 1% chance of being exceeded by a higher magnitude event in any year)

132. The above indicators give information on the overall impact of a certain scenario (calibrated considering the effect of the climate change). To measure only the impact of climate change (compared to the current situation), the indicators should be calculated including the expected impact and how this could develop in the future. In this last case, a modest annual change can have a substantial compounded impact in a longer time horizon.

133. The results of the analysis should also capture uncertainty where possible (such as using different tools to assess the same physical climate change risk or presenting results as a range). Qualitative assessments can, in some cases,

[42] Potential events linked to the climate change: Floods (coastal and inland); Wildfires; Droughts; Subsidence; Hurricanes; Tornados; Heat waves; Extreme precipitation events; Severe thunderstorms; Cyclones (tropical and extratropical.

[43] Average annual losses can be derived from an exceedance probability curve that shows the probability that a given threshold of losses will be exceeded in any one year

complement and support analysis given the uncertainty in current knowledge of climate change impacts for some material perils.

134. In addition to quantitative indicators, some qualitative information could be gathered with the aim of having a more comprehensive picture of the overall impact of the climate change. One aspect that could be investigated through a qualitative questionnaire is, for example, the sustainability of the business model and its evolution due to the climate changes (see also section 1.6 below).

Questions:

Q 23 Do you agree that the preferable indicators should be the ones based on the balance sheet information and that no information on SCR post stress should be requested in the context of a climate stress test exercise?

Q 24 Are there any technical indicators that you might not be able to provide?

Q 25 Which are, in your view, the more significant technical indicators in the context of a climate stress test exercise?

Q 26 Are you able to provide information on the exposures for other perils (not included in the Standard formula calculation) split by countries or geographical areas? Are there any relevant information that you think could be useful in order to analyse and validate the results?

Q 27 Are there any other indicators you would suggest to include?

1.6 Second-round effects, spillover and forward looking assessment

135. Climate change-related risks can have direct implications for both the asset side and liability side of insurers. In Table 1.2, the main transmission channels on insurer's business and BS were discussed. An assessment of the shocks applied to the BS of insurers will capture these first-round effects in each of the different climate change scenarios analyzed.

136. On top of these direct effects on insurer's business and BS, both physical and transition risks can pose indirect disruptions for the insurance sector, the economy and the wider financial system.

137. With regard to insurers, responses to climate change could lead to limitations in the availability and affordability of insurance coverage, which could be one of the main indirect effects of climate change. Increasing physical risks to insured property and assets may constrain insurers' capacity to underwrite insurance if premiums rise beyond demand elasticity and customer willingness to pay[44]. This can create a situation of underinsurance due to difficulties to access insurance, where premiums rise so high that insurance will no longer be seen as an affordable or attractive option, particularly for lower income areas and also for individuals and businesses located in hazard-prone regions.

[44] Issues Paper on Climate Change Risks to the Insurance Sector approved by IAIS executive Committee and the Sustainable Insurance Forum on 25 July 2018. Link:https://www.insurancejournal.com/research/app/uploads/2018/08/IAIS_and_SIF_Issues_Paper_on_Climate_Change_Risks_to_the_Insurance_Sector_-1.pdf

138. In the context of a changing and worsening climate, insurers may react offering more restrictive terms and conditions, shortening their contract time boundaries, increasing their withdrawal capacity, capping payouts or, ultimately, refusing to underwrite risks in a given area. High self-retentions on the customer side and other reactive management actions may make people decide to renounce coverage, which will in turn cause potential business losses for insurers and widen the insurance protection gap. Indeed, insurers could lose underwriting business due to increase of insurance prices in response to higher than expected insurance claims (non-life) or changes in policyholders' expectations and behavior related to sustainability factors (e.g. green reputation) (life).

139. The issues of underinsurance and the eventual limitations in the supply of insurance for high risk areas or for given risks due to uncertainty in the underlying risks could widen the already existing protection gap if governments and the insurance industry do not play a preventive role with measures such as risk perception and assessment, risk reduction and mitigation and finally risk transfer (reinsurance).

140. Besides the indirect effects of physical risks on insurers, the transition into a lower carbon economy may influence the types of insurance products and services demanded from insurers. These new products and services shaped by new technologies, policy changes and evolving market sentiment may disrupt conventional industrial organization, business models and associated needs for insurance coverage. While such changes may create opportunities, they may also indirectly create risk for the insurance sector.

141. Across these risk factors, the industry, academia and supervisors generally agree that there is potential for climate change to present a substantial challenge to the business model of insurers[45]. In particular, while there are opportunities for the sector from writing new climate change-related business, it is also possible that climate change may reduce or eliminate the sector's appetite to provide insurance cover for specific sets of activities, assets or groups. The inherent uncertainty and forward-looking nature of these indirect risks make them more challenging to assess.

142. EIOPA is therefore considering carrying out a forward-looking assessment of the reactive management actions and responses from insurers to climate change-related risks within a climate ST exercise. An exercise of this nature will help identify the risk mitigation responses that are considered by insurers and, at the same time, help better understand the implications of these indirect effects on insurers' business models (for instance with regards to risk coverage, GWP and/or protection gap) and their potential spillover effects.

1.6.1 Objective

143. The assessment of potential second-round effects through a forward-looking assessment of reactive management actions has both a microprudential and the macroeconomic objective; on the one hand it can provide insight in the response and resilience of individual insurers, and on the other hand it can also assess potential spillover effects stemming from the collective responses of the insurance sector.

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[45] "The impact of climate change on the UK insurance sector". A Climate Change Adaptation Report by the Prudential Regulation Authority. September 2015

144. The aim of collecting information that can help identify potential indirect effects within a climate ST exercise is to enhance the explorative power of this tool with forward-looking information that may give further insight on: the potential evolution of insurers' business models, the widening of the already existing protection gap in insurance, the availability of insurance and reinsurance coverage, issues of affordability of insurance, future loss of current levels of business and wider risks of financial spill-overs.

145. This kind of assessment will serve to gather both quantitative and qualitative information on how the insurance sector as a whole is preparing itself to tackle the indirect effects of climate change risks in their business models with preventive and reactive management actions. The forward-looking nature of a climate ST can contribute to raise awareness of these threats and incite the insurance sector to align their business models and risk management strategies with a more sustainable model that is prepared to cope with these challenges. Hence, an assessment of post-reactive management actions can shed some light on potential second-round effects caused by these actions.

146. While a forward-looking exercise of this nature will attempt to draw out qualitatively and, to the extent possible, quantitatively some of the potential second-round effects on insurers business from direct impacts of the climate change scenarios adopted in the ST, EIOPA recognizes the limitations of this exercise given the medium/long-term nature and the uncertainties surrounding climate change risks[46]. In this sense, although a forward-looking assessment of insurer's responses to climate change scenarios may not capture the full impact of potential indirect effects of climate change, it can serve as a first assessment of the adaptation of business models to different climate change scenarios as well as a starting point for future EIOPA assessments of second-round climate change effects.

1.6.2 Information gathering

147. The way forward in terms of a forward-looking assessment could be to carry out an information gathering exercise aimed to a sample of insurers and reinsurers. In order to analyze how climate change scenarios will impact insurer's business models and what post-reactive and preventive management actions they intend to implement, a combination of qualitative information gathered through a survey, with some quantitative elements, can be a good option.

148. With regards to the quantitative side of the information gathering exercise, insurers could be asked to quantify the impact of the ST scenarios on selected metrics of their business such as, for example, the current and expected level of underinsurance and insurance coverage, the reinsurance dependency and availability, and information on premium "tipping points".

149. For example, insurers can be asked to report information regarding the expected impact on future premiums (GWP) for specific peril coverage from the scenarios of the ST and the "tipping point" at which insurers might/will no longer be able to provide coverage. Also, the difference between the impact

[46] Mckinsey Global Institute, Climate risk and response: Physical hazards and socioeconomic impacts, January 2020 Report-Link: https://www.mckinsey.com/business-functions/sustainability/our-insights/climate-risk-and-response-physical-hazards-and-socioeconomic-impacts

on insurers from liability-shocks in terms of insured losses and the total economic losses of the prescribed shocks may be indicative of the protection gap that may arise in the future.

150. With regards to the more qualitative side of the exercise, questions could be asked to insurers in order to assess the level of integration of climate change risks in their governance, strategy, risk management, underwriting and investment practices and overall business models. In addition, they could be asked to provide forward-looking information on what management actions they anticipate taking in order to adapt to the various scenarios (e.g. changes to asset allocation, changes to reinsurance programs, and re-capitalization plans). This information can help assess the potential shift climate change is causing in the demand for insurance products, the geographic locations, perils and coverage for which an insurance company has increased its premium rates, limited its sales or limited or eliminated coverage because of catastrophic events, and the expected evolution of reinsurance coverage which can also help identify in which areas and for which risks the protection gap is widening.

151. Below are some potential qualitative questions (only for exemplificative purposes):

- Has your Board ever discussed the potential risks and implications of climate change in the company's business model? If so, how does your Board take into consideration these risks in defining future strategies and objectives?
- Has your company integrated or plan to integrate climate change considerations into their investment strategies and processes (i.e. in terms of risk appetite or asset allocation)?;
- What kind of reactive management actions/response would you take in each of the climate change scenarios prescribed in the ST?? What would be the impact of these management actions?;
- Has your company defined objectives in terms of reduction of GHG emissions in its asset portfolio? How would your asset portfolio change in order to align with the Paris agreement goals?;
- Has your firm changed its underwriting procedure in specific geographical areas more exposed to the effects of climate change (i.e. stopped providing coverage, increased premiums or required additional conditions for insurance coverage to commercial and private real estate such as, for example, preventive measures or minimal ISO standard for mitigating the risk)?;
- Has your company changed its underwriting processes? (e.g. to address protection gap issues);
- Has your firm implemented or plans to implement changes to its reinsurance programs due to the climate change?

152. For analyzing the impact on regional/national protection gap issues, the scope of this complimentary exercise would require a sufficiently large sample of solo undertakings at country-level in order to cover local markets and identify regional or country specific protection gap issues. In this regard, it is especially important that the information is then aggregated at country level. In addition, a certain degree of comparability across different participating insurers, distinguishing between life and non-life insurers, is also relevant.

Caveats in the analysis apply such as the existence of state guarantee schemes, risk-sharing platforms for nat-cat events and other country-specific government pools.

153. Finally, in the context of a forward-looking assessment on the responses and reactive management actions, it is important to validate the feasibility and consistency of the responses. For example, direct insurers could indicate a possible response to an increase in the frequency of windstorms would be to purchase additional reinsurance; whereas reinsurers could say that their response would be to reduce exposure to this segment; these responses are clearly incompatible. One possible solution to this would be a two-stage process for the forward-looking risk assessment, where management actions would be reviewed by EIOPA/NCAs for consistency followed by a second round of submissions where certain management actions could be in some way restricted (e.g. not permitted or permitted) based on the understanding of how the market dynamics might evolve. Such an approach would obviously have implications for both the duration of the exercise and the level of resources required to support the stress test.

154. An overview of the advantages and disadvantages of a forward-looking information gathering exercises is provided in Table 1-16 below.

Table 1-16 Advantages and disadvantages of an ancillary forward-looking assessment

Advantages	Disadvantages
• Can shed more light on potential issues regarding affordability and availability of insurance products • An exercise of this nature will help raise awareness about climate related risks within the industry • Can help enhance insurer's risk management capabilities • Can help better understand how insurers assess climate-related risks through preventive risk management and adaptation strategies to infer implications on business models	• Takes into account entity specific risk profiles which can pose challenges with regard to the comparability of the results • Existence of country specific guarantee schemes and government pooling can pose challenges with regards to comparability of the results • Can pose additional burden on the sample • Issues regarding the reliability of management actions • May not be relevant for smaller companies since climate integration (and other ESG elements) is an expensive strategy

Questions:

Q 28 Do you consider that the proposed forward-looking information gathering exercise will help shed light on potential second-round effects of climate change, such as the issues of availability and affordability and the protection gap in insurance?

Q 29 Do you agree that a qualitative questionnaire, with some quantitative elements, is a good option to assess post-reactive and preventive management actions within a climate change ST scenario?

Q 30 Do you agree on the quantitative metrics proposed or are there other relevant indicators that you would include?

Q 31 Do you agree on the type of questions asked with regards to the level of integration of climate change risks in business models and risk management strategies?

Q 32 Do you agree on the scope intended for the information gathering exercise?

Q 33 Do you have any other concerns related to the proposed exercise

2 Liquidity stress tests

2.1 Introduction

155. Liquidity risk is fundamentally different from capital risk: due to the different triggering events and the different time horizon of materialization of risks, an insurer can be solvent but still experience a liquidity distress. The Solvency II (SII) regime is designed to ensure a sound capital position of (re)insurance undertakings but it does not include quantitative requirements and relative metrics with respect to the liquidity position. The absence of a commonly agreed approach to assess the liquidity sources and needs of (re)insurers, the subsequent absence of standardized metrics such as the Solvency Capital Requirement (SCR) for the capital position, and the lack of a specifically designed reporting makes a methodological discussion on the liquidity stress test (ST) more difficult. Against this background, the paper proposes a definition of 'liquidity position' for a (re)insurer together with specific metrics to measure it. The discussion that follows on the liquidity ST builds on these elements.

156. So far the ST exercises conducted by EIOPA focused on the impact of adverse scenarios on the capital position of (re)insurers. The increasing consideration given to liquidity risk by the insurance industry and by the supervisors at EU and global level, highlighted the absence of a comprehensive conceptual approach to liquidity stress testing in the insurance industry. This contribution aims at initiating a process to fill this gap at the EU level. This conceptual framework also serves as a response to the developments of liquidity risk management and supervision introduced at global level where, the recently adopted International Association of Insurance Supervisors (IAIS) Holistic Framework for systemic risk[47] introduces new standards to cope with the liquidity exposures (ref to: IAIS Insurance Core Principles - ICPs and Common Framework - ComFrame).[48]

157. The main purpose of this chapter is to set out methodological principles that can be used to design ST exercises to assess the vulnerability of insurers to liquidity shocks. This first EIOPA proposal for a ST liquidity exercise is based on the current understanding and knowledge on the liquidity risk in the insurance industry, hence it might evolve in the future to reflect also the experience gained in the assessment of such risk at EU and global level.

158. Given the novelty of the topic, section 2.1.1 provides some background on the liquidity risk in the insurance industry as well as a definition of liquidity risk for the sector. The following sections describe the building blocks of a liquidity ST exercise starting from the exposures of insurers to liquidity risk (section 0) and the potential metrics to measure them (section 2.2.1). Section 2.3 presents the proposed approach to the design of scenarios to be used in liquidity ST including narrative, shocks and their calibration. The chapter concludes with guidelines on the application of the shocks (section. 2.3.3) and with some examples on potential analysis and presentation of the results (section. 2.3.4).

[47] IAIS (2019) Holistic Framework for Systemic Risk in the Insurance Industry. Available at: https://www.iaisweb.org/page/news/press-releases//file/87109/holistic-framework-for-systemic-risk

[48] IAIS (2019) Insurance Core Principles and ComFrame. Available at: https://www.iaisweb.org/page/supervisory-material/insurance-core-principles-and-comframe

2.1.1 Definition of liquidity risk in insurance

159. Liquidity risk in insurance is defined by the SII Directive as "the risk that insurance and reinsurance undertakings are unable to realize investments and other assets in order to settle their financial obligations when they fall due". It almost overlaps with the definition provided by the IAIS in its Glossary "The risk that an insurer is unable to realize its investments and other assets in a timely manner in order to meet its financial obligations, including collateral needs, as they fall due."[49]. Both definitions imply that liquidity risk arises as a result of an imbalance between liquidity sources and needs, hence it affects assets, liabilities and their interplay.

160. Liquidity is a well-known and extensively debated characteristic of assets and several widely applied approaches, mainly based on "haircuts"[50], are available for their classifications in prudential regimes including liquidity requirements to cover liquidity risk.[51] For example, according to the Basel Committee for Banking Supervision (BCBS) framework, an asset to be considered of high quality and liquid shall be easily and immediately converted into cash at little or no loss of value, even during time of stress.

161. The situation changes when we look at the liability side of the balance sheet (BS) of an insurer where the largest items are the best estimates (BE). The BE is a typical insurance concept whose computation depends on the characteristics of the in-force product portfolio. Currently there is no commonly accepted approach to their classification according to liquidity characteristics. The heterogeneity in products and in their features (e.g. guarantees, penalties) among jurisdictions provides additional complexity.

162. EIOPA, in its 2019 work on the asset and liability management in relation to the illiquidity of liabilities[52], provided a definition of "illiquidity" for the liabilities of an insurer: "Insurance liabilities are considered illiquid over a given period when they allow the insurer to hold assets for this period with a very low risk of forced selling. This property depends on the timing and the predictability of the liability cash flows that in turn are influenced by product features such as surrender options". EIOPA also provided a first classification of the liabilities based on a well identified subset of liquidity-relevant product's features (e.g. fiscal and economic penalties).[53]

163. Due to the characteristics of the traditional life and non-life insurance business model, liquidity risk is generally not considered a major source of concern for insurers compared to other exposures.[54] The inverted production cycle, where the cash inflows in form of collected premia precede outflows typically due to claims settlement, creates a stable source of funding for insurers. Against this, in normal periods, a soundly managed insurer can

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[49] IAIS (2019) Glossary. Available at: https://www.iaisweb.org/page/supervisory-material/glossary/file/87192/iais-glossary

[50] The term haircut is used when referring to the difference between an asset's market value and the amount that can be used for specific analysis or under specific circumstances.

[51] BCBS refers to the concept of high quality liquid asset (HQLA) in the Basel framework. Available at: https://www.bis.org/basel_framework/.

[52] EIOPA (2019) Report on insurers' asset and liability management in relation to the illiquidity of their liabilities. Available at: https://eiopa.europa.eu/Publications/Reports/EIOPA_Report_on_insurers_asset_and_liability_management_Dec2019.pdf

[53] The criteria for the classification of assets and liabilities according to their liquidity characteristics are extensively discussed in Section 205.

[54] Ref. to EIOPA Risk and Financial Stability report – December 2019, Chapter 5 - Risk Assessment. Available at: https://www.eiopa.europa.eu/content/eiopa-financial-stability-report-december-2019.

mainly rely on inflows from premia to cover their outflows. However, the materialization of insurance specific events (e.g. policyholder behavior, relevant and concentrated increase in claims) might generate unforeseen cash outflows which need to be matched by other sources of liquidity (e.g. sales of assets). If this event is accompanied by a liquidity shock on the markets the impact on the insurer might be sudden and severe. That is why liquidity risk in insurance can be described as a low probability type of risk, but with a potentially high impact and therefore insurers need to have proper liquidity management in place, to fulfil both expected and unexpected funding needs in tranquil and distressed market periods. An overview of the potential sources of liquidity distress in the insurance industry are provided in section 0.

164. It is worth noting that liquidity risk may be both a microprudential concern, e.g. affect the individual insurers, and a macroprudential concern when the shock generate wide-spread reactions or actions by a significant player in a particular market with potential spill-over to other markets.

2.1.2 Liquidity stress test framework

2.1.2.1 Objectives

165. The main objective of a ST exercise is to assess the resilience of financial institutions to severe but plausible scenarios and/or to assess the potential externalities generated by the individual or combined reactions of these institutions against the prescribed shocks. In this context, the aim is not to assess the capital situation but the liquidity position, namely the relation between liquidity sources and liquidity needs of an insurer over different time horizons against adverse circumstances.

166. In line with the discussion on the objective of a capital ST exercise[55], also a liquidity ST exercise can have micro- or macroprudential objective as listed in Table 2-1.

Table 2-1 Microprudential objectives vs. macroprudential objectives

Microprudential objectives	Macroprudential objectives
• Measure the exposures of individual insurers to liquidity risks • Assess vulnerabilities and resilience of individual insurers to liquidity risks • Enhance risk management capabilities to assess and mitigate liquidity risks	• Assess vulnerabilities and resilience of overall insurance sector and potential systemic liquidity risks • Assess potential spill-overs to other financial sectors and the real economy of liquidity risks

167. Given the novelty of applying the ST tool to the liquidity position of insurers, such an exercise can have additional overarching objectives like:

- Foster specific discussions on the build-up of the liquidity risk in the insurance industry and on potential mitigation actions and policy implications;
- Build an approach to the measurement and assessment of the liquidity position of the insurers. This is particularly true considering that the SII framework includes liquidity risk only as a Pillar II requirement;
- Have a sound understanding of the ways in which insurers' activities affect their liquidity risk profile under normal and stressed conditions.

[55] A comprehensive discussion on the objective for a capital stress testing can be found in Chapter 2.2 of the 1st paper on the methodological principles of insurance stress testing available at: https://www.eiopa.europa.eu/sites/default/files/publications/methodological-principles-insurance-stress-testing.pdf .

2.1.2.2 Scope

168. When assessing liquidity risk via ST, the scope is one of the cornerstones of the exercise and it should be strictly related to its objective.

169. Table 2-2 highlights the differences between solo and group, listing possible advantages and disadvantages.

Table 2-2 Advantages and disadvantages in selecting solos vs. groups in liquidity stress testing

	Advantages	Disadvantages
Solo	• Target specific business lines • Country/jurisdiction analysis • Easy to compute the market coverage • Easier application of shocks • Easier validation of data • Easier to issue potential recommendations and recovery/resolutions actions	• Less informative from a financial stability prospective • Need some coordination work from both the insurance groups and the National Competent Authorities (NCAs) in case of participating solos from more than one European country that are part of the same group with the risk of duplicating work (validation activities performed at local level) • Potential limitation in evaluating the impact of reactive post-stress management actions (if they have to be decided at group level) • Doesn't consider the impact of the liquidity risk management pursued by the group
Groups	• Impact on the systemic groups (more informative from a financial stability prospective) • Account for full diversification effect • Easier to assess the impact of reactive post stress management actions if needed • Considers the impact of the liquidity risk management pursued by the group (including intra-group support and fungibility). • Account for different risk profile of holding entities with respect to operating entities	• More complexity in the application and assessment of the scenarios with the consequence of the necessity to apply simplification and approximation that could have an impact on the comparability of the results • No country-based assessment • Harder to identify vulnerabilities of specific entities, especially when part of the group follows an accounting standard (like in the US) and uses D&A method for aggregation of the results • Harder to validate the data • The lack of common understanding in the definition of group cash-flows makes the validation of the results difficult

Questions:

Q 34 Do you agree with the advantages and disadvantages on groups and solos proposed in Table 2-2?

Q 35 Which additional advantages and disadvantages do you consider relevant?

Q 36 Do you consider the intra-group support a key part of the liquidity assessment? If yes how can this be included in the design of a Stress Test?

2.1.3 Sources of liquidity risk in insurance

170. The sources of liquidity risks for a (re)insurer depend on its full risk profile that comprises both balance sheet and off-balance sheet exposures (e.g. derivative positions). The specificity of the asset holdings, of the in-force liability portfolios and the interactions therein as well as the potential exposures to margin calls make a company prone to liquidity related events as described in the following paragraphs. It is worth noting that the exposures which make undertakings prone to liquidity risk may also have capital implication; consequently, some of the events that might lead to liquidity distresses can also generate impacts on the capital position. It is therefore of utmost importance in a liquidity ST exercise to clearly identify the events and dissect their effects on capital and liquidity.

2.1.3.1 Exposure to insurable events

171. The exposures to insurable events may incorporate considerations of the nature, recurrence and severity of these events, including natural catastrophes, pandemics or legal matters that may happen within the considered time horizon. These could be considered as triggering events for liquidity stress scenarios. When claims are significantly higher than expected and sudden in nature, this may cause liquidity risk. In addition, uncertainty in the projection of cash flows leads to liquidity risk. The liquidity risk stems on the assets side as well as on the liability side.

172. On the assets side, liquidity risks could occur from the fact that insurers might need to transform in a given (typically short) time frame their assets into cash to meet their debt obligations. As insurers hold on their balance sheet assets that are more liquid than others, it should be considered that in stressed market conditions it may be difficult to monetize some of these investments. Factors such as market depth and access, the time requirement, haircuts and the likelihood of forced sale losses should be taken into account. For example, in stressed market conditions it might be challenging to sell some types of assets or these could be sold at a significant discount causing losses for the insurance company.

173. On the liability-side, insurers might be confronted with sudden, unexpected sudden increase in claims (e.g. pandemic[56] for life insurers and cat events for the non-life). A side condition that could exacerbate the liquidity needs can be an unfavorable evolution of the legislation Features that determine the likelihood of lapses are, for instance, lapse fees, maturity dates, guarantees and customer or product type. These characteristics vary from product to product and from insurer to insurer and determine the likelihood of mass lapse events, which may cause a sudden large funding need. Non-life insurers are exposed to cat events, including market turning events that might trigger a liquidity risk. Reinsurers might be exposed to the same risks as above and also to some other contractual terms that might increase the liquidity needs.

2.1.3.2 Policyholder behavior

174. Policyholders can withdraw from specific insurance products at any time and insurers would have to provide the amount of cash equivalent to the

[56] Pandemics are one- time shocks from the extreme, adverse tail of the probability distribution that are not adequately represented by extrapolation from more common events and for which it is usually difficult to specify a loss value, and thus an amount of capital to hold.

surrender value. In case insurers do not hold sufficient high quality assets that can be exchanged rapidly and without a haircut against cash, they could be forced to sell many of their assets at distressed prices.

175. Features that determine the likelihood of lapses[57] are, for instance, the type of product, lapse penalties (contractual and fiscal), maturity dates, guarantees and customer type. These characteristics depends on the product features and determine the likelihood of mass lapse events, which may cause a sudden large funding need.

176. Liquidity risk might further increase in case of contracts where the surrender value exceed the value of the assets covering the obligations when the surrender option is exercised.

177. Possible triggers that may lead to a loss of confidence and policyholders surrendering their policies are, for instance, a prolonged economic crisis, a rating downgrade of the insurer, and reputational issues.

2.1.3.3 Off-balance sheet exposures

178. One example of liquidity risk that might arise from off-balance sheet activities is associated with holding derivatives positions. Following the AIG collapse, insurers' involvement in derivatives has been considered as a potential risk to financial stability. The AIG involvement in the CDS market had however been unique, and insurers traditionally use derivatives for hedging.

179. While derivatives can help insurers mitigate some of the risks in their balance sheets, they expose them to higher liquidity risk. Namely, following the financial crisis, it has been agreed globally to promote central clearing of derivatives. Both centrally cleared as well as bilateral derivatives trades require posting/exchanging of collateral, typically in the form of cash margins. Their purpose is to cover potential market movements and hence changes in the value of the derivative contracts.

180. For a more detailed discussion on derivatives as a potential source of liquidity risk to insurers as well as to a sensitivity analysis of EEA insurers on their interest rate swaps (IRS) please refer to the thematic article in the EIOPA Autumn 2019 Financial Stability Report[58].

181. Moreover, collateral needs could also emerge from reinsurance arrangements and/or any other obligations or guarantees provided to other parties. A triggering event for such a liquidity source could be an increase/decrease in interest rates.

182. Under normal circumstances repo markets will be able to secure the liquidity needs of insurers. However, banks' ability or willingness to provide liquidity can be limited for instance around year end.

2.1.3.4 Balance sheet exposures

183. Developments on financial markets can have strong impact on an insurer's liquidity position and can affect both the assets and the liabilities. An adverse

[57] Lapse should be understood in a holistic way, comprehensive of all the situations described in the Delegated Regulation on the level 2 text. Under this approach, lapses include all legal or contractual policyholder rights to fully or partly terminate, surrender, decrease, restrict or suspend insurance cover or permit the insurance policy to lapse all legal or contractual policyholder rights to fully establish, renew, increase, extend or resume the insurance or reinsurance cover

[58] De Jong et al (2019).

development might lead to a reduction in the market value of an insurer's assets or lead to decreased trading volume. Also, market developments and policyholder behavior can interact: when interest rates change rapidly, this might give an incentive to surrender affecting the liabilities side. A triggering event for such a liquidity source could be fire sales of assets in an unfavorable market development.

2.1.3.5 Funding risk

184. This source of liquidity risk comes from the fact the insurers might experience a deterioration of their credit rating or a reduced access to the repo market that would lead to a limited access to funding. These triggering events will lead to an increase in the funding costs of the insurer, a decrease in their capital and potential additional collateral requests.

2.1.3.6 Counterparty exposure

185. Other sources of liquidity risk could be counterparty exposures. Concentration of counterparty exposures might apply to risk transfer operations where the exposures towards reinsurers might be concentrated. A potential failure or distress of a primary reinsurer has a direct impact on the reinsurance recoverables and reinsurance receivables cutting or limiting a liquidity source. Claim settlements delay of reinsurers can cause liquidity problems to the undertakings. In the case of accepted reinsurance, downgrading could require to post additional collateral in favor of the cedant introducing a new source of liquidity risk.

186. Non-traditional insurance business such as the provision of loans and mortgages is also prone to counterparty risk, hence any deterioration of the credit quality reflected in an increased probability of default might reduce the liquidity inflow.

2.1.3.7 Other

187. Another source of risk concerns the fungibility and availability of the liquid funds such as the ability to transfer liquidity across entities, in particular intra-group and/or cross-border transfers. Intra-group transactions, especially if happening among entities operating in different countries and under the jurisdictions of different local authorities might be limited by legal or fiscal motivations and impeded by supervisors based on capital grounds.

188. In addition, the correlation and concentration of funding sources could lead to liquidity risk for insurers depending on how well diversified their sources of funding are. In this context the concept of concentration shall be intended broadly than bilateral counterparty exposures. Concentration of liquidity sources shall be considered also at market, sector and geographical level.

Questions:

Q 37 Do you consider the list of the liquidity exposures exhaustive? If not please elaborate on the missing elements.

Q 38 Do you consider the description of the exposures appropriate? If not please provide suggestions.

2.2 How to measure liquidity risk

2.2.1 Metrics

189. The use of a unified framework to measure liquidity risk of insurers is a relatively new field for both undertakings and supervisors. Unlike solvency, there are no standardized indicators to measure and assess liquidity risk in a normal and/or stressed environment. Also, liquidity risk has many drivers and is very entity specific which makes it difficult to capture in one single indicator. This section aims to set forth a liquidity indicator that can be used to assess the liquidity position of an insurer and the impact of a liquidity stress scenario on its liquidity position.

190. Many liquidity metrics can be envisaged to assess the liquidity risk of an insurer (see Table 2-3 for a partial overview), however most of them tend to capture only the needs or the sources of liquidity separately, hence neglecting the interactions thereof.

Table 2-3 Potential metrics to measure liquidity

Base	Indicator	Details
Assets	$Assets\ Liquidity = \frac{Liquid\ Assets}{Total\ Assets}$	• Focus on the liquidity sources • Stock based view • Provides an overview of the asset allocation from a liquidity perspective • Based on a classification of the assets • Definition of liquid assets can be narrow or broader
Liabilities	$Surrender\ Ratio = \frac{Surrenders}{Premium}$[59]	• Provides an overview of the liquidity sources and needs stemming from the in-force portfolio of liabilities • Based on cash flows of the product portfolio • The indicator can be based on other metrics
	$Liabilities\ Liquidity = \frac{Liquid\ Liabilities}{Total\ Liabilities}$	• Provides an overview of the liquidity needs stemming from the in-force portfolio of liabilities • Stock based view • Based on Best Estimates or surrender values • Based on a classification of the product portfolio by a liquidity perspective

191. Meaningful liquidity indicators combine both the liquidity needs and available liquidity sources of an insurer; they are built by comparing liquidity sources with an estimation of potential liquidity needs stemming from on- and off-balance sheet exposures. In practice, one compares assets, which are considered of sufficiently high quality to be transformed into cash when

[59] Surrender refers to any policyholder's action (e.g. request of lapse) that implies a cash disbursement for the company (e.g. payment of a surrender value).

needed, with an estimation of liquidity needs (e.g. surrender values) that the insurer would have to pay in a normal or exceptional situation.

$$Liquidity\ indicator = \frac{Liquidity\ sources}{Liquidity\ needs}$$

192. Well aware of the informative power of the other assets- and liabilities-based indicators, EIOPA considers the proposed liquidity indicator as the most relevant for a ST exercise given that it offers an integrated view on the liquidity position of an insurer, covering both the liquidity sources and the needs. This does not prevent the calculation of other indicators in specific analyses.

193. This indicator can be used to assess the liquidity position of an insurer both in a normal or a stressed situation. Analyzing the liquidity indicator in a normal situation allows to identify those insurers with a weaker liquidity position. Comparing the liquidity indicator before and after stress allows for an assessment of the impact of the liquidity stress scenario on the market and the identification of insurers that are more sensitive to liquidity risks.

Questions:

Q 39 Indicators such as the surrender ratio can be based on surrender values or exposures (e.g. best estimates). Which is in your opinion the best option?

Q 40 Which other liquidity indicators do you consider to be relevant especially in the context of a ST?

2.2.2 Approaches

194. There are at least two approaches that can be considered when assessing the liquidity position of an insurer, each with their benefits and shortcomings. The **balance sheet approach** is a stock-based approach that approximates the liquidity needs and sources stemming from a balance sheet exposure over a predefined time horizon by applying a factor or haircut to these exposures. The **cash flow approach** is a combined stock- and flow-based approach that relies on the bucketing of assets to determine the liquidity sources but instead uses the projected cash in and outflows of an exposure to determine its liquidity needs over a certain time horizon.

195. Table 2-4 gives an overview of the two approaches. Both the balance sheet and cash flow approach rely on a bucketing of the assets according to their liquidity characteristics to determine the available liquidity sources. There are divergent practices however when assessing the liquidity needs. Where the balance sheet approach uses a bucketing of the liabilities (based on their liquidity characteristics or based on a metric of (il)liquidity) to estimate the liquidity needs, the cash flow approach uses the *total net* cash outflows to approximate the liquidity needs. The different practices to determine the liquidity sources and needs are described in the next sections.

Table 2-4 Approaches to determine the liquidity indicator

Approach	Liquidity sources	Liquidity needs	Indicator
Balance sheet approach	Bucketing of assets according to liquidity characteristics (e.g. HQLA)	Bucketing of liabilities according to - Liquidity characteristics - illiquidity measure	$\frac{Liquidity\ sources}{Liquidity\ needs}$
Cash flow approach		Total net cash outflows	

196. The balance sheet and the cash flow approach have advantages and disadvantages both from an operational and informative perspective. Operationally, the balance sheet approach can rely on the standard SII reporting for the assessment of the liquidity sources. However, the SII reporting contains only limited information to assess the liquidity needs of the exposures. This assessment would require a limited request of additional information (e.g. surrender volumes).[60] Additional information is also needed to assess the development over time of the liquidity needs in case the cash flow approach is pursued. However, the request of cash flows comes with a cost, especially in a ST context, in terms of:

- specification of the request: which cash flows should be considered, which type of cash flows shall be used (real-word or risk-neutral); definition of the templates; scope of the request (how can a cash flow be defined at group level?);
- production of the information: the information requested should be internally available for asset and liability management purposes, however there is no standard reporting in place for it;
- validation of the information provided;
- analysis and interpretation of the information collected.

197. The **time horizon** over which liquidity risk is assessed is a key element when developing the liquidity indicator. Indeed, liquidity needs and liquidity sources vary according to the time horizon. A longer time horizon will generally lead to a higher share of liquid exposures on the balance sheet. Ideally, the time horizon used to determine the liquidity needs should match the one considered for the liquidity sources. Also, in the context of a liquidity ST it might be interesting to consider the impact of both short term and longer-term stress scenarios on the liquidity position of an insurer.

198. Advantage and disadvantages of the two approaches are summarized in Table 2 5. The application of the two approaches on the quantification of the liquidity needs is explained in sections 2.2.4 and 2.3.3.2.

[60] This statement holds for the level of granularity of bucketing of liquidity sources and needs proposed in the rest of this paper. In case the classification of the liquidity needs increases additional information might be requested.

Table 2-5 Advantages and disadvantages on the balance sheet approach vs. cash flow approach

Approach	Advantages	Disadvantages
Balance sheet approach	• Flexible method; the impact of different haircuts can easily be assessed • Better comparability of results • Builds on existing SII reporting	• Less risk sensitive • Less suitable for non-life business • Loss of information on mismatch between asset and liabilities
Cash flow approach	• More granular and precise method approach then the balance sheet approach • Considers both cash in- and outflows of the liabilities and gives information on mismatch between liquidity sources and needs • Covers all types of cash flows (life, non-life and non-insurance liabilities) • Can take into account the impact of derivatives	• Increased complexity of projecting multiple set of cash flows • Possible ambiguity on the cash in- and outflows that can be considered; risk of double counting

2.2.3 Liquidity sources and their quantification

199. Both the balance sheet and cash flow approach rely on a bucketing of the assets according to their liquidity characteristics to determine the available liquidity sources. Overall, the SII reporting (list of assets) contains enough information to assess the liquidity characteristics of most of the exposures on the asset side of the balance sheet. Also, there is a general understanding on the characteristics that determine the liquidity of assets.

200. IAIS defines liquid assets as assets that are easily and immediately convertible into cash, either through repo or outright sale, at little or no loss in value[61]. Such assets generally have low credit risk and low market risk; have easy, transparent and accurate valuations and have low correlation with risky assets. These assets typically also have active outright sale or repo markets at all times with evidence of market breadth and depth. Finally, assets should have a proven record as a reliable source of liquidity during stressed market conditions.

201. To ensure their availability to meet the insurer's liquidity needs, assets should be unencumbered. Instruments issued by other financial institutions should generally not be considered as liquid, except for deposits. This is due to the potential risk that their liquidity is correlated with developments in the financial markets and/or broader economy and may exacerbate stress at the insurer level.

Classification of liquid assets

202. There are many possibilities to classify assets (liquidity sources) according to their liquidity characteristics. The granularity of the classification will depend on its intended use and the availability of relevant data. Both the IAIS and the European Systemic Risk Board (ESRB) give an example of a possible

[61] IAIS (2019), Draft Application Paper on Liquidity Risk Management. Available at: https://www.iaisweb.org/page/consultations/closed-consultations/2019/draft-application-paper-on-liquidity-risk-management

classification/bucketing; they both start from the assumption that assets from the same asset class will have similar liquidity characteristics.

203. Each bucket will contain assets with similar liquidity characteristics and can be assigned with a factor or haircut that reflects its liquidity over a given time horizon. As an example, cash is the most liquid exposure on the balance sheet. It is always available as a liquidity source (a factor 100% applies or a 0% haircut). Real estate exposures on the other hand are not liquid over a short time horizon. A factor 0% would apply, reflecting that this exposure can't be used as a source of liquidity. The time horizon is key; the haircut to be applied to a given bucket will change depending on the time horizon that is considered. An exposure that is considered illiquid in the short term can become liquid over a longer time horizon.

Table 2-6 ESRB bucketing of liquid assets

Item		Haircut
Level 1 assets	Cash and cash equivalent Bonds and loans from: The European Central Bank EU Member States' central government and central banks denominated and funded in the domestic currency of that central government and the central bank Multilateral development banks referred to in paragraph 2 of Article 117 of Regulation (EU) No 275/2013 International organizations referred to in Article 118 of Regulation (EU) No 275/2013	0% 0%
Level 2A assets	Bonds and loans rated Credit Quality Step (CQS) 0 or 1, excluding those from financial institutions	15%
Level 2B assets	Covered bonds rated CQS 0 or 1, excluding those emitted by a bank which is part of the same group Qualifying RMBS Bonds and loans rated CQS 2 or 3, excluding those from financial institutions Qualifying common equity shares, excluding: Equities issued by a financial institution Equities qualifying for strategic participation Equities qualifying for the duration-based equity module Long-term equities	25% 50% 50% 50%

Source: ESRB (2020), Enhancing the macroprudential dimension of Solvency II. Available at: https://www.esrb.europa.eu/pub/pubbydate/2020/html/index.en.html

204. IAIS defines a "liquidity portfolio" consisting of liquid assets that should cover liquidity shortfalls under stressed conditions and ensure that an insurer can meet its liabilities as they fall due. There are differences in the liquidity of assets that would limit the insurer's ability to monetize them during a stressed situation. As a result, an insurer should group assets according to their usability in stress (i.e. three liquidity buckets).[62]

[62] The bucketing approach proposed in Table 2-7 was included in a draft application paper published by the IAIS for public consultation. The table and its content might therefore be subject to changes against the feedback received in the consultation process.

Table 2-7 IAIS bucketing of liquid assets

Asset Class	Other Considerations	Liquidity Bucket
Demand deposits	Sufficiently diversified	Primary
Securities issued or guaranteed by sovereign, supranational or other non-sovereign public sector entities backed by their full faith and credit	Used to back liabilities in the sovereign's jurisdiction	Primary
	Rated AA- / Aa3 or better	Primary
	Rated A- / A3 or better, but less than AA- / Aa3	Secondary
Securities issued by a Government Sponsored Enterprise senior to preferred equity	Rated AA- / Aa3 or better	Primary
	Rated A- / A3 or better, but less than AA- / Aa3	Secondary
Covered bonds	Rated AA- / Aa3 or better	Secondary
	Rated BBB+ / Baa1 or better, but less than AA- / Aa3	Tertiary
Vanilla corporate debt securities, including commercial paper	- Rated AA- / Aa3 or better; AND - Not issued by a financial institution or its affiliates	Secondary
	- Rated BBB+ / Baa1 or better, but less than AA- / Aa3; AND - Not issued by a financial institution or its affiliates	Tertiary
Other fixed income instruments issued by public sector entities	- Rated BBB+ / Baa1 or better	Tertiary
Common equity shares	- Publicly traded on a major exchange; AND - Not issued by a financial institution or its affiliates	Tertiary
Other assets	Demonstrated to have low credit risk and low market risk, is liquid and readily marketable and has a proven record as a reliable source of liquidity during stressed market conditions.	Primary / Secondary / Tertiary

Source: IAIS (2019), draft Application Paper on Liquidity Risk Management. Available at: https://www.iaisweb.org/page/consultations/closed-consultations/2019/draft-application-paper-on-liquidity-risk-management.

205. Please note that the two examples are aimed at providing an overview of the classification of the assets. In this consultation paper, any discussion on the calibration of the haircuts is deliberately not included. The calibration will be approached in future analytical works leveraging on experiences in the insurance and banking industry.

Questions:

Q 41 Which classification do you consider as the most appropriate between the ESRB and the IAIS?

Q 42 Which other methods to classify assets according to their liquidity do you consider to be relevant?

Q 43 Please provide your view on the exemplificative calibration of the haircuts presented in the IAIS and ESRB example. Do you have other suggestions for the calibration?

2.2.4 Liquidity needs and their quantification

206. Liquidity needs may arise both from the asset or liability side of the insurer's balance sheet. On the asset side, it is in particular the derivatives exposures of insurers that could be a source of liquidity needs due to variation margin calls. Further details about derivatives clearing and insurers' role have been explained in section 2.1.3.3 on the sources of liquidity risk. Also, EIOPA published a thematic article in its December 2019 Financial Stability Report on the impact of variation margining on EU insurers' liquidity.

207. The assessment of the liquidity characteristics of the liabilities is a relatively new area of interest. So far, there is no common understanding or generally accepted methodology that can be used to assess the liquidity of liabilities. One reason of this lack of common understanding is the vast variety of different insurance products throughout Europe each potentially subject to specific national fiscal regimes.

208. The SII reporting contains some information that can be used to assess the liquidity position of insurers (Annex 4.2.1). However, the primary objective of the SII quantitative reporting templates is to assess the solvency position of insurers and thus they include insufficient information for a comprehensive assessment of liquidity risk. Especially, the data available to assess the liquidity needs of exposures is limited. In order to make a proper assessment of the liquidity needs the dataset should become broader and more granular. Additional information on the surrender value of a policy is required when assessing the potential liquidity needs stemming from a (life) insurance contract. The need of additional data will ultimately depend on the granularity and type of assessment or classification that will be performed.

209. As discussed earlier, both the balance sheet and cash flow approach rely on a bucketing of the assets to determine the available liquidity sources. There are divergent practices however when it comes to assessing the liquidity needs. The balance sheet approach uses a bucketing of the exposures (based on their liquidity characteristics or based on a metric of (il)liquidity) to estimate the liquidity needs they generate; the cash flow approach uses the total net cash outflows.

2.2.4.1 Balance sheet approach

210. The bucketing of the insurance liabilities can be based on:

- **product features or liquidity characteristics** of a liability that, in turn, reflect or approximate the liquidity of the liability or,
- a **metric of the (il)liquidity of a liability** which reflects its sensitivity to specific liquidity risks.

211. Both methods aim at classifying (bucketing) the exposures according to their liquidity needs either by directly measuring the liquidity or by estimating it through an assessment of its product features and liquidity characteristics.

Product features-based method

212. The product features-based method focusses on the classification of life insurance liabilities and can be based on the product features or liquidity characteristics of a liability that, in turn, reflect or approximate the liquidity of the liability. Similar as to the bucketing of liquid assets, a factor-based approach can be used to approximate the liquidity needs stemming from the balance sheet exposures over a given time horizon. Exposures with a similar liquidity profile will be grouped into similar liquidity buckets (ranging from illiquid liabilities to very liquid liabilities) and receive a similar factor or haircut.

213. In its *Methodological Paper* EIOPA sets forth two possible approaches focusing on the classification of life insurance obligations[63]. These approaches could be further elaborated to cover potential liquidity needs stemming from non-life TP and other, non-insurance obligations (e.g. short-term funding, off-balance commitments, derivatives…).

Product type classification of liquid liabilities

214. This approach aims at defining a link between the sensitivity of lapse rates and a predefined range of product types. Regarding the choice of these product types it should be noted that it could be difficult to provide an appropriate specification of potential lapse sensitivities for each and every existing insurance product of the European insurance sector that is both granular enough as well as feasible with regard to implementation. This approach links certain product characteristics to higher or lower lapse sensitivity. In general, various product-related criteria can be seen to have a substantial impact on lapse rates:

- Protection against biometric risks: A stronger focus on the protection against biometric risk usually leads to more stable lapse rates. With increasing age the biometric protection becomes more and more valuable for policy holders and in addition it might get harder to get another contract.
- Savings components in traditional products: A stronger focus on the build-up of capital can lead to a stronger dependence of lapse rates on capital market movements as alternative investments become less or more attractive when compared to the expected return from the insurance product.
- Return characteristics of the insurance contract: If the return of the insurance contract is directly linked to the development of a capital market instrument or index (e.g. unit linked contracts) the dependence of lapse rates on capital market movements can be different than for traditional with-profit products (which often aim to smooth returns over time). It should be noted however that it might be difficult to derive a general rule whether these types of contracts is definitely exposed to a higher or to a lower lapse sensitivity with regard to capital markets than traditional products.

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[63] EIOPA (2020) Methodological Principles of Insurance Stress Testing. Available at: https://www.eiopa.europa.eu/sites/default/files/publications/methodological-principles-insurance-stress-testing.pdf

215. The application of some of these criteria allows to classify the different types of insurance products according to their sensitivity to lapses (see Table 2-8)

Table 2-8 Types of insurance products according to their sensitivity to lapses

Type of product	Characteristic	Sensitivity of lapse rate to capital market movements
Term insurance	Main goal is protection against biometric risk (no build-up of capital)	o
Endowments	Build-up of capital in combination with a protection against mortality risk	* *
Annuities in deferral phase	Build-up of capital in combination with protection against longevity risk	* *
Annuities in pay out phase	De-saving process providing protection against longevity risk	If lapse in pay out phase is possible: * Otherwise: o
Pure unit linked contracts (without financial guarantees)	Build-up of capital where the return is directly linked to the return of a capital market product such as an index Combination with a protection against mortality or longevity risk possible	o (assuming correlation with the capital market movements). The presence of additional features shall be considered.
Unit linked contracts with financial guarantees	Build-up of capital where the return is linked to the return of a capital market product such as an index but with additional guarantees provided by the insurance company Combination with a protection against mortality or longevity risk possible	*
Disability	Main goal is protection against biometric risk (no build-up of capital)	o
Health	Main goal is protection against biometric risk (no build-up of capital)	o

*o = low/no sensitivity, * = medium sensitivity, ** = high sensitivity*

Source: EIOPA (2020) Methodological Principles of Insurance Stress Testing. Available at: https://www.eiopa.europa.eu/sites/default/files/publications/methodological-principles-insurance-stress-testing.pdf

Questions:

Q 44 Could you please confirm the relevance of the classification of insurance products according to their sensitivity to lapses by a liquidity perspective?

Q 45 How much time and effort would be required to set up a classification of your product portfolio according to lapse sensitivity criteria (as proposed by Table 2-8 or by your answer to Q 44) and to implement such a product classification in your projection models for running a liquidity stress scenario as outlined in section 2.3?

216. It is worth noting that products whose surrender value is equal to the market value of the underlying investment expose companies to minor liquidity risk. Products with a higher lapse sensitivity are considered as more liquid and will receive a lower haircut than products with a lower lapse sensitivity.

<u>Surrender based classification of liquid liabilities</u>

217. An alternative approach to the classification of the life insurance portfolio by a product/lapse perspective relies on the existence and level of surrender penalties associated with a contract. Products with high surrender penalties could be assumed less likely to be lapsed, or better, lapse of these contracts

would require more important changes in the economic and financial market conditions than for products offering lower penalties in case of lapse.

218. The application of this approach presents as a major complexity the definition of a homogeneous and agreed approach to the definition of surrender penalties as well as the calibration of the thresholds to define the cohorts in the two elements thereof. This complexity is, amongst other reasons, driven by the large variety of different types of surrender penalties across the European insurance sector for which it seems very difficult to consistently define a relationship between their "level" and the likeliness of the associated insurance contracts being surrendered. Some surrender penalties imply deductions to the amount paid out to policyholders (the deduction being defined in terms of statutory reserves book values or in terms of market values), whilst other penalties induce various forms of tax disadvantages (which are often closely linked to the specific national legislative framework).

219. A viable penalty-based solution would be to classify the products according to the embedded types of penalties, assigning lower or no shocks to the ones with (high) contractual and fiscal penalties and higher shocks to the ones with no penalties as presented in Table 2-9.

Table 2-9 Classification of products according to the embedded types of penalties

	Low penalty rate (<20% on surrender value)[64]	**High penalty rate (>20% on surrender value)**
Contract AND Fiscal penalties	*	o
Contract OR Fiscal penalty	**	*
No penalties	***	

o = low/no sensitivity, * = medium sensitivity, ** = high sensitivity, *** = very high sensitivity

Source: EIOPA (2020) Methodological Principles of Insurance Stress Testing. Available at: https://www.eiopa.europa.eu/sites/default/files/publications/methodological-principles-insurance-stress-testing.pdf

Questions:

Q 46 Do you consider the relevance of the classification of insurance products according to their sensitivity to penalties such as tax incentives relevant for a liquidity perspective? Please elaborate.

Q 47 How much time and effort would be required to set up a classification of your product portfolio according to lapse penalties criteria (as proposed by Table 2-9 or by your answer to Q 46) and to implement such a product classification in your projection models for running a liquidity stress scenario as outlined in section 2.3?

(Il)liquidity metric method

220. Next to the product features classification of the liabilities to assess their liquidity one can also envisage to classify the liabilities by making use of a measurement of the illiquidity of the liabilities. In its report on insurers' asset and liability management in relation to the illiquidity of their liabilities EIOPA developed a measurement of the (il)liquidity of insurance liabilities[65]. The general concept of illiquidity could be considered as follows: the more stable

[64] In line with the IAIS data collection for the Individual Insurer Monitoring.

[65] EIOPA (2019) Report on insurers' asset and liability management in relation to the illiquidity of their liabilities. Available at: https://www.eiopa.europa.eu/sites/default/files/publications/reports/eiopa_report_on_insurers_asset_and_liability_management_dec2019.pdf?source=search

and predictable the cash flows are the more illiquid the liabilities. If cash flows are fixed irrespective of the scenario, they are considered as fully illiquid because they are perfectly predictable and stable.

221. The measurement of illiquidity is based on the variation between the best estimate cash flows and the cash flows after the application of the relevant SCR stress scenario. This approach is applicable for both life and non-life obligations, but the relevant stresses differ between the two. For life obligations, mortality, mass lapse and the relative lapse up scenarios are considered. For non-life obligations, mass lapse, reserve risk and catastrophe risks are considered. These liability cash flows before and after stresses can define the share of liabilities that are predictable and serves as the basis for the measure for the illiquidity of the liability.

Table 2-10 Advantages and disadvantages between the product features-based method and the (il)liquidity metric method

Approach	Advantages	Disadvantages
Product features-based method	• Relatively easy method	• Approach is currently limited to TP Life only
(Il)liquidity metric method	• More granular and precise method allowing for a better classification • Broader scope as it can be applied to all insurance liabilities	• More complex method based on best-estimate and stressed cash flows • The SCR stress scenarios might not adequately capture liquidity risk. • The method might not be suitable for all types of products (e.g. unit-linked business)

Questions:

Q 48 Which other methods to classify liabilities according to their liquidity do you consider to be relevant?

2.2.4.2 Cash flow approach

222. In its report the ESRB develops a cash flow liquidity indictor which is based on the Basel III LCR[66]. It relies on the concept of *Total net cash outflows* to define the stressed liquidity needs over a certain time horizon. The liquidity sources are determined by the assets bucketing approach (e.g. HQLA).

$$\frac{Stock\ of\ HQLA}{Total\ net\ cash\ outflows}$$

223. The total net cash outflows are the difference between the expected cash outflows and the cash inflows. The definition of the time horizon is key and will determine which cash in- or outflow should be considered. Also, the cash flows can be projected under normal circumstances or under stressed conditions. To ensure that the insurers do not solely rely on cash inflows to cover the (stressed) cash outflow the inflows are capped at 75% of the outflows. This implies that at least 25% of the cash outflow will have to be covered by HQLA.

224. This approach could be useful in a ST context where one would be able to compare the liquidity ratio before and after stress. The technical specification

[66] *Source: ESRB (2020), Enhancing the macroprudential dimension of Solvency II. Available at: https://www.esrb.europa.eu/pub/pubbydate/2020/html/index.en.html*

of such an exercise should determine which cash in- and outflows should be considered when calculating the Total net cash outflows in the baseline situation and how the stress scenario would impact each of them.

225. The cash flow approach offers several advantages compared to the balance sheet approach. It allows for a more granular assessment of the liquidity position of an insurer because of the projections of both the future cash in- and outflows. The cash flow approach can cover all potential liquidity needs (both stemming from insurance and non-insurance obligations). However, the cash flow approach implies a significant increase in complexity and a greater reliance on data from insurers.

226. When developing and designing a liquidity indicator EIOPA proposes to follow a step-by-step approach. The balance sheet approach, complemented with some minor cash flow based information, is less complex to implement and makes extensive use of the existing SII reporting, thus minimizing the additional data needed from the undertakings. During this first step, the use of this liquidity indicator will allow both insurers and supervisors to gain additional insights and a deeper understanding of liquidity risks present at the undertakings. The results of these analyses will be an element to take into account when considering the development of a more detailed and risk sensitive liquidity indicator based on the cash flow approach. The development of a fully-fledged cash flow liquidity indicator should follow a cost-benefit assessment.

Questions:

Q 49 Do you agree with the proposed approach and its foreseen evolutions?

Q 50 Are you already using similar method to assess your liquidity?

Q 51 Could you please explain the conceptual and practical gaps between the proposed analysis and the tools/approaches you are actually using?

2.3 How to shock the liquidity position

2.3.1 The core concept

227. The liquidity position of an insurer shall be tested under adverse circumstances by measuring, according to specific metrics, the liquidity sources and needs over different time horizons.

228. As mentioned in section 2.2.2, the time horizon is a key element for the identification and for the calibration of the shocks to liquidity sources and liquidity needs. For example, an increase in liquidity needs stemming from margin calls on the derivative position materializes in a short period of time and insurers are requested to fulfill the call within a few days making this type of shock eligible for a short term scenario. The regulation on the settlement of claims and redemption is country specific but on average insurers should settle policyholders' request of redemptions within 30 days. Against this it is reasonable to consider a shock to lapses only for scenarios based on at least 1 month or longer time horizons. Moreover, upon specific circumstances depicted in a narrative, it is fair to consider that the level of the lapses increases over time. Table 2-11 provides, without any aim of completeness, a representation of the relation between time horizon and shocks application and calibration.

Table 2-11 Representation between time-horizon and shocks application and calibration

	Scope	Shocks	Time horizon		
			Short (1 - 5 days)	Medium (30 days)	Long (6 months)
Assets	**Life and non-life**	Margin call	* * *	o	o
		Haircuts	* * *	* *	o
Liabilities	**Life**	Lapses	o	* *	* * *
		Premiums (decrease)	o	* *	* * *
		....			
	Non-life	Premiums (decrease)	o	o	* *
		Reinsurance	o	o	* * *
		Cost of claims	o	* *	* *
		Cat events	o	o	* * *
		...			

*o = low/no severity, * = medium severity, ** = high severity, *** = very high severity.*

229. In line with Table 2-11, the time horizons are reflected into three self - contained scenarios which can be applied in isolation. However, if compatible with the framework of the exercise (e.g. instantaneous shocks, multi-period set-up), the shocks belonging to different time horizons can be combined.

2.3.2 Possible scenarios

230. This section elaborates on possible scenarios that could be applied for liquidity stress testing of insurers. As discussed above, given the different nature of business, life and non-life insurers will be vulnerable to different sources of liquidity risk. At the same time, the same sources of liquidity risk are likely to affect them in different ways. For these reasons, the key factor determining the possible scenarios is the time horizon over which the stress unfolds. This report focuses on three possible scenarios extending over different time horizons:

- Short time horizon scenario (1 - 5 days);
- Medium time horizon scenario (30 days);
- Long time horizon scenario (6 months).

231. Each sub-section is structured as follows: first, a general description of the chosen focus of the scenario is given, followed by an illustrative narrative and further details on possible shocks.

232. Concrete calibration of the shocks to be applied will be added at a later stage once a methodological approach has been defined. Similarly, further details regarding the possibility to activate intra-group support will be added later once the scope (solo vs groups) and the approach towards the treatment of management actions have been determined.

233. Table 2-12 provides an overview of the sources of liquidity risk, possible triggering events and shocks which can be used, alone or combined in the design of the adverse scenarios.

Table 2-12 Overview of sources of liquidity risk, possible triggering events and shocks

SOURCES OF RISKS	TRIGGERING EVENTS	SHOCKS
Exposure to insurable events	Catastrophic events (e.g. natural catastrophes, pandemics)	Increase in frequency and magnitude of catastrophes
	Sudden inflation spike (general or concentrated in specific sectors – e.g. medical costs, car spare parts)	Increase in cost of claims
Policyholder behaviour	Insurance run	Mass lapse event (surrenders)
	Loss of confidence	Reduction in new business (premium inflow)
		Non-renewal of existing contracts (premium inflow)
		Mass Lapse event (surrenders)
	Financial crisis	Reduction in new business (premium inflow)
		Non-renewal of existing contracts (premium inflow)
		Mass Lapse event (surrenders)
Off-balance sheet exposures	Increase/decrease in interest rates	Request of collateral (example: margin call on Interest rate derivatives) due to changes in market value of assets
Balance sheet exposures	Fire sale	Haircuts to assets
Funding risk	Deterioration of own credit rating	Increase in funding costs
		Shock to own equity
		Shock to risk premia of issued bonds
		Requests of collateral
	Disruption of the repo market	Reduced access to repo market
Counterparty exposure	Default of a primary reinsurer	Haircut to reinsurance receivables and reinsurance recoverables
	Deterioration of lending balance sheet positions (banking activities)	Increase in the probability of default of counterparties

Questions:

Q 52 Could you please explain the conceptual and practical gaps between the proposed analysis and the tools/approaches you are actually using?

Q 53 Could you please explain the conceptual and practical gaps between the proposed analysis and the tools/approaches you are actually using?

Q 54 Do you think that relevant events or shocks are missing? If yes, please elaborate.

2.3.2.1 Short time horizon scenario

234. The short time horizon scenario unfolds over a very limited time period of up to maximum 5 days.

235. It focuses on assessing the capacity of both life and non-life insurers to withstand the liquidity needs resulting from off-balance sheet exposures, in particular in the form of variation margin calls on their derivatives portfolios.

<u>Exemplificative narrative:</u>

236. The scenario is assumed to be initiated by an abrupt reversal in global risk premia with impacts both on the swap rate curve and on the credit spreads. The required rate of return for holding fixed income assets would increase sharply (i.e. yield curves up).

237. Also, the financial market would experience a disruption in the repo market and in the overnight transactions making both intra-group and market-based transactions unfeasible.

238. Insurers use derivatives for hedging purposes. The value of their derivatives portfolios will change significantly and unexpectedly, and insurers will receive variation margin calls from central clearing counterparties (CCPs) via their clearing members which are to be paid within 24 hours in cash.

239. It is assumed that to meet the variation margin call, insurers would use a combination of the following options: post cash themselves, make use of collateral transformation services (incl. possibly a credit line) by their clearing member, access the repo market to convert assets into cash or sell (high quality) assets. In the latter case high haircuts will be applied.

Table 2-13 Summary of the short time horizon scenario

SOURCES OF RISKS	TRIGGERING EVENTS	SHOCKS	SEVERITY of the shock
Off-balance sheet exposures	Increase/decrease in interest rates	Collateral requests (example: margin call on derivatives) due to changes in market value of assets	***
Balance sheet exposures	Fire-sale	Haircuts to assets	***
Funding risk	Disruption of the repo market	Reduced assess to repo market	***

Questions:

Q 55 Do you think that the proposed sources / events and shocks are plausible for a scenario that evolves over 5 days?

Q 56 Do you think that the indication of the calibration of the shocks is plausible?

Q 57 Is the liquidity risk profile of insurers exposed to other shocks in the short time?

2.3.2.2 Medium time horizon scenario

240. The stresses in the medium time horizon scenario unfold over 30 days which is in practice the time horizon in a number of jurisdictions for the redemption of lapsable life insurance contracts.

241. The focus of this scenario would therefore be on assessing the capacity of insurers to withstand liquidity needs stemming from changes in policyholder behavior (life insurers) and funding risk (both life and non-life insurers).

Exemplificative narrative:

242. The medium time horizon scenario is assumed to be initiated by two triggering events. Firstly, a wide-spread misselling scandal in the life-insurance sector leading to a loss of trust by consumers. A considerably higher share of life insurance contracts are being lapsed. In order to meet the liquidity

needs, insurers are selling assets; haircuts are to be applied. Secondly, the credit rating of several life and non-life insurers has been downgraded and they are experiencing an increase in funding costs and additional collateral requests. Furthermore, their access to the repo market and intra-group transactions is impaired.

Table 2-14 Summary of the medium time horizon scenario

SOURCES OF RISKS	TRIGGERING EVENTS	SHOCKS	SEVERITY of the shock
Policyholder behaviour	Loss of confidence	Mass lapse event (surrenders)	**
		Non-renewal of existing contracts (premium inflow)	**
		Reduction in new business (premium inflow)	**
Balance sheet exposures	Fire sales	Haircut to assets	**
Funding risk	Deterioration of credit rating	Increase in funding costs	***
		Collateral requests	***
		Disruption in access to repo market and all the type of repo operation (e.g. intragroup)	***

Questions:

Q 58 Do you think that the proposed sources / events and shocks are plausible for a scenario that evolves over 30 days?

Q 59 Do you think that the indication of the calibration of the shocks is plausible?

Q 60 Is the liquidity risk profile of insurers exposed to other shocks in the medium run?

2.3.2.3 Long time horizon scenario

243. The long time horizon scenario covers a 6 months period and analyses insurers' resilience to several sources of liquidity risk, namely their exposure to insurable events, changes in policyholder behavior and funding risk. It combines elements of the medium time horizon scenario and several additions.

<u>Exemplificative narrative</u>:

244. This scenario is assumed to be initiated by several triggering events (Table 2-15). Similarly to the medium time horizon scenario, a wide-spread misselling scandal in the life-insurance sector leading to a loss of trust by consumers. A considerably higher share of life insurance contracts are being lapsed. In order to meet the liquidity needs, insurers are selling assets; haircuts are to be applied. Secondly, the credit rating of several life and non-life insurers has been downgraded and they are experiencing an increase in funding costs and additional collateral requests. Furthermore, their access to the repo market is impaired. In addition, an extreme natural catastrophic event occurs. The claims pay-outs by non-life insurers considerably exceed the provisions and inflows. A final element of scenario is the default of large primary reinsurer.

Table 2-15 Summary long time horizon scenario:

SOURCES OF RISKS	TRIGGERING EVENTS	SHOCKS	SEVERITY of the shock
Exposure to insurable events	Extreme natural catastrophe	Increase in frequency and magnitude of catastrophes	***
	Pandemic	Increase in cost of claims	***
	Material legal decision	Increase in cost of claims	***
Policyholder behaviour	Loss of confidence	Mass lapse event (surrenders)	***
		Non-renewal of existing contracts (premium inflow)	***
		Reduction in new business (premium inflow)	***
Funding risk	Deterioration of credit rating	Increase in funding costs	***
		Collateral requests	**
		Disruption in access to repo market	*
Balance sheet exposures	Fire sales	Haircut to assets	*
Counterparty exposure	Default of a primary reinsurer	Haircut to reinsurance receivables and reinsurance recoverables	***

Questions:

Q 61 Do you think that the proposed sources / events and shocks are plausible for a scenario that evolves over 6 months?

Q 62 Do you think that the indication of the calibration of the shocks is plausible?

Q 63 Is the liquidity risk profile of insurers exposed to other shocks in the long run?

2.3.3 Implementation of the scenarios

245. A comprehensive approach to the assessment of the liquidity position would take into account the time dimension of the liquidity inflows and of the liquidity outflows, namely it would be based on the analysis of the cash flows. As discussed in section 2.2, the computation, collection and aggregations of cash flows requires an extensive work and cooperation among EIOPA, NCAs and the industry.

246. As discussed in section 2.2.2 an alternative approach could be based on a pure balance sheet perspective, namely on a bucketing of assets and liabilities according to specific liquidity criteria. Such an approach would facilitate the implementation, but due to its static nature would face the challenge of an adequate translation of the stress scenario narrative into a consistent adjustment of the available free parameters (such as e.g. the level of the haircuts on the asset side).

247. Against this background EIOPA would opt to initiate the implementation of a potential liquidity ST based on an intermediate approach that combines the static balance sheet perspective (via a liquidity bucketing for the asset side)

and a simplified cash flow perspective (via an assessment of specific cash out-flows under the baseline and the under the stress scenario).

248. Furthermore, for a potential first exercise EIOPA would opt for a framework based on the instantaneous application of the shocks, namely any prescribed shock, despite its significance in short, mid or long scenarios as described before, should be applied instantaneously. Even though shocks would have to be applied instantaneously, their calibration will follow the assumption on the severity made in chapter 2.3.2.

249. Consistent with the instantaneous nature of the shocks no reactive management actions would be allowed in the calculation of the post stress liquidity position. EIOPA is well aware of the limitations that this assumption implies, especially if the shocks are supposed to happen in the mid-long run. The impact of the potential management actions and their potential spill-over effects could be covered however by a quali-quantitative assessment.

250. This approach would allow also for potential partial top-down estimation of the impacts without additional burden for the participants to the ST exercise.

2.3.3.1 Estimation of the baseline and post-stress liquidity sources

251. Given the instantaneous nature of the liquidity shocks, the baseline and the post stress liquidity position of the assets would be based on the application of haircuts to the asset classes following the classification approach described in section 2.2.3.

252. Haircuts for each bucket would be calibrated according to the narrative and the time horizon of the scenario starting from the baseline and moving towards more severe calibrations under stress scenarios reducing de-facto the amount of available liquid assets (e.g. the numerator of the liquidity indicator).

253. Counterparty exposure, with particular reference to the reinsurance recoverables and reinsurance receivables should be reported without haircuts in the baseline scenario and with the application of the haircuts prescribed in the scenario.

2.3.3.2 Estimation of the baseline and post stress liquidity needs

254. The calculation of the liquidity needs would be based on the assessment of the cash outflow under baseline and stressed scenarios according to the prescribed shocks.

255. In order to assess the liquidity needs in the baseline scenario insurance undertakings would be supposed to provide the following information for the assessed time horizon:

- For life business:
  - The total surrender value of the in-force life portfolio at the level of liquidity bucket based on the classification described in section 2.2.4;
  - The expected surrender value to be paid out for each bucket based on the (probability) assumptions used to compute the best estimate liability.
- For non-life business:
  - The value of the claims stemming from the non-life business expected to be paid out according to the best estimate assumptions classified by line of business.

256. The post stress position of the liquidity sources would have to be assessed in line with the scenario by (re)computing the expected cash out as follow:

- For the life business the surrender cash outflows shall be computed taking into account the shocks to lapses. The same level of granularity of the baseline shall be preserved;
- For the non-life business the prescribed increase in the cost of claims shall be reflected in the estimation of the cash outflows stemming from claims settlement.

257. The liquidity needs stemming from margin calls on interest rate swaps derivatives could be assumed to be equal to zero in the baseline scenario. Under stressed scenario the liquidity need stemming from the net IRS position would have to be estimated based on the prescribed shocks to the risk free rate curve.

258. In principle the assessment of the liquidity needs could be based on the present value of the cash outflows over the prescribed time horizon discounted at the risk free rate curve. Given the short time horizon (up to 6 month) however and the current level of the risk free rate a simple sum of the cash outflows could be deemed as reasonable.

259. Annex 4.3.1 presents a summary table containing an exemplificative template for the application of the shocks. The content is not meant to be exhaustive but it gives an example of the data insurers will be requested to provide in a liquidity ST exercise. This data collection might be complemented by additional information for validation purposes.

260. When applying the shocks, companies shall not take into account potential mitigation effects stemming from local micro- or macro-prudential regulatory regime e.g. temporary suspension of the redemption rights.

261. The described approach tackles liquidity risk from a pure microprudential perspective. In order to infer potential spill-over stemming from the action taken by insurers against the prescribed liquidity shocks the data collection can be complemented by a quali- quantitative questionnaire where companies are requested to provide information on the management actions (embedded and/or reactive) that would be triggered to cope with the liquidity shocks with specific reference to the disinvestment strategy:

- type and amount of security sold;
- sequence and timing of the sale of the securities;
- channels (primary, secondary, intra-group).

Questions:

Q 64 Do you think that the proposed approach provides meaningful information on the liquidity position of an insurer under adverse scenarios? Which other approaches could be considered?

Q 65 What is you view on the instantaneous nature of the shocks? What are the major limitations brought by this approach?

Q 66 Do you think that the exposures and the shocks proposed (please refer also to Annex 4.3.1) include the most relevant ones to assess the liquidity of an insurer?

Q 67 Are there any additional exposures or shocks you consider relevant to be assessed in a potential first liquidity ST?

Q 68 Do you consider the proposed “mixed” approach as a viable solution from an operational perspective?

Q 69 What question would you include in the quali-quantitative questionnaire to assess potential spill-over effects?

2.3.4 Analysis and presentation of the results

262. It goes without saying that no indicator or analyses can be borrowed from the SII framework and the former capital based ST exercises, hence a liquidity ST will not require participants to recalculate standard balance sheet indicators (e.g. the excess of assets over liabilities), capital indicators (e.g. Own Funds) or solvency indicators (e.g. Solvency Capital Requirement).

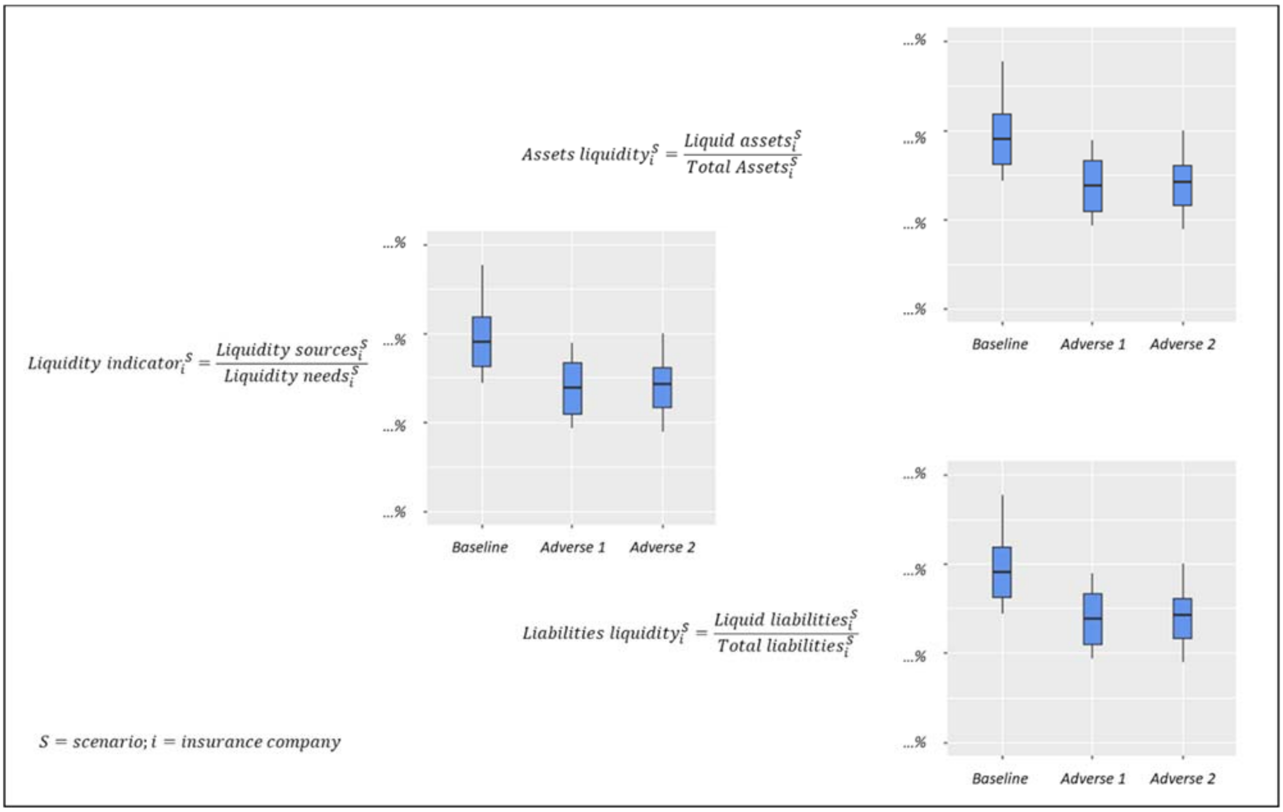
263. Additionally, the assessment of the liquidity position cannot rely on standardized and acknowledged metrics both for the baseline and the adverse scenarios. The main consequence of this gap is the lack of past and/or current reference values for the selected indicators which might reduce the significance of the conclusions inferred from the ST exercise.

264. Against this background the analysis will be, at least for the first ST exercise, mainly based on the relative changes of the selected indicators, namely calculating the indicators under baseline scenario, under adverse scenarios and analyzing their changes and their drivers.

265. Analysis of the levels of the indicators might be limited to the ability to cover the liquid liabilities with the liquid assets under baseline and adverse scenarios.

266. The vulnerabilities of insurers will initially be assessed according to the set of indicators presented in section 2.2.1 which might be complemented by further analyses on assets and liabilities (depending on whether the concerns stem from the asset or the liability side). An incomplete overview of the analysis is presented in Figure 2-1.

Figure 2-1 Exemplification of a potential vulnerability analysis



267. Pre- and post-stress indicators will be presented in an aggregate way (e.g. cumulated values or distributions). Any individual results will be presented only upon agreement of the participating insurer.

268. An assessment of the potential spill-over effects stemming from the insurance industry can be done by aggregating the reported changes in the asset allocation (disinvestments / investments) based on the qualitative and quantitative questionnaire. The amount and the sequence of sales of the securities might allow to infer potential qualitative footprints on other financial markets.

Questions:

Q 70 What are the main limitation you foresee in the proposed analysis?

Q 71 Do you have suggestions for additional analysis to be performed?

Leveraging on National experience – an alternative approach

The French Prudential Regulation Authority (ACPR) developed and used, mainly in banking regulation, an alternative approach. The framework, which diverges in several aspects from what presented in this chapter, tackles the assessment of the liquidity position under stressed situation by a reverse perspective. After the identification of the relevant risk drivers by a liquidity perspective, the approach aims at answering for each of them the following question: "Which severity of a given shock to a liquidity risk driver is necessary to breach a pre-defined threshold of the chosen liquidity metric?"

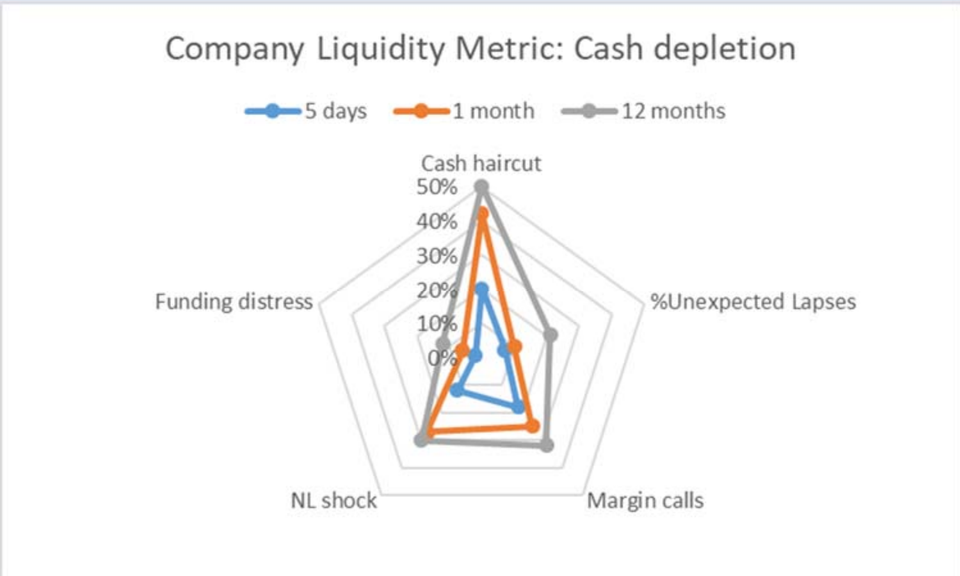
Operationally, the approach requires proceeding in three steps. First, define and calibrate a liquidity metric identifying the thresholds that signal a situation of liquidity distress. Second, define a set of single shocks[67]. On the asset side, a single shock could target haircuts to assets, or changes in business volume, collateral requirements/margin calls, or other management actions[68] (e.g. assumptions on short-term financing, recapitalization of subsidiary/participations, changes of structure and Intra-Group-Transactions, asset defaults, etc.). On the liability side, shocks could materialize as policyholder lapses, large unexpected claims payouts, or changes in regulation. Third, present the outcome including graphical presentation for each company's vulnerabilities.

As an illustration of this, let us consider the following analysis:

- Liquidity metric: level of cash (cash depletion);

- Five single shocks haircut to assets, funding distress, unexpected lapses, non-life shocks, margin calls.

The aim is to identify the level of each shock that leads to the breach of the threshold in the defined liquidity metric. On this basis, for each shock, the level that leads to the breach of the liquidity metric is plotted and all those points are connected to form a radar or spider net chart as displayed below.



This representation technique carries multiple advantages. At first, it allows to combine in one view the outcome of a set of singe shocks keeping at the same time a clear segregation of the impacts. It is therefore particularly appealing for risk identification with regard to liquidity risk, since liquidity risk is highly insurer and scenario specific. It helps to understand the underlying risks and

[67] For a definition of "single risk factor" please refer to Chapter 4 of the Methodological principles of insurance stress testing. Available at: https://www.eiopa.europa.eu/sites/default/files/publications/methodological-principles-insurance-stress-testing.pdf.

[68] Management actions are decisions taken by company boards in discretion, in response to changing economic conditions.

vulnerabilities in an insurer's business and products that may pose a threat to its liquidity position. Furthermore, it is a quick way to monitor and check the liquidity resilience of an insurance company: if the 0% shock is at the centre of the radar chart, then the bigger the area of the pentagon depicted, the more resilient a company is. In addition, this approach is a convenient way to strengthen the case of risk-scoring in the case of liquidity-risk-analysis.

Beside the advantage of identifying the impact of each shock, this exercise comes with disadvantages. Shocks are here considered independent from each other (the radar is the representation of 5 single-shock scenarios), whereas in reality, these drivers tend to act in a combined way and their impacts might be self-enforcing: an increase in lapses often occurs in a context of tight markets (which already affects securities' liquidity).

Other approaches with combination of risk drivers could be used to overcome this limitation.

Questions:

Q 72 What is your view on the alternative approach?

Q 73 What potential main limitations do you foresee in this technique?

3 Multi-period stress tests

3.1 Introduction

269. The regular EIOPA bottom-up stress test (ST) exercises converted the scenarios into instantaneous shocks to be applied to the balance sheet and solvency position at the reference date. The approach, based on fixed balance sheet assumptions and a constrained application of management actions, entails a set of limitations highlighted in the first methodological paper on stress testing. The paper also opened the floor for further work on the concept of multi-period approach recognizing the advantages but also the complexity of the implementation of such a framework.

270. This chapter aims at presenting from a theoretical perspective and without the aim of completeness the major challenges implied in the introduction of a multi-period approach in a bottom-up insurance stress test exercise. Any technical approach to the implementation of the framework will follow the feedbacks gathered form the consultation process.

271. The initial section of the chapter introduces the concept of multi-period framework in the stress test context providing a definition and a description of the constituent of the ST exercise (e.g. approach, scenario, shocks, and validation) in such a framework. Section 3.3 is devoted to present the methodological framework of a multi-period exercise with reference to the treatment of time dependent elements such as the concept of going concern, the future business, and the treatment of reactive management action. Section 3.4 discusses various operational aspects with specific focus on the process needed to deal with a multi-period set-up.

3.2 Definition of the concept of 'multi-period' stress test

272. Multi-period stress testing models for the insurance market deal with stressed positions of insurance undertakings under a specific scenario which evolves over a predefined time horizon. The scenario, typically stretching over a horizon of 3-5 years, shall describe the development of key financial, economic, and insurance-specific variables for each future period under consideration. Multi-period approach introduce dynamics to STs and allows simulation of situations similar to those that insurance sector may face such as scenarios encompassing risks that are assumed to evolve over a longer time horizon (e.g. a prolonged low interest rate environment) or based on non-permanent shocks (e.g. a drop in the markets followed by a recovery). Additionally multi-period STs allow to analyze the timely evolution of specific key metrics (e.g. excess of assets over liabilities).

273. As introduced in the first paper on the methodological principles of insurance stress testing[69] the multi-period framework diverges from the usual scenarios prescribed by EIOPA in its former bottom-up ST exercises and its implementation introduces consistent changes in each element of the exercise such as:

- the methodological approach;
- the definition of the scenarios;

[69] EIOPA. (2020). Methodological Principles of Insurance Stress Testing, available at: https://www.eiopa.europa.eu/sites/default/files/publications/consultations/methodological_principle_of_insurance_stress_testing_1.pdf

- the identification, the calibration, and the application of the shocks;
- the validation.

274. Additionally, the whole process and its operational steps shall be fully reconsidered to adapt to the complexity of a multi-period framework.

275. Multi-period exercises are usually used to assess the impact of financial shocks (for example to spread or interest rates) triggered by an adverse evolution of a macroeconomic variable such as divergence in the expected GDP, employment rate or inflation rate on the entities in scope of the exercise. Eventually, the impacts at entity level are aggregated to infer the resilience of an industry at country level (according to the different objectives depicted in the first methodological paper such an approach can be classified as microprudential).

276. Scenarios can be derived projecting key economic parameters which illustrates the financial and economic situation over the given time horizon according to *i*) the expected trajectory (baseline scenario) and *ii*) one or more alternative evolutions of the parameter therein (adverse scenario). The vulnerability of the participants is therefore evaluated by comparing the identified metrics calculated in the baseline and adverse scenarios over time. An alternative approach is based on the prescription of a set of shocks for each period with ripple effects (i.e. that some shocks implemented in the first periods may affect other variables in later periods) limiting the projection to the adverse scenario. Vulnerabilities are then estimated checking the balance sheet and solvency position at the end of the last period against the baseline at time T_0.

277. In general the multi-period exercises usually apply over 2 to 5 years "single scenarios" consisting, according to the definition provided in the first methodological paper, of multiple risk factors limited to a financial shocks. In some cases single shock approaches (e.g. based on the evolution over time of the interest rates) are applied.

278. In order to supplement the theoretical definition of a multi-period ST with some empirical evidence this section provides an overview on how the different elements are designed and combined in the multi-period frameworks used so far by other institutions.[70]

279. Consistently with the microprudential nature the exercises taken into account in the overview, they are all based on static or constrained balance sheet assumptions, namely limiting the application of management actions and the assumptions for new business.

280. A summary of the approaches taken by different authorities is provided in Table 3-1 and the description of the sources is provided in Annex 4.3).

[70] Monetary Authority of Singapore (MAS), International Monetary Fund (IMF) and World Bank, Office of the Superintendent of Financial Institutions Canada (OSFI Canada), Board of Governors of the Federal Reserve System, French Prudential Supervision and Resolution Authority (ACPR). Presentation of the research carried out by these institutions together with references for publication are provided in Annex.

Table 3-1 Summary of existing multi-period approaches

Element	Approach
Objectives	• Microprudential perspective: assessing the resilience of the individual institutions. The aggregated impact is used to infer the vulnerability of the sector
Type of scenario	• Single risk factors (e.g. change in the interest rate) • Single scenarios based on a set of financial shocks derived from macro triggering events (e.g. inflation rate, unemployment, GDP)
Balance sheet assumptions	• Static balance sheet assumption (e.g. no reactive management actions)
Treatment of the baseline	• In case of projection of baseline and adverse scenarios the calculation of the baseline over time is requested • In case of projections limited to the adverse scenario, no recalculation of the baseline at time T_0 is requested
Metrics	• Balance sheet based metrics • Solvency metrics
Consistency with the regulatory framework	• In general all the shocks are consistent with the in-force regulatory frameworks

3.3 Methodological framework for multi-period stress tests

281. This chapter deals with some of the technical / methodological prerequisites linked to multi-period stress scenarios, which can be broadly classified as follows:

- Specification and assumptions;
- Implementation;
- Validation.

282. It should be noted that the components mentioned above feature several conceptual and operational interdependencies. The proposed categorization merely aims at providing an appropriate structure for discussion.

3.3.1 Specification and implementation

283. The specification of an EIOPA ST exercise has to ensure amongst others

- that participants are provided with all the detailed technical information required to implement the stress scenarios in their stochastic valuation and risk models;
- that the implementation of the stress scenarios is performed in a consistent way across participants in order to guarantee an appropriate level playing field.

284. Empirical evidence from previous EIOPA STs confirms that such a technical specification is already a demanding task for one-period instantaneous stress scenarios. In the case of a multi-period ST, it is not sufficient to simply duplicate this type of technical information to two or three periods, but additional aspects that emerge because of the multi-period character have to be taken into account.

3.3.1.1 Temporal development of affected risk drivers

285. In order to implement the stress scenarios insurance companies need both granular as well as comprehensive information on the assumed changes of the affected risk drivers over the selected time horizon, including amongst others

- shocks to SWAP rates;
- shocks to government / corporate / RMBS yields or spreads;
- shocks to stock prices;
- shocks to real estate prices;
- shocks to other assets;
- shocks to inflation;
- shocks to FX rates (at least for major currencies);
- shocks to insurance specific risk drivers:
    - Life: mortality, disability, lapses, expenses;
    - Non-life: premium, claims.

286. In a multi-period ST, the scenario roll-out and the time evolution of the affected risk drivers represent a key element of the narrative. This narrative needs to be translated into a technical specification of the time development for each single risk driver for

- the multi-period baseline scenario;
- the multi-period stress scenario(s).

287. In case of an instantaneous ST, the "baseline scenario" usually simply relates to the situation at the reference date. That means that no further specification is required and that the "benchmark figures" (i.e. the corresponding regulatory reporting figures at this reference date) against which the ST results are compared to are already available before the start of the exercise. This is different to a multi-period setting where the baseline scenario itself has to be defined as a specific real-world development path over the intended time horizon. Depending on the objective of the exercise, this multi-period baseline scenario might for example reflect some kind of "expected" economic and business development over a mid-term planning horizon. It should be noted however that the technical specification must provide full information (and not just a generic description) on the development of all relevant risk drivers in order to enable companies to reevaluate their assets and liabilities at future dates. This means that the information required for the multi-period baseline scenario is not limited to market data (like expected equity returns or the risk free rate curve including and excluding the VA), but also insurance specific assumptions (like expected lapse rates or expense levels) in order to enable (at least in principle) a real-world projection of the SII balance sheet positions.

288. It is evident that an analogously granular specification is required for the multi-period stress scenario(s) under consideration. Again, it should be pointed out that this requirement also applies to cases where no specific "shock" events, but "normal / back-to-normal developments" for a subset of these drivers are assumed for specific periods (e.g. the assumed real-world return of equities in period two after an assumed price shock of 35% in period 1). In other words, the full information for each risk driver (affected or not affected by the scenario) is required for each time step of the considered stress periods.

289. Depending on the scope of participants and on the scale of the scenarios, these assumptions have to be defined for different geographical areas and currencies.

290. Another core component of the technical information relates to the basic risk-free interest term structures for different currencies including and excluding the volatility adjustment, which EIOPA needs to provide for each year of the considered time period. It should be noted that the level of the

volatility adjustment for future periods (i.e. for time steps t>0) depends on the assumed spread changes, and may depend on additional assumptions (e.g. with regard to the future composition of the representative currency or country portfolios or assumptions on the fundamental spread in the adverse market environment stipulated by the stress scenario).

291. A particular challenge in a multi-period setting relates to the derivation and the specification of the change of the volatility surface over the stress periods. Information on the level of implied volatilities is not only required for the revaluation of derivative positions on the asset side. The business models of traditional with-profit life and health insurance across Europa typically feature complex interactions between assets and liabilities and asymmetric return profiles between policyholders and shareholders. Furthermore, traditional life and health products often incorporate different types of financial options and guarantees for which no analytically closed valuation formulas are available. Against this background, the usual approach to derive the value for the best estimate liability (BEL) relies on Monte-Carlo simulations based on risk-neutral projections. These risk-neutral projections typically require granular information on the level and shape of the volatility surface (e.g. implied swaption volatilities for different term-tenor combinations).

Questions:

Q 74 Besides the potential operational challenges for the technical implementation of a multi-period (baseline or stress) scenario: do you consider the list of risk drivers to be specified over the time horizon of the scenario as comprehensive enough? If no, which further data would be required in which granularity?

Q 75 Which information on the assumed temporal development of implied volatilities would be precisely required from your perspective?

3.3.1.2 Revaluation of assets and liabilities over future periods

292. Some of the key metrics of a multi-period stress will correspond to the temporal development of specific SII balance sheet positions under the baseline and under the stress scenario(s). This means that the corresponding asset and liability items of the SII balance sheet have to be revalued at several different future points in time according to the respective scenario roll-out. It should be noted however that such a revaluation in a multi-period exercise requires specific additional information beyond the development of the risk drivers.

3.3.1.2.1 Future new business assumptions

293. The technical specification has to define a framework (or even specific prescriptions) regarding new business assumptions for both the baseline as well as for the stress scenario(s). These assumptions will refer amongst others to new business volumes and new business structure during the (baseline and stressed) periods under consideration.

294. Given the large variety of insurance products and their respective features across Europa, it is not deemed possible for EIOPA to provide granular development paths for each company-specific product type. Regarding the technical implementation the framework of new business assumptions may therefore be defined on the basis of different methodological alternatives:

“Constrained approach” excluding future new business

295. Such a constrained approach may be interpreted as some kind of run-off projection of the inforce business for the baseline as well as for the stress scenario(s). This run-off perspective may foster the comparability of the results as no company specific new business assumptions would have an impact on the key metrics under consideration. Furthermore, the approach avoids various material technical implementation challenges that relate to the fact that the stochastic valuation models used to derive SII balance sheet metrics were usually not designed to allow for consecutive future new business layers so that participants may be forced to apply approximations, which could hamper the comparability and interpretability of results.

296. On the other hand the particular run-off perspective should clearly be linked to the objectives of the exercise as otherwise it may be questioned whether excluding any future new business realistically reflects the exposure and the vulnerability of the company to the multi-period stress scenario.

“Individual approach” based on company specific new business assumptions

297. This approach delegates the task of defining appropriate new business assumptions for the baseline and the stress scenarios back to companies. For the baseline scenario, these assumptions may for example refer to the individual mid-term business plans of participants. For the stress scenario(s), the assumptions used should reflect the company’s perspective on future business activities under the adverse situation. This assessment should enable a tailored supervisory assessment and dialogue with the participants. Such a dialogue should ensure that companies are in position to provide credible and plausible arguments for their particular choice of new business assumptions. Given the company specific calibration of these assumptions the technical specification should include at least a principle based guidance on acceptable approaches and simplifications in order to ensure an adequate level playing field across participants.

“Intermediate approaches” based on scaling or mapping techniques

298. Alternative approaches for future new business assumptions may aim at striking a balance between the reduction of the implementation burden and the benefit of the additional informative value of projecting future new business. Examples for such approaches may refer to appropriate scaling or mapping techniques (based for example on the assumption that the product mix of the total inforce business remains constant for the baseline or even also for the stress scenario). The technical specification would need to provide sufficiently granular details regarding the methodological approach in order to enable a consistent technical implementation across participants.

Table 3-2 Approaches to future new business

Approach	Advantage	Disadvantage
Constrained	• Comparability of the results • Reduced complexity	• The run-off set-up represents a strong constraint in a multi-period projection • No reflection of the foreseen business plan in the projection
Intermediate	• More realistic projection of the situation of the companies over the observed timeframe	• Simplified projection of the new business may distort results • Difficult to find a one-fit-all approach to new business projections
Individual	• The inclusion of company specific new business assumptions (e.g from the mid-term business plan) allows a more realistic assessment of the post stress position	• Hard to assess the plausibility of the assumptions embedded in the business plan against the adverse scenario • Comparability of the results can strongly dependent on the assumptions

Questions:

Q 76 Do you agree with the presented advantages and disadvantages of the discussed alternative approaches for future new business assumptions?

Q 77 Do you have further methodological proposals for the specification of future new business assumptions in the context of a multi-period exercise?

Q 78 Do you have a preference for a specific approach? If so, please elaborate on the reasons for your preference, with a specific focus on conceptual, technical and operational aspects.

3.3.1.3 Projection of the risk margin

299. The specification should provide a framework for the revaluation of the risk margin for future periods. One of the main methodological challenges for such a revaluation relates to the question on the impact of the assumed risk driver development (for both baseline and stress scenarios) over time on the value of the risk margin. However, in a multi-period setting the risk margin in principle also depends on the assumed business mix (including new business) for future periods. Therefore quantifying the value of the risk margin for future periods is considerably more complex than for an instantaneous ST. Against this background, the specification should also discuss principles for acceptable approximations and simplifications regarding the revaluation of the risk margin.

300. From a purely theoretical perspective, one could argue that the projection of the risk margin would require the recalculation of the SCR according to article 38 of the Delegated Regulation for future periods (for both baseline and stress scenarios). However, the conceptual, technical and operational challenges linked to a SCR projection in the context of a multi-period exercise may be seen as too prohibitive for implementation. In that case, the technical specification should provide a comprehensive and sufficiently granular framework for acceptable alternative approaches. These approaches could for example relate to scaling solutions, that should however take into account the design (i.e. the risk drivers affected) and the severity of the stress scenario(s).

Questions:

Q 79 Do you have a preference for a specific approach for the projection of the risk margin? If so, please elaborate on the reasons for your preference, with a specific focus on conceptual, technical and operational aspects.

3.3.1.4 Projection of DTA and DTL

301. The derivation of the DTA and DTL positions is usually based on an item-by-item comparison between the SII balance sheet and the local statutory fiscal balance sheet. If the multi-period exercise aims at performing a revaluation of the SII balance sheet including deferred tax positions then the specification must also provide sufficient and appropriate information for the projection of the local statutory fiscal balance sheet for baseline and stress scenario(s).

302. Furthermore, the specification should also contain a separate framework for the recognition of DTA for future periods of the baseline and in particular of the stress scenarios. In principle, DTA can only be recognized in the SII balance sheet up to the amount that future taxable profits are available for utilization. However, providing evidence for such future taxable profits is particularly challenging in a multi-period setting. Amongst others, the framework on DTA has to specify whether the required assessment of future taxable profits should allow for the scenario roll-out or not.

Questions:

Q 80 Do you have a preference for a specific approach for the projection of DTA and DTL positions in the baseline and in the stress scenario? If so, please elaborate on the reasons for your preference, with a specific focus on conceptual, technical and operational aspects.

Q 81 Which criteria would be applicable from your perspective for the recognition of projected DTA positions?

3.3.1.5 Framework for reactive management actions

303. The application of the management actions and in specific of the reactive management actions[71], is a controversial topic in the context of a ST exercise. The definition of this element, already considered key in the instantaneous shocks framework, is of utmost importance in a multi-period framework where any action taken at one point in time shapes the exposure of the company that should be considered at the following point in time.

3.3.1.5.1 Definition of going-concern assumptions in a multi-period stress test

304. The granular prescription of the temporal development of the affected risk drivers is only a necessary, but not a sufficient condition for the revaluation of assets and liabilities over the stress periods. The technical specification of a multi-period ST must also define precisely which kind of real-world assumptions companies have to apply during the scenario rollout. Examples for such assumptions can relate to the asset side (e.g. by defining specific limitations on the asset allocation during the stress periods), to the liability side (e.g. new business assumptions for the stress periods), or to more general aspects (such as e.g. potential limitations to shareholder dividend pay

[71] Ref to definition used in the first paper

outs). These examples already illustrate the fact that from a technical perspective prescribing specific going-concern assumptions means nothing else than prescribing specific adjustments to the valuation and risk models of the participants. It should be pointed out that the implementation of such adjustments can be very complex because the underlying stochastic models were not necessarily designed for such applications (cf. the subsection on implementation where these challenges are discussed in more detail). Therefore, greatest care should be taken when defining these going-concern assumptions.

3.3.1.5.2 Principles for reactive management action

305. Methodological principles for the treatment of reactive management actions in a multi-period ST may cover a wide range of possible approaches::

<u>The specification excludes any allowance for reactive management actions during the scenario roll-out</u>

306. This constrained approach was chosen for the previous EIOPA ST exercises that were based on instantaneous shocks. The conceptual focus of such an exclusion of management action lies on the comparability of post-stress results, which can be hampered in case participants are allowed to define tailored reactions to the stress scenario. This perspective on comparability applies in particular in a complex multi-period setting, where not only the type but also the timing of assumed actions are relevant. Without any information on the quantitative impact of such actions, the ST results may be seen as merely analyzing the potential of the companies to seek for "optimal" combinations and progressions of risk-mitigating actions.

307. On the other hand it may be questioned whether disregarding any capability of senior management to react to the adverse development of a multi-period stress realistically reflects the vulnerability of the company to the scenario. While this question on the "degree of realism" of post-stress metrics without management actions can also posed in the context of an instantaneous ST, it can be seen as even more relevant for multi-period scenarios where risk are assumed to realize over a longer time horizon and therefore are more likely to induce collateral measures compared to sudden shock events.

<u>The specification does not define any conceptual limitations to the potential scope of reactive management actions (apart from obvious constraints such as compliance with legal provisions etc.)</u>

308. By granting full flexibility with regard to the choice and design of the reactive management actions, this approach may be seen as the most accurate reflection of the company specific perspective on possible and "realistic" responses to the multi-period scenario. It may therefore enable a tailored supervisory assessment of the particular exposure and risk-mitigating capacity of the respective participant. The fact that participants are allowed to tailor their management actions, on the other side, may hamper the comparability of results and open the door for various forms of "goal seeking" or "optimization" routines aiming to achieve an "attractive" level of risk-mitigation.

<u>Intermediate approach</u>

309. An intermediate approach for a multi-period ST could refer to a framework which leaves an appropriate level of flexibility to participants with regard to

the design of reactive actions, but which defines several side conditions for their application such as for example:

- a written explanation of the background and the reasons for the particular actions chosen by the participant and an assessment of the appropriateness of these actions
- a written assessment of the participants providing credible arguments that the assumed reactive actions could actually be implemented under the adverse conditions of the scenario
- a written assessment of the participants regarding the consistency of the assumed reactive actions with the company specific risk strategy and risk appetite (including a specific reference to existing recovery plans)

310. Such an intermediate approach could be further constrained by supplementing the technical specification with a concrete and comprehensive list of those reactive management actions that companies are allowed to consider. An explicit definition of acceptable reactive management actions can provide a certain level of control on the type and design of these risk mitigating measures. The "top-down" character of such a definition however has to abstract from the specific exposures and risk strategies of participants. It may therefore be exposed to the same kind of criticism regarding the "degree or realism" as the fully constrained approach.

311. Independently of the concrete design of such side conditions, the assessment of the appropriateness, plausibility and impact of the assumed reactive management actions should form a central component of the validation process – both within the companies as well as within the supervisory authorities. In this context the supervisory assessment needs to strike a balance between appropriate allowances for the company specific, tailored character of the some of the actions on the one hand and an adequate level playing field on the other hand. Striking this balance is a very demanding task not only for NCAs at national level, but also for EIOPA at aggregate level. A principle-based approach might be preferred in this context.

312. Regarding the application of reactive management actions, participants could furthermore be required to present results including and excluding the impact of the chosen actions (in relation to the full reporting package or to an appropriate subset of certain key metrics). Such a presentation could not only provide additional insight into the company specific impact of the assumed actions but also support an analysis of potential second round effects. Depending on the number, complexity and interconnectedness of the reactive management actions an iterative step-by-step analysis might be required. It should be noted however that the derivation of results including and excluding the impact of the assumed actions (in particular in case of an iterative analysis) could be faced with material (and even prohibitive) operational constraints. These potential constraints are discussed in more detail in the subsection on implementation.

Table 3-3 Approaches to reactive management actions

Approach	Advantage	Disadvantage
Constrained	• Easier specification and calculation • Comparability of the results	• Absence of reactions against stressed scenarios is unrealistic in a multi-period context • No assessment of potential spill-over effects
Intermediate	• Preserve to some degree the comparability of the results • Include (partly) the reactive management actions to ensure "real" outcome of the exercise	• Complexity in the definition of the specifications • Increased effort for participants • Complex and extensive validation of the results
Individual (open)	• Accurate and realistic reflection of the company behaviour	• Potential goal seeking behaviours tailored on the scenarios • Comparability of the results

Questions:

Q 82 Do you agree with the presented advantages and disadvantages of the discussed alternative approaches for the application of reactive management actions?

Q 83 Do you have further methodological proposals regarding the allowance for reactive management actions in the context of a multi-period exercise?

Q 84 Do you have a preference for a specific approach? If so, please elaborate on the reasons for your preference, with a specific focus on conceptual, technical and operational aspects.

3.3.1.6 Framework for potential SCR recalculation over the stress periods

313. The conceptual framework of a multi-period ST may not only refer to a revaluation of the SII balance sheet but also to a recalculation of the regulatory capital position over the stress periods. The calculation of the SCR post stress represented one of the core elements of the EIOPA ST 2018. This exercise however was based on instantaneous shock events. The SCR post stress therefore related to the same initial reference date at time t=0 as for the baseline scenario. Extending the requirement to quantify the SCR at future dates in the context of a multi-period stress scenario however go beyond a simple "repetition" of the calculations for the reference date at time t=0. This fact applies not only for the multi-period stress scenario, but also for the baseline situation. If the projection of the SCR at specific future points in time over the scenario roll-out (pre- or post-stress) should be required then the specification has to provide additional guidance, amongst others on the following technical aspects:

- Framework for the calibration of the real-world scenarios for the SCR recalculation for the baseline and for the stress scenarios at future dates (conditional on the scenario roll-out)
- Framework for the derivation of the loss-absorbing capacity of technical provisions (TP) for the baseline and for the stress scenarios at future dates
- Framework for the derivation of the loss-absorbing capacity of deferred taxes for the baseline and for the stress scenarios at future dates
- Framework for the application of regression techniques for the SCR recalculation for the baseline and the stress scenarios at future dates

- Scope of the SCR recalculation (e.g. including and excluding the impact of Long Term Guarantee (LTG) measures, including an excluding the impact of reactive management actions

314. The purely technical focus of the points mentioned above should not obscure the general fact that the increased complexity of a multi-period ST poses significant conceptual challenges for a potential SCR projection. This complexity is primarily driven by the dependency of the results on the various assumptions needed for such a projection. Setting these assumptions for a recalculation of the SCR post stress is a demanding exercise already in the case of an instantaneous shock. In the context of a multi-period exercise, these assumptions are inevitably exposed to a higher level of uncertainty that in turn induce a significantly higher level of uncertainty of the results. A point-estimator for the 99.5% quantile of the probability distribution forecast at future dates conditional to the roll-out of a severe, but plausible multi-period stress scenario may not only be difficult to calculate, but also to validate and to interpret.

315. Operationally the projection of the SCR over multiple time horizons poses challenges that may not be comparable with other types of projections of certain key metrics used for internal purposes (as e.g. in the context of the ORSA) where companies have far more freedom to specify and implement their own technical and conceptual approaches. Given the complexity and operational burden of a potential SCR projection in a multi-period exercise it can be expected that companies would have to heavily rely on approximations and simplifications, which in turn may have a detrimental impact on the comparability and interpretability of the results[72]. If a multi-period ST should therefore include the requirement to project the SCR over the scenario roll-out then the technical specification would need to define an appropriate framework for such approximations. It can be expected that this framework would require a principle-based rather than a rule-based approach, which again poses particular challenges for ensuring an appropriate level playing field of the results across the sample. Furthermore this framework would implicitly also define the extent (and in particular the limits) of the interpretability of the projected SCR figures. Given the generally higher level of uncertainty in the context of a multi-period exercise in combination with the expected need for material simplifications and approximations, these results should not be assumed to reflect precise estimations for future regulatory capital requirements even though they may be labelled as “SCR”.

316. Against this background, a potential requirement to project the SCR in a multi-period ST should be subject to a thorough and comprehensive cost-benefit analysis taking not only the conceptual, but also the implementation challenges and their consequences on the validation and the explanatory power of the results into account.

Questions:

Q 85 What is your view on the potential requirement to project the SCR in the baseline and / or in the stress scenario? Please elaborate on conceptual, technical and operational aspects regarding such a projection.

[72] The extensive discussions on acceptable simplifications for a SCR recalculation post-stress during the EIOPA ST 2018 (which was based on instantaneous stresses) and their impact on the validation and interpretation may provide an empirical indicator on the potential debates that are to be expected in a multi-period setting.

3.3.1.7 Technical implementation

317. The EIOPA discussion paper on ST methodology includes a reference to the operational challenges linked to calculation of a multi-period scenario. In this context, it is mentioned that insurance companies typically already incorporate multi-period STs as part of their ORSA and that these approaches could be extended to supervisory STs. It seems safe to assume however that the approaches for the forward-looking calculations within the ORSA processes across the European insurance sector show rather heterogeneous levels of sophistication, granularity and company-specific assumptions and approximations. It may be hard for EIOPA to translate all these approaches in a straightforward "one fits all" implementation guideline that is both granular as well as comprehensive enough to ensure a consistent application and a level playing field across participants. Nevertheless, it might be useful to refer to the company specific ORSA practices when defining a framework for acceptable simplifications.

318. In general, the discussion of methodological challenges linked to technical implementation of multi-period STs can be split into segment-specific aspects linked to the different business models of life and non-life sectors:

3.3.1.7.1 Life and health insurance sector

319. As already noted in the section on the revaluation of assets and liabilities, the usual approach to derive the value for the best estimate liability (BEL) for traditional with-profit life and health business relies on Monte-Carlo simulations based on risk-neutral projections. The design and algorithmic implementation of the underlying stochastic valuation models is specifically adapted to this purpose. It should be pointed out that it is **not** a trivial task to adjust and apply these models in a multi-period setting. The theoretical concept of implementing a multi-period scenario by simply prescribing a specific real-world development for the first x projection years (possibly combined with further going-concern assumptions like "keep asset allocation constant") followed by an appropriately calibrated risk-neutral projection can conflict with the operational and technical set-up of the stochastic model so that companies may not be in a position to take such an approach. Typical examples for such methodological problems could refer to modelled investment or disinvestment algorithms that may not easily be "overwritten" or "replaced" by a generic real-world path for a certain period (although this may sound straightforward from a purely theoretical perspective). When confronted with the task to derive forward-looking results on specific real-world paths (as for example in ORSA processes) traditional life and health companies often have to apply approximations[73].

320. A similar problem relates to the modelling of future new business over the stress period. The stochastic valuation models used for deriving the value of the BEL were not necessarily designed to allow for the technical implementation of future new business layers. Apart from technical aspects, it should also be noted that some national jurisdictions link the maximum admissible level of the technical interest rate for new business in the life and health sector to the development of the SWAP rates or to other types of interest benchmarks. This means that depending on the scenario design companies would have to adjust the product modelling for these future new

[73] In the context of a multi-period ST such simplifications could refer to approaches where the key metrics for each stress period are derived by one-year instantaneous shock with modified perimeters at the starting point that appropriately reflect the scenario roll-out

business layers (from a purely theoretical perspective even in a path-dependent way) which might not be feasible.

3.3.1.7.2 Non-life insurance sector

321. Similar as for the life and health sector the modelling of future new business layers may pose significant implementation challenges for non-life insurance companies as the valuation models for the calculation of the SII technical reserves usually do not feature a projection of new business. Such a projection would not only require assumptions on new business volumes (under the baseline and under the stress scenario), but also regarding the underwriting strategy (i.e. potential premium adjustments).

322. Depending on the design of the stress scenario (e.g. regarding assumed changes in frequency or severity of specific perils) companies may also consider to model adjustments to the reinsurance coverage strategy over the scenario roll-out. Also such adjustments may represent relevant technical challenges for implementation.

3.3.1.8 Principles for validation

323. The validation process designed for the previous EIOPA ST exercises (which were based on instantaneous shocks) had two main goals:

- Assess the correct application of the shocks and the consistent calculation of the post stress balance sheet and solvency position;
- Grant comparability among participants ensuring that the approximations and simplifications lead to a sufficiently accurate picture of the company.

324. The higher the complexity of an exercise the higher the importance of the latter point is. For example, the 2018 ST exercise allocated a time for the central and local validation comparable to the one allocated in previous exercises, whereas a newly developed pre-validation phase was planned to deal with the simplifications and approximations needed to deal with the recalculation of the SCR at group level.

325. The increased complexity brought by the multi-period framework would further move the focus of the validation towards the assessment of the applied approaches rather than on the results obtained. Against this background an overall rethink of the objectives of the ST validation would be needed.

326. The main objective of the validation process would be on the plausibility of the assumptions and simplifications applied in the projection of the position of the company in the baseline and adverse scenarios. As mentioned in section 3.2, it is not realistic to assume that the technical specifications would cover each and every detail needed for the recalculation of the balance sheet or the solvency position of the participants, therefore participants would be requested to complement the provided elements or to generate specific assumptions / simplifications from the provided guidelines. These assumptions / simplifications cannot be assumed to be the same for all the participants as they will be individually developed according to the specificities of their own exposure and consequently for their models applied for the estimations of the projections and of the calculation of their economic / regulatory balance sheet.

327. Assumptions and simplification cover all the aspects mentioned in the first methodological paper such as among others:

- the scope of applications of the shocks including potential scaling approaches used to estimate the post stress positions of part of the perimeter of a group of part of the liability portfolio;
- the approximations implied in the partial or not recalibration of the instruments used to calculate the best estimates;
- the approximations on the recalculation of the DTA and DTL;
- all the set of assumptions needed to calculate the post stress SCR (if requested) as stated in the first methodological paper and experienced in the 2018 ST exercise.

328. The impact of all this aspects would have to be considered over the time horizon of the projections widening for each period the uncertainty in the estimation of the position.

329. A multi period approach would also require assumptions on the evolution of the assets and liabilities, namely potential changes in the asset allocations and / or changes in the business mix. Technical Specifications would need to provide a comprehensive and sufficiently granular framework on the elements thereof, however the validation process should ensure that the guidelines are accurately reflected over the periods covered by the ST.

330. An additional element of complexity in the validation process is brought by the flexibility in the application of the both embedded and reactive management actions. The complexity of the assessment of the application and of the impacts of the reactive management actions does not need further explanation, however it is worth noting that in a multi-period framework also the embedded management actions (although their design is not prescribed by the technical specification) should be carefully considered and analyzed as their impact may amplify over time reducing the comparability.

3.4 Processes

3.4.1 The current EIOPA approach

331. The EIOPA ST exercise evolved over time building on a on a stable methodological framework based on 2 key elements: instantaneous shocks and static balance sheet (i.e. no reactive management actions allowed). These two cornerstones shaped a standardized process encompassing the sequential phases and activities displayed in Table 3-4.

Table 3-4 EIOPA ST exercise – Standard process

Phase	Activities	Main player	Contribution
1. Design	• Draft of the ST package • Consultation with stakeholders	EIOPA / NCAs	ESRB / ECB
2. Calculation	• Q&A process • Calculation of the post stress position • Interaction NCAs - Participants	Participants	EIOPA / NCAs
3. Validation	• Local/central validation activities • Request for clarifications / resubmissions • Interaction NCAs - Participants	EIOPA / NCAs	Participants
4. Reporting	• Draft of the ST report	EIOPA / NCAs	
5. Recommendations	• Draft of public / confidential recommendations	EIOPA	

332. Time-wise the phases had a variable duration and were usually distributed over a 20-months period with the exercise being launched to the public on May and results being published on December of the same year.[74] The activities included in each phase were tailored according to the specificities of the ST exercise. Over time, the increased number and complexity of scenarios (e.g. number and type of shocks), reporting (e.g. calculation of the post-stress solvency position) and transparency (e.g. request for individual disclosure) pushed the burden for participants, NCAs and EIOPA to its limit considering the time constraints imposed by the publication of the report in the same year.

333. According to the 2018 ST exercise post mortem questionnaire and EIOPA's experience, the more critical elements of a ST exercise relate to the calculation and the validation phases. Specifically:

- Calculation period was deemed too short to have a full recalculation of the balance sheet and solvency position without applying relevant simplifications;
- Validation phase was considered to be too concentrated, namely if on the one hand the effective time devoted to the validation was deemed as sufficient, on the other hand the gap between the two rounds of central validation was too short to allow proper reactions (explanations or resubmissions).

334. The experience gained with the pervious exercises showed the benefits of a thorough interaction among EIOPA, NCAs, stakeholders, and participants in the design, calculation and validation phases. The 2018 exercise introduced a number of innovations such as the calculation of the post-stress SCR and the request for individual public disclosure which increased substantially the complexity by a methodological and procedural standpoint. To cope with the increased complexity extended in number and intensity the moments of interaction from the traditional pre-launch consultation event, Q&A and validation process to a higher number of public events (EIOPA) and bilateral conversations (NCAs). In details the 2018 moments of interactions are summarized in Table 3-5.

[74] The 2018 ST exercise was launched on 14 May 2018 and the report was published on 14 December 2018.

Table 3-5 2018 ST exercise – interactions in the main phases

Phase	Event	Type	Content
1. Design	3 workshops with industry representative	Public	• Presentation of the technical specifications and of the process • Discussion on the feasibility and potential simplifications / approximations needed • Discussion on the timeline
	High level meeting with representatives of the participating insurance groups	Public	• Presentation of the exercise with focus on transparency and disclosure (aggregated / individual) of the results
2. Calculation	Q&A	Public	• Collection of the questions from participants at NCAs and EIOPA level • Resolutions and amendments to the ST package defined at EIOPA level
	Pre-validation meetings	Bilateral	• Set of bilateral discussion among NCAs and participants on the approaches the simplifications / approximations • Discussion among EIOPA and NCAs on the allowed simplifications
3. Validation	Resubmissions / clarifications	Bilateral	• Local validation: request for resubmission/clarification between NCAs and participants • Central validations: request for resubmission/clarification between EIOPA / participants through NCAs
4. Reporting	High level meeting with representatives of the participating insurance groups	Public	• Preliminary presentation of the results

335. The increased complexity brought by the recalculation of the post stress SCR at group level requested extensive interactions between supervisors and groups in order to ensure a meaningful and homogeneous application, in particular regarding simplifications.

336. The implementation of a multi-period framework might require to further intensify the interactions between stakeholders, participants, NCAs and EIOPA to cope with the increased complexity with particular reference to the calculation and validation phases which were already deemed as critical in the current framework.

3.4.2 Alternative approaches

337. The European Banking Authority (EBA) is regularly running EU-wide STs based on a multi-period framework. The EBA defines its approach as a "constrained" bottom-up approach and requires banks to project their P&L, balance sheet and capital position over a 3-year period under a baseline and adverse scenario. Recalculation of the positions shall be done under static balance sheet assumption, namely following a set of limitations in the expansion of business and management actions. The 2018 EBA exercise run according to the timeline described in Table 3-6.

Table 3-6 **EBA 2018 EU-wide stress test timeline**

Date	Item	Description
November 2017	Publication of the methodology	Technical specifications (methodological note): • describe how banks should calculate the stress impact of the common scenario • set constraints for their bottom-up calculation • provide banks with adequate guidance and support to perform the calculation
December 2017	Publication of the templates and further guidance	The final version of the ST package is published 11 month before the publication of the results
January 2018	Launch of the exercise	Including the macroeconomic scenario
Beginning of June 2018	First submission of results to the EBA	The results are shared by the participants with the supervisors, discussed and validated in 3 different stages
Mid-July 2018	Second submission to the EBA	
End-October 2018	Final submission to the EBA	
By 2 November 2018	Publication of results	Factual disclosure of the results based on standardised templates and indicators

338. EBA approach does not concentrate the validation phase at the end of the calculation process but alternates 3 processes of submissions and discussions / validations over a 9 months period.

339. The interactions between participants and supervisors is run by SSM and EBA resources whereas validations is run with the support of ECB making the need of a clearly identified local and central validation.

340. The 3-submission process allows for a proper understanding of the approach taken by banks in the calculation of the post-stress positions. The time between the 3 submissions grants a proper framework for *i*) supervisors to provide steers and request resubmission and *ii*) for banks to adjust their models in line with the steers, re-run the calculation and resubmit the data. This approach comes with a cost mainly in term of resources involved. The main advantages and disadvantages are listed in Table 3-7.

Table 3-7 **Advantages and disadvantages of the EBA approach**

	Advantages	Disadvantages
For participants	• Allows for a longer time for calculation • Allows for a proper time to react to comments / request for resubmissions • Allows for an open channel of interaction with supervisors	• Longer involvement (calculation and validation spans from January to October) • Resource-wise 3 run of calculations are needed
For supervisors	• Allows for a proper control of the assumptions and simplifications • Allows for a sufficient time for the validation and request for resubmissions • Allows for a structured and constant interactions with participants	• Resource-wise the 3 run of validations are extremely demanding • A proper top-down model for central cross-sectional validation is advisable

3.4.3 Potential evolution of the EIOPA approach under a multi-period stress test

341. The increased complexity and the need of simplifications approximations brought by a multi-period ST would suggest to:

- Increase the calculation time (including the time for resubmissions);
- Increase the interactions with participants;
- Increase the validation time (allowing for a proper check of the resubmitted data).

342. This direction is also suggested by the approach taken by the EBA in its long experience in multi-period ST exercises in the banking sector. Changes in the process shall be considered in the light of the time constraints imposed by a ST exercise whose public phase cannot be protracted for more than 12 months.

343. In order to achieve this the EIOPA process should undergo a restructuring in each of its phases for a potential multi-period ST. A possible approach for such a restructuring is illustrated in Table 3-8.

***Table 3-8* Possible amendments to the EIOPA ST process for a multi-period exercise**

Phase	Amendments	Critical elements
1. Design	Anticipation of the launch of the exercise	• Anticipation of the design phase including the ESRB/ECB engagement and the consultation with the stakeholders / participants
2. Calculation 3. Validation	Calculation and validation phases will be merged	• Major engagements of NCAs (supervisors) and EIOPA resources for meetings with participants • Legal constraints on the participation of EIOPA in dialogues between supervisors and participants • Increased effort in the central and local validation (number of rounds to be defined) • Coordination to ensure level playing fields
4. Reporting	Reduced time for the publication of the results	• Time for the analysis of the results and of the production of the report will be reduced • Consider to develop a factual report on the results obtained and to develop the analysis as a part of the follow-up exercise

344. The design phase should be anticipated with the aim of launching the exercise not in the second quarter but in January of the year of the exercise. This would imply an early start in the designing phase and, if required, an early engagement with the ESRB / ECB. Additionally, it the usual consultation with the stakeholders needs to be anticipated. The previous and current consultation papers on the methodological principles for stress testing goes in the direction of easing the design phase and the approval phase making them quicker.

345. What would be in need of a full restructuring in the context of a multi-period exercise are the calculation/ validation activities. The calculation and subsequently the results in a multi-period framework are particularly driven by the assumption taken. Given the complexity in the prescription and the heterogeneity of the valuation and risk models in use across Europe a higher consistency in the approaches could be ensured via:

- An increased number of submission and interactions spread over the calculation periods. The increased interactions would be beneficial both for the percipients and the supervisors allowing a more controlled development of the activities and sufficient time to react to potential issues.
- A larger set of requested information. The submission of the results should not be limited to the quantitative templates but should encompass extensive discussions on the assumptions taken in calculating the projected baseline and stress situation, the potential application of management actions and the potential simplification applied on the calculation of the post stress positions.
- An extended validation approach not limited to the validation of the quantitative information submitted but extended to the qualitative information. The increased complexity and higher level of uncertainty in the context of a multi-period exercise would require vertical and horizontal assessment not only on the quantitative results, but also with regard to the qualitative information from participants, in particular on implementation aspects and on approximations. Against this background additional considerations should be devoted to the link between local and central validations and the content of the activities therein. The national validation should include an assessment of the plausibility of the individual quantitative results and the appropriateness of the methodological and technical approaches implemented by participants. These analysis usually relies on specific expertise and experience with local business models. However the validation framework should also ensure an appropriate level of homogeneity in the assessment of the approaches and of assumptions / simplifications across the whole sample. In order to enable such a level playing field (within the discussed limits triggered by the inevitable higher complexity and uncertainty) a close and continuous cooperation between the central and local validation teams would be required.

346. The number of validation steps as well as the reporting requirements shall be tailored according to complexity of the exercise, however, compared to the process used in the past by EIOPA, a larger number of resources involved for a longer period of time would be envisaged for all stakeholders (participants, NCAs and EIOPA). An exact estimation of the additional workload depends on the number of validation interactions and on the complexity of the exercise (e.g. with regard to the scenario design and the reporting requirements). In order to extend the calculation / validation the report drafting phase, including the approval process, should be reduced to approximately one month. Against this timeline the report should consist of a factual presentation of the results according to the disclosure approach agreed for the exercise. Analysis and interpretation of the results as well as potential analysis on the determinants or deepening on specific aspects should be done in a follow-up phase as done in the 2018 ST exercise.

347. In summary, EIOPA considers that the process applied so far in the previous EIOPA ST exercises does not fit a potential multi-period exercise. The proposed change does not represent a marginal improvement of the current processes, but a full redesign of its key components (i.e. calculation and validation) which implies a material increase in the effort to be exerted by participants and supervisors. Without the new process EIOPA cannot guarantee a proper assessment of the results, hence the success of an exercise that already presents high technical and conceptual challenges. The review of the process should therefore be considered as a cornerstone of any multi-period ST exercise.

Questions:

Q 86 Do you think that a multi-period stress test exercise can run relying on the same process applied so far for the instantaneous shock based exercise?

Q 87 What is your view on the proposed approach based on iterative calculation / validation process?

Q 88 What is your view on the proposed timeline?

Q 89 Do you have different proposal on the operationalization of multi-period a stress test exercise?

3.5 Conclusion

348. A multi-period approach for Stress Testing in the insurance industry would represent a substantial evolution to the current EIOAP ST framework based on instantaneous shocks. While the multi-period approach is well established in the banking industry, its application in the insurance industry is still limited.

349. The implementation of such approach, if properly designed, would allow the assessment of the vulnerability of insurers from a different angle, but the increased complexity implies a general rethinking of the ST framework both by a content and procedural perspective.

350. The main improvements introduced by a multi-period approach regards the assessment of the positions of insurers:

- Against temporal rollout of shocks (e.g. sequence of events);
- Against non-monotonous trends of the tested variables (e.g. back to normal scenarios);
- Simulating chain effects (e.g. close to reality interactions/causality of market and insurance specific shocks).

351. In case of macro-prudential analysis, the framework can also allow a detailed assessment over time of the potential propagation / generation of shocks towards other markets.

352. Process-wise these enhancements come at a cost in many steps:

- Increased effort in designing the exercise. Given the additional complexity, the draft of the technical specifications, the design of the templates for the data collection, the type and quantity of the information to be provided and the calibration of the baseline and adverse scenarios would imply a substantial additional effort compared to the former EIOPA ST exercises. Furthermore a substantial effort in the definition of the assumption and limitations (e.g. hypothesis future business, management actions) as well as their discussion with the stakeholders would have to be considered;
- Increased effort in running the calculation. The projection of the position of the insurers over the prescribed time horizon should not be limited to the adverse scenarios but should also include a projection of the expected (baseline) evolution of the company;
- Increased effort in validating the results. The number of assumptions, limitations and simplifications needed to run multi-period exercise would imply material additional efforts in the validation of the results. The focus would not be limited to the plausibility of the results and their comparability

but should be extended to the assessment of the approaches taken for the calculations by the participants.

Especially the last two points lead to the conclusion that an iterative calculation and validation process would be needed to properly run a multi-period exercise.

353. By a technical standpoint the complexity of running a multi-period STs, even without a full recalculation of the solvency capital requirement, comes with a set of challenges that requires a large set of assumptions, simplifications and approximations to make the computation feasible in a constrained timeframe. These assumptions would require additional attention on the results in terms of:

- Comparability: the comparability of the results among the participants is strictly dependent on the control of the simplifications and of the assumption made which needs to be defined and controlled over the periods of the assessment.
- Interpretability: during the analysis it would be hard to disentangle the impacts stemming from the assumptions/simplifications and the one stemming from the risk profile of the insurer. Furthermore the standard Solvency II capital metrics (e.g. the SCR) are based on the concept of Value at risk over 1 year time horizon, hence their projection over multiple years (which implies assumptions on the new businesses) would require careful consideration.

354. Concluding, from an EIOPA perspective multi-period ST could be applied to the insurance industry but given the increased complexity a step-by-step approach in its implementation would be advised and a thorough cost-benefit analysis should be undertaken before any decision on the exercise is made.

4 Annexes

4.1 Annexes Climate change

4.1.1 Overview of ST exercises by supervisors with main elements

Authority	Publication	Method	Type of risk	Time horizon	Scenarios	Balance sheet impact	Description
Bank of England (i)	Link	Stress test (bottom-up)	Physical and transition risk	30 years, with 5 year reporting intervals	BUA, Early Policy Action, Late Policy Action	Asset and liabilities, based on impact on individual counterparties	Participating institutions (large UK banks and insurers) are required to calculate the impact on their exposures for three detailed climate scenarios provided by the Bank of England.
Bank of England (ii)	Link	Stress test (bottom-up)	Physical and Transition risk	2100 (with evaluations at 2022 and 2050)			Insurers analysed impact of physical and transition risk on both their assets and liabilities in three policy scenarios.
De Nederlandsche Bank (i)	Link	Stress test (top-down)					Analysis of how the asset-side exposures of Dutch banks, insurers and pension funds are affected in scenarios of a disruptive energy transition.
De Nederlandsche Bank (ii)							
California Insurance Commissioner							

Example of DNB physical risk stress test:
In 2017, DNB conducted a stress test that included stresses related to the physical climate risks of a sample of Dutch non-life insurers. The physical risk stress test focused on windstorm frequency and severity as well as hail risk severity. Insurers were asked to model the impacts of a large windstorm event; three medium-sized windstorm events happening in a single year; and a large local extreme weather event occurring in the area where the insurer has the largest concentration risk. (source: FSI 2019)

Example of Climate change scenarios in the PRA insurance stress test[75]

The PRA has asked large life and non-life insurers to explore – on a best-efforts basis – their exposures to the physical risks of climate change as well as risks associated with the transition to a low-carbon economy. The PRA specified three

[75] Source: FSI 2019 and PRA General Insurance Stress Test 2019.

climate change scenarios and requested insurers to consider the impact of each scenario on selected metrics of their business models and asset valuations:

- The first scenario involves a sudden transition, ensuing from rapid global action and policies, and materialising over the medium-term business planning horizon that results in achieving a temperature increase being kept below 2°C (relative to pre-industrial levels) but only following a disorderly transition. In this scenario, transition risk is maximised. This scenario is based on the disorderly transitions highlighted the IPCC Fifth Assessment Report (2014). Shock parameters are illustrative of potential impact in 2022.
- The second scenario involves a long-term orderly transition that is broadly in line with the Paris Agreement. This involves a maximum temperature increase being kept well below 2°C (relative to pre-industrial levels) with the economy transitioning in the next three decades to achieve carbon neutrality by 2050 and greenhouse-gas neutrality in the decades thereafter. The underlying assumptions for this Scenario are based on the scenarios assessed in the IPCC Special Report on Global Warming of 1.5°C (2018). Shock parameters are illustrative of potential impact in 2050.
- The third scenario with failed future improvements in climate policy, reaching a temperature increase in excess of 4°C (relative to pre-industrial levels) by 2100 assuming no transition and a continuation of current policy trends. Physical climate change is high under this scenario, with climate impacts for these emissions reflecting the riskier (high) end of current estimates. Shock parameters are illustrative of potential impact in 2100.

The point in time at which the shocks occur differs for each scenario, with the illustrative potential impacts occurring in 2022, 2050 and 2100.

Table 4-1 Impacts of physical risks on general insurers' liabilities

		Physical risks scenario		
Sector	Assumptions	A	B	C
US hurricane-exposed lines of business	% increase in frequency of major hurricanes	5%	20%	60%
	Uniform increase in wind speed of major hurricanes	3%	7%	15%
	% increase in surface run-off resulting from increased tropical cyclone-induced precipitation (cumecs)	5%	10%	40%
	Increase in cm in average storm tide sea-levels for US mainland coastline between Texas and North Carolina	10cm	40cm	80cm
UK weather-exposed lines of business – flood, freeze and subsidence	% increase in surface run-off resulting from increased precipitation (cumecs)	5%	10%	40%
	Uniform increase in cm in average storm tide sea-levels for UK mainland coastline	2cm	10cm	50cm
	Increase in frequency of subsidence-related property claims using as benchmark the worst year on record	3%	7%	15%
	Increase in frequency of freeze-related property claims using as benchmark the worst year on record	5%	20%	40%

Source: FSI 2019

4.1.2 Modelling approaches for transition risk

4.1.2.1 CLIMAFIN model application to sovereign bonds

The approach by Battiston and Monasterolo (2019) is based on the CLIMAFIN approach developed by Battiston, Mandel and Monasterolo (2019) and focuses on the analysis of a disorderly policy transition on sovereign bonds, through the channel of firms' profitability to sectors' Gross Value Added (GVA). The authors develop the first approach to price forward-looking climate transition risks in the value of individual sovereign bonds, by including the characteristics of climate risks (i.e. uncertainty, non-linearity and endogeneity of risk) in financial valuation. Using policy-relevant 2°C-aligned climate mitigation scenarios that correspond to a certain level of Greenhouse gases (GHG) emissions' concentration in the atmosphere (IPCC 2014), the authors calculate economic trajectories for fossil fuels and renewable energy sectors and sub-sectors associated to a disorderly transition (business-as-usual – BAU, i.e. no climate policy) to a mild or tight climate mitigation scenario using the LIMITS project database (Kriegler et al. 2013).

The authors analyse the impact of the shock on firms and sectors' profitability and calculate the change in market share and GVA for sectors and firms in fossil fuels and renewable energy sectors, using two Integrated Assessment Models (IAM) (GCAM and WITCH). This serves as a basis to calculate the impact on fiscal revenues of sovereigns and finally on sovereign fiscal assets and default probability. By introducing the "climate spread", the authors model the climate shock transmission to government's fiscal revenues, to the change in the value of the sovereign bond and its associated risk. Thus, climate policy shocks affect sovereign bonds on the country-level through the channel of probability of default, the value of sovereign bonds and the climate spread76.

The study uses different data sources. The NACE Rev2 classification of economic sectors allows to associate the exposure of a specific financial instrument to a specific sector of economic activity which allows, by remapping the subsectors in five climate-relevant sectors, to distinguish carbon-intensive and low-carbon sectors. Lastly, using data on energy and electricity production and proxies by fossil fuel, nuclear and renewable energy technology, by British Petroleum (BP)s Statistical Review of World Energy 2018 and by the IEAs World Energy outlook (2018), Battiston and Monasterolo (2019) estimate the gross value added of each technology and its share on total electricity production by country.

Battiston and Monasterolo (2019) apply the model to the sovereign bonds of the OECD countries included in the Austrian National Bank (OeNB)'s non-monetary policy portfolio. They find that the (mis)alignment of an economy could already be reflected in the sovereign bonds' spread (i.e. the climate spread) and change the fiscal and financial risk position of a country. Lastly, the authors calculate the Climate VaR and compute the largest gains/losses on the central bank's portfolio via financial network models (Battiston et al. 2017; Roncoroni et al. 2019).[77]
For illustrative reasons, Table 4-2 shows the impact of climate policy shocks on the value of sovereign bonds and sovereign bonds yields (climate spread)

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[76] According to Battiston et al. (2019), the climate spread metric introduces climate as a source of risk in 10-years' bond yields. Shocks are potential gains (positive) or losses (negative) on individual sovereign bonds associated to countries disordered transition to a 2°C-aligned economy by 2030.
[77] Battiston, S., Mandel, A., Monasterolo, I., Schtze, F., Visentin, G. (2017). A Climate Stress-test of the Financial System. Nature Climate Change, 7(4), 283288.
Roncoroni, A., Battiston, S., Escobar Farfan, L. O. L., Martinez-Jaramillo, S. (2019). Climate risk and financial stability in the network of banks and investment funds. Under review at Journal of Financial Stability.

computed with GCAM and WITCH under the tighter climate policy scenario StrPol-450.

Table 4-2 climate shocks on sovereign bonds (values and yields)

Models' region	WITCH: bond shock (%)	WITCH: yield shock (%)	GCAM: bond shock (%)	GCAM: yield shock (%)
EUROPE	1,30	-0,16	0,13	-0,02
REST_WORLD	-17,36	2,45	n.a.	n.a.
EUROPE	0,84	-0,10	0,03	0,00
PAC_OECD	-5,21	0,67	-18,29	2,61
REST_WORLD	3,65	-0,44	n.a.	n.a.
LATIN_AM	-6,10	0,79	-4,22	0,54
LATIN_AM	-0,50	0,06	-0,34	0,04
EUROPE	1,24	-0,15	-0,11	0,01
EUROPE	-1,27	0,16	1,18	-0,15
EUROPE	-0,36	0,04	-0,42	0,05
EUROPE	3,75	-0,45	0,51	-0,06
EUROPE	1,58	-0,19	1,05	-0,13
EUROPE	2,64	-0,32	0,47	-0,06
EUROPE	1,34	-0,16	0,21	-0,03
EUROPE	-0,46	0,06	0,66	-0,08
EUROPE	0,50	-0,06	-0,07	0,01
EUROPE	0,78	-0,10	-0,08	0,01
EUROPE	1,94	-0,24	0,42	-0,05
EUROPE	-1,42	0,18	0,33	-0,04
PAC_OECD	-5,05	0,65	-5,48	0,71
REST_ASIA	-0,48	0,06	-0,50	0,06
EUROPE	2,60	-0,32	0,58	-0,07
EUROPE	1,85	-0,23	0,44	-0,05
EUROPE	2,45	-0,30	0,47	-0,06
LATIN_AM	-6,30	0,82	-2,71	0,34
EUROPE	-5,05	0,65	-0,91	0,11
REST_WORLD	-14,82	2,05	n.a.	n.a.
EUROPE	-12,85	1,75	-2,49	0,32
EUROPE	1,86	-0,23	0,27	-0,03
REST_WORLD	-1,54	0,19	n.a.	n.a.
EUROPE	2,30	-0,28	0,32	-0,04
EUROPE	-0,36	0,05	-0,77	0,10
REF_ECON	-2,63	0,33	-0,01	0,00
NORTH_AM	-4,04	0,52	-1,06	0,13

Source: Battiston and Monasterolo (2019)

A similar approach by Battiston et al. (2019)[78] analyses the impact of a climate policy shock on the sovereign holdings of European insurers, using Quarterly Solvency II Reporting and Centralized Security Database (CSDB) with solo data of insurers from 31 countries in EU/EEA that reported Solvency II data at the end of 2018 in an Integrated Assessment Model (IAM)[79],. They find that in a mild scenario [80] the portfolio impact of the climate policy shock, i.e. the ratio of the value of the portfolio after the shock over the initial value before the shock, ranges from 99.6% to 99.8%. Whereas in the adverse scenario[81], the impact of a climate policy shock equals and the median shock is about three times larger than in the mild scenario (Figure 4-1 and Figure 4-2).

Figure 4-1 Impact on sovereign holdings (mild scenario)

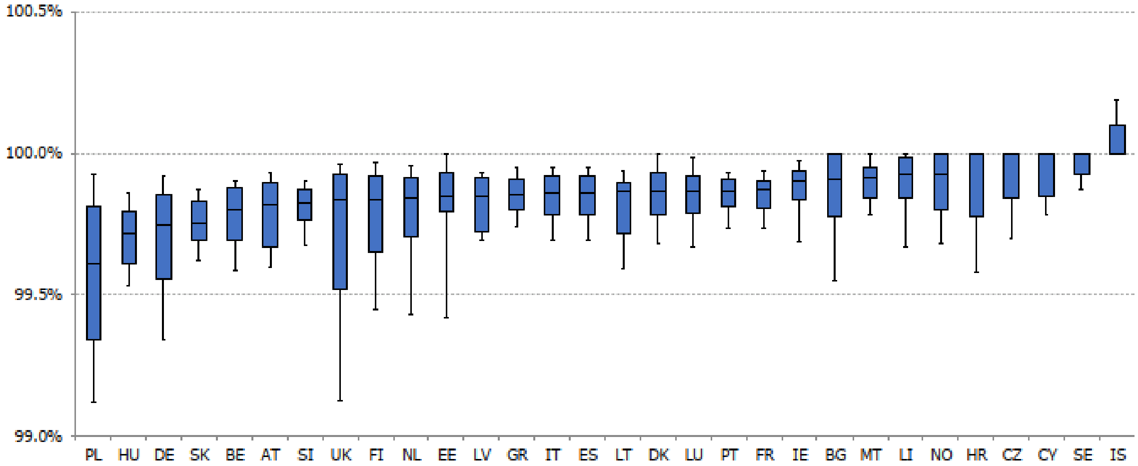
*Distribution of the impact on sovereign holdings of European insurers conditioned to the country of the holder, across climate policy shock scenarios under the **mild** scenario on market conditions.*

[78] Battiston, S., Jakubik, P., Monasterolo, I., Riahi, K. & van Ruijven, B. (2019). Climate risk assessment of sovereign bonds portfolio of European insurers, forthcoming.

[79] CLIMAFIN framework as described in Battiston et al. (2019).

[80] Loss given default equal to 0.2 and elasticity of probability with respect to market share of 0.2.

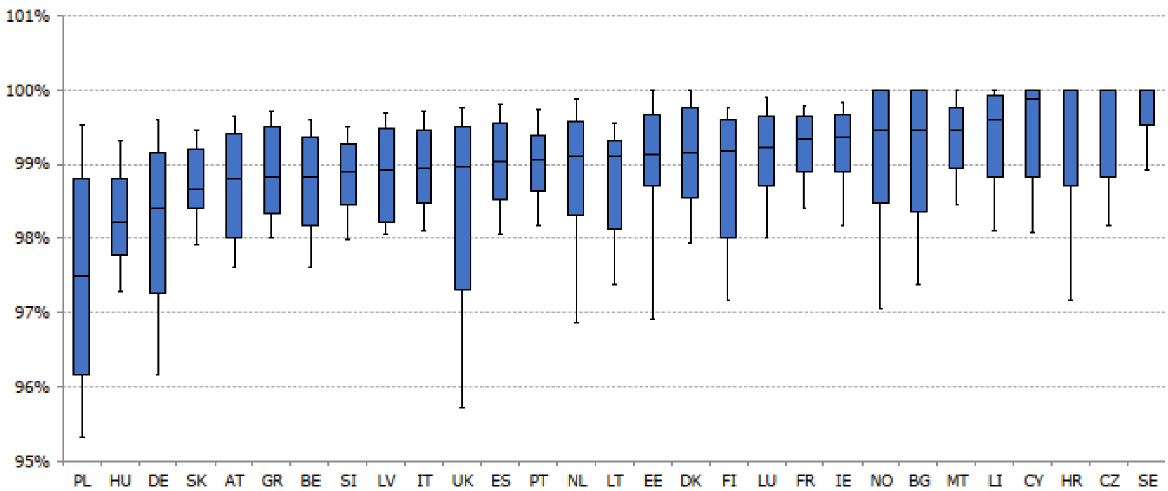
[81] Loss given default equal to 0.4 and elasticity of probability with respect to market share of 0.5.



Source: Battiston et al. (2019)
Note: Y-axis corresponds to the percentage of the original value of government portfolios (e.g. 100% expresses 0% impact, 97% corresponds to a drop of 3%).

Figure 4-2 Impact on sovereign holdings (adverse scenario)

*Distribution of the impact on sovereign holdings of European insurers conditioned to the country of the holder, across climate policy shock scenarios under the **adverse** scenario on market conditions.*



Source: Battiston et al. (2019)
Note: Y-axis corresponds to the percentage of the original value of government portfolios (e.g. 100% expresses 0% impact, 97% corresponds to a drop of 3%).

4.1.2.2 CARIMA model application

With the help of a comprehensive dataset[82], Görgen et al. (2019) design a scoring concept with 55 Carbon Risk Proxy Variables to assess whether firm values (or stock prices) are positively or negatively influenced by unexpected changes in the transition process towards a Green Economy, i.e. transition risk. Dividing these variables in group indicators “Value Chain”, “Adaptability”, and “Public Perception” to capture the three impact channels of carbon risk, the authors calculate a Brown-Green-Score (BGS) which measures the direction and magnitude of the changes in firm value due to transition risk.

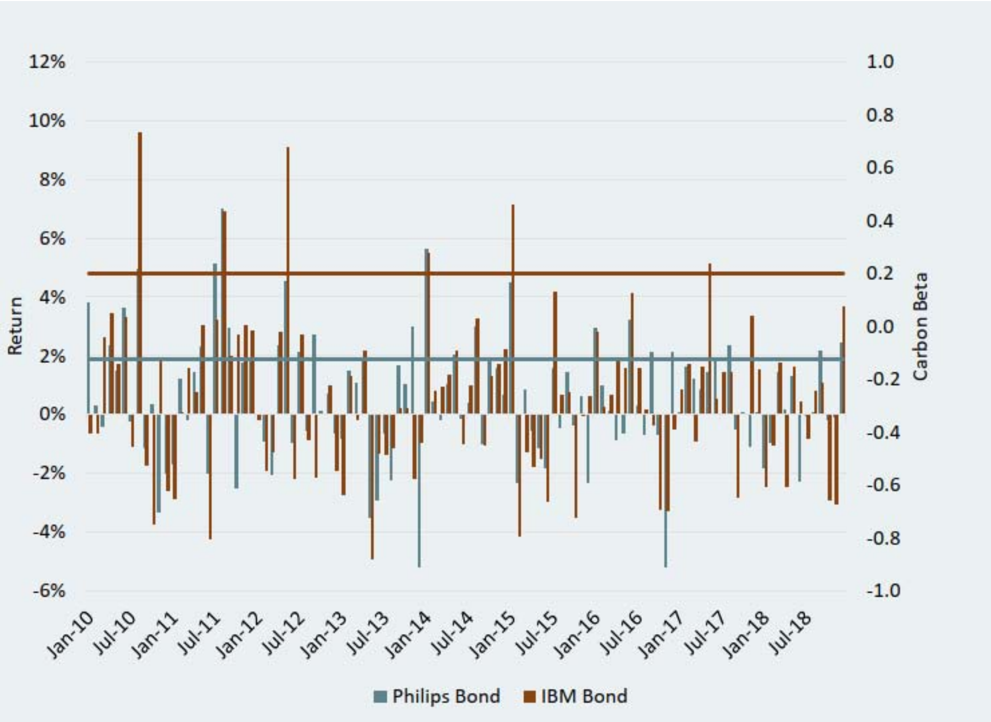
Using the Brown-Green-Score to identify brown and green firms, the authors assign to mimicking stock portfolios “brown” firms and “green” firms. Calculating a time series of historical portfolio returns for both stock portfolios and taking the

[82] The master dataset combines Thomson Reuters ESG, MSCI ESG-Stats and IVA-Ratings, Sustainalytics ESG Ratings and CDP and capital market data from Thomson Reuters Datastream, and comprises data on ESG and other capital market variables for about 40,000 firms.

difference between the two times series gives the Carbon Risk Factor BMG ("Brown-Minus-Green"). This time series of historical returns reflects investments in "brown" stocks while simultaneously selling "green" stocks.

By including the Carbon Risk Factor BMG in a factor model approach, one is able to analyse the impact of carbon risk on a financial asset. The regression analysis of the factor model allows the calculation of a Carbon Beta which measures the effect of Carbon Risk on financial assets. This Carbon Beta measures the effect of unexpected changes in the transition process of the economy towards a green economy, i.e. how will the return on an asset (bonds, stocks, funds or portfolios) change if the Carbon Beta changes, ceteris paribus, by one unit in relation to the market. An example of Carbon Betas for two corporate bonds are shown below in Figure 4-3.

Figure 4-3 Carbon Betas for two corporate bonds

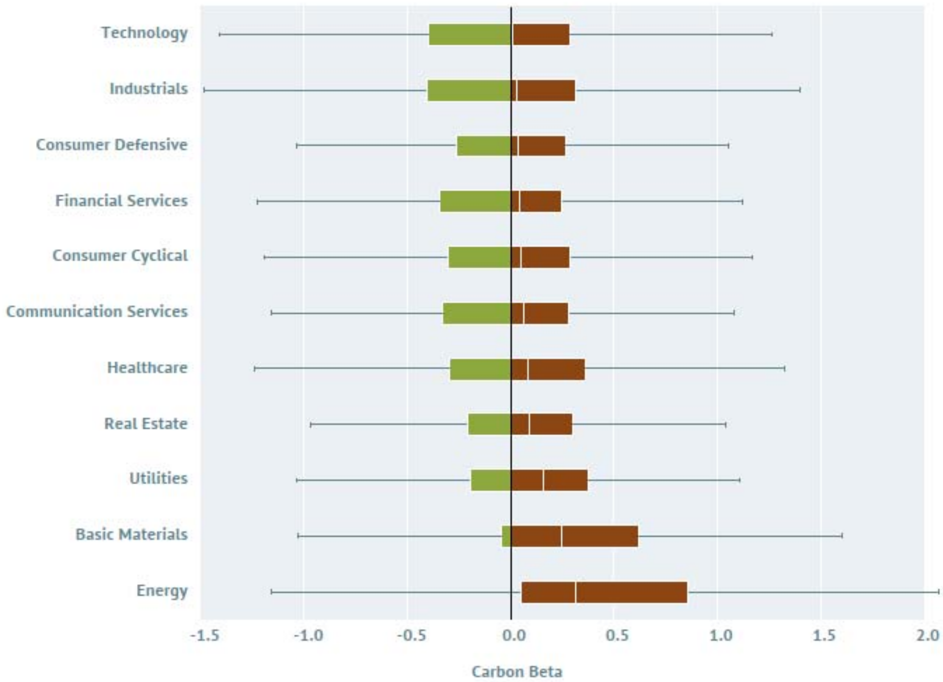


Source: CARIMA Excel-Tool (2019)

Similarly, Figure 4-4 shows an example of carbon betas across sectors (depicted as a Box-and-Whisker plot of equally weighted aggregate Carbon Betas across sectors). [83]

[83] The Carbon Beta of a sector can be determined on an equal- or value-weighted basis.

Figure 4-4 Equally weighted aggregate Carbon Betas across sectors



Source: CARIMA Excel-Tool (2019)

Finally, Table 4-3 shows an illustration for how a carbon beta can be estimated for a loan, using information on the corporate bonds and equity from the issuer or comparable firms.

Table 4-3 Estimating the Carbon Beta

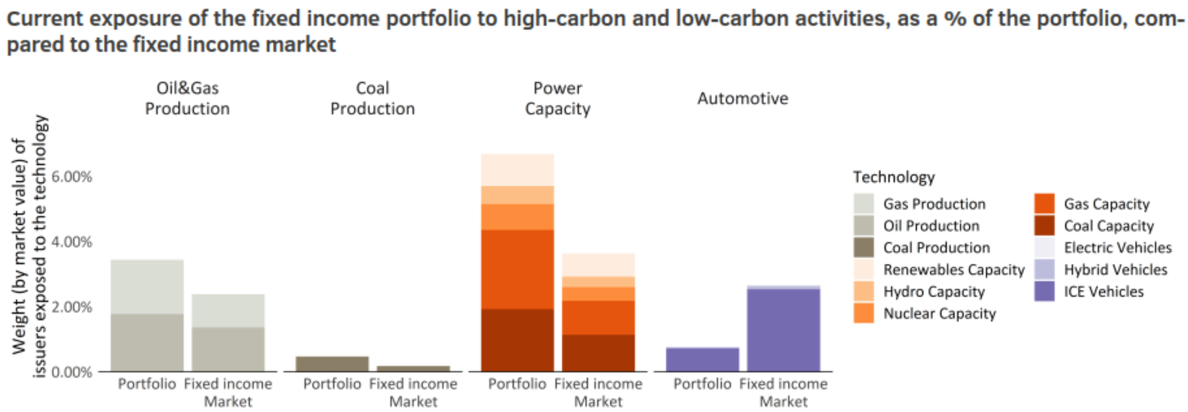
	Carbon Beta of the stock of the same firm is known	Carbon Beta of the stock of the same firm is unknown
Carbon Beta of a corporate bond of the firm is known	C Using the Carbon Beta of comparable firms to determine the Carbon Beta of a loan	A Using the Carbon Beta of a corporate bond to determine the Carbon Beta of a loan
Carbon Beta of a corporate bond of the firm is unknown	B Using the Carbon Beta of the stock to determine the Carbon Beta of the loan	D Using the Carbon Beta of comparable firms to determine the Carbon Beta of the loan

Source: CARIMA Manual (2019)

4.1.2.3 PACTA model application

The PACTA model allows to show the current technology exposure for asset classes, such as corporate bonds, with respect to a transition to a low carbon economy in comparison to a market portfolio. This market portfolio is based on the exposure of the global universe of assets in the relevant asset class to the sectors. Figure 4-5 shows the exposure for corporate bonds of California insurance companies.

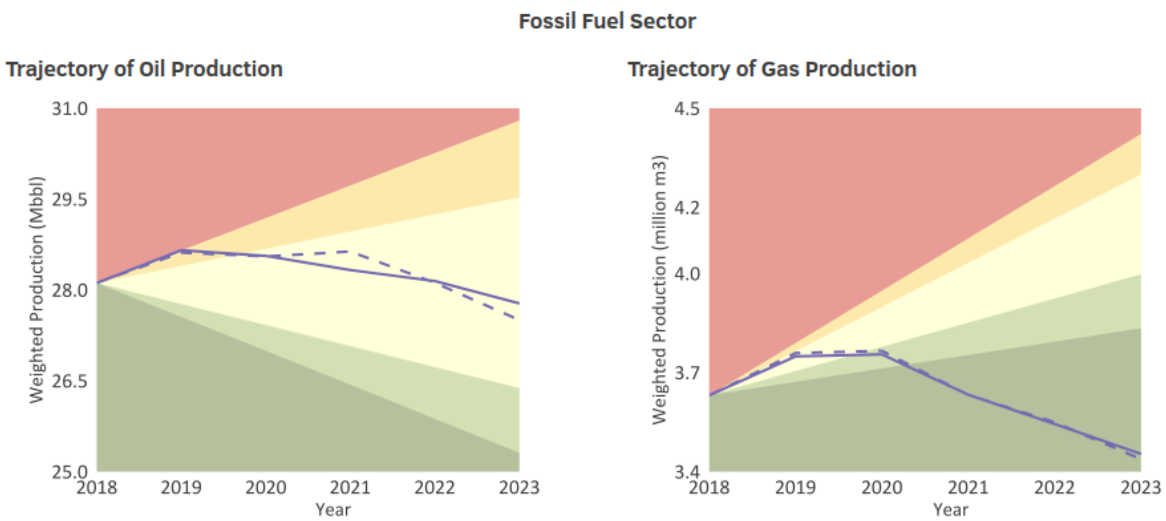
Figure 4-5 Current exposure of the fixed income portfolio to high- and low-carbon activities



Source: 2° Investing Initiative (2019). 2° SCENARIO ANALYSIS Report - Insurance Companies Operating in California.

Given the current exposure of corporate bonds with respect to a transition to low carbon economy, Figure 4-6 shows the alignment of investment and production plans of companies in the portfolio with different climate scenarios and the Paris Agreement. Here shown for the fossil fuel sector.

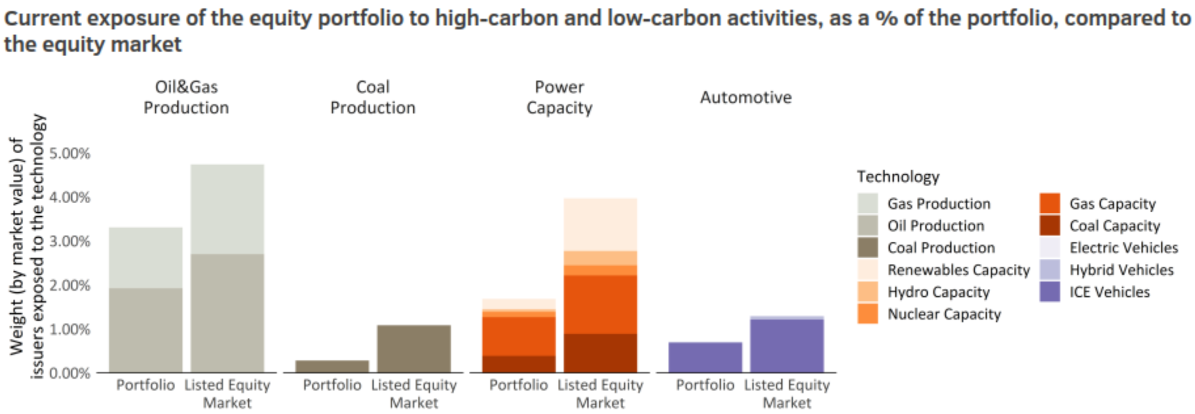
Figure 4-6 Alignment of investment and production plans different climate scenarios and the Paris Agreement



Source: 2° Investing Initiative (2019). 2° SCENARIO ANALYSIS Report - Insurance Companies Operating in California.

The current technology exposure for listed equity can be derived analogously to that for corporate bonds. Figure 4-7 below shoes the exposure for listed equity of California insurance companies.

Figure 4-7 Current exposure of the equity portfolio to high- and low-carbon activities



Source: 2° Investing Initiative (2019). 2° SCENARIO ANALYSIS Report - Insurance Companies Operating in California.

4.2 Annex to liquidity stress test

4.2.1 Solvency II reporting

List of assets and list of derivatives:

- Insurers report line-by-line information on their direct holdings. Where insurers have holdings in a collective investment undertaking, however, the information is less granular.
- Using the direct holdings, it is possible to classify the assets into different liquidity categories in order to estimate the total liquidity of the asset portfolio. For example, different indicators can be used to calculate the amount of liquid assets against the amount of illiquid assets.
- Analysis on specific assets can also be carried out, such as fixed income assets by buckets of maturities.

Life technical provisions:

- Best-estimate cash flow liabilities: insurers report their yearly expected cash flows. These data correspond to best-estimate cash flows and can be used and compared with asset cash flows (as in above). However, the added value of such information is small since it only refers to annual unstressed cash flows.
- Best estimate of products with a surrender option: can be used to derive the share of obligations which offer the possibility for policyholders to redeem their funds.
- Surrender value: insurers report the surrenders that occurred during the year as well as the surrender values. These latter reflect the amount, defined contractually, to be paid to the policyholders in the event of early termination of the contract. However, this information is not provided per type of contract.
- Lapse rate and duration of contract: the lapse rate is defined as the amount of TP fully or partially lapsed or surrendered during the reporting period divided by the amount of TP at the beginning of the period. It can reveal whether policyholders have increasingly redeemed their funds in recent years, but its reliability as an indicator of future mass lapse events is limited. The duration of the contract can indicate whether, on average, policyholders have secured a tax advantage (often depending on the time the funds remain under the insurer's management).

4.2.2 Application of the shocks (exemplificative)

Liquidity sources (LS)	Time horizon 5 days: Reference value (RV_{LS})	Shock: Baseline (B_{5d})	Shock: Adverse (S_{5d})	Time horizon 1 month: Reference value (RV_{LS})	Shock: Baseline (B_{1m})	Shock: Adverse (S_{1m})	Time horizon 6 months: Reference value (RV_{LS})	Shock: Baseline (B_{6m})	Shock: Adverse (S_{6m})
Level 1 assets	Market value of the position at time T_0	Haircut$_{Baseline,Level1}$	Haircut$_{Adverse,Level1,5\text{-}day}$	Market value of the position at time T_0	Haircut$_{Baseline,Level1}$	Haircut$_{Adverse,Level1,1\text{-}month}$	Market value of the position at time T_0	Haircut$_{Baseline,Level1}$	Haircut$_{Adverse,Level1,6\text{-}month}$
Level 2 assets	Market value of the position at time T_0	Haircut$_{Baseline,Level2}$	Haircut$_{Adverse,Level2,5\text{-}day}$	Market value of the position at time T_0	Haircut$_{Baseline,Level2}$	Haircut$_{Adverse,Level2,1\text{-}month}$	Market value of the position at time T_0	Haircut$_{Baseline,Level2}$	Haircut$_{Adverse,Level2,6\text{-}month}$
Level 3 assets	Market value of the position at time T_0	Haircut$_{Baseline,Level3}$	Haircut$_{AdverseLevel3,5\text{-}day}$	Market value of the position at time T_0	Haircut$_{Baseline,Level3}$	Haircut$_{AdverseLevel3,1\text{-}month}$	Market value of the position at time T_0	Haircut$_{Baseline,Level3}$	Haircut$_{AdverseLevel3,6\text{-}month}$
....	....	....	....	....	....	....	....	....	....
Level n assets	Market value of the position at time T_0	Haircut$_{Baseline,Leveln}$	Haircut$_{Adverse,Leveln,5\text{-}day}$	Market value of the position at time T_0	Haircut$_{Baseline,Leveln}$	Haircut$_{Adverse,Leveln,1\text{-}month}$	Market value of the position at time T_0	Haircut$_{Baseline,Leveln}$	Haircut$_{Adverse,Leveln,6\text{-}month}$
Reinsurance recoverable	Market value of the position at time T_0	-	-	Market value of the position at time T_0	-	Haircut$_{Adverse,Recoverables,1\text{-}month}$	Market value of the position at time T_0	-	Haircut$_{Adverse,Recoverables,6\text{-}month}$
Reinsurance receivables	Market value of the position at time T_0	-	-	Market value of the position at time T_0	-	Haircut$_{Adverse,Receivables,1\text{-}month}$	Market value of the position at time T_0	-	Haircut$_{Adverse,Receivables,6\text{-}month}$
		$LS = \sum_{Sources} RV_{LS} \; x \; B_{5d}$	$LS = \sum_{Sources} RV_{LS} \; x \; S_{5d}$		$LS = \sum_{Sources} RV_{LS} \; x \; B_{1m}$	$LS = \sum_{Sources} RV_{LS} \; x \; S_{1m}$		$LS = \sum_{Sources} RV_{LS} \; x \; B_{6m}$	$LS = \sum_{Sources} RV_{LS} \; x \; S_{6m}$

Liquidity needs	Time horizon 5 days: Reference value (RV_{LN})	Shock: Baseline (B_{5d})	Shock: Adverse (S_{5d})	Time horizon 1 month: Reference value (RV_{LN})	Shock: Baseline (B_{1m})	Shock: Adverse (S_{1m})	Time horizon 6 months: Reference value (RV_{LN})	Shock: Baseline (B_{6m})	Shock: Adverse (S_{6m})
Derivatives	Net position on IRS	-	Parallel shift in the swap rate term structure	Net position on IRS	-	-	Net position on IRS	-	-
Life portfolio									
Liquidity bucket 1	Surrender value$_{BE,Bucket1,5\text{-}days}$	-	-	Surrender value$_{BE,Bucket1,1\text{-}month}$	-	Lapse shock$_{Bucket1,1\text{-}month}$	Surrender value$_{BE,Bucket1,6\text{-}month}$	-	Lapse shock$_{Bucket1,6\text{-}month}$
Liquidity bucket 2	Surrender value$_{BE,Bucket2,5\text{-}days}$	-	-	Surrender value$_{BE,Bucket2,1\text{-}month}$	-	Lapse shock$_{Bucket2,1\text{-}month}$	Surrender value$_{BE,Bucket2,6\text{-}month}$	-	Lapse shock$_{Bucket2,6\text{-}month}$
Liquidity bucket 3	Surrender value$_{BE,Bucket3,5\text{-}days}$	-	-	Surrender value$_{BE,Bucket3,1\text{-}month}$	-	Lapse shock$_{Bucket3,1\text{-}month}$	Surrender value$_{BE,Bucket3,6\text{-}month}$	-	Lapse shock$_{Bucket3,6\text{-}month}$
....	....	....	....	....	....	....	....	....	....
Liquidity bucket n	Surrender value$_{BE,Bucketn,5\text{-}days}$	-	-	Surrender value$_{BE,Bucketn,1\text{-}month}$	-	Lapse shock$_{Bucketn,1\text{-}month}$	Surrender value$_{BE,Bucketn,6\text{-}month}$	-	Lapse shock$_{Bucketn,6\text{-}month}$
Non life portfolio									
Health Similar to life	Claims$_{BE,BusinessLine,5\text{-}day}$	-	-	Claims$_{BE,BusinessLine,1\text{-}month}$	-	Claims inflation$_{BuinessLine,1\text{-}month}$	Claims$_{BE,BusinessLine,6\text{-}month}$	-	Claims inflation$_{BuinessLine,6\text{-}month}$
General insurance	Claims$_{BE,BusinessLine,5\text{-}day}$	-	-	Claims$_{BE,BusinessLine,1\text{-}month}$	-	Claims inflation$_{BuinessLine,1\text{-}month}$	Claims$_{BE,BusinessLine,6\text{-}month}$	-	Claims inflation$_{BuinessLine,6\text{-}month}$
Motor	Claims$_{BE,BusinessLine,5\text{-}day}$	-	-	Claims$_{BE,BusinessLine,1\text{-}month}$	-	Claims inflation$_{BuinessLine,1\text{-}month}$	Claims$_{BE,BusinessLine,6\text{-}month}$	-	Claims inflation$_{BuinessLine,6\text{-}month}$
Nat-cat	Claims$_{BE,BusinessLine,5\text{-}day}$	-	-	Claims$_{BE,BusinessLine,1\text{-}month}$	-	-	Claims$_{BE,BusinessLine,6\text{-}month}$	-	Claims increase$_{BuinessLine,6\text{-}month}$
....	....	....	....	....	....	....	....	....	....
		$LN = \sum_{Needs} f(RV_{LN}, B_{5d})$	$LN = \sum_{Needs} f(RV_{LN}, S_{5d})$		$LN = \sum_{Needs} f(RV_{LN}, B_{1m})$	$LN = \sum_{Needs} f(RV_{LN}, S_{1m})$		$LN = \sum_{Needs} f(RV_{LN}, B_{6m})$	$LN = \sum_{Needs} f(RV_{LN}, S_{6m})$

Note:

i) The calculation of the liquidity sources (*LS*) is based on the application of the prescribed haircuts to the market value of the exposures via a simple multiplication.

ii) The calculation of the liquidity needs (*LN*) is based on shocks of different nature and it requires their application to the best estimate assumptions and to other positions (e.g. exposure to derivative). The *LN* positions shall therefore be calculated via different functions (f) according to the type of shock.

4.3 Annex to multi-period stress test

4.3.1 Example of application of multi-period Stress Test

4.3.1.1 Singapore[84]

Monetary Authority of Singapore (MAS) introduced the top-down test, which was used to control the resistance of both individual institutions and entire financial sector to macroeconomic and financial changes. The scenario assumes a global crisis, translating into a recession in Singapore and cumulative changes of a number of variables (like equity and oil prices drop, credit spread and domestic interest rate increase) illustrating the IU financial results over 5 years horizon.
In addition, the MAS participates in a project of International Monetary Fund (IMF) and World Bank called Financial System Stability Assessment (FSAP).[85] One of its part was stress test for banks and insurers, which compared the baseline scenario with two stress scenarios. The first scenario assumes a global crisis lowering house prices and raising short-term rates by appropriate values over the first two years, while the second scenario assumes an economic slowdown in China directly affecting Singapore. Each of the scenarios includes a projection of financially economic variables such as real GDP, unemployment rate change over a 5-year horizon (2019-2023).

4.3.1.2 Canada[86]

Canadian Office of the Superintendent of Financial Institutions (OSFI) introduced Dynamic Solvency Testing model (DST), which is based on cash-flow projection under a specific scenarios. Parameters selected for stress tests illustrate the economic environment (include government actions), current and planned business situation (productivity, sales, investment, capital). Stress tests consist of preparing financial statements projection, comparing them with shocked positions and verifying company's financial position on this basis. Projection period depends on type of business where 5 years is for life insurance and at least 2 years for general insurance. The scenarios rely on choosing basic risk for company, testing ripple effects (when one scenario affect other variables not included in this scenario) or combinations of tests.

4.3.1.3 USA[87]

The Federal Reserve carries out Dodd-Frank Act Stress Test for large bank holding companies and intermediate holding companies. Series of macroeconomic variables are projected in 3-years horizon, and then compared with pre- and post-stress values. Scenarios include both one-time parameter changes (e.g. reaching peak by unemployment) as well as year to year changes. For example severely adverse scenario of the global recession assumes both reaching certain peaks of

[84] Monetary Authority of Singapore. (2018). Financial Stability Review 2018. Available at: https://www.mas.gov.sg/-/media/MAS/resource/publications/fsr/FSR-2018.pdf
[85] International Monetary Fund (IMF). (2019). Singapore. Financial System Stability Assessment. Available at: https://www.imf.org/~/media/Files/Publications/CR/2019/1SGPEA2019001.ashx
[86] Office of the Superintendent of Financial Institutions Canada (OSFI Canada). (2006). Stress Testing: Insurance Companies in Canada. Available at: https://www.imf.org/external/np/seminars/eng/2006/stress/pdf/acc.pdf
[87] Board of Governors of the Federal Reserve System. 2019. Dodd-Frank Act Stress Test 2019: Supervisory Stress Test Results. Available at: https://www.federalreserve.gov/publications/files/2019-dfast-results-20190621.pdf.

the unemployment rate in a specific year of the time horizon and annual price index increases.

4.3.1.4 France[88]

ACPR conducted two tests examining the sensitivity of French insurance companies to the environment of low interest rates. The data was presented over a 5-year horizon. The first scenario concerns the occurrence of a low interest rate environment. The scenario assumes annual decreases in property and equity prices, a negative inflation rate and a decrease in RFR rates. The second scenario assumes a sharp rise in inflation in the third year of the projection, which will be counteracted by central bank by an increase in interest rates, the rest of the assumptions remain unchanged.

[88] ACPR. Banque de France. (2015). Notice technique décrivant les scénarios d'environnement de taux bas dans le cadre de la remise préparatoire 2015 de l'ORSA.

4.3.2 Annex - Impact analysis for reactive management actions

If the framework of the multi-period stress test allows for the application of reactive management actions participants might be required to report results including and excluding the impact of those actions. It should be noted however that the meaning of the term “including and excluding the impact of reactive actions” is not as straightforward in the context of a multi-period exercise as it is for an instantaneous stress test - in particular if the impact analysis for reactive management actions should target some kind of iterative step-by-step approach over time periods.

This subsection aims to discuss some possible interpretations of the term “including and excluding the impact of reactive actions” for multi-period stress tests together with their implications for the technical implementation (which can be material).

One of the core aspects in this context relates to the question on the precise **reference** of the term “impact of reactive management actions”. This question could be phrased as follows:

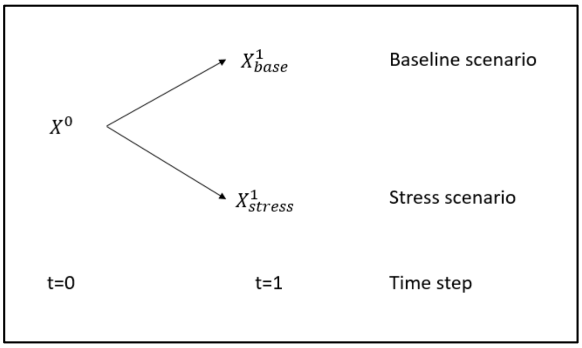
“Does term “including and excluding management actions” refer to the **change in value** of some key metrics in the **stress scenario** or to the **change in sensitivity** of the key metric in **relation to the baseline scenario**?”

This question has a rather fundamental character and applies to both instantaneous as well as multi-period stress tests. The implementation challenges for multi-period exercise however can increase significantly. In order to shed some light on this issue the distinction between the two approaches shall be illustrated in a simplistic example first.

The following illustrative example assumes a one-period stress test and a specific key metric (like for example the value of assets over liabilities) that shall be reported “including and excluding the impact of reactive management actions”. At time zero (i.e. at the reference date of the exercise), this key metric is supposed to take the value X^0 (the superscript indicating the time step). For the situation at the end of the period, the following notation is used:

X^1_{base}	=	value of key metric X at time-step 1 in **baseline** scenario **excluding** reactive actions
$\hat{X}^1_{base}$	=	value of key metric X at time-step 1 in **baseline** scenario **including** reactive actions
X^1_{stress}	=	value of key metric X at time-step 1 in **stress** scenario **excluding** reactive actions
$\hat{X}^1_{stress}$	=	value of key metric X at time-step 1 in **stress** scenario **including** reactive actions

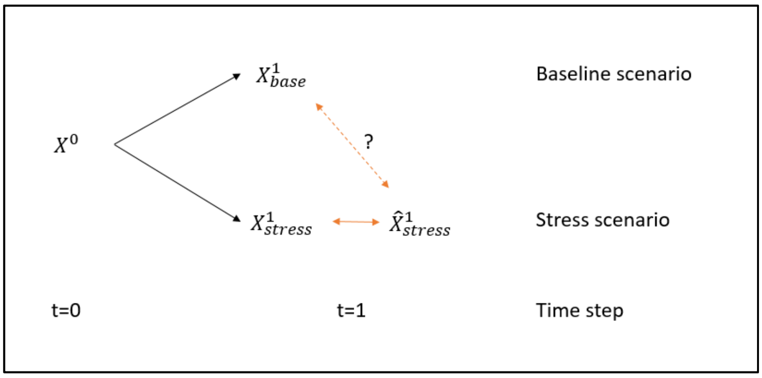
In a setting without any allowance for reactive management actions, the usual approach to quantify the impact of a stress scenario refers to the difference between the value of the key metric in the baseline and in the stress scenario. For a one-period scenario, this setting can be illustrated as follows:



In this notation, the impact of the stress scenario after the first period (in absolute terms) is

$$X_{stress}^1 - X_{base}^1$$

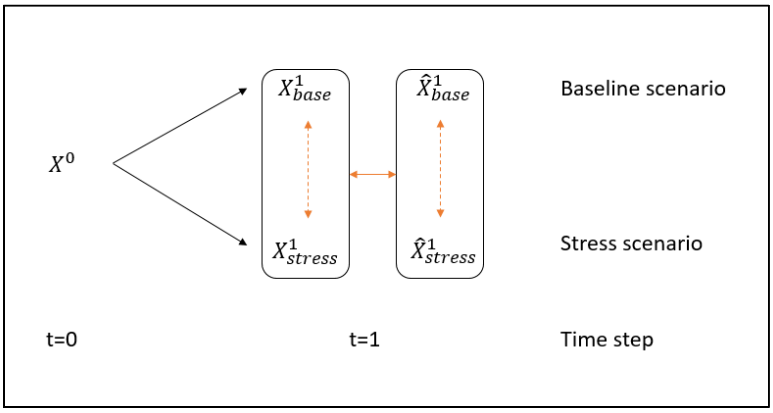
If companies are allowed to apply reactive management actions one possible approach is to incorporate these actions in the stress scenario only, leading to two different post stress results at the end of the first period:



In this case, the "impact of the reactive actions" could be quantified in absolute terms as the difference between the two post-stress results

$$\hat{X}_{stress}^1 - X_{stress}^1$$

However, it does not make sense to compare the post-stress result $\hat{X}_{stress}^1$ with the baseline result X_{base}^1. If the "impact of the reactive actions" should include a reference to a baseline situation then companies could be required to assume (in a somehow artificial manner) the same reactive actions to be applied in the baseline scenarios as well:



In the setting as illustrated above, the “impact of the reactive actions” under this interpretation would rather relate to the change in the sensitivity of the key metric, for example in relative terms as

$$X_{stress}^{1} - X_{base}^{1} \Big/ \hat{X}_{stress}^{1} - \hat{X}_{base}^{1}$$

This generic example shows that the second interpretation (including a reference to the baseline scenario) may indeed provide additional insight into the impact mechanism of reactive management actions, but at the price of introducing further complexity and (in particular for multi-period time horizons) significantly higher implementation burdens.

Another important aspect relates to the question whether the term “impact of reactive management actions” should be interpreted **in a cumulative or in an iterated way**.

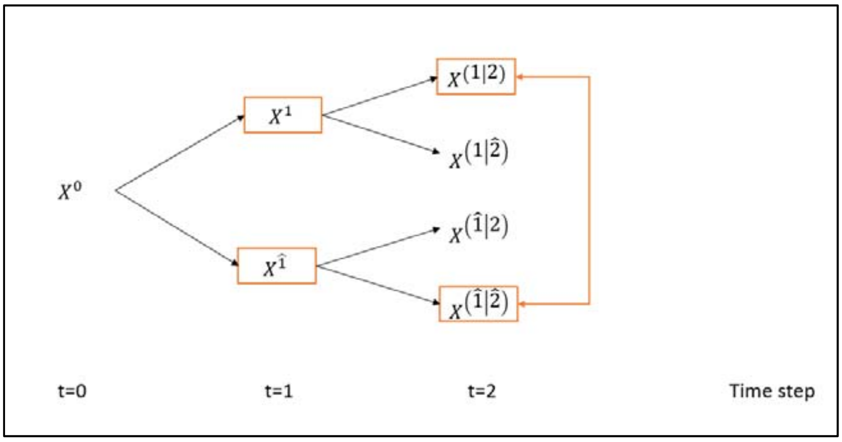
If the framework of the multi-period stress test allows for the application of reactive management actions, it can be expected that participants will adjust the timing of these actions according to the scenario roll-out. This means that companies will propose different management actions for different stress periods depending on the design of the stress scenario. While this timing of reactive management actions may seem quite natural from a conceptual perspective (as it simply reflects the reaction of the company to the adverse development assumed by the multi-period scenario), it introduces several possible alternatives to quantify the impact of these actions. The corresponding key question could be phrased as follows:

“Should the impact of reactive management actions be measured cumulatively (i.e. **comparing the impact of all consecutive actions to the situation without any actions**) or based on an iterative step-by-step analysis (**aiming at quantifying the marginal impact of specific actions in specific time periods**)?”

The following generic example aims at illustrating the distinction introduced above. In order to reduce the complexity the example assumes a stress test over only two periods and that the impact of reactive actions is measured only with reference to the stress scenario (and not to the baseline scenario). Management actions are supposed to be applied in both periods. Again, it is assumed that a specific key metric shall be reported “including and excluding the impact of reactive management actions” and that the value of this metric at time zero equals X^0 . Furthermore, the following notation is used:

X^1	=	value of key metric X at time-step 1 (**excluding** reactive actions in period 1)
$X^{\hat{1}}$	=	value of key metric X at time-step 1 (**including** reactive actions in period 1)
$X^{(1\|2)}$	=	value of key metric X at time-step 2 (**excluding** reactive actions in all periods)
$X^{(1\|\hat{2})}$	=	value of key metric X at time-step 2 (**excluding** actions in period 1, **including** actions in period 2)
$X^{(\hat{1}\|2)}$		value of key metric X at time-step 2 (**including** actions in period 1, **excluding** actions in period 2)
$X^{(\hat{1}\|\hat{2})}$		value of key metric X at time-step 2 (**including** reactive actions in all periods)

From a cumulative perspective, the "impact of the management actions" is measured by comparing the value of the key metric excluding and including reactive management actions:



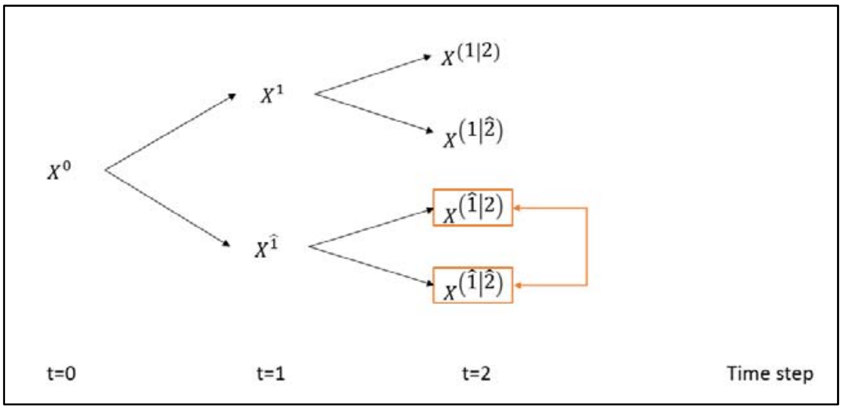
In absolute terms the impact of the reactive actions after the first period would be quantified as

$$X^{\hat{1}} - X^1$$

and after the second period as

$$X^{(\hat{1}|\hat{2})} - X^{(1|2)}$$

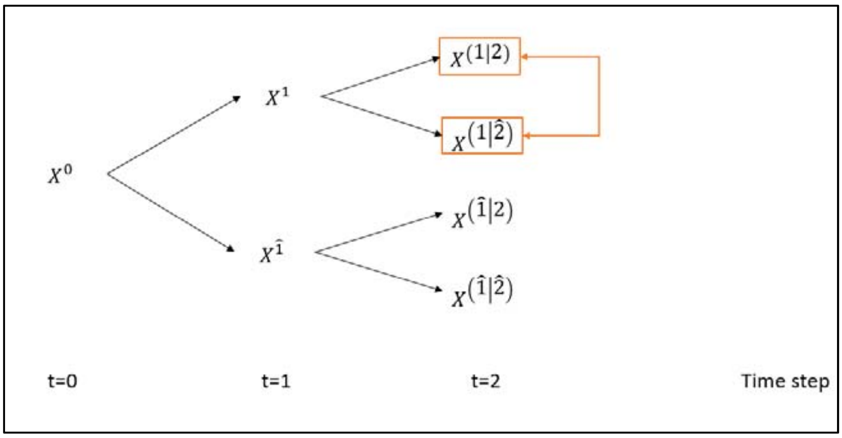
In principle, the "marginal impact of the management action in the second period" could then be defined as the difference between these two differences shown above. It could be argued however that such a marginal impact should rather reflect the effect of any action in the second period **conditional** to the setting after the first period instead of simply subtracting two cumulative values. This perspective would require companies to set up a model including the reactive actions during the first period, but excluding any actions during the second period:



In this approach, the marginal impact of the reactive management actions in the second period would be measured (in absolute terms) as the difference

$$X^{(\hat{1}|\hat{2})} - X^{(\hat{1}|2)}$$

From a purely theoretical perspective, one could even be interested in a kind of **standalone** impact of the reactive actions in the second period, disregarding (in a somehow artificial manner) any reactive action during the first period:



Such a standalone impact could be quantified (in absolute terms) as the difference

$$X^{(1|\hat{2})} - X^{(1|2)}$$

The discussion on possible interpretations of the generic term "including and excluding the impact of reactive actions" for multi-period stress tests shows that the consequences of a particular choice for such an interpretation can be severe (and in some cases prohibitively complex) with regard to the technical implementation. This holds in particular if companies would be required to set up and calibrate several "intermediate" or "comparative" models for different combinations of inclusion and exclusion of the reactive actions under consideration. Against this background, the decision for the conceptual approach regarding the measurement of the impact of reactive actions should take into account the results of a thorough cost-benefit analysis. From a practical perspective, the specification must provide a detailed and comprehensive description of the conceptual approach and all the necessary information for the concrete technical implementation.

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