CEIOPS-DOC-21/09

CEIOPS' Advice for Level 2 Implementing Measures on Solvency II:

Technical provisions -

Elements of actuarial and statistical methodologies for the calculation of the best estimate

(former CP 26)

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1. Introduction

1.1. In its letter of 19 July 2007, the European Commission requested CEIOPS to provide final, fully consulted advice on Level 2 implementing measures by October 2009 and recommended CEIOPS to develop Level 3 guidance on certain areas to foster supervisory convergence. On 12 June 2009 the European Commission sent a letter with further guidance regarding the Solvency II project, including the list of implementing measures and timetable until implementation.

1.2. This Paper aims at providing advice with regard to actuarial and statistical methodologies for the calculation of the best estimate as requested in Article 86 (a) of the Solvency II Level 1 text.[1]

1.3. The objective of this paper is to give draft advice on the valuation techniques which shall be considered as appropriate methodologies for the calculation of the best estimate and how these shall satisfy the requirements of the Level 1 text. This would include the application of approximations and simplified methods and techniques.

1.4. This advice should be read in conjunction with CEIOPS advice on related issues, including CEIOPS' Advice on the treatment of future premiums, CEIOPS' Advice on the allowance for management actions and CEIOPS' Advice on the calculation of the best estimate.[2]

2. Extract from Level 1 Text

2.1 Legal basis for implementing measure

Article 86 - Implementing measures

The Commission shall adopt implementing measures laying down the following:

(a) Actuarial and statistical methodologies to calculate the best estimate referred to in Article 77(2) … "

2.2 Other relevant articles for providing background to the advice

[1] Latest version from 19 October 2009 available at http://register.consilium.europa.eu/pdf/en/09/st03/st03643-re01.en09.pdf

[2] See CEIOPS DOC-25-09, see http://www.ceiops.eu//content/view/17/21/ (former CP30)
CEIOPS DOC-27-09, see http://www.ceiops.eu//content/view/17/21/ (former CP32)
CEIOPS DOC-33-09, see http://www.ceiops.eu//content/view/17/21/ (former CP39)

Article 76 – General provisions

2. The value of technical provisions shall correspond to the current amount insurance and reinsurance undertakings would have to pay if they were to transfer their insurance and reinsurance obligations immediately to another insurance or reinsurance undertaking

3. The calculation of technical provisions shall make use of and be consistent with information provided by the financial markets and generally available data on underwriting risks (market consistency).

4. Technical provisions shall be calculated in a prudent, reliable and objective manner.

Article 77(2) – Calculation of the technical provisions

The best estimate shall correspond to the probability-weighted average of future cash-flows, taking account of the time value of money (expected present value of future cash-flows), using the relevant risk-free interest rate term structure.

The calculation of the best estimate shall be based upon up-to-date and credible information and realistic assumptions and be performed using adequate, applicable and relevant actuarial and statistical methods.

The cash-flow projection used in the calculation of the best estimate shall take account of all the cash in- and out-flows required to settle the insurance and reinsurance obligations over the lifetime thereof.

The best estimate shall be calculated gross, without deductions of the amounts recoverable from reinsurance contracts and special purpose vehicles. Those amounts shall be calculated separately, in accordance with Article 81.

Article 84 - Appropriateness of the level of technical provisions

Upon request from the supervisory authorities, insurance and reinsurance undertakings shall demonstrate the appropriateness of the level of their technical provisions, as well as the applicability and relevance of the methods applied, and the adequacy of the underlying statistical data used.

3. Advice

3.1 Explanatory text

3.1.1. Definition of "best estimate"

3.1. The Level 1 text states that the best estimate shall correspond to the probability-weighted average of future cash-flows taking account of the time value of money, using the relevant risk-free interest rate term structure. This in effect acknowledges that the best estimate shall allow for uncertainty in the future cash-flows used for the calculation. In the context of this advice, allowance for uncertainty refers to the consideration of the variability of the cash flows necessary to ensure that the best estimate represents the mean of the cash flows. Allowance for uncertainty does not suggest that additional margins should be included within the best estimate.

3.2. The expected value is the average of the outcomes of all possible scenarios, weighted according to their respective probabilities. Although, in principle, all possible scenarios are considered, it may not be necessary, or even possible, to explicitly incorporate all possible scenarios in the valuation of the liability, nor to develop explicit probability distributions in all cases, depending on the type of risks involved and the materiality of the expected financial effect of the scenarios under consideration.

3.3. A proportionate application of the standard above is required as it is unlikely to be practical. The (re)insurance undertaking shall consider how far the assumptions underlying the valuation approach are likely to differ from this ideal.

3.4. In choosing an appropriate actuarial and statistical method to calculate the best estimate, the (re)insurance undertaking shall consider the limitations of the valuation approach used against the approach outlined in this advice.

3.1.2. Selection of valuation techniques

3.5. The causes of uncertainty in the cash-flows that shall be taken into consideration in the application of the valuation technique may include the following:

- Fluctuation in the timing, frequency and severity of claim events.
- Fluctuation in the period taken to settle claims and/or expenses.
- Fluctuation in the amount of expenses.

- Changes in the value of an index/market values used to determine claim amounts.

- Changes in both entity and portfolio-specific factors such as legal, social, or economic environmental factors, where relevant. For example, in some countries, this may include changes as a result of legislation such as Ogden rates, periodical payments, taxation or cost of care.

- Uncertainty in policyholder behaviour.

- The exercise of discretionary future management actions by the (re)insurance undertaking (to the extent they may depend on the above-mentioned causes of uncertainty and also on entity specific factors). The allowance of these management actions is subject to the requirements set out in CEIOPS DOC 27-09 (former CP 32)[3].

- Path dependency (as defined in this advice).

- Interdependency between two or more causes of uncertainty (as described in this advice).

3.6. Path-dependency is where the cash-flows depend not only on circumstances such as economic conditions on the cash-flow date, but also on those circumstances at previous dates. A cash-flow which has no economic path dependency can be valued by, for example, using an assumed value of the equity market at a future point in time. However, a cash-flow with path-dependency would need additional assumptions as to how the level of the equity market evolved (the equity market's path) over time in order to be valued.

3.7. Similarly, some risk drivers may be largely independent of the other factors which determine the cash-flows. Alternatively, other risk-drivers may be heavily influenced by or even determined by several other risk-drivers (interdependence). For example, a fall in market values may influence the (re)insurance undertaking's exercise of discretion in future participation, which in turn affects policyholder behaviour. Another example would be a change in the legal environment or the onset of a recession which could increase the frequency or severity of non-life claims.

3.8. The valuation of the best estimate shall meet the following requirements:

- The (re)insurance undertaking shall be able to demonstrate the appropriateness, including the robustness of the techniques and assumptions used, having regard to the nature, scale and complexity of risks. In order to meet this requirement, a (re)insurance undertaking shall be able to provide sound rationale for the choice of one technique over other relevant techniques. This also applies to simplified techniques.

- The (re)insurance undertaking shall assess the degree of judgement required in each method and to what extent the undertaking is able to carry out such judgement in an objective and verifiable manner according

[3] CEIOPS DOC-27-09, see http://www.ceiops.eu//content/view/17/21/ (former CP32)

the requirements set out in the CEIOPS' advice on actuarial and statistical methodologies to calculate the best estimate[4].

- The (re)insurance undertaking shall be able to demonstrate that the valuation technique and the underlying assumptions are realistic and reflect the uncertain nature of the cash-flows.

- The valuation technique shall be chosen on the basis of the nature of the liability being valued and from the identification of risks which materially affect the underlying cash-flows.

- The assumptions underlying the valuation technique shall be validated and reviewed by the (re)insurance undertaking.

- The valuation technique and its results shall be capable of being audited.

- If policy data is grouped, the (re)insurance undertaking shall demonstrate that the grouping process appropriately creates homogeneous risk groups that allow for the risk characteristics of the individual policies. This applies to either claims or policy data.

- Having regard to the above (i.e. having ensured that the valuation technique is appropriate and robust given the nature, scale and complexity of the risk), (re)insurance undertakings shall ensure that their capabilities (e.g. actuarial expertise, IT systems) are commensurate with the actuarial and statistical techniques used.

3.9. The responsibility for the choice of adequate techniques for the calculation of the best estimate liability rests with the (re)insurance undertaking subject to the requirements set out in the Level 1 text and in implementing measures. However the supervisor should be able to require, stating the reasons, the reassessment of the technical provisions which may involve the use of an alternative technique, if this reassessment or the use of a different technique is believed to better reflect the objective of the valuation (prudent, reliable and objective).

3.10. The (re)insurance undertaking shall be able to demonstrate the appropriateness, including the robustness, of the techniques, having regard to the nature, scale and complexity of risks. In order to meet this requirement, a (re)insurance undertaking shall provide sound rationale for the choice of one technique over other relevant techniques. This also applies to simplified techniques, approximations and the application of judgement. When such demonstration fails, the supervisor shall have the power to ask the undertaking to apply more appropriate techniques or refine the assumption and parameters of the models used.

3.1.3. Valuation techniques

3.11. For many types of uncertainty, there are a very large or possibly infinite number of possible future scenarios. Actuarial and statistical techniques

[4] CEIOPS DOC-33-09, see http://www.ceiops.eu//content/view/17/21/ (former CP39)

have developed to form a practical approach of estimating the value of (re)insurance liabilities, including stochastic simulation (referred to hereafter as simulation), deterministic and analytical techniques. Examples of each technique are included in section 3.1.4.

3.12. Rather than considering all possible future scenarios, (re)insurance undertakings can choose a suitably large number of scenarios which are representative of all possible futures, as for example in a Monte Carlo simulation. This approach is referred to as a "simulation technique".

3.13. The (re)insurance undertaking may be able to use a valuation technique based on closed form solutions. Such techniques are referred to as analytical techniques and are based on the distribution of future of cash-flows. For example:

- Techniques which use an assumption that future claim amounts follow a given mathematical distribution (e.g. Bayesian). These techniques calculate an undiscounted probability weighted average set of cash-flows without explicitly considering each potential scenario.

- Black-Scholes techniques which use an assumption that risky investment returns follow a given mathematical distribution

3.14. The (re)insurance undertaking may also be able to use a technique where the projection of the cash-flows is based on a fixed set of assumptions. The uncertainty is captured in some other way for example through the derivation of the assumptions. This is referred to below as a "deterministic approach".

3.15. Valuation techniques considered to be appropriate actuarial and statistical methodologies to calculate the best estimate as required by Article 86(a) include: simulation, deterministic and analytical techniques or a combination thereof.

3.16. When selecting the valuation technique, (re)insurance undertakings shall consider the following factors and the material impact on the value of the liability and be able to show that they have been adequately allowed for, subject to proportionality:

- Whether the cash-flows are materially path dependent.

- Existence of material non-linear inter-dependencies between several drivers of uncertainty.

- Whether the cash-flows are materially affected by the potential future management actions.

- Presence of risks that have a material asymmetric impact on the value of the cash-flows, in particular if contracts include material embedded options and guarantees or if there are complex reinsurance contracts in place.

- Whether the value of options and guarantees is affected by the policyholder behaviour assumed in the model.

- The availability of relevant data taking into account the requirements on data quality set out in CEIOPS' advice on standards for data quality.[5]

3.17. For certain life insurance liabilities, in particular the future discretionary benefits relating to participating contracts or other contracts with embedded options and guarantees, simulation may lead to a more appropriate and robust valuation of the best estimate liability. In such circumstances simulation techniques would normally be required.

3.18. For the estimation of non-life best estimate liabilities as well as life insurance liabilities not covered by the previous paragraph, deterministic and analytical techniques can be more appropriate. Some reasons are:

- Deterministic methods are usually the starting point for any estimation of best estimate. The application of simulation techniques can add useful insight into ranges around the mean and measures of uncertainty but they will not necessarily produce more accurate estimates of the best estimate because of the significant degree of uncertainty in the calibration of stochastic models.

- The mean of both the application of the simulation and deterministic method may well be the same under both methods (not least because deterministic results are often used to calibrate simulation methods) and meaning that the best estimate for Solvency II purposes will be the same for either method (before any judgment is applied).

- Both deterministic and simulation models are parameterised by the historic data available, as are most actuarial techniques. Regardless of whether a deterministic or simulation model is used, the resulting mean estimates will therefore be based on development similar to that seen in the history and not contain "all possible future outcomes".

3.19. Regardless of the technique, judgement is required in making additions or adjustments to the estimates to allow for circumstances not included in the history that need to be incorporated into best estimates (for example binary events). In all the methods judgement is an additional element in satisfying Article 76 of the Level 1 text.

3.20. The robustness of all actuarial techniques and the above issues have and continue to be considered by the actuarial profession globally and this is an area where much further work will occur. However, at the current point in time, stochastic reserving techniques, especially in non-life insurance, still have many limitations and it is incorrect to assume they produce necessarily the "right" answers. The impact of the current limitations/shortcomings of simulation methods are demonstrated by the levels they are actually used to set reserves in non-life practice - which is extremely limited. Conversely, they are used widely to estimate uncertainty around the mean estimates but not actually set the reserves

[5] CEIOPS DOC-37-09, see http://www.ceiops.eu//content/view/17/21/ (former CP43)

or estimate the mean. The application of deterministic techniques and judgement can be far more important than the mechanical application of simulation methods.

3.21. Furthermore there are particular challenges with using a simulation approach, as set below. As a result, a different approach may be more appropriate:

- The computing time and power required for a simulation technique can be much greater than for a closed form solution since thousands of projections are required. This is particularly true of any calculation which requires a stochastic projection of cash-flows which is calculated using a simulation technique as this in theory requires nested stochastic calculations.

- Where simulation techniques are used, economic scenario files[6] are usually a key assumption. Such scenario files could be produced by market consistent asset models which must in turn be calibrated appropriately. This calibration relies both on expert judgement and the availability of market data. The application of more sophisticated techniques is limited to cases where sufficiently robust knowledge/data is available.

- Owing to the greater computing time and power, simulation techniques in life (re)insurance are often applied to model points rather than policy by policy. The computing constraint can lead to the necessary grouping of contracts which introduces additional approximation error and may neglect important risk characteristics of the portfolio. Further advice on the grouping of contracts is covered by CEIOPS' advice on actuarial and statistical methodologies to calculate the best estimate previously.

- When the number of risk factors is high, a holistic approach treating all the variables stochastically may not be feasible (because the number of required simulations would be excessively high or data restrictions may prevent the use of stochastic approaches for all risk factors) and so some simplifications may have to be embedded in the model. Such limitations of the model shall be recognised as well as its potential for influencing the final results.

- The (re)insurance undertaking will also need to separate systematic influences from random influences and reflect them accordingly within the valuation technique.

- The use of simulation techniques means that the valuation results are based on (typically) many thousands of scenarios each with its own assumption set. The additional dimension in the assumption set adds considerably to the complexity of the simulation approach and thus increases the complexity, even may impede in practice, of internal/external audit of its processes and results.

[6] An economic scenario file is an output of a stochastic asset model. A stochastic asset model is a tool for producing meaningful future projections of market parameters. It is based on detailed studies of how markets behave, looking at averages, variations and correlations. The model estimate probability distributions of potential outcomes by allowing for random variation in one or more inputs over time.

- The model as well as the underlying assumptions may become increasingly difficult to understand due to complexity incorporated by the simulation technique. This may also lead to higher potential for human or IT errors during the implementation phase.

- The choice of technique will need to balance any expected loss of accuracy with a range of financial and non-financial costs and benefits.

3.22. Where a simulation approach is used, the underlying asset liability model (ALM) will be a vital component of the technique. The asset liability model will apply a holistic approach which captures all the guarantees and other costs within the portfolio together in order to capture the interactions between different items of cash-flows. This is particularly important when the liability cash-flows depend on the assets held and (re)insurance undertaking's use of discretion. The following areas should be taken into account when considering the advice on the use of simulation techniques:

- Management actions: The (re)insurance undertaking shall apply management actions which are objective, realistic and verifiable as set out in CEIOPS' advice on future management actions.[7]

- Setting assumptions: The model may require a large number of parameters which a more limited number of (external) people have the experience to calibrate. For example, a market consistent scenario file, or a list of scenarios generated by a catastrophe modeller. Although assumptions are based on past experience and current conditions as far as possible, judgement shall be used for some assumptions.

- Validation: Due to the additional dimension in the assumption set, it is insufficient to check the result obtained is accurate through a combination of summary statistics, spot checks and rough estimates (as may be the case for some deterministic/analytical approaches). The use of simulation approaches therefore means that the results require different techniques/tools to audit.

- Interpretation: With all approaches, interpretation of the results may require a clear understanding of the assumptions underlying the technique where this materially affects the overall results. With a simulation approach, particular attention shall be paid to the behaviour of the asset-liability model in extreme scenarios (where this materially affects the conclusions that can be drawn from the model).

- Model points: The (re)insurance undertaking shall measure the potential for additional error and review the grouping accordingly to ensure that important risk characteristics of the portfolio are not neglected.

3.23. (Re)insurance undertakings may consider deterministic techniques appropriate in circumstances such as:

    - Where an alternative technique may require the calibration of parameters for which only inadequate data is available.

[7] CEIOPS DOC-27-09, see http://www.ceiops.eu//content/view/17/21/ (former CP32)

- Where the nature of the liability is complex but the complexity does not materially affect the result or the complexity cannot be captured better by other techniques.

- Where the nature of the liability is sufficiently simple or for other reasons of nature such that best estimate assumptions result in a best estimate liability and this can be demonstrated.

3.24. A (re)insurance undertaking may use a combination of approaches when calculating the best estimate. For example:

- The (re)insurance undertaking may use a valuation technique which fails to include one or more causes of uncertainty. The excluded/additional cause of uncertainty could then be valued accurately as a separate set of cash-flows or measured through the use of validation tools and appropriate adjustments made.

- The (re)insurance undertaking may identify that much of the cause of uncertainty arises from one or more risk (e.g. investment returns) with the remaining risks making a much smaller contribution to the uncertainty (e.g. mortality experience). In this example, the (re)insurance undertaking may choose to use a valuation technique which combines a simulation approach for investment returns with either a deterministic or analytical approach for mortality experience provided the loss of accuracy is sufficiently small.

3.1.4. Examples of valuation techniques

3.25. Examples of simulation techniques:

- Monte-Carlo simulations: the value of the liabilities is calculated in a large number of scenarios where one or more assumptions are changed in each scenario. By simulating the behaviour of the random variable(s) in a very large number of scenarios, the model produces a distribution of possible outcomes. The mean of the distribution of scenarios may be considered a "probability weighted average".
    - For example, the nature of the financial options and guarantees embedded in some life (re)insurance contracts, particularly those with profit sharing features, is such that a set of deterministic best estimate assumptions may not be sufficient to produce a best estimate liability. The application of closed form analytical solutions to value the options and guarantees may also be limited, if it is difficult to find market hedges that replicate the cash-flows under the contract, for example to reflect the use of management actions or the effects of path dependency. A deterministic or an analytical technique may therefore not be suitable for valuing such contracts, and a simulation technique may be needed.
    - Stochastic variation in non-market assumptions such as lapses and option take-up rates can have a material influence on the valuation of options and guarantees. One possible approach used

is to assume that they are 100% correlated with interest rates/market value which allows the insurer to include the relationship within the liability models without an additional stochastic variable.

- Bootstrapping: one of the most extended uses of bootstrap within actuarial work is associated with estimation of claims provisions. Starting from a model that explains how losses are paid, it consists of resampling residuals from that model and obtaining a large sample of estimated provisions required to pay future outstanding losses.
- Simulating losses above a certain threshold and up to a certain limit is also a frequently used technique by (re)insurers to calculate an estimated expected loss in respect of a given excess of loss programme.
- Bayesian approaches, where explicit prior assumptions are blended with observations resulting in an estimate for the ultimate claim.

3.26. Examples of analytical techniques:

- Stochastic variation in non-market assumptions (such as mortality).
- The time value of options and guarantees may be captured by reference to the market costs of hedging the option or guarantee; if the market price is not directly observable, it may be approximated using option pricing techniques, for example closed form solutions such as the Black-Scholes formula.
- The Mack method, also known as the distribution free chain ladder.

3.27. Examples of deterministic techniques:

- Actuarial methods such as Chain ladder, Bornhuetter-Ferguson, average cost per claim method, etc… and any other derivations of the same.
- Stress and scenario testing; for example, adjusting data for inflation and allowing inflation to vary, thus producing sensitivities around this parameter.
- Influential observations or outliers have been allowed for appropriately, for example via case by case reserving.
- Systematic as well as other random features are being captured through sensitivity testing, diagnostics or other techniques (this could be stochastic).
- Where a calculation relies on assumptions of an even spread of risk over the policy year and this is not the case (e.g. seasonality such as due to weather or hurricane season) the proportions shall be adjusted.
- The use of relevant assumptions or other external/portfolio specific data as an input to the calculation when there is lack of data or as a benchmark for comparison.
- Embedded options may be captured by considering different scenarios chosen to capture, as far as possible, the full range of future scenarios. An appropriate average or worst-case technique could be used to derive an initial estimate of the value of options embedded in the life

insurance portfolio. A deterministic-to-stochastic adjustment could then be applied. This adjustment may be derived from any standardised method including flat benchmarked percentages.

3.2. CEIOPS' advice

3.28. The Level 1 text states that the best estimate shall correspond to the probability weighted average of future cash-flows taking account of the time value of money, using the relevant risk-free interest rate term structure. This in effect acknowledges that the best estimate calculation shall allow for the uncertainty in the future cash-flows used for the calculation of the best estimate.

3.29. In the context of this advice, allowance for uncertainty refers to the consideration of the variability of the cash-flows necessary to ensure that the best estimate represents the mean of the cash-flows. Allowance for uncertainty does not suggest that additional margins should be included within the best estimate.

3.30. Causes of uncertainty in the cash-flows that shall be taken into consideration in the estimation of the best estimate and the application of the valuation technique, where relevant, may include the following:

- Fluctuations in the timing, frequency and severity of claim events.
- Fluctuations in the period needed to settle claims.
- Fluctuations in the amount of expenses.
- Changes in the value of an index/market value used to determine claim amounts.
- Changes in both entity and portfolio specific factors such as legal, social, or economic environmental factors where relevant. For example, in some countries, this may include changes as a result of legislation such as Ogden rates, periodical payments, taxation or cost of care.
- Uncertainty in policyholder behaviour.
- The exercise of discretionary future management actions by the (re)insurance undertaking (to the extent they may depend on the above-mentioned causes of uncertainty and also on entity specific factors). The allowance of these future management actions should be subject to the requirements set out in CEIOPS' advice on actuarial and statistical methodologies to calculate the best estimate.
- Path dependency, where the cash-flows depend not only on circumstances such as economic conditions on the cash-flow date, but also on those circumstances at previous dates.
- Interdependency between two or more causes of uncertainty

3.31. The responsibility for the choice of adequate techniques for the calculation of the best estimate liability rests with the (re)insurance undertaking subject to the requirements set out in the Level 1 text as well as those requirements set out in this advice below. However, the supervisor should be able to require, stating the reasons, the reassessment of the technical provisions which may involve the use of an alternative technique, if this

reassessment or the use of a different technique is believed to better reflect the objective of the valuation (prudent, reliable and objective).

3.32. The valuation of the best estimate shall meet the following requirements:

- The (re)insurance undertaking shall be able to demonstrate the appropriateness, including the robustness of the techniques and assumptions used, having regard to the nature, scale and complexity of risks. In order to meet this requirement, a (re)insurance undertaking shall be able to provide sound rationale for the choice of one technique over other relevant techniques. This also applies to simplified techniques, approximations.
- The (re)insurance undertaking shall assess the degree of judgement required in each method and to what extent the undertaking is able to carry out such judgement in an objective and verifiable manner according the requirements set out in CEIOPS' advice on actuarial and statistical methodologies to calculate the best estimate.
- The (re)insurance undertaking shall be able to demonstrate that the valuation technique and the underlying assumptions are realistic and reflect the uncertain nature of the cash-flows.
- The valuation technique shall be chosen on the basis of the nature of the liability being valued and from the identification of risks which materially affect the underlying cash-flows.
- The assumptions underlying the valuation technique shall be validated and reviewed by the (re)insurance undertaking.
- The valuation technique and its results shall be capable of being audited.
- If policy data is grouped, the (re)insurance undertaking shall be able to demonstrate that the grouping process appropriately creates homogeneous risk groups that allow for the risk characteristics of the individual policies. This applies to either claims or policy data.
- Having regard to the previous bullet points, (i.e. having ensured that the valuation technique is appropriate and robust given the nature, scale and complexity of the risk), (re)insurance undertakings shall ensure that their capabilities (e.g. actuarial expertise, IT systems) are commensurate with the actuarial and statistical techniques used.

3.33. Valuation techniques considered to be appropriate actuarial and statistical methodologies to calculate the best estimate as required by Article 86(a) include: simulation, deterministic and analytical techniques or a combination thereof.

3.34. When selecting the valuation technique, (re)insurance undertakings shall consider the following factors and the material impact on the value of the liability, subject to proportionality:

- Whether the cash-flows are materially path dependent.
- Existence of material non-linear inter-dependencies between several drivers of uncertainty.

- Whether the liability cash-flows are materially affected by the potential future management actions.
- Presence of risks that have a material asymmetric impact on the value of the cash flows, in particular if contracts include material embedded options and guarantees or if there are complex reinsurance contracts in place.
- Whether the value of options and guarantees is materially affected by the policyholder behaviour assumed in the model.
- The availability of relevant data taking into account the requirements on data quality set out in CEIOPS' advice on standards for data quality

3.35. For certain life insurance liabilities, in particular the future discretionary benefits relating to participating contracts, especially those depending on assets performance, or other contracts with embedded options and guarantees, simulation may lead to a more appropriate and robust valuation of the best estimate liability. In such circumstances simulation techniques would normally be required.

3.36. For the estimation of non-life best estimate liabilities as well as life insurance liabilities not covered by the previous paragraph, deterministic and analytical techniques can be more appropriate. Some reasons are:

- Deterministic methods are usually the starting point for any estimation of best estimate. The application of simulation techniques can add useful insight into ranges around the mean and measures of uncertainty but they will not necessarily produce more accurate estimates of the best estimate because of the significant degree of uncertainty in the calibration of stochastic models.
- The mean of both the application of the simulation and deterministic method may well be the same under both methods (not least because deterministic results are often used to calibrate simulation methods) meaning that the best estimate for Solvency II purposes will be the same for either method (before any judgment is applied).

3.37. Both deterministic and simulation models are parameterised by the historic data available. Regardless of whether a deterministic or simulation model is used, the resulting mean estimates will therefore be based on development similar to that seen in the history and not contain "all possible future outcomes".

3.38. Regardless of the technique, judgement is required in making additions or adjustments to the estimates to allow for circumstances not included in the history that need to be incorporated into best estimates (for example emergence of latent claims, binary events, etc…). In all the methods judgement is an additional element in satisfying article 76 of the Level 1 text.