CONSULTATION PAPER

CONSULTATION PAPER

on the proposal for Implementing Technical Standards specifying the methodology to determine the set of scenarios to be used for the prudent deterministic valuation of the best estimate for life obligations with options and guarantees

EIOPA-BoS-24/324
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European Insurance and Occupational Pensions Authority

TABLE OF CONTENTS

RESPONDING TO THIS PAPER

EIOPA welcomes comments on the consultation paper on the proposal for Implementing Technical Standards specifying the methodology to determine the set of scenarios to be used for the prudent deterministic valuation of the best estimate for life obligations with options and guarantees.

Comments are most helpful if they:

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

Please provide your comments to EIOPA via EU Survey (link) by 2 January 2025 23:59 CET.

Contributions not provided via EU Survey or after the deadline will not be processed. In case you have any questions please contact SolvencyIIreview@eiopa.europa.eu.

Publication of responses

Your responses will be published on the EIOPA website unless: you request to treat them confidential, or they are unlawful, or they would infringe the rights of any third-party. Please, indicate clearly and prominently in your submission any part you do not wish to be publicly disclosed. EIOPA may also publish a summary of the survey input received on its website.

Please note that EIOPA is subject to Regulation (EC) No 1049/2001 regarding public access to documents and EIOPA's rules on public access to documents.[1]

Declaration by the contributor

By sending your contribution to EIOPA you consent to publication of all non-confidential information in your contribution, in whole/in part – as indicated in your responses, including to the publication of the name of your organisation, and you thereby declare that nothing within your response is unlawful or would infringe the rights of any third party in a manner that would prevent the publication.

Data protection

Please note that personal contact details (such as name of individuals, email addresses and phone numbers) will not be published. EIOPA, as a European Authority, will process any personal data in line with Regulation (EU) 2018/1725. More information on how personal data are treated can be found in the privacy statement at the end of this material.

[1] Public Access to Documents.

Next steps

EIOPA will revise the proposal in view of the stakeholder comments received. EIOPA will publish a report on the consultation including the revised proposal and the resolution of stakeholder comments.

1. BACKGROUND AND RATIONALE

The European Commission proposed amendments to Directive 2009/138/EC[2] (Solvency II Directive) in September 2021.[3] The provisional agreement of the European co-legislators on the amendments to the Solvency II Directive[4] introduces a new Article 77(8) which allows insurance and reinsurance undertakings that are classified as small and non-complex undertakings and undertakings that have obtained prior supervisory approval to use a prudent deterministic valuation of the best estimate for life obligations with options and guarantees that are not deemed material. The aim of this prudent deterministic valuation is to provide small and non-complex undertakings with an approach to reflect a prudent level of the time value of options and guarantees (TVOG) in their calculation of technical provisions, without requiring a full stochastic valuation.

MANDATE FOR DRAFT IMPLEMENTING TECHNICAL STANDARDS

In order to ensure uniform conditions of application of Article 77(8), Article 86(2a) of the Solvency II Directive mandates EIOPA to draft implementing technical standards (ITS) specifying the methodology to determine the set of scenarios to be used for the prudent deterministic valuation of the best estimate for life obligations. The addressee of these ITS will be EIOPA because EIOPA has to calculate and publish the set of scenarios for each relevant currency at least on a quarterly basis, as part of the technical information produced by EIOPA pursuant to Article 77e of the Solvency II Directive. According to paragraphs 2 and 3 of Article 77e of the Solvency II Directive, the Commission may adopt implementing acts which set out, for each relevant currency, the set of scenarios to be used for that valuation, making use of the technical information published by EIOPA.

The ITS pursuant to Article 86(2a) of the Solvency II Directive only cover the methodology to determine the set of scenarios. The Commission will adopt delegated acts laying down the prudent deterministic valuation as well as the conditions under which that valuation may be used.

INFORMATION REQUESTS CONDUCTED BY EIOPA

In order to identify and test potential candidates for a methodology to determine scenarios to be used for the prudent deterministic valuation, EIOPA carried out two European information requests with the insurance industry. The first information request was addressed at undertakings which already perform a full stochastic valuation of their technical provisions. It aimed at assessing the feasibility and impact of three different mathematical options for the methodology, additionally allowing for variants for each of these options relating to different levels of volatility. This information request was limited to

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[2] Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II), OJ L 335, 17.12.2009, p. 1–155

[3] Proposal for a Directive of the European Parliament and of the Council amending Directive 2009/138/EC as regards proportionality, quality of supervision, reporting, long-term guarantee measures, macro-prudential tools, sustainability risks, group and cross-border supervision

[4] See the corrigendum of the text of the provisional agreement as adopted by the European Parliament on 23 April 2024.

liabilities denominated in euro and was carried out by 18 undertakings in 9 countries. The addressees of the second information request were undertakings applying deterministic valuations for their technical provisions, as well as, for currencies other than the euro, undertakings using full stochastic valuations. In this second request, 34 undertakings in 13 countries participated. With regard to undertakings that assess their technical provisions on a deterministic basis, the second request aimed to assess the feasibility of the calculations foreseen under the prudent deterministic valuation, and the size of the resulting adjustments to deterministic technical provisions. With regard to undertakings using a stochastic valuation, the information requests allowed a comparison between the TVOG derived from the undertaking's own stochastic valuation and the TVOG derived on basis of a prudent deterministic valuation. On basis of the information derived from these information requests, EIOPA identified the methodology of "pure stochastic trajectories" as a candidate methodology for the determination of the scenarios to be used in the prudent deterministic valuation.[5]

APPROACH TO THE DRAFT ITS

EIOPA's approach to the ITS is to provide for a coherent methodology frame for the determination of the scenarios, specifying:

- the scope of currencies and financial market parameters covered by the scenarios;
- overall criteria that the set of scenarios determined by the methodology are required to fulfil;
- the base methodology that needs to be used to generate the scenarios, together with necessary adjustment steps that ensure that the chosen set of scenarios has a sufficiently prudent level of volatility and at the same time an acceptable martingale error;
- requirements on the selection of the volatilities for the scenarios, with the aim to allow for an approach which is practically feasible and limits the risk of underestimation of the time value of options and guarantees embedded in the insurance obligations.

EIOPA aims to keep the description of the methodology high-level in order to allow for sufficient flexibility in the calculation. In addition to the draft ITS, EIOPA plans to provide a mathematical implementation that includes all details of the calculation. A draft of that mathematical implementation is set out in Annex II.

Overall, EIOPA aims for a simple and robust methodology to determine the scenarios to be used for the prudent deterministic valuation. This applies to the choice of the type of methodology as well as to its calibration. In line with this overall aim, the calibration of the volatility hypotheses for the scenarios shall be based on information derived from the stresses of the SCR standard formula for the relevant market parameters (such as e.g. interest rates, equity, real estate), thereby avoiding the use of market data from external vendors and the lack of market data for specific currencies and countries.[6]

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[5] for a description of this methodology, see section 1.a in the methodological note on PHRSS, available here

[6] cf. section 3 in the methodological note on PHRSS, *ibid*

2. DRAFT TECHNICAL STANDARDS

EUROPEAN COMMISSION

Brussels, dd.mm.yyyy
C(20..) yyy final

COMMISSION DELEGATED REGULATION (EU) No …/..

of [ ]

COMMISSION IMPLEMENTING REGULATION (EU) No …/… laying down implementing technical standards with regard to the methodology to determine the set of scenarios to be used for the prudent deterministic valuation of the best estimate for life obligations in accordance with Directive 2009/138/EC of the European Parliament and of the Council Text with EEA relevance

of [ ]

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II)[7], and in particular Article 86(2a), second subparagraph thereof,

Whereas:

(1) Article 77(8) of Directive 2009/138/EC permits insurance and reinsurance undertakings that are classified as small and non-complex undertakings and undertakings that have obtained prior supervisory approval to use a prudent deterministic valuation of the best estimate for life obligations with options and guarantees that are not deemed material.

(2) In order to ensure uniform conditions of application of Article 77(8) of Directive 2009/138/EC, this Regulation specifies the methodology to determine the set of scenarios to be used for the prudent deterministic valuation of the best estimate for life obligations with options and guarantees that are not deemed material.

(3) To limit the burden of calculation for insurance and reinsurance undertakings, the set of scenarios determined by the methodology should include only a small number of scenarios so that it is operationally compatible with an iterative calculation by a non-stochastic model.

(4) The matching adjustment and the volatility adjustment are undertaking-specific adjustments to the risk-free interest rate term structure. Taking into account these adjustments in the scenarios derived by the methodology would unduly increase the complexity of the calculations and of the framework of the prudent deterministic valuation as a whole. The methodology should therefore derive the scenarios using basic risk-free interest rates, without application of a matching adjustment or a volatility adjustment.

(5) The methodology should set out a two-step approach. The first step should generate a small sample of scenarios by applying a simple base methodology. The second step should adjust the scenarios produced in the first step. These adjustments are necessary to ensure that the resulting set of scenarios has acceptable martingale properties and they exhibit sufficient volatility.

(6) For the determination of the sample of scenarios under the base methodology, a stochastic process based on random variables following a normal distribution should be used to simulate

[7] OJ L 335, 17.12.2009, p. 1–155.

evolutions of the financial market parameters considered. This model is preferable to more complex ones in order to ensure transparency and simplicity.

(7) The methodology should adjust the sample of scenarios determined by the base methodology by assigning weights to each scenario to ensure that on a weighted basis, the chosen set of scenarios has a sufficiently prudent level of volatility and at the same time has a low weighted average martingale error. For the robustness of the assessment of the materiality of the time value of options and guarantees, it is preferable to use the information from as many scenarios as possible. Therefore, the chosen weights should not be too low.

(8) In order to limit the reliance to external vendor market data, the volatility parameters used in the methodology should be derived on basis of the respective standard formula market stresses, taking into account the sampling error inherent in the prudent deterministic valuation.

(9) Under the prudent deterministic valuation of the best estimate, the time value of options and guarantees embedded in the insurance obligations is measured on basis of a much smaller set of scenarios than under a full stochastic valuation. This methodological choice inevitably increases the sampling error and leads to a degree of inaccuracy of the measurement performed. In order to ensure the prudency of the deterministic valuation of the best estimate, and to limit the risk of underestimation of the time value of options and guarantees, the volatility parameters used in the methodology should therefore be set at a sufficiently prudent level.

(10) This Regulation is based on the draft implementing technical standards submitted to the Commission by the European Insurance and Occupational Pensions Authority.

(11) The European Insurance and Occupational Pensions Authority has conducted open public consultations on the draft implementing technical standards on which this Regulation is based, analysed the potential related costs and benefits and requested the advice of the Insurance and Reinsurance Stakeholder Group established by Article 37 of Regulation (EU) No 1094/2010.

HAS ADOPTED THIS REGULATION:

Article 1

Financial market parameters

1. The set of scenarios determined by the methodology shall cover the most material financial market parameters affecting the valuation of the best estimate for life insurance obligations with options and guarantees.

2. The following financial market parameters shall at least be considered to be material:

(a) risk-free interest rates;
(b) market prices for equity investments;
(c) market prices for real estate.

Article 2

Criteria for the set of scenarios

1. The set of scenarios determined by the methodology shall comply with the following criteria:

(a) the requirements set out in Article 22(3)(b) and (c) of Delegated Regulation (EU) 2015/35;
(b) it exhibits sufficient volatility to ensure a prudent deterministic valuation of options and guarantees;
(c) it consist of at most 10 scenarios.

2. For any given combination of reference date, basic risk-free interest rate term structure, and relevant currency, only one set of scenarios shall be determined.

Article 3

Base methodology

1. The base methodology shall use a stochastic process based on random variables following a normal distribution to simulate the evolution of future financial market parameters.

2. Changes in the risk-free interest rates shall be modelled by applying a random uniform shift to the risk-free forward rates derived from the relevant risk-free interest rate term structure to be used to calculate the best estimate.

3. Relative changes in the financial market parameters modelled through indices, including indices on market prices for equity investments and on market prices for real estate, shall be modelled assuming a normal distribution.

4. The different financial market parameters shall be simulated under the assumption of stochastic independence.

Article 4

Adjustments to the set of scenarios

1. The adjustments to the set of scenarios determined by the base methodology shall consist of a combination of a re-weighting adjustment and a moment matching adjustment. These adjustments shall ensure that the adjusted set of scenarios complies with the criteria set out in Article 2(1)(a) and (b).

2. The re-weighting adjustment shall use an algorithm to minimize a weighted combination of the following amounts:

(a) the average difference between the volatility parameters referred to in Article 5, and the effective volatilities calculated on the set of scenarios;
(b) the difference between the average discounted value of the financial market parameters calculated in the scenario, and the expected return derived from the risk-free interest rate term structure to be used to calculate the best estimate (martingale test);
(c) a term increasing in value in case the distribution of the individual scenarios deviates from a uniform distribution of the weights among the scenarios.

3. The moment matching adjustment shall ensure that, for each time step in the simulation of the future values of the financial market parameters, the discounted value of these parameters is, on average over the sample of scenarios, coherent with the risk-free interest rate term structure to be used to calculate the best estimate.

4. The moment matching adjustment and the re-weighting adjustment shall be combined as follows:

(a) in a first step, the re-weighting adjustment is applied to the set of scenarios;
(b) in a second step, the moment matching adjustment is applied to the adjusted set of scenarios derived from the first step.

Article 5

Selection of volatilities

1. For the base methodology and for the adjustments to the set of scenarios, the methodology shall select volatility parameters.

2. The volatility parameters used shall be derived on basis of the respective stress scenarios in the Solvency Capital Requirement standard formula as set out in Delegated Regulation (EU) 2015/35.

3. The volatility parameters used in the re-weighting adjustment shall be chosen so that the adjusted scenarios exhibit sufficient volatility to ensure a prudent deterministic valuation of the time value of options and guaranties.

Article 6

Currencies

The methodology shall be suitable to determine scenarios for each relevant currency.

Article 7

Entry into force

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels,

[For the Commission

The President]

[For the Commission

On behalf of the President]

[Position]

ANNEX I: IMPACT ASSESSMENT

OBJECTIVES

In accordance with Article 29 of the EIOPA Regulation[8], EIOPA carries out, where relevant, analyses of costs and benefits during the policy development process. The analysis of costs and benefits is undertaken according to an impact assessment methodology.

This impact assessment concerns the EIOPA draft ITS on the methodology to determine the set of scenarios to be used for the prudent deterministic valuation of the best estimate for life obligations with options and guarantees. It is based on a qualitative and quantitative assessment done by EIOPA and takes into account the results from two European information requests which EIOPA carried out on this subject.

In drafting these ITS, EIOPA sticks to the general objectives of the Solvency II Directive, as agreed by the legislators in 2009. These general objectives are:

- adequate protection of policyholders and beneficiaries, being the main objective of supervision;
- financial stability;
- proper functioning of the internal market.

In view of the specific purpose of these technical standards, the following more specific objectives were identified:

- ensuring adequate market-consistent valuation of technical provisions;
- ensuring transparency and ease of application;
- improving proportionality, in particular by limiting the burden for small and non-complex undertakings.

POLICY ISSUES

POLICY ISSUE A: CHOICE OF BASE METHODOLOGY FOR DETERMINING SCENARIOS

The draft ITS foresees the application of a base methodology for the determination of the set of scenarios to be used in the prudent deterministic valuation of technical provisions (see Article 3 in draft

[8] Regulation (EU) No 1094/2010 of the European Parliament and of the Council of 24 November 2010 establishing a European Supervisory Authority (European Insurance and Occupational Pensions Authority), amending Decision No 716/2009/EC and repealing Commission Decision 2009/79/EC; OJ L 331, 15.12.2010, p. 48–83.

ITS). This policy issue considers the choice of this base methodology.

POLICY OPTIONS

POLICY ISSUE A: CHOICE OF BASE METHODOLOGY FOR DETERMINING SCENARIOS

Policy option A.0: No change

This option means that no ITS are in place. It is a hypothetical baseline that is only introduced as a benchmark against which the impact of the other policy options is compared.

This option is not considered as a viable option given the specific mandate to EIOPA in Article 86(2a) of the Solvency II Directive.

Policy option A.1: Use of pure stochastic trajectories

This option is the most immediate option for generating the PHRSS scenarios to be used for the prudent deterministic valuation. It consists in using a stochastic model to generate scenarios. For this purpose, it is possible to use a simple model such as a basic Gaussian stochastic process to ensure robustness, transparency, and simplicity in order to simulate evolutions of the financial market parameters to be covered. Hence, the interest rates are modelled under a Gaussian dynamic centred on forward rates. As for the equity-like indexes (equities total return, real estate total return), they are modelled with a Black and Scholes model. Finally, the innovations of the different stochastic risk factors are simulated independently (no dependence structure embedded).

Policy option A.2: Use of percentile level methodology

This methodology consists in generating a more extensive number of scenarios (e.g. 1 000, 10 000 scenarios) with a model such as the one described under policy option A.1.

Then, several percentiles are defined (e.g. 10%, 20%, 50%, 70%, 90%, …), and the percentile scenarios at each time-step are obtained by selecting the defined percentiles of the evolution of each of the financial market parameters over the time-step.

The scenarios generated under such an approach are continuously increasing or decreasing in the value of the financial market parameters, which could be an issue for the equity-like indexes. Indeed, for a given year an increase in 10 % of equities is rather common due to the high volatility of these assets. However, a continuous increase of 10 % each year on a 30 year projection is very unlikely. As the percentile lines methodology consists in taking the percentile of the financial market parameters (here, the change in market value) independently for each year of simulation, the equity like indexes simulated might be extreme. To cope with this issue, the percentiles could be defined for equity-like indexes as the percentiles of the values of the indexes rather than the percentiles of the capital change.

Policy option A.3: Use of ranked scenarios with conditional expectations

In this methodology, the scenarios are not ranked independently for each time-step and risk factor. Instead, a reference portfolio is built with a certain proportion of bonds (assuming an average duration D), equity and property. The proportions could for instance be based on the EIOPA reference portfolio.

Similarly to the previous methodology option, the input is based on a high number of scenarios produced within the methodology described under policy option A.1. A reference horizon is then defined, and the value of the portfolio is calculated at this horizon. Then, the scenarios are ranked according to the value of the portfolio for this given time horizon.

Then, several percentiles are defined (e.g. 10%, 20%, 50%, 70%, 90%, …). Simply selecting the scenario which exactly corresponds to each of these quantiles q_α would lead to a dependency on the random number seed, as for the methodology described under policy option A.1.

To cope with this issue, it is proposed in this alternative methodology to use conditional expectation, i.e. to define the scenarios as the average scenario that would lead at time T to a value P_α of the reference portfolio that corresponds to the q_α percentile. In practice, this average scenario is based on a window whose size is adjustable. A large window will lead to very smooth scenarios, while a window of size = 1 will allow to pick a single scenario.

However, the scenarios produced by this method can suffer from a strong smoothing effect that reduces the inner volatility of the scenarios. To cope with that issue, a nearest neighbour research could be introduced to find in the original large sample of pure stochastic trajectories the scenario that minimizes the distance with the average scenario obtained for a given quantile of the value of the portfolio. The final scenario which is picked by the methodology would therefore be directly extracted from the pure stochastic trajectories, but a reduced sampling error and a certain coherence of the trajectory.

Such an approach could ensure more explainable scenarios than for the methodology of pure stochastic trajectories and a limitation of the dependency on the random number generator seed, whilst keeping the internal time coherence of the scenarios and the inner volatility. At the same time, it would lead to a significantly more complex approach.

IMPACT OF THE POLICY OPTIONS

POLICY ISSUE A: CHOICE OF BASE METHODOLOGY FOR DETERMINING SCENARIOS

Policy option A.0: No change

Policy option A.0		
Costs	Policyholders	No material impact.

	Industry	Lack of predictability and transparency on the methodology for deriving the scenarios.
	Supervisors	Lack of predictability and transparency on the methodology for deriving the scenarios.
	Other	No material impact.
Benefits	Policyholders	No material impact.
	Industry	No material impact.
	Supervisors	No material impact.
	Other	No material impact.

Policy option A.1: Use of pure stochastic trajectories

Policy option A.1		
Costs	Policyholders	None. All methods are deemed equivalents from this perspective.
	Industry	As the number of scenarios is intended to be very limited (approx. 10 scenarios), the methodology is sensitive to a sampling error. The scenarios are less interpretable with pure stochastic trajectories than with percentile lines method.
	Supervisors	As the number of scenarios is intended to be very limited (approx. 10 scenarios), the methodology is sensitive to a sampling error. The scenarios are less interpretable with pure stochastic trajectories than with percentile lines method.
	Other	As the number of scenarios is intended to be very limited (approx. 10 scenarios), the methodology is sensitive to a sampling error. The scenarios are less interpretable with pure stochastic trajectories than with percentile lines method.
Benefits	Policyholders	The pure stochastic trajectories set of scenario provides a simple methodology, similar to a real ESG, which can be easily implemented and understood to allow for a better estimation of the time value of options and guarantees for insurance with profit participations, in particular when these products include path dependency, thereby contributing to the protection of policyholder's rights.
	Industry	The pure stochastic trajectories set of scenario provides a simple methodology, similar to a real ESG, which can be easily implemented and understood to allow for a better estimation of the time value of options and guarantees for insurance with profit participations, in particular when these products include path dependency.
	Supervisors	The pure stochastic trajectories set of scenario provides a simple methodology, similar to a real ESG, which can be easily

		implemented and understood to allow for a better estimation of the time value of options and guarantees for insurance with profit participations, in particular when these products include path dependency.
	Other	The pure stochastic trajectories set of scenario provides a simple methodology, similar to a real ESG, which can be easily implemented and understood to allow for a better estimation of the time value of options and guarantees for insurance with profit participations, in particular when these products include path dependency.

Policy option A.2: Use of percentile level lines

Policy option A.2		
Costs	Policyholders	The percentile lines set of scenario underestimates the TVOG for non-path dependent products compared to the pure stochastic trajectories approach. Indeed, the scenarios are continuous increase or decrease in the value of the risk factors: there is therefore no "internal volatility" in one given scenario, which might be an issue for some liabilities, thereby not fully contributing to the protection of policyholder's rights.
	Industry	The percentile lines set of scenario underestimates the TVOG for non-path dependent products compared to the pure stochastic trajectories approach. Indeed, the scenarios are continuous increase or decrease in the value of the risk factors: there is therefore no "internal volatility" in one given scenario, which might be an issue for some liabilities.
	Supervisors	The percentile lines set of scenario underestimates the TVOG for non-path dependent products compared to the pure stochastic trajectories approach. Indeed, the scenarios are continuous increase or decrease in the value of the risk factors: there is therefore no "internal volatility" in one given scenario, which might be an issue for some liabilities.
	Other	The percentile lines set of scenario underestimates the TVOG for non-path dependent products compared to the pure stochastic trajectories approach. Indeed, the scenarios are continuous increase or decrease in the value of the risk factors: there is therefore no "internal volatility" in one given scenario, which might be an issue for some liabilities.
Benefits	Policyholders	No material impact.
	Industry	The trajectories are relatively easy to interpret (strong increase in the IR, moderate increase, …).
	Supervisors	The trajectories are relatively easy to interpret (strong increase in the IR, moderate increase, …).

	Other	The trajectories are relatively easy to interpret (strong increase in the IR, moderate increase, …).

Policy option A.3: Use of ranked scenarios with conditional expectations

Policy option A.2		
Costs	Policyholders	This method is more complex than the two other options and introduces a dependence on a reference portfolio which might not fit all undertakings, while still being dependent on the random number generator seed, thereby not fully contributing to the protection of policyholder's rights.
	Industry	This method is more complex than the two other options and introduces a dependence on a reference portfolio which might not fit all undertakings, while still being dependent on the random number generator seed.
	Supervisors	This method is more complex than the two other options and introduces a dependence on a reference portfolio which might not fit all undertakings, while still being dependent on the random number generator seed.
	Other	This method is more complex than the two other options and introduces a dependence on a reference portfolio which might not fit all undertakings, while still being dependent on the random number generator seed.
Benefits	Policyholders	None.
	Industry	This method results in more reliable and representative scenarios than the pure stochastic trajectories as well as reduced sampling error. Compared to percentile line as well as ranked scenarios with conditional expectation but without nearest neighbour research, the methodology allows to maintain the volatility through avoiding smoothing effect.
	Supervisors	This method results in more reliable and representative scenarios than the pure stochastic trajectories as well as reduced sampling error. Compared to percentile line as well as ranked scenarios with conditional expectation but without nearest neighbour research, the methodology allows to maintain the volatility through avoiding smoothing effect.
	Other	This method results in more reliable and representative scenarios than the pure stochastic trajectories as well as reduced sampling error. Compared to percentile line as well as ranked scenarios with conditional expectation but without nearest neighbour research, the methodology allows to maintain the volatility through avoiding smoothing effect.

COMPARISON OF POLICY OPTIONS

POLICY Issue A

EFFECTIVENESS (0,+,++)			
	Ensuring adequate market-consistent valuation of technical provisions	Improving transparency and better comparability	Improving proportionality, in particular by limiting the burden for small and non-complex undertakings
Policy option A.0	0	0	0
Policy option A.1	++	++	++
Policy option A.2	+	+	+
Policy option A.3	+	0	+

EFFICIENCY (0,+,++)			
	Ensuring adequate market-consistent valuation of technical provisions	Improving transparency and better comparability	Improving proportionality, in particular by limiting the burden for small and non-complex undertakings
Policy option A.0	0	0	0
Policy option A.1	++	++	++
Policy option A.2	+	+	+
Policy option A.3	+	0	0

PREFERRED OPTIONS

Option A.0 does not appear to be viable considering the specific mandate given to EIOPA in Article 86(2a) of the Solvency II Directive. The evidence provided indicates that the options A.2 and A.3 would not lead to a material improvement in the quality of the scenario set or a reduction in the TVOG estimation error compared to option A.1. At the same time, they would lead to a more complex methodology. Overall, the evidence provided indicates that Option A.1 (use of pure stochastic trajectories) is the most appropriate and proportionate option.

ANNEX II: POTENTIAL MATHEMATICAL IMPLEMENTATION OF THE METHODOLOGY

1. Introduction

This annex contains a potential mathematical implementation of the methodology that EIOPA foresees at this point for the determination of the scenarios to be used in the prudent deterministic valuation of the best estimate of life insurance obligations with options and guarantees pursuant to Article 77(8) of the Solvency II Directive.

This methodology follows a two-step approach:

Step 1 consists of the generation of a small set of scenarios through a given methodology, called “base methodology” in the draft ITS and described in section 2.

Step 2 consists of adjusting the scenarios produced in step 1. These adjustments aim to ensure that the resulting set of scenarios has acceptable martingale properties and that the scenarios exhibit sufficient volatility. These adjustments are described in section 3.

2. Step 1: Base methodology to determine the initial set of scenarios

For each relevant currency, a set of stochastic scenarios is simulated with annual time-steps for the following financial market parameters:

1. Risk-free interest rates;
2. Market prices for equity investments;
3. Market prices for real estate.

a. Risk-free interest rates

The risk-free interest rate term structures at future time steps (t = 1, 2, …) are simulated using a parallel shift of the forward rate curve with

$$\tilde{f}(t;t,S) = f(0;t,S) + \sigma_{IR} \sum_{k=1}^{t} \varepsilon_k^{IR}, \quad 1 \leq t < S,$$

where

- $\tilde{f}(t;T,S)$ is the continuously compounded stochastic forward rate at time t for the expiry-maturity pair T,S and f denotes the deterministic forward rate;
- σ_{IR} denotes the interest-rate volatility parameter (see also section 4); and
- ε_k^{IR} are standard normal random variables (using the notation $\varepsilon_k^{IR} \sim \mathcal{N}(0,1)$).

The initial forward rates $f(0;T,S)$ are derived from EIOPA’s risk-free interest rate term structures of the respective currency and do not include a matching adjustment or a volatility adjustment.
After the simulation of the forward rates, the corresponding zero-coupon bond prices $P(t,T)$ at time t for maturity T are calculated as

$$P(t,T) = e^{-\tilde{f}(t;t,T)(T-t)}.$$

The deflator $D(t)$ at time t can then be expressed as

$$D(t) = \begin{cases} 1, & t = 0 \\ \prod_{s=1}^{t} P(s-1,s), & t \geq 1 \end{cases}.$$

Questions to stakeholders:

Question 1:
The proposed interest rate model could be augmented with an additional drift term that would render its dynamics inherently risk-neutral. Under such an augmented model, the martingale equations $\mathrm{E}[D(t)] = P(0,t)$ and $\mathrm{E}[D(t)P(t,T)] = P(0,T)$ (see section 3, subsection a.) would in theory be fulfilled.

However, the low number of scenarios would inevitably lead to deviations from martingality in practice. Moreover, the subsequent adjustments (see section 3) ensure that for the adjusted scenarios, the martingale equations are in any case fulfilled. Therefore, in order to keep the formulas as simple as possible, an additional drift term was omitted.

Do you agree with this approach? If not, what would be the advantages of an additional drift term in the interest rate evolution equation?

b. Market prices for equity and real estate investments

The indices describing the evolution of market prices for equity investments and real estate investments are modelled with a normal dynamic of the excess returns:

$$S^{EQ}(t) = S^{EQ}(t-1) \cdot \frac{1}{P(t-1,t)} \cdot e^{-0.5\sigma_{EQ}{}^2 + \sigma_{EQ}\varepsilon_t^{EQ}} \quad (t \geq 1), \quad S^{EQ}(0) = 1$$

$$S^{RE}(t) = S^{RE}(t-1) \cdot \frac{1}{P(t-1,t)} \cdot e^{-0.5\sigma_{RE}{}^2 + \sigma_{RE}\varepsilon_t^{RE}} \quad (t \geq 1), \quad S^{RE}(0) = 1.$$

with independent standard normal random variables

$$\varepsilon_t^{EQ} \sim \mathcal{N}(0,1) \text{ and } \varepsilon_t^{RE} \sim \mathcal{N}(0,1),$$

as well as volatility parameters σ_{EQ} and σ_{RE} (see section 4 for the calibration).

The random variables ε_k^{IR}, ε_t^{EQ} and ε_t^{RE} are simulated under the assumption of stochastic independence.

3. Step 2: Adjustments to the set of scenarios

In the second step, the generated scenarios are adjusted to ensure that the resulting set of scenarios has acceptable martingale properties of the discounted processes and exhibits sufficient volatility.

The adjustments consist of a combination of a re-weighting adjustment and a moment matching adjustment.

a. Re-weighting adjustment

This re-weighting adjustment assigns weights to each scenario to ensure that on a weighted basis, the chosen set of scenarios has a low weighted average martingale error and at the same time a sufficiently prudent level of volatility. Specifically, the theoretical martingale equations that should hold are

$$\mathrm{E}[D(t)] = P(0,t),$$

$$\mathrm{E}[D(t)P(t,T)] = P(0,T),$$

$$\mathrm{E}[D(t)S^{EQ}(t)] = S^{EQ}(0), \text{ and}$$

$$\mathrm{E}[D(t)S^{RE}(t)] = S^{RE}(0).$$

The weight of each scenario is selected using an optimisation algorithm to minimize a combination of weighted average volatility replication errors and weighted average martingale errors. The volatility targeted in this adjustment is described in section 4. For the robustness of the assessment of the materiality of the TVOG, it is preferable to use the information from as many scenarios as possible. Therefore, in the optimisation algorithm a penalty term is added so as to ensure that the chosen weights are not too low, and all scenarios are used.

For N scenarios, the optimal weights $p^* = (p_1^*, \dots, p_N^*)$ are therefore

$$(p_1^*, \dots, p_N^*) = \underset{(p_1, \dots, p_N)}{\mathrm{ArgMin}} \left\{ \begin{array}{c} w_1 \cdot \sum_{c \in C} \sum_t \left(\widehat{\mathrm{Std}[h^c(t)]} - \sigma_c' \right)^2 \\ + w_2 \cdot \sum_t \left(\widehat{\mathrm{E}[D(t)]} - P(0,t) \right)^2 \\ + w_3 \cdot \sum_t \sum_{T \geq t+1} \left(\widehat{\mathrm{E}[D(t)P(t,T)]} - P(0,T) \right)^2 \\ + w_4 \cdot \sum_t \left(\widehat{\mathrm{E}[D(t)S^{EQ}(t)]} - S^{EQ}(0) \right)^2 \\ + w_5 \cdot \sum_t \left(\widehat{\mathrm{E}[D(t)S^{RE}(t)]} - S^{RE}(0) \right)^2 \\ + w_6 \cdot \sum_k \frac{1}{p_k + \delta} \end{array} \right\}$$

with:

- $w_1, \dots, w_5$ coefficients used to control the relative importance of the different elements embedded in the optimization function. These coefficients are chosen by expert judgement in order to generate a coherent output;
- $p_1, \dots, p_N$ the scenario weights with $p_k > 0$ $(1 \leq k \leq N)$ and $\sum_k p_k = 1$;
- $\widehat{\mathrm{E}[\circ]}$ the estimator of the expected value, i.e. the weighted arithmetic mean using the weights p_k;
- $\widehat{\mathrm{Std}[\circ]}$ the estimator of the standard deviation defined accordingly;
- $C = \{IR, EQ, RE\}$ the set of financial market parameters;
- σ_c' the volatility parameters for the adjustment step (see section 4);

- $h^c(t)$ a time-dependent change function; in particular $h^c(t) = \ln \frac{S^c(t)}{S^c(t-1)} - f(t-1; t-1, t)$ for $c \in \{EQ, RE\}$ and $h^{IR}(t) = f(t; t, T) - f(t-1; t-1, T-1)$ for a fixed maturity T;
- $\delta \ll 1$ for numerical stability in the optimization procedure.

Figure 1: Illustration of the weights of the scenarios

Questions to stakeholders

<u>Question 2:</u>
The interest rate volatility targeting is based on the standard deviation of the spot rate changes for a fixed maturity. This is a simplification to the method used for the information requests where swaption volatility prices were calculated.

Would you agree with this simplification?

<u>Question 3:</u>
In accordance with recital 7 of the draft ITS, the optimisation contains a penalty term for the weights. This penalty term ensures that the weights are not too low and thus all simulated scenarios contribute to the calculation of the best estimate.

Do you agree with the proposed design and parametrisation of this penalty term? If not, which alternative design would you propose and why?

b. Moment matching adjustment

After the re-weighting adjustment, moment matching techniques are applied to adjust financial market parameter simulations in order to ensure convergence towards martingale test targets.

The technique applies adjustment factors to the deflator and the market prices such that the estimated expectations of the adjusted processes (denoted by superscript “adj”) satisfy exactly the following martingale tests targets:

$$\mathrm{E}[\widehat{D^{adj}(t)}] = P(0,t)$$

$$\mathrm{E}[\widehat{D^{adj}(t)P^{adj}}(t,T)] = P(0,T)$$

$$\mathrm{E}[\widehat{D^{adj}(t)S^{EQ,adj}}(t)] = S^{EQ}(0)$$

$$\mathrm{E}[\widehat{D^{adj}(t)S^{RE,adj}}(t)] = S^{RE}(0)$$

Adjustments for the deflator and zero-coupon bond prices

Let $D^{adj}(t)$ denote the adjusted deflator defined by

$$D^{adj}(t) = D(t) \cdot DefAdjFactor_t \quad (t \geq 1), \quad D^{adj}(0) = 1 .$$

The adjustment factor $DefAdjFactor_t$ is chosen such that the corresponding martingale test is met by D^{adj}, i.e.

$$DefAdjFactor_t = \frac{P(0,t)}{\mathrm{E}[\widehat{D(t)}]}.$$

Similarly, let $P^{adj}(t,T)$ denote the adjusted zero-coupon bond price defined by

$$P^{adj}(t,T) = P(t,T) \cdot PAdjFactor_t^T \quad (t \geq 1, t < T\ ), \quad P^{adj}(0,T) = P(0,T).$$

The adjustment factor $PAdjFactor_t^T$ is chosen such that the corresponding martingale test is met by P^{adj}, i.e.

$$PAdjFactor_t^T = \frac{P(0,T)}{\mathrm{E}[D^{adj}\widehat{(t)P}(t,T)]}.$$

Adjustments for equity and real estate

Let $S^{adj}(t)$ denote the adjusted index (either equity or real estate) defined by

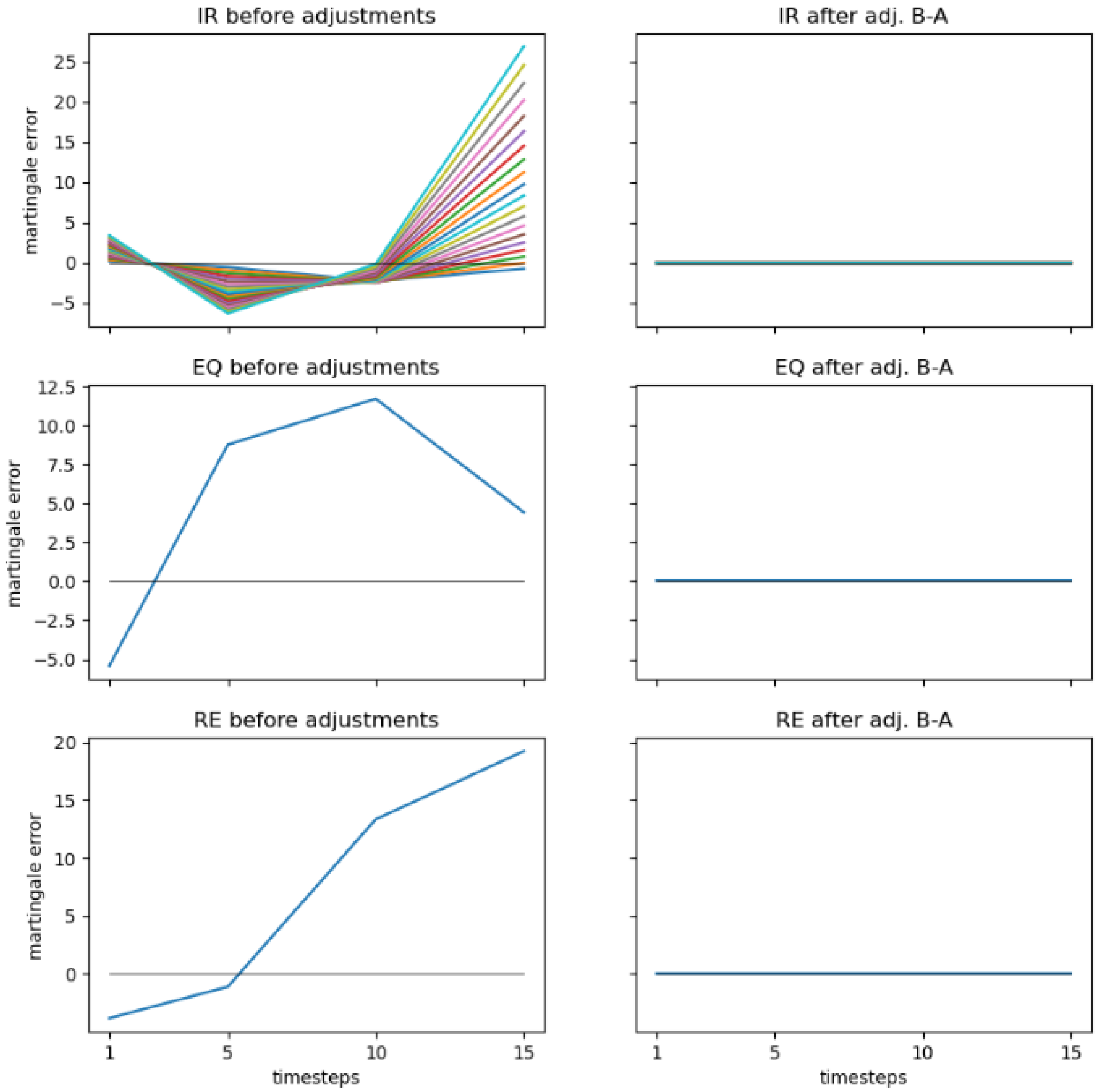
$$S^{adj}(t) = S^{adj}(\mathrm{t}-1) \cdot \frac{S(t)}{S(t-1)} \cdot AdjFactor_t \quad (t \geq 1), \quad S^{adj}(0) = 1 .$$

The adjustment factor $AdjFactor_t$ is chosen such that the corresponding martingale test is met by S^{adj}, i.e.

$$AdjFactor_t = \frac{S(0)}{\mathrm{E}[D^{adj}(t) \cdot \widehat{S^{adj}}(\mathrm{t}-1) \cdot \frac{S(t)}{S(t-1)}]}.$$

Figure 2: illustration of moment matching adjustment

Martingale test before adjustment is shown on the left, and martingale test after adjustment is shown on the right showing that the test is passed as expected. These results are shown for interest rates, equity and real estate.



c. Combination of adjustments

The moment matching adjustment and the re-weighting adjustment shall be combined as follows:

a) in a first step, the re-weighting adjustment is applied to the set of scenarios;
b) in a second step, the moment matching adjustment is applied on the adjusted set of scenarios derived from the first step.

This approach aims to match as much as possible the targets in terms of martingale properties and market consistency. Since it is essential that the martingale tests are passed, the moment matching adjustment is performed as a last step, i.e. after the weights of the scenarios are calculated. Note that this might lead to a small change of the simulated volatility.

4. Calibration of the volatilities

For both steps of the methodology (simulation and adjustments), volatility parameters need to be selected.

To derive these volatilities, the stresses of the standard formula are inverted to obtain real-world "implied volatilities". Then for each of the steps, a multiple of these real-world implied volatilities is used.

While ensuring transparency and providing a simple proportionality solution, this option also has the merit to show clearly that the methodology is not intended to replace a real stochastic valuation for undertakings with material options and guarantees, to avoid any market data licencing fees and to ensure a certain stability of the TVOG assessment across time.

Derivation of real-world implied volatilities

- ***Interest rate (IR) implied volatility***

For interest rates, we calibrate the volatility parameter σ_{IR}^{SII} in order to replicate the real-world absolute shock of the relevant risk-free interest rate term structure of the currency for maturity 10 years (denoted $s_{IR\,SII}^{10Y}$) at the 99.5th quantile $q_{99.5\%}$ of the simulation. The real-world implied volatility is therefore calculated by solving

$$q_{99.5\%}\left(\sigma_{IR}^{SII} \cdot \varepsilon^{IR}\right) = s_{IR\,SII}^{10Y}$$

with $\varepsilon^{IR} \sim \mathcal{N}(0,1)$.

We obtain

$$\sigma_{IR}^{SII} = \frac{s_{IR\,SII}^{10Y}}{q_{99.5\%}(\varepsilon^{IR})}.$$

- ***Equity (EQ) implied volatility***

To derive the EQ real-world implied volatility, we consider the standard formula stress factor for type 1 equities (without the symmetric adjustment of equity capital charge) of 39%. By neglecting IR drift, we get the equation

$$e^{-0.5{\sigma_{EQ}^{SII}}^2 + \sigma_{EQ}^{SII} \cdot q_{0.5\%}(N(0,1))} = 1 - 39\%.$$

- ***Real estate (RE) implied volatility***

To derive the RE real-world "implied volatility" we consider the standard formula stress factor for property risk of 25%. By neglecting IR drift, we get the equation below:

$$e^{-0.5{\sigma_{RE}^{SII}}^2 + \sigma_{RE}^{SII} \cdot q_{0.5\%}(N(0,1))} = 1 - 25\%$$

Derivation of volatility targets in adjustment step

In order to ensure the prudency of the deterministic valuation of the best estimate, and to limit the risk of underestimation of the TVOG, the volatility parameters used in the adjustment step $(\sigma'_{IR}, \sigma'_{EQ}, \sigma'_{RE})$ should be chosen at a sufficiently prudent level. The results of the first information request showed that at year end 2021, the volatility parameter used for the adjustment step would need to be reinforced compared to the real-world implied volatility to avoid an underestimation of the TVOG. The results of the second impact assessment showed that at year end 2022, using a twofold reinforcement of the real-world implied volatility in order to calculate the volatility parameter used for the adjustment step leads on average to an overestimation of the TVOG.

Derivation of the volatility parameters used in the simulation step

The volatility parameters used in the simulation step ($\sigma_{IR}, \sigma_{EQ}, \sigma_{RE}$) should be chosen in order to minimize the result of the function used in the re-weighting adjustment (section 3.a), so as to ensure a proper functioning of the optimization algorithm. This may require an adjustment of the real-world implied volatilities (by way of multiplication with a factor greater than one) derived from the standard formula shocks.

Questions to stakeholders

Question 4:

Do you agree with this approach for the derivation of the volatility parameters used in the simulation step? If not, could you propose a better technique in order to enhance the convergence of the optimisation algorithm?

Privacy statement related to Public (online) Consultations

Introduction

1. **EIOPA, as a European Authority, is committed to protect individuals with regard to the processing of their personal data in accordance with Regulation (EU) No 2018/1725 (further referred as the Regulation).**[9]

Controller of the data processing

2. **The controller responsible for processing your data is EIOPA's Executive Director. Address and email address of the controller:**
3. **Westhafenplatz 1, 60327 Frankfurt am Main, Germany fausto.parente@eiopa.europa.eu**

Contact details of EIOPA's Data Protection Officer

4. **Westhafenplatz 1, 60327 Frankfurt am Main, Germany dpo@eiopa.europa.eu**

Purpose of processing your personal data

5. The purpose of processing personal data is to manage public consultations EIOPA launches and facilitate further communication with participating stakeholders (in particular when clarifications are needed on the information supplied).
6. Your data will not be used for any purposes other than the performance of the activities specified above. Otherwise, you will be informed accordingly.

Legal basis of the processing and/or contractual or other obligation imposing it

7. **EIOPA Regulation, and more precisely Article 10, 15 and 16 thereof.**
8. EIOPA's Public Statement on Public Consultations.

Personal data collected

[9] Regulation (EU) 2018/1725 of the European Parliament and of the Council of 23 October 2018 on the protection of natural persons with regard to the processing of personal data by the Union institutions, bodies, offices and agencies and on the free movement of such data, and repealing Regulation (EC) No 45/2001 and Decision No 1247/2002/EC.

9. **The personal data processed might include:**
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    - **Employment details.**

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10. **The personal data collected are disclosed to designated EIOPA staff members.**

Transfer of personal data to a third country or international organisation
11. **No personal data will be transferred to a third country or international organization.**

Retention period
12. **Personal data collected are kept until the finalization of the project the public consultation relates to.**

Profiling
13. **No decision is taken in the context of this processing operation solely on the basis of automated means.**

Your rights
14. **You have the right to access your personal data, receive a copy of them in a structured and machine-readable format or have them directly transmitted to another controller, as well as request their rectification or update in case they are not accurate.**   15. **You have the right to request the erasure of your personal data, as well as object to or obtain the restriction of their processing.**   16. **For the protection of your privacy and security, every reasonable step shall be taken to ensure that your identity is verified before granting access, or rectification, or deletion.**   17. **Should you wish to access/rectify/delete your personal data, or receive a copy of them/have it transmitted to another controller, or object to/restrict their processing, please contact [legal@eiopa.europa.eu]**   18. **Any complaint concerning the processing of your personal data can be addressed to EIOPA's Data Protection Officer (DPO@eiopa.europa.eu). Alternatively, you can also have at any time recourse to the European Data Protection Supervisor (www.edps.europa.eu).**