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Discussion Paper on
Methodological principles of insurance stress testing

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EIOPA welcomes comments on the "Discussion Paper on Methodological principles of insurance stress testing".

Comments are most helpful if they:

- respond to the question stated, where applicable;
- contain a clear rationale; and
- describe any alternatives EIOPA should consider.

Please send your comments to EIOPA in the provided Template for Comments, by email to <eiopa.stress.test@eiopa.europa.eu> by 18 October 2019.

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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).
[2] Public Access to Documents (See link: https://eiopa.europa.eu/Pages/SearchResults.aspx?k=filename:Public-Access - (EIOPA-MB-11-051).pdf).
[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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List of Abbreviations

BE	Best Estimate
CAT	Catastrophe
CRA	Credit Risk Adjustment
CQS	Credit Quality Step
D&A	Deduction and Aggregation
DTA	Deferred Tax Asset
DTL	Deferred Tax Liability
EA	Euro Area
EU	European Union
FSS	Financial Shock Simulator
GWP	Gross Written Premium
HICP	Harmonized Index Consumer Price
LACDT	Loss Absorbing Capacity of Deferred Taxes
LACTP	Loss Absorbing Capacity of Technical Provisions
LGD	Loss Given Default
LLP	Last Liquid Point
LSMC	Least Square Monte Carlo
LTG	Long-Term Guarantee
NAT CAT	Natural Catastrophe
NCAs	National Competent Authorities
OF	Own Funds
ORSA	Own Risk and Solvency Assessment
PD	Probability of Default
QRT	Quantitative Reporting Templates
REIT	Real Estate Investment Trust
RFR	Risk Free Rate
RM	Risk Margin
RMBS	Residential Mortgage-Backed Security
RP	Replicating Portfolio
SII	Solvency II
SCR	Solvency Capital Requirement
ST	Stress Test
TA	Total Assets
TP	Technical Provisions
UFR	Ultimate Forward Rate
UL/IL	Unit-Linked and Index-Linked
VA	Volatility Adjustment

1 Introduction

1.1 Background

1. Stress testing frameworks have evolved considerably over the last few years and have become an increasingly important risk management instrument for the financial sector. Stress Tests (ST) form an integral part of financial risk management of individual institutions, and have become a core tool for supervisors to assess risks and vulnerabilities in the financial system.
2. EIOPA is required to conduct regular EU-wide ST exercises for the European insurance sector, in collaboration with the ESRB. The EIOPA Regulation distinguishes between two possible objectives of these Union-wide assessments:
   - Assessing the resilience of insurers to adverse market developments; [4]
   - Assessing the potential for systemic risk that may be posed by insurers.[5]
3. As part of the regular ST exercises, EIOPA is tasked with developing common methodologies for assessing the effect of adverse economic and financial scenarios on the European insurance sector, for application by national competent authorities. For each exercise, EIOPA can tailor specific elements of the ST according to the market conditions and their potential negative implications for insurers[6]. Currently, the methodology for the EIOPA ST has been specified for each exercise separately in technical specifications.
4. Given the complexity involved in conducting EU-wide ST for insurers, having a set of common methodological principles and guidelines agreed beforehand can greatly facilitate the stress test process. To that aim, EIOPA has developed this Discussion Paper setting out the main methodological elements of an EU-wide ST exercise and is seeking feedback from stakeholders. Insurers, market participants, investors, supervisors and any other interested stakeholders are invited to provide their views on the Discussion Paper by sending an email to <eiopa.stress.test@eiopa.europa.eu> by 18 October 2019, in particular for the specific questions to stakeholders included throughout the paper.
5. This discussion paper is part of a general enhancement of the EIOPA approach to stress testing by a methodological and operational standpoint. Time-wise, a reduction of the frequency of the EU-wide ST exercises is under consideration in order to allow proper follow-up analyses of the stress test results and to better develop and follow-up on the potential recommendations issued. Between two ST exercises EIOPA will conduct focused sensitivity analyses and assessment to specific exposures through top-down and / or bottom-up approaches reducing the burden to the industry. By a methodological perspective EIOPA plans to issue additional documents on specific ST related topics such as the assessment of liquidity positions under adverse scenarios, assessment of the positions against transition and physical

[4] Article 32(2) EIOPA regulation (EU) No 1094/2010 specifies that EIOPA "shall, in cooperation with the ESRB, initiate and coordinate Union-wide assessments of the resilience financial institutions to adverse market developments." Recital 42 of the EIOPA regulation explains that "Union-wide assessments" should be interpreted as "Union-wide stress tests", i.e. EIOPA "should also, in cooperation with the ESRB, initiate and coordinate Union-wide stress tests to assess the resilience of financial institutions to adverse market developments, […].".
[5] Article 23(1) EIOPA regulation (EU) No 1094/2010.
[6] In this consultation paper the term "insurer" includes both insurance and reinsurance undertakings if not elsewhere specified.

risks stemming from climate changes, and potential approaches to multi-period stress tests.

1.2 Purpose of the Discussion Paper

6. The purpose of this Discussion Paper is twofold:
   - Set out common methodological principles and guidelines for the EIOPA EU-wide ST exercise to be used in future assessments;
   - Engage with stakeholders in a structured way to collect feedback on key elements of a ST exercise.
7. The Discussion Paper can as such be seen as a tool-box to inform and facilitate both the design and execution phase of EIOPA ST exercises.

1.3 Scope of the Discussion Paper

8. ST can be used by different stakeholders with different objectives. Supervisors use stress tests as a supervisory tool; insurers regularly run stress tests in the context of their Own Risk and Solvency Assessment (ORSA) or the development of their capital and risk management policies; other interested stakeholders (e.g. academia, rating agencies) might use stress tests for analytical purposes.
9. Supervisory stress tests can be implemented via a top-down or bottom-up approach (see Box 1.1). The focus of this Discussion Paper is on bottom-up (institution-run) supervisory ST, which resembles the EU-wide ST exercises conducted so far by EIOPA. This Discussion Paper focuses on improving and deepening the current bottom-up methodology as part of a step-by-step approach to enhance the ST methodology for insurers. The methodology for a top-down supervisory stress test will be explored at a later stage.

Box 1.1: Different types of supervisory stress test exercises

Supervisory bottom-up stress test

A supervisory bottom-up stress test is an exercise run by a supervisor or regulatory authority, whereparticipating institutions are requested to perform the calculations. The supervisor provides the stress testing framework, methodologies, adverse stress scenarios, prescribed shocks and guidance to the application of the shocks. Participants shall calculate the impact of the prescribed shocks on their balance sheet and capital requirements according to the provided guidances using their own models.

Supervisory top-down stress test

A supervisory top-down stress test is a stress test performed and run by a supervisor or regulatory authority. The supervisor determines the impact of a scenario directly based on the regulatory data provided by the insurers using its own framework, models and specifications (i.e. no calculations from individual institutions required).

Bottom-up and top-down can be run in isolation but can also be seen as complementary exercises where top-down approaches can be used in a bottom-up stress test for validation purposes.

1.4 Structure of the Discussion Paper

10. The Discussion Paper is structured as follows. Chapter 2 discusses the ST process, objectives and approaches. Chapter 3 elaborates on the scope of a stress test exercise. Chapter 4 focuses on scenario design. Chapter 5 considers the calibration and application of specific shocks, including simplifications. Finally, Chapter 6 discusses the approaches to data collection and validation of the stress test results.

1.5 Definitions

11. Given the wide and varied definitions of different stress testing frameworks, the meaning of some commonly used stress testing terms can vary depending on the context. Therefore, a glossary has been developed, setting out the key terms used throughout the Discussion Paper (Annex I - Glossary). The aim of this glossary is to provide a common set of definitions for stress testing terms to facilitate the dialogue among insurers and supervisors in the area of stress testing.

2 Stress test process and objectives

2.1 Stress Test process

12. The stress testing process consists of several elements that need to be considered when developing a ST exercise (Figure 2-1). These different elements should not be seen in isolation as their interrelations and interactions can influence the design and the outcome of the ST exercise.

13. In order to be effective, each ST exercise should have clearly defined objectives at the inception. ST can be used to achieve different objectives including microprudential and macroprudential objectives, (see section 2.2). The objectives will shape all other elements of the ST process, such as the time horizon and the use of management actions. Time-wise, the set of shocks prescribed in a stress test exercise can be instantaneous or cover multiple periods. Additionally, management actions can either be allowed, constrained, or not allowed (see section 2.3).

14. Once the objective and approach have been defined, the scope has to be tailored to the objectives (see Chapter 3). Generally, the scope of a ST with macroprudential objectives will be larger in terms of market coverage than the scope of a microprudential exercise, because in order to assess the impact of a scenario at macro level, the exercise needs to cover a representative share of the market. The scope should also be targeted to insurers that have an actual exposure to the risks drivers that are included in the stress scenarios.

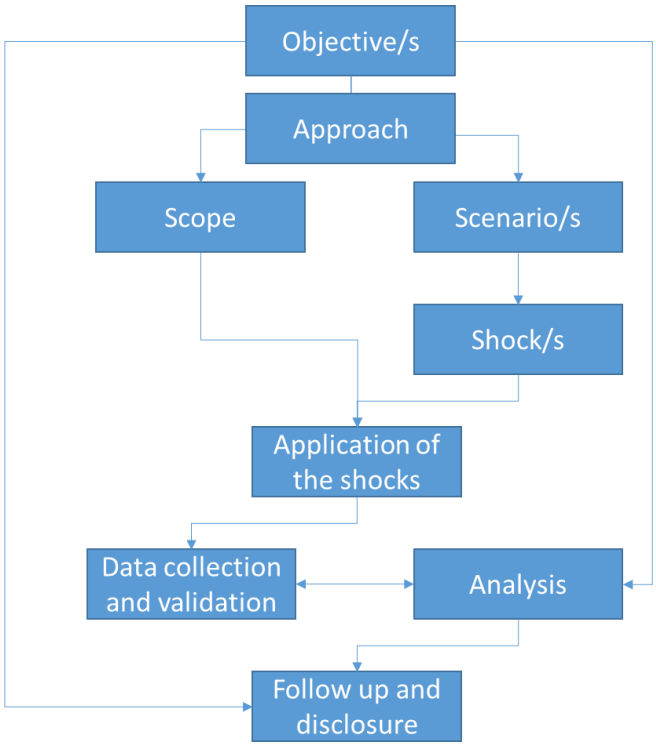
15. Scenario design is another key element of STs (see Chapter 4). In order to be relevant, the scenarios should be built on a thorough risk assessment of the economic environment, and should reflect severe but plausible adverse evolutions of the markets and / or of the whole economy. The type of scenario can vary from a relatively simple sensitivity analysis that assesses the impact of a stress to a single or a limited set of risk factors, to a more developed scenario analysis that considers the impact of a stress to multiple macroeconomic and insurance specific variables simultaneously.

16. The calibration of the shocks should be robust and consistent with the scenario design (see Chapter 5). Furthermore, a bottom-up ST relies on the insurers to calculate the impact of the shocks. To ensure comparability of the results, the technical specifications and additional guidance should therefore also provide clarity on how to apply the different shocks and potential simplifications that could be used in the calculations. These aspects are also discussed in Chapter 5.

17. Any type of action following a ST exercise should be the result of a thorough analysis of the collected data which can only be accomplished if the quality of the results is of a sufficiently high quality. Clear data reporting requirements and validation should safeguard the credibility of the exercise (Chapter 6). Communication is a crucial component of this as well. This includes interactions with the participants before the start of the exercise, during the calculation phase, and during the validation of the results. Stakeholder events, launch events, workshops and validation meetings all increase the understanding of the expectations, possible methodological or operational issues and the final results.

18. Finally, the output of the ST and the follow-up will depend on its objectives. Generally, the output consists of a report and a set of recommendations. The published report will provide an overview of the exercise and discuss the results at country and/or EU aggregated level, whereas individual results, used in dialogues between EIOPA and national competent authorities, might be published upon consent of the participants. The recommendations can be directed at the whole market or target specific insurers based on their individual results. Recommendations shall be calibrated to the outcome of the exercise.

Figure 2-1 Stress Test process and elements



Questions:
Q. 1 : What are your views on the presented stress test elements and their relations? Please elaborate on any relevant elements that have not been covered.

2.2 Stress test objectives

19. Supervisory ST can have different objectives, which drive the design, methodology and application of each stress test exercise. The most important distinction is between microprudential objectives and macroprudential objectives.

2.2.1 Microprudential objectives

20. ST exercises with a microprudential objective are designed to assess the resilience of individual insurers or insurance groups to adverse scenarios, providing supervisors with information on whether these insurers are able to

withstand severe shocks and take remedial actions if necessary. These STs might also allow supervisors to request further actions to be taken by undertakings to improve the resilience of individual insurers.

21. In general, the following microprudential objectives of ST can be identified:

- Assess individual sensitivity to specific shocks
- Assess individual vulnerabilities to adverse economic and financial conditions, which can be used to trigger inspections or issue recommendations;
- Assess individual capital adequacy under adverse scenarios;
- Enhance understanding of insurance sector vulnerabilities;
- Foster individual risk management and stress testing capabilities.

22. It should be noted that the Solvency Capital Requirement (SCR) under the Solvency II (SII) framework is also built around a stylized ST approach: the market value of the assets of an insurance undertaking should exceed the market value of its liabilities even under extreme circumstances (99.5% confidence level). SII lays down detailed rules – scenarios and assumptions – on how these values are to be calculated, both within the standard model, and for companies applying an internal model.

23. A microprudential stress test may therefore also be seen as assessing the solvency position of individual undertakings under alternative circumstances, i.e. scenarios, risks, and assumptions that are not foreseen in the standard SII framework. While company-specific circumstances are covered by the ORSA, concerted microprudential stress test exercises are important for assessing market-wide risks not covered in the standard framework. This assessment can be used for evaluating potential vulnerabilities in the insurance sector.

24. An overview of the advantages and disadvantages of a microprudential ST exercise is provided in Table 2-1.

Table 2-1 Advantages and disadvantages of a microprudential stress test

Advantages	Disadvantages
• Allows to assess the resilience of individual insurance undertakings to economic, financial and insurance shocks • Allows supervisors to issue specific recommendations to insurers or national supervisors that were affected by the specific stresses • Simpler design and validation phases by a technical perspective compared to a macro-prudential exercise as propagation dynamics are out of scope	• System wide aspects, interactions and second-round effects are not assessed. The objective of assessing the potential for systemic risk that may be posed by the European insurance sector is only partially achieved • Spillovers to other financial sectors and the real economy are not fully assessed

2.2.2 Macroprudential objectives

25. Macroprudential STs aim at assessing the system-wide resilience to financial, economic and insurance shocks and the potential spill-over to other markets generated or amplified by the insurance sector. In these STs the interaction between insurers and the interlinkages of insurers with the financial system

and the real economy have to be taken into account. In line with the current discussion on the systemic risk[7] macro-STs should:

- Assess resilience of insurance sector and of individual insurers that, due to their nature, scale and complexity, might generate or amplify systemic events against stress scenarios;
- Assess potential spill-over effects to other parts of the financial system and the real economy stemming from common reactions of insurers against stress scenarios.

26. The assessment of systemic risk and potential spillovers is part of the overall supervisory framework and serves to increase preparedness and define priorities in case of materialization of a stress scenario and can help inform the calibration of macroprudential policies and instruments. An overview of the advantages and disadvantages of a macroprudential ST is provided in Table 2-2.

Table 2-2 Advantages and disadvantages of a macroprudential stress test

Advantages	Disadvantages
• Allows to assess systemic risk in the insurance sector and potential spillovers across financial sectors and the real economy • Provides information about the resilience for the whole insurance system under stressed conditions • May be used by authorities as an input to calibrate macroprudential measures	• Significantly more complex, as second-round effects and other interactions have to be modelled in order to reflect the system-wide aspects • May require a longer time horizon than micro stress test to consider the propagation of the initial shocks in the financial system and in the economy

2.2.3 Sub-conclusion

27. Well governed stress testing frameworks include objectives that are clearly articulated at the outset. It is important to identify what the objective is for each exercise, as this will shape the design, modelling and process for each stress test.

28. The type of ST should be aligned with the objectives and should be fit for purpose. For example: a top-down ST at market level might be better suited for exercises with a clear macroprudential objective given that it will provide better insights on the feedback loops, amplification mechanisms and spill-overs between insurers and other financial institutions.

29. Until the publication of this Discussion Paper, the EIOPA insurance ST had a primarily microprudential approach. STs were meant to "assess the resilience of insurers to adverse market developments". In line with the non pass-or-fail nature of these exercises, recommendations were issued by EIOPA to the NSAs and focused on enhanced supervision of individual insurers or groups that were affected by the specific stresses, addressing the underlying vulnerabilities and increasing preparedness to potential adverse scenarios.

[7] EIOPA approach to systemic risk can be retrieved at: https://eiopa.europa.eu/financial-stability-crisis-prevention/crisis-prevention. IAIS approach to systemic risk can be retrieved at: https://www.iaisweb.org/page/consultations/closed-consultations/2019.

30. Nevertheless, microprudential STs could be enriched with macroprudential elements to consider interlinkages, interactions and cross sectoral impacts in order to assess systemic risk in the insurance sector, in line with the objective of achieving stability in European financial markets and assessing the potential impact of the insurance sector on the real economy under adverse scenarios. While a full macroprudential ST is likely too complex to implement at this stage, combining a microprudential ST with a quantitative assessment of post-stress reactions by insurers could provide valuable additional insight in potential second-round effects, without the costs of fully modelling all behavioral and network effects.

31. To summarize, an overview of the differences between a microprudential and macroprudential exercise is provided in Table 2-3.

Table 2-3: Characteristics of microprudential and macroprudential stress tests

	Microprudential	Macroprudential
Objective	• Assess the resilience of individual insurance undertakings to economic, financial and insurance shocks • Address specific recommendations to individual undertakings	• Assess the resilience of the insurance industry as a whole • Address systemic risk across financial sectors, and potential spillovers to the real economy
Scope	Sufficiently large groups of entities (solo or group) to cover local markets or the EU wide market (depending on the target)	Material part of the European insurance industry, with focus on large internationally active groups
Second round effects and spillovers	Marginally covered. Some entity based effects might be inferred from the potential distress of large institutions	Taken into account both by an entity and activity based perspective
Scenario design	Idiosyncratic risk for individual insurers could be considered	Focus on systemic risk
Cross sectoral dimension	Not specifically needed but still important (e.g. Financial conglomerates)	Interactions with other financial sectors should be taken into account

Questions:
Q. 2: What are your views on the different stress test objectives and the advantages and disadvantages mentioned?
Q. 3: What are your views on combining a microprudential stress test with a quantitative assessment of post-stress reactions by insurers to provide additional insight in potential second-round effects?

2.3 Approaches

32. Different approaches exist towards certain conceptual elements of a stress test exercise. These relate to the definition/recalculation of the baseline

(2.3.1), the time horizon (2.3.2) and the use of management actions (2.3.3). The advantages and disadvantages of the different approaches for these conceptual aspects of a ST are considered here.

2.3.1 Recalculation/definition of the baseline

33. As STs are specific "what if" exercises, hence ensuring the comparability of the pre- and post-stress results is paramount. This starts with the definition of the baseline (pre-stress) situation/scenario.

34. In general, the comparability of the pre- and post-stress situation depends on the following aspects:

- on the structure of the entity under scrutiny (e.g. potential changes in the perimeter of a group due to acquisition / sale of entities or businesses);
- on the changes in the estimation model (e.g. move to (partial) internal model, improvement of the estimation techniques) approved and implemented after the computation of the baseline;
- on the simplifications and approximations that may be chosen for the application of the stress test scenario (which may differ from the baseline model).

35. Changes in the perimeter, model and/or simplifications affect the value of the outcome metric. Since the outcome metric under stress is compared to the outcome metric under the baseline situation, it may be desirable and/or necessary to apply the same assumptions for the computation of the baseline. Such an approach where the model used for the baseline is the same as the model used in the ST exercise provides a more clean picture of the ST impact: in case the model used for the ST deviates from the baseline model (for instance through the use of simplifications) it may be impossible to disentangle the effect of the stress test scenario and of the changes to the baseline model.

36. However, recalculating the baseline, while essential for comparability and interpretability of the ST exercise, also comes with downsides. Besides the additional burden placed on participating undertakings, a recalculation may be interpreted as questioning the baseline (year-end) models and financial position of the undertaking. If the ST exercise requires a recalculation of the baseline, there has to be clear internal and external communication that this is purely for the purposes of the exercise and that both baseline as well as post-stress results do not correspond to regulatory reporting values.

Questions:
Q. 4: What are your views on the definition and recalculation of the baseline for stress test purposes? If a recalculation of the baseline would be requested, what would be the estimated additional resources/costs for this?

2.3.2 Time horizon

37. This section presents several alternatives for the design of insurance STs along different time dimensions and discusses the possible advantages and disadvantages of these approaches. The discussion will also consider which approach might be most appropriate to achieve a particular ST objective.

38. This section will first consider instantaneous stress scenarios, followed by a discussion of instantaneous shocks combined with stretched shocks over a longer time horizon for specific scenario components. Finally, multi-period ST approaches will be considered. The discussion of the pros and cons of each approach will focus on the following aspects:

- Complexity (both methodological and operational);
- Validation of results;
- Explanatory power / interpretability of results;
- Comparability of results.

2.3.2.1 **Instantaneous stress scenarios**

39. Instantaneous stress scenarios are assumed to be applied as a one-off shocks to the balance sheet at reference date. Examples are instantaneous market stress scenarios affecting several asset classes (e.g. sudden increase of risk premia affecting not only spreads but also equity and real estate prices) or an instantaneous combined market and insurance scenario (e.g. increased interest rates with an instantaneous lapse event).

40. Instantaneous shocks were used for the EIOPA 2016 and 2018 ST exercises. Usually instantaneous stress scenarios refer to a specific narrative where the source(s) of the shock and the risk drivers affected by the triggering event(s) are defined and the shocks are assumed to be instantaneous. An overview of the main advantages and disadvantages of this approach is provided in the table below.

Table 2-4: Advantages and disadvantages of instantaneous shocks

Advantages	Disadvantages
• Instantaneous shocks are easier to model, implement and validate compared to temporally stretched shocks, enhancing the comparability and interpretability of the results • Instantaneous shocks offer a greater flexibility to be tailored to the specific objective of the stress test exercise	• Instantaneous shocks may not be considered as realistic for specific scenario components, limiting the explanatory power/interpretability of the results • Even for instantaneous shocks the interaction between different risk drivers can be very complex and often depends on entity specific risk profiles, and the order of the specific shocks, which may still imply specific challenges with regard to the comparability of the results • Instantaneous shocks may be less suited to assess potential second-round effects and interactions among financial institutions

2.3.2.2 **Instantaneous stress scenarios complemented with specific scenario components stretched out over a longer time horizon**

41. Instantaneous shocks can be complemented with specific shocks stretched out over a longer time horizon. This can better reflect the nature of certain scenario components, for instance with regards to the insurance shocks. Examples are a combined market and stretched insurance scenario (e.g.

increased interest rates with an initial increase of lapses returning to normal levels after x years) or a cascade of CAT events over a certain period of time.

42. This type of scenario goes beyond the assumption of an instantaneous event by including the temporal development of certain risk drivers (often linked to insurance shocks). It differs from a multi-period version of a ST (see 2.3.2.3) as the impact on the key metric is still only analyzed at the valuation date. An overview of the advantages and disadvantages of this approach is provided in Table 2.5.

Table 2-5: Advantages and disadvantages of instantaneous shocks combined with specific stretched components

Advantages	Disadvantages
• With a reference to historical events, it can be argued that it is more realistic to assume that stress scenarios involve a time dimension, e.g. regarding the spillover from the triggering event to other risk drivers • Compared to instantaneous events the allowance for an additional time dimension extends the analysis of potential vulnerabilities (e.g. for risk profiles that are more exposed to gradual changes over time than to one-off events)	• The implementation of a temporally stretched event in the valuation and risk models of insurance companies can imply significant operational burdens for the participants and may require the use of approximations, which could hamper a consistent application of the scenarios, and the comparability and interpretability of the results • The increased complexity of temporally stretched shock events places considerably higher demands on the specification of the scenario in order to ensure a consistent application across participants

43. While a combination of instantaneous and stretched shocks allows for more realistic scenarios and assess vulnerabilities to gradual changes over time, the implementation of a temporally stretched event in the valuation and risk models of insurance companies can imply significant operational burdens for the participants. For instance if the best estimate assumptions in the modelled products have to be adjusted for a specific time horizon over the projection. This would also put a higher burden on the specification of the scenario in order to ensure a consistent application across participants. This refers not only to the specification of the stretched component itself, but also to a comprehensive discussion and guidance related to any potential temporal cross effects, in particular with regard to other risk drivers and to any management actions as reaction to the adverse developments.

2.3.2.3 **Multi-period stress scenarios**

44. Multi-period stress scenarios outline a specific scenario over a horizon of several periods, usually 3-5 years, with the development of key financial and economic variables described for each period. In case of a multi-period ST the scenario is designed as a path of macroeconomic and insurance specific variables rather than a set of stressed variables at one point in time. Insurers will calculate their stressed financial position over multiple periods and the impact is evaluated at different points in time. Insurers typically already incorporate multi-period STs internally as part of their ORSA and this approach could be extended to supervisory ST.

Examples of multi-period stress scenarios are:

- A macroeconomic financial crisis scenario with specific triggering events (e.g. abrupt reversal in risk assessment on financial markets, implying a material increase in bond yields) with subsequent real economy spillover effects over the next years (e.g. affecting equity and real estate prices and policyholder lapse behaviour)
- A pandemic event on global scale over a certain period of time, followed by an adverse feedback loop on real economy and also affecting financial markets (e.g. higher demand for safe bond investments leading to further decrease of interest rates)

45. The narrative of a multi-period ST scenario does not only include a specification of one or several triggering events but also a concrete description of assumed after-effects. The scenario roll out and the time evolution of the affected risk drivers represent a central component of this type of stress test. The quantification of the effects of the scenario is also usually not limited to the valuation date, but comprises an analysis of the development of certain key metrics over time. In such a multi-period context the appropriate allowance for post-stress management actions as a reaction to the adverse developments is of particular relevance (see also section 2.3.3). An overview of the main advantages and disadvantages of a multi-period ST is provided in Table 2-6.

Table 2-6: Advantages and disadvantages of a multi-period stress test

Advantages	Disadvantages
• Multi-period scenarios can address second-round effects and feedback loops directly by incorporating the implications of the companies' reactions to the adverse developments over time • Multi-period stress tests can be seen as more appropriate for analysing the impact of stress scenarios that address slow-burning risks (like for example climate risks) or risks that are assumed to expand over a longer time horizon (like for example a prolonged low interest rate environment) • Multi-period stress tests can be seen as providing a more appropriate framework for the analysis of the timely evolution of specific key metrics (such as for example the ratio of assets over liabilities)	The main challenge of a multi-period stress test for the insurance sector is linked to its high complexity. This complexity affects various components of the exercise: • Specification of the scenario: the time evolution of the affected risk drivers must be fully specified at a very granular level in order to enable insurance companies to apply the scenario in their risk and valuation models.[8] Furthermore, the specification must include elements that by definition are not applicable in the context of an instantaneous stress test (regarding for example assumptions on future new business volumes, structure and profitability under a stressed environment) • Operational implementation: the implementation of a multi-period scenario poses significant burdens on the participating companies. This applies in particular to the life sector. It may be impossible for companies to

[8] It can be expected that more detailed information for such a multi-period specification is required than for an instantaneous event in order to enable a consistent application .As an example the specification should not only include the development of the entire risk free yield curve over the considered time horizon, but also additional information on other relevant aspects as the change in the volatility surface over time.

	apply such multi-period scenarios without considerable approximations and simplifications (which in turn may affect the consistency and comparability of the results) • Validation of results is significantly more complex • Interpretability and comparability of results: great care should be taken when analysing or presenting individual versus aggregated results or when deriving conclusions from a comparison of results across specific peer groups, as multi-period stress tests seem only feasible with a more principle-based approach

Questions:
Q. 5: What are your views on the different time horizon approaches for stress tests purposes? What would be the most appropriate approach in your view in light of the different stress test objectives?

2.3.3 Management Actions

46. The term *management actions* comprises two methodologically different concepts: the *embedded* management actions, and the *reactive post-stress* management actions. The distinction, thoroughly explained in Box 2.1, is mainly based on a time- and purpose-dimension: embedded management actions are supposed to be in place at the reference date and are designed to run the business under standard circumstances, whereas reactive post-stress management actions are ad-hoc actions implemented as a reaction to specific circumstances (in the context of a stress test to the prescribed shocks).

Box 2.1: Management actions

Embedded management actions

Embedded management actions refer to all types of management actions that are algorithmically embedded in the stochastic risk and valuation models of the companies (i.e. these actions are already implemented for the calculations in the baseline scenario). Typical examples for such algorithmically modelled management actions include investment / disinvestment rules on the assets side, profit sharing mechanisms (in particular bonus crediting rules for traditional with-profit life and health business) or escalation rules in adverse financial situations (often linked to specific national legislative prescriptions). The Delegated Regulation refers to this type of modelled management actions under the label of "future management actions", for example in article 23 (in the context of the calculation of the technical provisions) and in article 236 (in the context of statistical quality standards for internal models). The range of modelled actions and their level of sophistication will depend on various conditions for example, the national business model, the company specific risk profile (e.g.

with regard to the nature, scale and complexity of the risks underlying the insurance obligations), the business and risk strategy of the company etc.

Given a specific stochastic simulation (e.g. for the calculation of the best estimate liability) the results of these algorithms are usually both time- and path-dependent. This implies that algorithmically modelled management actions will react automatically on the adverse setting defined by a stress scenario (e.g. by a reduction of policyholder bonuses). This automatic change of the modelled metrics has to be clearly distinguished from a situation where a company changes the design or specific key parameters of the algorithm itself (e.g. in order to reflect a fundamental change in the bonus crediting strategy after a shock event).

Reactive post-stress management actions

Reactive post-stress management actions refer to all types of management actions that are applied independently of the algorithmically embedded management rules. In the context of a stress test they therefore represent actions that would be taken by institutions in direct response to the stress scenario and that are not assumed to be applied in the baseline scenario. These actions typically include but are not limited to increases in capital (e.g. through equity issuance or asset sales), changes in the investment portfolio (e.g. through divestments), repricing, reductions in expenses (e.g. staff layoffs), hedging of exposures and/or dividend and profit sharing decisions.

47. One of the key issues in the methodological design of a ST exercise relates to whether or not the participants should be allowed to incorporate specific management actions as a reaction to the adverse stress scenarios. When addressing the use of management actions, there is a difficult balance to strike between the comparability of the results at market level, on the one hand, and the accuracy of the calculated impact of the scenario at an individual level on the other hand. Limiting the use of certain management actions will increase the comparability of the results but these results may no longer fully reflect the view of the insurer on the impact of the scenario.

48. The specification of the previous EIOPA ST exercises excluded the allowance for any mitigating management actions post-stress for reasons of comparability and due to the instantaneous nature of the assumed stress events.[9] This section will discuss the advantages and disadvantages of allowing post-stress management actions.

2.3.3.1 **Reactive post-stress management actions**

49. Given the variety of individual management actions it is not realistic to discuss the appropriateness of single, particular management actions post-stress in this paper. The following table (Table 2-7) therefore aims to discuss the potential advantages and disadvantages for the application of reactive post-stress management actions on a principle based level.

[9] "In order to achieve a level playing field and to ensure that the results after stress reflect the instantaneous nature of the stresses, participating groups should not take into account measures, actions or risk mitigating strategies that rely on taking future actions after the reference date. This includes e.g. dynamic hedging, de-risking strategies and any future action taken in the context of a recovery plan." (cf. "Insurance Stress Test 2018 Technical specifications (EIOPA-BoS-18-189)", paragraph 20). The reassessment of the "foreseeable dividends or other foreseeable distributions" under the stressed scenarios was however included in the allowed actions.

Table 2-7: Advantages and disadvantages of allowing reactive post-stress management actions

Advantages	Disadvantages
• Allowing post-stress management actions is more realistic and can improve the explanatory power and interpretability of the stress test exercise • Allowing post-stress management actions can provide additional insight in potential second-round effects	• Allowing post-stress management actions can hamper comparability of results, as each participant can tailor management actions • Post-stress management actions could impair one of the main goals of the stress test, i.e. the identification of vulnerabilities. Without any information on the quantitative impact of such actions the stress test results may be seen as merely analysing the potential of the companies to react on the specific stress event, rather than their vulnerability

50. In general, the decision on whether or not to allow reactive post-stress management actions should be linked to the goals and objectives of a specific ST exercise. For instance, if the main objective is to identify individual vulnerabilities the use of post-stress management actions might not be appropriate, whereas if the objective is to assess the resilience of the insurance sector as a whole (macroprudential perspective), the use of post-stress management actions could be considered to enhance the explanatory power of a ST exercise and assess potential second-round effects.

51. Furthermore, given the relevance of reactive post-stress management actions in a stressed environment, an appropriate level of qualitative and quantitative information on the impact of the enforced post-stress management actions on the ST results is warranted (i.e. showing the impact of the post-stress management actions separately). This should allow a comparison of the results with and without any reactive post-stress management actions. Depending on the number, complexity and interconnectedness of the enforced management actions an iterative step-by-step analysis (based on a specific order of the assumed actions) may be required. This kind of analysis including the impact of management actions (with and without) could also enable an analysis of potential second-round effects in the context of an instantaneous stress scenario, without facing the complexities of a multi-period exercise. Potentially, a framework for allowed management actions as part of the ST specification could also be considered, in order to ensure consistent application, avoid inappropriate "optimal responses" (with regard to the level of mitigation of the negative impact of the shock) and ensure comparability of the results.

52. The assessment of the appropriateness and plausibility of the post-stress management actions should also form a central component of the validation process – both within the companies as well as within the supervisory authorities. Reactive post-stress management actions shall be realistic and shall take account of the time needed to implement them and any expenses caused by them. Companies should be able to provide credible arguments that the post-stress management actions could actually be implemented under the adverse conditions of the stress scenario, taking also into account any potential secondary consequences (as e.g. limitations to inter-company capital movement in case of financial distress). Supervisors should assess the

assumed post-stress management actions not only in isolation, but also based on a cross-comparison for appropriate peer groups. Against this background, companies and supervisors could benefit from entering into a dialogue on the appropriateness of the assumed management actions at an early stage of the ST process and before companies start their calculations.

2.3.3.2 **Embedded management actions**

53. Notwithstanding their soundness under the SII framework, embedded management actions that are algorithmically programmed in the stochastic risk and valuation models of insurers may limit the comparability of the ST results, as the application and sophistication of these embedded management actions may differ across insurers. Whereas for one insurer the reaction to a stress scenario could be embedded in the model and automatically respond to the adverse scenario, for others – where this is not embedded in the model - this could require a specific reactive management action to achieve the same result (for instance a reduction of policyholder bonuses), which is typically not allowed. Hence, potential limitations on the use of embedded actions could be considered as well to enhance the comparability of the results and to better reflect the objective and the framework of the exercise.

54. One possible way to address embedded management actions is to prescribe a 'constrained baseline model', in which undertakings are supposed to limit/keep constant certain elements of the modelled embedded management actions. These could relate to embedded management actions on assets (e.g. dynamic asset allocation, target duration, target allocation) and on liabilities (e.g. target rates, dynamic lapse).

Questions:
Q. 6: What are your views on the treatment of management actions in the context of a stress test exercise?
Q. 7: What are your views on requesting post-stress calculations both with and without management actions?
Q. 8: Please provide your view on the distinction and different treatment of embedded management actions and reactive post-stress management actions
Q. 9: Which elements in your view can/should be limited in the embedded management actions to enhance the comparability of the post-stress results?
Q. 10: Please elaborate on the key elements of the technical information that would be required in order to implement potential limitations to embedded actions (content, scope, granularity etc.).
Q. 11: Please elaborate on the feasibility (e.g. time and effort needed for the implementation) of the potential limitation to embedded management actions to calculate post-stress positions.

2.3.4 Sub-conclusion

55. This section elaborated on 3 conceptual elements to be considered in a ST exercise: *i)* definition and recalculation of the baseline, *ii)* time horizon and iii) management actions, presenting advantages and disadvantages of the different approaches in insolation. For the purpose of future EIOPA STs, the options offered by the 3 elements should be assessed holistically and consider both the objective of the ST exercise and the complexity of the approach.

56. In case of a microprudential ST focusing on assessing the sensitivity of insurers to specific shocks, the most appropriate choice would be an instantaneous shock approach with limitations on the application of embedded (if feasible) and no allowance for reactive post-stress management actions. If the calculation of the post-stress key metrics should require material simplifications then a recalculation of the baseline scenario using the same simplifications could be considered. This set-up can be based on one-shock scenarios or on multiple shocks scenarios. If the latter applies information on the marginal impacts of specific shocks might be requested.

57. In case the objective is to assess the vulnerability of the industry (either at micro or macro level), the most appropriate choice would be an instantaneous stress scenario complemented with specific scenario components (e.g. insurance specific shocks) stretched out over a longer time horizon. No limitation should be applied in the use of embedded management actions whereas reactive post-stress management actions should not be applied. Alternatively reactive post-stress management actions could be allowed, whereby the impact of these actions shall be reported separately.

58. In case of a macroprudential objective focusing on the spill-over effects the proposed approach would be based on a one period instantaneous shock approach once with restrictions on the use of reactive post-stress management actions and potential limitations to the embedded management actions, and once without restrictions and thus allowing for all types of management actions. This kind of analysis including the impact of management actions (with and without) could enable a quantitative analysis of second-round effects in the context of an instantaneous stress scenario, without facing the complexities of a multi-period exercise.

59. The proposed approaches represent a viable step forward to be implemented in any forthcoming EIOPA exercise ST. Over time, the approaches might be further enhanced towards a multi-period framework. However, the inherent complexity of a multi-period and comprehensive macroprudential ST needs to be further analyzed and this type of ST analysis can therefore only be considered as a second step.

60. A summary of the proposed approaches linked to the specific stress objective can be found in the table below:

Table 2-8 Proposed approaches linked to the specific stress objective

	Vulnerability of the industry (Micro/Macro)	Sensitivity to shocks (Micro)	Spill-over analysis (Macro)
Recalculation of the baseline	In principle not needed, however this depends on the allowed simplifications	Advised, in case simplifications / approximations are used in the calculation of the post-stress position (materiality principles apply)	In principle not needed, however this depends on the allowed simplifications
Time horizon	All the approaches can be applied	One period instantaneous shocks	All the approaches can be applied, though multi-period more appropriate

Management actions	No limitation to the embedded management actions. In principle reactive post-stress management actions not allowed If considered the impact shall be reported separately	Limitation to embedded management actions (limit/keep constant certain assumptions in the baseline model) Reactive post-stress management actions not allowed	No limitation to the embedded management actions. Reactive post-stress management actions allowed to assess systemic implications (impact both with and without post-stress management actions)

Questions:
Q. 12: What are your views on the 3 possibilities for future EIOPA stress test exercises summarized in Table 2-8?
Q. 13: Do you have any further considerations regarding the potential evolution of future EIOPA stress test exercises?

3 Scope

3.1 General considerations

61. The scope is one of the cornerstones of the ST framework and it is strictly related to the objective assigned to a ST exercise. It guides the definition of the application criteria for the shocks prescribed in the scenarios.

62. This chapter elaborates on the potential guidelines to define the proper scope to fit the objective of a ST exercise, highlighting the advantages and disadvantages of each solution.

63. From a procedural perspective, the identification of the participants to a ST exercise is a collective exercise which involves EIOPA and the NSAs. The criteria for the selection as well as the proposed list of insurance undertakings are discussed and finally adopted by the EIOPA Board of Supervisors.

3.2 Target

64. The main choice to be made for the scope of the ST is whether to target solo or group insurance undertakings. Under specific circumstances a "synthetic group" approach could also be considered. With a synthetic group approach only subsamples of solos belonging to a group are considered, for example according to geographical location, business lines or exposures to specific risk factors. What differentiates this approach from a full solo-based exercise is the consolidation of the post-stress results of the solos according to the approach followed by the group (or according to a simplified approach if allowed by the specifications of the exercise) with the aim of allowing for diversification effects within this synthetic group.

Table 3-1: Advantages and disadvantages of targeting solos, groups or synthetic groups

	Advantages	Disadvantages
Solo	• Target specific business lines • Country/jurisdiction analysis • Easy to compute the market coverage • Easier application of the shocks (no consolidation at group level needed) • Easier to validate the data (single SCR model and LTG / transitional measures) • Easier to issue potential recommendations and recovery/resolutions actions (one NCA involved) • More useful as an input to micro-supervision	• No diversification effect accounted • Less informative from a financial stability perspective • Need some coordination work from both the insurance groups and the 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)
Group	• Impact on the systemic groups (more informative/useful from a financial stability perspective)	• High complexity in the application and assessment of the shocks with the consequence

	• Account for full diversification effects • Easier to assess the impact of reactive post-stress management actions if needed	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 issue potential recommendations and recovery/resolutions actions • Harder to validate the data • Harder to assess the effect on TPs (issues on reporting CFs)
Synthetic group	• Assess the impact of the scenarios according to the aggregating principles (e.g. geography, business lines). In particular the approach might allow to assess the impact of the scenarios to the EU business of groups operating globally • Allow to approximate the vulnerabilities of groups reducing the complexity	• Potentially difficult to calculate (these are ad hoc calculations to aggregate part of the total group) • Synthetic groups do not reflect a legal entity like a solo undertaking or a group • Diversification effects not fully accounted • Intra-group dynamics partly applicable • Potential issues in the calculation for the Groups using accounting methods to aggregate the entities • Potential need to complement the data collected via a top-down approach

65. It is worth noting that many of the weaknesses reported for the groups might be alleviated by asking the groups to complement the consolidated data with the data of the largest solos belonging to the group covering a defined part of the group balance sheet. The solo based information allows to assess potential localized distresses and to have a more accurate validation of the post-stress liabilities. However, this would also place an additional burden on participants as both group and solo ST impacts would have to be reported.

3.3 Coverage and metrics

66. In an EU-wide exercise the general approach to the market coverage can be summarized in the statement "the higher the better". However, many details have to be taken into account in defining this aspect, starting from the definition of the reference, namely the concept of "market".

67. The natural reference for an EU-wide exercise is the size of the EU insurance market which can be further detailed into the size of the life and non-life business according to the goals of the exercise.

68. In general, it is quite straightforward to define and measure the market coverage for solo undertakings assuming that they are operating primarily in

the country where they are based. For groups however, measuring market share and coverage becomes more complicated as groups usually operate globally.

69. For solos, the reference shall always be the size of the local markets or of the EU insurance business, if needed, detailed by business line. The size of a company as a whole (measured through a specific metric e.g. total asset - TA, total technical provisions - TP, and Gross Written Premium - GWP) or the size of specific business lines could be used as exposure. In case the objective of the exercise is to assess the vulnerabilities of the whole insurance sector, particular attention shall be devoted to the metric to assess the market coverage to ensure a representative coverage in terms of business mix (for instance life and non-life). Details on the reference, exposure and metrics to be applied to solos is displayed in Table 3-2. An additional criterion to be taken into account is the inclusion of solo undertakings belonging to different size cohorts. This will allow, especially in the analysis of local jurisdictions, to detect potential pockets of vulnerabilities coming from the distress of a sufficiently large number of small and mid-size entities.

Table 3-2: Reference metrics for solos

Geographical criteria \ business criteria	Life	Non-life	Specific Line of Business (Lob(s))	Undifferentiated business
Local jurisdiction	• Reference: Size of the life local market • Exposure: size of the Life business • Metric: Preferred: TP life (w/wo UL/IL); others: TA (w/wo UL/IL), GWP	• Reference: Size of the non-life local market • Exposure: size of the non-Life business • Metric: Preferred: GWP non-life, others: TP non-life, TA;	• Reference Size of the local market (for that specific Lob(s)) • Exposure: size of the specific Lob(s) business • Metric: Preferred: Lob(s) TP for life; Lob(s) GWP for non-life; others: TA (w/wo UL/IL)	• Reference Size of the local market • Exposure: size of the company • Metric: Preferred: TA (w/wo UL/IL); other GWP, total TP (w/wo UL/IL)
EU wide	• Reference: Size of the EU market • Exposure: size of the Life business • Metric: preferred: TP life (w/wo	• Reference: Size of the EU market • Exposure: size of the non-Life business • Metric: preferred: GWP non-	• Reference Size of the EU market for that specific Lob(s) • Exposure: size of the specific	• Reference: Size of the EU market • Exposure: size of the company • Metric: Preferred: TA (w/wo UL/IL);

	UL/IL); others: TA (w/wo UL/IL), GWP	life, others: TP non-life, TA;	Lob(s) business • Metric: preferred: Lob(s) TP for life; Lob(s) GWP for non-life; others: TA (w/wo UL/IL)	other GWP, total TP (w/wo UL/IL)

70. Groups, due to their global activities, are not suitable for analyses at country level. Therefore, the focus shall be on the assessment of the coverage at EU level and the coverage of the business lines. From a geographical perspective, the coverage across EU countries can still be assessed by comparing the sum of the size of the solos belonging to the targeted groups and operating in EU to the total size of the EU business and its detail by business lines and across countries. Table 3-3 provides an overview of the options. Same considerations on the metrics used for solo undertaking applies.

Table 3-3: Reference metrics for groups

Geographical criteria \ business criteria	Life	Non-life	Specific Lob(s)	Undifferentiated business
Local jurisdiction	N/A	N/A	N/A	N/A
EU wide	• Reference Size of the EU market potentially approximated by the groups subject to the financial stability reporting. • Exposure: size of the life business • Metric: Preferred: TP life (w/wo UL/IL); others: TA (w/wo UL/IL), GWP potentially limited to the EU business	• Reference: Size of the EU market potentially approximated by the groups subject to the financial stability reporting. • Exposure: size of the non-life business • Metric: Preferred: GWP non-life, others: TP non-life, TA; potentially limited to the EU business	• Reference Size of the EU market for that specific Lob(s) potentially approximated by the groups subject to the financial stability reporting • Exposure: size of the specific Lob(s) business • Metric: Preferred: Lob(s) TP for life; Lob(s) GWP for non-life; others: TA (w/wo UL/IL)	• Reference: Size of the total EU market potentially approximated by the groups subject to the financial stability reporting. • Exposure: size of the group, • Metric: Preferred: TA (w/wo UL/IL); other GWP, total TP (w/wo UL/IL) potentially limited to the EU business

71. In addition to the metrics mentioned above, one could consider some additional metrics in case of a ST based on a specific risk factor (insurance or financial). In this specific case, the exposure to that specific risk factor could be considered as a metric. As an example, in case of a NAT-CAT scenario, the exposure to NAT-CAT events (e.g. sum insured) could be used as a metric, or in case of an equity stress, the total equities held by the group/solo could be used as a metric.

3.4 Sub-conclusion

72. The target and scope of the ST are important choices to be made for the execution of a ST. These choices are largely dependent on the objectives of the ST at hand. For instance, targeting groups might provide more insight from a financial stability perspective as full diversification effects and intra-group transactions are taken into account.

73. At the same time, STs at the group level come with a high level of complexity. In particular the aggregation with non-EU entities results in operational difficulties and less meaningful results. Also, the results of a group ST are more difficult to validate, less useful for supervisory objectives and cannot be easily used for country-level analysis.

74. An intermediate target between solos and groups would be to apply the ST to synthetic groups. For instance, this would enable the exclusion of non-EU entities. However, also targeting synthetic groups for the ST comes with significant shortcomings. Again, the aggregated results are more difficult to validate. Also, synthetic groups are non-existent legal entities and, as such, both the communication about the results as well as supervisory actions are more difficult.

75. In light of these considerations, the most appropriate scope for micro-oriented ST by an operational perspective would be to target solo undertakings. This would provide more meaningful input for micro-supervision, facilitates the application of shocks and data validation process, while also allowing for more country-specific analysis. Specific considerations are needed in case of macro-oriented analyses.

Questions:
Q. 14: What is your view on the appropriate scope for a stress test exercise? Do you agree with the advantages and disadvantages of the different approaches?
Q. 15: What are your views on the metrics to be used for defining the scope for solos and groups, respectively?
Q. 16: What are the main challenges (if any) to assess the post-stress position of a synthetic group?

4 Scenario design

4.1 Definition of scenarios

76. Stress scenarios are severe but plausible hypothetical situations that can adversely affect the balance sheet and solvency position of insurance undertakings. Scenarios could exist of a single shock or a combination of market, demographic, financial and insurance specific shocks that are expected to affect the resilience of individual undertakings and the insurance sector as a whole. The main constituents of a scenario are the narrative and the shocks.

4.2 Requirements of the scenario design

77. The starting point for the design of a scenario is its narrative. The narrative describes the state of the shocked variables (e.g. financial markets, the economy and/or the insurance specific elements / assumptions) and should elaborate on the adverse developments to be taken into account in the design. Without any aim of completeness, a narrative should include information on the triggering event(s) of the economic downturn (in case of a market scenario) and in which sector of the economy it originates, what are the propagation channels and what are the foreseen reactions of the other sectors. The narrative should also articulate how the scenario captures the risks faced by insurance undertakings and should provide a rationale for the exclusion, if any, of material and relevant risks.[10]

78. A robust narrative can serve as a basis for NCAs to issue potential recommendations and/or to request specific actions against the corresponding ST results. The narrative will also help supervisors and insurers to communicate and understand which risks are targeted by the scenario. Importantly, recommendations and actions should be derived from a conceivable (severe but plausible) stress configuration. A well-defined narrative therefore strengthens a meaningful follow-up of the ST.

4.3 Derivation of the scenarios

79. A ST exercise starts with a baseline situation, which marks the economic environment at the valuation date. STs have at least one severe but plausible stress scenario that is relevant to the insurance industry. The scenario design should take into account the most relevant risk factors for the undertakings involved with a specific reference to the objectives of the exercise.

80. A scenario should in general be severe and plausible. The severity criterion refers to the fact that scenarios should not be based on expectations or likely future developments. Instead, scenarios are defined with the aim to test the resilience of insurers against adverse developments. The plausibility criterion refers to the requirement that the scenario could potentially happen in practice and should be in conformity with economic theory and the economy as a whole. Please note that this does not preclude scenarios that have not materialised before, as these may be justified based on a forward-looking

[10] Basel Committee on Banking Supervision (2018) Stress testing principles. Available on the Bank of International Settlement website (www.bis.org).

approach. The calibration and application of the shocks is discussed further in Chapter 5.

81. Below, we focus on four important aspects to consider in the context of scenario development:

- Historical or forward-looking scenarios;
- The consistency with the SII framework versus the need to move towards more market compatible scenarios;
- Single or combined scenarios;
- The level of granularity of shocks.

82. Finally, box 4.1 elaborates on possible approaches to incorporate climate risk scenarios in a ST. Climate risk can lead to increased physical risks for insurers (due to more frequent and severe climate-related losses) and to transition risks, which may arise in the transition to a more carbon-neutral economy.

4.3.1 Historical or forward-looking scenarios, with a backward or forward looking approach

83. A ST can be based on historical or forward-looking configurations. Forward looking metrics would be preferred when historical stresses are considered too low, for example the defaults and credit losses in the period just before the 2008 financial crisis. A hybrid approach would combine historical experience with expert judgement to include forward looking considerations in the scenario(s). Until now, the EIOPA insurance STs have been based on such a hybrid approach derived from a combination of the historical and forward looking scenario features. Both backward-looking and forward-looking approaches have advantages and disadvantages, which should be taken into account in scenario design. Table 4-1 provides an overview of the main pros and cons of each approach.

Table 4-1: Advantages and disadvantages of backward-looking and forward-looking approaches in scenario design

	Advantages	Disadvantages
Historical approach	• Past events provide a benchmark of what could potentially happen in the future • Consistency (plausibility) of the scenarios may be more easily achieved. The scenarios might be more easily justified when something similar has already occurred in the past	• Financial crises or insurance shocks that exceed or are different from what happened in history might not be captured when the stress is based only on historical data • A purely historical approach would not allow for a partly forward looking perspective • Limitation in flexibility • Specific future scenarios could possibly not emerge or be derived from historical data
Forward-looking approach	• More conceivable future scenarios could be reached when one would not be limited to historical data only • Possibly more flexibility in design	• Requires an adequate justification of the scenarios provided • Requires a higher degree of expert judgement which

		should also be carefully justified

84. The historical approach could be seen as a preferable option when it gives a solid empirical basis for a ST. However, when it is not combined with a forward looking approach it could potentially not reach the goal of the ST of assessing potential vulnerabilities of undertakings, which are not strictly related to observed historical events.

85. Therefore, the most appropriate approach for a ST exercise remains the hybrid approach that would allow to include unexperienced severity or unexpected combinations of shocks in stresses that originate from historical observations, while maintaining the plausibility of the scenario.

Questions:
Q. 17: What are your views on the historical versus forward looking approach? Do you envisage additional advantages / disadvantages on top of the ones listed?

4.3.2 The consistency with the Solvency II framework versus the need to move towards more market compatible scenarios.

86. EIOPA ST exercises rely on the SII framework as a common ground for the assessment of the resilience of the insurance industry against adverse developments. SII offers common and shared principles for the evaluation and reporting of balance sheet and capital positions (SCR and Own Funds - OF), which ensure comparability of the baseline position and serve as a guidance for the recalculation of the post-stress positions.

87. Some SII elements, especially those aimed at reducing procyclicality and at taking into account the long term nature of insurance business, may however not be fully consistent with the objectives and the narrative of a stress test scenario. It is therefore worthwhile to consider departing from some of its elements under specific circumstances. A ST framework fully consistent with SII might impede a full translation of the narrative into the prescribed shocks, therefore not allowing a meaningful evaluation of the impact of the stress test scenario on the industry. The main concern goes to the approach to derive the risk free rate (RFR) term structure.

88. The EIOPA RFR curve is designed via an agreed methodology based on the Smith-Wilson model, which includes parameters such as the Ultimate Forward Rate (UFR), the Last Liquid Point (LLP) and the convergence period[11]. The methodology generates a market consistent RFR term structure to be used for the estimation of the SII balance sheet and capital requirements. However, for some scenarios, such as the one assuming a protracted period of low interest rates, the parameters used to derive the RFR curve might not fully fit

[11] Information on the Solvency II methodology to derive the Risk Free Rate term structure can be retrieved at: https://eiopa.europa.eu/regulation-supervision/insurance/solvency-ii-technical-information/risk-free-interest-rate-term-structures

the purpose. In particular, a level of the UFR kept unchanged with respect to the baseline might not return an extrapolated part of the curve consistent with the market situation depicted by the specific scenario. In this situation, the level of the UFR should be adjusted to consistently reflect the economic situation all-over the post-stress term structure of the RFR including the higher maturities, which otherwise will be mainly driven by the model and its parameters. Similar considerations can be extended to the LLP and also this parameter should be eligible for adjustments.

89. Against this background, it seems reasonable to allow, in the context of a ST, for deviations from the SII RFR curve in order to see whether important vulnerabilities can arise. One example of a deviation from the SII RFR curve is the reduction of the UFR, as was incorporated in the 2018 ST scenario to assess the vulnerabilities in a low yield environment.

90. In general, two different approaches can be followed to assess the impact of an adjustment to the UFR:

- Option 1: the UFR is adjusted as part of the scenario and the prescribed RFR curve for the stress test includes the adjusted UFR directly;
- Option 2: the UFR is kept unchanged in the ST scenario, but the marginal impacts of changes of the UFR may be requested separately in the pre- and post-stress situation (similar to the Long Term Guarantees (LTG) and transitional measures).

The advantages and disadvantages of the two approaches are listed in Table 4-2.

Table 4-2: Advantages and disadvantages on the treatment of the UFR

	Advantages	Disadvantages
Option 1: adjust UFR as part of the scenario	• More consistent with the narrative for the scenario (e.g. in case of low-for-long scenario) • Less burdensome for undertakings in case of requested recalculation of the baseline as only the post-stress situation with the adjusted UFR has to be calculated	• Scenario is not consistent with the SII framework and post-stress SCR position may therefore be more difficult to explain • Impact of UFR cannot be assessed specifically, as it interacts with other shocks in the scenario
Option 2: UFR kept unchanged in the scenario with marginal impact of adjustment of UFR is requested separately	• Scenario would be consistent with SII and post-stress SCR position may therefore be easier to explain • Allows to assess the impact of the UFR independent of the other shocks	• More burdensome for undertakings as both the position with and without the adjustment to the UFR would have to be calculated • Scenario may be less consistent with the narrative (in case of low-for-long scenario)

91. Based on these two approaches, EIOPA proposes that the adjustment of the UFR and of other RFR curve parameters shall be considered in the light of the objective for each ST exercise:

- For the assessment of the post-stress regulatory position it is advised to keep the UFR unchanged with respect to the baseline. However, in this approach, the sensitivity to movements of the UFR is worth being assessed both in the baseline and post-stress situations;
- For an evaluation of the economic impacts of a scenario the preferred option would be to adjust the UFR to make it consistent with the prescribed scenario.

92. Regarding the impact of the LTG and transitional measures, these measures shall be treated in line with the SII framework, i.e. the impact of the LTG and transitional measures shall be reported separately in the post-stress results in order to enhance comparability and better assess the economic impact and the regulatory impacts of the shocks for supervisory analyses.

Questions:
Q. 18: What is your view on the consistency of the scenarios with the Solvency II framework versus market compatible scenarios for the purpose of a stress test, in particular for the treatment of the RFR parameters?

4.3.3 Single risk factors, single scenarios or combined scenarios

93. Another important aspect of scenario design concerns the question if and how to combine risk factors into one scenario. There are different kinds of bottom-up stress test scenario approaches. In this paragraph three approaches are distinguished; *i)* single risk factors; *ii)* single scenarios; and *iii)* combined scenarios.

94. *Single risk factors* are defined as shocks to, for instance, a specific asset class or insurance risk factor. Examples are an instantaneous drop in equity prices by *x*%, an increase in the risk-free rates by *x* basis points or an increase of *x*% in life expectancy. This type of sensitivity analysis with single risk factors is used by many companies as an important element of their risk management. A *single scenario* consists of multiple risk factors, but is limited to a specific area of shocks, e.g. only market shocks or insurance-specific shocks. These scenarios often relate to a specific narrative where the source(s) of the shock and the risk drivers affected by the triggering event(s) are defined. A *combined scenario* consists of both market and insurance-specific shocks, e.g. increased interest rates combined with a mass lapse event. Table 4-3 lists the advantages and disadvantages for each of the approaches

Table 4-3: Advantages and disadvantages of single risk factors versus single scenarios versus combined scenarios

	Advantages	Disadvantages
Single risk factors	• In particular for standard market stress sensitivities, it can be expected that companies can leverage on existing processes for implementing the required calculations and for reporting the results • The isolated view on single risk factor movements facilitates the	• The explanatory power of the results can be seen as limited. In particular, it can be very difficult to derive the impact of a combination of sensitivities just based on the single sensitivity results. Tail dependencies and their potential

	validation and the interpretability of results • The focus on single risk factor movements facilitates a consistent and uniform application of the scenario[12] and therefore supports the comparability of the results • The approach allows the estimation of the likelihood of the prescribed shock	implications are completely out of scope • As most of the historical crisis events were not limited to single risk factor movements, the approach could be seen as rather narrowed for a stress test exercise. Against this background, it may be difficult for supervisors to define specific follow-up measures only based on sensitivity results
Single scenarios	• It is simpler in design than a combined scenario that includes both market and insurance shocks • It allows for the design of several scenarios consisting of single risk factors with different likelihoods • There is no need to take the interactions and dependencies between market and insurance-related risk factors into account	• Due to the existence of multiple risk factors with their mutual impact, it may not seem real to look at the effects of important risk factors – i.e. market and insurance - in isolation. Since the business of the undertakings is exposed to a combination of risk factors, financial and insurance risks should be seen in conjunction • The explanatory power of scenarios can be superior to single factor sensitivities as it covers inter-dependencies between different risk-drivers and their (often complex) combined impact. For the same reason combined scenarios can be superior to single scenarios. Undertakings adopt a diversified strategy to deal with the occurrence of different risks at the same time. This diversification strategy is important and valuable to the insurer, but also important from a supervisory point of view. This diversification strategy cannot be assessed when a single risk factor is shocked or in a single scenario design

[12] It should be noted however that a detailed specification of the single risk factor movement remains important to ensure a consistent application. A typical example relates to changes in the risk free interest rates where in a Solvency II context changes to the entire risk free yield curve (including the extrapolated part and the level of the UFR) need to be specified.

Combined scenario	• Compared to single factor sensitivities, combined scenarios offer a greater flexibility to be tailored to the specific objective of the stress test exercise • The explanatory power of combined scenarios can be superior to single factor sensitivities or single scenarios as it covers inter-dependencies between different risk-drivers	• The interaction between different risk drivers can be very complex and often depends on entity-specific risk profiles. Moreover, the final stress depends on the order in which the various stresses occur (e.g. in case of an interest rate and a lapse shock: it matters whether the interest rate stress occurs first and subsequently the lapse stress, or the other way around) • The results usually show the effect of combined shocks, and, consequently, there will not be information about the effects of the separate shocks

95. ST are demanding exercises for both the industry and the supervisor. In this sense, ST based on single scenarios and perhaps even simple combined scenarios could result in reduced calculation time and effort.

96. One of the disadvantages of combined scenarios is that they do not give information about the separate shocks. This, however, could be addressed if the effect of the scenarios is disentangled and reported separately by insurers. This is only possible when sufficient information about the separate shocks is requested.

97. When specific preconditions are met, combined scenarios are the preferred option. First of all, the design of the combined stress test should allow for the isolation of effects of the various single shocks or scenarios. Secondly, it should be clear in what sequence the shocks take place, as this is relevant for calculating the impact of the shocks, and what the expected effects of the various shocks would be). Thirdly, the interdependencies between risk factors should be made transparent and carefully assessed.

Questions:
Q. 19: What are your views on using single risk factors, single scenarios or combined scenarios for the purpose of a stress test?
Q. 20: What are your views on having combined scenarios, but allowing the identification of the single shocks in isolation (for instance impact of market and insurance shocks shown separately)?

4.3.4 Granularity of the shocks

98. An important consideration in scenario design is the level of granularity of the shocks. Previous ST exercises were characterized by a high level of granularity in the market shocks. For instance, equity and real estate shocks were defined at country level. An alternative to a granular scenario design is an approach in which individual shocks are bucketed instead of having a highly granular calculated shock for each individual risk factor as follows:

- Shocks to equity markets. In the 2018 ST (*Yield curve down scenario*) the equity shocks in Europe ranged from -1% for Slovakia to -19% for Italy,

whereas the US stock markets decreased by 21%. If one would take a more forward looking stance, one could question whether there should be country-specific shocks. A possible alternative is to define shocks per bucket, for instance by making the distinction between emerging and developed countries;[13]

- Shocks to government bond yields that differ for countries with the same rating, depending on the triggering event. An alternative to country specific shocks would be the application of the same shock to government bonds that share the same rating (AAA, AA, A, BBB, BB, B).

A similar approach shall be applied to other shocks where relevant. Granular and bucketing approaches have their advantages and disadvantages as reported in Table 4-4.

Table 4-4: Advantages and disadvantages of granular approach versus bucketing approach

	Advantages	Disadvantages
Granular approach	• Allows to take into account the specific characteristics of the risk factor considered • Certain measures like the Volatility Adjustment can be derived immediately without the need of approximations • Allows country based analysis	• Differences in shocks between risk factors sometimes are small and might not be statistically significant and the differences could be meaningless or not justify the required extra effort to calculate the ST results • Country based calibrations based on past observations have always been challenged extensively and subsequently adjusted via expert judgement • Not suitable for some undertakings that already base their risk management strategies on a bucketing approach
Bucketing approach	• Reduces the risk of having small differences derived from statistically marginal observations and hardly justifiable in a forward looking scenario • Allows a more efficient process in the designing phase of the ST	• Complexity in the design and application of the bucketing criteria • The recalculation of the country VA may seem not as straight forward as in the case of a granular approach, but it can be done, for example by using the spreads from the relevant buckets to go into the formula

99. It is proposed to follow a bucketing approach, unless the narrative of the ST prescribes more granular shock(s). With a bucketing approach some homogeneity criteria should be determined in order to avoid unfair or unreasonable results. This requires the use of objective criteria, like ratings or volatilities.

[13] For a classification between advanced economies and emerging markets please refer to the IMF World Economic Outlook database available at:
https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/weoselgr.aspx

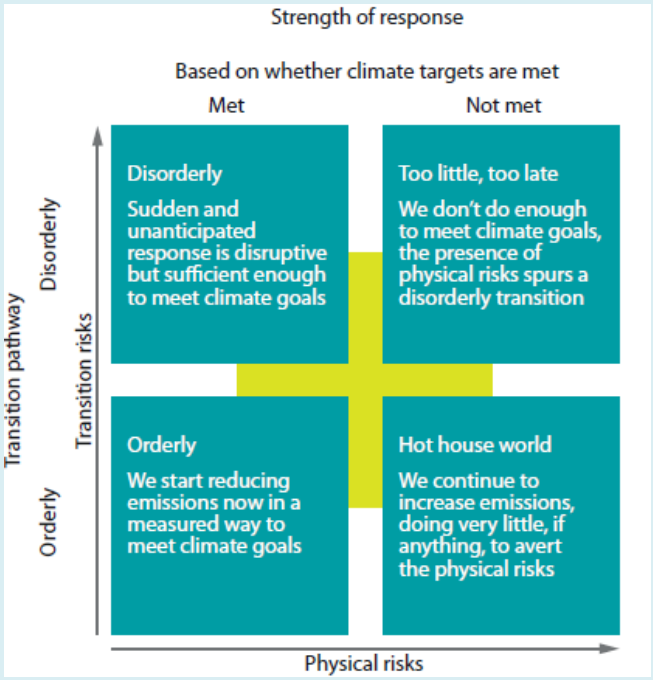
Questions:
Q. 21: What is your view on the bucketing approach for market shocks? Does a bucketing approach reduce the operational burden for the application of the shocks?

Box 4.1 Possible approaches to climate risk stress testing

The potential financial impacts of climate-related risks are well-documented.[14] However, the use of climate scenarios in traditional stress testing models is still very much in development and no common methodology has been agreed yet (due to significant modelling and data challenges). EIOPA is mindful of the work undertaken by other supervisory authorities and organizations related to climate stress testing, and is committed to enhance its supervisory stress testing methodology to incorporate climate-related risks. To this end, EIOPA is seeking high-level input from stakeholders on the possible approaches to climate stress testing, two of which are outlined below.

1. **Long-term climate scenario analysis**

One of the challenges of including climate risk scenarios in traditional stress testing frameworks concerns the time horizon. The impact of the climate change scenarios are expected to only manifest themselves fully over a considerable time period, beyond the time horizon typically used for stress testing (1-3 years). To overcome this issue, a long-term climate change scenario analysis could be used to assess the vulnerability of insurers to climate related risks, and to help understand how different firms are managing difficult-to-assess risks. The scenarios could explore different climate transition paths and incorporate both physical and transition risks:



Source: NGFS, 2019

Each scenario would have different assumptions about the physical risk factors (such as increased frequency extreme weather events or rising sea levels) and the transition risk

[14] See for instance, Waterproof? (DNB, 2017), The impact of climate change on the UK insurance sector (Bank of England, 2015, Issues Paper on Climate Change Risks to the Insurance Sector (IAIS, 2018), A call for action: Climate change as a source of financial risk (NGFS, 2019).

factors (such as carbon prices and shocks to assets, for instance based on CO_2 intensities/emissions across all scopes[15]). This could potentially be extended to shocks to other macroeconomic variables consistent with each scenario. Considering the long-term nature of the climate-change scenarios, this type of analysis might be more suited for a multi-period stress test.

Insurers would subsequently be asked to consider the expected impact on their assets, liabilities and business models for the different scenarios, assuming that their in-force insurance exposures and their current investment profile remain constant.

The advantages of this type of scenario analysis are:

- Allows to assess vulnerability to different climate scenarios for both physical and transition risks, even when the consequences of climate change will take time to materialize;
- Allows to gather quantitative information and enhance understanding regarding financial impacts under a given set of climate change-related assumptions;
- More realistic in terms of scenario materialization.

The disadvantage of this type of scenario analysis are:

- Long term horizon not compatible with the traditional format of a stress test and hence, no real stress impact as the scenarios typically take a long time to materialize;
- Impact of climate policies on climate changes and other macroeconomic variables can be very hard to model. Very assumption driven;
- No commonly agreed scenarios or broadly accepted methodology yet available.

2. Short-term climate stresses

A short-term stress test approach would incorporate climate-related stresses within the typical stress-testing time horizon (1-3 years). The stresses could incorporate both physical risks and transition risks. For physical risks these shocks could relate to a sudden increase in the severity and frequency of extreme weather related events (particularly relevant for general insurers). This approach would be similar to the Nat-Cat scenario included in EIOPA's 2018 Insurance Stress Test exercise.

For transition risks, the stresses could relate to a sudden and substantial increase in the price of carbon, a technology shock or changing consumer behaviour, which would translate into shocks to assets based on their CO_2 intensities. The transition to a low-carbon economy could happen more quickly than expected, which would create short-term impacts, especially if forward-looking asset prices suddenly change in response to shifts in expectations or sentiment concerning the transition path.

The advantages of this type of climate stress tests are:

- Short-term horizon compatible with the format of traditional stress tests;
- Allows to assess real stressed impacts due to sudden increase in physical and/or transition risk (for instance due policy or technology shock and/or sudden increase in extreme weather events).

The disadvantages of this type of climate stress test are:

- No common agreed methodology to calibrate the climate-related shocks. High degree of expert judgment;
- Short-term horizon less compatible with long-term climate-change transition scenarios.

[15] The GHG Protocol Corporate Standard classifies a company's GHG emissions into three 'scopes'. Scope 1 emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy. Scope 3 emissions are all indirect emissions (not included in scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions.

Questions:
Q. 22: What is your view on the possible approaches to climate stress testing?
Q. 23: What would be appropriate metrics to assess transition risk in assets?
Q. 24: What level of granularity would be needed in your view (i.e. industry level, underlying technology level, asset level)? Please distinguish between different asset categories if possible (i.e. equities, government bonds, corporate bonds, real estate)
Q. 25: How could climate related shocks be calibrated (please distinguish between physical risks and transition risks in your answer)? What data sources could be considered?
Q. 26: Do you have any further considerations on the inclusion of climate related risks in EIOPA's stress testing framework?

4.3.5 Sub-conclusion

100. A hybrid approach for scenario development is preferred above a purely historical or a pure forward looking approach as it allows to assess the envisaged risks maintaining consistency with the co-movements of the markets.

101. The choice on single-shock, single scenario, and combined scenario shall be strictly related to the objective of the exercise. Ideally, one would like to disentangle the impact of macro-economic versus insurer-specific shocks in combined scenarios.

102. Consistency with the SII framework is desired, however changes in the approach to derive the risk free rate curve are advised to better reflect the market conditions depicted by the narrative. If the UFR is kept unchanged with respect to the baseline, information on the sensitivity to UFR changes under stressed scenarios (if applicable) can be collected.

103. For supervisory purposes the impacts of LTG and transitional measures on the post-stress position need to be reported and analyzed, in line with the SII framework.

104. The granularity of the market shocks shall be considered in conjunction to the objective of the exercise. A bucketing approach can be considered as a preferred option for EU-wide assessments, unless specific country based analyses require a higher level of granularity.

5 Shocks and their application

105. The chapter is devoted to present, without any aim of completeness, a list of the main shocks that can be part of a ST exercise and their application to the balance sheet and capital position of undertakings. Completeness cannot be reached as the shocks to be prescribed in an exercise also depend on the evolution of the markets and the risk profiles of insurers. A distinction is made between market based shocks (section 5.1) and insurance based shocks (section 5.2). For each shock or group of shocks the approaches to its calibration, its expected impact as well as information on its application are provided. The chapter also includes a specific section on the simplifications and approximations potentially allowed in the estimation of the post-stress positions (section 5.4).

106. In principle, participants are requested to apply the shocks to their full balance sheet following the prescribed guidance and to calculate their post-stress positions utilizing the baseline model used for the production of their end-of-year SII report. In order to enable companies to meet the requirement of such a full balance sheet approach the technical specifications of each ST exercise will, amongst others, include particular guidance on the order of the shocks to be applied in case different choices on the sequence could materially impact the results. Potential limitations on the use of management actions as defined in paragraph 2.3.3 might be applied as well.

5.1 Market shocks

107. Market shocks represent the risk of an adverse movement in the values of assets or liabilities as a result of market movements such as interest rates, foreign exchange rates or the repricing of risk premia. The calibration of the shocks might be based on a historical approach, forward-looking approach or a combination of both (as discussed in Chapter 4). Market shocks also include shocks to the creditworthiness of market players resulting from fluctuations in the credit standing of issuers of securities, counterparties and any debtors to which insurance and reinsurance undertakings are exposed.

108. In principle, shocks shall be applied with the highest possible accuracy to the assets, namely a look-through approach shall be pursued wherever possible. This applies specifically to collective investments [R0180] and assets held for index-linked and unit-linked contracts [R0220].[16] In case asset classes which are supposed to be treated via look-through are not material, namely falls below the threshold on total assets defined in section 5.4.1, undertakings are allowed to apply a simplified approach which consists of applying the shock prescribed to the largest asset class in the respective portfolio.

109. The potential market shocks applicable are the following:

- government bond yields;
- corporate bond yields;
- equity prices;
- swap rates;
- residential real estate prices;

[16] Items in brackets refer to the EIOPA Solvency II balance sheet templates S.02.01.01 for solo undertakings and S.02.01.01 for groups available at https://eiopa.europa.eu/Pages/Supervision/Insurance/Supervisory-Reporting-and-Public-Disclosure-requirements.aspx

- commercial real estate prices;
- loans and residential mortgage-backed securities (RMBS) yields;
- other assets prices (private equity, hedge funds, real estate investment trusts (REITs), commodities);
- Downgrade of credit ratings.

Calibration of market shocks

110. EIOPA shall prescribe in its ST exercise severe but plausible scenarios which converts into shocks the economic conditions depicted in the narrative. The plausibility of a scenario is reflected by the consistency of the market movements generated by the prescribed set of shocks, combining both backward-looking and forward looking approaches.

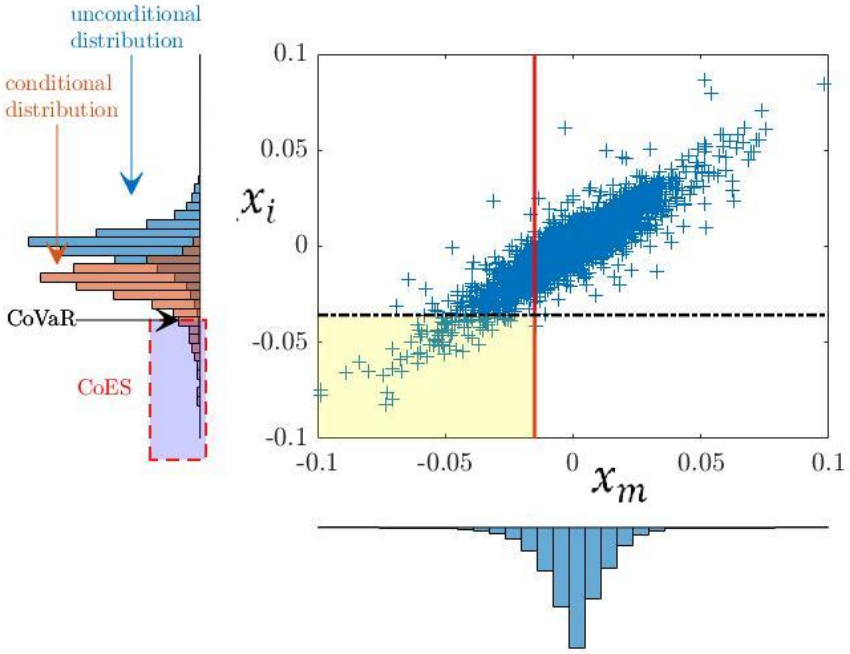
111. The calibration of the market shock is run in cooperation with the ESRB and it is based on the Financial Shock Simulator (FSS) developed and regularly used by the ECB for the design of EBA, EIOPA, ESMA ST scenarios and for internal and external policy analyses (e.g. impact assessment contained in the ECB Financial Stability Review). The model is based on a set of well-known and applied risk measurement techniques such as the Conditional Value at Risk[17] and the Marginal Expected Shortfall[18]. The simulation method is a non-parametric approach to capturing dependence structures across markets, i.e. it does not impose any parametric model structure which might not fit the tails of the distributions. The FSS allows to capture correlations in the extreme tails of financial returns' distributions relying on a large number of time series.

112. The construction of the scenario originates from definition of one (x_m) or more triggering events and the subsequent joint distribution of the event thereof with the other financial variables (x_i). The reaction of the other variables is captured via their conditional distributions as shown in figure 5.1 for the bivariate case. The metric used to estimate the values of the reacting variables condition that the triggering variable is under stressed condition are:

- Conditional Value at Risk (CoVaR): the VaR of a variable, given that another variable is in a distress scenario defined as values in a certain tail of its distribution;
- Conditional Expected Shortfall (CoES): the ES of a variable, given that another variable is in a distress scenario defined as values in a certain tail of its distribution;
- Conditional Mean Return (CMR): mean value of the dependent variable conditional on distribution being is in a distress scenario defined as values in a certain tail of its distribution.

[17] Adrian, T. and Brunnermeier, M. K. (2016), "CoVaR", American Economic Review, Vol. 106, No 7, pp. 1705-1741.
[18] Acharya, V., Engle, R. and Richardson, M. (2012), "Capital shortfall: A new approach to ranking and regulating systemic risks", American Economic Review, Vol. 102, No 3, pp. 59-64.

Figure 5-1 : Histogram and scatter plot for bivariate data



Source: ECB

113. The outcome of the process is a scenario where the encompassed variables co-moved according to patterns empirically observed, therefore generating a market consistent scenario. However, getting the joint probability of the stress test scenario is extremely difficult because of the large number of variables and data length issues (please see Annex II for more details). Detailed information on the Financial Shock Simulator can be retrieved form the FSS Technical note.[19]

5.1.1 Shocks to bonds

114. Fixed income assets are shocked by prescribing an increase of yields reflected in the reduction of the prices.

115. Shocks to prices are provided in term of change in yields (bps) with respect to the baseline. Geographical or time to maturity specifications can be provided for the different types of bonds. The provided shock shall be applied to the SII value of the fixed income assets taking into account the combined effect of the change in yields and of the change in the RFR derived from the shocks to SWAP rates for the different currencies.

116. In order to derive changes in the spreads the shocks applied to the SWAP rates shall be taken into account as follow:

a) The level after shock of the Euro swap curves are provided by the following equation: $SWAP_{Shock} = SWAP + Shock$;
b) The yield level of a bond generally includes a credit spread on top of the swap curve (which may also be zero or negative), therefore the yield of a

[19] Technical documentation available here: https://www.esrb.europa.eu/mppa/stress/shared/pdf/esrb.stress_test190403_technical_note_EIOPA_insurance~4fb409600b.en.pdf?fad046baaf28f167b817d46ddf4486fc

bond with a specific maturity can be expressed as $Y_{Bond} = SWAP + CreditSpread_{Bond}$ (where the swap term equals the maturity of the bond);

c) The shock levels for sovereign or corporate yields prescribed in each ST exercise refer to a change in the respective yields (and not to a change in credit spreads). The change in credit spreads can also be derived by $\Delta CreditSpread_{Bond} = \Delta Y_{Bond} - \Delta SWAP$.

5.1.1.1 **Government bonds [R0140]:**

117. Shocks to Government bonds can be provided per country, geographical area or by rating (depending on the granularity) and per selected maturity. In case shocks to a specific country/area are not provided, the closest geographical approximation shall be taken (e.g. EU average, EA average, Other advanced economies, Emerging markets)[20].

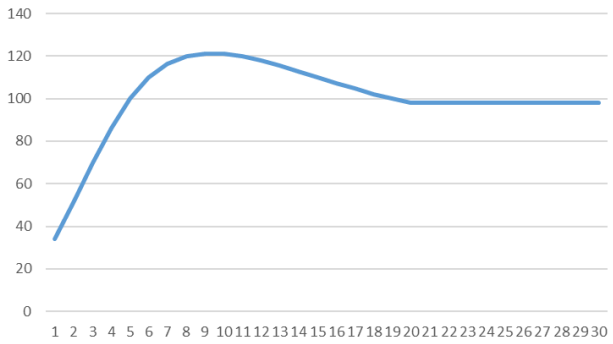
118. Shocks to sovereign bonds are provided for selected maturities. Shocks to missing maturities shall be derived:

- via interpolation (e.g. spline) for maturities that are not explicitly provided;
- by keeping the shock constant for all maturities exceeding the last maturity provided with an explicit shock.

An example of derivation of the shocks is provided in Table 5-1.

Table 5-1 Derivation of the shocks to sovereign bonds

Maturity (y)	Shocks (bp)	Maturity (y)	Shocks (bp)
1	34.16	16	107.26
2	52	17	104.65
3	69.84	18	102.21
4	86.30	19	99.98
5	100	20	98
6	109.90	21	98
7	116.30	22	98
8	119.85	23	98
9	121.20	24	98
10	121	25	98
11	119.81	26	98
12	117.92	27	98
13	115.52	28	98
14	112.81	29	98
15	110	30	98



Shocks reported in red are explicitly provided. Shocks reported in black are derived according to the approach described in paragraph 118 specifically interpolated valies are calculated via cubic-spline.

119. Sovereign bonds denominated in a currency other than the currency of the country of issuance should be first shocked according to the country shock and then, the resulting amount shall be transformed into the country currency by applying the exchange rate registered at the reference date. Example: "Country A" currency is EUR and it issues two bonds: "bond 1" denominated in EUR and "bond 2" denominated in USD. Both bonds shall be treated according to the shock prescribed to "Country A" and converted in the currency of "Country A" by translating the value of "bond 2" from USD to EUR applying the exchange rate registered at the reference date.

[20] For a classification between advanced economies and emerging markets please refer to the IMF World Economic Outlook database available at: https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/weoselgr.aspx

120. Bond issued by supra-national or multi-national organizations either EU or non-EU (Ref. EU 2015/35 Art. 180 (2)) are not subject to specific shocks to yields. The assets shal be revaluated only according to the prescribed changes on the risk free rate (ref. section Shocks to SWAP rates5.1.3).

5.1.1.2 Corporate bonds [R0150], Structured notes [R0160], Collateralised securities [R0170]:

121. In order to account for different yield volatilities based on the sector, the creditworthiness of the issuer and the country exposure, shocks to corporate bonds are distinguished in financial / non-financial[21] and grouped by rating (from AAA to CCC) and geographical area (e.g. EU, US, ASIA). The corporate bond portfolio shall be allocated to the proper group and stressed according the prescribed shock. In the absence of a precise allocation, the following proxies can be applied:

- Bonds issued by corporations based in non-covered geographical areas shall be shocked according to the average shocks provided for larger geographical areas (e.g. EU, US, Asia);
- The shocks to CCC rating class shall also be applied to corporate bonds with lower ratings. Unrated bonds shall be shocked according to the shocks prescribed to the BBB-rated bonds.

Shocks shall be applied homogeneously to all the maturities.

Questions:
Q. 27: What are your views on the calibration and application of the shocks to fixed income assets? Do you think that the proposed specifications are sufficiently detailed? If not please provide suggestion on how to improve the guidance.
Q. 28: With regard to the derivation of the shocks to different maturities do you have different solutions to propose?

5.1.2 Shocks to equity (Holdings in related undertakings, including participations [R0090], equity listed [R0110], equity unlisted [R0120] and own shares [R0390])

122. Shocks are provided in terms of percentage change in the stock prices per country or geographical area, and shall be applied to the SII value of the equity at the reference date according to the country or geographical area where the equity is listed.

123. When shocks are provided per country, in case the equity shock for a specific country is not provided, it should be approximated from the average of the shocks provided to the closest geographical area (e.g. EU average for all the European countries, US for North America). In case any of the proposed

[21] For the classification of financial/non-financial refer to ESA 2010 definition for "Financials" which includes the sectors "Central bank", "Deposit-taking corporations except the central bank", "Money market funds", "Non-MMF investment funds", "Other financial intermediaries, except insurance corporations and pension funds (excluding financial vehicle corporations engaged in securitization transactions), "Financial auxiliaries", "Captive financial institutions and money lenders", "Financial vehicle corporations engaged in securitization transactions", "Insurance corporations" and "Pension funds". All other positions would be assigned to "Non-Financials".

areas fit the purpose, participants shall apply the shock provided to the "other advanced economies" or "Emerging markets".[22]

124. In case of equities listed in more than one stock exchange *i*) the average of the shocks prescribed to the countries where the stock exchange are located shall be applied or *ii*) the shock prescribed to the country of the stock exchange where the majority of the equity is listed shall be applied.

125. Stock Indices shall be treated according to geographical criteria, e.g. DAX with shocks prescribed to equity DE, EURO STOXX 50 with EU average equity shock.

126. The SII value of an unlisted equity at the reference date shall be recalculated by applying the percentage change in the listed equity prices per country according to the country where the parent company of the issuing entity is located. Same treatment prescribed for the listed equities applies.

127. Own shares (held directly) shall be treated as the other equities in line with their listed or unlisted status.

128. Shocks to listed equities shall be used to stress the Holdings in related undertakings, including participations [R0090].

Questions:
Q. 29: What are your views on the shocks to equities?
Q. 30: What are your views on treating Equity unlisted [R0120] according to the shocks prescribed to listed equities? Do you consider the approximation reasonable?

5.1.3 Shocks to SWAP rates

129. Shocks to SWAP rates serve as an input to derive the RFR curve used to discount the cash flows to determine:

- non-life (excluding health) best estimate [R0540];
- health (similar to non-life) best estimate [R0580];
- health (similar to life) best estimate [R0630];
- life (excluding health and index-linked and unit-linked) best estimate [R0670];
- index-linked and unit-linked best estimate [R0710].

130. Shocks to swaps are used to derive the EIOPA RFR curves in line with the standard approach based on the Smith-Wilson model.[23] In principle the risk free rate curve under stressed scenario is derived by feeding the baseline model (e.g. unchanged UFR, LLP, convergence period) with the shocked SWAP rates, however parameters might be adapted to reflect the narrative and the market conditions depicted in the scenarios.

131. Ancillary elements of the Risk free rate curve:

[22] For a classification between advanced economies and emerging markets please refer to the IMF World Economic Outlook database available at: https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/weoselgr.aspx
[23] Technical documentation of the methodology to derive EIOPA's risk-free interest rate term structures. Available at: https://eiopa.europa.eu/Publications/Standards/Technical%20Documentation%20%2831%20Jan%202018%29.pdf

- Risk free term structures with and without Volatility Adjustment (VA) are provided for the most used currencies. For the currencies whose RFR curves are not provided, the baseline term structure shall be used;
- In case no shock to credit risk is provided in the scenario, the credit risk adjustment (CRA) is kept unchanged with respect to the baseline, otherwise the value of the CRA under stress is provided.

132. Stressed SWAP curves serves also as an input to re-valuate the full balance sheet positions, e.g. to derive the shocks to spreads for the fixed income assets in case the shocks are provided to yields (ref. to Shocks to bonds 5.1.1).

5.1.4 Shocks to real estates ([R0080 and R0060])

133. Separate shocks to prices are usually provided for commercial and residential real estates at country level. In case the shocks for a specific country are not provided, they should be approximated from the average of the shocks provided to the closest geographical area (e.g. EU average for all the European countries, US for North America). In case any of the proposed areas fit the purpose, participants shall apply the shock provided to the "other advanced economies" or "Emerging markets".

134. Property other than for own use [R0080] shall be fully shocked according to the shocks provided to the area where they are located.

135. Shocks to real estate could be also applied to the item "Property, plant & equipment held for own use" [R0060]. Specifically, real estate property shall be treated in line with the commercial real estate held for investment purposes whereas equipment shall be kept constant with respect to the baseline.

Questions:
Q. 31: What are your views on the shocks to real estate?
Q. 32: What are your views on the treatment of property, plant and equipment held for own use?

5.1.5 Shocks to Loans and mortgages ([R0230])

136. Shocks to RMBS yields shall be used to determine the post-stress SII value of Loans and mortgages ([R0230] and its sub-items) according to the investment grade of the portfolio and the geographical location.

137. The following approximations can be considered:

- In case the rating quality of the (different) portfolio(s) cannot be determined, a BBB rating quality has to be assumed;
- In case the shock to RMBS for a specific country is not provided, it should be treated according to the closest proxy.

Questions:
Q. 33: Are RMBS yields the proper index to treat Loans and mortgages ([R0230])? Is an additional granularity needed to treat the sub-items of the loan and mortgages category (i.e. Loans on policies, Loans and mortgages to individuals, Other loans and mortgages)? If yes, please provide suggestions for fitting indices.

5.1.6 Shocks to Collective Investments Undertakings" [R0180] and to Other Assets [R0420]

138. In line with the general principles on the application of the market shocks stated in paragraph 5.1, Collective investment undertakings shall be treated via a full look-through approach applying to the underlying assets the specific shock prescribed to each asset class.

139. Shocks to private equity, hedge funds, REITs and commodities shall be used for the treatment of the items "Any other assets, not elsewhere shown" [R0420]. Any residual "Collective Investments Undertakings" [R0180] (i.e. for those where look-through was not feasible) should be shocked according to the asset shocks most closely resembling the Collective Investment Undertakings. The application of the shocks depends on specific assets included in the Balance sheet items.

Questions:
Q. 34: Do you envisage potential constraints in the application of a look-through approach?

5.1.7 Shocks to Type 1 exposures (reinsurance recoverable [R0270], Insurance intermediate receivables [R0360], Reinsurance receivables [R0370])[24]

140. Reinsurance related exposures and other exposures that are classified under Type I counterparty exposures shall be treated according to specific shocks prescribed to the credit rating associated to the counterparty and the subsequent adjustment of its probability of Default (PD) and Loss Given Default (LGD). The prescribed shock might span from a downgrade to a default of the counterparty.

141. For example, the amount of recoverables from the reinsurance arrangement or insurance securitization and the corresponding debtors shall be adjusted in line with the shocks prescribed to Credit Quality Step (CQS) of the counterparty, namely accounting for the increased expected losses due to default of the counterparties (ref. Art 81 SII directive and art 42 of the SII delegated regulation). [25]

Questions:
Q. 35: What is your view on the shocks to type 1 Exposures? Do you consider the shocks to counterparties sufficiently specified? If not please provide indication on how to improve the specification.

5.2 Insurance specific shocks

142. The identification of the insurance risk factors to be shocked is a consequence of the defined scenarios and it is related to the degree of

[24] For a definition of Type 1 exposure please refer to the Solvency II Delegated Regulation 2009/138/EC.
[25] Ratings are usually provided according to the iBoxx rating classification. (Re)Insurance undertakings may use an external credit assessment in their stress tests issued by an External Credit Assessment Institution (ECAI) or endorsed by an ECAI. Conversions in different rating structures can be done according to the CQS classification as reported in the COMMISSION IMPLEMENTING REGULATION (EU) 2016/1800 of 11 October 2016.

complexity of the exercise. The risk exposure of the European insurance industry are the natural starting point for any consideration.

143. The chapter elaborates on the identification and calibration of the potential insurance specific shocks that could be included in a ST exercise making a distinction between shocks applicable to life business (5.2.1) and those applicable to non-life business (5.2.2). The expected impacts of these shocks on the balance-sheet items, on the OF and on the SCR are addressed as well.

144. Insurance specific shocks might relate to the risk that an inappropriate underwriting strategy is adopted or that unexpected losses arise even when an appropriate strategy is adequately implemented. Insurance shocks focus on the impact of the underwriting and claims functions on the insurers' premia and TP. Insurance shocks may cover underwriting risk, catastrophe risk, or the risk of deterioration of TP. According to the SII directive underwriting risk means the risk of loss or of adverse change in the value of insurance liabilities, due to inadequate pricing and provisioning assumptions.

145. Insurance shocks might be short-term and medium term. The short-term scenario should analyze the key risk exposure of the insurer in the face of catastrophic events, such as natural calamities, a severe economic recession. The medium-term scenarios should analyze the insurers' ability to withstand continuous adverse developments over the period of projection. Such adverse developments should include persistent inflation, recession, falling stock markets, and claims experience. For example:

- mortality or renewal expenses in real terms, may reasonably be relied on as fairly stable or having a stable trend. However, attention should be paid to both the risk of sudden change (e.g. a new infectious disease) and the possibility of a change in the trend;
- policy persistency, may need to be considered in the context of both historical experience and changes anticipated in the light of different operating methods used by the (re) insurer.

146. When designing and calibrating the shocks potential overlapping with the standard formula should be considered. It should also be noted that even the application of a shock similar to one considered in the standard SCR calculation could have a very different impact on the post-stress balance sheet, OF and SCR of insurers because of its combination with the other different shocks of the scenario, the implicit (not considered explicitly as in the standard formula approach) correlation with the other risk factors and the different economic conditions that might have a large effect especially on the life TP[26]. Therefore, it could be worth applying a shock similar to one already considered in the standard formula approach provided that the whole scenario to be tested is different from the assumed scenario underlying the Standard Formula calculation.

147. The potential insurance shocks applicable are the following:

- Longevity/mortality;
- Lapse/surrender;
- Life expense risk;

[26] As an example one could consider the case (taken form the 2018 EIOPA ST exercise) of an insurer that for the aim of calculating the SCR, in the baseline situation is more exposed to lapse up shock while, in an economic stressed situation, is mostly exposed to the standard formula mass lapse shock.

- Other life risk:
  - Disability/Morbidity;
  - Revision;
  - Pandemic;
- Provision deficiency (claims and expense inflation);
- Nat-Cat and man-made cat.

148. One or more insurance shocks could be considered for each ST exercise as long as they are consistent with the narrative and coherent with the other market and insurance specific shocks prescribed in the scenario.

149. Insurance specific shocks shall be applied to the entire in-force business of the participant. Potential limitations might be prescribed in case shocks are targeting specific business lines.

5.2.1 Life insurance shocks

150. In this Section the range of the potential life insurance shock is explored. For each risk factor a description is given of the potential shocks, the way how to calibrate them, and the expected impact on the balance-sheet items, the OF, and the SCR.

151. It should be noted that some life insurance shocks, namely lapse and longevity/mortality, could have a positive or negative impact depending on the characteristics of the in-force policies (i.e. guaranteed rates, surrender and lapse penalties, presence of annuity business) and on the economic financial conditions at the moment of the shocks. For this reason clustering of the portfolio could be considered when applying the shocks in order to have a common direction of the expected impacts on the balance sheet, OF and SCR items.

5.2.1.1 **Longevity / Mortality**

Description

152. The longevity/mortality risks represent the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level, trend, or volatility of longevity/mortality rates.

153. Mortality risk refers to a situation where an increase in the mortality rate leads to an increase in the value of insurance liabilities, whereas longevity risk refers to a situation where a decrease in the mortality rate leads to an increase in the value of insurance liabilities. This definition requires to select those homogenous risk groups where the respective stress implies an increase in the liabilities. Therefore, a positive marginal impact on the balance sheet post-stress is excluded.

Calibration approach

154. Life insurance portfolios are in general undertaking specific. The nature of the insured population as well as the nature of the products in such portfolios vary over different insurance undertakings. As a result the liabilities for such portfolios vary and show different sensitivities with respect to mortality characteristics, cash flow patterns, and interest rates used for discounting. Mortality sensitivity can be measured by changes in life expectancies.

155. For longevity/mortality shocks data at the total level (male and female together) or divided might be used from, for example, the Human Mortality Database (HMD).[27]

156. Longevity/mortality risk addresses different sources of uncertainty mainly level, trend and volatility. The consideration of the different sources result in differences in the possible design of the stress. The most favored approach in calibrating longevity/mortality risk is to use a Lee-Carter model – a well-known model often applied in the insurance industry. In order to take account of cohort effects the Cairns-Blake-Dowd model might be used as a possible alternative to compensate for the shortcomings of the Lee-Carter model. A combination of several models could be used to take into account model and parameter risks.

157. Many common mortality models can be expressed in the framework of generalized linear or non-linear models comprising of four components:

- A random component capturing the statistical behaviour of the number of deaths in the model;
- A systematic component or predictor capturing the effects of age, calendar year and year-of-birth;
- A link function associating the random component and the systematic component;
- A set of parameter constraints as most stochastic mortality models are only identifiable up to a transformation and therefore require parameter constraints to ensure unique parameter estimates.

158. During the review of methods, assumptions and standard parameters used when calculating the SCR with the standard formula (performed by EIOPA between 2016-2018) Table 5-2 has been derived demonstrating a possible more granular approach to mortality and longevity shocks: age and remaining term (i.e. calculation horizon) are as at the valuation date, the maximum remaining term for life long policies is defined as 120 minus attained age[28].

Table 5-2: Mortality and longevity

h(x) mortality	Remaining term to maturity							
Attained Age	> 0	> 10	> 20	> 30	> 40	> 50	> 60	> 70
≤ 40	10%	14%	17%	20%	24%	27%	31%	34%
≤ 60	10%	14%	18%	22%	26%	30%		
≤ 80	14%	16%	19%	21%				
> 80	11%							

[27] The HMD is a joint project of the Department of Demography at the University of California at Berkeley, USA and the Max Planck Institute for Demographic Research in Rostock, Germany. The Human Life-Table Database (HLD) was designed to supplement the HMD and provides access to additional mortality data. The HLD provides life tables assembled from different sources: statistical and scientific publications, official reports, data collections compiled by individual researchers, and so on. HMD is a reliable source of data to calibrate mortality models but data might be complemented by other source of information using national specific database. It should be highlighted that the mortality rates of the general population differ from the ones of the insured population and data might be complemented by other source of information using national specific database.

[28] EIOPA's second set of advice to the. European Commission on specific items in the Solvency II Delegated. Regulation, EIOPA-BoS-18/075.

h(x) longevity	Remaining term to maturity							
Attained Age	> 0	> 10	> 20	> 30	> 40	> 50	> 60	> 70
≤ 40	-9%	-12%	-14%	-17%	-20%	-23%	-25%	-28%
≤ 60	-8%	-12%	-15%	-18%	-22%	-25%		
≤ 80	-12%	-14%	-16%	-18%				
> 80	-11%							

159. Using single stresses that apply to all mortality rates, whatever their differences, might not take into account the specific characteristics of the best estimate of liabilities of the specific insurer. Mortality rates when applying shocks may differ per age or age groups, gender, type of product, socio-economic factors such as job or wealth, and geographical location. The stresses might be different depending on the age of the insured person. In particular younger persons would need to have higher stresses given that they benefit more from future mortality improvements than older persons.

Expected impacts

160. No impact on the asset side of the balance sheet is expected from longevity or mortality shocks. TP is expected to increase (as the mortality / longevity shock shall only be applied in case of a detrimental impact). While in principle an increase of the SCR post-stress could be expected, it should be noted that the final impact depends on additional second order effects (like for example potential reductions in policyholder bonuses).

Application

161. For operational reasons the mortality / longevity stress parameters provided often encompass changes in all the risk drivers mentioned above, i.e. changes in the level, trend, or volatility of longevity/mortality rates. Therefore, shocks should directly be applied to the BE mortality assumptions that are used to calculate the BE liabilities.

Questions:
Q. 36: What are your views on the calibration and application of the mortality/longevity shocks?

5.2.1.2 **Lapse/surrender**

Description

162. The lapse risk is the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level (both upward and downward as well as a massive change) or volatility of the rates of policy lapses, terminations, renewals and surrenders. In this paper, the technical term "lapse" refers to any kind of policyholder lapse options (lapses, terminations, renewals and surrenders) as specified in Art. 142 of the Delegated Regulation[29].

[29] Art. 142 (4) of the Delegated Regulation specifies the following types of "relevant options":
"(a) 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;
(b) all legal or contractual policyholder rights to fully or partially establish, renew, increase, extend or resume the insurance or reinsurance cover."

Calibration approach:

163. Shocks shall be based on the usage of expert judgement due to the scarcity of data for most markets.

Expected impact:

164. The impact of a lapse shock is strictly linked to the way the shocks are defined and applied. If the lapse shocks are applied assuming instantaneous payment then some specific asset items (cash and cash holdings, liquid assets like bonds, depending on the assets used) will decrease and the relevant TP (if positive) will decrease as well. If the lapse shocks are applied as a permanent change of the BE assumption or as a massive lapse event not instantaneously paid, the asset items in the SII balance sheet at the reference date will not change, while the relevant TP will increase/decrease depending on the characteristic of the life portfolios. As a consequence, the application of lapse shock could either increase or decrease the OF. Regarding the SCR, again it depends on the way shocks are applied. If an item other than cash and sovereign bond will be assumed to be sold to pay instantaneously the lapses then the relevant submodules of the market risk module will slightly decrease before the Loss Absorbing Capacity of Technical Provisions (LACTP). At the same time, all the SCR modules and submodules that are influenced by the TP (included the market risk module) could increase or decrease depending on the change in TP following the application of the shocks.

Application

165. Lapse stresses can feature characteristics that require particular guidance on the application of the shocks. This introduction aims to discuss two of the main elements that need to be considered in this context. The first aspect relates to the specific interdependency between the design of the lapse shock and its consistent application across participants, and the second aspect deals with the issue of a potentially positive marginal impact of a lapse stress component and its implications for the application of the shock.

Design of the lapse shock

166. In general, lapse shocks can be modelled as instantaneous lapse events as well as permanent changes in lapse rates (or a combination of both). The application of an instantaneous lapse event usually requires specific adjustments to the stochastic valuation and risk models of the participants in order to reflect the assumed sudden increase of lapses at the start of the projection. In particular, the specification of the stress scenario must provide details on the scope (lines of business affected) and the severity (level of lapses) of the instantaneous event. A stress in the form of a permanent change in lapse rates has until now been assumed to come in the form of an adjustment to BE lapse assumptions. However, a different approach based on the payout of the surrender values with an impact on the asset side might be pursued. For operational reasons the calibration and specification of the stress parameters for such a permanent increase or decrease is usually not related to the specific choice of participants with regard to the definition of the term "best estimate lapse rate" (e.g. whether lapses are measured against a number of contracts, sum assured, premiums or other volume measures).

167. A more subtle issue regarding the dependency between the design of a lapse stress and its application refers to any potential relations between the

lapse stress parameters and specific product features. The stress parameters for an instantaneous or a permanent lapse shock can be chosen to depend on one or several product features (like e.g. type of product, level of financial guarantees, type and impact of lapse penalties or other characteristics). While such dependencies may be backed by empirical evidence, the variety of insurance products and features across the Europe does generally not allow a "one-fits-all" solution at the required level of granularity. Therefore, the technical specification of any interrelation between lapse shock parameters and product features may require principle-based approaches that in turn can pose specific challenges to a consistent application. Against this background, the following subsection discusses some possible approaches for so-called "bucketing criteria" with the purpose of linking the lapse shock parameters to the type of insurance product.

Marginal impact of the lapse shock

168. The impact of an adjustment of best estimate lapse assumptions on the best estimate of traditional life insurance products depends on several conditions, including amongst others:

- contract specific features (like for example the level of interest rate guarantees);
- capital market situation (like for example the level of the SII risk free rate curve);
- cross-subsidisation effects across the in-force business (like for example different levels of interest guarantees across tariff generations);
- modelling approaches in the company specific stochastic valuation and risk measurement models (like for example the modelling of management actions or the modelling of dynamic policy holder behaviour).

169. Given the contract / company specific nature of lapse risk and its interaction with the asset allocation, it is very complex to define a general and "one-fits-all" rule that correctly describes in each and every case whether such an adjustment implies an increase or a decrease of the best estimate of a single contract or of a homogenous risk group (in the sense of the SII Delegated Regulation).

170. Consequently, an explicit decision on how to handle this complex issue has to be taken in the context of a ST exercise. If a potentially positive marginal impact of a lapse stress component is not a proper outcome in a stress test exercise, the technical specification has to provide specific guidance on the respective conditions with regard to the application of the shock to the in-force portfolio.

171. From a methodological perspective, several approaches can be taken to avoid such potential positive marginal impacts, which are discussed in more detail below.

172. Alternative approaches do not seek to avoid a positive marginal impact of a lapse stress "ex ante" as in the SII standard formula, but by defining specific conditions "ex post". The so-called "cap approach" used for the 2018 EIOPA ST exercise can be seen as an illustrative example for this class of techniques. It was formulated as a decision rule in such a way that the lapse stress was to be applied only in case of a net detrimental impact on the SII balance sheet

conditional to the situation after the market shock[30]. This approach also required the calculation of interim results for the BE reserve after the market stresses, but offered some more flexibility compared to the "standard formula approach" with respect to the stipulated level of granularity. It could be applied to the total in-force business instead of differentiating between homogeneous risk groups, i.e. it could focus on the net impact across product lines instead of the gross impacts for different blocks of business. It should be noted that the comparability of results may be hampered by a potentially heterogeneous application of such caps across participants. This issue could however be addressed by requesting additional information from participants on the application of such a cap and its materiality for the stressed SII balance sheet[31].

5.2.1.3 **Options for the application of lapse shocks: bucketing criteria**

The "Standard Formula Approach"

173. The idea to link the design of a lapse shock to characteristic features of the underlying insurance product (where the concept of a "characteristic feature" is not necessarily limited to the type of product) is implicitly embedded in the SII Standard Formula framework. This applies in particular to traditional life with-profit business. Article 142 of the Delegated Regulation (dealing with the calculation of the lapse risk submodule for life business) distinguishes between three different "types" of capital requirements (with the resulting capital requirement for the lapse submodule defined as the maximum of these three intermediate results):

a) The capital requirement for the risk of a permanent increase in lapse rates. For this calculation "the increased option exercise rates […] shall only apply to those relevant options[32] for which the exercise of the option would result in an increase of TP without the risk margin.";
b) The capital requirement for the risk of a permanent decrease in lapse rates. For this calculation "the decrease in option exercise rates […] shall only apply to those relevant options for which the exercise of the option would result in a decrease of TP without the risk margin.";
c) The capital requirement for mass lapse risk. For this calculation the "discontinuance of the insurance policies" shall be applied to those contracts for which "discontinuance would result in an increase of TP without the risk margin".

174. These provisions therefore take explicitly into account that a decrease or increase of lapse assumptions can have a positive impact on the OF (or on Assets over Liabilities) in the SII balance sheet for some policies or

[30] Cf. "Insurance Stress Test 2018 Technical specifications (EIOPA-BoS-18-189)", paragraph 81: "The application of the lapse shock is subject to the following general side condition: if the application of the lapse stress […] should imply a positive marginal impact on the Solvency II own funds of the participating groups (conditional to the situation after the application of the market shocks), then this positive marginal impact should be neutralised and capped to zero at group level. […]".

[31] Cf. "Insurance Stress Test 2018 Technical specifications (EIOPA-BoS-18-189)", paragraph 81: "[…] A separate line in the reporting template of the group own funds after stress requires participating groups to report the total amount of the caps applied at group level outside the scope of the regular post-stress reporting items."

[32] The term "relevant option" is further specified in Art. 142 (4) of the Delegated Regulation as follows:
(a) 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;
(b) all legal or contractual policyholder rights to fully or partially establish, renew, increase, extend or resume the insurance or reinsurance cover.

homogenous risk groups while for others this impact would be negative. In principle, this means that the company has to check for each contract / homogenous risk group whether the adjustment in question for the different lapse shocks implies an increase or a decrease of the BE reserve. Furthermore, potential cumulative effects have to be taken into consideration. This (potentially iterative) comparison of best estimate reserves therefore forms the methodological core of an accurate application of the Standard Formula regulation.

175. It is acknowledged that the specifications for the permanent shocks can be interpreted to refer rather to homogenous risk groups (in the sense of the Delegated Regulation) as a whole than to an individual contract level. However it is clear that the allocation of single policies, or model points to such a homogenous risk group requires considering the specific contractual features.

176. The specification for the mass lapse risk addresses individual policies explicitly: in principle it has to be checked for each contract / model point whether an instantaneous surrender would increase the BE liability or not[33].

177. Another type of "contract specific" approach is applied for simplified calculation of the capital requirement for permanent changes in lapse rates. Article 95 and Article 102 of the Delegated Regulation introduce the concept of a "surrender strain" for a single policy, defined as the difference between "the amount currently payable by the insurance undertaking on discontinuance by the policy holder, net of any amounts recoverable from policy holders or intermediaries" and "the amount of technical provisions without the risk margin". This is by definition a calculation on contract level, with the result depending on the specific contract features[34]. The simplified calculation of the capital requirement for the risk of a permanent increase (resp. decrease) in lapse rates according to Article 95 and Article 102 addresses only those policies with a positive (resp. negative) surrender strain. It should be noted that neither of these articles deal with the concept of an instantaneous (mass) lapse event.

178. The SII Standard Formula specifications discussed so far all refer to the calculation of the regulatory capital requirement for lapse risk in the baseline scenario. As a such, they do not deal with any kind of ST exercises. With regard to the application of a lapse shock in the context of a stress test however, the methodological core of this approach can be extended in order to:

- define a bucketing criterion for the application of the lapse stress;
- define an approach to avoid a potential positive marginal impact of the lapse stress component.

179. A straightforward application of the standard formula approach for lapse stresses in a combined market – insurance stress scenario would require

- to calculate the BE reserve for each homogenous risk group after the market shocks in order to derive the sign of the surrender strain[35];
- to apply an instantaneous lapse event / a permanent increase (resp. decrease) of best estimate lapse assumptions to those homogenous risk

[33] This paper does not aim to discuss any methodological challenges or approaches regarding the technical implementation of this specification.
[34] Cf. previous footnote.
[35] It should be noted that the calculation of these intermediate results requires several additional stochastic runs.

groups with a positive (resp. negative) surrender strain after the capital market shock.

180. In principle, this approach would imply that the bucketing is defined in terms of a positive / negative surrender strain. Due to this explicit link to the sign of the surrender strain it can be expected that the marginal impact of a lapse shock based on this bucketing criterion should automatically be negative[36].

The "classification approach"

181. This approach aims at defining a link between the sensitivity of lapse rates and a selection of certain 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. Therefore, a rather principle-based approach was chosen for the following discussion. Two different options are presented.

Option 1

182. 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 (depending on the underwriting standards of insurers).
- 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. Given the fact that market movements are directly reflected in the value of the insurance contract the comparison with alternative investment opportunities might not have such an influence on potential lapse decision as for traditional products. On the other hand a higher volatility of returns, e.g. in case of an equity shock like in the yield curve up scenario, might lead to higher volatility of lapse rates than for traditional products. A further aspect that could be considered here relates to the

[36] It should be noted though that for operational reasons the approach would focus on the surrender strain of each homogenous risk group in isolation and would in particular not require to iteratively check all possible combinations across homogenous risk groups.

impact of various types of financial and non-financial guarantees included in some of these capital market oriented products.

183. The application of some of this criteria allows to classify the different types of insurance products according to their sensitivity to lapses as depicted in Table 5-3.

Table 5-3 Sensitivity of lapse rates and a selection of certain product types

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

Option 2

184. An alternative approach to classify the portfolio of the life products by a lapse perspective based on the rational investment behavior of policyholders relies on the levels of surrender penalties and guaranteed rate. Products with higher guaranteed rates and high surrender penalties are less likely to be lapsed, or better, requires less likely changes in the economic and financial

market conditions than products offering lower or no guarantees and higher penalties in case of lapse.

185. The application of this approach presents as a major complexity the definition of a homogeneous and agreed approach to the definition of both surrender penalties and guaranteed rate, 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 and interest guarantees 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). For interest guarantees the required classification with respect to their "level" and the assumed correlation to the lapse behavior of policyholders is even more challenging. Some guaranteed rates are fixed over the entire contract term, whilst others are renewed and repriced after specific time periods. Some interest guarantees only refer to the point of maturity of the contract, whilst others are defined on a yearly or even monthly basis. When referring to the "level" of an interest guarantee it has furthermore to be defined whether this level relates to the entire gross premium or only to specific (e.g. savings) components which again might be differently defined across Europe.

186. 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 one presenting contract related and fiscal related (high) penalties and higher shocks to the one with no penalties as presented in Table 5-4.

Table 5-4 Penalty-based bucketing

	Low penalty rate (<10% on surrender value)	High penalty rate (>10% 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

187. The guaranteed rate dimension can be approached relying on the technical rate used to compute the statutory BE as depicted in Table 5-5. Thresholds shall be defined in a relative way with respect to the level of the yields in the post-stress scenario. Potential reference might be the post-stress level of the risk free rate as presented in the table. It is worth noting that the figures reported in the table for the thresholds are mere examples, and are not an outcome of a calibration process.

Table 5-5 Guaranteed rate bucketing

Technical rate	Low (<RFR_5 - 100bp)	Medium (RFR_5-100bp<x<RFR_5+100bp)	High (>RFR_5+100bp)
Sensitivity	**	*	o

o = low/no sensitivity, * = medium sensitivity, ** = high sensitivity
RFR_5 = post-stress Risk Free Rate maturity 5 years

188. The penalty-based and the guaranteed rate dimensions can be combined as presented in Table 5-6.

Table 5-6 Combined guaranteed rate / penalty-based bucketing

Penalties	Contract AND Fiscal	o	o	o
	Contract OR Fiscal	**	*	o
	No penalties	***	**	o
		Low (RFR_5 - 100bp)	Medium (RFR_5-100bp<x<RFR_5+100bp	High (>RFR_5+100bp)
		Technical rate		

o = low/no sensitivity, * = medium sensitivity, ** = high sensitivity, *** = very high sensitivity
RFR_5 = post-stress Risk Free Rate maturity 5 years

<u>The "uniform approach"</u>

189. This approach puts specific emphasis on the empirical evidence of the sensitivity of policy holder lapse behavior to movements in capital markets, in particular during the financial crisis beginning in 2008. It could be argued that at least in some member states this crisis induced indeed a temporary increase in lapses, however without significantly discriminating any product type. Against this background the reason for this temporary lapse increase could be assumed to rather be linked to the direct consequences of the crisis (e.g. significantly lower incomes) than to a kind of sophisticated financial rational policy holder behavior that differentiates between certain insurance product types or features. The approach therefore assumes that the decision of policy holders whether to lapse their contract after a severe event is rather linked to their ability and willingness to continue to pay premiums than to a comparison between the surrender value and the economic value of their contract[37]. This assumption may be seen as further supported by the observation that in some member states lapse rates reversed to their pre-crisis level after a certain period of time when the economic situation (e.g. with regard to private income) improved again.

190. In order to reflect these empirical observations the approach for the design of the lapse stress could refer to an instantaneous increase of lapses which however prevails for a certain period of time (e.g. 2-3 years) and which is applied in a uniform way to all insurance products (i.e. without differentiating between product type or other product related features). After this period of time it would be assumed that lapse rates return to their former best estimate

[37] It can be argued in general that it is extremely difficult for a single policyholder to quantify the economic value of the contract because of the usually very complex contractual options and guarantees and all the potential cross subsidization effects with the rest of the in-force business.

level. Table 5-7 presents the advantages and the disadvantages of the 3 described approaches to the application of the shock to lapse.

Table 5-7: Advantages and the disadvantages of the 3 approaches to the application of the shock to lapse

Approach	Advantage	Disadvantage
Standard Formula	• The approach does not only address differences in product types, but also in other product features (e.g. the guaranteed interest rate) which have an impact on the value and the sign of the surrender strain • The similarity with existing specifications in the Delegated Regulation might support a consistent application across participants[38] and therefore improve the comparability of the results • The formal criterion "positive / negative surrender strain" is related to the result of a technical calculation and not to a subjective allocation of the participants, therefore mitigating the risk of a potential cherry picking • The approach addresses the problem of a potentially positive marginal impact of a lapse shock directly	• In case of a combined scenario the approach requires the calculation of the best estimate reserve after the capital market shock as an interim result in order to derive the value and in particular the sign of the surrender strain. This additional calculation increases the complexity and the operational workload for participants significantly and may require further guidance regarding acceptable simplifications • The approach could be characterized as a form of reverse stress test as the reference to the formal criterion "positive / negative surrender strain" implicitly assumes a kind of "most adverse policy holder behavior". It could be argued that this reverse stress character is not fully compatible with the intention of a bottom-up stress test
Classification	• The approach does not require any additional intermediate stochastic calculations from participants (like in the "Standard Formula approach"), but just a mapping of the individual products to the "type of product" category • The approach is flexible enough to be further refined according to the goals of the stress test exercise (e.g. in case of a specific interest in specific product lines)	• Given the required principle-based character of the bucketing criteria it might be challenging for participants to allocate all their products appropriately. The need for potential clarifications and / or decisions during the Q&A process might either lead to a late start of the required calculations (possibly affecting the quality of results) • The approach does not exclude a potentially positive marginal impact of

[38] Assuming that also IM users apply similar criteria for the calculation of the capital requirement for lapse risk.

		the lapse stress without imposing further side conditions
Uniform	• The approach does not require any additional calculation from participants (like in the "Standard Formula approach") or any allocation of model points to "type of contracts" (like in the "classification approach") but an adjustment of lapse assumptions • The approach can be backed by empirical evidence supporting its plausibility	• The approach does not exclude a potentially positive marginal impact of the lapse stress without imposing further side conditions

Questions:
Q. 37: Can you suggest any time-series to be used to calibrate the shock to lapse?
Q. 38: What are your views on the described approaches to the application of the lapse shocks?
Q. 39: What are the main theoretical and operational issues you envisage in the application of the "standard formula" approach?
Q. 40: What are the main theoretical and operational issues you envisage in the application of the classification approach based on product characteristics (option 1 in the classification approach)?
Q. 41: Does the proposed classification approach based on product characteristics fit your liability portfolio? If not please suggest a different classification.
Q. 42: What are the main theoretical and operational issues you envisage in the application of the classification approach based on guaranteed rate / penalties (option 2 in the classification approach)?
Q. 43: Is the technical rate a proper reference to assess the level of the guarantee? If not do you have other suggestions?
Q. 44: What are proper thresholds to be applied to the technical rate?
Q. 45: What is in your view a proper criteria to classify the penalties?
Q. 46: Do you have other suggestion to classify the life portfolio in the light of a lapse shock?

5.2.1.4 **Life expense risk**

Description

191. Life expense risk refers to the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level, trend, or volatility of the expenses incurred in servicing life insurance or reinsurance contracts.

Calibration approach

192. Expenses might be influenced by a variety of factors, some exogenous (e.g. general consumer price index and specific inflations on medical costs) and some internal to the company (e.g. management actions).

193. The calibration of the shocks can account for the cycle of the general economy and reflect the measures available to central banks to control inflation rates. Central banks have a target for long-term inflation rate, making large volatility on long-term inflation rate less likely, but fluctuations in short-term inflation can still occur.

194. Another component of a life expense risk shock relates to an adjustment of the best estimate expense assumptions. For operational reasons the calibration and specification of the stress parameters for a permanent increase of such best estimate expenses is usually not related to the specific choice of participants with regard to the definition of the term "expense rate" (e.g. whether expenses are measured against a number of contracts, premiums or other volume measures).

195. In assessing what expense shocks should be applied the following factors should be considered:

- Expense shocks are subject to a wide variety of future sensitivities. For example, some expenses are a direct multiple of a benchmark value, e.g., premiums for agent commission or premium tax/duty, claim amounts for claim expenses and investment management for investment expenses, and thus not subject to inflation/productivity effects. It might be welcome not to apply a single inflation factor to all company expenses;
- Other expenses are often partially fixed and partially variable. The variable expenses should in most cases correspond to changes in corresponding units (e.g. premium or other measure of the volume of business, claims or assets), management productivity and general inflation;
- The larger the company, the smaller the unit-expense level tends to be. Faster growing companies can experience reductions in unit expense levels, while those companies with plateauing or declining volumes of business can experience unit expense increases;
- For some classes of insurance, expense charges are built directly into the premiums charged and are not subject to change over the term of the contract. If this term is for many years, the expense risk can be large and a combination of both a level risk charge and inflation factor is needed. For other classes of longer-term insurance, expense charges may be subject to management action and adjustment.

Expected impact:

196. An increase of Life TP is expected and, as a consequence, a negative impact on the OFs is envisaged. Regarding the SCR, due to the increase of TP the SCR is expected to increase. The most impacted modules will be the life underwriting and the operational risk.

Questions:
Q. 47: What are your views on the calibration and application of the life expense shock? What data sources could be used to calibrate the shocks?

5.2.1.5 Other life risk

197. Beside shocks described in this chapter insurance undertakings may stress the following risks taken into account their specific business portfolio:

- Morbidity or disability shock - associated with all types of insurance compensating or reimbursing losses (e.g. loss of income) caused by illness, accident, or disability (income insurance), or medical expenses due to illness, accident or disability (medical insurance), or where morbidity acts as an acceleration of payments or obligations which fall due on death. Morbidity or disability shock is intended to reflect the uncertainty in morbidity and disability parameters as a result of changes in the level, trend and volatility of disability, sickness and morbidity rates, and capture the risk that more policyholders than anticipated are diagnosed with the diseases covered, or are or unable to work as a result of sickness or disability during the policy term.
- Revision shock – associated with a risk of loss, or of adverse change in the value of insurance liabilities resulting from fluctuations in the level, trend, or volatility of the revision rates applied to annuities, due to changes in the legal environment, or in the state of health of the person insured. It represent the risk of a rapid growth or decline in the volume of the underwriting portfolio, including the effects of increasing longevity on pension products. Technical provisions deficiency result also because of the link with other market and insurance factors such as interest rate risk.
- Pandemic shock – associated with the risk of loss, or of adverse change in the value of insurance liabilities, resulting from the significant uncertainty of pricing and provisioning assumptions related to extreme or irregular events (like a pandemia).

198. While these shocks could have a significant impact on insurers, further work would be needed on how they could be calibrated and incorporated within a stress test framework.

Questions:
Q. 48: What are your views on other life risk shocks, in particular regarding morbidity and disability shocks, revision shocks and/or pandemic shocks in a stress test? What data sources could be used to calibrate the shocks?

5.2.2 Non-Life insurance shocks

199. In this Section the range of the potential non-life insurance shock is discussed. For each risk factor a description of the potential shocks, the way how to calibrate them and the expected impact on the balance sheet items, on the OF and on the SCR are described.

200. Non-life underwriting risk is the specific insurance risk arising from non-life insurance contracts. It relates to the uncertainty about the results of the insurer's underwriting. This includes uncertainty about:

- the amount and timing of the eventual claim settlements and expenses in relation to existing liabilities;
- the premium rates which would be necessary to cover the liabilities created by the business written;
- The frequency and severity of cat-events.

201. The potential non-life insurance shocks to be considered are the following:

- Provisions deficiency shock (claims and expense inflation);
- Cat-event shocks (both Nat-cat and man-made catastrophes with shock to recoverability of the ceded losses).

5.2.2.1 **Provisions deficiency shock: claims and expense inflation**

Description

202. A provision deficiency shock assumes an increase in the insurance provisions caused by a higher than expected increase of the cost of claims (both outstanding and future claims) and expenses, which modifies the best estimate assumptions. Provision deficiency might be driven by shocks related to the different components of the technical provisions such as:

- The level/severity and frequency of insurance claims;
- The level of expenses related to servicing claims;
- Revision risk for annuities where the benefits payable under the underlying insurance policies could increase as a result of changes in the legal environment or in the state of health of the person insured.

Calibration approach

203. Mainly usage of expert judgement. While some US indexes are available[39], no European proper indexes can be found[40].

Expected impacts:

204. No impact on the asset side of the balance sheet is expected from a provision deficiency shock. On the liability side, the provision deficiency shock will lead to higher TP and a decrease in the OF. The SCR is expected to increase due to the higher TPs. The modules and submodules that are likely to be most impacted are non-life underwriting risk and operational risk (where this is based on TP).

Application

205. The provisions deficiency shock applies to the whole in-force business with potential differentiation between life and non-life lines. Health similar to life shall be treated according to the shocks prescribed to the life business whereas health similar to non-life according to the shocks prescribed to the non-life.

206. Shocks are prescribed as a percentage uplift to the annual claim and expense inflation assumed for the calculation of the best estimate under baseline scenario. Using a time-vector $I^B = [i_1 + i_2 + \ldots + i_t + \cdots i_n]$ (where i_t is the value of the inflation at time t) to express the value of the claim inflation used to compute the best estimate, the shock can be applied in 3 ways:

A. Additive approach
The inflation vector to be used in the calculation of the best estimate under stressed scenario I^S is derived by summing the prescribed shock s (scalar) to the baseline inflation vector I^B. Therefore $I^S = s + I^B$, hence the claim

[39] Information available at: https://www.bls.gov/pir/diseasehome.htm.
[40] Only some statistics (not in the form as price indexes) can be found at the following link https://ec.europa.eu/eurostat/statistics-explained/index.php/Healthcare_expenditure_statistics#Health_care_expenditure.

inflation at time t is: $i_t^S = i_t^B + s$. The approach implies a parallel shift in the cost of claims vector;

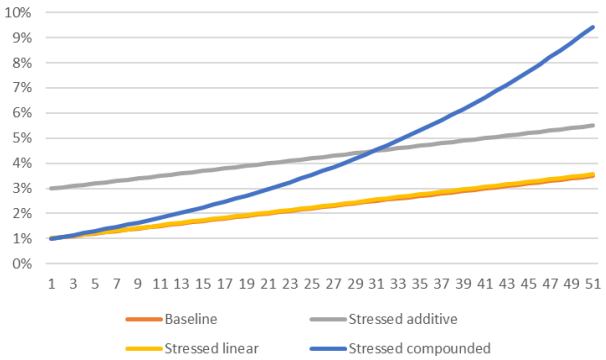
B. Linear approach
The inflation vector to be used in the calculation of the best estimate under stressed scenario I^S is derived by multiplying the baseline vector I^B by the prescribed shock *s* (scalar). Therefore, $I^S = s * I^B$, hence the claim inflation at time t is: $i_t^S = (1+s)i_t^B$;

C. Compounded approach
The approach implies that the projected inflation at time t is computed as follow: $i_t^S = i_t^B * (1+s)^t$.

The three approaches lead to materially different impacts as shown in Table 5-8 where the projection of a 2% claims inflation shocks is displayed.

Table 5-8 Claims inflation approaches
(Shock = 2%)

Time	Baseline	Stressed		
		Additive	Linear	Compounded
0	1.00%	3.00%	1.02%	1.00%
1	1.05%	3.05%	1.07%	1.07%
2	1.10%	3.10%	1.12%	1.14%
3	1.15%	3.15%	1.17%	1.22%
4	1.20%	3.20%	1.22%	1.30%
5	1.25%	3.25%	1.28%	1.38%
6	1.30%	3.30%	1.33%	1.46%
7	1.35%	3.35%	1.38%	1.55%
8	1.40%	3.40%	1.43%	1.64%
9	1.45%	3.45%	1.48%	1.73%
10	1.50%	3.50%	1.53%	1.83%
...	...%	...%	...%	...%
20	2.00%	4.00%	2.04%	2.97%
...	...%	...%	...%	...%
30	2.50%	4.50%	2.55%	4.53%
...	...%	...%	...%	...%
50	3.50%	5.50%	3.57%	9.42%



5.2.2.2 **Catastrophe risk scenarios: Nat-cat and man-made**

Description:

207. Nat-cat and man-made catastrophic events relate to specific perils that insurers provide cover for. Nat-cat and man-made catastrophe shocks should be applied to all lines of business.

Calibration approach:

208. Due to the specificity of the risk the definition of an event-based scenario should rely on external data provider or, alternatively, a *standard formula approach* could be followed. Advantages and disadvantages of the two approaches are listed in the following table.

Table 5-9: advantages and the disadvantages of the approaches for the definition of the events or, alternatively, a standard formula

Approach	Advantage	Disadvantage
Standard Formula	• The similarity with existing specifications in the Delegated Regulation might support a consistent application across	• The approach will consist in a pure replication of the standard formula computation (only with different

	participants[41] and therefore improve the comparability of the results • Easy to be implemented by participants (easy to be validated as well) • The approach allows for a similar severity of the impact of the shock for all participants notwithstanding the geographical distribution of their exposures to Cat events • The approach avoids the need for participants that don't have an internal model to calculate Cat losses to pay external providers for calculating the impact of the shocks • The approach avoids the reputational risk of EIOPA in relying on specific external providers (if not properly communicated)	parameters) not giving any real additional insight on the vulnerability of the insurance sector. In particular, given the structure of the Cat submodules the only way for applying it differently from the SCR calculation is to select one or some specific regions/risk factors and to ask participants to compute their losses without taking into account any diversification effects • The approach does not allow for the evaluation of the impact of a specific set of Cat events on the European insurance sector (namely a specific earthquake or windstorm). Therefore it seems not adequate to test the impact of a realistic ST scenario
Event-based scenario	• The approach will allow for the evaluation of the impact of a specific set of Cat events on the European insurance sector (namely a specific earthquake or windstorm) providing additional insights on the resilience of the sector to the Cat risks	• The approach could be expensive and challenging for undertakings / groups that do not have an internal model for computing Cat losses. This is particularly true for medium/small non-life solo undertakings • Medium/small undertakings could not have enough granular and sufficient data to feed into the Cat software (features of the buildings, destination of the buildings, type of policy coverage,…). As a result, the final estimation of the losses could be very rough (under/overestimated) • If not properly communicated, it might exposes EIOPA to the reputational risk of preferring one specific external providers among the few existing competitors of the sector (altering the competition and level playing field) • The approach doesn't allow for a similar severity of the shocks for all participants (as an example Iberian groups

[41] Applicable to standard formula users only.

		have had no huge impact from the 2018 ST Nat-Cat scenario since no Nat Cat events were localized in that geographical area) • The comparability of results could be hampered by the fact that current Cat software allow for some customization by participant groups that may concur to the lowering of the estimation of the final losses

209. The *event-based scenario* approach, where feasible, is the preferred option for a Stress Test exercise. The s*tandard formula approach* will be only a replication of the computation of the Cat sub modules not providing any additional insight on the vulnerability of the European insurance sector to a series of realistic Cat events, that can only be assessed through a "scenario" approach similar to how internal model users compute their Cat capital requirement.

210. The legal risk which EIOPA could be exposed to when selecting one specific Cat providers for the identification of the set of the events could be decreased by means of not selecting the same provider each time.

Man-made catastrophes

211. The following databases might be used for man-made catastrophes: World Trade Center Cases in the New York Workers' Compensation System", New York State Workers' Compensation Board, ICA Catastrophe Datasets[42], SwissRE database[43]. Specific scenarios would be established in consultation with external data providers.

Expected impact:

212. The impact on the balance sheet items strictly depends on how the shocks are applied. If claims are supposed to be instantaneously paid (not so realistic for these type of non-life claims that need some time for the assessment of the damage) an impact (decrease) on the cash and other liquid assets is observed, while if the claims are reserved then an increase of the non-life claims technical provision is registered. Notwithstanding the approach followed the reinsurance recoverables item increases. The final impact on OF will always result in a decrease whatever approach of application of the shocks is chosen. The decrease of OF will be larger if the default of some reinsurers is also considered. In this last case the amount of reinsurance recoverables will be less relevant. Considering the SCR post shock, an increase is expected due to higher losses and lower recoverables.

Application:

213. The computation of the impacts of the prescribed cat events on the balance sheet and solvency capital requirement of an insurance undertaking depends on the two main elements:

[42] Available at: https://docs.google.com/spreadsheets/d/1vOVUklm2RR_XU1hR6dbGMT7QFj4I0BGI_JAq4-c9mcs/edit#gid=2147027033.
[43] Available at: http://www.sigma-explorer.com/.

A. The approach to the settlement of the claims;
B. The assumption made on the reinstatement of the reinsurance treaties.

Claim disbursement

214. The management of the claims, especially with regard to natural or man-made catastrophes, encompasses several steps which could stretch the time incurring from the filing to the settlement. Given the time dimension the impact on the balance sheet of a claim might be twofold: *i*) before the settlement the impact is on the liability side with an increase of the technical reserves whereas *ii)* after the settlement the impact is transferred from the liability side (reduction of TP) to the asset side with a reduction of the assets used to pay out the claim.

215. Given that the time requested varies according to the type of claim, its complexity and the operational efficiency of an insurer some assumptions need to be done in order to fit the process into the general framework of a stress test exercise and to grant the comparability of the results. To that aim two "black or white" approaches can be followed:

A. The instantaneous disbursement which implies the instantaneous payment of the claims and no impact on the technical reserves;
B. The full reserve approach which implies no payment of claims, hence no impact on the assets and effect of the prescribed shocks fully on the TP.

Option A requires assumptions on the assets to be sold against the claim disbursement and their sequence of sale. The main challenge in a ST context is to avoid a "cherry-picking" approach in the selection of the assets to be sold (e.g. participants can opt for the sale of the assets which according to thte prescribed shocks generates the smaller impact on the post-stress balance sheet and post-stress SCR). ST technical specifications can cope with this issue via a principle based approach by asking participants to proceed in the treatment of the assets according to their investment strategy regularly adopted. Alternatively, a set of rules on the selection of the assets and on the sequence of sale shall be prescribed. Independently by the approach, assets are assumed to be sold in "stressed" markets, therefore valued at shocked prices.
Against this background *option B* offers operational advantages in the definition of the technical specifications and in the comparability of the results. Without claims disbursement assumptions on the assets to be sold and on the sequence of sale can be avoided potentially enhancing the comparability of the results.

Reinsurance treaties

216. Cat scenarios encompasses a series of events which are supposed to be independent and designed to happen in a short timeframe. Insurers are supposed to account for the risk mitigation techniques in place at the reference date including the use of proportional and non-proportional reinsurance treaties in place.

217. In case reinsurance treaties in-force at the reference date allow for reinstatement, reinstatements (including potential related cost) shall be taken into account between the events. However, any change in the treaties including changes in the reinstatement regime against the prescribed shocks shall be treated as post-stress reactive management actions, therefore not allowed if not differently specified.

218. With regard to the reinsurance recoverable, two approaches could be applied as well:

A. Recoverables were accounted as immediately received after the event, therefore they net the instantaneous disbursement in the "A" approach stated in the previous paragraph or will increase the assets (potentially the deposit item) in approach "B";
B. Recoverables are accounted as a credit to be received from reinsurers ([R0370]), therefore they will increase the asset side of the balance sheet in both approaches A and B of the previous paragraph (i.e. notwithstanding whether the claims are immediate paid or not).

219. If the Cat shocks are included in a more complex Cat scenario the recoverability of insurance losses through reinsurance treaties could also be shocked. To this aim an additional shock considering the default of some reinsurers (e.g. 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 the CQS of the reinsurer (using as a reference the PD prescribed in SII standard formula).

Questions:
Q. 49: What is your view on the Scenario based approach versus the Standard formula based approach?
Q. 50: What is your view on the approaches to the application of the Shocks: A) claim disbursement; B) full reserve?
Q. 51: What is your view on the options presented on the treatment of the reinsurance recoverables?

5.3 Other impacts on the balance sheet stemming from the revaluation of the positions against shocks

5.3.1 Deferred Tax Assets [R0040] / Deferred Tax Liabilities [R0780]

220. Assets and liabilities of the post-shock balance sheet might create tax "advantages" or "disadvantages". Typically, the deferred tax per single item is recognized as the tax rate times the difference in the valuation on the balance sheet and the fiscal balance sheet. Tax disadvantages per balance sheet item, Deferred Tax Liabilities (DTL), are fully recognized, whereas tax advantages, Deferred Tax Assets (DTA), can only be recognized up to the amount that future taxable profits are available for utilization. A tax advantage, DTA, may also occur if the undertaking has fiscal losses from previous years that it can carry-forward.

221. In the post-stress situation undertakings should recalculate the deferred taxes in relation to all assets and liabilities that are recognised for solvency and tax purposes. This post-stress evaluation should be consistent to the regulatory framework.

222. As an alternative to the general principle of full recalculation of DTA and DTL under stressed situation, their value can be kept unchanged with respect to the baseline. In this regard, scenarios can prescribe the total lack of the reevaluation of both DTA and DTL. This could depart from the assessment of

the participant who, for example, in case of expected losses through the application of the scenario could envisage the increasing of its DTAs.

223. Another possible way to estimate the post-stress deferred taxes would be to impose a cap on the position under stressed scenario. This cap could be relative to the generated losses. This would limit the maximum amount of deferred taxes reported after imparting the different shocks in the adverse situation. Such limitation could use proportional proxies with national corporate tax rates or equivalent.

224. In all cases, the evolution of those quantities would need to be explained both in a qualitative and quantitative way. A dedicated table related to deferred taxes could be used in the validation (those would be of paramount help for example in case of positive evolution of the DTAs).

Questions:
Q. 52: Do you have suggestions on the treatment of the post-stress DTA/DTL and on potential controls to be applied?

5.3.2 Derivatives [R0190] [R0790]

225. Derivatives are held by insurers for hedging and investment purposes. No specific shock to the market price of derivative is prescribed, however participants are expected to reassess the SII value of their exposures to derivatives taking into account the change in prices of the underlying securities against the shocks prescribed to in the scenario. The normal volatility of the underlying assets has to be kept unchanged.

226. In case derivative are held for risk-mitigation their use in a ST exercise shall be aligned with the SII Level II guidelines. Risk-mitigation technique might be restricted to individual instruments or it covers well-defined hedging strategies. The recognition of risk-mitigation techniques (derivatives) in the ST should reflect the economic substance of the technique used, and should be restricted to risk-mitigation techniques that effectively transfer the risk outside the insurance or reinsurance undertaking.

227. Insurance or reinsurance undertakings should take into account basis risks stemming from performing ST which means the risk resulting from the situation in which the exposure covered by the risk mitigation technique does not correspond to the risk exposure of the insurance or reinsurance undertakings should be included in calculations. Material basis risk should be reflected while performing ST.

Questions:
Q. 53: Do you consider the information provided sufficient for a revaluation of the post-stress position on derivatives? If not please provide indications on the missing information.

5.4 Simplifications

228. In principle, the participants shall use the same models and processes they use for the calculation of the annual QRT to compute the impact of the stressed scenarios (full recalculation using baseline model). Significant changes to

these models and processes that occurred after the reference date should be discussed with the supervisor, in order to assess how these could be addressed. This also holds for significant changes to the business activities after the reference data, e.g. merger and acquisitions or divestments (please also refer to Chapter 2.3.1 recalculation of the baseline).

229. Given the operational and methodological challenges linked to a ST exercise, the use of approximations and simplifications can be considered by the participants. However, a trade-off between the feasibility of the exercise and the reliability of the results is needed and should take into account the objectives of the exercise. Therefore, the use of approximations and simplifications should respect this trade-off and should allow for a fair reflection of the direction and magnitude of the impacts, i.e. not distorting inappropriately the interpretability and the comparability of the results.

230. All approximations and simplifications used for the calculation of the post-stress results (that go beyond these used for the pre-stress calculations) should be clearly identified, discussed and approved (if needed by national regulations) by the supervisor before the start of the calculation phase.

231. The participants should provide details on the approximations and simplifications used. Why is this simplification needed? What is the exact simplification and how is it applied? The participants should also be able to give a quantitative or qualitative indication on the materiality of the deviations created by the use of the simplification. This information should allow the supervisor to judge on the suitability of each of the simplifications.

5.4.1 Perimeter

232. EIOPA ST exercises are based on the SII framework, hence on a full balance sheet approach. Participants are expected to reevaluate their balance sheet items against the provided yield curve and the specific shocks (if any). In principle, shocks shall be applied to the entire in-force business, hence to the full balance sheet (assets and liabilities), and to each element of the solvency position. However, based on relevance and materiality criteria, participants can be allowed to reduce the perimeter of application of the shocks to a subset of their activities, treating the remaining part via a scaling approach.

233. Relevance of the scenario is the key condition to exclude part of the business (an entity in case of a group or part of the portfolio) from the post-stress calculation. A portion of the business can be excluded from the full recalculation if it is insensitive to the prescribed shocks due to its nature (e.g. life / non-life), or to its geographical location. In case a participant demonstrates the non-vulnerability, they are allowed to estimate the contribution of the excluded business to the overall post-stress balance sheet and solvency position via a scaling approach.

234. Beside the element of the relevance, the exclusion of part of the in-force business is subject to a materiality criteria. In order to avoid large approximations in the post-stress position, participants are allowed to apply a simplified treatment only to a portion of the business not exceeding materiality thresholds specifically defined for each exercise based on the pre-stress value of:

- Total Assets;
- Total Best Estimate;
- Eligible Own Funds;
- Solvency Capital Requirement.

235. The post-stress values of the part of the business excluded in line with the above mentioned criteria shall be scaled according to the change of the corresponding items calculated for the treated business. Undertakings are requested to apply the shocks following the prescribed guidance, and to rely on the baseline model used for the production of their year report.

Questions:
Q. 54: What are your views on the general approach to simplifications and the materiality criteria?

5.4.2 Loss Absorbing Capacity of Deferred Taxes

236. LACDT implies that undertakings are able to transfer a part of a shock loss to their tax authority and that the impact of the loss on OF is therefore lower than the original gross loss itself. The idea is that the economic loss also results in fiscal losses and that these fiscal losses result in tax reductions if fiscal profits are available to utilize/offset these fiscal losses.

237. In the post-stress scenario undertakings should:

- recognise and value deferred taxes in relation to all assets and liabilities that are recognised for solvency or tax purposes;
- calculate LACDT in accordance with the baseline model.

238. The complexity of LACDT and the high level of judgment may result in diverging practices among undertakings regarding methods for LACDT calculations. LACDT is considered to be a complex and subjective, but also material, aspect of the capital requirements.

239. ST approach should be aligned with an appropriate application and consideration of cash flows resulting from taxes. It should be verified that a sufficient amount of future taxable profits will be available after the shock event, against which the deferred taxes can be utilized.

240. In the recent amendment to the Delegated Regulation articles 207, 297, and 311, the substantiation of LACDT on the basis of future profitability is mentioned as a possibility. However, in the context of a ST and the need for simplicity and comparability it is proposed to allow only the DTL on the balance sheet as a substantiation for the LACDT. Allowing for future profitability as a substantiation for the LACDT in addition to the DTL would require a much deeper analysis by the NCAs.

241. Undertakings should calculate LACDT at a level of granularity that reflects all relevant regulations in all applicable tax regimes. When determining the tax consequences of the loss an approach based on average tax rates might be used provided they those average tax rates are determined at an appropriate level.

242. Simplifying and reducing the subjectivity involved in the calculation of LACDT would be possible by capping LACDT to the amount of net DTL on the

base case balance sheet, since this part of the demonstrated utilization of LACDT typically involves no complex and subjective projections.

$$LACDT \leq \max(0, netDTL)$$

243. Undertakings should be able to provide appropriate evidence supporting their approach for LACDT post-stress calculations.

Questions:
Q. 55: What are your views on the proposed simplifications for the post-stress LACDT? Do you agree with the rough assessment of the post-stress LACDT with the pre-stress net DTL? If not please provide different approach to identify potential miscalculations of the LACDT

5.4.3 Regression techniques for liabilities or own funds[44]

244. This subsection focuses on some specific challenges regarding the recalculation of the post-stress SCR for insurance undertakings using an approved internal model.

245. These companies have to comply amongst others with article 122 of the SII Directive, which requires that the SCR shall be derived from the probability distribution forecast generated by the internal model. For traditional life / health with profit business however, this requirement implies some specific technical and operational problems. These problems relate in particular to the complex, path-dependent interactions between assets and liabilities in the stochastic simulations for the calculation of the BE, which in the absence of analytic formulae are necessary to price the various implicit options and guarantees of the respective liabilities in a market-consistent way. Therefore, the derivation of the SCR from the probability distribution forecast would in principle require a full Monte Carlo simulation for each real world scenario of the distribution, a setting that is often referred to as "nested stochastic simulation". However, brute-force Monte Carlo approaches to tackle such nested simulations represent a technical challenge, especially regarding the computational capabilities of today's hardware and software solutions.

246. Several approaches to avoid such nested stochastic simulations have been developed and implemented by the industry. Usually these approaches use different kinds of regression techniques in order to quantify the change of a target variable (such as the best estimate liability or the Present Value of Future Profits) under a change of specific risk drivers. Some of the most prominent examples for such regression techniques in the insurance sector are labelled as:

- Curve-fitting;
- Replicating Portfolios (RP);
- Least Square Monte Carlo (LSMC).

247. While all of these approaches provide a solution to avoid the problem of nested stochastic simulations, the implementation and validation of these techniques remain methodologically complex and operationally challenging for the companies. The calibration of the target functions (e.g. for LSMC) or of the replicating portfolios are key aspects in this complicated process and

[44] Regression tecniques for liabilities or own funds can also be referred as "proxy modelling".

involve expert judgement. The results of the regression are subject to validations in order to assess the quality and appropriateness of the approximations.

248. The calibration of the target functions or of the replicating portfolio depends amongst others on the capital market situation. To illustrate this fact for the case of a RP, it is clear that the composition of an asset portfolio that is supposed to replicate the best estimate liability will very likely vary for different levels of the RFR curves[45]. Therefore, a straightforward application of these regression techniques in the context of a stress test would require a full recalibration post-stress, ideally complemented by similar validation tools as for the baseline situation.

249. Such a recalibration might be seen as the preferred option as it represents the most accurate solution. However, such a full recalibration is hardly feasible in practice within the granted timeframe for the stress test exercise[46]. Apart from these operational constraints, the specification of the required technical framework for such a recalibration should also be provided. To give an illustrative example in the context of replicating portfolios, the stress test specification would need to provide concrete information amongst others on the following aspects:

- Admissible range of parameters for the risk neutral training scenarios (used for calibration) and out of sample scenarios (used for validation) post-stress (including for example information on volatility surfaces post-stress);
- Guidance on potential limitations on the asset candidate universe for replication post-stress (which might be different from the baseline situation).

250. In general, due to their heterogeneity and the complexity it may is challenging to provide comprehensive and detailed information for such a recalibration exercise that consistently covers all different types of regression techniques across Europe.

251. Against this background, beside the full recalibration of the parameter / portfolios supporting the mentioned techniques, it can be expected that companies apply approximations or simplifications in order to translate the results of the regression from the baseline to the post-stress environment generating less accurate and comparable results. Some possible solutions for approximations were tested in the context of the EIOPA ST 2018, for example by scaling the loss distribution generated by the regression in the baseline situation by use of specific post-stress sensitivities.

252. The assessment of the appropriateness and plausibility of approximations should form a central component of the validation process – both within the companies, as well as within the supervisory authorities. Companies should be able to provide credible quantitative or qualitative arguments that the approximations are appropriate with regard to the quality of the results (e.g. not systematic or material under-estimation of the SCR post-stress) and with regard to the technical implementation (e.g. link to the structure and modelling approaches in the internal model). Given the complexity of the issue

[45] This difference is amongst others due to the asymmetric split of profits between companies and policyholders.
[46] It should be noted that further iterations of the recalibration processes would be required in case the stress test specifications require quantifying the potential impact of LTG measures or management actions on the SCR post-stress.

at stake companies and supervisors could benefit from entering into a dialogue on the appropriateness of the intended approximations at an early stage of the stress test process and before companies start their calculations.

Questions:
Q. 56: What are your views on the possible simplifications for the use of regression techniques post-stress? In your answer please clearly distinguish between theoretical principles and the viable (in terms of feasibility) solutions in the context of a Stress Test exercise.
Q. 57: In case of a scaling approach what are the proper parameters to estimate the post-stress loss distributions?
Q. 58: In case of a full recalibration of the regression techniques against stressed conditions, what are the parameters you may need as an input? Would the addition of other price categories in the list of asset shocks and the volatility surface reassessment under stressed situation be enough to re-calibrate your different tools?
Q. 59: What are your views on the extra resources required to achieve a full and complete recalibration? Please quantify the amount of days involved and how important the expert judgement is.

5.4.4 Use of Long Term Guarantees and Transitional measures

253. The LTG and Transitional measures are part of the ST framework, in alignment with SII. Hence, groups are requested to apply any LTG and Transitional measures they used at reference date. When the application of a measure requires a prior approval by the NCA or group supervisor this measure can only be used insofar approval at reference date has been granted.

254. The calculation of the impact of the LTG and Transitional measures post-stress shall be aligned with the objectives of the ST exercise. Due to its different nature, the potential disclosure of these measures shall be done separately.

255. Calibration of the LTG measures shall be assumed unchanged with respect to the baseline if not differently specified. However, if the shocks prescribed under stress scenario trigger a material change in the LTG measures, their values are recalibrated according to the EIOPA methodology. In details:

- The impact, in absolute terms, of the Transitional measure on the TP shall be calculated in the pre-stress scenario and then kept constant in the post-stress scenario;
- The transitional measure on the risk-free interest rates shall be re-evaluated under the stressed scenarios and applied consistently with the baseline case;
- Transitional measures on Equity shall be applied consistently with the baseline scenario;
- Matching adjustments shall be re-evaluated under stressed scenarios and applied consistently with the baseline case;
- Recalculated VA are provided by EIOPA under the stress scenarios;
- Symmetric adjustment mechanism to the equity risk charge under stressed scenario is provided by EIOPA.

Questions:
Q. 60: What are your views on the proposed simplifications for the use of LTG and transitional measures post-stress?

5.4.5 Calculation of the post-stress risk margin

256. The main objective of the Risk Margin (RM) is to evaluate the price of maintaining the activity until the extinction of liabilities. It mean that undertakings must be able to evaluate the capital along extinction years to at least cover the SRC(t) actualized and multiply to a cost of capital.

257. SII allows different methodologies for this calculation based on a hierarchy of four methods going from the full computation to the scaling approach (calculating the RM as a percentage of the BE).

258. In order to grant the comparability with the baseline, the post-stress RM shall be computed, as a default option, using the same method used for the calculation of the year-end balance sheet. However, taking into account that the full recalculation could be quite onerous and not fully feasible in a ST exercise given the time constraints, participants may be allowed to use the method immediately following in the hierarchy of methods listed in guideline 61[47] the one that they use regularly for the production of the year-end financial statements (namely going one notch down in the hierarchy of methods) provided that the approximation applied does not hamper the proper assessment of the technical provisions.

Questions:
Q. 61: What are your views on the proposed simplifications for the calculation of the post-stress risk margin?

5.4.6 Consolidation

259. The selection of insurance group undertakings as scope for a ST exercises introduces the additional complexity of the consolidation of the post-stress results of solos. The SII Directives (2009/138/EC) allows to consolidate the solo's positions according to two calculation methods: the Accounting consolidation-based method[48] and the Deduction and aggregation method (D&A)[49].

260. In principle the balance sheet and the capital need at group level under stressed scenarios shall be estimated according to the consolidation method used for the standard year-end reporting without any simplification.

261. Potential simplifications might be applied to the calculation of the post-stress positions of solos according to the principle of materiality, as described in paragraph 5.4.1. The reference for the application of the materiality thresholds shall be baseline consolidated position of the group.

262. The 2018 Insurance ST allowed participating groups to depart from the standard evaluation of the solo positions and subsequent consolidation by applying a *group consolidated-based approach* to its entire in-force business

[47] EIOPA Guidelines on the valuation of technical provisions (guideline 61)
[48] Directive 2009/138/EC, Art. 230 Method 1 (Default method): Accounting consolidation-based method.
[49] Directive 2009/138/EC, Art. 233 Method 2 (Alternative method): Deduction and aggregation method

or to part of it. A pure *group consolidated-based approach* consists of the use of a group model (e.g. model points) granting the assessment of companies' balance sheet positions. In this concern, balance sheet calculations involved should give a prudential picture of the group, with, at least the same reliability as any quarterly financial stability reporting. Therefore, this group consolidated-based approach should guarantee a calculation of the post-stress group balance sheet with enough precision to fill in the ST reporting templates. The *group consolidated-based approach* did exclude any approximation via sensitivity analysis and all simplifications should consist of, for example, grouping liabilities in tractable quantities instead of breaking them down at solo level.

263. Based on the experience of the 2018 ST exercise, the group consolidated-based approach presents several issues in different phases of the ST exercise both for EIOPA and the participating groups:

- Design of the exercise: difficulties in prescribing homogeneous and widely applicable guidance on the definition of the model-points;
- Calculation: difficulties in producing the cash-flows stemming from the model points approximating homogeneous portfolio of liabilities;
- Validation: difficulties in assessing the post-stress best estimates via the provided cash flows.

264. Against these limitations the group consolidated-based approach is not considered a proper way-forward for the future EIOPA ST exercises, unless proper solutions for a homogeneous definition of the model points to approximate liability portfolios and a sufficiently accurate approach to validate the post-stress BE liabilities are defined.

Questions:
Q. 62: What are your views on the group consolidated based approach? Do you agree with the drawbacks presented on the group consolidated based approach? If not can you provide ideas on how to allow a proper validation of the results?
Q. 63: What would be in your view a proper approach to define model points? (please provide concrete examples)
Q. 64: What would be in your view a proper approach to validate the best estimate produced via model points? (please provide concrete examples)
Q. 65: Do you envisage any other approach to simplify the consolidation at group level?

6 Data collection and validation

265. This chapter elaborates on general principles related to data and reporting templates required from the participants during an EIOPA ST exercise as well as potential validation approaches.

6.1 Data collection and reporting templates

6.1.1 Principles of data collection and restrictions

266. The design of the reporting templates, as well as the data to be collected from the participants should be in line with the goals of the exercise and should serve in identifying vulnerabilities and risks. The data request should also allow for the identification of the main drivers of the changes in the stressed scenarios to assess the impact of the prescribed shocks.

267. The set of templates used to report the results under the baseline and stressed scenarios should be as close as possible to the SII QRT reporting templates. In principle, baseline information shall match the set of data requested in the regular reporting templates, whereas post-stress information should be equal to or less granular than what is requested in the SII QRT templates. ST participants should be able to provide this type of information as they can rely on the processes in place for the regular reporting. In case an ad hoc template and/or new data points are needed, this needs to be thoroughly justified and will be subject to discussion in terms of costs and benefits.

268. The information requested in the ST may be quantitative and/or qualitative. This should be embedded in the templates published along with the technical specifications. Furthermore, the data request should be in line with the scope of the exercise (group templates vs. solo templates). The data request should be aligned with the time horizon of the ST and with the treatment of the management actions.

269. A key aspect in the data request is to distinguish between data needed for the analysis of the results and disclosure, and data needed for validation. Therefore, with the purpose of having a sound understanding of the ST results and the ability to perform a proper data quality assurance process, participants might be requested to submit additional information in line with the approach utilized to run the calculations.

6.1.2 Templates for core solvency analysis purpose

270. Participants shall fill in the reporting templates in the spreadsheets provided, published together with the technical specifications and the technical information. The reporting templates are usually grouped around the baseline situation and each of the prescribed scenario(s).

271. Depending on the scope of the exercise, the balance sheet shall fully replicate the SII QRT S.02.01.01, with SII figures reported under the baseline and under each of the stress scenarios. In case of a group exercise, the template shall be used to report balance sheet data of all the participants, irrespective of the method applied for the calculation of group solvency,

namely the "accounting consolidation-based method", the "deduction and aggregation method" or a "combination of both methods".

272. To assess the impact of the LTG and transitional measures throughout the exercise, the templates should replicate the SII QRT S.22.01. This assumes the application of the step-by-step approach on the impact of LTG and transitional measures on TP, basic and eligible OF, and SCR (consistently with the metrics to be reported under the stress scenario). The version of the template could be simplified in certain cases (i.e. less granular). For instance, the information on the tiering of the OF under stressed scenarios could be exempted from reporting.

273. Information on the OF is collected under each scenario via SII QRT S.23.01. This could fully replicate the format of the standard QRT, or in some cases, it can be simplified under stressed scenarios for only a subset of the information to be provided by the participants.

274. The templates required for the collection of data on the Solvency Capital Requirement based on the standard QRT (S.25.01; S.25.02; S.25.03) are mutually exclusive. Undertakings shall only fill in the template that is in line with the approach they use to report the capital position to the NCA, namely the standard formula template (in case of no authorization for a full or partial internal model), or one of the two others in case either a partial internal model or a full internal model was approved by the NCA. This information shall be requested if the goal of the exercise is to recalculate the SCR under stressed scenarios.

275. Participants are requested to provide a breakdown of their asset allocation under the baseline and the stressed scenario(s). The templates are usually constructed as simplifications of the S.06.01 and S.06.02 Annual SII reporting. Market valuation shall be provided for equity and for asset classes with contractual cash flows computed according to the methodology internally applied by undertakings. In particular, details on the decomposition of the exposures and of the modified durations for sovereign bonds, corporate bonds, collateralized securities, structured notes, and loans and mortgages could be requested. Depending on the scope of the exercise and the design of the stress scenario, further information on the decomposition of the equity portfolio according to the country of issuance could also be requested. When completing the templates, participants shall exclude the asset held for unit and index linked portfolios. In general, no look-through approach to report collective investments is requested. However, depending on the objective of the exercise a more granular details might be required. The credit quality of the assets, when requested, is defined according to CQS.

276. The liability description is a template that elaborates on the annual SII technical provisions reporting for life and health (S.12.01) and for non-Life (S.17.01). Depending on the objectives and scope of the exercise, it requires only a subset of information with respect to the standard templates. In this context, the use of the S.14 template, or simplification of it, could be required. Regarding the specificities of the shock involved, a breakdown between homogeneous categories (e.g. long-duration and short-duration type of liabilities) could be requested. In the case of a group stress test exercise, the reported liabilities shall refer only to the entities consolidated via Method 1 in

order to grant consistency with the values of the TP reported in the balance sheet.

277. The templates on duration of TP (if included in the reporting package) should in principle be completed in consistence with QRT S.38.01 of the Financial Stability Reporting (i.e. the term "duration" refers to Macaulay duration). Different approaches to the calculation of the duration might be prescribed under specific circumstances

278. If the stress scenario comprises insurance specific shock(s) (e.g. shock to lapse) additional dedicated templates might be needed to be able to estimate the magnitude of the impact of the shock on the company (e.g. surrender values)

6.2 Data validation principles and templates

6.2.1 Quality assurance methodology

279. The validation of the reported numbers should ensure an appropriate level of confidence in the ST results and analysis. One of its main goals is to ensure the consistent application of the prescribed shocks amongst the participants. As a result, this process should guarantee a level playing field and comparability of the results.

280. The collection of ST data via the regular reporting described in the previous section is complemented with additional templates that are designed to make a dedicated validation and analysis processes possible. Those templates should allow for cross checking of reported numbers.

281. As an overarching principle, the evolution of any reported number from the baseline to the situation under stress shall be validated. For this reason ST specific reporting information can also be requested in addition to the regular reporting to allow for dedicated validation checks.

282. Different types of validations can be distinguished, ranging from basic consistency and completeness checks within specific reporting templates, to more complicated types of validations to check the outcome of models used in the ST.

283. Validations are grouped in different layers:

- Level 0: Consistency and completeness check;
- Level 1: Consistent application of shocks (Closed-form formulas validation)
- Level 2: Benchmark analysis against peer-levels
- Level 3: Proprietary in-house model of analysis

284. Level 0 validations are simple verifications for consistency and completeness purposes. These are for example defined by the taxonomy or template specifications or stemming from the regulation. Finally, they should ensure that all the required cells in the reporting templates are filled and the submissions are complete. Those validations could directly be incorporated to the reporting templates.

285. Level 1 validation checks aim at ensuring a consistent application of the prescribed shocks. These type of quality assurance validations are less automatic and typically need formulas or proxies to check the correctness of specific figures of the templates. These types of validations cannot be

considered as binding as the level 0 checks, as for example the level of granularity of the look-through approach used by the participant would be a key component of the different comparisons. Indeed, the results obtained via the level 1 validations could be slightly different from the precise calculations made by the stress test participants using for example a more refined classification of its collective funds.

286. Level 2 validations checks consist of benchmarking analysis among peers. Due to the complexity of the liabilities estimations, not all balance sheet items can be calculated or checked by means of simple closed-form formulas. Level 2 validations therefore take the form of regression analysis on the impact of shocks against participant characteristics, aimed at outlier detection. Additional variables to the standard reporting templates are paramount for this analysis to group and/or classify the different participants by common characteristics.

287. Alongside the different exercises EIOPA developed in-house models to estimate liabilities' items based on limited number of parameters and hypotheses. Those tools utilize techniques used by the industry with simplifications and approximations. They are in essence more speculative since they might rely on hypotheses and are not based on information found in the regular QRT. The hypotheses are required to complete the computations. Level 3 validation checks rely notably on those tools.

6.2.1.1 **Level 1 examples of validation checks**

288. A typical example is the validation of the asset side under a stress scenario. Since the granularity of the baseline figures and the shock tables match, one can roughly compute the different impacts using the submitted technical information. For instance, a first step to validate the asset values under stressed circumstances where no lapsing and no surrenders have been taken into account would be to re-play each and every shock from EIOPA's point of view using the baseline values and the prescribed shocks. However, if any kind of liabilities' stresses involving surrenders would incur before the assets' scenario, then no comparability could be achieved between baseline and adverse situations. Further hypotheses would be required to produce other types of estimations.

289. Relative changes in the market value of equities would be the simplest to validate against the prescribed shocks. As far as financial securities are concerned, the change in prices can be calculated via an approximation. The first derivative, linking the prices variation with duration and spreads may provide an appropriate range of stressed prices under adverse situations. To allow a proper validation, participants are requested to submit detailed information on the decomposition of their portfolio according to the country where the equity is traded. With this information, approximations of the change in equity value in the balance sheet can be performed under each of the stress scenarios.

290. For fixed income there are three categories of assets in a typical stress test exercise: *i)* sovereign bonds, *ii)* corporate bonds, collateralized securities, structured notes, and *iii)* loans and mortgages. For each of these categories, information is submitted on the decomposition of the exposures and of the modified durations. This information allows for approximations of the change

in the value of these assets on the balance sheet, under each of the market risk stress scenarios.

6.2.1.2 Level 2 examples of validations checks

291. Despite the use of type 1 validation checks, a perfect recalculation of the stress test impact might not be feasible. This may be caused by, for instance, the existence of optionalities, differences in accounting of portfolios, and rounding errors.

292. Against this observation, level 2 validation checks tackle the issue by comparing stress results among participants and identify potential outliers. Several examples are described below. All validation checks can be performed both at NSAs and EIOPA level using different databases. These include changes in the amount of fixed income assets, equity, and the BE.

293. For both validation and analysis, additional templates can be used to collect information on control variables, designed to summarize results. Aimed at characterizing all participants with similar underlying risk profiles and models, they are ultimately used in regression analyses to interpret results and detect potential outliers.

294. Different control variables used in previous ST exercises can be used. Some of those are already part of the standard reporting templates: use of LTG, business mix, country of the home supervisor, etc. For others, it consists in simplifications of regular templates. In addition, other variables can be used to complement the core reporting templates. For example, the characteristics of the hypotheses entering in the estimation process can also be requested: use of dynamic lapses and/or types of Economic Scenario Generators used. This can be extended to also request information on the models used to produce the BE or different sub-modules which can subsequently be used as a dummy variable in regression analysis.

6.2.1.3 Level 3 examples of validation checks

295. As already mentioned in the previous paragraphs, the estimation of some insurance balance sheet items can challenging and it is in general model based. In this context, EIOPA developed simplified models which can be used for validation. Two examples are provided in this section. One is about the cash flow analysis principally used to check the plausibility of the BE reassessment under stressed situation, and the other is about the RM.

296. For the potential validation of the BE, the participants are requested to submit detailed cash flow estimations. One of the major issues with this approach is the absence of a homogeneous definition of a cash flow with respect to the S.13 QRT (e.g. accounting cash flows, certainty equivalent cash flows). Nevertheless, discounting the submitted cash flows both on the baseline and under stressed scenario should give an approximation of the stressed amount, which can be compared with the reported stressed amount. However, due to the use of very different definitions for these cash flows, a precise reconciliation would not be possible. Therefore, a rejection threshold should be set, and participants would need to comply or explain any breach of this threshold.

297. Information on future discretionary benefits is requested to analyze the overall change in optionalities in the materialization of the shocks. This

information can also be used to compare the reported cash flow patterns with the baseline cash flows. The same idea can be used to estimate the effect of an inflation shock with, on the one hand, a simple comparison of an actualization of the baseline cash flow sequence, and on the other hand, the cash flow sequence under stressed scenario. Again, this analysis would not be a full reconciliation, and a well-accepted threshold should be used to compare the outcome of the approximation with the reported numbers.

298. Cash flow patterns are also analyzed. For example, the outflows in the baseline and in the stressed scenario would be compared. A good explanation would be required when there is a complete change in outflow pattern resulting in large deviations from the baseline cash flow. The lack of a clear explanation could lead to a request for resubmission. For this type of analysis, a separate reporting of guaranteed and discretionary cash flows could be required at the start of the stress test exercise.

299. Another example of a possible test concerns the RM calculation. In previous stress tests exercises the stressed RM could be inferred from the stressed BE. A key principle used in previous stress tests is that the ratio between RM and BE after stress would be with some degrees of approximation the same as in the baseline situation. To ensure that RM is properly recalculated, a model-based estimation done by EIOPA can be used to assess the changes with respect to the baseline and to highlight outliers among participants.

300. A more restrictive view of this validation check on RM would be a common methodology for the calculation of the so called "base RM". This would be used during the ST as a reference to check the plausibility or the required justification of the presented RM post-stress. A possible framework for the control variable "base RM" could be the following:

Table 6-1 Possible framework for the control variable "base RM"

Approach	Advantage	Disadvantage
SII framework	• Already in use and supervised • No special specification to be given • No baseline recalculation • Flexible in terms of implementation from baseline to adverse scenario	• Lack of comparability. • The choice of the model impacts the magnitude of the RM
More restrictive than SII	• Better comparability since the same formula is used for all participants • Validation made simple	• One-Fits-All model not easily defined (see under) • Needs a baseline re-calculation to be fully used

301. Depending on the choice of the framework, the definition for the "base RM" would be picked up and could be aligned with one of the definitions proposed in the Table 6-2. This would potentially involve additional calculation for the baseline figures. In this context, "base RM" could be defined with one of the following (see also section 2.3.1).

Table 6-2 Advantages and disadvantages in the definition of "base RM"

Approach	Advantage	Disadvantage
Full, no simplification Method 1	• Exact valuation • Full comparability?	• Must be based on a strong hypothesis • Extremely complex to specify (might need extra parameter for each point in time in the future, such as the volatility surface) • Time consuming (nested stochastic calculation needed)
SCR freeze at t=0 (before shock) and calculation based on BE(t) Method 2	• Well established simplification • Information needed is contained in the run-off cash-flow providing BE(t) • Applicable in the same way for both Standard formula or Internal Model users. • Comparability and robustness	• Cannot be finely tuned with LAC (t) (simplification with LAC(0) needed) • Baseline needs to be re-estimated
SCR freeze at t=0+ (post shock) and calculation based on BE(t) Method 3	• SCR already part of the shock calculation • Information needed is contained in the run-off cash-flow providing BE(t) • Applicable in the same way for both Standard formula or Internal Model users • Comparability and robustness	• Cannot be finely tuned with LAC(t) (simplification with LAC(0) needed) • Simplification using LAC(0)
Modified duration Without hypothesis of constant Modified Duration Method 4	• Depend only on SCR baseline and aftershock and RM(baseline)	• Impact of LAC evolution not taken into account
Fixed factor based on RM/BE at t=0 Method 5	• Simple approach applicable at Line of Business level (with RM proportional to SCR_{Lob}/SCR_{Total}) • No recalculation of baseline	• Rough approximation
Mix Method Method 6	• Simple and flexible to help the objective of the ST	• Specially implemented for the ST exercise • Might need recalculation of baseline RM figures

Questions:
Q. 66: What is your view on the overall approach of validation and the different types of validations?
Q. 67: What is your view on the approach used for the validation of the Best Estimate under stressed situation using cash flow values and their evolution under stressed situation? Which additional parameters would you suggest to improve the framework?
Q. 68: What is your view on a common approach for the Risk Margin estimation even used in Baseline calculations? Which drawback would you envisage if a "Base RM" is used as a control variable?
Q. 69: Do you have any further considerations on validations which could improve the level playing field?

7 Annex I - Glossary[50]

Adverse stress scenario	An adverse (stress) scenario is a set of economic and financial conditions (significantly more negative than a baseline scenario) which is designed to stress the financial performance of a financial system, sector, institution, portfolio or product (reflecting severe but plausible conditions). The design of the adverse scenario depends on the objectives of the stress test, availability of data and the time horizon chosen, among others.
Baseline situation	The baseline situation is a set of economic and financial conditions under non-stressed circumstances. One of the purposes of the baseline is to provide a benchmark to compare results of stressed scenarios. The baseline situation is generally consistent with current economic and financial conditions and/or the best (or average) estimate of future economic and financial conditions.
Individual institution-run stress test	An individual institution-run stress test is a stress test performed by an institution using its own stress testing framework as part of its own risk management and/or ORSA. See also "supervisory bottom-up stress test".
Macroprudential stress test	A macroprudential stress test is a stress test that is designed to assess the system-wide resilience to shocks in the financial sector, which may include second-round effects emerging from linkages with the broader financial system or the economy. Unlike microprudential stress tests, macroprudential stress tests generally take into account second-round effects and interactions between institutions (eg via interconnected exposures and collective behaviour). Alternatively, microprudential stress tests can also be used to assess risks on a systemic level, by aggregating the results from the micro level (in particular if the microprudential stress test is performed by systemically important institutions). However, this approach does not incorporate the second-round effects and interactions among institutions that would constitute a true macroprudential stress test. See also "microprudential stress test" and "second-round effects".

[50] Adapted from 'Supervisory and bank stress testing: range of practices' (BIS 2017).

Microprudential stress test	A micro-prudential stress test is a stress test designed to assess the resilience of an institution to adverse economic and financial conditions. The instruments, mechanisms and measures available to supervisors are usually applied at the individual institution level (microprudential). See also "macroprudential stress test".
Perimeter	Perimeter defines the part (e.g. business lines, specific geographical activities) of any given participant to be treated in the stress test exersies.
Reverse stress test	A reverse stress test is the process of assessing a pre-defined adverse outcome for an institution, such as a breach of regulatory ratios, and identifying possible scenarios that could lead to such an adverse outcome. A reverse stress test helps to understand underlying risks and vulnerabilities in institutions' businesses and products that pose a threat to its viability and helps to identify scenarios that could threaten resilience.
Scenario analysis	Scenario analysis is the process of applying historical and/or hypothetical circumstances to assess the impact of a possible future event on a financial system, sector, bank, portfolio or product. Scenario analysis typically involves applying a combination of two or more economic and/or financial vulnerabilities simultaneously (multi-factor stress). Scenarios are not considered forecasts; rather, they are coherent and credible narratives, describing potentially different paths to the current or expected conditions. Scenario analysis incorporates many economic and financial parameters in a consistent manner, in contrast to sensitivity analysis, which may focus on a subset of parameters. See also "sensitivity analysis"
Scope of a Stress Test exercise	Scope defines the insurance and reinsurance undertakings to be included in a stress test exercise also referred as "participants"
Second-round effects	Second-round effects are shocks resulting from the transmission of initial shocks from institutions to parts of the financial system and the real economy. A stress testing framework involves designing a scenario and mechanisms to simulate how a scenario affects a financial system, business line, sector, institution, portfolio, or product. These initial or first order effects may affect other financial institutions (through interconnections/contagion) and/or the real economy (eg lower growth or investments). These transmission mechanisms may also arise from

	management actions taken by institutions. These effects can arise from some endogenous reaction and amplification mechanism within the financial system through collective behaviour (eg fire sales).
Sensitivity analysis	Sensitivity analysis or single-factor stress is the process of assessing the impact of a change of a single or limited set of risk factors, variables, assumptions or other factors. Typically sensitivity analyses do not relate changes to a cohesive narrative or underlying event (as opposed to scenario analysis). See also "scenario analysis"
Stress test	A stress test is a forward looking risk management tool used to estimate the potential impact under adverse circumstances on a financial system, sector, institution, portfolio or product.
Stress test horizon	The stress test horizon is the amount of time which is covered in the forward looking part of the stress test. It should be in line with the objective, methodology and the hypothetical scenarios. See also "baseline scenario" and "hypothetical stress scenario".
Supervisory bottom-up stress test	A supervisory bottom-up stress test is an exercise run by a supervisor or regulatory authority, whereparticipating institutions are requested to perform the calculations. The supervisor provides the stress testing framework, methodologies, adverse stress scenarios, prescribed shocks, and guidance to the application of the shocks. Participants shall calculate the impact of the prescribed shocks on their balance sheet and capital requirements according to the provided guidances using their own models. See also "Individual institution-run stress test" and "Supervisory top-down stress test".
Supervisory top-down stress test	A supervisory top-down stress test is a stress test performed and run by a supervisor or regulatory authority. The supervisor determines the impact of a scenario directly based on the regulatory data provided by the insurers using its own framework, models and specifications (i.e. no calculations from individual institutions required).

8 Annex II – Likelihood of a scenario

Getting the joint probability of a stress test scenario is extremely difficult because the large number of variables and data length issues. Please find below a statistic example on how the probabilities would be assessed in a n-variable exercise.

Let us assume that *n* variables are included in the scenario, $x_1,\ x_2\ ,\ldots x_n$. Let suppose also that the variables in the distress scenario assume values $x_1^s,\ x_2^s,\ldots\ x_n^s$. The joint probability of getting a results which is at least as extreme as the one obtained by the stress test exercise is $P(x_1 \le x_1^s,\ x_2 \le x_2^s, \ldots, x_n \le x_n^s)$.
The conditioning event of the scenario is defined by variable x_k being below its $\alpha 100\%$ worst case scenario, i.e.

$$x_k \le F_k^{-1}(\alpha), \qquad (1)$$

where $F_k^{-1}(\alpha)$ is the $\alpha 100$-th quantile of variable *k*.
The scenario is instead defined by is the response of the other variables when the distress scenario materializes, i.e.

$$x_j^s \ is \ such \ that \ \ P\left(x_j \middle| x_k \le F_k^{-1}(\alpha)\right) = p \quad for \ j = 1,2,3,..n \ and \ j \ne k \qquad (2)$$

The higher is the dependence across the variables, the closer is the joint probability of the stress test to $\alpha\ p\%$. Instead, if these variables are approximately independent under the distress scenario, the closer is the joint probability of the exercise to $p^n \alpha 100\%$. Hence, we can stablish an upper bound and a lower bound for the joint probability of the stress test but the exact probability is determined by the joint dependence among all variables in the distress scenarios.

Given the huge amount of financial variables that are included in the stress test scenarios, (more than 1000 variables in all ESAs' scenarios) it is numerically challenging to assess the joint probability of the stress test scenario, because it depends on the relationship of each output with the remainder results of the stress test. In addition, for each scenario, multiple simulations might be run in order to create a scenario which was not observed in the past, which might make it more difficult to calculate a joint probability of the scenario.

The probability $\boldsymbol{\alpha 100\%}$ of the triggering variable in Equation (1) indicates how likely is that a distress event materializes, which is at least as extreme as the threshold set in Equation (1). The closer is $\boldsymbol{\alpha}$ to zero, the lower are the probabilities of observing this event, but the more extreme would be the scenario.

9 Annex III - Solvency II Balance sheet

Solvency II Balance sheet item	QRT reference	Document Section references
Assets		
Goodwill	R0010	
Deferred acquisition costs	R0020	
Intangible assets	R0030	
Deferred tax assets	R0040	5.3.1
Pension benefit surplus	R0050	
Property, plant & equipment held for own use	R0060	5.1.4
Investments (other than assets held for index-linked and unit-linked contracts)	R0070	
Property (other than for own use)	R0080	5.1.4
Holdings in related undertakings, including participations	R0090	5.1.2
Equities	R0100	
Equities - listed	R0110	5.1.2
Equities - unlisted	R0120	5.1.2
Bonds	R0130	
Government Bonds	R0140	5.1.1.1
Corporate Bonds	R0150	5.1.1.2
Structured notes	R0160	5.1.1.2
Collateralised securities	R0170	5.1.1.2
Collective Investments Undertakings	R0180	5.1.6
Derivatives	R0190	5.3.2
Deposits other than cash equivalents	R0200	
Other investments	R0210	
Assets held for index-linked and unit-linked contracts	R0220	5.1.5
Loans and mortgages	R0230	5.1.5
Loans on policies	R0240	5.1.5
Loans and mortgages to individuals	R0250	5.1.5
Other loans and mortgages	R0260	5.1.5
Reinsurance recoverables from:	R0270	5.1.7
Non-life and health similar to non-life	R0280	
Non-life excluding health	R0290	
Health similar to non-life	R0300	
Life and health similar to life, excluding health and index-linked and unit-linked	R0310	
Health similar to life	R0320	
Life excluding health and index-linked and unit-linked	R0330	
Life index-linked and unit-linked	R0340	
Deposits to cedants	R0350	
Insurance and intermediaries receivables	R0360	5.1.7
Reinsurance receivables	R0370	5.1.7
Receivables (trade, not insurance)	R0380	
Own shares (held directly)	R0390	5.1.2
Amounts due in respect of own fund items or initial fund called up but not yet paid in	R0400	
Cash and cash equivalents	R0410	
Any other assets, not elsewhere shown	R0420	5.1.6
Total assets	**R0500**	
Liabilities		
Technical provisions – non-life	R0510	5.1.6
Technical provisions – non-life (excluding health)	R0520	
Technical provisions calculated as a whole	R0530	
Best Estimate	R0540	
Risk margin	R0550	5.4.5
Technical provisions - health (similar to non-life)	R0560	
Technical provisions calculated as a whole	R0570	

Best Estimate	R0580	
Risk margin	R0590	5.4.5
Technical provisions - life (excluding index-linked and unit-linked)	R0600	5.1.6.1
Technical provisions - health (similar to life)	R0610	
Technical provisions calculated as a whole	R0620	
Best Estimate	R0630	
Risk margin	R0640	5.4.5
Technical provisions – life (excluding health and index-linked and unit-linked)	R0650	5.1.6.1
Technical provisions calculated as a whole	R0660	
Best Estimate	R0670	
Risk margin	R0680	5.4.5
Technical provisions – index-linked and unit-linked	R0690	5.1.6.1
Technical provisions calculated as a whole	R0700	
Best Estimate	R0710	
Risk margin	R0720	5.4.5
Other technical provisions	R0730	
Contingent liabilities	R0740	
Provisions other than technical provisions	R0750	
Pension benefit obligations	R0760	
Deposits from reinsurers	R0770	
Deferred tax liabilities	R0780	5.3.1
Derivatives	R0790	5.3.2
Debts owed to credit institutions	R0800	
Financial liabilities other than debts owed to credit institutions	R0810	
Insurance & intermediaries payables	R0820	
Reinsurance payables	R0830	
Payables (trade, not insurance)	R0840	
Subordinated liabilities	R0850	
Subordinated liabilities not in Basic Own Funds	R0860	
Subordinated liabilities in Basic Own Funds	R0870	
Any other liabilities, not elsewhere shown	R0880	
Total liabilities	**R0900**	
Excess of assets over liabilities	**R1000**	