METHODOLOGICAL PRINCIPLES OF INSURANCE STRESS TESTING

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Abbreviations

BE	best estimate
CRA	credit risk adjustment
CQS	credit quality step
D&A	deduction and aggregation
DTA	deferred tax asset
DTL	deferred tax liability
ECB	European Central Bank
EIOPA	European Insurance and Occupational Pensions Authority
ESRB	European Systemic Risk Board
EU	European Union
FSS	Financial Shock Simulator
GWP	gross written premium
LACDT	loss absorbing capacity of deferred taxes
LLP	last liquid point
LSMC	least square Monte Carlo
LTG	long-term guarantees
Nat-Cat	natural catastrophe
NCA	national competent authority
OF	own funds
ORSA	own risk and solvency assessment
QRT	quantitative reporting template
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 and purpose of the methodological paper

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 (STs) form an integral part of the financial risk management of individual institutions and have become a core tool for supervisors to identify and assess risks and vulnerabilities in the financial system. STs can provide additional insights and a forward-looking perspective on the risk and vulnerabilities of insurers that cannot be derived from the regular Solvency II reporting.

2. EIOPA is required to conduct regular EU-wide ST exercises for the European insurance sector, in collaboration with the European Systemic Risk Board (ESRB). The EIOPA Regulation distinguishes between two possible objectives of these EU-wide assessments:

- assessing the resilience of insurers to adverse market developments ([1]);
- assessing the potential for systemic risk that may be posed by insurers ([2]).

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, in cooperation with national competent authorities (NCAs). For each exercise, EIOPA can tailor specific elements of the ST according to the market conditions and their potential negative implications for insurers ([3]). Currently, the methodology for EIOPA STs is specified separately for each exercise in technical specifications.

4. Given the complexity involved in conducting EU-wide STs for insurers, having a set of common methodological principles and guidelines agreed beforehand can greatly facilitate the ST process. To that end, EIOPA has developed this paper setting out the main methodological elements and principles of and guidelines for an EU-wide ST exercise. The document will serve as a tool-box to inform and facilitate both the design and execution phases of EIOPA ST exercises. The methodological paper was circulated for consultation with stakeholders from 22 July 2019 to 18 October 2019. All comments have been duly considered and, where necessary, the paper has been modified accordingly.

5. This methodological paper is part of a general enhancement of EIOPA's approach to stress testing from methodological and operational standpoints. Conscious of the effort needed to run a bottom-up ST exercise at industry and supervisor level, STs should be used in a proportionate way and focused on relevant risks defined following a risk-based approach and taking into account the cost-benefit of such exercises. Time-wise, a reduction in the frequency of EU-wide STs reflects the EIOPA Board of Supervisors' decision to go for a 3-

([1]) 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, …'.

([2]) Article23(1) EIOPA Regulation (EU) No 1094/2010.

([3]) In this methodological paper the term 'insurer' includes both insurance and reinsurance undertakings if not specified elsewhere.

year cycle to allow proper follow-up analyses of the ST results and to better develop and follow-up on the potential recommendations issued. Between two ST exercises EIOPA will conduct focused sensitivity analyses and assessments of specific exposures through top-down and/or bottom-up approaches, thereby reducing the burden on the industry. From a methodological perspective, EIOPA plans to issue an additional paper on specific ST-related topics such as the assessment of liquidity positions under adverse scenarios, assessment of the positions against transition and physical risks stemming from climate change, and potential approaches to multi-period STs.

1.2 Scope of the methodological paper

6. STs can be used by different stakeholders with different objectives. Supervisors use STs as a supervisory tool; insurers regularly run STs 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 STs for analytical purposes.
7. Supervisory STs can be implemented through a top-down or bottom-up approach (see Box 1.1). The focus of this methodological paper is on bottom-up (institution-run) supervisory STs, which resemble the EU-wide ST exercises conducted so far by EIOPA. This methodological 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 ST will be developed according to a separate timeline aligned with the EIOPA workplan on stress testing.

Box 1.1 — Types of supervisory stress test exercises

<u>Supervisory bottom-up stress test</u>

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

<u>Supervisory top-down stress test</u>

A supervisory top-down stress test is an exercise 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 required from individual institutions).

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

1.3 Structure of the methodological paper

8. The methodological paper is structured as follows. Chapter 2 discusses the ST process, objectives and approaches. Chapter 3 elaborates on the scope of a ST 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 ST results.

1.4 Definitions

9. 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 methodological paper (Annex I — Glossary (). The aim of this glossary is to provide a common set of definitions for stress testing terms to facilitate dialogue among insurers and supervisors in the area of stress testing.

2 Stress test process and objectives

2.1 Stress testing process

10. 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.

11. In order to be effective, each ST exercise should have clearly defined objectives at its inception. STs 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 management actions. Time-wise, the set of shocks prescribed in a ST exercise can be instantaneous or cover multiple periods. In addition, management actions can be allowed, constrained or not allowed (see Section 2.3).

12. 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, to assess the impact of a scenario at the 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 risk drivers that are included in the stress scenarios.

13. Scenario design is another key element of STs (see Chapter 4). To be relevant, the scenarios should be built on a thorough risk assessment of the economic environment and they should reflect severe but plausible adverse developments in 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 on multiple macroeconomic and insurance-specific variables simultaneously.

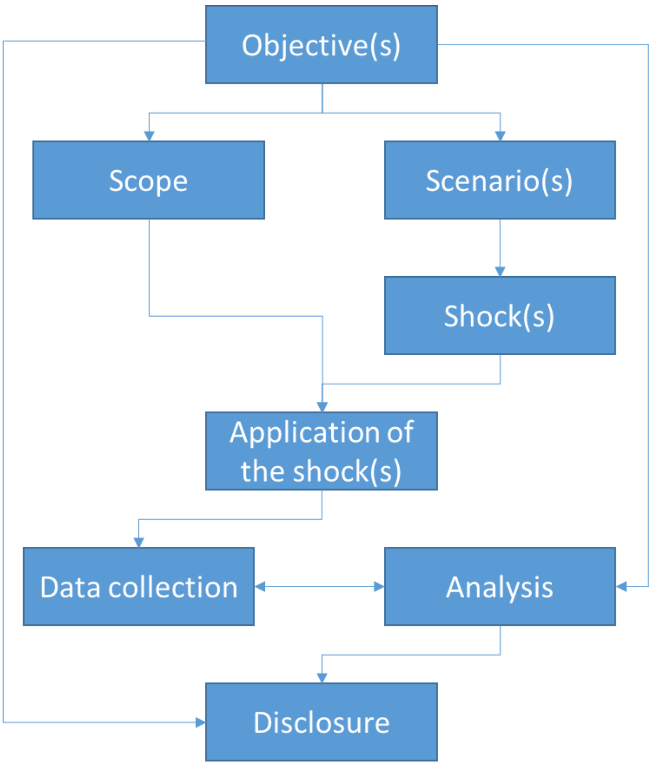
14. The calibration of the shocks should be robust and consistent with the scenario design (see Chapter 5). Furthermore, a bottom-up ST relies on the insurers to calculate the impact of the shocks. To ensure comparability of the results, the technical specifications and additional guidance should therefore also provide clarity on how to apply the different shocks and potential simplifications that could be used in the calculations. Assumptions, limitations and potential simplifications are defined upfront and further elaborated during the consultation phase in order to ensure a level playing field and comparability of the results.

15. Any type of action following a ST exercise should be the result of a thorough analysis of the data collected, which can only be accomplished if the quality of the results is sufficiently high. Clear data reporting requirements and validation should safeguard the credibility of the exercise (Chapter 6). Communication is a crucial component of this too. 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 final results.

16. 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 NCAs, 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 are calibrated to the outcome of the exercise.

Figure 2.1 — Stress test process and elements



2.2 Stress test objectives

17. Supervisory STs can have various objectives, which drive the design, methodology and application of each ST exercise. The most important distinction is between microprudential objectives and macroprudential objectives.

2.2.1 Microprudential objectives

18. 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 action if necessary. These STs might also allow supervisors to request further action to be taken by undertakings to improve the resilience of individual insurers.

19. In general, the following microprudential objectives of ST exercises 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.

20. It should be noted that the solvency capital requirement (SCR) under the Solvency II (SII) framework is also built around a stylised 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 also for companies applying an internal model.

21. A microprudential ST 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 envisaged in the standard SII framework. Although company-specific circumstances are covered by the ORSA, concerted microprudential ST exercises are important for assessing market-wide risks not covered in the standard framework. By aggregating the impact for individual entities, market-wide developments can be inferred; hence, this assessment can be used for evaluating potential vulnerabilities in the insurance sector.

22. 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 assessment of 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 • Increases the understanding of the existing measures (e.g. long-term guarantees) included in the Solvency II framework in a stressed environment • Simpler design and validation phases from a technical perspective than for a macro-prudential exercise, as propagation dynamics are outside its 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

23. Macroprudential STs aim to assess the system-wide resilience to financial, economic and insurance shocks and the potential spillover to other markets generated or amplified by the insurance sector. In these STs the interaction between insurers and the interlinkages between insurers and the financial system and the real economy have to be taken into account. In line with the current discussion on the systemic risk ([4]) macro-STs should:

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

24. The assessment of systemic risk and potential spillovers is part of the overall supervisory framework and serves to increase preparedness and define priorities in the event that a stress scenario materialises 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 assessment of systemic risk in the insurance sector and potential spillovers across financial sectors and the real economy	• Significantly more complex, as second-round effects and other interactions have to be modelled to reflect the system-wide aspects
• Provides information about the resilience of the whole insurance system under stressed conditions	• May require a longer time horizon than microprudential stress testing to consider the propagation of the initial shocks in the financial system and in the economy
• May be used by authorities as an input to calibrate macroprudential measures	

2.2.3 Conclusion

25. STs should be used in a proportionate way and focused on relevant risks and vulnerabilities of insurers. A risk-based approach should be followed and the costs and benefits associated with a ST should be duly considered when designing an exercise. 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 ST. A ST exercise can combine microprudential and macroprudential objectives by focusing on the impact at individual level as well as the impact at market-wide level by aggregating individual results.

([4]) EIOPA's approach to systemic risk can be found at: https://www.eiopa.europa.eu/sites/default/files/publications/pdfs/syssystemic_risk_and_macroprudential_policy_in_insurance.pdf. The International Association of Insurance Supervisors' (IAIS's) approach to systemic risk can be found at: https://www.iaisweb.org/page/consultations/closed-consultations/2019.

26.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 an exercise with a clear macroprudential objective, given that it will provide better insights on the feedback loops, amplification mechanisms and spillovers between insurers and other financial institutions.

27.Until the publication of this 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 NCAs 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. Although former STs had a predominantly microprudential approach, they allowed EIOPA to infer market-wide impacts and to identify market-wide vulnerabilities by aggregating the impact of the prescribed shocks on the participating entities.

28.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. Although a full macroprudential ST is likely to be too complex to implement at this stage, combining a microprudential ST with a quantitative assessment of post-stress reactions (e.g. need to recapitalise and/or de-risk after stress) by insurers could provide valuable additional insights into potential second-round effects, without the costs of fully modelling all behavioural and network effects.

29.To summarise, an overview of the differences between a microprudential and a 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 a focus on large internationally active groups
Second-round effects and spillovers	• Marginally covered. Some entity-based effects might be inferred from the	• Taken into account by both an entity and an activity-based perspective

	potential distress of large institutions	
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

2.3 Approaches

30. Different approaches exist towards certain conceptual elements of a ST exercise. These relate to the definition/recalculation of the baseline (Section 2.3.1), the time horizon (Section 2.3.2) and the management actions (Section 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

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

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

- 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);
- the changes in the estimation model (e.g. move to (partial) internal model, improvement in estimation techniques) approved and implemented after the computation of the baseline;
- the simplifications and approximations that may be chosen for the application of the ST scenario (which may differ from the baseline model).

33. Changes in the perimeter, model and/or simplifications affect the value of the outcome metric. As the outcome metric under stress is compared with 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 in which the model used for the baseline is the same as the model used in the ST exercise provides a clearer picture of the ST's impact: in the event that the model used for the ST deviates from the baseline model (e.g. through the use of simplifications) it may be impossible to disentangle the effect of the ST scenario and of the changes to the baseline model.

34. However, recalculating the baseline, while essential for the comparability and interpretability of the ST exercise, also comes with downsides. Apart from 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 and post-stress results do not correspond to regulatory reporting values.

35. In the light of these considerations, EIOPA will rely on the submitted regulatory (SII) financial position at the relevant reference date as the baseline for the ST exercise and will consider a recalculation of the baseline position only in exceptional circumstances. This would apply where there has been a change in the undertaking's structure and/or valuation model that would materially affect the regulatory financial position and the outcome of the ST exercise (e.g. a change in the perimeter of the entity through restructuring or mergers and acquisitions, a change in the risk model used for the calculation of the solvency capital requirement — standard formula, undertaking-specific parameters or partial/internal models — and major model changes). Any potential recalculation of the baseline will be assessed and discussed on a case-by-case basis.

2.3.2 Time horizon

36. 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.

37. 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

38. Instantaneous stress scenarios are assumed to be applied as one-off shocks to the balance sheet at a reference date. Examples are instantaneous market stress scenarios affecting several asset classes (e.g. sudden increase in risk premiums 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).

39. Instantaneous shocks were used for the EIOPA 2016 and 2018 ST exercises. Usually instantaneous stress scenarios refer to a specific narrative in which 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 Table 2.4.

Table 2.4 — Advantages and disadvantages of instantaneous shocks

Advantages	Disadvantages
• Instantaneous shocks are easier to model, implement and validate than temporally stretched shocks, enhancing the comparability and interpretability of the results	• Instantaneous shocks may not be considered realistic for specific scenario components, limiting the explanatory power/interpretability of the results

• Instantaneous shocks offer greater flexibility allowing them to be tailored to the specific objective of the stress test exercise	• 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

40. 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 in lapses returning to normal levels after *x* years) or a cascade of catastrophic events over a certain period of time.

41. 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 Section 2.3.2.3) as the impact on the key metric is still only analysed 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 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 with 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 that could hamper 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 consistent application across participants

42. Although a combination of instantaneous and stretched shocks allows for more realistic scenarios and assessment of 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 (BE) 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 to ensure a consistent application across participants. This refers not only to the specification of the stretched component itself but also to 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 a reaction to adverse developments.

2.3.2.3 Multi-period stress scenarios

43. 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 the 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 STs.

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 following years (e.g. affecting equity and real estate prices and policyholder lapse behaviour);
- a pandemic event on a global scale over a certain period of time, followed by an adverse feedback loop on the real economy that also affects financial markets (e.g. higher demand for safe bond investments leading to further decrease in interest rates).

44. The narrative of a multi-period ST scenario includes not only a specification of one or several triggering events but also a concrete description of assumed after-effects. The scenario roll-out and the development over time 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 not usually 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 adverse developments is of particular relevance (see also Section 0). 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	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:

• Multi-period stress tests can be seen as more appropriate for analysing the impact of stress scenarios that address slow-burning risks (e.g. climate risks) or risks that are assumed to expand over a longer time horizon (e.g. a prolonged low-interest-rate environment) • Multi-period stress tests can be seen as providing a more appropriate framework for analysis of the timely development of specific key metrics (e.g. the ratio of assets over liabilities)	• Specification of the scenario: the development over time of the affected risk drivers must be fully specified at a very granular level to enable insurance companies to apply the scenario in their risk and valuation models ([a]). 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 participating companies. This applies in particular to the life insurance sector. It may be impossible for companies to 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

Note:

(a) 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 consistent application .As an example, the specification should include not only the development of the entire risk-free yield curve over the considered time horizon but also additional information on other relevant aspects such as the change in the volatility surface over time.

2.3.3 Management actions

45. The term *management actions* comprises two methodologically different concepts: *embedded* management actions and *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 ST 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 of 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 insurance 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 action under the label of 'future management actions', for example in Article 23 (in the context of 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 such as 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) and the business and risk strategy of the company.

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.

46. 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.

47. The specification of the previous EIOPA ST exercises excluded an allowance for any mitigating management actions post stress for reasons of comparability and because of the instantaneous nature of the assumed stress events ([5]). This section will discuss the advantages and disadvantages of allowing post-stress management actions.

([5]) '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

2.3.3.1 Reactive post-stress management actions

48. 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. Table 2.7 therefore aims to discuss the potential advantages and disadvantages of applying reactive post-stress management actions at a principle-based level.

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 insights into potential second-round effects	• Allowing post-stress management actions can hamper the comparison of results, as each participant can tailor its 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 companies' potential to react to the specific stress event rather than their vulnerability

49. 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, 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), post-stress management actions could be considered to enhance the explanatory power of a ST exercise and assess potential second-round effects.

50. 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 the 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 to ensure consistent application, avoid

recovery plan.' (see *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.

inappropriate 'optimal responses' (with regard to the level of mitigation of the negative impact of the shock) and ensure the comparability of the results.

51. 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 and within the supervisory authorities. Reactive post-stress management actions need to be realistic and take account of the time needed to implement them and any expenses arising from them. Companies should be able to provide credible explanations on whether and how the post-stress management action could actually be implemented under the adverse conditions of the stress scenario, also taking into account any potential secondary consequences (e.g. limitations to inter-company capital movement in the event 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

52. A variety of different types of management actions are algorithmically embedded in the stochastic valuation and risk models of insurance companies across Europe. It should be noted, however, that even for those embedded management rules that address similar conceptual features (e.g. 'dynamic asset allocation' or 'policyholder profit participation') the actual modelling approaches may differ to a considerable degree between companies. There are several reasons for these differences in the modelling and implementation approaches, which are, among others, because the embedded management rules have to be adapted to the different national business models and legislations across countries. Furthermore, these management rules aim to reflect core elements of company-specific risks and business strategies. For that reason they often reflect company-specific features and characteristics. When assessing the appropriateness of embedded management actions in the context of a ST, these company-specific features should therefore be taken into account. It should also be noted that an assessment of specific embedded management actions in isolation may not provide an appropriate basis for a comprehensive validation, as many of these embedded actions show strong and unavoidable interdependencies (e.g. a change in the target asset allocation is likely to imply changes in the bonus credited to policyholders).

53. Given a specific stochastic simulation (e.g. for the calculation of the BE liability) the results of the algorithmically embedded management actions are usually both time and path dependent. This implies that embedded management actions will react automatically to the adverse setting defined by a stress scenario (e.g. by a reduction in policyholder bonuses). This automatic change in the modelled metrics (e.g. the level of policyholder bonuses) has to be clearly distinguished from a situation in which a company changes the design or specific key parameters of the algorithm itself (e.g. to reflect a fundamental change in the bonus-crediting strategy after a shock event). Such an adjustment in the algorithmic features of embedded management actions to reflect risk-mitigating measures would have to be considered a post-stress reactive management action.

2.3.4 Conclusion

54. This section has elaborated on three conceptual elements to be considered in a ST exercise: (i) definition and recalculation of the baseline; (ii) time horizon; and (iii) management actions, presenting the advantages and disadvantages of the different approaches in isolation. For the purpose of future EIOPA STs, although any recalculation of the baseline has been discarded (except under exceptional circumstances), the options offered by the other two elements should be assessed holistically and consider both the objective of the ST exercise and the complexity of the approach.

55. In the 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 without any allowance for reactive post-stress management actions. This set-up can be based on one-shock scenarios or on multiple-shock scenarios.

56. In the event that the objective is to assess the vulnerability of the industry (at either micro- or macro-level), the most appropriate choice would be an instantaneous stress scenario complemented with specific scenario components (e.g. insurance-specific shocks) potentially stretched out over a longer time horizon. As a general guideline, reactive post-stress management actions should not be applied. Alternatively, reactive post-stress management actions could be allowed, in which case the impact of these actions should be reported separately.

57. In the case of a macroprudential objective focusing on spillover effects, the proposed approach for the near future would be based on a single-period instantaneous shock approach, allowing for all types of management actions. However, the applied management actions would have to be clearly documented and the impact of the prescribed shocks would have to be reported both with and without the application of management actions (both qualitative and quantitative evaluation). 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.

58. The proposed approaches represent a viable step forward to be implemented in any forthcoming EIOPA ST exercise. Over time, the approaches might be further enhanced towards a multi-period framework. Given the inherent complexity of a multi-period and comprehensive macroprudential ST, EIOPA plans to proceed with its analysis and to further engage on the progress made with stakeholders.

59. A summary of the proposed approaches linked to the specific stress objective can be found in Table 2.8.

Table 2.8 — Proposed approaches linked to the specific stress objective

	Vulnerability of the industry (micro-/macroprudential)	Sensitivity to shocks (microprudential)	Spillover analysis (macroprudential)
Time horizon	• All the approaches can be applied	• Single-period instantaneous shocks	• All the approaches can be applied

Management actions	• In principle, reactive post-stress management actions are not allowed. If considered, the impact should be reported separately	• Reactive post-stress management actions are not allowed	• Reactive post-stress management actions allowed to assess systemic implications (impact both with and without post-stress management actions)

3 Scope

3.1 General considerations

60. 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.

61. This chapter elaborates the potential guidelines for defining the correct scope to fit the objective of a ST exercise, highlighting the advantages and disadvantages of each solution.

62. From a procedural perspective, the identification of the participants in a ST exercise is a collective exercise that involves EIOPA and the NCAs. The criteria for the selection of and the proposed list of insurance undertakings are discussed and finally adopted by the EIOPA Board of Supervisors.

3.2 Target

63. The main choice to be made in defining the scope of the ST is whether to target solo or group insurance undertakings. Each option have advantages and disadvantages as presented in Table 3.1. Based on a cost-benefit analysis, any aggregation of entities within the perimeter of a group based on defined criteria (e.g. geographical, undertaking business type) will not be pursued.

Table 3.1 — Advantages and disadvantages of targeting solo or group undertakings

	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 solvency capital requirement model and long-term guarantees /transitional measures) • Easier to issue potential recommendations and recovery/resolution actions (one national competent authority involved) • More useful as an input to microprudential supervision	• No diversification effect accounted for • Less informative from a financial stability perspective • Need some coordination work from both the insurance groups and the national competent authorities in the 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 level of complexity in the application and assessment of the shocks with the consequence that it is necessary to apply simplification and approximation

	• Account for full diversification effects • Easier to assess the impact of reactive post-stress management actions if needed	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 (as in the US) and uses the deduction and aggregation method to aggregate the results • Harder to issue potential recommendations and recovery/resolution actions • Harder to validate the data • Harder to assess the effect on technical provisions (issues on reporting cash flows)

64. It is worth noting that many of the weaknesses reported for the groups might be alleviated by asking them to complement their 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 assessment of potential localised distress and gives a more accurate validation of the post-stress liabilities. However, this would also place an additional burden on participants, as basically both group and solo ST impacts would have to be reported.

3.3 Coverage and metrics

65. In an EU-wide exercise the general approach to the market coverage can be summarised in the statement 'the higher the better'. However, many details have to be taken into account in defining this aspect, starting with defining the reference, namely the concept of 'market'.

66. The natural reference for an EU-wide exercise is the size of the EU insurance market, which can be further broken down into the size of the life and non-life businesses according to the goals of the exercise.

67. 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.

68. For solos, the reference is always 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 assets — TA, total gross technical provisions — gross TP, and gross written premium — GWP) or the size of specific business lines could be used as exposure. In the case that the objective of the exercise is to assess the vulnerabilities of the whole insurance sector, particular attention should 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) and of local jurisdictions, if

needed. Details of the reference, exposure and metrics to be applied to solos are 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, detection of potential pockets of vulnerabilities arising from the distress of a sufficiently large number of small and medium-sized entities.

Table 3.2 — Reference metrics for solo undertakings

Geographical criteria\business criteria	Life insurance	Non-life insurance	Specific line(s) of business	Undifferentiated business
Local jurisdiction	• Reference: size of the life local market • Exposure: size of the life business • Metric: preferred: gross 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: gross TP non-life, TA	• Reference size of the local market (for that specific line of business) • Exposure: size of the specific line(s) of business • Metric: preferred: line(s) of business gross TP for life; line(s) of business 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 gross TP (w/wo UL/IL)
EU-wide	• Reference: size of the EU market (a sub-reference to ensure a minimum coverage at country level could be considered as well) • Exposure: size of the life business	• Reference: size of the EU market (a sub-reference to ensure a minimum coverage at country level could be considered as well) • Exposure: size of the non-life business	• Reference size of the EU market for that specific line of business (a sub-reference to ensure a minimum coverage at country level could be considered as well)	• Reference: size of the EU market (a sub-reference to ensure a minimum coverage at country level could be considered as well) • Exposure: size of the company • Metric: preferred:

	• Metric: preferred: gross TP life (w/wo UL/IL); others: TA (w/wo UL/IL), GWP	• Metric: preferred: GWP non-life, others: gross TP non-life, TA	• Exposure: size of the specific line(s) of business • Metric: preferred: line(s) of business gross TP for life; line(s) of business GWP for non-life; others: TA (w/wo UL/IL)	TA (w/wo UL/IL); other GWP, total gross TP (w/wo UL/IL)

Note: GWP, gross written premium; TA, total assets; TP, technical provisions; w/wo UL/IL, with/without unit-linked and index-linked.

69. Groups, because of their global activities, are not suitable for analyses at country level. Therefore the focus should 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 Member States can still be assessed by comparing the sum of the size of the solos belonging to the targeted groups and operating in the EU with the total size of the EU business and its detail by business line and across countries. It is worth noting that, although the selection of the participating groups should primarily refer to EU-wide criteria, the number of home jurisdictions of groups to be included in the exercise might also be considered. Table 3.3 provides an overview of the options. The same considerations on the metrics used for solo undertaking applies.

Table 3.3 — Reference metrics for group undertakings

Geographical/business criteria	Life	Non-life	Specific line(s) of business	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 financial stability reporting Sub-reference: number of home	• Reference: size of the EU market potentially approximated by the groups subject to financial stability reporting Sub-reference: number of home	• Reference: size of the EU market for that specific line of business potentially approximated by the groups subject to financial stability reporting Sub-	• Reference: Size of the total EU market potentially approximated by the groups subject to the financial stability reporting. Sub-reference:

	jurisdictions of groups included in the exercise • Exposure: size of the life business • Metric: preferred: gross TP life (w/wo UL/IL); others: TA (w/wo UL/IL), GWP potentially limited to the EU business	jurisdictions of groups included in the exercise • Exposure: size of the non-life business • Metric: preferred: GWP non-life, others: gross TP non-life, TA; potentially limited to the EU business	reference: number of home jurisdictions of groups included in the exercise • Exposure: size of the specific line(s) of business • Metric: preferred: line(s) of business gross TP for life; line(s) of business GWP for non-life; others: TA (w/wo UL/IL)	Number of home jurisdictions of groups included in the exercise • Exposure: size of the group, • Metric: preferred: TA (w/wo UL/IL); other GWP, total gross TP (w/wo UL/IL) potentially limited to the EU business

Note: GWP, gross written premium; N/A, not applicable; TA, total assets; TP, technical provisions; w/wo UL/IL, with/without unit-linked and index-linked.

70. In addition to the metrics mentioned above, one could consider some additional metrics in the 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 a metric. As an example, in the case of a natural catastrophe (Nat-Cat) scenario, the exposure to Nat-Cat events (e.g. sum insured) could be used as a metric or, in the case of an equity stress, the total equities held by the group/solo undertaking could be used as a metric.

3.4 Conclusion

71. The target and scope of the ST are important choices to be made in its execution. These choices are largely dependent on the objectives of the ST in question. 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.

72. 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. In addition, 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.

73. In the light of these considerations, the most appropriate scope for microprudential-oriented STs from an operational perspective would be to target solo undertakings. This would provide more meaningful input for microprudential supervision and facilitate the application of shocks and the

data validation process, while also allowing for more country-specific analysis. Specific considerations are needed in the case of macroprudential-oriented analyses.

4 Scenario design

4.1 Definition of scenarios

74. Stress scenarios are severe but plausible hypothetical situations that can adversely affect the balance sheets and solvency positions of insurance undertakings. Scenarios can comprise 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 for the design of scenarios

75. 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 aiming to be complete, a narrative should include information on the triggering event(s) of the economic downturn (in the 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 ([6]).

76. 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

77. 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 specific reference to the objectives of the exercise.

78. 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 of testing the resilience of insurers against adverse developments. The plausibility criterion refers to the requirement that the scenario could potentially happen in practice and should conform with economic theory and to the economy as a whole or be supported by other scientific expertise (e.g. climate science, demographical study) for the economy as a whole. Please note that this does

([6]) Basel Committee on Banking Supervision (2018), 'Stress testing principles'. Available on the Bank of International Settlement's website: https://www.bis.org/bcbs/publ/d450.htm.

not preclude scenarios that have not materialised before, as these may be justified based on a forward-looking approach. The calibration and application of the shocks is discussed further in Chapter 5.

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

- historical or forward-looking scenarios;
- 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.

80. Finally, Box 4.1 elaborates possible approaches to incorporating climate risk scenarios in a ST. Climate risk can lead to increased physical risks for insurers (because of more frequent and severe climate-related losses) and to transition risks, which may arise from the transition to a more carbon-neutral economy.

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

81. A ST can be based on historical or forward-looking configurations. Historical approaches are purely based on the conditions observed in the markets in the past; hence, the approach is only able to re-propose, maybe in different combinations, events that have already materialised. Forward-looking metrics are 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 combines historical experience with expert judgement based on plausible assumptions in line with economic theory or supported by other scientific expertise (e.g. climate science) to include forward-looking considerations in the scenario(s). 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 to 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 • Limited flexibility • Specific future scenarios might not emerge or be derived from historical data

Forward-looking approach	• More conceivable future scenarios could be achieved when one is not be limited to historical data only • Possibly more flexibility in design	• Requires an adequate justification for the scenarios provided • Requires a higher degree of expert judgement, which should also be carefully justified

82. The historical approach can 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 the potential vulnerabilities of undertakings, which are not strictly related to observed historical events.

83. The preferred option for a ST exercise is the hybrid approach which allow to include unexperienced severity or unexpected combinations of shocks in stresses that originate from historical observations, while maintaining plausibility and consistency with the economic theory of the scenario.

4.3.2 Consistency with the Solvency II framework versus the need to move towards more market-compatible scenarios

84. EIOPA ST exercises rely on the SII framework as 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 the comparability of the baseline positions and serve as guidance for recalculating the post-stress positions.

85. Some SII elements, especially those aiming to reduce procyclicality and to take into account the long-term nature of the insurance business, may, however, not be fully consistent with the objectives and the narrative of a ST scenario. It is therefore worthwhile considering 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, thereby not allowing a meaningful evaluation of the impact of the ST scenario on the industry. The main concern is the approach to deriving the risk-free rate (RFR) term structure.

86. The EIOPA RFR curve is designed in accordance with 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 ([7]). 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 that assuming a protracted period of low interest rates, the parameters used to derive the EIOPA RFR curve might not fully fit the purpose. In particular, keeping a level of the UFR unchanged with respect to the baseline might not result in 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

([7]) Information on the Solvency II methodology for deriving the risk-free rate term structure can be found at: https://www.eiopa.europa.eu/tools-and-data/risk-free-interest-rate-term-structures-0_en.

term structure of the RFR, including higher maturities, which otherwise would be mainly driven by the model and its parameters. Similar considerations can be extended to the LLP and this parameter should also be eligible for adjustment.

87. Against this background, it is reasonable to allow, in the context of a ST, for deviations from the SII RFR curve to assess the impact of changes in the long-term spot rates on insurers' positions and whether this impact might generate important vulnerabilities ([8]).

88. 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 in the UFR may be requested separately in the pre- and post-stress situation (similar to the long-term guarantees (LTGs) 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 ultimate forward rate

	Advantages	Disadvantages
Option 1: adjust ultimate forward rate as part of the scenario	• More consistent with the narrative for the scenario (e.g. in the case of a low-for-long scenario) • Less burdensome for undertakings in the case of requested recalculation of the baseline as the only post-stress situation in which the adjusted ultimate forward rate has to be calculated	• Scenario is not consistent with the Solvency II framework and the post-stress solvency capital requirement position may therefore be more difficult to explain • Impact of ultimate forward rate cannot be assessed specifically, as it interacts with other shocks in the scenario
Option 2: ultimate forward rate kept unchanged but marginal impact of changes in the ultimate forward rate may be requested separately	• Scenario would be consistent with Solvency II and the post-stress solvency capital requirement position may therefore be easier to explain • Allows assessment of the impact of the ultimate forward rate independent of the other shocks	• More burdensome for undertakings, as the positions with and without the change in the ultimate forward rate have to be calculated • Scenario may be less consistent with the narrative (in the case of a low-for-long scenario)

([8]) An example of deviation from the Solvency II risk-free rate curve is the reduction in the ultimate forward rate, as incorporated in the 2016 and 2018 stress test scenarios to assess vulnerabilities in a low-yield environment.

89. Based on these two approaches, any change in the RFR parameters in a ST exercise should be considered in line with the scenario and the objective of the exercise:

- For the assessment of the post-stress regulatory position it is advisable to keep the UFR unchanged with respect to the baseline. However, in this approach, the sensitivity to movements of the UFR is also worth assessing in both 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.

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

4.3.3 Single risk factors, single scenarios or combined scenarios

91. Another important aspect of scenario design concerns the question whether risk factors should be combined into one scenario and how to do so. There are various bottom-up stress test scenario approaches. In this section three approaches are distinguished: (i) single risk factors; (ii) single scenarios; and (iii) combined scenarios.

92. *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 using 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 in which 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 of each approach.

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 of single risk factor movements facilitates the validation and the interpretation of results	• 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 based only on single sensitivity results. Tail dependencies and their potential implications are completely outside the scope • As most of the historical crises were not limited to single risk

	• The focus on single risk factor movements facilitates a consistent and uniform application of the scenario ([a]) and therefore supports the comparison of the results • The approach allows the estimation of the likelihood of the prescribed shock	factor movements, the approach may be seen as rather narrow for a stress test exercise. Against this background, it may be difficult for supervisors to define specific follow-up measures based only on sensitivity results
Single scenarios	• They are simpler in design than a combined scenario, which includes both market and insurance shocks • They allow 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	• Because of the existence of multiple risk factors with mutual impacts, it may not seem real to look at the effects of important risk factors — i.e. market and insurance — in isolation. As the business of the undertakings is exposed to a combination of risk factors, financial and insurance risks should be viewed in conjunction • The explanatory power of scenarios can be superior to single-factor sensitivities, as they cover interdependencies 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

Combined scenario	• Compared with single factor sensitivities, combined scenarios offer greater flexibility for tailoring 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 they cover 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 the event 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 be no information about the effects of the separate shocks

Note:

([a]) It should be noted, however, that a detailed specification of single risk factor movements remains important to ensure consistent application. A typical example relates to changes in the risk-free interest rates, which in a Solvency II context change to the entire risk-free yield curve (including the extrapolated part and the level of the ultimate forward rate) and need to be specified.

93. STs are demanding exercises for both the industry and the supervisors. In this sense, STs based on single scenarios and combined scenarios could result in reduced calculation time and effort compared with exercises based on a large number of single risk factors.

94. One of the disadvantages of combined scenarios is that they do not give information about the separate shocks. Given the operational burden and the methodological challenges of estimating the marginal impacts of single shocks or of a subset of the shocks in a combined scenario, quantitative information on the impact of specific shocks may not be requested. In the case that marginal impacts are requested, EIOPA will complement the technical specifications with additional information such as the sequence of application of the shocks.

95. Each of the described approaches presents valuable aspects; hence, the choice of the approach will be made according to the objective of the ST exercise.

4.3.4 Granularity of the shocks

96. An important consideration in scenario design is the level of granularity of the shocks. Previous ST exercises were characterised 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.

- 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 were to 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 advanced economies and emerging markets ([9]).

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

A similar approach should 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 the granular approach versus the bucketing approach

	Advantages	Disadvantages
Granular approach	• Allows the specific characteristics of the risk factor considered to be taken into account • Certain measures such as the volatility adjustment can be derived immediately without the need for approximations • Allows country-based analysis	• Differences in shocks between risk factors are sometimes small and might not be statistically significant and the differences could be meaningless or not justify the extra effort required to calculate the stress test results • Country-based calibrations based on past observations have always been challenged extensively and subsequently adjusted using 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 barely justifiable in a forward-looking scenario • Allows a more efficient process in the design phase of the stress test	• Complexity in the design and application of the bucketing criteria • The recalculation of the country volatility adjustment may seem less straightforward than in the case of a granular approach, but it can be done, e.g. by using the spreads from the relevant buckets in the formula

97. EIOPA will give due consideration to the option of the bucketing approach in the design of future STs, taking into account the specific objective of the exercise (e.g. country-based analyses). In the bucketing approach, some homogeneity criteria should be determined to avoid unfair or unreasonable results. This requires the use of objective criteria, such as ratings or volatilities.

([9]) For an explanation of the distinction between advanced economies and emerging markets, please refer to the International Monetary Fund (IMF) World Economic Outlook database: https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/weoselgr.aspx.

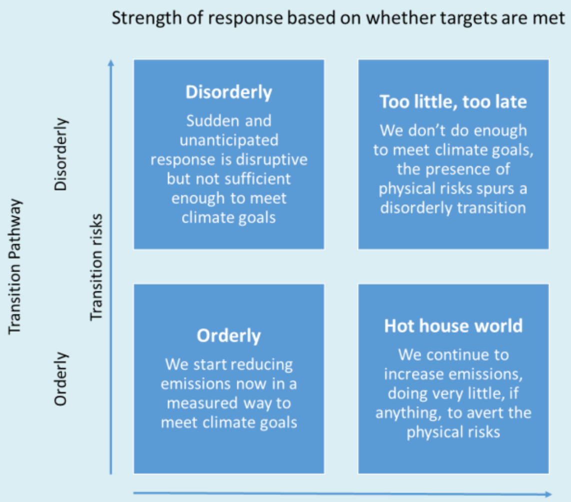
98. Independently, by the approach followed for the prescription of market shocks, the post-stress volatility adjustment (VA) will be calculated according to EIOPA's methodology.

Box 4.1 — Possible approaches to climate risk stress testing

The potential financial impacts of climate-related risks are well-documented ([10]). However, the use of climate scenarios in traditional stress testing models is still very much under development and no common methodology has yet been agreed (because of significant modelling and data challenges). EIOPA is mindful of the work undertaken by other supervisory authorities and organisations relating to climate stress testing and is committed to enhancing its supervisory stress testing methodology to incorporate climate-related risks. To this end, EIOPA is seeking high-level input from stakeholders on 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 impacts of climate change scenarios are expected to manifest themselves fully only over a considerable 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, as shown below.



Source: NGFS, 2019.

Each scenario would have different assumptions about the physical risk factors (e.g. increased frequency of extreme weather events or rising sea levels) and the transition risk factors (e.g. carbon prices and shocks to assets, for instance based on CO_2

([10]) See, for instance, DeNederlandscheBank, 2017, *Waterproof? An exploration of climate-related risks for the Dutch financial sector* (https://www.dnb.nl/en/binaries/Waterproof_tcm47-363851.pdf); Bank of England, 2015, *The impact of climate change on the UK insurance sector* (https://www.bankofengland.co.uk/-/media/boe/files/prudential-regulation/publication/impact-of-climate-change-on-the-uk-insurance-sector.pdf); IAIS (International Association of Insurance Supervisors), 2018, *Issues paper on climate change risks to the insurance sector* (https://www.insurancejournal.com/research/app/uploads/2018/08/IAIS_and_SIF_Issues_Paper_on_Climate_Change_Risks_to_the_Insurance_Sector_-1.pdf); NGFS (Network for Greening the Financial System), 2019, *A call for action: climate change as a source of financial risk* (https://www.banque-france.fr/sites/default/files/media/2019/04/17/synthese_ngfs-2019_-_17042019_0.pdf).

intensities/emissions across all scopes ([11])). 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 better suited to 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 current investment profile remain constant.

The advantages of this type of scenario analysis are:

- it allows assessment of vulnerability to different climate scenarios for both physical and transition risks, even when the consequences of climate change will take time to materialise;
- it allows gathering of quantitative information and enhanced understanding of the financial impacts under a given set of climate change-related assumptions;
- it is more realistic in terms of scenario materialisation.

The disadvantages of this type of scenario analysis are:

- the long-term horizon is not compatible with the traditional format of a stress test, and hence there is no real stress impact as the scenarios typically take a long time to materialise;
- the impact of climate policies on climate changes and other macroeconomic variables can be very hard to model and are very assumption driven;
- no commonly agreed scenarios or broadly accepted methodology are 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, the 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 a change in 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 changed in response to shifts in expectations or sentiment concerning the transition path.

The advantages of this type of climate stress tests are:

- the short-term horizon is compatible with the format of traditional stress tests;
- it allows assessment of real stressed impacts due to sudden increases in physical and/or transition risks (e.g. due to policy or technology shock and/or sudden increase in extreme weather events).

The disadvantages of this type of climate stress test are:

- there is no common agreed methodology to calibrate the climate-related shocks and it requires a high degree of expert judgement;
- the short-term horizon is less compatible with long-term climate change transition scenarios.

([11]) The Greenhouse Gas Protocol Corporate Standard classifies a company's greenhouse gas 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.

4.3.5 Conclusion

99. A hybrid approach to scenario development is preferred over a purely historical or a pure forward-looking approach, as it allows assessment of the envisaged risks maintaining consistency with the co-movements of the markets. Expert judgement applied in the definition of the forward-looking component of the scenario should generate plausible outcomes that are in line with economic theory or supported by other scientific expertise on specific aspects (e.g. climate science).

100. The choice between single-shock, single scenario and combined scenario should be strictly related to the objective of the exercise. Combined scenarios are deemed the most suitable in the case of vulnerability (individual and aggregated) and spillover analyses. In principle, no quantification of the marginal effects of individual shocks under combined scenarios is expected; however, if required, the sequence of application of the shocks will be clearly specified.

101. Consistency with the SII framework is desirable; however, changes in the approach to deriving the RFR curve are advisable to better reflect the market conditions depicted by the narrative. If the UFR is kept unchanged with respect to the baseline, information on sensitivity to UFR changes under stressed scenarios (if applicable) can be collected.

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

103. The granularity of the market shocks should be considered in conjunction with the objective of the exercise. A bucketing approach can be considered a preferred option for EU-wide assessments, unless specific country-based analyses require a higher level of granularity. Independently of the level of granularity of the shocks the post-stress VA will be calculated in accordance with the standard EIOPA methodology.

5 Shocks and their application

104. This chapter is devoted to presenting, without any aim of completeness, a set of the main shocks that can be applied as part of a ST exercise to the balance sheets and solvency positions of undertakings. A complete list cannot be given, as the shocks prescribed in an exercise also depend on the development 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 and information on its application are provided. The chapter also includes a specific section on the simplifications and approximations potentially allowed in estimating the post-stress positions (Section 5.4).

105. In principle, participants are requested to apply the shocks to their full balance sheets following the prescribed guidance and to calculate their post-stress positions using the baseline model used for the production of their end-of-year SII report. To enable companies to meet the requirements of such a full balance sheet approach the technical specifications of each ST exercise will, among other things, include particular guidance on the order of the shocks to be applied in case different sequences of shocks could materially affect the results. Potential limitations on the use of management actions as defined in Section 0, might also be applied.

5.1 Market shocks and calibration

106. 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 premiums. The calibration of the shocks might be based on a historical approach, a 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.

107. In principle, shocks should be applied with the greatest possible accuracy to the assets, namely a look-through approach should be pursued wherever possible. This applies specifically to collective investments [R0180] and assets held for index-linked and unit-linked contracts [R0220] ([12]). In the event that asset classes that are supposed to be treated with the look-through approach are not material, namely that fall below the threshold on total assets defined in Section 5.4.1, undertakings are allowed to follow a simplified approach that consists of applying the shock prescribed to the largest asset class in the respective portfolio.

108. The potentially applicable market shocks are the following:

- government bond yields;
- corporate bond yields;
- equity prices;
- swap rates;

([12]) 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://www.eiopa.europa.eu/tools-and-data/supervisory-reporting-dpm-and-xbrl_en.

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

109. On the calibration, EIOPA prescribes in its ST exercise severe but plausible scenarios that convert the economic conditions described in the narrative into shocks. The plausibility of a scenario is reflected in the consistency of the market movements generated by the prescribed set of shocks, combining both backward-looking and forward-looking approaches.

110. 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 European Central Bank (ECB) for the design of European Banking Authority (EBA), EIOPA and European Securities and Markets Authority (ESMA) ST scenarios and for internal and external policy analyses (e.g. the impact assessments 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 ([13]) and the marginal expected shortfall ([14]). The simulation method is a non-parametric approach to capturing dependence structures across markets, i.e. it does not impose any parametric model structure that might not fit the tails of the distributions. The FSS allows the capture of correlations in the extreme tails of financial returns' distributions relying on a large number of time series.

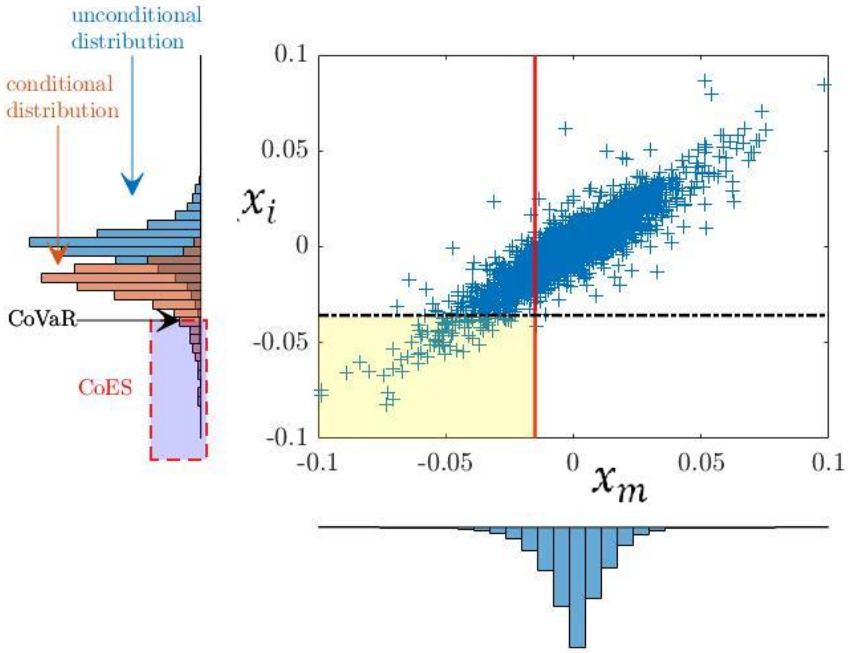
111. The construction of the scenario originates from the definition of one (x_m) or more triggering events and the subsequent joint distribution of the event thereof with the other financial variables (x_i). The reaction of the other variables is captured through their conditional distributions, as 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 in a stressed condition are:

- Conditional value at risk (CoVaR): the value at risk 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 expected shortfall 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 the distribution being in a distress scenario, defined as values in a certain tail of its distribution.

Figure 5.1 — Histogram and scatter plot for bivariate data

([13]) Adrian, T. and Brunnermeier, M.K., 2016, 'CoVaR', *American Economic Review*, Vol. 106, No 7, pp. 1705-1741.

([14]) 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.



Source: European Central Bank.

112. The outcome of the process is a scenario in which the encompassed variables co-moved according to patterns empirically observed, thereby generating a market-consistent scenario. However, getting the joint probability of the ST scenario is extremely difficult because of the large number of variables and time series length issues (please see Annex II for more details). Detailed information on the FSS can be found in the FSS technical note ([15]).

5.1.1 Shocks to bonds

113. Shocks to fixed income asset prices can be prescribed in terms of change in yields (basis points, bps) with respect to the baseline. Geographical or time to maturity specifications can be provided for the different types of bonds. The shock should 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.

114. To derive changes in the spreads, the shocks applied to the swap rates should be taken into account as follows:

a) The level of the euro swap curves after the shock is provided by the 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 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

([15]) ECB, 2019, *Technical note on the Financial Shock Simulator (FSS)*. Available at: https://www.esrb.europa.eu/mppa/stress/shared/pdf/esrb.stress_test190403_technical_note_EIOPA_insurance~4fb409600b.en.pdf?fad046baaf28f167b817d46ddf4486fc.

credit spreads). The change in credit spreads can also be derived by the equation $\Delta CreditSpread_{Bond} = \Delta Y_{Bond} - \Delta SWAP$.

115. Alternatively, the shocks to fixed income assets can be prescribed in terms of the increase in the credit spread. In that case the post-stress price of the assets is derived taking into account the change in the RFR and the increased spread component.

5.1.1.1 Government bonds [R0140]:

116. Shocks to government bonds can be provided by country, geographical area or rating (depending on the granularity) and also by selected maturity. In the event that shocks to a specific country/area are not provided, the closest geographical approximation should be taken (e.g. EU average, euro area average, other advanced economies, emerging markets) ([16]).

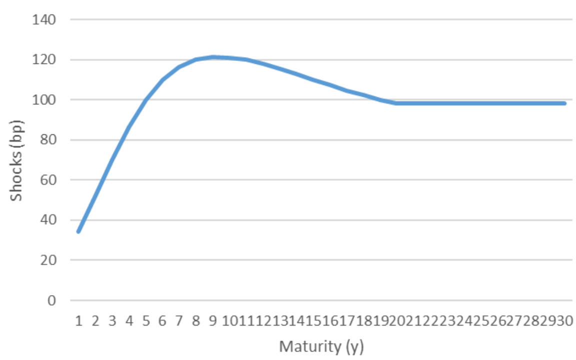
117. Shocks to sovereign bonds are provided for selected maturities. Shocks to missing maturities should be derived:

- by 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 the 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 in accordance with the approach described in paragraph 117. Specifically interpolated values are calculated by cubic-spline.

118. Sovereign bonds denominated in a currency other than that of the country of issuance should be first subject to the country shock and then the resulting amount should be transformed into the country currency by applying the exchange rate registered at the reference date. Example: country A currency is euros and it issues two bonds — bond 1, denominated in euros, and bond 2, denominated in US dollars. Both bonds are subject to the shock prescribed to country A and converted in the currency of country A by translating the

([16]) For an explanation of the distinction between advanced economies and emerging markets, please refer to the International Monetary Fund (IMF) World Economic Outlook database: https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/weoselgr.aspx.

value of bond 2 from US dollars to euros by applying the exchange rate registered at the reference date.

119. Bonds issued by supranational or multinational organisations, either EU or non-EU (Delegated Regulation EU 2015/35, Art. 180 (2)), are not subject to specific shocks to yields. The assets should be revaluated only in accordance with the prescribed changes on the RFR (see Section 5.1.3).

5.1.1.2 Corporate bonds [R0150], structured notes [R0160] and collateralised securities [R0170]

120. To account for different yield volatilities based on the sector, the creditworthiness of the issuer and the country's exposure, shocks to corporate bonds are distinguished as financial/non-financial ([17]) and grouped by rating (from AAA to CCC) and geographical area (e.g. EU, United States, Asia). The corporate bond portfolio is allocated to the correct group and stressed according to 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 are to be shocked according to the average shocks provided for larger geographical areas (e.g. EU, United States, Asia).
- The shocks to the CCC rating class should also be applied to corporate bonds with lower ratings. Unrated bonds should be shocked according to the shocks prescribed to the BBB-rated bonds.

Shocks should be applied homogeneously to all the maturities.

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

121. Shocks are provided in terms of percentage changes in the stock prices per country or geographical area and should 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.

122. When shocks are provided per country, in the case that 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, United States for North America). In the case that any of the proposed areas fit the purpose, participants should apply the shock provided to the 'other advanced economies' or 'emerging markets' ([18]).

123. In the case of equities listed in more than one stock exchange, (i) the average of the shocks prescribed to the countries where the stock exchange

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([17]) For an explanation of financial vs non-financial, please refer to the European Supervisory Authorities' 2010 definition of 'financials', which includes the sectors 'central bank', 'deposit-taking corporations except the central bank', 'money market funds' (MMF), '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 are assigned to 'non-financials'.

([18]) For an explanation of the distinction between advanced economies and emerging markets, please refer to the International Monetary Fund (IMF) World Economic Outlook database: https://www.imf.org/external/pubs/ft/weo/2019/01/weodata/weoselgr.aspx.

is located should be applied, or (ii) the shock prescribed to the country of the stock exchange where the majority of the equity is listed should be applied.

124. Stock indices should be treated according to geographical criteria, e.g. DAX index should be shocked with shocks prescribed to equity issued in Germany, EURO STOXX 50 index with EU average equity shock.

125. The SII value of an unlisted equity at the reference date should 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. The same treatment prescribed for the listed equities applies.

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

127. Shocks to listed equities should be used to stress the holdings in related undertakings, including participations [R0090].

5.1.3 Shocks to SWAP rates

128. 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].

129. Shocks to swaps are used to derive the EIOPA RFR curves in line with the standard approach based on the Smith-Wilson model ([19]). In principle, the RFR curve under a 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.

130. Ancillary elements of the RFR curve:

- Risk-free term structures with and without (VA) are provided for the most used currencies. For the currencies whose RFR curves are not provided, the baseline term structure should be used.
- In the event that 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.

131. Stressed swap curves also serve 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 the event that the shocks are provided to yields (see Section 5.1.1).

5.1.4 Shocks to real estate [R0080 and R0060]

132. Separate shocks to prices are usually provided for commercial and residential real estate at country level. In the case that the shocks for a specific

([19]) EIOPA, 2018, *Technical documentation of the methodology to derive EIOPA's risk-free interest rate term structures*. Available at: https://www.eiopa.europa.eu/tools-and-data/risk-free-interest-rate-term-structures-0_en.

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, United States for North America). In the event that any of the proposed areas fit the purpose, participants should apply the shock provided to 'other advanced economies' or 'emerging markets'.

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

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

5.1.5 Shocks to loans and mortgages [R0230]

135. In general, sub-items of the loans and mortgage categories should be treated as follows:

- loans on policies [R0240] — no shocks should be applied; hence, the value of the balance sheet item should be kept constant with respect to the baseline;
- loans on mortgages to individuals [R0250] — shocks to covered bonds or to residential mortgage-backed security (RMBS) should be used as a proxy to determine the post-stress SII value of the position;
- other loans and mortgages [R0260] — shocks to covered bonds or to RMBS should be used as a proxy to determine the post-stress SII value of the position.

136. The following approximations can be considered:

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

5.1.6 Shocks to collective investment undertakings [R0180] and to other assets [R0420]

137. In line with the general principles on the application of the market shocks stated in Section 5.1, collective investment undertakings should be subject to a full look-through approach that applies the specific shock prescribed to each asset class to the underlying assets.

138. Shocks to private equity, hedge funds, REITs and commodities should be used to treat the items 'any other assets, not elsewhere shown' [R0420]. Any residual 'collective investments undertakings' [R0180] (i.e. for those for which 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.

5.1.7 Shocks to type 1 exposures (reinsurance recoverables [R0270], insurance intermediaries receivables [R0360], reinsurance receivables [R0370]) ([20])

139. Reinsurance-related exposures and other exposures that are classified under type I counterparty exposures should be treated according to specific shocks prescribed to the credit rating associated with the counterparty and the subsequent adjustment of its probability of default and loss given default. The prescribed shock might span from a downgrade to a default of the counterparty.

140. For example, the amount of recoverables from the reinsurance arrangement or insurance securitisation and the corresponding debtors should be adjusted in line with the shocks prescribed to the credit quality step (CQS) of the counterparty, namely accounting for the increased expected losses due to the default of the counterparties (SII Directive, Art. 81, and SII Delegated Regulation, Art. 42) ([21]).

5.2 Insurance-specific shocks

141. The identification of the insurance risk factors to be shocked depends on the defined scenarios and it is related to the degree of complexity of the exercise. The risk exposure of the European insurance industry is the natural starting point for any consideration.

142. This 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 (Section 5.2.1) and those applicable to non-life business (Section 5.2.2). The expected impacts of these shocks on the balance sheet items, the OF and the SCR are also addressed.

143. Insurance-specific shocks could 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' premiums and TP. Insurance shocks may cover underwriting risk, catastrophe risk or the risk of a deterioration in TP. According to the SII Directive, underwriting risk means the risk of loss of or adverse change in the value of insurance liabilities, due to inadequate pricing and provisioning assumptions.

144. Insurance shocks may be short or medium term. The short-term scenario should analyse the insurer's key risk exposure in the face of catastrophic events such as natural calamities or a severe economic recession. The medium-term scenario should analyse the insurers' ability to withstand continuous adverse developments over the projected period. Such adverse developments should include persistent inflation, recession, falling stock markets and unusual high volume of claims. For example:

([20]) For a definition of type 1 exposure, please refer to the Solvency II Delegated Regulation 2009/138/EC.

([21]) 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 to different rating structures can be done according to the credit quality step classification reported in Commission Implementing Regulation (EU) 2016/1800 of 11 October 2016.

- Mortality or renewal expenses in real terms may reasonably be relied on to be fairly stable or to maintain 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 the operating methods used by the (re)insurer.

145. When designing and calibrating the shocks potential overlapping with the SII 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 interaction with the other shocks in 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 ([22]). 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.

146. The potentially applicable insurance shocks are the following:

- longevity/mortality;
- lapse/surrender;
- life expense risk;
- other life risks:
    - disability/morbidity;
    - revision;
    - pandemic;
- provision deficiency (claims and expense inflation);
- natural catastrophes and man-made catastrophes.

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

148. Insurance-specific shocks should be applied to the participant's entire in-force business. Potential limitations might be prescribed in the case in which shocks are targeting specific business lines.

5.2.1 Life insurance shocks

149. In this section the range of potential life insurance shocks is explored. For each risk factor the following is described: the potential shocks, how to calibrate them and the expected impact on the balance sheet items, the OF and the SCR.

150. 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

([22]) As an example one could consider the case (taken from the 2018 EIOPA stress test exercise) of an insurer that, for the purpose of calculating the solvency capital requirement, in the baseline situation is more exposed to lapse shock, while in an economically stressed situation is mostly exposed to the standard formula mass lapse shock.

lapse penalties, presence of annuity business) and on the economic financial conditions at the moment the shocks are applied. For this reason clustering of the portfolio based on homogeneous risk groups and type or features of the outstanding contracts could be considered when applying the shocks to better reflect the narrative of the scenarios (e.g. rational behaviour of policyholders).

5.2.1.1 Longevity/mortality

Description

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

152. Mortality risk refers to a situation in which an increase in the mortality rate leads to an increase in the value of insurance liabilities, whereas longevity risk refers to a situation in which a decrease in the mortality rate leads to an increase in the value of insurance liabilities. Against this definition undertakings may be required to classify their liability portfolio according to homogeneous risk groups and to apply specific shocks to the defined clusters to reflect the narrative of the prescribed scenario.

Calibration approach

153. Life insurance portfolios are generally undertaking specific. The nature of the insured population and the nature of the products in such portfolios vary over 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.

154. For longevity/mortality shocks, either combined data or separate male and female data might be used from, for example, the Human Mortality Database (HMD) ([23]).

155. Longevity/mortality risk addresses various sources of uncertainty, mainly level, trend and volatility. Considering the various sources results in differences in the possible design of the stress. The most favoured approach in calibrating longevity/mortality risk is to use the Lee-Carter model — a well-known model often applied in the insurance industry. 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.

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

([23]) The Human Mortality Database (HMD) is a joint project of the Department of Demography at the University of California at Berkeley, United States, 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 various 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 sources of information using specific national databases. It should be highlighted that the mortality rates of the general population differ from those of the insured population, and data might be complemented by other sources of information using specific national databases.

- 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.

157. Using single stresses that uniformly apply to all BE mortality rates, might not take into account the specific characteristics of the BE of liabilities of the specific insurer. Mortality rates when applying shocks may differ by age or age group, gender, type of product, socio-economic factors such as job or wealth, and geographical location. However, given the challenge implied in the definition of commonly applicable multidimensional shocks and the operational burden of their application, the single-parameter shock emerges as the preferred approach.

Expected impacts

158. No impact on the asset side of the balance sheet is expected from longevity or mortality shocks. TP are expected to increase (in particular if the mortality/longevity shock should be applied only in the case of a detrimental impact). Although in principle an increase in the SCR post stress could be expected, it should be noted that the final impact depends on additional second-order effects (e.g. potential reductions in policyholder bonuses).

Application

159. For operational reasons the mortality/longevity stress parameters provided often encompass changes in all of the risk drivers mentioned above, i.e. changes in the level, trend or volatility of longevity/mortality rates. Therefore, shocks should be applied directly to the BE mortality assumptions that are used to calculate the BE liabilities. In principle, if a scenario does not aim to gather specific mortality/longevity impacts, it will be based on a single-parameter shock.

5.2.1.2 Lapse/surrender

Description

160. The lapse risk is the risk of loss of or adverse change in the value of insurance liabilities, resulting from changes in the level (both upward and downward as well as 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 Article 142 of the Delegated Regulation ([24]).

Calibration approach

([24]) 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.’

161. Shocks should be based on expert judgement because of the scarcity of data for most markets.

Expected impact

162. 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 such as 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 in 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 or decrease depending on the characteristic of the life portfolios. As a consequence, the application of a lapse shock could either increase or decrease OF. Regarding the SCR, again it depends on the way shocks are applied. If an item other than cash or a sovereign bond is assumed to be sold to pay instantaneously the lapses, then the relevant submodules of the market risk module will decrease slightly before the loss absorbing capacity of technical provisions. At the same time, all the SCR modules and submodules that are influenced by the TP (including the market risk module) could increase or decrease depending on the change in TP following the application of the shocks.

Application

163. 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

164. 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 participants' stochastic valuation and risk models to reflect the assumed sudden increase in lapses at the start of the projection. In particular, the specification of the stress scenario must provide details of 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, sums assured, premiums or other volume measures).

165. 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 (e.g. type of product, level of financial guarantees, type and impact of lapse penalties or other characteristics). Although such dependencies may be backed by empirical evidence, the variety of insurance products and features across Europe generally does not allow a 'one-size-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 for consistent application. Against this background, the following subsection discusses some possible approaches for what are known as 'bucketing criteria' with the purpose of linking the lapse shock parameters to the type of insurance product.

Marginal impact of the lapse shock

166. The impact of an adjustment of BE lapse assumptions on the BE of traditional life insurance products depends on several conditions, including:

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

167. 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-size-fits-all rule that correctly describes in each and every case whether such an adjustment implies an increase or a decrease of the BE of a single contract or of a homogeneous risk group (in the sense of the SII Delegated Regulation).

168. Consequently, an explicit decision on how to handle this complex issue has to be made in the context of a ST exercise. Technical specifications have to provide detailed guidance on the respective conditions with regard to the application of the shock to the portfolio in force to reflect the narrative of the scenario. If in the context of a ST exercise no agreement is reached on the operationalisation of the following proposed options, EIOPA might opt, following discussion at steering committee and board level, for other limitations on the positive marginal impacts of the lapse shock (e.g. the 'cap approach' used for the 2018 EIOPA ST exercise ([25])).

5.2.1.3 Options for the application of lapse shocks: bucketing criteria

The 'standard formula approach'

169. The idea of linking 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

([25]) See *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. …'.

life insurance 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 ([26]) 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' should be applied to those contracts for which 'discontinuance would result in an increase of TP without the risk margin'.

170. These provisions therefore explicitly take into account that a decrease or increase in lapse assumptions can have a positive impact on OF (or on assets over liabilities) in the SII balance sheet for some policies or homogeneous risk groups, while for others this impact would be negative. In principle, this means that the company has to check for each contract/homogeneous 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 BE reserves forms the methodological core of the accurate application of the standard formula approach.

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

172. 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 ([27]).

173. Another type of 'contract-specific approach' is applied to simplify the calculation of the capital requirement for permanent changes in lapse rates. Articles95 and 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

([26]) 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.'

([27]) This paper does not aim to discuss any methodological challenges or approaches regarding the technical implementation of this specification.

intermediaries' and 'the amount of technical provisions without the risk margin'. This is by definition a calculation based on contract level, with the result depending on the specific contract features ([28]). The simplified calculation of the capital requirement for the risk of a permanent increase (or decrease) in lapse rates according to Articles95 and 102 addresses only those policies with a positive (or negative) surrender strain. It should be noted that neither of these articles deals with the concept of an instantaneous (mass) lapse event.

174. 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. Therefore, they do not deal with any kind of ST exercises. With regard to the application of a lapse shock in the context of a ST, however, the methodological core of this approach can nevertheless be extended 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.

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

- calculating the BE reserve for each homogeneous risk group after the market shocks to derive the sign of the surrender strain ([29]);
- applying an instantaneous lapse event/a permanent increase (or decrease) of BE lapse assumptions to those homogeneous risk groups with a positive (or negative) surrender strain after the capital market shock.

176. In principle, this approach would imply that the bucketing is defined in terms of a positive/negative surrender strain. Because of 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 ([30]).

<u>The 'classification approach'</u>

177. This approach aims to define 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 in the European insurance sector that is both granular enough and possible to implement. Therefore, a rather principle-based approach was chosen for the following discussion. Two options are presented.

<u>Option 1</u>

178. 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.

([28]) See previous footnote.

([29]) It should be noted that the calculation of these intermediate results requires several additional stochastic runs.

([30]) It should be noted, however, that for operational reasons the approach would focus on the surrender strain of each homogeneous risk group in isolation and would in particular not require iteratively checking all possible combinations across homogeneous risk groups.

- Protection against biometric risks. A stronger focus on protection against biometric risk usually leads to more stable lapse rates. With increasing age biometric protection becomes more and more valuable for policyholders and in addition it might become 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 compared with 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 from that of 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 regarding whether these types of contracts are definitely exposed to a higher or lower lapse sensitivity with regard to capital markets than traditional products. Given 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 decisions as for traditional products. In contrast, a higher volatility of returns, for example in the case of an equity shock such as in the yield curve-up scenario, might lead to greater volatility of lapse rates than for traditional products. A further aspect that could be considered here relates to the impact of various types of financial and non-financial guarantees included in some of these capital market-oriented products.

179. The application of some of these criteria allows classification of the different types of insurance products according to their sensitivity to lapses as depicted in Table 5.2.

Table 5.2 — Sensitivity of lapse rates and 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 in which the return is directly linked to the return of a capital market product such as an index Combination with protection against mortality or longevity risk possible	o (assuming correlation with the capital market movements). The presence of additional features should be considered
Unit-linked contracts with financial guarantees	Build-up of capital in which 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 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

Note: o, low/no sensitivity; *, medium sensitivity; **, high sensitivity.

<u>Option 2</u>

180. An alternative approach to classifying the portfolio of life products taking a lapse perspective based on the rational investment behaviour of policyholders relies on the levels of surrender penalties. Products with high surrender penalties could be assumed to be less likely to lapse, or better, require less likely (or more severe) changes in economic and financial market conditions than products offering lower penalties in to be lapsed.

181. Taking this approach raises the major complexity of finding a homogeneous and agreed approach to the definition of surrender penalties and the calibration of the thresholds to define the cohorts in the two elements thereof. This complexity is, among other reasons, driven by the large variety of types of surrender penalties across the European insurance sector for which it is very difficult to consistently define a relationship between their 'levels' 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 reserve book values or in terms of market values), while other penalties induce various forms of tax disadvantages (which are often closely linked to the specific national legislative framework).

182. 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 product presenting contract-related and fiscal-related (high) penalties and higher shocks to the product with no penalties, as presented in Table 5.3.

Table 5.3 — 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	***	

Note: o, low/no sensitivity; *, medium sensitivity; **, high sensitivity; ***, very high sensitivity.

The 'uniform approach'

183. This approach puts specific emphasis on the empirical evidence for the sensitivity of policyholder lapse behaviour to movements in capital markets, in particular during the financial crisis that began in 2008. It could be argued that at least in some Member States this crisis indeed induced a temporary increase in lapses without, however, significantly discriminating against any product type. Against this background the reason for this temporary increase in lapses could rather be assumed to be linked to the direct consequences of an adverse economic situation (e.g. significantly lower incomes) than to some kind of sophisticated financial rational policyholder behaviour that differentiates between certain insurance product types or features. The approach therefore assumes that policyholders' decisions on 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 ([31]). This assumption may be further supported by the observation that in some Member States lapse rates reverted to their pre-crisis levels after a certain period of time when the economic situation (e.g. with regard to private income) improved again.

184. To reflect these empirical observations the approach to the design of the lapse stress could refer to an instantaneous increase in lapses that 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 is assumed that lapse rates would return to their former BE level. Table 5.4 presents the advantages and the disadvantages of the three approaches to applying lapse shocks.

Table 5.4 — Advantages and the disadvantages of the three approaches to applying lapse shocks

Approach	Advantage	Disadvantage
Standard formula	• The approach addresses differences not only 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	• In the case of a combined scenario the approach requires the calculation of the best estimate reserve after the capital market shock as an interim result to derive the value and in particular the sign of the surrender strain. This

([31]) 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 subsidisation effects with the rest of the in-force business.

	• The similarity with existing specifications in the Delegated Regulation might support consistent application across participants ([a]) 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, thereby mitigating the risk of potential cherry picking • The approach addresses the problem of a potentially positive marginal impact of a lapse shock directly	additional calculation significantly increases the complexity and the operational workload for participants and may require further guidance regarding acceptable simplifications • The approach could be characterised 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 policyholder behaviour'. 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 (as 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 the case of specific interest in particular 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 to the required calculations (possibly affecting the quality of the results) • The approach does not exclude a potentially positive marginal impact of the lapse stress without imposing further side conditions
Uniform	• The approach does not require any additional calculation from participants (as in the 'standard formula approach') or any allocation of model points to 'type of contracts' (as in the 'classification approach') but an adjustment of lapse assumptions	• The approach does not exclude a potentially positive marginal impact of the lapse stress without imposing further side conditions

	• The approach can be backed by empirical evidence to support its plausibility	

Note:
([a]) Assuming that Internal Model users also apply similar criteria for the calculation of the capital requirement for lapse risk.

5.2.1.4 Life expense risk

Description

185. 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

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

187. 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 the long-term inflation rate, making large volatility on long-term inflation rate less likely, but fluctuations in short-term inflation can still occur.

188. Another component of a life expense risk shock relates to an adjustment in the BE expenses. For operational reasons the calibration and specification of the stress parameters for a permanent increase of such BE 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).

189. 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 or claim amounts for claim expenses and investment management for investment expenses, and thus are not subject to inflation/productivity effects. It might be welcome not to have 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

190. An increase in life TP is expected and, as a consequence, a negative impact on OF is envisaged. Regarding the SCR, because of the increase in TP the SCR is expected to increase. The modules most impacted will be life underwriting and operational risk.

5.2.1.5 Other life risk

191. Apart from shocks described in this chapter, insurance undertakings may stress the following risks taken into account in their specific business portfolios:

- 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 accelerates payments or obligations that 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 represents the risk of a rapid growth or decline in the volume of the underwriting portfolio, including the effects of increasing longevity on pension products. TP deficiencies also result 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 (e.g. a pandemic).

192. Although these shocks could have a significant impact on insurers, further work is needed on how they could be calibrated and incorporated within a ST framework. The inclusion of these risks in future ST exercise will be considered according to the relevance and materiality of the respective risk drivers.

5.2.2 Non-life insurance shocks

193. In this section the range of the potential non-life insurance shocks is discussed. For each risk factor the following are described: potential shocks, how to calibrate them and the expected impact on the balance sheet items, the OF and the SCR.

194. Non-life underwriting risk is the specific insurance risk arising from non-life insurance contracts. It relates to the uncertainty over 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 that would be necessary to cover the liabilities created by the business underwritten;
- the frequency and severity of catastrophic events.

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

- provisions deficiency shock (claims and expense inflation);
- catastrophic event shocks (both natural and man-made catastrophes together with shocks to the recoverability of the ceded losses).

5.2.2.1 Provisions deficiency shock: claims and expense inflation

Description

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

- the level/severity and frequency of insurance claims;
- the level of expenses related to servicing claims;
- revision risk for annuities in which 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

197. Mainly use of expert judgement. While some US indices are available ([32]), no proper European indices can be found ([33]).

Expected impacts

198. No impact on the asset side of the balance sheet is expected from a deficiency of provision shock. On the liability side, the shock will lead to higher TP and a decrease in OF. The SCR is expected to increase because of the higher TP. 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

199. The provisions deficiency shock applies to the whole in-force business with potential differentiation between life and non-life lines. Health that is similar to life should be subject to the shocks prescribed to the life business, whereas health that is similar to non-life should be subject to the shocks prescribed to the non-life business.

([32]) Information available from the US Bureau of Labor Statistics: https://www.bls.gov/pir/diseasehome.htm

([33]) Only some statistics on healthcare expenditure (not in the form of price indices) are available from Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php/Healthcare_expenditure_statistics#Health_care_expenditure

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

a) Additive approach
The inflation vector to be used in the calculation of the BE under stressed scenario I^S is derived by summing the prescribed shock s (scalar) to the baseline inflation vector I^B. Therefore $I^S = s + I^B$, and hence the claim inflation at time t is $i_t^S = i_t^B + s$. The approach implies a parallel shift in the cost of claims vector.

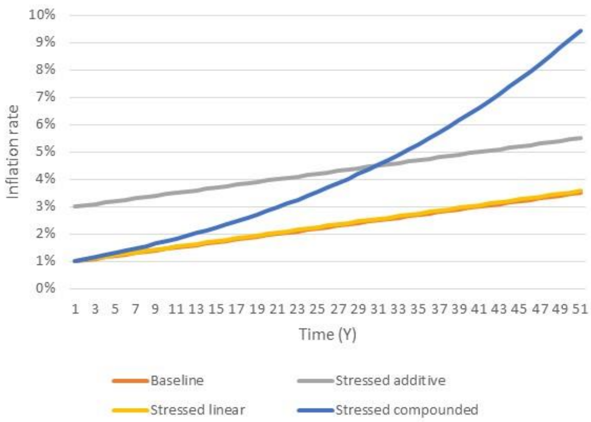
b) Linear approach
The inflation vector to be used in the calculation of the BE under stressed scenario I^S is derived by multiplying the baseline vector I^B by the prescribed shock s (scalar). Therefore, $I^S = s * I^B$,and hence the claim inflation at time t is $i_t^S = (1+s)i_t^B$.

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

The three approaches lead to materially different impacts as shown in Table 5.5 where the projection of a 2% claims inflation shocks is displayed.

Table 5.5 — Claims inflation approaches
(Shock = 2%)

Time (Y)	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: natural and man-made

Description

201. Natural and man-made catastrophic events relate to specific perils that insurers provide cover for. Such shocks should be applied to all lines of business.

Calibration approach

202. Due to the specificity of the risk the definition of an event-based scenario should rely on an external data provider or, alternatively, a *standard formula approach* could be followed. The advantages and disadvantages of the two

approaches are listed in Table 5.6 — Advantages and disadvantages of using the event-based scenario and standard formula approach Table 5.6.

Table 5.6 — Advantages and disadvantages of using the event-based scenario and standard formula approach

Approach	Advantage	Disadvantage
Standard formula	• The similarity with existing specifications in the Delegated Regulation might support consistent application across participants ([a]) and therefore improve the comparability of the results • The approach is easy to implement for participants (easy to validate as well) • The approach allows for a similar severity of the impact of the shock for all participants notwithstanding the geographical distribution of their exposure to catastrophic events • The approach avoids the need for participants that don't have an internal model to calculate catastrophic losses to pay external providers for calculating the impact of the shocks • The approach avoids reputational risk to EIOPA in relying on specific external providers (if not properly communicated)	• The approach will consist in a pure replication of the standard formula computation (only with different parameters) not giving any real additional insight into the vulnerability of the insurance sector. In particular, given the structure of the catastrophe submodules the only way to apply it differently from the calculation of the solvency capital requirement 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 catastrophic events on the European insurance sector (namely a specific earthquake or windstorm). Therefore it seems inadequate to test the impact of a realistic stress test scenario
Event-based scenario	• The approach will allow for the evaluation of the impact of a specific set of catastrophic events on the European insurance sector (namely a specific earthquake or windstorm) providing additional insights into the resilience of the sector to such risks	• The approach could be expensive and challenging for undertakings/groups that do not have an internal model for computing catastrophic losses. This is particularly true for medium-sized/small non-life solo undertakings • Medium-sized/small undertakings will not have sufficient or granular enough data to feed into the software (features of the buildings, destination of the buildings, type of policy coverage, etc.). As a result, the final estimation of the losses could

		be very rough (under-/overestimated) • If not properly communicated, the approach might expose EIOPA to the reputational risk of preferring one specific external provider among a few existing competitors in the sector (altering the competition and level playing field) • The approach doesn't allow for a similar severity of shocks for all participants (e.g. Iberian groups have seen no huge impact from the 2018 stress test Nat-Cat scenario, as no Nat-Cat events occurred in that area) • The comparability of results could be hampered by the fact that current software allows for some customisation by participant groups that may lower the estimations of the final losses

Note:

([a]) Applicable to standard formula users only.

203. The event-based scenario is the preferred option; however, a number of elements should be considered in the calibration of natural and man-made catastrophes in a ST context. The pros and cons of each approach should be carefully considered and assessed according to the objective of each exercise and to the risk profiles of the (re)insurers within its scope.

204. The reputational risk that EIOPA could be exposed to when selecting one specific providers for the identification of the set of catastrophic events could be decreased by the transparent selection of more than one provider at a time or, alternatively, not selecting the same provider each time.

Man-made catastrophes

205. The following databases could be used for catastrophes originating in human activity: World Trade Center Cases in the New York Workers' Compensation System, New York State Workers' Compensation Board, ICA Catastrophe datasets ([34]), SwissRE database ([35]). Specific scenarios should be established in consultation with external data providers.

Expected impact

206. 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

([34]) Available at: https://www.icadataglobe.com/access-catastrophe-data.
([35]) Available at: http://www.sigma-explorer.com/

the damage) an impact (decrease) on the cash and other liquid assets is observed, whereas, if the claims are reserved, then an increase in the non-life claims TP is registered. Notwithstanding the approach followed, the reinsurance recoverables item increases. The final impact on OF will always result in a decrease whatever approach to applying the shocks is chosen. The decrease in 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 because of higher losses and lower recoverables.

Application

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

a) the approach to the settlement of the claims;
b) the assumption made on the reinstatement of the reinsurance treaties.

Claim disbursement

208. The management of the claims, especially with regard to natural or man-made catastrophes, encompasses several steps that could extend the time from the filing of the claim to its 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 in the technical reserves, whereas (ii) after the settlement the impact is transferred from the liability side (reduction in TP) to the asset side with a reduction in the assets used to pay out the claim.

209. 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 made to fit the process into the general framework of a ST exercise and to grant the comparability of the results. To that end two 'black or white' approaches can be followed:

a) 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 or effect of the prescribed shocks on the TP.

Option a) requires assumptions about 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 to sell the assets that, according to the prescribed shocks, generate the smaller impact on the post-stress balance sheet and post-stress SCR). ST technical specifications can cope with this issue using a principle-based approach by asking participants treat the assets in accordance with the investment strategy they regularly adopt. Alternatively, a set of rules on the selection of the assets and on the sequence of sale should be prescribed. Independent of the approach taken, assets are assumed to be sold in 'stressed' markets, and therefore they are 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 about the assets to be sold and about the sequence of sale can be avoided, potentially enhancing the comparability of the results.

Reinsurance treaties

210. Catastrophe scenarios encompasses a series of events that are supposed to be independent and happen in a short timeframe. Insurers are supposed to take account of the risk mitigation techniques in place at the reference date including proportional and non-proportional reinsurance treaties in place.

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

212. With regard to the reinsurance recoverables, two approaches could also be applied:

a) Recoverables were accounted for as immediately received after the event and therefore they net the instantaneous disbursement in the option a) above or will increase the assets (potentially the deposit item) in option b) above.
b) Recoverables are accounted for as a credit to be received from reinsurers [R0370]. Therefore, they will increase the asset side of the balance sheet in both options a) and b) above (i.e. notwithstanding whether the claims are paid immediately or not).

213. If the catastrophic shocks are included in a more complex catastrophe scenario the recoverability of insurance losses through reinsurance treaties could also be shocked. To this end an additional shock considering the default of some reinsurers (e.g. the largest ones) or their ability to fully repay the claims could be considered. To do so, the largest counterparty could be selected and their recovery rate could be shocked according to the CQS of the reinsurer (using as a reference the probability of default prescribed in the SII standard formula).

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]

214. Assets and liabilities of the post-shock balance sheet might create tax ‘advantages’ or ‘disadvantages’. Typically, the deferred tax per single item is recognised 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 (DTLs), are fully recognised, whereas tax advantages, deferred tax assets (DTAs), can only be recognised up to the amount that future taxable profits are available for use. A tax advantage, DTA, may also occur if the undertaking has fiscal losses from previous years that it can carry forward.

215. 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 to ensure that all amounts that could give rise to future tax cash flows are captured. This post-stress evaluation should be consistent with the regulatory framework. In the event that the baseline or stressed balance sheet includes a positive DTA value, undertakings should be able to provide reasonable and plausible arguments that future or past taxable profits will be available against which DTAs can be utilised, taking into account any legal or regulatory requirements.

216. The development of those quantities would need to be explained in both a qualitative and a quantitative way. A dedicated table related to deferred taxes could be used in the validation (those would be of considerable help, for example in the event of the positive development of the DTAs).

5.3.2 Derivatives [R0190] and [R0790]

217. Derivatives are held by insurers for hedging and investment purposes. No specific shock to the market price of derivatives 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 in the scenario. The normal volatility of the underlying assets has to be kept unchanged.

218. In the case that derivatives are held for risk mitigation their use in a ST exercise should be aligned with the SII level II guidelines. Risk mitigation techniques might be restricted to individual instruments or cover 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.

219. Insurance or reinsurance undertakings should take into account basis risks stemming from performing STs, which means that 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. The material basis risk should be reflected while performing stress testing.

5.4 Simplifications

220. In principle, the participants should use the same models and processes that they use for the calculations included in the annual quantitative reporting template (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 to assess how these could be addressed. This also holds for significant changes to business activities after the reference date, for example merger and acquisitions or divestments (please also refer to Section 2.3.1 on recalculation of the baseline).

221. 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 inappropriately distorting the interpretability and the comparability of the results.

222. 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 necessary by national regulations) by the supervisor before the start of the calculation phase.

223. The participants should provide details of 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 of the materiality of the deviations created by the use of the simplification. This information should allow the supervisor to judge the suitability of each of the simplifications.

5.4.1 Perimeter

224. EIOPA ST exercises are based on the SII framework and 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 should be applied to the entire business in force, 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 using a scaling approach.

225. Relevance of the scenario is the key condition to exclude part of the business (an entity in the 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 because of its nature (e.g. life/non-life) or to its geographical location. In the case that a participant demonstrates non-vulnerability, it is allowed to estimate the contribution of the excluded business to the overall post-stress balance sheet and solvency position using a scaling approach.

226. Apart from the element of the relevance, the exclusion of part of the in-force business is subject to a materiality criterion. To avoid large approximations in the post-stress position, participants are allowed to apply a simplified treatment to only 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.

227. The post-stress values of the part of the business excluded in line with the above-mentioned criteria should be scaled according to the change in the corresponding items calculated for the business being treated. Undertakings

are requested to apply the shocks following the prescribed guidance and to rely on the baseline model used for the production of their yearly report.

5.4.2 Loss absorbing capacity of deferred taxes

228. 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 use/offset these fiscal losses.

229. 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.

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

231. The 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 used.

232. In the recent amendment to Articles 207, 297 and 311 of the Delegated Regulation, 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 substantiation of the LACDT. Allowing for future profitability as substantiation of the LACDT in addition to the DTL would require a much deeper analysis by the NCAs.

233. 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 that those average tax rates are determined at an appropriate level.

234. In the case that an undertaking would not pursue a full recalculation, it is allowed either to set the post-stress LACDT at zero or to approximate it with reference to the value of post stress net DTL, namely:

- if the post-stress net DTL is greater than zero, then participants are allowed to apply a reduction in LACDT by this amount in the calculation of the post-stress SCR;
- if the post-stress net DTL is negative, than this reduction can be set to zero.

This approach is formalised in the following equation:

$$LACDT_{post-stress} = \max(0, netDTL_{post-stress})$$

235. Undertakings should be able to provide evidence to support their approach to LACDT post-stress calculations and its appropriateness.

5.4.3 Regression techniques for liabilities or own funds ([36])

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

237. These companies have to comply among others with Article 122 of the SII Directive, which requires the SCR to 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 analytical 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.

238. 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 to quantify the change in a target variable (such as the BE liability or the present value of future profits) under a change in specific risk drivers. Some of the most prominent examples for such regression techniques in the insurance sector are labelled as:

- curve-fitting;
- replicating portfolios (RPs);
- least square Monte Carlo (LSMC).

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

240. The calibration of the target functions or of the replicating portfolio depends among other things on the capital market situation. To illustrate this fact for the case of a replicating portfolio it is clear that the composition of an asset portfolio that is supposed to replicate the BE liability will very likely vary for different levels of the RFR curves ([37]). Therefore, a straightforward application of these regression techniques in the context of a ST would require a full

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([36]) Regression techniques for liabilities or own funds can also be referred to as 'proxy modelling'.

([37]) This difference is among other things due to the asymmetric split of profits between companies and policyholders.

recalibration post stress, ideally complemented by validation tools similar to those used for the baseline situation.

241. 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 ST exercise ([38]). Apart from these operational constraints, the specification of the required technical framework for such a recalibration should also be provided. To illustrate with an example in the context of replicating portfolios the ST specification would need to provide concrete information on the following aspects among others:

- the 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).

242. In general, because of their heterogeneity and complexity, it is challenging to provide comprehensive and detailed information for such a recalibration exercise that consistently covers all types of regression techniques used across Europe.

243. Against this background, apart from the full recalibration of the parameters/portfolios supporting the techniques mentioned, it can be expected that companies will apply approximations or simplifications 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 in 2018, for example by scaling the loss distribution generated by the regression in the baseline situation by using specific post-stress sensitivities.

244. Providing additional information with respect to previous EIOPA ST exercises should alleviate the burden of the recalibration and increase the comparability of the results obtained through those techniques. The minimum amount of necessary extra hypotheses will be identified through future exchanges with stakeholders and participants. Other types of scenario hypotheses, different from those that are usually part of the technical specifications (e.g. implied volatility surfaces for both equity and interest rates, especially their change from baseline to stressed situations) will be investigated to fill the existing gap between the information needed by the companies and what is provided by EIOPA for a ST exercise.

245. The assessment of the appropriateness and plausibility of approximations should form a central component of the validation process — within both the companies and 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 underestimation 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 at stake, an early

([38]) It should be noted that further iterations of the recalibration processes would be required in the event that the stress test specifications require quantifying the potential impact of long-term guarantee measures or management actions on the solvency capital requirement post stress.

dialogue between companies and supervisors on the appropriateness of the intended approximations will be a key ingredient to ease the recalibration and better understand the limitations encountered. This dialogue should happen at an early stage of the ST process and before companies start their calculations.

5.4.4 Use of long-term guarantees and transitional measures

246. 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 prior approval by the NCA or group supervisor, this measure can be used only insofar as approval has been granted at the reference date.

247. The calculation of the impact of the LTG and transitional measures post stress should be aligned with the objectives of the ST exercise. Because of its different nature, the potential disclosure of these measures should be done separately.

248. Calibration of the LTG measures should be assumed to be unchanged with respect to the baseline if not specified differently. However, if the shocks prescribed under the stress scenario trigger a material change in the LTG measures, their values are recalibrated in accordance with EIOPA's methodology. In detail:

- the impact, in absolute terms, of the transitional measure on the TP should 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 should 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 should be re-evaluated under stressed scenarios and applied consistently with the baseline case;
- recalculated VA are provided by EIOPA under the stress scenarios;
- a symmetric adjustment mechanism for the equity risk charge under the stressed scenario is provided by EIOPA.

5.4.5 Calculation of the post-stress risk margin

249. The main objective of the risk margin (RM) is to evaluate the price of maintaining the activity until the extinction of liabilities. It means that undertakings must be able to evaluate the capital along extinction years to at least cover the SCR(t) actualised and multiply by the cost of capital.

250. 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).

251. To ensure comparability with the baseline, the post-stress RM should be computed, as a default option, using the same method used for the calculation of the year-end balance sheet. In any case, 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 one of the

methods listed in EIOPA guideline 61 ([39]) independently of the one that they use regularly for the production of their year-end financial statements (namely dropping one notch down in the hierarchy of methods), provided that the approximation applied does not hamper the proper assessment of the TP.

5.4.6 Consolidation

252. The selection of insurance group undertakings to be included in the scope of a ST exercise introduces the additional complexity of the consolidation of the post-stress results of solo undertakings. The SII Directive (2009/138/EC) allows groups to consolidate their solo's positions using one of two calculation methods: (i) the accounting consolidation-based method ([40]); and (ii) the deduction and aggregation method (D&A) ([41]).

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

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

255. 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 their entire in-force business 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 case 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 the calculation of the post-stress group balance sheet with enough precision to fill in the ST reporting templates. The *group consolidated-based approach* excluded any approximation using sensitivity analysis and all simplifications should consist in, for example, grouping liabilities into tractable quantities instead of breaking them down at solo undertaking level.

256. Based on the experience of the 2018 ST exercise, the group consolidated-based approach presents several issues in different phases of the ST exercise for both 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 a homogeneous portfolio of liabilities.
- Validation: difficulties in assessing the post-stress BE using the cash flows provided.

257. In view of these limitations the group consolidated-based approach is not considered a good way forward for future EIOPA ST exercises unless proper

([39]) EIOPA, 2015, 'Guidelines on valuation of technical provisions' (guideline 61). Available at: https://www.eiopa.europa.eu/content/guidelines-valuation-technical-provisions_en.
([40]) Directive 2009/138/EC, Art. 230, Method 1 (default method): accounting consolidation-based method.
([41]) Directive 2009/138/EC, Art. 233, Method 2 (alternative method): deduction and aggregation method.

solutions allowing homogeneous definition of the model points to approximate liability portfolios and a sufficiently accurate approach to validating the post-stress BE liabilities are defined.

6 Data collection and validation

258. This chapter elaborates the 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

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

260. 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. In principle, baseline information should match the set of data requested in the regular reporting templates, whereas post-stress information should be as granular or less so than what is requested in the SII QRT. 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 the event that 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.

261. 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.

262. 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 used to run the calculations.

6.1.2 Templates for the purpose of core solvency analysis

263. Participants should fill in the reporting templates using 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).

264. Depending on the scope of the exercise, the balance sheet should fully replicate SII QRT S.02.01.01, with SII figures reported under the baseline and under each of the stress scenarios. In the case of a group exercise, the template should be used to report the balance sheet data of all the participants, irrespective of the method used to calculate group solvency, namely the ‘accounting consolidation-based method’, the ‘deduction and aggregation method’ or a combination of both methods.

265. 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 OF under stressed scenarios could be exempted from reporting.

266. Information on OF is collected under each scenario using 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.

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

268. 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 QRTs S.06.01 and S.06.02 Annual SII reporting. Market valuation should be provided for equity and for asset classes with contractual cash flows computed according to the methodology applied internally by undertakings. In particular, details of the decomposition of the exposures and of the modified durations for sovereign bonds, corporate bonds, collateralised 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 should exclude the asset held for unit- and index-linked portfolios. In general, a look-through approach to reporting collective investments is not requested; however, depending on the objective of the exercise, more granular details might be required. The credit quality of the assets, when requested, is defined according to CQS.

269. The liability description is a template that elaborates on the annual SII reporting of TP for life and health (QRT S.12.01) and for non-life (QRT 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 QRT S.14 template, or a 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 types of liabilities) could be requested. In the case of a group ST exercise, the liabilities reported should refer only to the entities consolidated using method 1 to achieve consistency with the values of the TP reported in the balance sheet.

270. The templates on duration of TP (if included in the reporting package) should in principle be completed in a manner consistent 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

271. If the stress scenario comprises insurance-specific shock(s) (e.g. shock to lapse) additional dedicated templates might be needed to allow estimation of 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

272. 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 among the participants. As a result, this process should guarantee a level playing field and comparability of the results.

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

274. As an overarching principle, the evolution of any number reported from the baseline to the situation under stress should be validated. For this reason ST-specific reporting information can also be requested in addition to the regular reporting to allow dedicated validation checks. All templates differing from the standard QRT need appropriate justification and should be introduced to stakeholders before use, allowing an adequate time for discussion.

275. Various 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.

276. Validations are grouped into various levels:

- Level 0: consistency and completeness check.
- Level 1: consistent application of shocks (validation of closed-form formulae).
- Level 2: benchmark analysis against peer levels.
- Level 3: proprietary in-house model used for analysis.

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

278. Level 1 validation checks aim to ensure consistent application of the prescribed shocks. This type of quality assurance validation is less automatic and typically needs formulae or proxies to check the correctness of specific

figures in 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 comparisons. Indeed, the results obtained from the level 1 validations could be slightly different from the precise calculations made by the ST participants using, for example, a more refined classification of their collective funds.

279. Level 2 validation checks consist of benchmarking analysis among peers. Because of the complexity of the liability estimations, not all balance sheet items can be calculated or checked by means of simple closed-form formulae. Level 2 validations therefore take the form of regression analysis on the impact of shocks against participant characteristics, aimed at detecting outliers. Variables in addition to those in the standard reporting templates are paramount for this analysis to group and/or classify the participants by common characteristics.

280. Alongside the various exercises, EIOPA has developed in-house models to estimate liability items based on a limited number of parameters and hypotheses. Those tools utilise techniques used by the industry with simplifications and approximations. They are in essence more speculative, as 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 notably rely on those tools.

6.2.1.1 Examples of level 1 validation checks

281. A typical example is the validation of the asset side under a stress scenario. As the granularity of the baseline figures and the shock tables match, one can roughly compute the different impacts using the technical information submitted. For instance, the first step to validate the asset values under stressed circumstances in which 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 liability stresses involving surrenders would be incurred before the assets scenario, then comparability could not be achieved between baseline and adverse situations. Further hypotheses would be required to produce other types of estimations.

282. 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 using an approximation. The first derivative, linking the price 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.

283. For fixed income there are three categories of assets in a typical stress test exercise: (i) sovereign bonds; (ii) corporate bonds, collateralised securities and 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 approximation 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 Examples of level 2 validation checks

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

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

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

287. Various 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 entered 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 that can subsequently be used as a dummy variable in regression analysis.

6.2.1.3 Examples of level 3 validation checks

288. As already mentioned in the previous paragraphs, estimation of some of the value of an insurance balance sheet item can prove to be challenging and is, in general, model based. In this context, EIOPA has developed simplified models that 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 a stressed situation, and the other is about the RM.

289. 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 QRT S.13 (e.g. accounting cash flows, certainty equivalent cash flows). Nevertheless, discounting the submitted cash flows both on the baseline and under a stressed scenario should give an approximation of the stressed amount, which can be compared with the reported stressed amount. However, because very different definitions are used for these cash flows, a precise reconciliation will not be possible. Therefore, a rejection threshold should be set, and participants will need to comply with or explain any breach of this threshold.

290. Information on future discretionary benefits is requested to analyse the overall change in options for the materialisation 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 the actualisation of the baseline cash flow sequence and, on the other hand, the cash flow sequence under a 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 numbers reported.

291. Cash flow patterns are also analysed. For example, the outflows in the baseline and in the stressed scenario are 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, separate reporting of guaranteed and discretionary cash flows could be required at the start of the ST exercise.

292. Another example of a possible test concerns the calculation of the RM. In previous ST exercises the stressed RM could be inferred from the stressed BE. A key principle used in previous STs is that the ratio between RM and BE after stress would be subject to some degree of approximation, 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. In any case, a RM should never be negative either in the baseline or under a stressed scenario.

293. A more restrictive view of this validation check on the RM is a common methodology for calculating what is known as the 'base RM'. This can be used by EIOPA during the ST as a reference to check the plausibility or the justification required for the RM presented post stress. A possible framework for the control variable base RM is shown in Table 6.1.

Table 6.1 — Possible framework for the control variable base risk margin

Approach	Advantages	Disadvantages
Solvency II 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 risk margin
More restrictive than Solvency II	• Better comparability, as the same formula is used for all participants • Validation made simple	• One-size-fits-all model not easily defined (see below) • Needs a baseline re-calculation to be fully used

294. Depending on the choice of the framework, the definition of the base RM could be aligned with one of the definitions proposed in Table 6.2. This could involve additional calculations by EIOPA to achieve the baseline figures.

Table 6.2 — Advantages and disadvantages of the approaches to defining base risk margin

Approach	Advantage	Disadvantage
Method 1 Full, no simplification	• Exact valuation • Full comparability?	• Must be based on a strong hypothesis • Extremely complex to specify (might need an extra parameter for each point in time in the future, such as the volatility surface) • Time consuming (nested stochastic calculation needed)
Method 2 SCR freeze at *t*=0 (before shock) and calculation based on BE(*t*)	• 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
Method 2 bis SCR freeze at *t*=0+ (post shock) and calculation based on BE(*t*)	• 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)
Method 3 Modified duration Without hypothesis of constant modified duration	• Depends only on SCR baseline and post-shock and RM (baseline)	• Impact of LAC development not taken into account
Method 4 Fixed factor based on RM/BE at *t*=0	• Simple approach applicable at line of business level (with RM proportional to SCR_{Lob}/SCR_{Total}) • No recalculation of baseline	• Rough approximation

Method 5
Mixed method
	• Simple and flexible to help the objective of the ST	• Approach tailored on each ST exercise hence:
		  • Lack of comparability across ST exercises
		  • Non-reusable models
		• Might need recalculation of baseline RM figures

Note: BE, best estimate; LAC, loss absorbing capacity; Lob, line of business; RM, risk margin; SCR, solvency capital requirement; ST, stress test.

7 Annex I — Glossary ([42])

Adverse stress scenario	An adverse (stress) scenario is a set of economic and financial conditions (significantly more negative than a baseline scenario) that 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 other things.
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 with which to compare the 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 own risk and solvency assessment. 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 (e.g. through interconnected exposures and collective behaviour). Alternatively, microprudential stress tests can also be used to assess risks at 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 comprise a true macroprudential stress test.

([42]) Adapted from BIS, 20217, *Supervisory and bank stress testing: range of practices*. Available at: https://www.bis.org/bcbs/publ/d427.htm

	See also 'microprudential stress test' and 'second-round effects'.
Microprudential stress test	A microprudential 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 subject to the stress test exercises.
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 in understanding underlying risks and vulnerabilities in institutions' businesses and products that pose a threat to their 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 paths potentially different from 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 (e.g. 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 (e.g. fire sales).
Sensitivity analysis	Sensitivity analysis or single-factor shocks is the process of assessing the impact of a change in 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 that is covered in the forward-looking part of the stress test. It should be in line with the objective, methodology and 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, in which participating institutions are requested to perform the calculations. The supervisor provides the stress testing framework, methodologies, adverse stress scenarios, prescribed shocks and guidance on the application of the shocks. Participants are to calculate the impact of the prescribed shocks on their balance sheets and capital requirements, according to the guidance provided, 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

Calculating the joint probability of a stress test scenario is extremely difficult because of the large number of variables and issues of time series length. Below is a statistical example of 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 ,...x_n. Let us also suppose that the variables in the distress scenario assume values x_1^s, x_2^s,... x_n^s. The joint probability of getting a result that is at least as extreme as the one obtained by the stress test exercise is $P(x_1 \leq x_1^s, x_2 \leq x_2^s, \dots, x_n \leq x_n^s)$.
The conditioning event of the scenario is defined by variable x_k, being below its $\alpha 100\%$ worst case scenario, i.e.:

$$x_k \leq F_k^{-1}(\alpha), \quad (1)$$

where $F_k^{-1}(\alpha)$ is the α100-th quantile of variable *k*.
The scenario is instead defined by the response of the other variables when the distress scenario materialises, i.e.:

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

The higher the dependence across the variables, the closer the joint probability of the stress test to $\alpha\, p\%$. Instead, if these variables are approximately independent under the distress scenario, the joint probability of the exercise is closer 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 1,000 variables in all European Supervisory Authority 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 remaining results of the stress test. In addition, for each scenario multiple simulations might be run to create a scenario that has not been observed in the past, which might make it more difficult to calculate the joint probability of the scenario.

The probability $\boldsymbol{\alpha 100}\%$ of the triggering variable in equation (1) indicates how likely it is that a distress event materialises, which is at least as extreme as the threshold set in equation (1). The closer $\boldsymbol{\alpha}$ is 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	Main references
Assets		
Goodwill	R0010	
Deferred acquisition costs	R0020	
Intangible assets	R0030	
Deferred tax assets	R0040	Section 5.3.1
Pension benefit surplus	R0050	
Property, plant & equipment held for own use	R0060	Section 5.1.4
Investments (other than assets held for index-linked and unit-linked contracts)	R0070	
Property (other than for own use)	R0080	Section 5.1.4
Holdings in related undertakings, including participations	R0090	Section 5.1.2
Equities	R0100	
Equities — listed	R0110	Section 5.1.2
Equities — unlisted	R0120	Section 5.1.2
Bonds	R0130	
Government Bonds	R0140	Section 5.1.1.1
Corporate Bonds	R0150	Section 5.1.1.2
Structured notes	R0160	Section 5.1.1.2
Collateralised securities	R0170	Section 5.1.1.2
Collective Investments Undertakings	R0180	Section 5.1.6
Derivatives	R0190	Section 5.3.2
Deposits other than cash equivalents	R0200	
Other investments	R0210	
Assets held for index-linked and unit-linked contracts	R0220	
Loans and mortgages	R0230	Section 5.1.5
Loans on policies	R0240	Section 5.1.5
Loans and mortgages to individuals	R0250	Section 5.1.5
Other loans and mortgages	R0260	Section 5.1.5
Reinsurance recoverables from:	R0270	Section 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	Section 5.1.7
Reinsurance receivables	R0370	Section 5.1.7
Receivables (trade, not insurance)	R0380	
Own shares (held directly)	R0390	Section 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	Section 5.1.6
Total assets	**R0500**	
Liabilities		
Technical provisions — non-life	R0510	Sections 5.1.3 and 5.2.2
Technical provisions — non-life (excluding health)	R0520	
Technical provisions calculated as a whole	R0530	
Best Estimate	R0540	
Risk margin	R0550	Section 5.4.5
Technical provisions — health (similar to non-life)	R0560	
Technical provisions calculated as a whole	R0570	
Best Estimate	R0580	
Risk margin	R0590	Sections 5.1.3 and 5.2.1
Technical provisions — life (excluding index-linked and unit-linked)	R0600	Section 5.1.6
Technical provisions — health (similar to life)	R0610	
Technical provisions calculated as a whole	R0620	
Best Estimate	R0630	
Risk margin	R0640	Sections 5.1.3 and 5.2.1
Technical provisions — life (excluding health and index-linked and unit-linked)	R0650	Section 5.1.6
Technical provisions calculated as a whole	R0660	
Best Estimate	R0670	
Risk margin	R0680	Section 5.4.5
Technical provisions — index-linked and unit-linked	R0690	Section 5.1.3 and 5.2.1
Technical provisions calculated as a whole	R0700	
Best Estimate	R0710	
Risk margin	R0720	Section 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	Section 5.3.1
Derivatives	R0790	Section 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**	

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