EIOPA-14-322

25 July 2014

The underlying assumptions in the standard formula for the Solvency Capital Requirement calculation

This document has been drafted to reflect the content of the Directives 2009/138/EC and 2014/51/EU and the content of the working documents of the (Level 2) Delegated Acts available at the time this document was drafted.

EIOPA – Westhafen Tower, Westhafenplatz 1 - 60327 Frankfurt – Germany – Tel. + 49 69-951119-20
Fax. + 49 69-951119-19, Website: https://eiopa.europa.eu

Table of Contents

Introduction

1.1 This document presents the underlying assumptions of the standard formula that are used for the SCR calculations. It should be read in conjunction with the Guidelines on the forward looking assessment of own risks (based on the ORSA principles) and, from 2016 onwards, with the Guidelines on ORSA.

1.2 The assessment of the significance with which the risk profile of an insurance or reinsurance undertaking ("undertaking") or group deviates from the assumptions underlying the SCR calculation, is an important process which undertakings and groups are required to perform starting from 2015. It should ensure that the undertaking or group understands the assumptions underlying its SCR calculation and considers whether the relevant assumptions are appropriate for the undertaking or group. To do so, the undertaking or group will have to compare those assumptions with its risk profile. The purpose of the assessment is not to review the appropriateness or calibration of the standard formula.

1.3 The standard formula for Solvency Capital Requirement (SCR) aims to capture the material quantifiable risks that most undertakings are exposed to. The standard formula might however not cover all material risks a specific undertaking is exposed to. A standard formula is, by its very nature and design, a standardised calculation method, and is therefore not tailored to the individual risk profile of a specific undertaking. For this reason, in some cases, the standard formula might not reflect the risk profile of a specific undertaking and consequently the level of own funds it needs.

1.4 The document at hand covers all risk modules of the standard formula, addressing the assumptions related to the risks covered by the respective modules as well as the assumptions for the correlation between the modules. It does not address why some risks are not explicitly formulated in the standard formula. However, this does not mean that these risks do not need to be considered for the purpose of the assessment of the significance of the deviation. The fact that the document does not specifically refer to every assumption underlying the standard formula should also not automatically lead an undertaking or group to assume that it does not need to consider whether the application of the standard formula in those parts, where no underlying assumptions are specified, results in adequate capital requirements for the risks it is exposed to.

1.5 The document is divided between the assumptions *per se,* which are given in the boxes at the start of the chapters, and background information. The text in the boxes is information about the assumptions underlying the standard formula that EIOPA would expect the administrative, management or supervisory body (AMSB) of the undertaking to be aware of in order to perform its role in the FLAOR/ORSA process. The background information is intended to assist persons performing the assessment of the significance of the deviation.

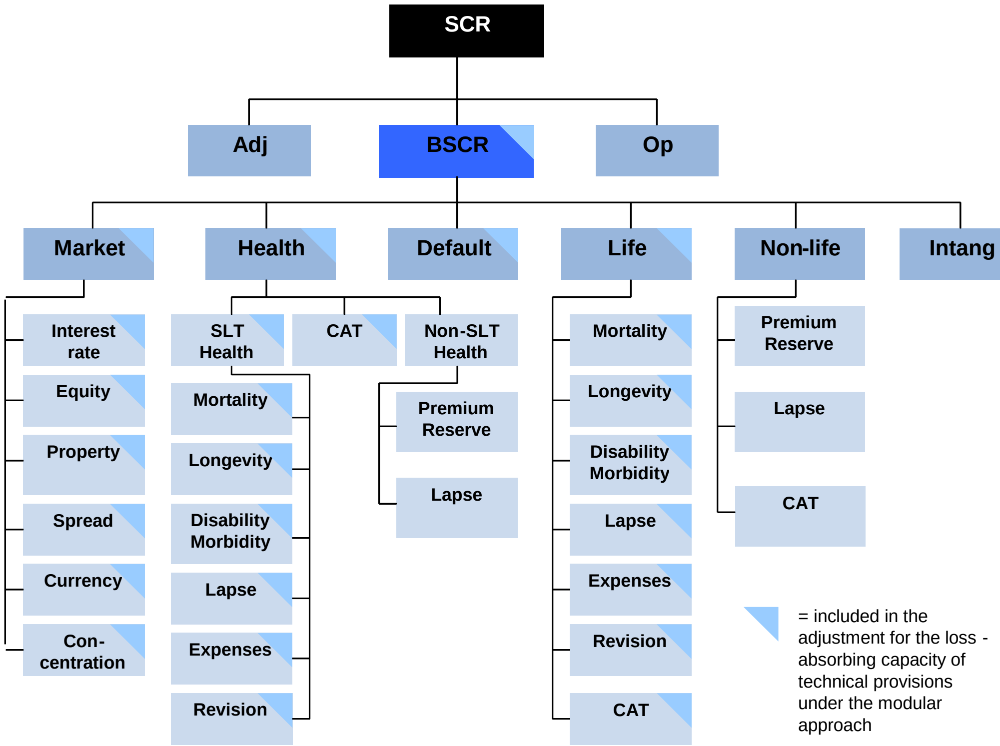
1.6 In line with the general approach that the assessment of the significance of the deviation itself is left to the undertaking or group, the document does not seek to prescribe explicitly the circumstances under which it would be appropriate for an undertaking or group to consider possible deviations of its risk profile from the assumptions on which the SCR standard formula calculation is based, or what exactly the undertaking or group should take into account in the assessment.

1.7 This document provides background information to the technical analysis carried out for the calibration of key parameters of the SCR standard formula, thus serving as a reference background document for undertakings in performing their FLAOR/ORSA. Moreover, this document tries to point out the main underlying assumptions in the standard formula design. It is however not intended to give an exhaustive description of all underlying assumptions of the standard formula nor does it aim to list all risks that are not explicitly formulated in the standard formula calculation. Where simplified calculations are available, they have been developed based on the same assumptions as for the standard calculation. In most cases, more assumptions were made in order to derive the simplified calculation. Where applicable, the additional underlying assumptions for the simplified calculations of the standard formula are also reflected in this document.

1.8 In accordance with Article 45(6) of Directive 2009/138/EC the undertaking will have to give information on the significance of the deviation of its risk profile from the assumptions underlying the SCR calculation to the supervisory authority in the FLAOR/ORSA supervisory report. This will require either an indication of why the deviation is significant or an explanation of and evidence why any deviations singly or taken together are not considered to be significant. As stated in the Explanatory Text to FLAOR Guideline 16 (respectively Guideline 12 of the ORSA consultation paper issued June 2014), the undertaking should consider possible consequences deriving from the significant deviation and if and how it intends to address this issue. Such a significant deviation also requires closer scrutiny from the supervisory authority which has to assess whether it agrees that there is a significant deviation and if so, has to consider which steps to take to address this issue from a supervisory perspective.

1.9 The document was informally consulted with stakeholders in spring 2014 and revised following the comments received. The document may be further amended as supervisory authorities and undertakings and groups gain experience with the use of the standard formula and the way undertakings and groups assess the significance of the deviation of the risk profile from the assumptions underlying the standard formula.

1. The overall structure of the standard formula



The underlying assumptions for the overall structure of the standard formula can be summarised as follows:

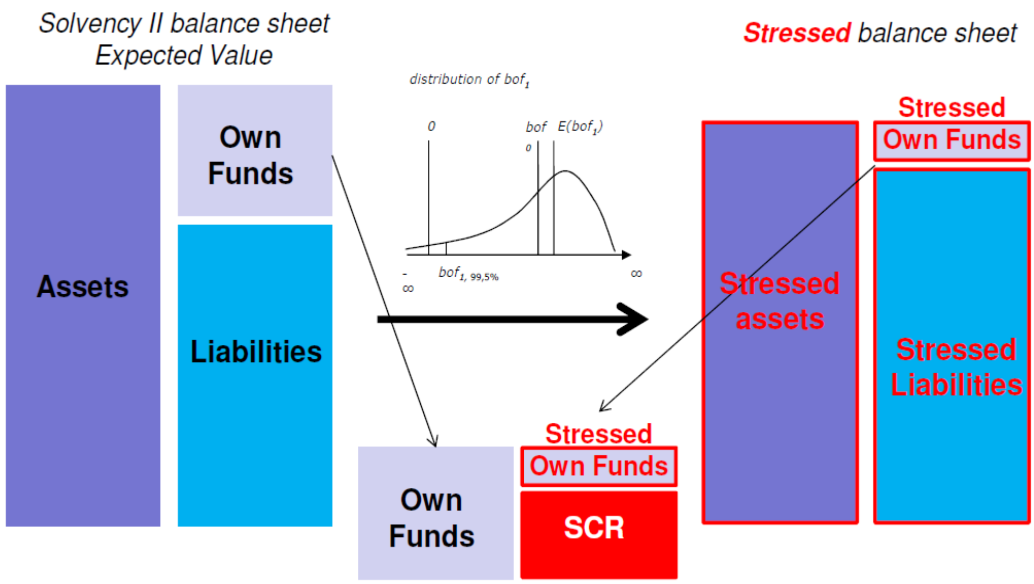
- Diversification effects are taken into account when capital requirements are aggregated by using correlation matrices. For aggregating the individual risk sub-modules and modules to obtain the overall SCR, linear correlation techniques are applied. The setting of the correlation coefficients is intended to reflect potential dependencies in the tail of the distributions, as well as the stability of any correlation assumption under stress conditions.

- The SCR covers all quantifiable risk for existing business and also new business expected to be written in the following 12 months. However, in the scenario-based calculations, the changes in the value of assets and liabilities over the 12 months following the scenario stress are not taken into account, given the instantaneous nature of the stresses. Therefore, in such cases the capital requirements do not take into account the profit or loss of the business expected to be written during the following months. The formula-based calculations allow capturing risks associated with new business expected to be written in the following 12 months.

- The SCR is calibrated using the Value at Risk (VaR) of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5 % over a one-year period. This calibration objective is applied to each individual risk module and sub-module.

The SCR standard formula follows a modular approach where the overall risk which the insurance or reinsurance undertaking (hereby undertaking) is exposed to, is divided into sub-risks and in some risk modules also into sub- sub risks. For each sub-risk (or sub-sub risk) a capital requirement is determined. The capital requirement on sub-risk or sub-sub risk level is aggregated with the use of correlation matrices in order to derive the capital requirement for the overall risk.

To ensure that the overall SCR is calibrated using the Value-at-Risk of the basic own funds of an undertaking subject to a confidence level of 99.5% over a one-year period this calibration objective applies to each individual risk module in a consistent manner.



Formula-based calculations are used for sub-modules where a scenario-based approach was not considered as the most appropriate. Formula-based calculations allow capturing risks associated with new business expected to be written in the following 12 months. However, the effects of risk-mitigation techniques are more difficult to take account when using a formula-based calculation.

1.1 Correlations in the standard formula

The underlying assumptions for the correlations in the standard formula can be summarised as follows:

- The dependence between risks can be fully captured by using a linear correlation coefficient approach.
- Due to imperfections that are identified with this aggregation formula (e.g. cases of tail dependencies and skewed distributions) the correlation parameters are chosen in such a way as to achieve the best approximation of the 99.5 % VaR for the overall (aggregated) capital requirement.

The selection of the correlation parameters has a significant influence on the final SCR, since the choice of correlation parameters has an impact on the level of diversification recognised within the standard formula.

The aggregation formula in the standard formula is based on the assumption that the dependence between the distributions can be fully captured by linear correlations. In the mathematical literature a number of examples can be found where linear correlations are insufficient to fully reflect the dependence between distributions and where the use of linear correlations could lead to incorrect aggregated results, i.e. producing either an under-estimation or an over-estimation of the capital requirements at the aggregated level.

Two main reasons can be identified for this aggregation issue:

- The dependence between the distributions is not linear; for example there are tail dependencies.
- The shape of the marginal distributions is significantly different from the normal distribution; for example cases where marginal distributions are skewed.

Unfortunately, both characteristics appear in many risks which an insurance or reinsurance undertaking is exposed to. Tail dependence can exist in underwriting risks (e.g. low-frequency and high-severity catastrophe events) market and credit risks. As to the second characteristic, it is generally known that the underlying distributions of the relevant risks of an insurance or reinsurance undertaking are not normal distributions. They are usually skewed and some of them are truncated by reinsurance or hedging effects.

Because of these shortfalls of correlation technique and the relevance of such shortfalls for the risks covered in the standard formula, the choice of the correlation factors should avoid a mis-estimation of the aggregated risk. In particular, linear correlations are not an appropriate choice for the aggregation of risks in many circumstances.

In the standard formula, correlation parameters should be chosen in such a way as to achieve the best approximation of the 99.5% VaR for the aggregated capital requirement. In mathematical terms, this approach can be described as follows:
For two risks X and Y with E(X)=E(Y)=0, the correlation parameter ρ should minimize the following aggregation error:

$$|VaR(X+Y)^2 - VaR(X)^2 - VaR(Y)^2 - 2\rho \cdot VaR(X) \cdot VaR(Y)|$$

1.2 Setting correlation parameters for independent risks

Several risks covered in the standard formula are intended to be independent. For the aggregation of independent risks, a correlation parameter set at 0 is considered.
However, the choice of the correlation parameter for independent risks is not straightforward. If the underlying distributions are not normal, setting a correlation parameter of 0 can lead to an mis-estimation of the aggregated risk, hence to an mis-estimation of the required capital at the aggregated level. Where the shape or the type of the marginal distributions is known, sometimes it is possible to determine a correlation parameter which more closely reflects the aggregated risks. However, in practice, this often proves to be difficult. The shape of the underlying distributions is often not known or it differs across undertakings and over time. For example, even if the distribution of an underlying risk driver is known, hedging and reinsurance effects can modify the net risk in an undertaking-specific way. Hence where a standard formula correlation parameter between two risks assumed to be independent has to be specified, it appears to be acceptable to choose a low correlation parameter, reflecting that model risk might lead to an over- or under-estimation of the combined risk.

1.3 Risks not explicitly formulated in the standard formula calculation

The underlying assumptions for risks not explicitly formulated in the standard formula calculation can be summarized as follows:

- Not all quantifiable risks have been explicitly formulated in the standard formula. As a consequence some risks which are not explicitly included in the standard formula may be relevant for a particular undertaking. Some risks whose nature and calibration strongly depend on the single undertaking specificity may not be explicitly covered in the framework of the standard formula.

- The standard formula was designed from a solo perspective and applied mutatis mutandis for groups. Therefore, some risks which are relevant only for entities belonging to a group may not be covered by the standard formula.
- Certain risks are implicitly considered in other risk modules or sub-modules or in even multiple risk modules or sub-modules simultaneously. These risks are therefore considered to be implicitly formulated in the standard formula design and calibration.

For some risks (mostly sub-risks or parts of risks covered already in the standard formula) it can generally be assumed that the exposure is not always material enough to justify a separate and more granular SCR quantification within the context of the standard formula. These (sub-) risks are not explicitly formulated in the standard formula calculation.

The SCR calibration objective, corresponding to the VaR of basic own funds subject to a confidence level of 99.5 % over a one-year period, is applied to each individual risk sub-module. However, for certain risks data availability is very scarce and therefore no reliable calibration that is representative for the whole market can be obtained. Therefore these types of risks are also not explicitly formulated in the standard formula calculation.

Finally, it would be inappropriate to cover some risks through pillar 1 capital requirements but these should be covered instead through pillar 2 requirements, in particular through risk management requirements for an appropriate monitoring and disclosing of the risk profile of an undertaking.

For illustration purposes, the following risks can be identified as being not explicitly formulated in the standard formula calculation (note that this is not intended to be an exhaustive list of excluded risks):

- **Inflation risk**:
The sensitivity of the values of assets, liabilities and financial instruments to changes in the term structure of inflation rates, or in the volatility of inflation rates is not explicitly taken up as a separate risk sub-module in the standard formula. However, for the Life expense and SLT Health expense risk sub-modules as well as for the SLT Health disability-morbidity risk sub-module for medical expense (the capital requirement for the increase or decrease of medical expense payments), undertakings shall apply a 1 percentage point annual increase in expense inflation rates used for the calculation of technical provisions . For the health revision risk sub-modules the increase in annuity benefits is assumed to be related to changes in for example, inflation. Other sources of inflation risk are assumed implicitly in the calibration of the upward and downward interest rate shocks in the interest rate sub-module. However,

the modelling of the Life and SLT Health underwriting risk modules should be based on the assumption that the risk relating to the dependence of insurance and reinsurance benefits on inflation is not material.

- **Reputation risk**:

The risk related to the trustworthiness of an undertaking resulting in loss of revenues or destruction of shareholders value is not explicitly covered in the standard formula. The operational risk module explicitly excludes reputation risk and risks arising from strategic decisions. Given the limited amount of data or relevant information on past events of reputation risks, no reliable calibration of a capital requirement for reputation risk would be appropriate for the whole market. Therefore it is assumed inappropriate to cover reputation risk within the context of a standard formula approach.

- **Liquidity risk**:

The risk that insurance and reinsurance undertakings are unable to realize investments and other assets in order to settle their financial obligations when they fall due is not explicitly covered in the standard formula SCR calculation. It is assumed that a capital requirement to cover liquidity risk would be ineffective and that it is appropriate to cover such risk by an explicit liquidity risk management policy within the overall risk management system. Undertakings are supposed to publicly disclose qualitative and quantitative information regarding their risk profile, including exposures to liquidity risk where these are material or in case of material changes in the liquidity risk profile.

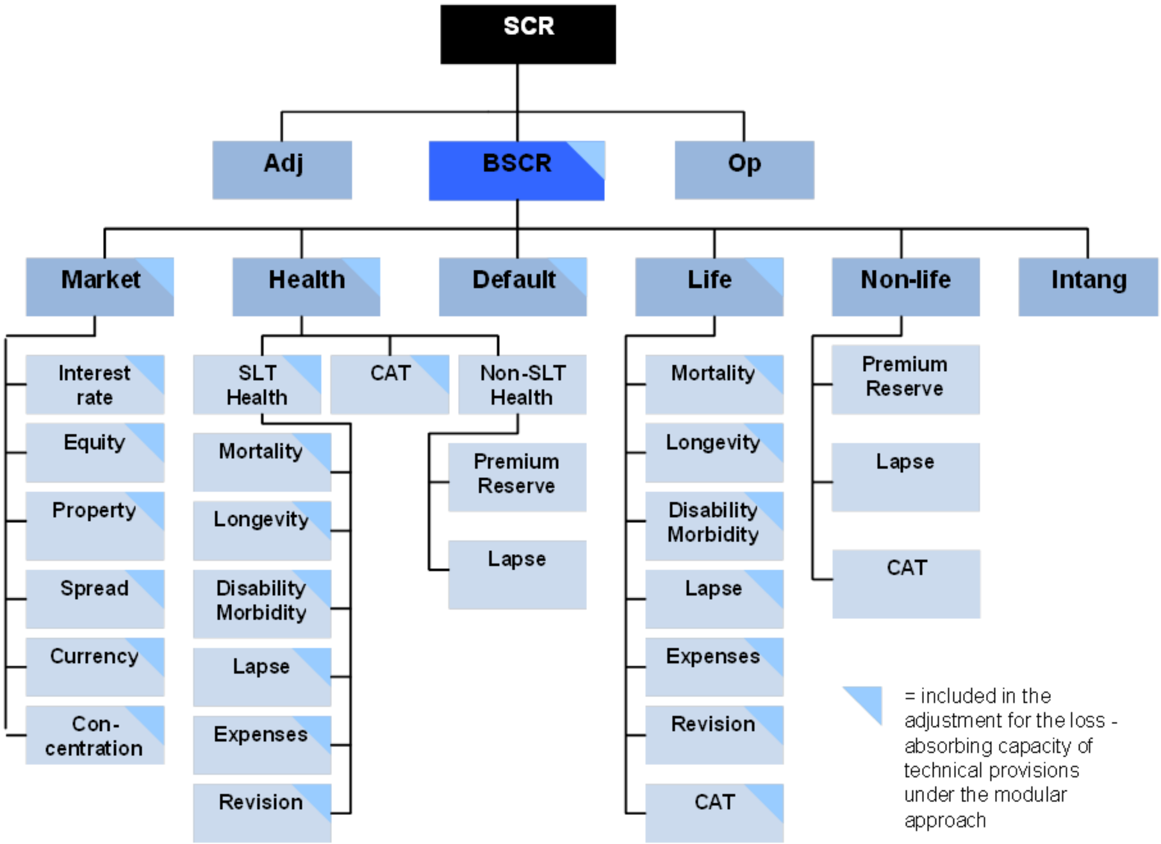
- **Contagion risk**:

An insurance or reinsurance undertaking could be exposed to the risk that an adverse event or situation will spread from one undertaking to another. For example an insurance undertaking could be exposed to the financial weakness of other group entities affected by for instance market, reputation or operational risk. Conversely, some risks crystallizing at entity level can have knock-on or ripple effects on the wider group level. Such exposures to contagion risk are not explicitly covered in the standard formula, as the sources of contagion effects and the financial losses in case of contagion events are very specific to the business profile of individual undertakings and to the context of the group structure within which undertakings operate. Undertakings are anyway supposed to publicly disclose qualitative and quantitative information regarding their risk profile, including exposures to contagion risk and concentration risk where these are material or in case of material changes in the concentration risk profile.

- **Legal environment risk**:

This is the risk that insurance and reinsurance undertakings are unable to adapt their risk profile in response to sudden or unexpected changes in the legal environment, such as an unforeseen change in the legal retirement age. This is supposed to be understood as being different from legal risk directly affecting an undertaking, which is covered by a SCR for operational risk.

2. Market risk



The underlying assumption for the market risk module can be summarised as follows:

- The sensitivity of assets and liabilities to changes in the volatility of the market parameters is not material.

Market risk arises from the level or volatility of market prices of financial instruments. In the market risk module, exposure to market risk is measured by the impact of movements in the level of financial variables, such as equity prices, interest rates, yield spreads, property prices, and exchange rates. It is assumed that the sensitivity of assets and liabilities to changes in the volatility of the market parameters is not material. An assumption in the market risk module is that assets that are allocated to policies where the policyholder bears the investment risk are excluded from the module only to the extent that the risk is passed on to policyholders.

2.1 Interest rate risk

The underlying assumptions for the interest rate risk sub-module can be summarised as follows:

- Only interest rate risk that arises from changes in the level of the basic risk free interest rates is captured.
- Volatility and changes in the shape of the yield curve are not covered explicitly in the interest risk sub- module.
- The undertaking is not exposed to material inflation or deflation risk.

- For the use of a simplified calculation of the capital requirement for interest rate risk for captives it is assumed that all assets and liabilities sensitive to interest rate movements held by captives can be considered materially less diversified in terms of duration of maturity intervals and of lines of business compared to the portfolio used in the calibration of the standard formula.

The interest rate risk sub-module should capture interest rate risk in relation to all interest rate sensitive assets and liabilities. The upward and downward shocked term structures are derived by multiplying the current interest rate curve by an upward and downward stress factor. It is important to note that the stress should only be applied to the basic risk-free interest rates. The assumption underlying the design of the interest rate risk sub- module is that in times of lower interest rates also the absolute shocks are lower, and vice versa. The interest risk module does not fully capture the risk of inflation or deflation. The undertaking should take into account any risk arising from inflation or deflation as part of their own risk and solvency assessment.

The interest risk sub- module only captures interest rate risk that arises from changes in the level of the basic risk-free interest rates. Volatility and changes in the shape of the yield curve are not covered in the standard formula. The volatility of forward rates plays a vital role in the determination of the slope and convexity of the underlying yield curve. This particular volatility can be implied from market prices for swaptions, which render the right to the holders to enter into a swap agreement for a specified term at the maturity of the option. In particular, any increase in the implied volatility surface can have subsequent "spill over" effects onto the shape and convexity of the underlying term structure. As a result, shocks in the volatility of the term structure are usually only relevant where insurer's asset portfolio and/or their insurance obligations are sensitive to changes in interest rate volatility, for example where liabilities contain embedded options and guarantees. Insurers can also be exposed to volatility if they hold derivatives in their asset portfolios for interest rate hedging purposes.

The calibration of the interest rate shocks in the standard formula are based on the relative changes of the term structure of interest rates using the following 4 datasets:

EUR government zero coupon term structures (1997 to 2009)[1], GBP government zero coupon term structures (1979 to 2009)[2], and both Euro and GBP LIBOR/swap rates (1997 to 2009)[3].

For each of the four individual datasets, stress factors were assessed through a Principal Component Analysis[4] (PCA), according to their maturity. PCA is a tractable and easy- to- implement method for extracting market risk factors. For each maturity, the mean of the results in the four datasets was taken as a single stress factor[5].

The datasets chosen for calibrating the interest risk sub- module represent the deepest and most liquid markets for interest rate sensitive instruments in the European area. Moreover, the use of all four datasets together introduces a control against the uncertainties that could result from using just one dataset in isolation. For example, using the longer data period available for the GBP government bond data introduces additional balance and a greater depth of information to the economic cycle than the other three datasets. There are several technical idiosyncrasies in each of the other data sets generating uncertainties that can be balanced out by combining the results from all four datasets appropriately.

The analysis is based on time series of EUR and GPB interest rates and therefore reflects the European economic experience over the last 30 years. However, financial parameters can develop differently from what has been observed in the past in Europe. For instance, there can be deflationary scenarios like in Japan in the 1990s.

A simplified calculation of the capital requirement for interest risk is also available to captive insurance and reinsurance undertakings as it is considered to be proportionate to the nature, scale and complexity of the risks they face. The underlying assumption for the use of a simplified calculation of the capital requirement for interest rate risk for captives is that all assets and liabilities sensitive to interest rate movements held by captives can be considered materially less diversified in terms of maturity intervals and of lines of business compared to the portfolio used in the calibration of the standard formula.

2.2 Equity risk

The underlying assumptions for the equity risk sub-module can be summarised as follows:

- Assets and liabilities subject equity risk are only exposed to a fall in the level of equity prices and not to a rise in those prices.

[1] Rates for maturities from 1 year to 15 years.
[2] Rates for maturities of 6 months, 12 month, 18 months up until 25 years.
[3] Rates for maturities 3-month, 6-month, 1 year until 10 years, 15 years, 20 years and 30 years.

[4] PCA is mathematically defined as an orthogonal linear transformation that transforms the data to a new coordinate system such that the greatest variance by any projection of the data comes to lie on the first coordinate (called the first principal component), the second greatest variance on the second coordinate, and so on. PCA is theoretically the optimum transform for given data in least square terms. For further details, please refer to Jolliffe I.T, (2002), Principal Component Analysis, Springer Series in Statistics, 2nd ed., Springer-Verlag.
[5] In addition to the calibration of the relative stress factor, a floor of 1 percentage point for the absolute change of interest rate in the downward scenario is defined.

- The value of equity investments cannot fall below zero.
- For the split between type 1 and type 2 equities it is assumed that type 2 equities consist of more risky equities than the equities covered in the type 1 category. For this reason, the stress factor for type 2 equities is higher than for type 1 equities.
- The undertaking holds a type 1 equity portfolio that is well diversified with respect to geography (developed market countries), stock size (large, mid, small, micro cap), sectors and investment style (growth, value, income etc.).
- The undertaking owns a private equity portfolio, as part of its type 2 equity portfolio, of mainly large private equity companies. The portfolio is assumed to be well-diversified with respect to geography, stock size, investment and financing style as well as vintage years.
- The undertaking owns a commodity portfolio of liquid commodities as part of its type 2 equity portfolio. The portfolio is assumed to be well-diversified with respect to the composition (proportion according to the world-wide production).
- The undertaking owns a hedge funds portfolio of medium and large size hedge funds trading on a transparent basis. It is assumed that the portfolio is well-diversified with respect to fund strategies and geographic location.
- The undertaking owns a portfolio of equities in emerging markets that is well-diversified with respect to geography, stock size (large, mid, small, micro cap), sectors and investment style (growth, value, income etc.).
- For the symmetric adjustment mechanism in the standard approach in the equity risk sub- module it is assumed that equity prices have a mean reverting behaviour. Therefore, in times of rising equity markets the symmetric adjustment mechanism will increase the capital charge, and in times of falling equity indices the symmetric adjustment mechanism will reduce the capital charge. This is an assumption that is made about the behaviour of equity markets.
- For the duration-based approach in the equity risk sub- module it is assumed that a lower stress can be applied if the undertaking is exposed to a lower level of volatility of equities in the long-term compared to the short-term, consistent with the assumption of mean reverting behaviour of stock markets. It is assumed that for the business where the duration-based approach is used, the typical holding period of equity investments is consistent with the average duration of such liabilities.
- The equity risk charge applies to all equity investments including those in related undertakings and participations in financial and credit institutions in respect of the value not deducted from own funds in accordance with [Article 71 POF1]. While equity investments in related undertakings are also categorised as type 1 or type 2 exposures, a reduced risk charge of 22% applies to both types where the investments are of a strategic nature as set out in [Article 152 ER4].

Equity risk arises from the level or volatility of market prices for equities. Exposure to equity risk arises in respect of all assets and liabilities whose value is sensitive to changes in equity prices. In the standard formula, the equity risk sub-module only captures changes in the level of equity prices, and the module only covers a downward equity stress scenario.

Many insurers are sensitive to changes in equity volatility either through the investments they hold (equities and equity derivatives) or through equity- linked options and guarantees embedded in their liability portfolio. As a result, equity volatility has an impact particularly on insurers writing traditional participating business, investment-linked business and other investment contracts. However, volatility is not explicitly covered in the equity risk sub-module.

An underlying assumption in respect of an equity investment is that its value cannot fall below zero where the undertaking remains exposed to loss in basic own funds not captured in the counterparty default risk module (especially referred to in [Article 174 CDR1 (2) (e) of the draft Delegated Acts]). This is particularly relevant in the case of investments in related undertakings valued with the adjusted equity method in accordance with [Article 9 V5]. For instance, the valuation of an investment in a non-regulated related undertaking based on Solvency II principles might lead to a negative value in the Solvency II balance sheet notwithstanding the fact that the related undertaking is not in a stressed financial position under local accounting rules.

For the purpose of the standard formula the application of the equity risk sub-module in respect of related undertakings only arises in the case that the participating undertaking holds an equity investment in its related undertaking. For clarification, a related undertaking can also be identified by reference to the nature of the relationship and extent of influence exercised by the participating undertaking. Therefore, the holding of an equity investment at all or of a specified percentage is not a pre-requisite for the identification of a related undertaking. In the light of the aforementioned the participating undertaking's equity investment in the related undertaking may not be fully representative of its equity exposure to the related undertaking notwithstanding other exposures dealt with elsewhere in the standard formula in respect of bonds, receivables and legal commitments made.

There are two possible methods to calculate the equity risk capital charge: the "standard" approach and the "duration based" approach. For the "standard" approach there is also a symmetric adjustment mechanism, which is always in force, to be applied to the standard capital stress. This symmetric adjustment mechanism allows the equity shock to move within a band of 10% on either side of the underlying standard equity stress. The calibration of the "standard" approach therefore firstly looks at the underlying standard equity stress, which is calibrated to the 99, 5% VaR level for both "type 1" and "type 2" equities. The symmetric adjustment mechanism then overlays the standard charge to arrive at the full standard approach.

Standard equity capital charge

The equity risk sub- module consists of two "sub-sub" modules for type 1 and type 2 equities. The underlying assumption for this split is that type 2 equities are more risky than the equities that are covered in the type 1 category. The category of type 2 equities also covers alternative investments. For this reason, the stress factor for type 2 equities is higher than for type 1 equities.

The category of "type 1" equities covers equities listed in regulated markets which are members of the EEA or the OECD. "Type 1" equities also include:

- exposures to European Long-term Investment funds;
- exposures to collective investment undertakings qualifying as social entrepreneurship funds;
- exposures to collective investment undertakings qualifying as venture capital funds; and
- exposures to close-ended and unleveraged alternative investment funds where those alternative investment funds are established in the Union or, if they are not established in the Union, they are marketed in the Union.

The calibration of the stress is based on data from the MSCI World Developed Price Equity Index (1979 to end 2009, i.e. data from stressed markets are included). This index consists of equities listed in developed countries located across America, Europe and the Pacific Basin[6]. An underlying assumption in respect of type 1 equities is that the undertaking owns a diversified equity portfolio.

Simplified observations about the distribution of equity and other financial returns tend to confirm that at longer horizons equity returns appear to be normally distributed. The exact distribution of financial returns is an open question; however, at weekly, daily and higher frequencies the equity return distribution displays definite non-normal properties. In the calibration exercise, a huge amount of equity return data was studied, and higher densities (known as "fat tails") than that predicted under the assumption of normality were observed.

The category "type 2" equities comprises equities listed in countries other than EEA and OECD countries, non-listed and private equities, hedge funds, commodities and other alternative investments. In the calibration exercise the following indices were used: LPX50 Total Return (Private Equity), S&P GSCI Total Return Index (Commodities), HFRX Global Hedge Fund Index (Hedge Funds) and MSCI Emerging Markets BRIC (Emerging Markets). An underlying assumption in the calibration of the equity type 2 shock is that the underlying portfolio of type 2 equities are diversified and that this portfolio is representative for an average European insurance or reinsurance undertaking.

[6] Further information on the MSCI Barra International Equity Indices can be found at http://www.mscibarra.com/products/indices/equity/index.jsp

The results of the calibration exercise demonstrated a rather wide variation between the different classes of "type 2" equities.

The equity risk charge applies to all equity investments including those in related undertakings and participations in financial and credit institutions in respect of the value not deducted from own funds in accordance with Article 71 POF1. While equity investments in related undertakings are also categorised as type 1 or type 2 exposures, a reduced risk charge of 22% applies to both types where the investments are of a strategic nature as set out in [Article 152 ER4].

Symmetric adjustment mechanism

For the "standard" approach a symmetric adjustment mechanism is introduced, which is always in force, to be applied to the standard capital stress. This symmetric adjustment mechanism allows the equity shock to move within a band of 10% on either side of the underlying standard equity stress.

The justification of such an adjustment, in the context of a 99.5% percentile approach, is based on the underlying assumption that equity prices have a mean reverting behaviour.

The symmetric adjustment is included due to the following objectives:

- To avoid that insurance and reinsurance undertakings are unduly forced to raise additional capital or sell their investments as a result of adverse movements in financial markets;
- To discourage or avoid fire sales which would further negatively impact the equity prices – i.e. prevent a pro-cyclical effect of the capital requirements which would in times of stress lead to an increase of capital requirements and hence have a potential de- stabilising effect on the economy.

Therefore, in times of rising equity markets the dampener will increase the capital charge, and in times of falling equity indices the dampener will reduce the capital charge.

The symmetric adjustment mechanism is based on the following formula:

$$SA = \frac{1}{2} \cdot \left(\frac{CI - AI}{AI} - 0{,}08 \right) \cdot 100$$

In this formula CI is the current value of the representative European Equity index calculated by EIOPA on a regular basis and AI is the weighted average of the daily levels of such representative equity index over the last 36 months.

Duration-based approach

The duration- based equity risk sub- module only applies to life undertakings providing certain occupational retirement provisions or retirement benefits where the typical holding period of equity investments is assumed to be consistent with an average duration of liabilities for such business and exceeds 12 years. The concept behind this idea is that equity investments can be used to back liabilities beyond a certain duration. The argument is that for long-term equity investments short-term volatility should not be considered, and therefore should lead in turn to a lower capital requirement.

When designing the equity risk sub-module there was an assumption that a level of confidence of 99.5% at a 1-year time horizon is equivalent to the level of confidence $99.5\%^{T}$ - if a holding period of T years is assumed. Implicitly, temporal independence of events was assumed. The equity charge was derived based on a Brownian motion argument. However, for the purpose of prudence and in order to be consistent with the property risk sub- module calibration, an absolute floor for the equity charge was set at 22%.

2.3 Currency risk

The underlying assumptions for the currency risk sub-module can be summarised as follows:

- The sub-module takes into account currency risk arising from all possible sources, and the underlying assumption of the market risk module design is that currency effects only appears in this sub-module, i.e. currency effects have been stripped out in the calibration of the other market risk sub- modules.
- For currencies pegged to the Euro, either by way of currencies participating in the European Exchange Rate Mechanism, or where a decision from the Council recognizes pegging arrangements to the Euro or where a pegging arrangement is established by law of the country establishing the country's currency, a reduced shock factor in the currency risk sub- module is used. The underlying assumption is that for these currencies, the rate against the Euro will fluctuate within a limited band, and therefore the currency risk shocks against the Euro should be limited as well. The same reduced shock factors will apply between pairs of currencies pegged to the Euro, based on the same underlying assumption.

Currency risk arises from changes in the level or volatility of currency exchange rates. Undertakings can be exposed to currency risk arising from various sources, including their investment portfolios, as well as assets, liabilities and investments in related undertakings located in a different currency area. The design of the currency risk sub-module is intended to take into account currency risk arising from all possible sources, and the underlying assumption of the market risk module design is that currency effects appear only in this sub-module, i.e. currency effects have been stripped out in the calibration of the other market risk sub modules.

In the calibration of the currency stress factor, daily data to study the distribution of holding period rate of returns derived from EUR and GBP currency pairs were used. The data sample, sourced from Bloomberg, covers a daily period from January 1971 to June 2009, a total of circa 10,000 observations across 14 currency pairs against GBP. In addition, the sample consisted of 14 currency pairs expressed against the EUR. For most pairs, the sample covered a daily period spanning a period of 10 years starting in 1999 to 2009. Annual holding period returns were computed for the Japanese Yen (JPY), the Brazilian Real (BRL), the Lithuanian Litas (LTL), the Indian Rupee (INR), the Chinese Yuan (CNY) the US, Hong Kong (HKD), the Australian (AUD) and the New Zealand (NZD) Dollars, the Norwegian (NOK), Swedish (SEK) and Danish (DKK) Krone, the Swiss Franc (CHF) and the British Pound (GBP).

This is a currency basket expressed against the EUR, and is equally distributed across CNY, INR, HKD, AUD, BRL and ARS. It was preferred to extend the definition of the emerging market to include developed economies, whilst including the dominant Latin American countries, Brazil and Argentina excluding Mexico. The presence of the Australian and Hong Kong economy to the mix balances out the level of the stress as it was believed that insurance groups are more exposed to these economies across the Pacific basin region.

In the calibration of the currency risk stress factor, a visual inspection of different standardised distributions, which were plotted against the normal distribution, showed that the data did not adhere to the laws of normal distribution. Most distributions were skewed and exhibited excess kurtosis ("fat tails").

For currencies pegged to the Euro, either by way of currencies participating in the European Exchange Rate Mechanism, or where a decision from the Council recognizes pegging arrangements to the Euro or where a pegging arrangement is established by law of the country establishing the country's currency, a reduced shock factor in the currency risk sub-module is used. The underlying assumption is that for these currencies the rate against the Euro will fluctuate within a limited band, and therefore the currency risk shocks against the Euro should be limited as well. The same reduced shock factors will apply between pairs of currencies pegged to the Euro, based on the same underlying assumption.

2.4 Property risk

The underlying assumptions for the property risk sub-module can be summarised as follows:

- The risk-profile of any of the undertaking’s exposures to property located in third countries is not materially different from the risk profile of European property markets.
- The distributions of property returns are characterised by long left- fat tails and excess kurtosis (signifying disparity from normal distribution).

The property shock is the immediate effect expected in the event of a fall in real estate benchmarks, where all direct and indirect exposures of the insurer to property prices are taken into account. It is assumed that the volatility of property prices is implicitly covered in the calibration of the property shock. The property shock was calibrated using UK data extracted from the Investment Property Databank (IPD) indices. The IPD indices are based on survey data collected from institutional investors, property companies and open-ended investment funds, and are the most widely used commercial property indices. Indices for most European markets and some countries outside Europe are produced, but for most European markets long time series are lacking. The indices consist of time series of income (rental yield) and capital growth for the main property market sectors – retail, office, industrial and residential.

The calibration was based on monthly IPD total return[7] indices for the UK market (1987 to 2008), because this dataset provides the greatest and most detailed pool of information. Total return indices are based on appraised market values rather than actual sales transactions, so by using them smoothed data were to some degree used (because appraisers tend to be "backward-looking", the current appraisal values mirror also previous valuation prices). Even though the calibration of the property shock is based on UK data, it is implicitly assumed that the UK property market can be used as a good proxy for the average European property market. Undertakings not exposed to the UK property market can rely on this assumption underlying the property risk module. It should also be assumed that the risk-profile of any exposures to property located in third countries is not materially different from the risk-profile European property markets.

The lower percentiles of the distribution of the "smoothed" property returns – i.e., the unadjusted index data –were derived by using non-parametric methods. The distributions of property returns are generally characterised by long left fat-tails and excess kurtosis (signifying disparity from normal distribution). Different methods were applied to de-smooth the annual returns, but this resulted in even heavier left tails.

As the historical values at risk for the different property classes did not diverge too much, no breakdown in different property classes was proposed.

2.5 Spread risk

The underlying assumption for the spread risk sub-module can be summarised as follows:

- It is assumed that spreads will increase for all instruments in a 1 in 200 years event. It is therefore also assumed that there will be no diversification between the different sub-sub-modules of the spread risk sub-module.

[7] Calibrating based on total return indices is based on the inherent assumption that the rental yield earned on a property portfolio is re-invested back into the same pool.

- Downgrades and default risk are not explicitly covered. Instead, both risks are addressed implicitly in the calibration of the factors of movements in credit spreads. The factors also implicitly address not only the change in the level of credit spreads, but also the shape of the term structure for the level of spreads.
- For bonds and loans other than residential mortgage loans, it is assumed that the spreads on all instruments increase, as undertakings are only exposed to the risk of a rise in credit spreads.
- An undertaking's exposures in the form of covered bonds with a high credit quality step (0 or 1) and short or medium duration (less or exactly 10 years) are covered by the diversified pool of assets securing most of the bond's value in case of a default of the issuer. The spread of the bond therefore also depends on this diversified pool of assets which is assumed to have a low volatility over the duration of the bond. Where covered bonds cannot be assigned to a high credit quality step (0 or 1) or they have a long duration a lower risk factor is assumed to be not appropriate.
- For securitisation positions it is assumed that the spread risk depends not only on the rating but also on the structure of the securitisation and the type and quality of the assets in the securitised pool. Therefore, the calibration of the spread shock factors has been differentiated between two types of securitisations and resecuritisation positions.
- A simplified calculation of the capital requirement for spread risk on bonds and loans is available if it is considered to be proportionate to the nature, scale and complexity of the risks an undertaking faces. The underlying assumption is that the asset portfolio is materially less diversified in terms of credit quality and duration compared to the portfolio used in the calibration of the standard formula. Therefore, the product of the duration and a risk factor dependent on the credit quality is assumed to be a prudent approximation for spread risk.
- The underlying assumption that all assets held by captives can be assigned to credit quality step 3 for the purpose of the simplified calculation for spread risk is that asset portfolios of captives are materially less diversified in terms of credit quality compared to the portfolio used in the calibration of the standard formula.

The spread risk module is designed to reflect the change in the value of assets and liabilities caused by changes in the level or the volatility of credit spreads over the risk free term structure. It applies to bonds and loans other than residential mortgage loans (residential mortgage loans are covered in the counterparty default risk module as type 2 exposures, as it is assumed that this is a well-diversified portfolio of small single name exposures without a rating), structured credit products (such as asset-backed securities and collateralised debt obligations) and credit derivatives (such as credit default swaps, total return swaps and credit linked notes). The capital charges are assessed for each class of instruments and then added to get the capital charge for spread risk:

$SCR_{spread} = SCR_{bonds\&loans} + SCR_{securitisation} + SCR_{cd}$

Perfect positive correlation between the different sub-sub-modules in the spread risk sub-module is assumed, so no diversification effect is allowed for. Empirically, spreads tend to move in the same direction in a stressed scenario, and therefore the assumption is made that spreads on all instruments increase at the same time.

Spread risk on bonds and loans other than residential mortgage loans

The spread risk capital charge on bonds and loans other than residential mortgage loans is assessed through a factor-based calculation (starting from the market value of the instrument and taking into account its credit quality step and duration). The assumption is made that the spreads on all instruments increase, leading to an instantaneous reduction in the value of bonds. The undertaking should multiply the market value of the instrument with a risk factor $stress_i$ that depends on the credit quality step of the instrument, and the modified duration of the bond or loan denominated in years. For variable interest rate bonds or loans, the duration is equivalent to the modified duration of a fixed interest rate bond or loan of the same maturity and with coupon payments equal to the forward interest rate. The shock in spread risk for bonds and loans other than residential mortgage loans is designed as a concave function of duration ("kinking"). The reason for this is to ensure righti ncentives that long-term liabilities are backed by long term assets.

The calibration of the risk factor $stress_i$ was based on the factors on Corporate Bond Indices from Merrill Lynch. Monthly re-balanced sub-indices for EMU Corporates, for different maturity buckets and rating classes[8] between 1999 and February 2010 were used. Each maturity bucket and rating class was split into new maturity buckets in order to be able to calibrate on more granular buckets.
There are lower capital requirements for covered bonds. The underlying assumption is that a pool of assets of high credit quality covers the bond and therefore the shock factors for covered bonds should be somewhat aligned with the shocks for bond exposures of credit quality steps 0 or 1.
A simplified calculation of the capital requirement for spread risk on bonds and loans is available if it is considered to be proportionate to the nature, scale and complexity of the risks an undertaking faces. The underlying assumption is that the asset portfolio is materially less diversified in terms of credit quality and duration compared to the portfolio used in the calibration of the standard formula.

The simplified calculation of the capital requirement for spread risk on bonds and loans is assumed to apply to captives. The underlying assumption is that assets held by captives can be assigned to credit quality step 3 for the purpose of the simplified calculation for spread risk as these are materially less diversified in terms of credit quality compared to the portfolio used in the calibration of the standard formula.

[8] Data for rating classes AAA, AA, A, BBB, BB and B were used.

Spread risk on securitisation positions

The spread risk capital charge on securitisations positions is determined by a method comparable to the method for bonds and loans other than residential mortgage loans, i.e. by multiplying the market value of the instrument with its modified duration and a risk factor $stress_i$ that depends on the credit quality step of the instrument. The spread risk sub-module differentiates between securitisations positions of Type I and Type II other than resecuritisation exposures. Type I securitisations have to meet quality criteria regarding structural features, asset class eligibility and related collateral characteristics, listing and transparency features and underwriting processes. It is noted that since the beginning of the crisis (2007) the indices of structured credit products have exhibited highly diverging performance patterns, as not only the ratings[9] of tranches determines the price but also the type and quality of the assets in the securitised asset pool are important. Therefore, the calibration was not based solely on the ratings of securitisations.

The risk factor $stress_i$ for securitisation positions other than resecuritisations was calibrated using spread data of US and European indices from Bank of America Merrill Lynch and Markit between January 2007 and September 2013. The indices consisted either of Type I or Type II securitisations positions[10]. To derive the spread risk charge from this data it was assumed that investments are made mainly in European securitisations.

The data justified a lower spread risk charge for Type I securitisations.

As the observed credit spread of resecuritisations was considerably higher than for Type II securitisations a different set of capital requirements for the former was introduced in the spread risk sub-module.

Spread risk on credit derivatives

The capital charge for credit derivatives is determined as the change in the value of the derivative (i.e. as the decrease in the asset or the increase in the liability after netting with offsetting corporate bond exposures) that would occur following (a) a widening of credit spreads if overall this was more onerous, or (b) a narrowing of credit spreads by 75% if this was more onerous.

2.6 Market risk concentration risk

The underlying assumptions for the market risk concentration sub-module can be summarised as follows:

- Undertakings are only exposed to concentration risk regarding the accumulation of exposure with the same counterparty. The concentration risk sub- module

[9] The tranche ratings are considered to be one of the reasons for the financial crisis.
[10] Some of the Bank of America Merrill Lynch indices contain a number of subsectors. Separate subsector time series were calculated where necessary.

does not include other types of concentration risks, such as geographical or sector concentrations of the assets held.

- Undertakings are at risk and a capital requirement is determined when accumulated single name exposures are above the specified concentration thresholds. When accumulated single name exposures are below the specified thresholds, undertakings are not at risk, and no capital requirement for concentration risk is determined.

- The risk (volatility- VaR) of a badly diversified portfolio is higher than for a well-diversified basket of investments. It is assumed that undertakings have a portfolio with an investment mix that does not deviate materially from an EU average undertakings' portfolios of investments, i.e. it consists of significantly more bonds than equity.

- Undertakings' exposures in the form of covered bonds with high credit quality steps (0 or 1) are covered by a diversified pool of assets securing most of the bond's value in case of a default of the issuer. Where covered bonds cannot be assigned to a high credit quality step (0 or 1) a higher concentration threshold is assumed to be not appropriate.

- A higher excess exposure threshold is assumed appropriate for captives in the concentration risk module, due to the fact that for captives the insured entities are part of the same group owning the captive. The concentration risk referring to the amounts between the two thresholds (i.e. 3% or 1,5% versus 15%) is entirely mitigated by the existence of explicit or implicit intragroup compensation mechanisms. Even without formal compensation mechanisms, the group (the owner and simultaneously insured party) has an interest in supporting the captive in case of financial or other problems of the captive.

The scope of the market risk concentration risk sub-module covers assets considered in the equity, interest rate, spread and property risk sub-modules within the market risk module, but excludes assets covered by the counterparty default risk module in order to avoid any overlap between both elements of the standard calculation of the SCR.

The risk dealt with in the market risk concentration risk sub-module is restricted to the risk regarding the accumulation of exposure with the same counterparty i (denoted with E_i). It does not include other types of concentration risk, such as geographical or sector concentrations of the assets held. The calculation is performed in three steps: (a) determination of excess exposure XS_i, (b) calculation of risk concentration capital charge per 'name', (c) aggregation across single names.

The underlying assumption in the market risk concentration risk sub-module is that when the undertaking is above the specified excess exposure thresholds, the undertaking is at risk in case a single name counterparty defaults and a capital requirement is determined, and when the undertaking is below the specified thresholds, the undertaking is not at risk, and no capital requirement for concentration risk is determined.

The calibration of the market risk concentration risk sub-module is based on simple evidence: the risk (volatility- VaR) of an undiversified portfolio is higher than for a well- diversified basket of investments. The calibration process for concentration risk was based on the comparison of the historical VaR of a well-diversified portfolio with the VaR of a set of portfolios where one single concrete exposure was increased step by step by 1 per cent, i.e. an initially well-diversified portfolio was progressively transformed into a badly diversified portfolio.

In each step the initial VaR of the well-diversified portfolio was compared to the VaR of the progressively more concentrated portfolio. The increase of VaR was mapped as a function of the level of the concentration in the portfolio. For each exposure ('name' i) a regression line was fitted through the data points. The parameters that were estimated from the fitted functions, delivered the calibration parameters g_i, per 'name' i.

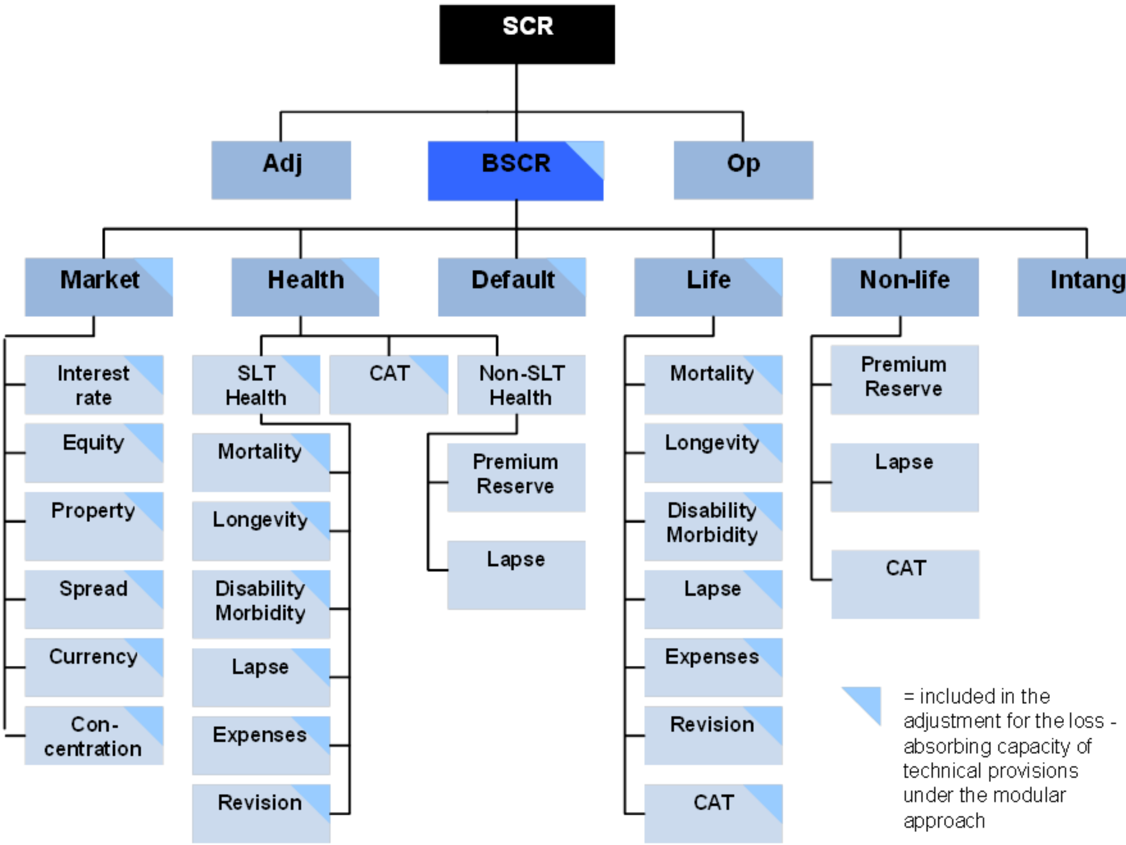
The starting portfolio was designed as a portfolio with an investment mix that is assumed to be representative of an EU average undertakings' portfolio of investments. The mix proposed was 80% of bonds - 20% of equities. Undertakings should rely on the assumption that the mix is representative of an EU average portfolio of investments.

Within each of these two groups, a sector-distribution of investments was built, according to an EU expected average: 25 % of total portfolio was deemed to be invested in bonds issued by central governments of Member States, and 55% in corporate bonds of different sectors and ratings.[11] To obtain a sufficiently numerous and well-diversified portfolio, additional names were added.

Simplified calculations that are specifically available to captive insurance and reinsurance undertakings are considered to be proportionate to the nature, scale and complexity of the risks they face. For market risk concentration the underlying assumption of the higher excess exposure threshold for captives is that, due to the fact that for captives the insured entities are part of the same group owning the captive, the concentration risk referring to the amounts between the two thresholds (i.e. 1% or 3% versus 15%) is entirely mitigated by the existence of explicit or implicit intragroup compensation mechanisms. Even without formal compensation mechanisms, the group entity has an economic interest in supporting the captive in case of financial or other difficulties of the latter.

[11] Equity portfolio: To the extent that this exercise assumes as starting point a well-diversified portfolio, consequently it should be based on a sufficiently representative and well-known equity index. In a first instance the selected names were those belonging to the Eurostoxx 50 index, and the period used to record data of prices, ranged from 1993 until 2009. However, the assessment of the historical vector of prices for each equity revealed that for a number of elements of the index the records of price data are only available for a significantly shorter period than that mentioned or are not homogeneous.
Bond portfolio: Bonds used in the computation were notional bonds, all of them issued at a 5% rate and pending 5 years to maturity. Throughout the simulation each bond maintained these features.

3. Life underwriting risk



The underlying assumptions for the Life underwriting risk module can be summarised as follows:

- The calibration of the Life underwriting risk parameters captures changes in the level and trend of the parameter. It is assumed that the volatility risk component is implicitly covered by the level, trend and catastrophe risk components. This is considered to be acceptable, since volatility risk is thought to be considerably lower than the trend risk.
- The dependence of benefit payments on inflation is not material.
- The insurance portfolios is well-diversified with respect to: age, gender, smoker status, socio- economic class, level of life insurance cover, type of insurance cover, degree of underwriting applied at inception of the cover and geographical location.

The calibration of the life underwriting parameters captures changes in the level and trend of the parameters only. It is assumed that the volatility risk component is implicitly covered by the level, trend and catastrophe risk components. This is considered to be acceptable, since volatility risk is thought to be considerably lower than the trend risk.

For the life underwriting risk module it should be assumed that the dependence of benefit payments on inflation is not material.

An underlying assumption in the life underwriting risk module is the diversification in the insurance portfolios. The reference population underlying all calibration work is an insured population that is well diversified with respect to:

- age
- gender
- smoker status
- socio- economic class
- level of life insurance cover
- type of insurance cover
- degree of underwriting applied at inception of the cover
- geographic location

Therefore, one example of deviations from the assumptions underlying the standard formula calculation would be an insurance portfolio with a higher than average level of concentration in on or more risk factors (e.g. death protections are sold to a high number of impaired lives, for instance due to poor underwriting or adverse selection). Also a niche player is likely to have a materially different risk exposure than the one reflected in the calibration of the standard formula.

Underwriting risk can affect undertakings liabilities as well as its assets. The scope of the life underwriting risk module is therefore not confined to the liabilities. Undertakings can have indirect underwriting exposures, like exposure to catastrophe bonds and longevity bonds.

It is important to point out that the calibration of the life underwriting risk stress factors are considered to be in line with the 99,5% VaR and a one-year time horizon.

For mortality, longevity, disability-morbidity, expenses and revision risk, the calibration regarded of great importance a study by Watson Wyatt, published in 2004.[12] The study analysed the 99.5% assumptions over a 12 month time horizon that firms were proposing to make for their Individual Capital Assessments (ICAS) submissions in the UK.

[12] For more information about the Watson Wyatt study see https://eiopa.europa.eu/fileadmin/tx_dam/files/consultations/QIS/QIS3/QIS3CalibrationPapers.pdf under life underwriting risk.

3.1 Mortality

The stress factor for mortality risk reflects the uncertainty in mortality parameters as a result of mis-estimation and/or changes in the level, trend and volatility of mortality rates and captures the risk that more policyholders than anticipated die during the policy term.

The underlying assumptions for the mortality risk sub-module can be summarised as follows:

- The undertaking has established a system to restrict adverse selection.
- The probability distribution for mortality is skewed, with a current trend towards improving mortality.
- For the simplified calculation of the capital requirement for mortality risk it is assumed that there is no material decrease in the respective sum of capital at risk in the next n years, where n is the modified duration (in years) of payments payable on death included in the best estimate projection. It is furthermore assumed, that the average mortality rate of the insured persons (weighted by sum insured) will not increase materially over the next n years.

The capital charge for mortality risk is intended to reflect the uncertainty in mortality parameters, stemming from:

- changes in the level, trend and volatility of mortality rates;
- possible mis-estimation of the mortality rates used when calculation technical provisions

and therefore to capture the risk that more policyholders than anticipated die during the policy term.

The mortality risk sub- module is applicable for (re)insurance obligations contingent on mortality risk i.e. where the amount currently payable on death exceeds the technical provisions held and, as a result, an increase in mortality rates leads to an increase in the technical provisions. The risk is normally captured by increasing the mortality rates either by a fixed amount or by a proportion of the base mortality rates.

An underlying assumption in the mortality risk sub- module is that the probability distribution for mortality is skewed, with a current trend towards improving mortality.

A simplified calculation for mortality risk is available for undertakings, where it is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumption for the simplified calculation of the capital requirement for mortality risk is that there is no material decrease in the respective sum of capital at risk in the next n years, where n is the modified duration (in years) of payments payable on death included in the best estimate projection. It is furthermore assumed, that the average mortality rate of the insured persons (weighted by sum insured) will not increase materially over the next n years.

3.2 Longevity

The stress factor for longevity risk is intended to reflect the uncertainty in mortality parameters as a result of mis-estimation and/or changes in the level, trend and volatility of mortality rates and captures the risk of policyholders living longer than anticipated.

The underlying assumptions for the longevity risk sub-module can be summarised as follows:

- The annual mortality improvements follow a normal distribution.
- For the simplified calculation of the capital requirement for longevity risk it is assumed that the average age of policyholders within the portfolio is 60 years or more.
- It is furthermore assumed that the average mortality rate of the respective insured persons does not increase by more than 10% each year.

The capital charge for longevity risk is intended to reflect the uncertainty in mortality parameters as a result of mis-estimation and/or changes in the level, trend and volatility of mortality rates and to capture the risk of policyholders living longer than anticipated. It is applicable for (re)insurance obligations contingent on longevity risk i.e. where there is no death benefit or the amount currently payable on death is less than the technical provisions held and, as a result, a decrease in mortality rates is likely to lead to an increase in the technical provisions.

The Watson Wyatt study indicated a single uniform permanent decrease in mortality rates between 5% and 35%, with an average decrease around 18%. Feedback from internal model firms indicated that the median stress for the decrease in mortality rates used was 25%.
Furthermore, a calibration exercise was performed, where the mortality data for nine countries[13] was analysed; both historic data and stochastically projected[14] future mortality improvements of the mortality rates were considered.

From the historical data the mean and the standard deviation of annual unisex mortality improvements were assessed separately for each age group for the years 1992-2006. The improvements in mortality rates over this past 15 years can be seen to be higher than 25% for almost all age groups.

[13] Data is available at www.mortality.org.
[14] The model was similar to the stochastic model presented by Towers Perrin to the UNESPA: UNESPA Longevity Risk Investigation, Towers Perrin, 21 January 2009.

Based on the assumption that the annual mortality improvements follow a normal distribution[15], stochastically simulated future mortality rates were produced. Instead of assuming an improvement of x% per annum, the shock was calibrated as an equivalent one-off shock (a permanent change in mortality rates for each age). However, the result of the stochastic model of future mortality improvements implied a lower stress than the 25 % as derived from historical data.

A simplified calculation for longevity risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumption for the simplified calculation of the capital requirement for longevity risk is that the average age of policyholders within the portfolio is 60 years or more. It is furthermore assumed, that the average mortality rate of the respective insured persons does not increase by more than 10% each year.

3.3 Disability-morbidity risk

The stress factors for disability-morbidity risk reflect the risk that more policyholders than anticipated become disabled or sick during the policy term (inception risk), and that disabled people recover less than expected (recovery risk).

The underlying assumptions for the disability-morbidity risk sub-module can be summarised as follows:

- The insurance portfolio is well diversified in terms of likelihood of disability or sickness (inception rates) or change in the severity of disability or sickness (recovery rate).
- For the simplified calculation of the capital requirement for disability-morbidity risk it is assumed that there is no material decrease in the respective sum of capital at risk in the next n-1 years after the following year, where n is the modified duration (in years) of payments payable on disability-morbidity included in the best estimate projection. It is furthermore assumed, that the expected average disability-morbidity rate of insured persons (weighted by the sum insured) will not increase materially during that period. Finally, it is also assumed that the expected average disability-morbidity rate and the expected termination rates do not increase by more than 10% each year.

The capital requirement for disability-morbidity risk is intended to capture the risk that more policyholders than anticipated become disabled or sick during the policy term (inception risk), and that disabled people recover less than expected (recovery risk). An underlying assumption in the disability- morbidity risk sub-module is that the

[15] This assumption was verified in the Towers Perrin paper.

insurance portfolio is well diversified in terms of likelihood of disability or sickness (inception rates) or change in the severity of disability or sickness (recovery rate).

A simplified calculation for disability-morbidity risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumption for the simplified calculation of the capital requirement for disability-morbidity risk is that there is no material decrease in the respective sum of capital at risk in the next n-1 years after the following year, where n is the modified duration (in years) of payments payable on disability-morbidity included in the best estimate projection. It is furthermore assumed, that the expected average disability-morbidity rate of insured persons (weighted by the sum insured) will not increase materially during that period. Finally, it is also assumed that the expected average disability-morbidity rate and the expected termination rates do not increase by more than 10% each year. The design of the disability-morbidity risk sub-module is a combination of the approaches for mortality and longevity risks. The assumptions regarding disability-morbidity parameters are therefore also a combination of the assumptions for the other two sub-modules.

Inception and recovery rates

The stress factors for the inception rates were based on several studies. The Watson Wyatt study indicated an increase of disability/morbidity inception rates between 10% and 60%, with an average increase of around 40%.

In addition an investigation by the Swedish Financial Supervisory Authority was performed. This study indicated that an increase of 50% in morbidity/disability inception rates for the first year would be appropriate. The results also suggested that the appropriate calibration of the decrease in morbidity/disability recovery rates would be 20%.

The total recovery rate has been estimated from the proportion of provisions released as a result of recovery for a number of companies over 6 years (2002-2007). Based on these estimates, it was prescribed that the recovery rate stress should be a 20% decrease.

3.4 Expenses

The underlying assumptions for the expense risk sub-module can be summarised as follows:

- Undertakings are exposed to the risk of the change of expenses arising predominantly from: staff costs, cost of commissions to sales intermediaries (on the basis of the contractual terms of the arrangements), cost of IT infrastructure, cost of land and buildings occupied.

- The undertaking operates in a macroeconomic environment where inflation, though subject to fluctuations, is broadly under control (i.e. inflation targeting).
- For the simplified calculation of the capital requirement for expense risk it is assumed that there is no material increase due to other sources than inflation in the expenses incurred in servicing life insurance obligations, and where the projected cash-flows follow a certain pattern.

Expense risk arises from the variation in the expenses incurred in servicing insurance or reinsurance contracts. It is likely to be applicable for all insurance obligations.

The model undertakings underlying the calibration are subject to expenses arising predominantly from:

- staff costs
- cost of commissions to sales intermediaries (on the basis of the contractual terms of the arrangements)
- cost of IT infrastructure
- cost of land and buildings occupied

The Watson Wyatt study from 2004 indicated a potential increase in the level of expenses between 5% and 50%, with an average increase of around 26%.

Later ICAS submissions in the UK showed an increase of around 10% in the level of expenses in the following year, together with an increase of between 1% and 2 % per annum in the rate of future expense inflation.

The expense inflation assumption is based on a macro economy in which inflation, though subject to fluctuations, is broadly under control (i.e. inflation targeting).

Based on these studies, it was decided that the stresses should be based on an increase of 10% in future expenses compared to the best estimate anticipations and an increase of 1% per annum of the expense inflation rate compared to anticipations.

A simplified calculation for expense risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumption for the simplified calculation of the capital requirement for expense risk is that there is no material increase due to other sources than inflation in the expenses incurred in servicing life insurance obligations other than health insurance in the next n years, where n is the modified duration (in years) of expenses included in the best estimate projection. Moreover, the simplified calculation is applicable only insofar as the future expenses follow a certain pattern.

3.5 Revision risk

The underlying assumptions for the revision risk sub-module can be summarised as follows:

- All annuities are independent and their annual amount is assumed to be constant.
- The average sized portfolio comprising annuities at different legal stages is in 'average' proportions.

Revision risk is intended to capture the risk of adverse variation of an annuity's amount, as a result of an unanticipated revision of the claim process. This risk should only be applied to annuities and to those benefits that can be approximated by a life annuity arising from non-life claims, including accident insurance, but excluding workers compensation that are allocated to the life underwriting risk module.

The calibration for revision risk was based on historical data for pensions in payment for the workers' compensation line of business in Portugal.

In the analysis a binomial compound distribution was fitted to the historical data, assuming a binomial distribution for the frequency process and a lognormal distribution to model the severity of revision. The aggregate loss distribution was derived using Monte Carlo simulation for different portfolio sizes. All annuities were assumed to be independent and their annual amount was assumed to be constant. Different assumptions were considered for annuities homologated and annuities not yet defined; the latter with higher frequency and severity volatilities.

Revision risk is calculated assuming an increase of 3% in the annual amount payable for annuities exposed to revision risk. The 3% scenario corresponds to the 99.5% quantile of the aggregate loss distribution for an average sized portfolio comprising annuities at different legal stages in 'average' proportions.

3.6 Lapse risk

The lapse risk sub-module captures the adverse change in the value of insurance liabilities, resulting from changes in the level or volatility of the rates of policy lapses, terminations, renewals, and surrenders.

The underlying assumptions for the lapse risk sub-module can be summarised as follows:

- The increase and the decrease of lapse rates, is a symmetrical stress for the scenarios of increase and decrease of lapse rates (not the mass lapse event).
- The risk relating to the options that a ceding insurance or reinsurance undertaking of a reinsurance contract can exercise is not material.

- A split between insurance policies falling or not within the scope of management of group pension funds in the mass lapse event shock is assumed appropriate. This is due to the fact that for management of group pension funds, the risk of a mass lapse is deemed to be substantially greater because there are generally no surrender penalties, and institutional investors tend to be better informed and therefore would be quick to withdraw funds if there was any question over the solvency of a firm.
- For the simplified calculation of the capital requirement for life lapse risk the following is assumed: the simplified calculation is done at an appropriate granularity, such that the group of policies to which the method is applied is homogeneous in terms of lapse rate; the lapse rates are not significantly sensitive to trends in economic variables; the lapse rates do not vary significantly with the age of the policyholder; and the capital requirement for life lapse risk determined with the simplification is not material compared to the overall capital requirement.

The lapse risk sub- module should capture the adverse change in the value of insurance liabilities, resulting from changes in the level or volatility of the rates of policy lapses, terminations, renewals, and surrenders. The capital requirement for lapse risk is the maximum of the capital requirement in one of the following scenarios: a permanent increase of lapse rates, a permanent decrease of lapse rates, and the mass lapse event.

Increase and decrease of lapse rate

The calibration of the shock of the decrease of lapse rates was based on a study of the UK with-profit life insurance market in 2003 performed by order of the British FSA[16]. The study does not cover the risk of a permanent increase of lapse rates; however, it was deemed appropriate to assume a symmetrical stress for both scenarios.

In addition to the above mentioned study, further evidence was studied from other markets. An analysis of the Polish supervisors on their national life insurance market shows that the 99.5% quantile of annual lapse rates deviates from the long-term mean by 60% to 100% for increases and by -60% to -90% for decreases. As these values are based on an annual deviation, they over-estimate the shock of a permanent change.

A simplified calculation for lapse risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation of the capital requirement for lapse risk are the following: the simplified calculation is done at an appropriate granularity, such that the group of policies to which the method is applied

[16] Financial Services Authority "Calibration of the Enhanced Capital Requirement for with-profits life insurers" 2004, http://www.fsa.gov.uk/pubs/policy/04_16/ww_report.pdf

is homogeneous in terms of lapse rate; the lapse rates are not significantly sensitive to trends in economic variables; the lapse rates do not vary significantly with the age of the policyholder; the capital requirement for life lapse risk determined with the simplification is not material compared to the overall capital requirement.

Mass lapse event

The empirical basis to calibrate the mass lapse event is scarce. It can be assumed that different types of life insurance policies are affected differently by mass lapse events: products with significant guarantees, like with-profit products, can show a higher persistency than products with low guarantees like many unit-linked policies. However, it was decided to discriminate only between insurance policies falling or not within the scope of management of group pension funds.

The underlying assumption behind this split is due to the fact that for management of group pension funds[17], the risk of a mass lapse is deemed to be substantially greater because there are generally no surrender penalties, and institutional investors tend to be better informed and therefore would be quick to withdraw funds if there was any question over the solvency of a firm.

3.7 Life catastrophe risk

The life catastrophe risk sub-module captures the risk stemming from extreme death events that are not sufficiently captured by the mortality risk sub- module.

The underlying assumptions for the life catastrophe risk sub-module can be summarised as follows:

- Life catastrophe risk is restricted to obligations that are contingent on mortality i.e. where an increase in mortality leads to an increase in technical provisions.
- The sub-module is assumed not to be applicable to obligations, such as annuities, where the increase in mortality leads to a reduction in technical provisions.
- For the simplified calculation of the capital requirement for catastrophe risk it is assumed that the capital at risk is an appropriate proxy for the instantaneous loss caused by the death of the person insured by the respective contract.

The life catastrophe risk stems from extreme death events that are not sufficiently captured by the mortality risk sub- module. Life catastrophe risks are one- time shocks from the extreme, adverse tail of the probability distribution that are not adequately represented by extrapolation from more common events and for which it is usually difficult to specify a loss value, and thus an amount of capital to hold. For example, a contagious disease process or a pandemic can affect many persons simultaneously, nullifying the usual assumption of independence among persons.

[17] As referred in article 2(3)(b)(iii) and (iv) of Directive 2009/138/EC.

The capital requirement for the life catastrophe risk sub-module should be calculated as an absolute increase in the rate of policyholders dying over the following year. The life catastrophe risk stress factor is restricted to obligations which are contingent on mortality i.e. where an increase in mortality leads to an increase in technical provisions.

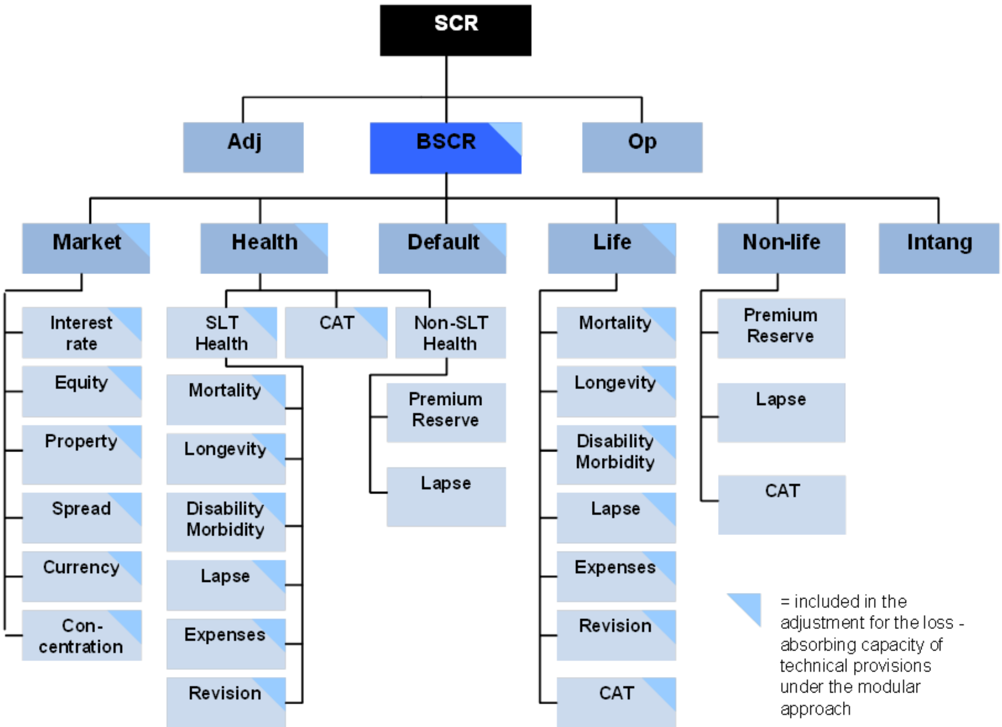
The life catastrophe risk sub- module is assumed not to be applicable to obligations, such as annuities, where the increase in mortality leads to a reduction in technical provisions. Although this seems to reflect the economic substance of insurance - allowing for the diversification between different lines of business –enough evidence suggests that this diversification benefit might not exist in reality. (In particular, historic data indicates that it is primarily young and healthy people that die as a result of influenza pandemics.)

The calibration of the mortality catastrophe stress is based on a study carried out by Swiss Re in 2007, which estimated that the 1 in 200 year pandemic stress for most developed countries is between 1.0 and 1.5 per mille within insured lives. This study was based on a sophisticated epidemiological model, but had a number of weaknesses (such as not adequately allowing for the probability of flu jumping across species, not allowing for non-influenza pandemics as AIDS, drug resistant TB and the Ebola virus, not allowing for catastrophe due to terrorism or earthquakes, and so on). If these weaknesses were addressed, it is likely that the estimated stress would increase.

In light of this, a mortality catastrophe stress of 1.5 per mille was proposed.

A simplified calculation for catastrophe risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumption for the simplified calculation of the capital requirement for catastrophe risk is that the capital at risk is an appropriate proxy for the instantaneous loss caused by the death of the person insured by the respective contract.

4. Non- Life underwriting risk



4.1 Non-Life Premium and reserve risk[18]

The non-life premium and reserve risk sub-module only takes into account losses that occur at a regular frequency. Extreme events, which occur very rarely, have not been taken into account when calibrating the premium and reserve risk factors. Such extreme events should be taken into account in the catastrophe risk sub-module. The capital requirement also takes into account risk associated with new business expected to be written in the following 12 months.

The underlying assumptions for the non-life premium and reserve risk sub-module can be summarized as follows:

- The risk of an accumulation of a large number of similar claims that are covered by third party liability insurance obligations is not material.
- The underlying risk follows a lognormal distribution.
- Complex relationships between different risks that could give rise to dependencies in the risk profile are implicitly taken into account in the correlation parameters between the segments, lines of business and between premium and reserve risk for each line of business.

[18] For more details on the calibration of premium and reserve risk factors, see the joint working group calibration paper: https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/reports/EIOPA-11-163-A-Report_JWG_on_NL_and_Health_non-SLT_Calibration.pdf. The report includes extensive annexes with detailed results of the various methodologies considered by the JWG to derive the final recommendations.

- The final factors are reflective of the average size and performance of the portfolios of insurers in the European market.
- Net earned premium can be used as a proxy for premium risk exposure.
- Net provisions for claims outstanding can be used as a proxy for reserve risk exposure.
- Expenses are not evolving independently or in an opposite way from the underlying risk over time.
- Non-proportional reinsurance reduces the premium risk volatility by 20% in the segments 1, 4 and 5. No reduction is allowed for other segments in case Undertaking Specific Parameters are not used.
- For the use of a simplified calculation of the capital requirement for non-life premium and reserve risk for captives it is assumed that the segmentation of insurance obligations by captives can be considered materially less diversified in terms of lines of business compared to the portfolio used in the calibration of the standard formula.
- In the design of the geographical diversification coefficient adjusting the volume measure for non-life premium and reserve risk, it is assumed that geographically diversified portfolios are diversified in respect of size and timing of losses which an insurance undertaking faces.

.

Premium risk is understood to relate to future claims arising during and after the period for the solvency assessment. The risk is that the expenses plus the volume of (covered but not incurred) losses for these claims (comprising both amounts paid during the period and (incurred but not settled) claim provisions made at its end) are higher than the premiums received. Premium risk is present at the time the policy is issued, before any events occur. Premium risk also arises because of uncertainties prior to issues of policies during the time horizon.

Reserve risk stems from two sources: on the one hand, the absolute level of the claims provisions could be mis-estimated. On the other hand the actual claims will fluctuate around their statistical mean value because of the stochastic nature of future claims payouts.

The premium and reserve risk sub-module only takes into account losses that occur at a regular frequency. Extreme events, which occur very rarely, have not been taken into account when calibrating the premium and reserve risk factors. Such extreme events should be taken into account in the catastrophe risk sub-modules.

As a matter of mathematical convenience the underlying risk can be viewed to follow a normal or lognormal distribution. This applies to premium as well as reserve risk.

It is important to note that some undertakings have specific risk characteristics of assets and liabilities, and the factor based approach to premium and reserve risk in non- life insurance only partially reflects the undertaking- specific profile of its non-life business (which is impacted e.g. by the specific type of products sold, or the sales policy of the undertaking).

The expected value of the combined ratio of the portfolio does not change substantially over time.

The expected value of run-off ratios of the portfolio does not change substantially over time.

The premium and reserve risk capital requirement is calculated based on a factor-based approach. Formula-based calculations are used for sub- modules where a scenario-based approach was not considered as the most appropriate. The formula based calculations allow capturing risks associated with new business expected to be written in the following 12 months. However, to take the effect of risk mitigation techniques into account is more difficult with a formula based calculation.

Complex relationships between different risks could also give rise to dependencies in the risk profile. The most obvious of these is the relationship between non-life underwriting risk and contingent credit risk. The circumstances that cause increased insurance losses, and therefore an increase in reinsurance recoveries, could in turn have a negative effect on the creditworthiness of the reinsurer. However, such complex relationships between premium and reserve risk and counterparty default risk or market risks have not been considered in the premium and reserve risk module. They are implicitly taken up in the correlation parameters between the risk modules.

$$3 \cdot \sigma V$$

σ denotes the combined standard deviation for premium and reserve risk and V denotes the total volume measure for premium and reserve risk. The volume measure V is equal to the sum of all volume measures for the different segments the undertaking is exposed to. Originally in the design of the SCR for non-life insurance underwriting risk, the lognormal probability distribution acted prominently as a vehicle to model a skew bell-shaped probability distribution. This implied a function of σ that should amount more or less to the value 3σ. Later on it was decided just to focus on this simple factor and downsizing the explicit assumption of an exact lognormal probability distribution.

The combined standard deviation is equal to the following:

$$\sigma = \frac{1}{V} \cdot \sqrt{\sum_{s,t} CorrS_{(s,t)} \cdot \sigma_s \cdot V_s \cdot \sigma_t \cdot V_t}$$

To calculate this combined standard deviation, the undertaking needs estimates for premium and reserve risk standard deviations for the particular LoBs the undertaking is exposed to and calculate the volume measures for each segment. For calculating the standard deviations for each LoB, the following formula applies:

$$\sigma_s = \frac{\sqrt{\sigma^2_{(prem,s)} \cdot V^2_{(prem,s)} + \sigma_{(prem,s)} \cdot V_{(prem,s)} \cdot \sigma_{(res,s)} \cdot V_{(res,s)} + \sigma^2_{(res,s)} \cdot V^2_{(res,s)}}}{V_{(prem,s)} + V_{(res,s)}}$$

In order to estimate the capital charge for the premium and reserve risk sub module, the following calibrated factors for the following inputs are needed:

- Standard deviations for premium risk *σ* (prem, LoB)
- Standard deviations for reserve risk *σ* (res, LoB)
- Correlation factors between lines of business

In the design of the geographical diversification coefficient adjusting the volume measures for non-life premium and reserve risk, it is also assumed that the regions represent an appropriate geographical division of the undertaking’s insurance portfolio in each line of business; i.e. it is assumed that an insurance portfolio of an undertaking with contracts across regions does not contain sub-portfolios split per region that in fact generate positively correlated losses. This situation can occur when the portfolios are located in few similar (in respect of type and time of losses) countries but assigned to different regions or when portfolios are locally concentrated around both sides of the border between two regions

4.1.1 The combined approach for setting premium and reserve risk factors

An underlying assumption in the premium and reserve risk module is that the final factors are reflective of the average size of the portfolios of insurers in the European markets.

In the calibration exercise two broad options emerged for setting premium and reserve risk factors:

- a pan- European approach; and an
- averaging approach

Under the pan- European approach, the factors are set on the basis of the pooled European data set. Under the averaging approach, in a first step factors are set at a regional (country) level. The final Europe- wide factor is then determined by averaging across the regional factors.

Based on these two approaches a combined approach was developed and used for calibrating premium and reserve risk factors. Under this combined approach the modeling focused on the efficient estimator of a pan- European volatility parameter. However, in order to more fully address the issue of heterogeneity between different markets, the methodology was applied at the level of an individual country. The intermediate output by country was then grouped by taking a weighted average also resulting in a single pan- European volatility. One could regard this as a kind of voting procedure where voting power is proportional with market share. This combined approach therefore offers the advantage of taking into account the heterogeneity of the non-life risks in the individual markets for the setting of the European factors. At the same time, it ensures that the final factors are reflective of the average size of the portfolios of insurers in the European markets to which they are applied.

For the calculation of a pan- European weighted average, this presented the difficulty that the standard portfolio sizes would typically differ between different countries. An approach which would average across unbiased estimates in individual countries based on such different portfolio sizes would lead to inconsistencies. To overcome this difficulty, the following two-step method was applied:

- In a first step, unbiased estimates per member state for a common European portfolio size- selected as the average portfolio size of all the undertakings in the sample across the countries- were calculated.
- The pan- European factor was then derived in a second step as a weighted average of these unbiased sigmas per individual country.

The following sections will provide a summary description of the methods that were applied in order to derive estimates of the premium and reserve risk factors. A more detailed description of these methods including the underlying statistical framework is contained in Annex 3 of the calibration report on premium and reserve risk factors.[19] This summary excludes the calibration of the factors for credit and suretyship reserve risk, assistance reserve risk and the non-proportional lines of business for which too few observations were available to draw statistically founded conclusions.

4.1.2 Premium risk

For premium risk undertakings submitted the following data split by LoB and accident year:

- Volume of earned premium for the accident year gross of acquisition costs

[19] See "Annex 3 - Manual on methods for calibration", p. 47 in Report of the Joint Working Group on Non-Life and Health NSLT Calibration, "Calibration of the Premium and Reserve Risk Factors in the Standard Formula of Solvency II", 12/12/2011, EIOPA-11-163-A:
https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/reports/EIOPA-11-163-A-Report_JWG_on_NL_and_Health_non-SLT_Calibration.pdf

- Acquisition costs/ earned commission
- Expense information, if available, comprising relevant Unallocated Loss Adjustment Expenses (ULAE) as well as other relevant paid expenses
- Information on the current estimate of ultimate loss[20] (henceforth referred to as CE ultimate loss data), comprising;

  - Paid claims up until 2009 for that accident year
  - QIS5 best estimate claims provisions (including IBNR) as at year end 2009

- Information on the ultimate loss as at the end of the first development year (henceforth referred to as YE ultimate loss data), comprising;

  - Paid claims in the first development year for that accident year
  - Best estimate claims provisions (including IBNR) posted at the end of the first development year

The undertakings were also asked to submit this set of data items separately for:

- raw data gross of reinsurance;
- adjusted data gross of reinsurance, excluding catastrophe loss; and
- adjusted data net of reinsurance, excluding catastrophe loss.

To obtain estimates of ultimate losses, two different concepts were considered: the year-end estimate (YE) and the current estimate of the ultimate losses (CE). In the end, a combined approach that maximizes the use of both loss concepts was used in the calibration exercise. This approach was seen to be in line with the observation that in most cases, the results obtained from the two different concepts were found to be comparable.

The calibration of the premium risk factors needed to be based on data gross of reinsurance (excluding catastrophe events). Although adjusted gross data was collected, its quality and quantity was insufficient compared to non- adjusted gross data. Therefore, a pragmatic approach was followed in order to quantify a "potential" catastrophe effect. The approach followed was to view the premium risk analysis results at the initial stage and examine the time series of loss ratios for each undertaking separately. When such time series showed a smooth flat or somewhat cyclic pattern this was viewed as evidence of a catastrophe-free experience for this undertaking. If on the other hand such a smooth pattern was distorted by a sudden upward outlying loss ratio (typically exceeding twice the neighboring level), this was viewed as an observation where the occurrence of a catastrophe was a real possibility. Removing such observations created in the end a new dataset for analysis in the standard way. Finally, by comparing the results arising from the cleaned data (which was the result of this pragmatic approach) and the risk factors arising from the

[20] Here "ultimate loss" denotes the estimated aggregate claims expenditure that will have to be paid to finally settle the claims for the accident year considered.

original gross (raw) database, it was possible to estimate a factor to adjust the gross volatility factors for catastrophe events. In the end, the final capital charge for premium risk needs to be on a net basis. Therefore, a gross to net adjustment is introduced a posteriori within the design of the standard formula of this capital charge. Thus, the calibration process did not take into account such adjustments.

In the calibration of premium risk gross earned premium adjusted for catastrophe events was used as a proxy for exposure. The mean of the aggregate year loss was modeled as being proportional to the volume of gross earned premiums where the proportionality factor was an undertaking-specific loss ratio parameter subject to statistical parameter estimation.

For the variance of the aggregate year loss a general quadratic expression in gross earned premiums was used. This formulation contains as special cases both the case where the variance is proportional to gross earned premiums and also the case where the variance is proportional to its square.

After the specification of the mean and variance, this was embedded into both a normal probability model as well as into a lognormal probability model. Therefore, two models were obtained to fit the data and to compare them as regards their goodness of fit. For more details about the parameter estimation, see annex 3 in the calibration report published by the Joint working group[21].

4.1.3 Reserve risk

For reserve risk undertakings submitted the following data split by LoB and accident year:

- triangles of paid claims;
- triangles of best estimate claims provisions; and
- reported triangles, if available

Undertakings were asked to submit this set of data items separately for:

- raw data gross of reinsurance;
- adjusted data gross of reinsurance, excluding catastrophe loss; and
- adjusted data net of reinsurance, excluding catastrophe loss.

[21] https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/reports/EIOPA-11-163-A-Report_JWG_on_NL_and_Health_non-SLT_Calibration.pdf.

When it comes to the selection of data for reserve risk, factors net of reinsurance needed to be calibrated. However, it was found that much fewer data net than gross of reinsurance was available in the individual lines of business, To achieve a more representative analysis, it was therefore decided to base the calibration on gross of reinsurance data, and to apply a separate "gross-to-net" factor to derive an estimate of the standard deviation net of reinsurance.[22] This gross to net adjustment is introduced a posteriori within the design of the standard formula of this capital charge. Thus, the calibration process does not take into account such adjustment.

For reserve risk two different model approaches were considered:

- A model approach based on financial year end data under which the premium risk methodology was applied in an analogous way to reserve risk (hereafter referred to as premium risk type methods); and
- A model approach based on runoff triangle accident year data (will not be described in this report since this model approach was not used for the final calibration).

Premium risk type methods applied for reserve risk

Based on financial year-end data, reserve risk was modeled completely analogous to the methods described for premium risk. This is possible by using claims provisions instead of premiums as volume measure, and by considering aggregate loss as the run-off losses incurred in a financial year t for accidents years less than t. Such an approach enables the application of a single and consistent methodology across both premium and reserve risk.

After a preliminary analysis, it was decided that where the premium risk tool was used, the undertaking- specific runoff ratio parameters should be assumed to be subject to parameter estimation. It was found that such an assumption would better fit the data than an assumption under which these were fixed at the value of 1.

Probability distribution assumptions

For the premium risk analysis as well as for the reserve risk analysis based on premium risk type methods, models based on the assumption of a normal probability distribution for the underlying data (normal models) and also models based on the assumption of a lognormal probability distribution for the underlying data (lognormal models) were used. It is difficult to discriminate on theoretical grounds between the normal and log-normal probability distribution. The findings on this issue- for example, with regards to the various goodness-of-fit diagnostics and PP-plots- were also inconclusive.

[22] See also section 6.5 in the final calibration report for a more detailed exploration of this issue.

Recognition of size variations in recommended factors

The volatility factors for premium and reserve risks are typically impacted by the size of the portfolio (in the sense that with increasing size the volatility will typically decrease). In the analysis, a curvature parameter modeling the decrease of volatility with size was estimated and the calibration process was then pursued using the average portfolio size of undertakings in the sample. If no adjustment were introduced in order to correct a potential mismatch between the average size or portfolios in the sample and the average size of the portfolios in the market, the volatility factors produced would likely be underestimated if the average size of the sample is above the average market size, or overestimated in the opposite situation. This issue was solved by applying a corrective factor to obtain a calibration appropriate for the median portfolio size at market level.

4.2 Non-Life lapse risk

For non-life lapse risk it is assumed that either relevant option exercise rates are not used in the calculation of technical provisions for non-life obligations or, where they are used in the calculation, changes of the relevant option exercise rates used in the calculation of technical provisions would not have a material impact on the value of technical provisions.

For non-life lapse risk it is assumed that either relevant option exercise rates are not used in the calculation of technical provisions for non-life obligations or, where they are used in the calculation, changes of the relevant option exercise rates used in the calculation of technical provisions would not have a material impact on the value of technical provisions. The design of this module is therefore different from the design for life lapse Risk. The module does not cover a change of lapse rates used in the calculation of technical provisions like the lapse-up and lapse-down scenario in life underwriting risk. The capital charge for non-life lapse risk is instead calculated in a way that it would cover a loss in basic own funds that would result from a discontinuance of 40% of the policies where the discontinuance would result in an increase in technical provisions without risk margin. Undertakings that write furthermore reinsurance have to calculate a capital charge for policies that cover business to be written in the future in a way that the capital charge would cover a loss in basic own funds that would result from a decrease of 40% in the number of those future contracts used in the calculation of technical provisions.

4.3 Non-Life catastrophe risk

The non-life catastrophe risk sub-module is essentially split into three separate and independent sub-sub-modules that cover catastrophe risk related to natural perils, risk related to man-made events and other catastrophe events.

4.3.1 Natural catastrophe risk

The underlying assumptions for the natural catastrophe risk sub-module can be summarized as follows:

- The calibration of the natural catastrophe risk sub-module is based on "average" conditions for any given country-peril combination. It is assumed that the undertaking's non- life insurance portfolio is not focused on residential, commercial, industrial or agricultural.

- There is an underlying assumption of an average vulnerability per peril-country combination, as well as an average deductible and an insured to value relationship.

- The scenario based approach for the natural catastrophe risk sub-module assumes that the portfolio of the financial statement date is representative for the whole year. In the design of the geographical diversification coefficient adjusting the volume measure for non-life premium and reserve risk, it is assumed that geographically diversified portfolios are diversified in respect of the type and time of losses which an insurance undertaking faces.

- In the design of the geographical diversification coefficient adjusting the volume measure for natural catastrophe risk (windstorm, earthquake, flood, hail and non-proportional property reinsurance), it is assumed that geographically diversified portfolios are diversified in respect of the type and time of losses which an insurance undertaking faces.

- In the design of the geographical diversification coefficient adjusting the volume measures for natural catastrophe risk (windstorm, earthquake, flood, hail and non-proportional property reinsurance), it is also assumed that the regions represent an appropriate geographical division of the undertakings insurance portfolio in each line of business; i.e. it is assumed that an insurance portfolio of an undertaking with contracts in different regions does not contain sub-portfolios split per region that in fact generate positively correlated losses. This situation can take place when the portfolios are located in few similar (in respect of type and time of losses) countries but assigned to different regions or when portfolios are locally concentrated around both sides of the border between two regions.

The natural catastrophe risk sub-module is based on a consistent, comprehensive, risk commensurate and fair approach to account for all possible **natural perils**. This had to apply across all countries and perils, as well as for all types of insurers. All member states of the European Economic Area (the European Union, Iceland, Lichtenstein and Norway) plus Switzerland were in scope.

Every significant natural peril should be covered; earthquake, flood, hail, subsidence, and windstorm (winter storm). Exposures and perils outside the European Economic Area and Switzerland were not in scope, apart from the French Dom Toms. The calibration is based on known geographic distributions of natural hazard risk, and that accounts for variability in building stock and damageability, rather than one which relies on "what-if" scenarios – e.g. what if a major windstorm strikes Paris, which would not capture the risk that exists in others parts of the country.

Probabilistic cat models are the most widely used tool to perform the calibration. However, probabilistic catastrophe risk models are not available for all the perils and countries in scope. In addition, several decades of scarce loss experience are not sufficient to calibrate a one in two hundred year loss level for any natural peril. Hence, in an attempt to ensure consistency and risk adequacy much of the calibration assumptions were based on expert judgment and scenario-based approaches were chosen. These do not take into account insurance written in the following 12 months.

Country Factors

The country factors represent the per-occurrence 99.5% loss for that peril in the country under consideration, as a ratio of the total sums insured in the country. This can be represented as the one in two hundred years per occurrence PML (Probable Maximum Loss) percentage. For each peril best estimates of each country's 1/200 year per occurrence PML were provided. Expert judgment was used to identify outliers and obtain consensus on the outcome. It was assumed that a peril is not significant for a given country, if its estimated country factor was less than 1/15 of the largest peril-specific factor for that country.

Country & Peril Correlations

The matrices for the correlations between perils and between countries were also derived using an iterative discussion process using expert judgment.

Annual Aggregate vs. per Occurrence

The same procedure was used as for the country factors. Estimates of the ratio of the 1 in 200 year annual aggregate loss to the 1/200 year per occurrence loss for each peril were provided. A consensus on how to distribute the 1/200 year aggregate loss between two occurrences for each peril was based on expert judgment.

Zonal Relativities and Correlations

The zonal relativities are proportional to the 1 in 200 year loss of each zone, and the aggregation matrices reflect the correlation between zones at the 1 in 200 year loss level. The calculation and calibration of these relativities were derived using several underlying, stochastic event-based catastrophe risk models and an assumption about the relative distribution between the zones of the total sums insured within the country. While the methodology was consistent, not all countries and perils benefitted from the same level of detailed model treatment. It should be noted that the zonal relativities and correlations only become relevant to the extent that the geographic distribution of an undertaking's exposures deviate from the industry average distribution assumed in the calibration.

4.3.2 Man-made catastrophe risk

The underlying assumptions for the man-made catastrophe risk sub-module can be summarized as follows:

- The calibration factors for man-made catastrophe risk are likely to be understated, compared to the risk for an individual undertaking. Countering this, the market represented by the data is likely to have a mix of business that is likely to be higher risk (larger sized risks and risks that are inherently more exposed to risk of loss) than the typical EU undertaking. Hence the factors calculated could overstate the 1 in 200 loss for undertakings writing only small limits and/or risks with low inherent exposure to liability losses. It is assumed that the overestimation/underestimation of the factors cancel each other out.
- For motor third party liability the fundamental assumption used is that the number of vehicles insured is the best measure of exposure. The resulting loss is extrapolated down to a 1-in-200 year level using a Pareto assumption and allowance is made for policy limits common in some countries. The main implicit assumption is that the number of vehicles insured is a good measure of frequency of extreme loss – i.e. all vehicles are equally likely to cause a major loss, or all undertakings have a similar mix of vehicle types.
- While for fire risk (fire, explosion and acts of terror) explosion or acts of terrorism can trigger general liability insurance coverage losses, the general liability line of business is assumed not to be considered in the fire sub-module.
- It is assumed that for third party liability insurance the risk of an accumulation of a large number of similar claims is not material.

For **man-made catastrophe risk** an event scenario based approach is assumed to be less appropriate for the following reasons:

- to cover the range of insurances falling into the liability category, a lengthy list of scenarios would need to be specified;
- liability scenarios are more varied and less predictable in their nature than natural catastrophe losses, so specifying a list of scenarios that represent current and potential concerns at a particular moment in time runs the risk of missing out the scenario behind the next actual major event; and
- an undertaking with material potential liability catastrophe risk, but not in an area picked up by any of the listed scenarios would not be subject to a capital charge.

Instead the chosen approach is to derive a factor to apply to premiums that represents the additional loss from a 1 in 200 liability catastrophe.

Calibration for man-made catastrophe risk

The calibration for man-made catastrophe risk was based on industry data. It was assumed that the 1 in 200 year factor would vary between different types of liability cover, and therefore a split of the liability category into a small number of subsets of a less heterogeneous nature is appropriate. The industry data allows an estimation of a factor for each subset. The factor was calculated as the 1 in 200 year loss for the subset less the expected loss for that subset based on the industry data, expressed as a percentage of the corresponding insurance premiums for that subset.

As the industry data covered a large and geographically diverse market the resulting 1 in 200 factors were felt to already incorporate geographical diversification, so no country level aggregation matrices would be required. However, the factors are likely to be understated, compared to the risk for an individual undertaking.

Countering this, the market represented by the data is likely to have a mix of business that is likely to be higher risk (larger sized risks and risks that are inherently more exposed to risk of loss) than the typical EU undertaking. Hence the factors calculated could overstate the 1 in 200 loss for undertakings writing only small limits and/or risks with low inherent exposure to liability losses. It was assumed that the overestimation/underestimation of the factors cancel each other out.

For **motor third party liability** coverage the scenario works on the principle of allocating a pan-Europe extreme market loss assumption across undertakings. With the concern being primarily a large loss from an individual risk, as opposed to accumulation loss of many individual risks in the same event, the 'allocation' is based not on severity but on frequency. The fundamental assumption used here was that, within the constraints of a standardized scenario harmonized across Europe, the number of vehicles insured is the best measure of exposure. The resulting loss is extrapolated down to a 1-in-200 year level using a Pareto assumption and allowance is made for policy limits common in some countries. The main implicit assumption is that the number of vehicles insured is a good measure of frequency of extreme loss. – i.e. all vehicles are equally likely to cause a major loss, or all undertakings have a similar mix of vehicle types.
Relevant exaples where the assumptions may not be made are–

- Vehicles operating "air-side" at airports are much more likely to cause a major loss than other vehicles.
- Younger & less experience drivers (especially male) are generally higher risk than other drivers.
- Fleet vehicles (where the driver of the car is not the owner) are usually higher risk

- Commercial vehicles are often driven for long hours and might carry inflammable cargo. This is a particular concern in some of the situations this scenario is intended to cover (tunnel fire and football team coach)
- Mopeds are generally driven slower and over much shorter distances than cars. Although they can exhibit a high frequency of loss, these tend to be smaller than average.

To the extent that an undertaking's portfolio varies from the average mix implicit in the assumptions, the standardized scenario can deviate either way from the intended 1-in-200 year loss.

The approach to account for **fire risk** (fire, explosion and acts of terror) under the catastrophe risk sub-module in the standard formula draws upon the measure of a maximum probable loss (100% damage ratio) for the total sum insured of the largest known concentration of exposures under the Fire and Other Damage line of business in a 200 meter radius.

The concentration is intended to cover, for example, damage in the vicinity of industrial facilities (which could also impact residential, commercial or other industrial risks).

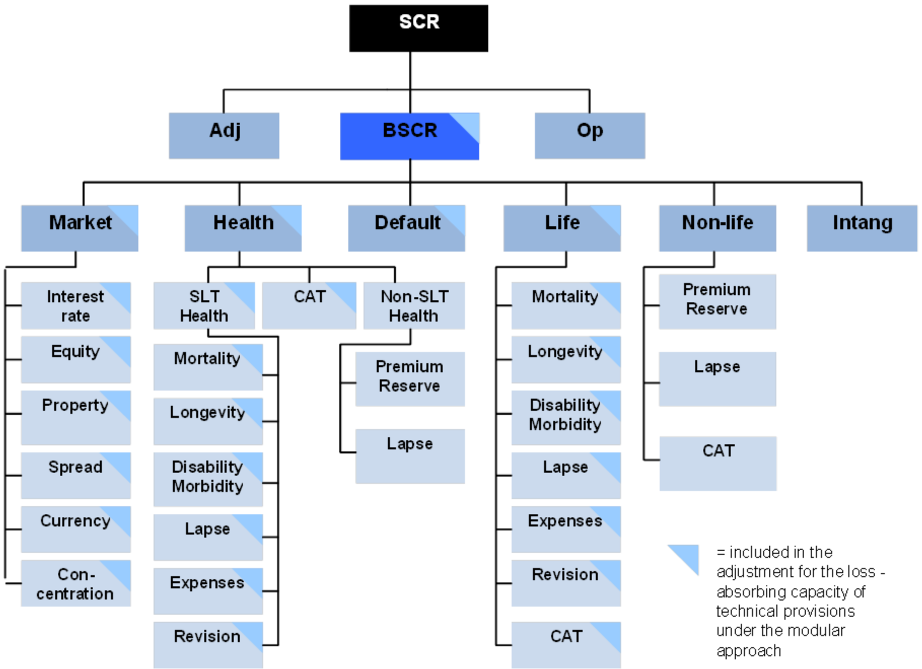
While other methods have been considered (e.g. damage ratios on the overall undertaking portfolio), the current methodology is the only one that provides a sense for risk concentration, which is a key element for fire, explosion and acts of terror risk factors.

The scope of the fire sub-module is relevant for all exposures from the Fire and other damage to Property insurance line of business present in the undertaking's portfolio (not limited to EEA countries). While fire, explosion or acts of terrorism can trigger general liability insurance coverage losses, the general liability LoB is assumed not to be considered in the fire sub-module.

The fire risk concentration scenario loss considers 100% damage on the total sum insured of all buildings located partly or fully within a 200m radius.

No distinction for risk types or coverage type is being made: residential, commercial and industrial risks covering building, contents and time elements are being considered similarly both for exposure accumulation and damage ratio.
The scenario applies to insurance as well as to proportional and non-proportional reinsurance coverage. While the relative weighting of coverage will vary from policy to policy, the damage ratio factor of 100% is to be applied to the total exposure in the 200 meters radius. The choice of the 200 m radius as a measure for concentration is the result of loss statistics and expert judgment.

5. Health underwriting risk



The underlying assumptions for the health underwriting risk module can be summarised as follows:

- It is assumed that the volatility risk component is implicitly covered by the level, trend and catastrophe risk components. This is considered to be acceptable, since volatility risk is thought to be considerably lower than the trend risk.
- The design of the health underwriting risk module has been kept simple by including only the level, trend and catastrophe risk components.
- The underlying assumptions for the SLT Health underwriting risk module as well as for the SLT Health underwriting risk simplified calculations are assumed to be the same as for the life underwriting risk module, with the exception of disability risk for medical expense insurance, SLT Health lapse risk, SLT Health revision risk and the health catastrophe risk modules.
- The underlying assumptions in the Non-SLT Health underwriting risk module are the same as for the non-life underwriting risk module, with the exception of the health catastrophe risk module.

The health underwriting risk sub-module is split into 3 sub-modules, according to the technical basis of the health insurance obligations:

- Health (re)insurance obligations pursued on a similar technical basis to that of life insurance (**SLT Health**)

- Health (re)insurance obligations pursued on a similar technical basis to that of non-life insurance (**Non-SLT Health**).
- Health (re)insurance obligations exposed to catastrophe risk (**Health CAT**)

The calibration of the health underwriting risk parameters should capture changes in the level, trend and volatility of the parameter. However for the sake of simplicity it has been decided to keep the design of the health underwriting risk module simple by including only the level, trend and catastrophe risk components. It is assumed that the volatility risk component is implicitly covered by the level, trend and catastrophe risk components. This is considered to be acceptable, since volatility risk is thought to be considerably lower than the trend risk.

5.1 SLT Health underwriting risk

- The underlying assumptions for the SLT Health underwriting risk module are assumed to be the same as for the Life underwriting risk module, with the exception of disability risk for medical expense insurance, SLT Health lapse risk, SLT Health revision risk and health catastrophe risk.
- A simplified calculation for health underwriting risk sub-modules (mortality risk, longevity risk, disability-morbidity risk, expense risk, lapse risk) is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are the same as for the Life underwriting risk sub-modules, except for medical expense disability-morbidity risk.

The calibration of the SLT Health underwriting parameters captures changes in the level and trend of the parameters only.

An underlying assumption in the SLT Health underwriting risk module is the substantial degree of diversification in the insurance portfolios. The reference population underlying all calibration work is identical to the life underwriting risk module and refers to an insured population that is well diversified with respect to:

- age
- gender
- smoker status
- socio- economic class
- level of health insurance cover
- type of health insurance cover
- degree of underwriting applied at inception of the cover
- geographic location

Therefore, one example of deviations from the assumptions underlying the standard formula calculation would be an insurance portfolio with a higher than average level of concentration in one or more risk factors (e.g. death protections are sold to a high number of impaired lives, for instance due to poor underwriting or adverse selection). Also a niche player is likely to have a materially different risk exposure than the one reflected in the calibration of the standard formula.

Underwriting risk can affect undertakings liabilities as well as its assets. The scope of the SLT Health underwriting module is therefore not confined to the liabilities. Undertakings can have indirect underwriting exposures, like exposure to catastrophe bonds and longevity bonds.

It is important to point out that for most of the SLT Health underwriting risk sub-modules (except for disability risk for medical expense insurance, lapse risk and catastrophe risk) there was no specific calibration analysis carried out for the stress factors, as the SLT health insurance obligations are pursued on a similar technical basis to that of life insurance.

For mortality, longevity, disability-morbidity for income protection insurance, expenses and revision risk, the calibration was based on the corresponding Life underwriting risk sub-modules.

5.1.1 SLT Health Mortality risk

No health-specific analysis for the calibration of health mortality risk was made. As there are no indications that the mortality risk of health obligations differs substantially from the mortality risk of life obligations, the same shock is assumed as for the life underwriting risk module (a permanent increase of 15% in mortality rates for each age and each policy where the payment of benefits is contingent on mortality risk).

A simplified calculation for health mortality risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are the same as for life mortality risk.

5.1.2 SLT Health Longevity risk

No health-specific analysis for the calibration of health longevity risk was made. As there are no indications that the longevity risk of health obligations differs substantially from the longevity risk of life obligations, the same shock is assumed as for the life underwriting risk module. Based on the analysis of historic mortality improvements the longevity risk shock should be based on a revised permanent 20% decrease in the mortality rates.

A simplified calculation for health longevity risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are the same as for life longevity risk.

5.1.3 SLT Health Disability-Morbidity risk for medical expense insurance

The underlying assumptions for the SLT Health disability-morbidity risk sub-module can be summarised as follows:

- It is assumed that the same parameter assumptions about the trend of health claims (inflation risk) as for the life expense risk sub-module are applicable. The reason is that there are no indications that the variability of the level of claims is significantly different from life insurance obligations.
- For estimation risk due to assumptions on the level of claims based on past observations, it is assumed that undertakings estimate the level of claims from the last five years observations. The estimated result is assumed to be appropriate for an average European health (re)insurance portfolio.
- A simplified calculation for health medical expense disability-morbidity risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are that notwithstanding the inflation factor, the amounts of claims taken into account in the calculation of the best estimate for medical expense obligations are constant over time, until the end of the payment period; the effect of discounting on the change in value of the best estimate before and after shock can be neglected; the reinsurance applied to medical expense obligations is proportional, and the application of the shock has no impact on the ability of the reinsurer to pay its quota-share of losses; the average projected inflation rate is close to zero (in practice, no more than 3%); the modified duration of the cash-flows included in the best estimate of the obligations considered is equal (or very close) to the total length of the claims settlement period.

For medical insurance, disability-morbidity risk can be split into three components:

- The assumption on the trend of health claims needs to be revised (inflation risk).
- The assumptions on the level of claims need to be revised because the level estimated from past observations deviates from the underlying claims level of more recent observations (estimation risk).
- The assumptions on the level of claims need to be revised for any other reason than estimation risk (e.g. model risk, risk of change, random error).

There is no reliable database to estimate the volatility of medical claims inflation on a 99.5% VaR level. For the calculation of the medical claims inflation risk sub-module an increase of inflation rate by 1% per annum (in absolute terms) is assumed. Although the level of medical claims inflation might deviate from the level of general expense inflation, there are no indications that the variability of the level is significantly different. Therefore, the same inflation shock is assumed as for life expense risk. For estimation risk it is assumed that undertakings estimate the level of claims from the last five years observations, i.e. the annual inflation-adjusted claims for the last five years. If the distribution of annual claims is assumed to be approximately normal, the estimation error on a 99.5%-VaR level can be calculated as follows:

estimation error = $N^{-1}(0.995) \cdot 5^{-1/2} \cdot \sigma \approx 1.15 \cdot \sigma$

where N is the cumulative distribution function of the standard normal distribution and σ the standard deviation of annual claims. From data of the German health insurance market the standard deviation of annual claims was estimated for 37 health insurance undertakings. In order to allow for inflation and portfolio changes the annual claims were standardised with the expected annual claims as taken into account in the premium calculation. The standard deviations varied from 2% to 10% of the expected annual claims; the average value was 4.4%. Using the formula above the estimation error is 5% of the expected annual claims. Therefore the resulting shock for estimation risk is a permanent increase of the claims level of 5%.

A simplified calculation for health medical expense disability-morbidity risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are the following:

1. Notwithstanding the inflation factor, the amounts of claims taken into account in the calculation of the best estimate for medical expense obligations are constant over time, until the end of the payment period. Expressed differently, it is possible to approximate the amount of claims paid in year *t* by the following formula:

$$\forall t \in \{1, T\}\ EI_t = EI_{t-1}.(1+i)$$

   where:

- EI_0 is the amount of claims paid during the last year with respect to medical expense obligations, net of reinsurance
- T is the length (in years) of the payment period considered in the calculation of the best estimate
- i denotes the weighted average inflation rate included in the calculation of the best estimate of those obligations, weighted by the present value of expenses included in the calculation of the best estimate for servicing existing life obligations.

2. The effect of discounting on the change in value of the best estimate before and after shock can be neglected.

3. The reinsurance applied to medical expense obligations is proportional, and the application of the shock has no impact on the ability of the reinsurer to pay its quota-share of losses.

4. The average projected inflation rate is close to zero (in practice, no more than 3%).

5. The modified duration of the cash-flows included in the best estimate of the obligations considered is equal (or very close) to the total length of the claims settlement period.

5.1.4 SLT Health Disability-Morbidity risk for income protection insurance

No health-specific analysis for the calibration of health disability-morbidity risk was made. As there are no indications that the disability risk of health obligations differs substantially from the disability risk of life obligations, the same shock is assumed as for the life underwriting risk module. It was proposed to calculate the morbidity/disability capital charge from a combined scenario, where the morbidity/disability inception rates for the first year are increased by 35% and for all subsequent years by 25%, the morbidity/disability recovery rates are permanently decreased by 20%, the morbidity/disability rates are permanently decreased by 20%.

A simplified calculation for health income protection disability-morbidity risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are the same as for life disability-morbidity risk.

5.1.5 SLT Health Expenses

No health-specific analysis for the calibration of health expense risk was made. As there are no indications that the expense risk of health obligations differs substantially from the expense risk of life obligations, the same shock is assumed as for the life underwriting risk module. It is proposed to maintain the QIS4 calibration of the expense risk stress i.e. the stress is based on an increase of 10% in future expenses compared to best estimate anticipations and an increase of 1% per annum of the expense inflation rate compared to anticipations.

A simplified calculation for health expense risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are the same as for life expense risk.

5.1.6 SLT Health Revision risk

No health-specific analysis for the calibration of health revision risk was made. As there are no indications that the revision risk of health obligations differs substantially from the revision risk of life obligations, a similar approach is used as for the life underwriting risk module. For SLT Health revision risk a permanent increase of 4% in the amount of annuity benefits is assumed, which corresponds to the 99.5% quantile of the aggregate loss distribution for an average sized portfolio comprising pensions at different legal stages in ‘average’ proportions.

5.1.7 SLT Health Lapse risk

The underlying assumptions for SLT Health lapse risk can be summarized as follows:

- The lapse take-up rates follow a normal distribution.
- The lapse take-up rates are age-independent and a medium lapse shock across age bands produces an appropriate calibration for the minimum floor to assumed lapse rates.
- Option take-up rates by policyholders are assumed higher than the minimum floor under stressed situations.
- For health mass lapse risk, the underlying assumptions are the same as for the life lapse risk sub-module, however excluding the distinction made between non-retail and retail business in policyholder behaviour.

A statistical study was carried out on the basis of comprehensive data in the German Health insurance market. The raw data comprised lapse take-up rates from each insurance undertaking in the German market writing Health SLT business in the time period 2001 to 2008, differentiated per individual ages of the insured. In the statistical analysis, the data on the lapse take-up rates for individual ages was grouped into over-lapping age bands comprising each 10 years of age, beginning with the age band of 21 years. For each age band, the mean value and standard deviation of the observed lapse take-up rates for the time period 2001 to 2008 was determined. Assuming a normal distribution this then allowed computation of a lapse shock for each age band corresponding to the VaR 99.5% confidence level. To determine which age-independent lapse risk shock would be appropriate on the basis of these results, it was considered that the absolute take-up rates for lapse risks from age 70 on-wards are very small, and so for the calibration purpose the ages 60 to 100 were disregarded. A medium lapse shock can appropriately be determined as an average across the age bands with mid-points between 25 and 55. Overall, this resulted in a medium lapse take-up rate of 20%, which is proposed as a minimum floor in the scenario of a decrease of lapse rates. The lapse shock scenarios correspond to a 50% instantaneous permanent increase/decrease of the lapse exercise rates for those contracts where technical provisions would increase under the scenarios, assuming a higher option take-up rate by policyholders under stressed situations.

A simplified calculation for health lapse risk is available for undertakings, where such simplified calculation is proportionate to the nature, scale and complexity of the risks faced and where the standard calculation would lead to an undue burden for the undertaking. The underlying assumptions for the simplified calculation are the same as for life lapse risk.

5.2 Non-SLT Health underwriting risk

- All underlying assumptions for the Non-Life underwriting risk module, with the exception of the Non-Life natural catastrophe risk sub-module are assumed to be also valid for the Non-SLT Health underwriting risk module.

The calibration of the Non-SLT Health underwriting risk module follows the same approach as the non-life underwriting risk module, with the exception of the non-life natural catastrophe risk sub-module, but was specifically performed on the Medical expense, Income protection, Workers compensation and Non-proportional health reinsurance lines of business.

5.2.1 Non-SLT Health Premium and reserve risk[23]

The premium and reserve risk module for Non-SLT Health is similar to the non-life risk premium and reserve risk sub-module and only takes into account losses that occur at a regular frequency. Extreme events, which occur very rarely, have not been taken into account when calibrating the premium and reserve risk factors. Such extreme events should be taken into account in the catastrophe risk modules.

In order to estimate the capital charge for the Non-SLT premium and reserve risk sub module, there was a need to provide calibrated factors for the following inputs:

- Standard deviation for premium risk σ (prem, LoB)
- Standard deviation for reserve risk σ (res, LoB)
- Correlation factors between lines of business

The calibration factors were derived for the LoBs Medical expense, Income protection, Workers compensation and Non-Proportional health reinsurance. EIOPA launched a European wide statistical data request to carry out this calibration exercise as part of the Joint Working Group on Non-Life and Health NSLT calibration work. This full calibration exercise was meant to be a refinement of previous CEIOPS calibration results, including the calibration results as used in QIS5 which were based on German data only for premium risk, some UK and German data for reserve risk and French data for the health segments. The estimation methods used and calibration assumptions made follow the same combined approach as described for the non-life premium and reserve risk calibration assumptions.

[23] For a more detailed calibration report regarding premium and reserve risk, see: https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/reports/EIOPA-11-163-A-Report_JWG_on_NL_and_Health_non-SLT_Calibration.pdf.

5.2.2 Non-SLT Health lapse risk [24]

The Non-SLT Health lapse sub-module was included in QIS5, assuming both a decrease and an increase of 50% in the option take-up rates in all future years for all policies where this would lead to an increase in technical provisions. There is currently no information available about the calibration of the Non-SLT Health lapse shocks used in QIS5. The currently proposed lapse shocks assume a combined stress of a discontinuance rate of 40% of insurance policies where this would lead to an increase in technical provisions and a decrease of 40% of the number of reinsurance contracts or insurance contracts to be written in the future where these are covered by reinsurance contracts. There is no information available about the calibration of these factors.

5.3 Health Catastrophe risk[25]

The underlying assumptions for the health catastrophe risk sub-module can be summarised as follows:

- The three health catastrophe risk scenarios (mass accident, accident concentration and pandemic) are assumed to be independent events.
- The scenario based approach for the health catastrophe risk sub- module assumes that the portfolio of the financial statement date is representative for the whole year.

The health catastrophe risk module is based on standardized scenarios as a method for the estimation of the catastrophe risk charge to apply across all countries for medical expense plus accident and sickness products. The final calibration aims to provide a catastrophe risk charge at the 99.5 % VaR for undertakings that are exposed to extreme or exceptional events relevant for health insurance obligations. It is assumed that all events are independent (arena scenario for mass accident risk for health insurance obligations other than workers compensation, concentration scenario for accident concentration risk for workers compensation and group income protection insurance obligations, pandemic scenario for pandemic risk for health insurance obligations other than workers compensation).

The three health catastrophe risk scenarios (mass accident, accident concentration and pandemic) are based on standardized scenarios as these risks are unlikely to be appropriately captured by a formula based approach. It is important to highlight that the standardized scenarios in the catastrophe risk modules is a tradeoff between accuracy and ease of use. There could be many circumstances where the standardized scenarios will be inadequate because the risk profile of the (re)insurance undertaking

---

[24] For a more detailed calibration report regarding premium and reserve risk, see: https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/reports/EIOPA-11-163-A-Report_JWG_on_NL_and_Health_non-SLT_Calibration.pdf.

[25] For a detailed report on the calibration of the standardized scenarios for the catastrophe risk module in the standard formula see: https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/submissionstotheec/CEIOPS-DOC-79-10-CAT-TF-Report.pdf. Please note that this report was updated in June 2011 with some amendments.

deviates from the assumptions underlying the standard formula calculations. Moreover, it is impossible to allow for all undertakings and risk profile particularities within the standard formula. It is recommended that undertakings consider alternative measures, in particular partial internal models, before choosing to use the standardized scenarios. This particularly applies to undertakings with significant exposure to health catastrophe events where close proximity to the source of the event requires a more sophisticated approach to resolve the geographical distribution of the risk, or those with a need to distinguish between vulnerability of different lines of business, rather than the aggregate approach provided by the scenarios.

Circumstances, in which the standardised scenarios for health catastrophe risk presented in this document might be inadequate because of the risk profile of the (re)insurance undertaking, include among others situations

- where undertakings are not able to recognize geographical boundaries.
- where undertakings write non-proportional reinsurance business.
- where undertakings have exposures that are not captured by the standardised scenario.

If an undertaking writes for example a material amount of travel insurance with durations of few weeks or days and the financial statement date falls into a period when less people travel its risk will not be appropriately captured in the health risk catastrophe scenario.
It is important to note that the above list is not complete.

5.3.1 Calibration of Health Mass Accident Catastrophe standardized scenario

The mass accident scenario captures the risk of having many people in one location at the same time, causing mass accidental deaths, disabilities and injuries with a high impact on the cost of medical treatment sought.

The underlying assumptions for the health mass accident catastrophe risk sub-module can be summarised as follows:

- It is assumed that the insurance cover is shared amongst a large number of insurance undertakings (which is different from the Health Accident Concentration scenario).
- The scopes of insurance products affected by the scenario are assumed to be limited to products covering Deaths caused by Accidents, Permanent Total Disability, Long Term Disability (lasting 10 years), Short Term Disability (lasting 12 months), and Medical/Injuries treatment. It is assumed that mass accident risk in relation to workers' compensation insurance is not material.
- It is assumed that the undertaking’s exposure to mass accident risk situated in third countries, other than specific European countries is not material.

Therefore, the calibration of the ratio of persons affected by the mass accident has only been performed for European countries.

- The proportion of people who will receive benefits under the mass accident scenario has been calibrated based on injury distributions per product type and are assumed to be fixed and the same for each country.

The assumption underlying the choice of the Health Mass Accident Catastrophe scenario is that the event captures the risk of having many people in one location at the same time, causing mass accidental deaths, disabilities and injuries with a high impact on the cost of medical treatment sought. It is assumed that the insurance cover is shared amongst a large number of insurance undertakings, but that not all people affected are insured. The calibration of the Health Mass Accident Catastrophe standardised scenarios (Arena scenarios) is based on a 99.5% confidence level and assumes the following parameters and volume measures:

- The choice of the scenario was based on a footprint for a 10-ton truck bomb, the largest bomb modelled, causing fatalities and serious injuries within the largest arena in each country.
- The maximum capacity of the largest arena in each country to derive the number of persons affected by the scenario in each country (S). It is assumed that 50% of the arena capacity is affected by the scenario;
- The proportion of people affected (accidental deaths/disabilities and injuries) (r_s) has been calibrated by product type P and are assumed to be fixed and the same for each country. The scope of insurance products affected by the scenario (P) are assumed to be limited to Accidental Deaths, Permanent Total Disability, Long Term Disability (lasting 10 years), Short Term Disability (lasting 12 months), Medical/Injuries treatment;
- As the standardized scenario is based on a market share approach each undertaking has to apply their own market share factor per product type (x_e based on written premiums) to the insurance penetration rate per product type. x_e can be considered as a share of the total loss to ascertain the loss that will be claimed from the insurance industry in case of a catastrophe, and was estimated for some countries based on health care coverage data;
- The volume measure is assumed to be total sum insured per person (E_s) by product type and by country

Calibration of the proportion of people affected (r_s)

The calibration of injury distributions per product type P were derived from the frequency distributions of WTC Worker's compensation claims and the proportion of workforce affected for the different types of products. The same parameters would also apply to group income protection insurance.

5.3.2 Calibration of Health Accident Concentration Catastrophe standardised scenario

The accident concentration scenario captures the risk of having concentrated exposures due to densely populated locations, causing concentrations of accidental deaths, disabilities and injuries in the event of the scenario as applies also to mass accident catastrophe risk.

The underlying assumptions for the health accident concentration Catastrophe risk sub- module can be summarized as follows:

- It is assumed that the insurance cover is shared amongst only a limited number of insurance undertakings (which is different from the Health Mass Accident scenario).
- The scope of insurance products affected by the scenario is assumed to be limited to products covering Deaths caused by Accident, Permanent Total Disability, Long Term Disability (lasting 10 years), Short Term Disability (lasting 12 months), and Medical/Injuries treatment. The same calibration is used as for mass accident catastrophe risk. It is assumed that accident concentration risk in relation to medical expense insurance and income protection insurance other than group contracts is not material to the undertaking.
- The accident concentration scenarios are applicable to worldwide exposures. It is assumed that undertakings have information on the largest accident risk concentration value and the average value of benefits payable for the largest accident risk concentration for the countries they are exposed to.
- The proportion of people who will receive benefits under the scenario has been calibrated based on injury distributions per product type and are assumed to be fixed and the same for each country.

The assumption underlying the choice of the Health Accident Concentration Catastrophe scenario is that the event captures the risk of having concentrated exposures due to densely populated locations, causing concentrations of deaths caused by accident, disabilities and injuries in the event of the scenario as applies also to mass accident catastrophe risk. It is assumed that the insurance cover is shared amongst only a limited number of insurance undertakings. The calibration of the Health Accident Concentration Catastrophe standardized scenarios are based on 99.5% confidence level and assume the following parameters and volume measures:

- The choice of scenario was based on a footprint for a 10-ton truck bomb, the largest bomb modelled, causing fatalities and serious injuries to extend in measurable quantities up to 300m in low-rise buildings and 200m in high-rise engineered buildings commonly found in central business districts. The scenario assumes that people are affected within densely populated office blocks in a financial district.

- Number of persons insured in the largest known concentration of persons working in a single building, including number of people covered and working within a 300m radius;
- The proportion of people affected (accidental deaths/disabilities and injuries) (x_P) has been calibrated by product type P and are assumed to be fixed and the same for each country. The scope of insurance products affected by the scenario (P) is assumed to be limited to products that cover Deaths caused by Accidents, Permanent Total Disability, Long Term Disability (lasting 10 years), Short Term Disability (lasting 12 months), and Medical/Injuries treatment. The same calibration is used as for mass accident catastrophe risk;
- The volume measure is assumed to be total sum insured per person (E_p) by product type p

5.3.3 Calibration of Health Pandemic Catastrophe standardised scenario

The pandemic scenario captures the risk of having a large number of non-lethal disability and income protection claims and where victims are unlikely to recover as a result of a pandemic. The scenario is different from the Life Catastrophe scenario where mass mortality is assumed to occur.

The underlying assumptions for the health pandemic catastrophe risk sub- module can be summarized as follows:

- It is assumed that the insurance cover is shared amongst only a limited number of insurance undertakings.
- The scope of insurance products affected by the pandemic scenario is assumed to be limited to Long Term Disability (lasting 10 years) products.
- The proportion of disabilities following a pandemic event, the proportion of affected people that survive, and the proportion of people thereof that become chronically disabled in a one of two hundred years event is not higher than the proportions for the Encephalitis Lethagica (EL) pandemic.
- The pandemic catastrophe scenarios are applicable to worldwide exposures. It is assumed that undertakings have information on the number of insured persons covered by medical expense insurance other than workers' compensation that cover medical expenses from an infectious disease and the expected average value of benefits payable in case of a pandemic for the countries they are exposed to.
- The ratio of persons with clinical symptoms which will utilize a certain type of healthcare under the pandemic scenario has been calibrated based on disability

distributions per product type and are assumed to be fixed and the same for each country.

The assumption underlying the choice of the Health Pandemic Catastrophe scenario is that the event captures the risk of having a large number of disability and income protection claims and where victims are unlikely to die or recover as a result of a pandemic infection. The scenario is different from the Life Catastrophe scenario where mass mortality is assumed to occur. The calibration of the Health Pandemic Catastrophe standardized scenarios are based on 99.5% confidence level and assume the following parameters and volume measures:

- The choice of scenario is driven by a pandemic event that causes only health claims but no death claims as in the life catastrophe risk module. The choice of the Encephalitis Lethagica (EL) was retained.
- The proportion of people affected (disabilities) (R) has been calibrated and are assumed to be fixed and the same for each product P. Based on empirical estimations of the incidence rate of EL, the proportion of affected people that survive, and the proportion of people thereof that become chronically disabled (the R factor) was calibrated at 0.075‰;
- As the underlying data suggests that people affected by the EL were mostly young and likely to live more than 10 years, it is assumed that only Long Term Disability (lasting 10 years) products are impacted;
- The volume measure is assumed to be total sum insured per person by product type p.

6. Operational risk

Operational risk increases together with the activity size as it stems from inadequate or failed internal processes, personnel or systems, or from external events, unless the undertaking is well diversified and managed which corresponds to a low value of the BSCR.

The underlying assumptions for the operational risk module can be summarized as follows:

- The overall assumption in the operational risk module is that a standardized level of risk management is present.
- For unit-linked businesses the characteristics are similar to those of other life products. Therefore, the parameters will evolve in line with the life parameter.
- In relation to the expense volume measure for unit-linked business, it is assumed that acquisition expenses are exclusively relating to insurance intermediaries, which do not give rise to any operational risk.

The overall assumption in the operational risk module is that a standardised level of risk management is present. The operational risk module is based on a linear formula, and is therefore not risk sensitive.

The calibrations of the operational risk factors have been a particular challenging task due to the lack of information available. The underlying assumption of the operational risk module is that the capital charge for operational risk can be set at a level of 99, 5 % VaR. As there is no explicit way of measuring operational risk at the tail of the distribution, indications from internal model users on operational risk charges were used as a benchmark for where firms believe their 99.5% VaR for operational risk lies. In the standard formula, factors should be chosen so that the standard formula operational risk charge is broadly in line with the undiversified operational risk from a firm's internal model. This is due to the fact that there is no allowance for diversification within the standard formula.

Several analyses were carried out and reference to external information for validation and benchmarking purposes was used.[26] One of these analyses was the basis for the factors set in the operational risk charge of the standard formula. This analysis was based on 5 EU countries and 32 entities in total, including both data on the pre-diversification and post-diversification charges. The sample of undertakings providing post- diversification charges was different from the sample providing pre-diversification charges.

[26] These analysis can be found in QIS5 Calibration document under operational risk: http://ec.europa.eu/9D814DC5-CAAE-4EF7-86B6-DC3BB89737B4/FinalDownload/DownloadId-D44D9ED693D85AE849BEC81E6236A338/9D814DC5-CAAE-4EF7-86B6-DC3BB89737B4/internal_market/insurance/docs/solvency/qis5/ceiops-calibration-paper_en.pdf

The following data was used in for setting the factors:

- Internal models operational pre-diversification charge in relation to non-life technical provisions.
- Internal models operational pre-diversification charge in relation to non-life earned premiums.
- Internal models operational pre- diversification charge in relation to life technical provisions excluding unit-linked business.
- Internal models operational pre-diversification charge in relation to life earned premiums excluding unit- linked business.

In the calibration summary statistics for each of the data subsets above were produced, and a charge was selected based on the median of the pre- diversification charge of the internal models.

For unit-linked businesses it was assumed that the characteristics were similar to those of other life products. Therefore, the parameters will evolve in line with the life parameter.

In relation to the expense volume measure for unit-linked business it is assumed that administrative expenses exclude acquisition expenses as these are primarily related to insurance intermediaries. Acquisition expenses are excluded from operational risk.

7. Counterparty default risk

Different treatments of exposures to single name counterparties are deemed appropriate, depending on the degree of diversification of the portfolio with respect to counterparties, credit quality of counterparties and whether counterparties are rated or not. Loss given default takes account of potential recovery of funds, risk-adjusted value of collateral under the market risk stresses as well as the impact on underwriting and market risk due to ineffectiveness of risk mitigation under a default scenario.

The underlying assumptions for the counterparty default risk sub-module can be summarised as follows:

- For type 1 exposures, the LGD on counterparties that do not belong to the same group are independent and the LGD on counterparties that belong to the same group are not independent.
- Exposures which are neither captured in the spread risk sub-module nor the counterparty default risk module as type 1 exposures should be captured as type 2 exposures within the counterparty default risk module.
- Default probabilities assume a shocked component and tail correlation between counterparty defaults to reach a 99.5% quantile of the loss distribution. This

method assumes that the default probability of a given counterparty can vary significantly over time and there can be significant dependence between defaults at certain points in time.

- The recovery rates for risk mitigation techniques (reinsurance recoverables, derivatives and mortgages related to residential mortgage loans) are assumed to reflect best practices.
- For the simplified calculation of the risk mitigation effect it is assumed that there is no financial relationship between the counterparty and the insurance undertaking other than the risk mitigation technique. In particular, no net additional loss to the undertaking (in addition to the loss of the risk mitigation on the SCR per se) would occur following the default of the counterparty (e.g. no triggering of contingent liabilities).
- For the simplified calculation of the risk mitigation effect for reinsurance arrangements or securitisation it is assumed that there is no financial relationship between the counterparty and the insurance undertaking other than the risk mitigation technique. In particular, no net additional loss to the undertaking (in addition to the loss of the risk mitigation on the SCR per se) would occur following the default of the counterparty (e.g. no triggering of contingent liabilities).
- For the simplified calculation of the risk mitigation effect for proportional reinsurance arrangements, it is assumed that reinsurance programs provided to the undertaking by different counterparties are the similar in term of covers and limits and nature. It is also assumed that there is no financial relationship between the counterparty and the insurance undertaking other than the risk mitigation technique. In particular, no net additional loss to the undertaking (in addition to the loss of the risk mitigation on the SCR per se) would occur following the default of the counterparty (e.g. no triggering of contingent liabilities).
- For the simplified calculation of the risk adjusted value of collateral to take into account the economic effect of the collateral it is assumed that the collateral instrument is neither a re-utilised collateral nor foreseen to be re-utilized for other purposes. In addition, the market risk adjustment for the collateral is assumed lower than 15% of the market value and the collateral is of an asset class that is sufficiently diversified with regards to the asset portfolio of the undertaking.

The counterparty default risk module is designed to reflect the change in the value of assets and liabilities caused by unexpected default or deterioration in the credit standing of independent counterparties and debtors. It applies to reinsurance arrangements, securitisations, derivatives (excluding credit derivatives which are already treated under the spread risk module), deposits with ceding and credit institutions, which are classified as type 1 exposures and are assumed not to be diversified but likely to be rated. Exposures to receivables from intermediaries and policyholder debtors are classified as type 2 exposures, which are assumed to be well diversified but unlikely to be rated. The capital charges are assessed for exposures to each and every independent counterparty and are then summed into either type 1 or type 2 exposures. Exposures to multiple counterparties that belong to the same group are assumed to count as one single independent counterparty. The aggregated capital charge for counterparty default risk assumes a correlation of 0.75 between both types of exposures.

$$SCR_{def} = \sqrt{SCR_{def,1}^2 + 1.5 \cdot SCR_{def,1} \cdot SCR_{def,2} + SCR_{def,2}^2},$$

The capital charges for type 1 or type 2 exposures are calculated in a very different way, as the behaviour of default probabilities and the loss in the event of default are assumed to be inherently very different.

Capital requirement for type 1 exposures

For type 1 exposures the design of counterparty default risk is driven by the loss given default (LGD) and the probability of default (PD) for a given single name counterparty. The PD is driven by the rating of the counterparty (for rated exposures). For unrated (re-) insurance undertakings subject to Solvency II the PD is determined on the basis of the SCR ratio.

The calibration of $\boldsymbol{p_i}$ is based on a model that scales up a baseline default probability in order to take account of a shock-induced default probability and allowing for tail correlation between default probabilities of different counterparties. This method assumes that the default probability of a given counterparty can vary significantly over time and there can be significant dependence between defaults at certain points in time.

In order to define the appropriate quantile of the loss distribution of the exposures, the PD and LGD parameters are used to derive the variance of the loss distribution of type 1 exposures $\boldsymbol{V}$, which is then scaled up with a quantile factor $\boldsymbol{q}$ to derive the 99.5% quantile. It is assumed that the portfolio of counterparties is sufficiently diversified and that the credit quality is reasonably high. On this basis it would seem appropriate to assume a skewed lognormal distribution of $\boldsymbol{q}$, which produces a value of $\boldsymbol{q} = 3$. In case of a less diversified portfolio or lower credit quality (assumed to be lower than BBB rating) a higher quantile factor of $\boldsymbol{q} = 5$ is used when the standard deviation of the loss distribution exceeds 7% of the single name LGD. The final capital charge for type 1 exposures then becomes:

$$SCR_{def,1} = \begin{cases} 3 \cdot \sqrt{V}, & \text{if } \sqrt{V} \le 7\% \cdot \sum_i LGD_i \\ 5 \cdot \sqrt{V}, & \text{if } 7\% \cdot \sum_i LGD_i < \sqrt{V} \le 20\% \sum_i LGD_i \\ \sum_i LGD_i, & \text{if } 20\% \sum_i LGD_i < \sqrt{V} \end{cases}$$

In case of default of a given counterparty, typically a part of the exposure can still be recovered. The LGD is therefore adjusted for the share of the exposure that can be recovered (recoverables in case of reinsurance arrangements or market value in case of derivatives), net of the risk-adjusted value of existing collateral or mortgage and taking into account the additional loss of risk mitigation effect (*RM*) in the underwriting risk (in case of reinsurance and insurance securitisation) or market risk (in case of financial derivatives or mortgage loans) resulting from the default of the counterparty. The resulting LGD then becomes:

$$\max\left[50\%.\left(Recoverables_i + 50\%.RM_{re,i}\right) - F.Collateral_i; 0\right]$$

for non-heavily collateralised reinsurance counterparties (less than 60% of the assets)

$$\max\left[90\% * \left(Recoverables_i + 50\% * RM_{re,i}\right) - F * Collateral_i;\ 0\right]$$

for heavily collateralised reinsurance counterparties (at least 60% of the assets)

$$\max\left[90\% * (Derivative_i + RM_i) - F' * Collateral_i;\ 0\right]$$

for derivatives and

$$\max\left[Loan - Mortgage;\ 0\right]$$

for outstanding amounts of mortgage loans.

The recovery rate of 50% on reinsurance counterparties is assumed to reflect best practices. Based on the 2008 Lehman Brothers default experience a 9.3% recovery rate was observed. Therefore for credit derivatives a 10% recovery rate is assumed.

A simplified calculation of the risk mitigation effect RM is available, where it is assumed that there is no financial relationship between the counterparty and the insurance undertaking other than the risk mitigation technique. In particular, no net additional loss to the undertaking (in addition to the loss of the risk mitigation on the SCR per se) would occur following the default of the counterparty (e.g. no triggering of contingent liabilities).

In particular, for the simplified calculation of the risk mitigation effect for reinsurance arrangements or securitisation it is assumed that there is no financial relationship between the counterparty and the insurance undertaking other than the risk mitigation technique. In particular, no net additional loss to the undertaking (in addition to the loss of the risk mitigation on the SCR per se) would occur following the default of the counterparty (e.g. no triggering of contingent liabilities).

Specifically for the simplified calculation of the risk mitigation effect for proportional reinsurance arrangements, it is assumed that reinsurance programs provided to the undertaking by different counterparties are similar in term of covers and limits and nature. It is also assumed that there is no financial relationship between the counterparty and the insurance undertaking other than the risk mitigation technique. In particular, no net additional loss to the undertaking (in addition to the loss of the risk mitigation on the SCR per se) would occur following the default of the counterparty (e.g. no triggering of contingent liabilities).

Specifically for the simplified calculation of the risk adjusted value of collateral to take into account the economic effect of the collateral, it is assumed that the collateral instrument is neither a re-utilised collateral nor foreseen to be re-utilised for other purposes. In addition, the market risk adjustment for the collateral is assumed lower than 15% of the market value and the collateral is assumed to be of an asset class that is sufficiently diversified with regards to the asset portfolio of the undertaking.

Capital requirement for type 2 exposures

The capital charge for type 2 exposures is based on scenario of a fall in the value of type 2 exposures. The scenario assumes a 15% fall of the market value of the exposure assuming a well-diversified portfolio and a credit quality between BBB and BB rating. For exposures to 3 month past-due receivables from intermediaries a higher fall of 90% of the value is assumed, given the higher probability of default and the limited recovery rate in the event of default. The combined scenario is therefore given by:

$$\sum_i 15\,\% * LGD_i + 90\% * LGD_{receivables>3\,months}$$