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Consultation Paper No. 70

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

SCR Standard Formula

Article 109 b

Calibration of Market Risk Module

CEIOPS welcomes comments from interested parties on the following Consultation Paper.

*Please send your comments to CEIOPS by email (Secretariat@ceiops.eu) by **11.12.2009 12.00 CET**, indicating the reference "CEIOPS-CP-70/09".*

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1. Introduction

1.1. Background

1.1. In its letter of 19 July 2007, the European Commission requested CEIOPS to provide final, fully consulted advice on Level 2 implementing measures by October 2009 and recommended CEIOPS to develop Level 3 guidance on certain areas to foster supervisory convergence. On 12 June 2009 the European Commission sent a letter with further guidance regarding the Solvency II project, including the list of implementing measures and timetable until implementation.[1]

1.2. This consultation paper aims at providing advice with regard to the calibration of the market risk module of the SCR standard formula, as required by Article 109 of the Solvency II Level 1 text.[2]

1.3. This paper follows CP47 which was published in June 2009, and for which the consultation period closes on 11 September 2009.

1.4. The equity risk sub-module and the correlations between the market risk sub-modules and between the market risk module and other modules are not covered in this draft advice as they will be addressed in a separate consultation paper due to be published in October 2009. In addition, advice on simplifications to the standard formula, including the calibrations of these simplifications, will also be published at this stage.

1.5. The objective of this paper is to give draft advice on the calibration of the interest rate risk, spread risk, currency risk, property risk and equity risk sub-modules, as well as on the correlations between the market risk sub-modules. The calibration of the concentration risk sub-module has already been covered in CP47, published in June 2009.

[1] See http://www.ceiops.eu/content/view/5/5/
[2] Text adopted by the European Parliament on 22 April 2009, see http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+TA+20090422+SIT-03+DOC+WORD+V0//EN&language=EN.

2. Extract from Level 1 text

2.1 Article 104 – Design of the Basic Solvency Capital Requirement

1. The Basic Solvency Capital Requirement shall comprise individual risk modules, which are aggregated in accordance with point 1 of Annex IV.

It shall consist of at least the following risk modules:

[…]

(d) market risk

[…]

5. The same design and specifications for the risk modules shall be used for all insurance and reinsurance undertakings, both with respect to the Basic Solvency Capital Requirement and to any simplified calculations as laid down in Article 108.

[…]

It should be noted that there is no possibility based on the Level 1 text (art. 104 7) for the use of undertaking-specific parameters in the market risk module.

2.2 Article 105 – Calculation of the Basic Solvency Capital Requirement

[…]

5. The market risk module shall reflect the risk arising from the level or volatility of market prices of financial instruments which have an impact upon the value of assets and liabilities of the undertaking. It shall properly reflect the structural mismatch between assets and liabilities, in particular with respect to the duration thereof.

It shall be calculated, in accordance with point 5 of Annex IV, as a combination of the capital requirements for at least the following sub-modules:

(a) the sensitivity of the values of assets, liabilities and financial instruments to changes in the term structure of interest rates, or in the volatility of interest rates (interest rate risk);

(b) the sensitivity of the values of assets, liabilities and financial instruments to changes in the level or in the volatility of market prices of equities (equity risk);

(c) the sensitivity of the values of assets, liabilities and financial instruments to changes in the level or in the volatility of market prices of real estate (property risk);

(d) the sensitivity of the values of assets, liabilities and financial instruments to changes in the level or volatility of credit spreads over the risk-free interest rate term structure (spread risk);

(e) the sensitivity of the values of assets, liabilities and financial instruments to changes in the level or in the volatility of currency exchange rates (currency risk);

(f) additional risks to an insurance or reinsurance undertaking stemming, either from lack of diversification in the asset portfolio, or from large exposure to default risk by a single issuer of securities or a group of related issuers (market risk concentrations).

[…]

2.3 Article 109 of the Level 1 text sets out the requirements for implementing measures, including the following:

1. In order to ensure that the same treatment is applied to all insurance and reinsurance undertakings calculating the Solvency Capital Requirement on the basis of the standard formula, or to take account of market developments, the Commission shall adopt implementing measures laying down the following:

[…]

(c) the methods, assumptions and standard parameters to be used, when calculating each of the risk modules or sub-modules of the Basic Solvency Capital Requirement laid down in Articles 104, 105, the symmetric adjustment mechanism and the appropriate period of time, expressed in the number of months, as referred to in Article 105ter, and Article 305b, as well as the appropriate approach for integrating the method referred to in Article 305b related to the use of this method in the Solvency Capital Requirement as calculated in accordance with the standard formula;

(d) the correlation parameters, including, if necessary, those set out in Annex IV, and the procedures for the updating of those parameters;

[…]

2. The Commission may adopt implementing measures laying down quantitative limits and asset eligibility criteria in order to address risks which are not adequately covered by a sub-module. Such implementing measures shall apply to assets covering technical provisions, excluding assets held in respect of life insurance contracts where the investment risk is borne by the policyholders. Those measures shall be reviewed by the Commission in the light of developments in the standard formula and financial markets.

[…]

3. Market risk in QIS4

3.1 From April to July 2008, CEIOPS carried out the fourth Quantitative Impact Study on Solvency II (QIS4). This included testing each of the sub-modules of the market risk module, according to the structure set out in Article 105.

3.2 For both life and non-life undertakings, as well as for composites, the quantitative results indicated that market risk represented one of the most significant modules for the standard formula SCR.

3.3 The largest components of the market risk charge were interest rate and equity risk, with each of these typically contributing around 40-50% of the total market risk requirement. Property risk and spread risk contributed less: property contributed between 8% and 15% of the total market risk, and spread risk contributed 11-21%. Currency risk contributed less than 7% of the total market risk. These statistics are useful to bear in mind when considering the calibration of the market risk module.

3.4 The feedback from the QIS4 exercise indicated few difficulties with the design and structure of the market risk module and its sub-modules. The majority of comments related to the aspects of the market risk module producing the greatest contribution to the market risk capital charge. The main points raised were as follows:

General comments

– The risk of changes to implied volatility when valuing options and guarantees in the liabilities should be allowed for.

– One supervisor suggested considering the calibration of shocks for assets and liabilities linked to inflation rates.

– Another supervisor recommended reviewing the calibration of the market risk module against the background of the current market developments.

– The structured product charge was considered too simplistic, as no account was taken of nature/security of underlying assets or priority order/structure of tranches.

Interest rate risk

– Some undertakings considered the interest rate shock to be too high, while others thought it too low.

– Undertakings in one country suggested that the stress scenario should also take the absolute level of the interest rate into account.

– Some undertakings asked for guidance on how to stress the term structure for index-linked bonds.

Currency risk

– In some countries, both undertakings and supervisors considered the shock for currencies linked to the Euro to be too high, especially for pegged currencies.

Spread risk

– The capital charges for credit spread risk were seen by some undertakings as too low for AA and AAA corporate bonds, but too high for lower rated bonds and for structured bonds, and especially for unrated bonds.

– Some undertakings would like to use internal ratings for unrated instruments.

– Some undertakings suggested excluding instruments issued in OECD currency by supranational entities.

3.5 This paper takes into account the results and comments from the QIS4 exercise with the aim of refining the calibration of the market risk module further.

4. Advice

4.1. General comments on calibration of the market risk module

4.1 As discussed in CEIOPS' paper of March 2009 "Lessons learned from the crisis (Solvency II and beyond)", the recent financial turbulence has highlighted a need for further refinement of the existing Solvency II calibrations, both at module and sub-module levels.

4.2 This paper also noted that developments in various asset classes have provided fresh insight on the amount of volatility the system will have to absorb in a stress situation and the resulting calibration of the market risk module.

4.3 The events of the past several months have resulted in losses for many insurers, driven in large part by significant declines in equity and property markets as well as unforeseen levels of credit spreads.

4.4 The CEIOPS "lessons learned" paper therefore recommended that the corresponding areas reflected in the market risk sub-modules may need refining, taking into account also the interdependencies between market risks in times of crisis.

4.5 It was recommended that "CEIOPS should review the calibration and correlations of the different sub-modules, on the light of the lessons drawn from the crisis by CEIOPS Pillar 1 expert group, FinReq, to assess its soundness and accuracy, in particular in crisis times".

4.6 The analysis set out in this paper enables CEIOPS to act on this recommendation by taking account of observed market developments during the financial crisis.

4.7 The calibrations tested in QIS3 and QIS4 can therefore be refined and improved by making use of data observed during the crisis period and incorporating this in the analysis that will underlie CEIOPS' Draft Advice on the calibration of the market risk module.

4.8 CEIOPS points out that the calibration in this advice is being considered to be in line with 99.5% VaR and a one year time horizon, incorporating the experience from the current crisis. QIS5 will give an indication of the overall impact of the proposed calibrations, not limited to the SCR but including technical provisions and own funds.

4.2 Interest rate risk

4.2.1. Explanatory text

4.9 The calibration of the standard formula interest rate capital charge is based on the delta-NAV approach proposed in CP47.

4.10 In CP47, we set out the capital charge arising from this sub-module, termed Mkt_{int}, to be based on two pre-defined factors, an upward and downward shock in the term structure of interest rates combined with specific alterations in the interest rate implied volatility. The combination of the instantaneous shift of these factors yields a total of four pre-defined scenarios.

4.11 The first two scenarios will consider an upward shock to interest rates, whilst implied volatility experience an upward and downward parallel shift and will deliver $Mkt_{int}^{Up}{}_{ivol}^{Up}$ and $Mkt_{int}^{Up}{}_{ivol}^{Dn}$. The last two scenarios will consider a downward shock to interest rates and will deliver $Mkt_{int}^{Dn}{}_{ivol}^{Up}$ and $Mkt_{int}^{Dn}{}_{ivol}^{Dn}$. The capital charge Mkt_{int} will then be determined as the maximum of the capital charges $Mkt_{int}^{Up}{}_{ivol}^{Up}$, $Mkt_{int}^{Up}{}_{ivol}^{Dn}$, $Mkt_{int}^{Dn}{}_{ivol}^{Up}$ and $Mkt_{int}^{Dn}{}_{ivol}^{Dn}$, subject to a minimum of zero.

4.12 The capital charges Mkt_{int}^{Up} and Mkt_{int}^{Down} will be calculated as

$Mkt_{int}^{Up}{}_{ivol}^{Up} = \Delta NAV|_{upwardshock}$ and $Mkt_{int}^{Up}{}_{ivol}^{Dn} = \Delta NAV|_{up\&downshock}$

$Mkt_{int}^{Dn}{}_{ivol}^{Up} = \Delta NAV|_{down\&upshock}$ and $Mkt_{int}^{Dn}{}_{ivol}^{Dn} = \Delta NAV|_{downwardshock}$

where $\Delta NAV|_{upwardshock}$, $\Delta NAV|_{downwardshock}$, $\Delta NAV|_{up\&downshock}$ and $\Delta NAV|_{down\&upshock}$ are the changes in net values of assets and liabilities due to revaluation of all interest rate sensitive assets and liabilities based on:

1. Specified alterations to the interest rate term structures

combined with:

2. Specified alterations to interest rate volatility.

4.13 The volatility shocks are relevant only where insurers' asset portfolios and/or their insurance obligations are sensitive to changes in interest rate volatility, for example where liabilities contain embedded options and guarantees. Thus, for many non-life obligations, for example, the interest rate volatility stress will be immaterial and on that basis could be ignored.

4.14 The analysis below considers the calibration of the shock scenarios across the interest rate term structure, and also takes into account the impact of corresponding changes in implied volatility, as proposed in CP47.

Shocks to interest rate term structure

4.15 The altered term structures used in calculating the capital charge for this sub-module will be composed of several factors, although there will only be one upward shock and one downward shock to be applied at each maturity. As proposed in CP47, the analysis below provides a decomposition of the shocks so that the assumptions underlying the calibration are transparent.

4.16 The QIS4 technical specification paper alters the term structure of interest rates using two sets of upward and downward maturity dependent factors. Our analysis attempts to calibrate the relative changes of the term structure of interest rates using the following datasets:

- EUR government zero coupon term structures. The daily data spans a period of approximately 12 years and starts from August 1997 to May 2009. The data, sourced from Bundesbank's website, contains daily zero coupon rates of 1 year to 15 year maturities spaced out in annual intervals. The data is publicly available at www.bundesbank.de/statistik/.

- GBP denominated government zero coupon term structures. The data is daily and sourced from the Bank of England. The data covers a period from 1979 to 2009, and contains zero coupon rates of maturities starting from 6 months up until 25 year whilst the in between data points are spaced on semi-annual intervals. In total, we have 50 data points every day since 1979, albeit some of the longer maturities (i.e., beyond 15 years) are only available at later dates. The data is available at http://www.bankofengland.co.uk/statistics/index.htm.

- Euro and GBP libor/swap rates. The daily data is downloaded from Bloomberg and covers a period from 1997 to 2009. The data contains 3-month, 6-month and 12-month libor rates, the 2 to 10 year rates spaced out in one year intervals, as well as the 15 year, 20 year and 30 year rates across both currencies.

4.17 In the spirit of QIS4, the altered term structures are derived by multiplying the current interest rate curve by the upward and downward stress factors. These factors are defined across maturity and currency, as well as type of security.

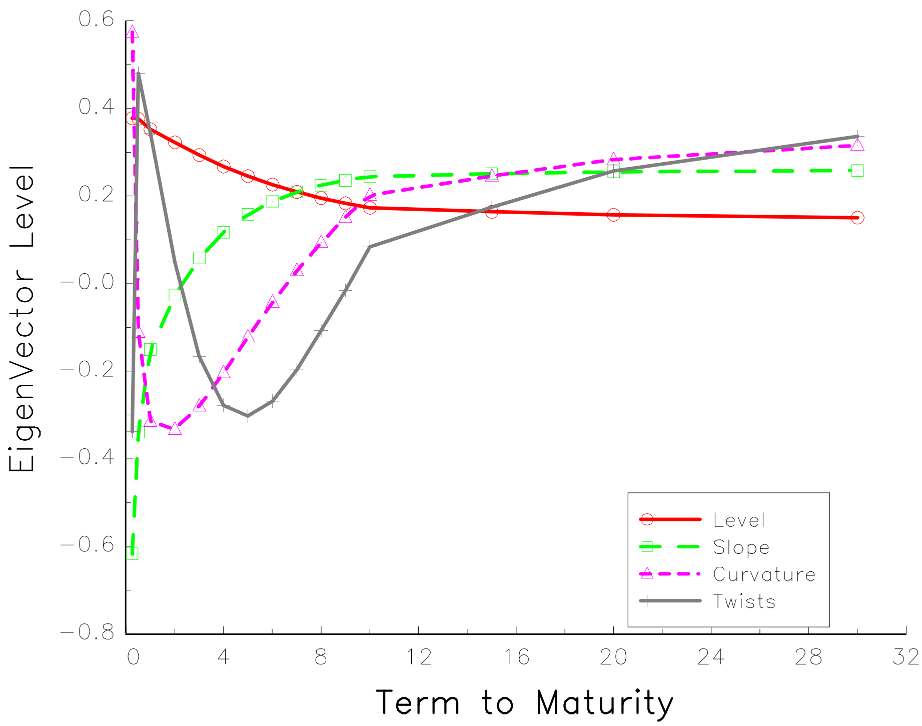
4.18 Our analysis relies on Principal Component Analysis[3] (PCA) to specify the above tabulated scenarios. PCA is proposed as a tractable and easy-to-implement method for extracting market risk. For a collection of annual percentage rate changes, the number of principal components (PCs) to be retained for further analysis is determined by the variance–covariance structure of each underlying data set (i.e., PCA is applied to each individual dataset).

[3] 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.

4.19 We find that four principal components are common across all datasets, and these explain 99.98% of the variability of the annual percentage rate change in each of the maturities in the underlying datasets.

4.20 The derived factors are recognised as the level, slope and curvature of each of the term structures, whilst the fourth factor may represent a "twist" in certain maturity points of the underlying yield curve. The figure below illustrates the associated eigenvectors.

4.21 The position of the yield curve is affected by current short term interest rates, denoted by the 'level', whilst the slope is mainly affected by the difference between long-term and short term interest rates. The curvature of the interest rates is associated with the volatility of the underlying interest or forward rate and the twists represent shocks to specific maturity point on the interest rate yield curve.



4.22 The table below presents the total variance explained by successive principal components (1=level, 2=slope, 3=curvature, 4=twist)

PC's	EU GOV	EUR Swap	GBP GOV	GBP Swap
1	90.32%	89.20%	76.37%	92.04%
2	9.02%	9.00%	20.15%	6.33%
3	0.61%	1.52%	2.88%	1.23%
4	0.04%	0.14%	0.35%	0.21%
Total Variance Explained	**99.99%**	**99.86%**	**99.76%**	**99.81%**

4.23 The derived PC's or factors are standardised (i.e., have zero mean and unit standard deviation) and are subsequently used in a regression model. The purpose of this model is to calculate the 'beta' sensitivity of each yield to maturity, expressed as annual percentage rate changes, to the above four factors[4]. Our table of upward and downward stressed factors represent the maximum and minimum model-implied shifts respectively. These are proposed in the following table:

	QIS 4		New Stresses	
Maturity in Years	**Up**	**Dn**	**Up**	**Dn**
0.25			94%	-87%
0.5			94%	-87%
1	94%	-51%	94%	-87%
2	77%	-47%	85%	-73%
3	69%	-44%	78%	-63%
4	62%	-42%	70%	-56%
5	56%	-40%	64%	-50%
6	52%	-38%	60%	-46%
7	49%	-37%	58%	-42%
8	46%	-35%	55%	-39%
9	44%	-34%	53%	-36%
10	42%	-34%	51%	-34%
11	42%	-34%	49%	-34%
12	42%	-34%	47%	-34%
13	42%	-34%	45%	-34%
14	42%	-34%	43%	-34%
15	42%	-34%	44%	-34%
16	41%	-33%	41%	-33%
17	40%	-33%	40%	-33%
18	39%	-32%	40%	-32%
19	38%	-31%	40%	-32%
20	37%	-31%	40%	-33%
21			39%	-33%
22			39%	-33%
23			38%	-34%
24			37%	-43%
25+			37%	-49%

4.24 By blending the results of analysis of the various term structure data sets, we arrive at the above table of stress factors. Our analysis indicates that the effects of the current credit crisis induce more pronounced stresses on both the government and swap yield curves when compared to the stress factors specified in QIS4. In the Annex to this paper, we provide a detailed analysis of this comparison.

[4] For a maturity, m, we regress the derived annual percentage rate changes on the four PCs to derive the 'beta' sensitivity of each rate to each PC. The combined sum returns the stress factor for maturity m.

4.25 The analysis is based on time series of euro and pound interest rates and therefore reflects the European economic experience of the last 30 years. This experience may not in all cases be representative of future economic conditions. A comparison with other developed economies (e.g. the United States or Japan) shows that financial parameters may develop differently from what was observed in the past in Europe. In particular, there may be deflationary scenarios like in Japan in the 1990s.

4.26 The multiplicative stress approach where the current interest rate is multiplied with a fixed stress factor to determine the stressed rate leads to lower absolute stresses in times of low interest rates. This may underestimate in particular the deflation risk. In order to capture deflation risk in a better way, the floor to the absolute decrease of interest rates in the downward scenario could be introduced. For example, the absolute decrease could have a lower bound of one percentage point. If the interest rate for maturity 10 years is 2%, the shocked rate would not be (1 - 34%)·2% = 1.32%, which is likely to underestimate the 200 year event, but 2% - 1% = 1%, which can be considered to be a more reasonable change.

4.27 The downward stress can be defined by the following formula:

$r' = \max(\min((1 + \text{stress factor})\cdot r;\ r\text{-}1\%);0)$,

where r is the unstressed and r' the stressed rate.

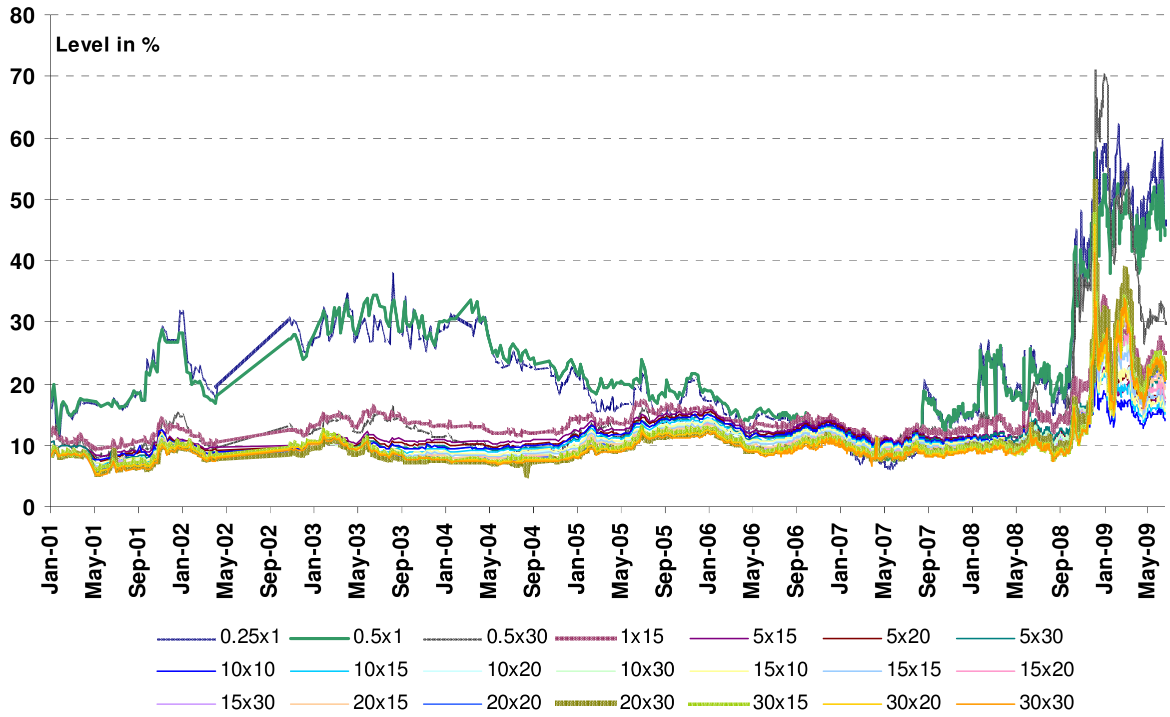
Shocks to interest rate volatilities

4.28 The volatility of forward rates plays a vital role in the determination of the slope and curvature 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 may have subsequent "spill-over" effects onto the shape and curvature of the underlying term structure.

4.29 As a result, interest rate volatility has material impact on the assets and/or liabilities of (re)insurance undertakings that have embedded guarantees in their business. This is likely to affect in particular traditional participating business, certain types of annuity business and other investment contracts.

4.30 Insurers may be sensitive to a reduction in volatility via derivatives they may hold in their asset portfolios for interest rate immunisation purposes. Additionally, and as observed during the recent financial crisis, insurers' assets and liabilities are sensitive to increases in volatility wherever there are embedded guarantees. As an "order of magnitude" estimate, the impact of changes in interest rate volatility might be around 1% of the undiversified SCR – however, the impact will vary between member states as well as between the types of products written.

4.31 We use a set of EUR and GBP implied volatility data covering a daily period of 11 years to deduce the stress factors at the 99.5% level. This data sample starts in April 1998 and ends in May 2009 and spans across 8 option maturities and 8 swap terms. The data is sourced from Bloomberg. The figure below presents historical time series of selected implied volatility series (N-year option x T-year swap, as explained in the next paragraph below).



4.32 Using the above data, we calculate the distribution of the annual percentage changes in the implied volatility. We note that there are two dimensions to the implied volatility data. One dimension is the maturity of the option and the other denotes the term of the swap. For example, a 30 x 30 swaption contract denotes that the maturity of the option is 30 years, whilst the term of swap is 30 years starting from the maturity of option. In the figure above, we use 21 of these contracts, while in our database we have 64 series.

4.33 For the standard formula calibration we have used only at-the-money swaption prices. However, in practice, the optionality in insurers' asset portfolios and in embedded guarantees will exhibit a spectrum of moneyness at any particular point in time. Insurers whose legacy portfolios and new business embeds high guarantees could experience capital shortfalls when implied volatility is shocked upwards.

4.34 The altered implied volatility surfaces are derived by multiplying the current implied volatility term structure by upward and downward stress factors. An analysis of downward volatility stresses leads to the following stress factors:

Option Maturity	Swap Term 1	2	3	5	10	15	20	30
0.25	-44%	-28%	-25%	-21%	-11%	-8%	-10%	-10%
0.5	-36%	-26%	-23%	-18%	-14%	-13%	-13%	-13%
1	-27%	-23%	-20%	-16%	-20%	-21%	-20%	-21%
5	-23%	-24%	-23%	-22%	-21%	-21%	-20%	-19%
10	-24%	-24%	-23%	-22%	-20%	-20%	-19%	-18%
15	-24%	-23%	-22%	-22%	-21%	-19%	-18%	-17%
20	-23%	-21%	-22%	-20%	-21%	-20%	-18%	-19%
30	-24%	-21%	-22%	-20%	-22%	-20%	-20%	-21%

4.35 In addition, an analysis of the upward volatility stress leads to the following stress factors:

Option Maturity	Swap Term 1	2	3	5	10	15	20	30
0.25	309%	288%	236%	204%	206%	260%	330%	464%
0.5	253%	241%	198%	180%	173%	219%	263%	378%
1	176%	151%	137%	130%	142%	176%	214%	295%
5	65%	66%	68%	72%	88%	114%	147%	200%
10	55%	58%	60%	70%	95%	155%	171%	222%
15	85%	88%	92%	108%	157%	193%	227%	264%
20	172%	182%	194%	215%	228%	254%	280%	288%
30	245%	250%	243%	229%	253%	256%	251%	251%

4.36 For example in the case of the N x T -year implied volatility the rate in 12 months time in the downward stress test scenario corresponds to:

$$R_{12}(N\ x\ T) = R_0(N\ x\ T)x(1+s_{dn})$$

where N denotes the option maturity and T corresponds to the swap maturity of the specific implied volatility rate. For example, the stressed implied volatility corresponding to an option term of 10 years and to a swap term of 10 years, that is the 10 x 10 contract, is stressed by -20% in the downward scenario, whilst the same contract experiences an upward shock of 95% in the upward scenario.

4.37 To avoid excessive complexity, this matrix will be collapsed to consider only one contract, which may approximate better the characteristics of the guarantees embedded in the (re)insurers' liabilities. This is the most important dimension when considering the impact of volatility on (re)insurers' embedded guarantees. Reduction to one dimension can be achieved by considering the typical duration of (re)insurers' liabilities; the proposal below assumes a duration corresponding to an option term of 10 years and of a swap term of, say, 10 years.

4.38 As a natural extension of the two-sided stress proposed above, we consider using the 10x10 contract as a representative on average of the duration of the guaranteed liabilities embedded in (re)insurer's balance sheets. On an annual implied volatility basis, therefore, the above analysis therefore leads to the following (relative) volatility stresses:

Up stress (relative)	95%
Down stress (relative)	-20%

4.39

Question to stakeholders

Is the downward shock to volatility relevant and material for insurers' portfolios in the context of the standard formula? Please provide examples to explain your view.

4.40 As set out in paragraph 4.11, the empirical charge for interest rate risk is derived from the type of shock that gives rise to the highest capital charge including the risk absorbing effect of profit sharing. The capital charge Mkt_{int} will then be determined as the maximum of the capital charges $Mkt_{int}{}^{Up}{}_{ivol}{}^{Up}$, $Mkt_{int}{}^{Up}{}_{ivol}{}^{Dn}$, $Mkt_{int}{}^{Dn}{}_{ivol}{}^{Up}$ and $Mkt_{int}{}^{Dn}{}_{ivol}{}^{Dn}$, subject to a minimum of zero. This can be expressed as

$$Mkt_{int} = \mathrm{Max}\ (\ \mathrm{Mkt_{int}}^{\mathrm{Up}}{}_{\mathrm{ivol}}{}^{\mathrm{Up}}, \mathrm{Mkt_{int}}^{\mathrm{Up}}{}_{\mathrm{ivol}}{}^{\mathrm{Dn}}, \mathrm{Mkt_{int}}^{\mathrm{Dn}}{}_{\mathrm{ivol}}{}^{\mathrm{Up}}, \mathrm{Mkt_{int}}^{\mathrm{Dn}}{}_{\mathrm{ivol}}{}^{\mathrm{Dn}}, 0\ )$$

4.41 As an example, to calculate the capital charge $Mkt_{int}{}^{Up}{}_{ivol}{}^{Dn}$ applying for an interest rate of term 10 years, and given current 10-year rate of r% and volatility of v%, an undertaking would need to calculate the change in net asset value on moving to stressed interest rate of (1+51%).r% and stressed volatility of (1-20%).v%.

4.2.2. CEIOPS' advice

Interest rate risk

4.42 Based on the assumptions contained in the explanatory text, CEIOPS has calibrated the sub-module according to 99.5% VaR and a one year time horizon.

4.43 The calibration of the standard formula interest rate capital charge is based on a delta-NAV approach, as proposed in CP47.

4.44 The capital charge arising from this sub-module, termed Mkt_{int}, will be based on two pre-defined factors, an upward and downward shock in the term structure of interest rates combined with specific alterations in the interest rate implied volatility. The combination of the instantaneous shift of these factors yields a total of four pre-defined scenarios.

4.45 The first two scenarios will consider an upward shock to interest rates, whilst implied volatility experience an upward and downward parallel shift and will deliver $Mkt_{int}{}^{Up}{}_{ivol}{}^{Up}$ and $Mkt_{int}{}^{Up}{}_{ivol}{}^{Dn}$. The last two scenarios will consider a downward shock to interest rates and will deliver $Mkt_{int}{}^{Dn}{}_{ivol}{}^{Up}$ and $Mkt_{int}{}^{Dn}{}_{ivol}{}^{Dn}$. The capital charge Mkt_{int} will then be determined as the maximum of the capital charges $Mkt_{int}{}^{Up}{}_{ivol}{}^{Up}$, $Mkt_{int}{}^{Up}{}_{ivol}{}^{Dn}$, $Mkt_{int}{}^{Dn}{}_{ivol}{}^{Up}$ and $Mkt_{int}{}^{Dn}{}_{ivol}{}^{Dn}$, subject to a minimum of zero.

The capital charges Mkt_{int}^{Up} and Mkt_{int}^{Down} will be calculated as

$Mkt_{int}^{Up}{}_{ivol}^{Up} = \Delta NAV|_{upwardshock}$ and $Mkt_{int}^{Up}{}_{ivol}^{Dn} = \Delta NAV|_{up\&downshock}$

$Mkt_{int}^{Dn}{}_{ivol}^{Up} = \Delta NAV|_{down\&upshock}$ and $Mkt_{int}^{Dn}{}_{ivol}^{Dn} = \Delta NAV|_{downwardshock}$

where $\Delta NAV|_{upwardshock}$, $\Delta NAV|_{downwardshock}$, $\Delta NAV|_{up\&downshock}$ and $\Delta NAV|_{down\&upshock}$

are the changes in net values of assets and liabilities due to revaluation of all interest rate sensitive assets and liabilities based on specified alterations to the interest rate term structures combined with specified alterations to interest rate volatility.

4.46 The term structure stresses for interest rates will be as follows, with QIS4 stresses for comparison:

	QIS 4		New Stresses	
Maturity in Years	**Up**	**Dn**	**Up**	**Dn**
0.25			94%	-87%
0.5			94%	-87%
1	94%	-51%	94%	-87%
2	77%	-47%	85%	-73%
3	69%	-44%	78%	-63%
4	62%	-42%	70%	-56%
5	56%	-40%	64%	-50%
6	52%	-38%	60%	-46%
7	49%	-37%	58%	-42%
8	46%	-35%	55%	-39%
9	44%	-34%	53%	-36%
10	42%	-34%	51%	-34%
11	42%	-34%	49%	-34%
12	42%	-34%	47%	-34%
13	42%	-34%	45%	-34%
14	42%	-34%	43%	-34%
15	42%	-34%	44%	-34%
16	41%	-33%	41%	-33%
17	40%	-33%	40%	-33%
18	39%	-32%	40%	-32%
19	38%	-31%	40%	-32%
20	37%	-31%	40%	-33%
21			39%	-33%
22			39%	-33%
23			38%	-34%
24			37%	-43%
25+			37%	-49%

4.47 Irrespective of the above stress factors, the absolute change of interest rates in the downward scenario should at least be one percentage point. Where the unstressed rate is lower than 1%, the shocked rate in the downward scenario should be assumed to be 0%.

4.48 Based on the analysis set out earlier in this paper we propose interest rate volatility stresses of 95% in the upward direction and 20% in the downward direction, to be applied as relative stresses.

4.3 Currency risk

4.3.1. Explanatory text

4.49 CP47 proposed a scenario-based approach for calculating the capital charge for currency risk.

4.50 As set out in that paper, the capital charge arising from this sub-module will be Mkt_{fx} and will be calculated based on two pre-defined scenarios: for each currency C, one scenario will consider a rise in the value of the foreign currency against the local currency and will deliver $Mk_{fx,C}{}^{Up}$; the other scenario will consider a fall in the value of the foreign currency against the local currency and will deliver $Mkt_{fx,C}{}^{Down}$. All of the undertaking's individual currency positions and its investment policy (e.g. hedging arrangements, gearing etc.) should be taken into account. For each currency, the contribution to the capital charge $Mkt_{fx,C}$ will then be determined as the maximum of the results $Mkt_{fx,C}{}^{Up}$ and $Mkt_{fx,C}{}^{Down}$. The total capital charge Mkt_{fx} will be the sum over all currencies of $Mkt_{fx,C}$.

4.51 We note at this point that currency effects appear only in this sub-module. That is, the calibration of the other market risk sub-modules has been carried out in such a way that currency effects are stripped out.

4.52 The QIS3 technical specification document derived a 20% stress factor for currency risk, in preference to the 25% stress factor proposed in QIS2. Furthermore, for QIS3 the implied stress factor was derived assuming a diversified currency portfolio (i.e., 35% in USD, 24% in GBP, 13% in Argentine Peso, 8% in JPY, 7% in SEK, 7% in CHF and 6% in AUD), which approximates the currency positions held by Dutch financial institutions. In this exercise, currency exposure to emerging markets was approximated by the Argentine Peso.

4.53 In our analysis, we show that the risk at the 99.5th percentile is exacerbated above the 20% level proposed for QIS3 in portfolios whose composition is solely in currencies that suffered much stronger moves. Furthermore, we use a currency portfolio diversified across 6 economies as a proxy to currency exposures of emerging markets.

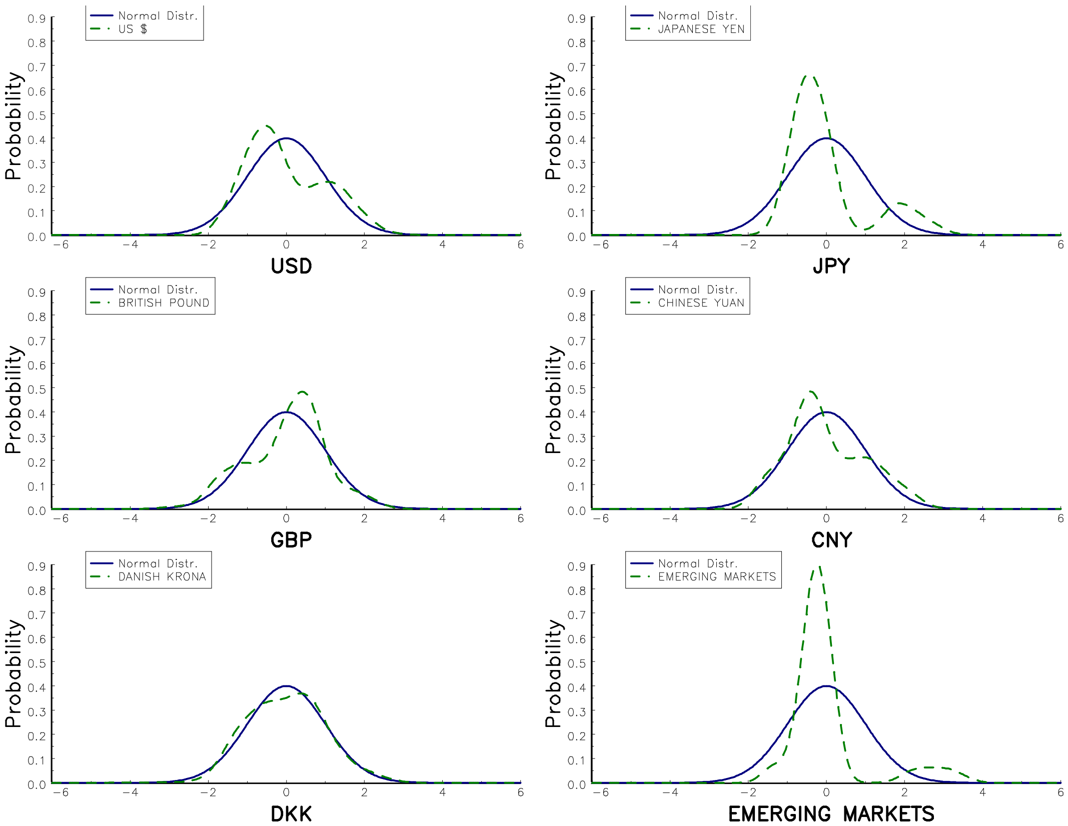
4.54 We use daily data to study the distribution of holding period rate of returns derived from EUR and GBP currency pairs. Our data sample, sourced from Bloomberg, covers a daily period from January 1971 to June 2009, a total of circa 10,000 observations across 14 currency pairs against GBP. In addition, our sample consists of 14 currency pairs expressed against the EUR. For most pairs, this sample covers a daily period spanning a period of 10 years starting in 1999 to 2009. We compute annual holding period returns 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).

4.55 Our proxy to emerging market economies is mainly a proxy to Pacific Basin[5] economies. This is a currency basket expressed against the EUR, and is equally distributed across CNY, INR, HKD, AUD, BRL and ARS. We prefer to extend the definition of the emerging markets 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 our mix balances out the level of the stress as we believe that insurance groups are more exposed to these economies across the Pacific basin region. Below, we refer to this currency mix as EM.

4.56 We estimate the full probability density and especially the lower percentiles using non-parametric methods as described in Silverman (1986). The figures below illustrate the standardised probability density functions of a representative sample of six currency pairs against EUR, which are implied from the annual holding period returns of the corresponding currency pairs.

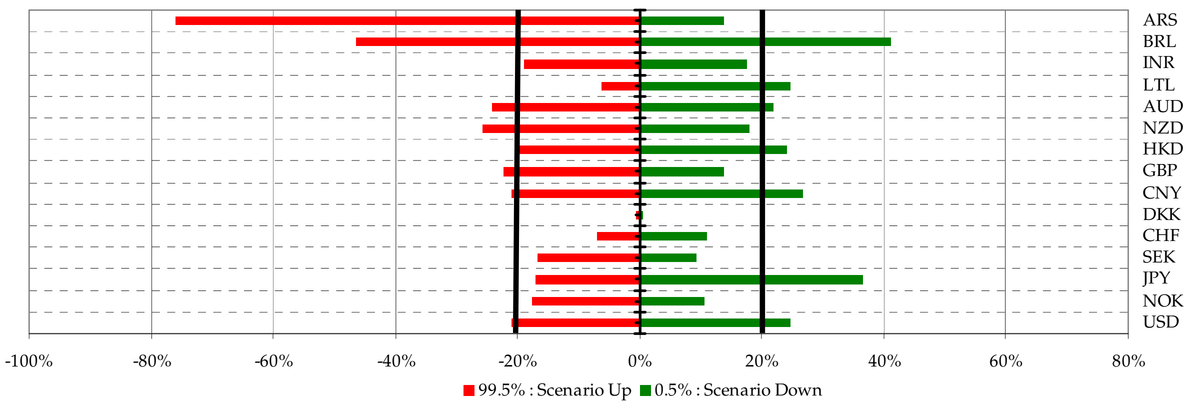
4.57 QIS3 and 4 define a symmetric stress factor on the assumption that the percentage changes in currency rates are normally distributed. A visual inspection of different standardised distributions, which are plotted against the normal distribution shows that the data does not adhere to the laws of normal distribution. Most distributions are skewed and exhibit excess kurtosis.

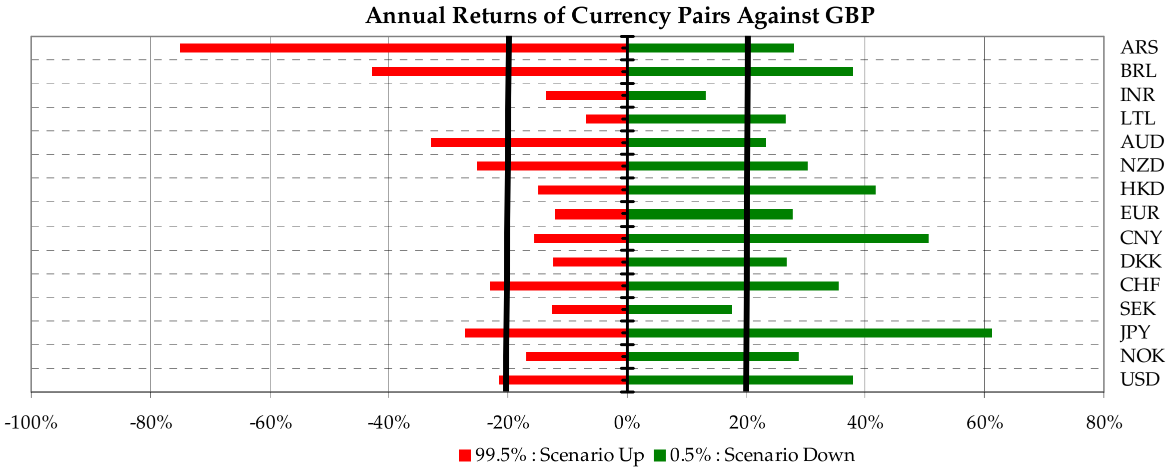
[5] The term Pacific Basin economies mainly refers to all East Asian Economies. In this basket are approximated by Hong Kong dollar, the Chinese Yuan and the Indian Rupee. However, as discussed in 4.68 below, our conclusion would be broadly unchanged if other emerging market currencies, or for example Eastern European currencies, were used instead of Pacific Basin economies.



4.58 The following two charts illustrate the 99.5th percentiles, left and right tail, of the annual holding period returns of currency pairs against the EUR and GBP respectively. The symmetric band proposed by QIS3 is highlighted with a bold black line.

Annual Returns of Currency Pairs Against EUR





4.59 The above results indicate that the year-on-year movements in currencies are asymmetric at the tail of the distribution and are likely to fall out of the symmetric 20% band. According to our results, this is equally likely also for currency pairs against the British pound. Most breaches of the proposed band occurred over 2008 to 2009 across both sets of currency pairs.

4.60 The following table illustrates the worst year-on-year percentage currency change estimated within the period covered by our sample (1971 – 2009). In almost all cases, the currency pairs have breached the proposed stress factor of 20%. Exceptions are the Danish krone and the Lithuanian litas. These results indicate that correlations break down at the tail of the distribution, albeit the documented evidence tabulated below occurs at different periods.

	EUR	GBP	Band Breach	QIS 3: Portfolio Weights
USD	**-22.44%**	**-29.35%**	Yes	35%
NOK	**-20.05%**	**-21.83%**	Yes	
JPY	*-18.37%*	**-30.30%**	Only in GBP	8%
SEK	*-19.99%*	*-14.72%*		7%
CHF	*-7.93%*	**-25.53%**	Only in GBP	7%
DKK	*-1.64%*	*-13.28%*		
CNY	**-22.39%**	*-16.25%*	Only in EUR	
HKD	**-22.47%**	*-15.84%*	Only in EUR	
NZD	**-26.93%**	**-28.34%**	Only in GBP	
AUD	**-26.20%**	**-36.05%**	Yes	6%
LTL	*-8.43%*	*-7.82%*		
INR	*-19.97%*	*-14.71%*		
BRL	**-48.14%**	**-46.46%**	Yes	
ARS	**-77.66%**	**-83.64%**	Yes	13%
EUR		**-13.21%**		
GBP	**-24.69%**		Only in EUR	24%
Revised Shock	-28.87%	-28.55%		

4.61 Given our analysis, we would not expect the symmetric stress factor of $\pm 20\%$ to be a strict representative of a 1 in 200 stress even for a well diversified currency mix. In this particular case, if we were to combine the above tabulated shocks with the specific currency mix proposed in QIS3 technical specification paper, the currency stress test is closer to 29%.

4.62 The level of the revised stress test crucially depends upon the choice of the optimal currency weights, while the choice of the Argentine peso as a proxy to emerging markets introduces a degree of bias as well as conservatism. We have carried out sensitivity testing on our result by varying both sets of assumptions. The table below presents 16 sets of alternative choices of portfolio weights, whilst we use a well diversified proxy of emerging markets termed EM.

4.63 The results demonstrate the sensitivity of our revised shock to the initial assumptions. Portfolio 1 represents the currency exposures of Dutch financial institutions, as proposed by QIS3 and discussed above. Portfolio 2 tests the sensitivity of the revised shock to the Argentine peso, and uses the alternative EM portfolio as a proxy to currency exposures across different markets. Portfolio 2 produces a 25% shock compared to the 29% shock produced by Portfolio 1.

4.64 Ideally, we would prefer to have an average weight representing the average currency exposures of European insurers to Pacific Basin economies. The lack of aggregate data encourages further testing. We further carried out sensitivity analysis of our results to different weights of EM, testing the sensitivity of the revised shock to concentration in EM of 10%, 20%, 25%, 33% and 50% of the total portfolio. The table below presents the results of this analysis.

	Resulting Shock	Portfolio Weights															
		USD	NOK	JPY	SEK	CHF	DKK	CNY	GBP	HKD	NZD	AUD	LTL	INR	BRL	ARS	EM
1	-28.87%	35%		8%	7%	7%			24%			6%				13%	
2	-24.80%	35%		8%	7%	7%			24%			6%					13%
3	-21.84%	33%		33%					33%								
4	-29.05%	33%		33%													33%
5	-21.02%			33%	33%				33%								
6	-27.96%	25%		25%					25%								25%
7	-18.36%	25%		25%		25%			25%								
8	-22.93%	25%		25%					25%			25%					
9	-28.36%	25%			25%				25%								25%
10	-24.59%	25%	10%	10%	10%		10%		15%								20%
11	-23.57%	50%							50%								
12	-20.41%	50%		50%													
13	-34.39%	50%															50%
14	-24.49%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	
15	-22.26%	80%		10%					10%								
16	-19.68%	10%	10%	10%	10%	10%	10%		10%		10%		10%				10%

4.65 The sensitivity of the revised shock to alternative portfolio allocations to currencies in the emerging market (EM) basket is analysed in portfolios 2, 4, 6, 9, 10, 13 and 16. These results demonstrate that the revised shock could vary from a maximum of 34% to a minimum of 20%. A revised shock of 34% reflects a portfolio composision which is principally dominated by US dollar and emerging market currency exposures. On the other hand a resulting minimum of 20% reflects a small currency exposure of 10% to emerging market currencies, whilst maintaining all other allocations also equal to 10%.

4.66 We have also investigated the sensitivity of the results to USD, JPY, CHF and GBP concentrations as well as permutations of the portfolio in the absence of the emerging market basket. In these cases, the results of the revised shock vary within 18% to 25%.

4.67 On the basis of the above sensitivity stress tests, we propose a revised stress factor of 25%.

4.68 We could further expand our emerging market basket to include other currency pairs and re-test our proposed stress factor. Currency pairs that experience higher volatility than our proposed basket may contribute positively and further increase the stress factor, whilst currencies with more constrained volatility would not dramatically change our results.

4.69 In particular, we have investigated the inclusion of the Russian rouble and the Hungarian forint in the currency basket, as proxy for eastern European currencies. However, there was no substantial change in the overall results on the introduction of these two currencies.

4.70 Exceptions to the above analysis are the member states of the European Exchange Rate Mechanism (ERM II). The mechanism currently includes the the Danish krone, the Estonian kroon, the Lithuanian litas, and the Latvian lats[6]:

- The Danish krone entered the ERM II in 1999, when the euro was created, and the Denmark’s National bank keeps the exchange rate within a narrow range of ± 2.25% against the central rate of EUR 1 = DKK 7.460 38.

- The Lithuanian litas joined the ERM II on 28 June 2004.

- Latvia has a currency board arrangement, whose anchor switched from the IMF's SDR to the euro on 1 January 2005.

- The Estonian kroon had been pegged to the German mark since its re-introduction on 20 June 1992, and is pegged to the euro since 1 January 1999. Estonia joined the ERM II on 28 June 2004.

For the latter 3 currencies, on the basis of ERM II the exchange rate is fixed within a broader nominal band of ± 15%.

4.71 Moreover, for the three baltic currencies the responsible national banks strictly control the exchange rate to the euro:

[6] For definitions and further details on the exhange rate mechanism (ERM II) between the euro and participating national currencies, please refer to:
http://ec.europa.eu/economy_finance/the_euro/joining_euro9407_en.htm

- According to a commitment of the Bank of Lithuania the Lithuanian litas is pegged to the euro with a fixed exchange rate of 3.4528 since 2 February 2002.[7]

- As of 1 January 2005 the Latvian lats are pegged to the euro (at the rate 1 EUR = 0.702804 LVL. The Bank of Latvia performs interventions when the exchange rate of the lats exceeds the normal fluctuation margins of ±1%.

- According to a commitment of the Bank of Estonia the Estonian kroon is pegged to the euro with a fixed exchange rate of 15.6466 since 1 January 1999.[8]

4.72 Based on these central bank commitments the currency stress for the Lithuanian litas and the Estonian kroon against the euro can be neglected. The stress for the Latvian lats can be reduced to 1%.

Question to stakeholders:

CEIOPS would appreciate feedback on the particular treatment defined above for the three Baltic currencies.

4.73 The analysis set out above leads to the following proposal for calibration of the currency stress scenario:

Currency	**FX Stress: Up & Down scenario**	***QIS4 FX Stress***
Danish Krone against EUR	2.25%	*2.25%*
Estonian Kroon against EUR	0%	*15%*
Latvian lats against EUR	1%	*15%*
Lithuanian litas against EUR	0%	*15%*
All other currency pairs	25%	*20%*

4.74 The proposed currency tests for currencies that are pegged to the euro revert to the standard test of 25% when a country member of ERM II accepts euro as its currency or drops out of the ERM II.

[7] See website of the Bank of Lithuania: http://www.lb.lt/exchange/default.asp?lang=e.
The official fixed exchange rate of the litas against the euro (3.4528 litas per 1 euro), effective as of 2 February 2002, was set by the Resolution of the Government of the Republic of Lithuania (the official gazette "Valstybes zinios", 2002 No. 12-417) and the Resolution of the Board of the Bank of Lithuania (the official gazette "Valstybes zinios", 2002 No. 12-453).

[8] See website of the Bank of Estonia:
http://www.eestipank.info/pub/en/dokumendid/dokumendid/oigusaktid/maaruste_register/_1998/_118.html?metadata=yes&content=yes

4.3.2. CEIOPS' advice

Currency risk

4.75 Based on the assumptions contained in the explanatory text, CEIOPS has calibrated the sub-module according to 99.5% VaR and a one year time horizon.

4.76 The currency risk sub-module will be calculated as set out in CP47. The calibration of the required currency stresses is as follows, with the same magnitude of stress applying in both upward and downward directions:

Danish Krone against euro	±2.25%
Estonian Kroon against euro	±0%
Latvian Lats against euro	±1%
Lithuanian Litas against euro	±0%
All other currency pairs	±25%.

4.77 The stress tests for currencies that are pegged to the euro revert to the standard test of 25% when a country member of ERM II accepts euro as its currency or drops out of the ERM II.

4.4 Property risk

4.4.1. Explanatory text

4.78 CP47, on the design and structure of the market risk module, proposed a delta-NAV approach for the calculation of the property risk capital charge, with the capital charge Mkt_{prop} calculated as the result of a pre-defined scenario(s), $= \quad |$.

4.79 The property shock is the immediate effect on the net value of assets less liabilities of an x% fall in real estate values; the paragraphs below set out the analysis underlying CEIOPS' proposal for the calibration of the x% property shock scenario.

4.80 The stress factor for property risk is calibrated below using data extracted from the IPD (i.e., Investment Property Databank) indices. The indices are produced directly from survey data collected from institutional investors, property companies and open-ended investment funds. IPD produces (publicly available) property indices for most European markets and across some counties outside Europe (i.e., Australia, Canada US, Japan and South Africa).

4.81 The IPD index is, according to our understanding, the most widely used commercial property index in most countries. Other available indices include the JLL (Jones Lang LaSalle), the REI (Richard Ellis) indices and several residential indices.

4.82 IPD indices consist of time series of income (i.e., rental yield) and capital growth for main property market sectors – retail, office, industrial and residential. These sub-indices can further be divided into detailed sub-sectors, regions, size bands etc. IPD indices always show annual results, and for some countries there are also quarterly (Netherlands) and monthly indices (UK). IPD indices reporting frequencies are entirely dependent upon the prevailing local market valuation practices.

4.83 One of the most challenging factors of this specific calibration is the lack of long time series across most European markets. The QIS3 technical specification estimates the 99.5% shock "using the shortest common subset of returns", which reflects annual observations recorded over the period from 1998 to 2005. Instead of using the results derived from a market-weighted index of five countries, the final result is conservatively rounded to 20%. In addition, QIS2 offered no distinction between direct and indirect real estate holdings, while both QIS2 and QIS3 ignore different property market sectors.

4.84 We have based our analysis on monthly UK IPD total return indices spanning a period between 1987 to the end of 2008, a total of 259 monthly total returns. This data set provides the greatest and most detailed pool of information. In addition, our analysis aims to distinguish the 99.5% stress test scenario across types of property or property market sectors.

4.85 We recognise that the IPD total return indices are based on appraised market values rather than actual sales transactions. This leads to a degree of smoothing within the index data, as appraisers tend to be "backward-looking", dependent on previous valuation prices as part of the current valuation process.

4.86 A number of approaches have been put forward to de-smooth property returns. The QIS3 technical specification follows the most widely referenced approach, proposed by Fisher, Geltner and Webb (1994)[9]. This method expresses the "de-smoothed" return as a function of the present and past observable annual returns. The exact weight decomposition between present and past observations depends upon the estimation of an autoregressive model and on the condition that the "true" volatility of property values is approximately half the volatility of the S&P 500 stock market index.

4.87 The de-smoothing procedure proposed by Fisher, Geltner and Webb (1994) is modelled by applying standard time series estimation procedures to the IPD annual "smoothed" returns. A major disadvantage of this approach, however, is that the error term in the regression model does not necessarily have an expectation of zero.

[9] Fisher, J.D., Geltner, D. & Webb, R.B. (1994), Value indices of commercial real estate: a comparison of index construction methods, Journal of Real Estate Finance and Economics, 9, 137-164

4.88 Chao, Kawaguchi and Shilling (2003)[10] attempted to correct the inherent bias in the Fisher, Geltner and Webb approach and proposed to adjust the property returns by inflation. Although, Chao, Kawaguchi and Schilling (2003) limit the extent of the bias, the inflation-adjusted method does not eliminate this completely. Our preliminary analysis demonstrates that property returns are strongly influenced by equity returns, the slope of the government term structure and short-term interest rates. All these factors may also contribute to the appraised market values.

4.89 In fact, Booth and Marcato (2004)[11] follow the Fisher, Geltner and Webb (1994) approach to describe a regression model. Their results indicate that de-smoothing the UK IPD index over the period 1977 to 2002 increased the standard deviation of annual returns from 9.3% to 16.7%, whilst the 'de-smoothed' mean return rises by 0.9%. The mean total return from the IPD annual index is 12.5% from 1977 to 2002. When the capital value returns are de-smoothed the mean return increases slightly to 13.4%. Their method is still subjective and does not remove completely the serial correlation in the underlying data.

4.90 Edelstein and Quan (2006)[12] estimate the bias in an index by empirically comparing individual property appraisals to the aggregate index. Their procedure effectively estimates the smoothing effects and derives the corrected moments for commercial real estate. They report that the volatility of commercial real estate appears to be lower than the S&P 500 and the S&P Small Cap 600 indices.

4.91 Given these drawbacks in attempting to "de-smooth" the index data, our methodology concentrates on deriving the lower percentiles of the distribution of the "smoothed" property returns – that is, the unadjusted index data. We do this by using non-parametric methods, rather than drawing from a particular distribution.

4.92 The table below presents descriptive statistics and the lower percentiles of the distribution of the annual 'smoothed' property returns. These are recovered from the different property sectors throughout the UK. We have extracted annual returns from the data by creating rolling one-year windows from the monthly data.

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[10] Hoon, C., Y. Kawaguchi, Y. & Shilling, J.D. (2003), Unsmoothing commercial property returns: A revision of Fisher-Geltner-Webb's unsmoothing, Journal of Real Estate Finance and Economics, Vol. 27,3, 393-405

[11] Booth, P.M. and G. Marcato (2004), The measurement and modelling of commercial real estate performance, British Actuarial Journal, Vol. 10, 1,5-61

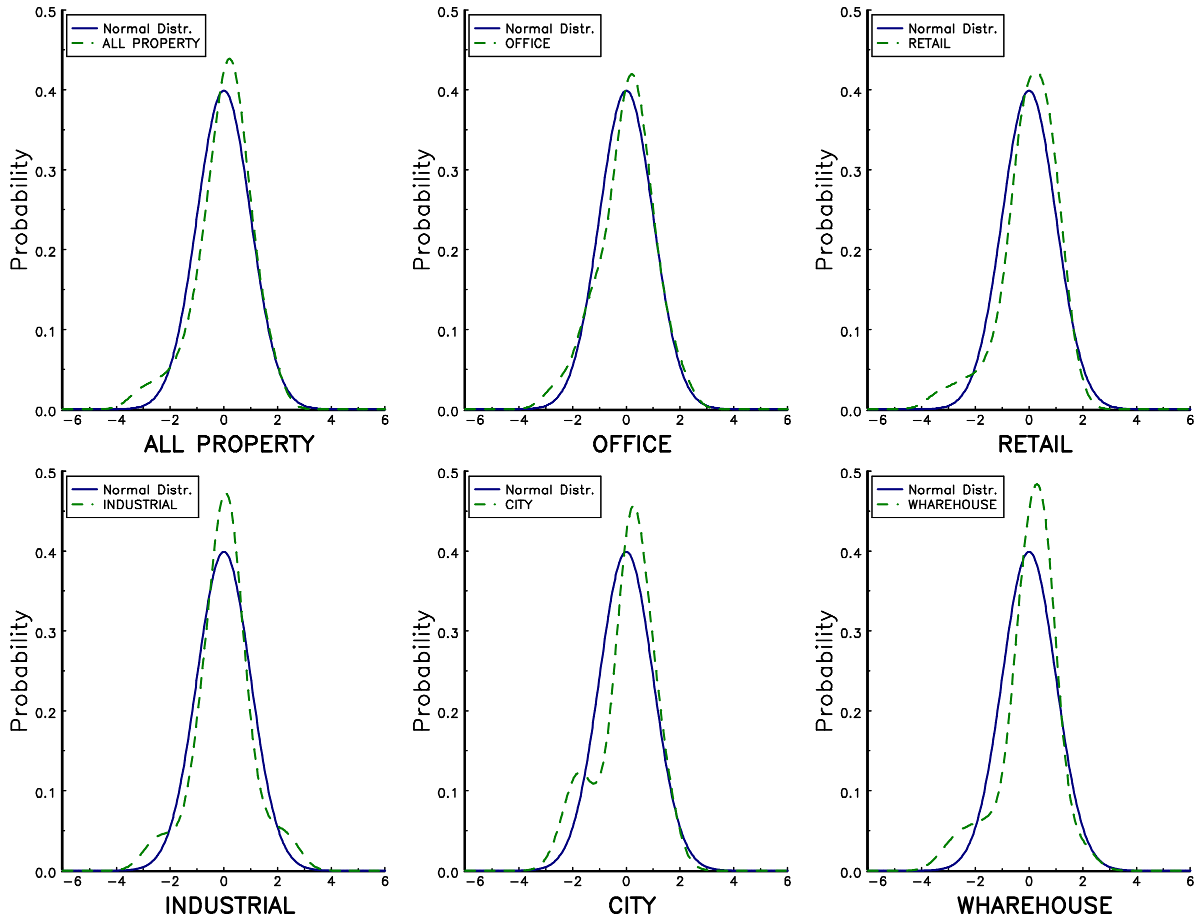
[12] Edelstein, R.H., & Quan, D. (2006), How Does Appraisal Smoothing Bias Real Estate Returns Measurement? , Journal of Real Estate Finance and Economics, 32, No.1

	ALL Property	Office	City Offices	Retail	Commercial
Maximum	29.51%	34.74%	33.14%	25.84%	40.14%
50%	9.78%	9.92%	8.00%	9.74%	13.54%
Mean	8.79%	8.19%	5.42%	8.56%	11.37%
1 in 10 or 10%	-5.26%	-8.50%	-18.87%	-4.76%	-6.61%
1 in 20 or 5%	-13.63%	-13.60%	-22.13%	-14.40%	-17.89%
1 in 100 or 1%	-25.28%	-25.62%	-29.42%	-26.82%	-27.38%
1 in 200 or 0.5%	**-25.74%**	**-25.93%**	**-30.03%**	**-27.47%**	**-27.67%**
Minimum	-25.88%	-25.96%	-30.10%	-27.69%	-27.71%
Std. Dev.	10.51%	11.93%	13.70%	10.15%	12.08%
Skewness	-0.8973	-0.4506	-0.7526	-1.2395	-1.1113
Excess Kurtosis	1.3527	0.3688	0.0572	2.0621	1.8115
Historical VAR	**25.74%**	**25.93%**	**30.03%**	**27.47%**	**27.67%**

4.93 In the definitions for the IPD datasets, the category "All-property" refers to a portfolio consisting of all-retails, all-offices, all-industrials and other commercials properties across the UK. The exact weight decomposition of this portfolio is 47.2%, 34.6%, 14.8% and 3.4% respectively. The category "Office" refers to offices located in London's West End, in the South East of England and in rest of UK. This category does not include offices in the city of London. The category "City Offices" is analysed separately and reflects offices in prime business location within a major financial area. "Retails" refer to high street shops in the south east England and in the rest of the UK as well as shopping centres and retail warehouses. The last category, "commercial" reflects warehouses other than retail located in different parts of the UK. These categorisations can easily be extended for application to the more general European case.

4.94 The figures below demonstrate the standardised distribution (i.e., mean is zero and unit standard deviation) of annual property returns across alternative property market sectors. All distributions of property returns are characterised by long left fat-tails and excess kurtosis signifying disparity from normal distribution.

4.95 In light of the above results, we further "un-smooth" annual returns using the aforementioned methods, albeit the methods do not eliminate the inherent bias. We find that the method further exacerbates the left tail to result in stress tests that may prove even more onerous, whilst the volatility of the adjusted de-smoothed index is much lower than the volatility of the MSCI developed total return index.



4.96 Our analysis on total return indices incorporates an element of conservatism, since we inherently assume that the rental yield earned on a property portfolio is re-invested back into the same pool.

4.97 In periods of severe stress, we may experience dramatic falls in property values combined with severely depressed rental yields, which in the worst case may collapse to zero. In this environment, the gap risk remains. Insurers may not be able to earn the minimum rental income equal to the risk free rate to match the underlying liabilities.

4.98 On the basis of our analysis of the smoothed data, we therefore recommend the following stress tests for property:

Property Sector	**Property Stress**
City Offices, Retail, Warehouse	30%
Offices other than City Offices	25%
All Other Property	25%

4.99 The capital charges arising from application of the stresses for each sector will be summed to arrive at the overall property risk capital charge.

4.100 These stresses compare with the uniform stress of 20% tested in QIS4.

4.101 In case of a fall of property returns as defined in the property stress scenario, the loss of basic own funds of the undertaking may exceed the loss directly connected to the property portfolio (i.e. loss in market value minus net rental yield), because the portfolio may cover discounted liabilities. The run-off of the discounted best estimate over the one year time horizon produces a technical loss in the amount of the discount rate. The discounting of technical provisions is based on the expectation that the undertaking will earn (at least) the discount rate. If the assets have a negative performance, the discount rate usually causes an additional technical loss. This loss is not allowed for in the property stress for reasons of practicability.

4.4.2. CEIOPS' advice

Property risk

4.102 Based on the assumptions contained in the explanatory text, CEIOPS has calibrated the sub-module according to 99.5% VaR and a one year time horizon.

4.103 Where the property stress is not broken down by sector, and for all other sectors not highlighted in paragraph 4.104, the stress is 25%.

4.104 The property stress applying for City Offices, Retail and Warehouse properties is 30%.

4.105 In the classification above, City Offices can be distinguished from Office properties as being offices located in prime city centre locations.

4.106 Retail properties include high street shops, shopping centres/malls and retail warehouses. Warehouse properties are warehouses other than retail warehouses.

4.107 The capital charges arising from application of the stresses for each sector will be summed to arrive at the overall property risk capital charge.

4.5. Spread risk

4.5.1. Explanatory text

4.108 Spread risk reflects the change in value of net assets due to a move in the yield on an asset relative to the risk-free term structure. The spread risk sub-module should address changes in both level and volatility of spreads.

4.109 According to CP 47, the spread risk sub-module applies to:

- Bonds (including loans guaranteed by mortgages, and deposits with credit institutions),

- Structured credit products, such as asset-backed securities and collateralised debt obligations,

- Credit derivatives, such as credit default swaps, total return swaps and credit linked notes.

4.110 The capital charge for spread risk will be determined by assessing the results of a factor-based calculation which considers a rise in credit spreads. 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. This also helps to avoid excessive complexity.

4.111 The spread risk sub-module will not explicitly model migration and default risks. Instead, these risks will be addressed implicitly, both in the calibration of the factors and in movements in credit spreads. For example, the impact of intra-month changes in rating will be reflected in any indices used to inform the calibration of the factors. The factors will also implicitly address not only the change in the level of credit spreads but also the term structure for the level of spreads. The sensitivity of the underlying portfolio to changes in the level of volatility of credit spreads is also indirectly considered in this sub-module.

4.112 In that regard, CEIOPS is considering developing risk factors that vary by spread duration to take into account the non-linearity of spread risk across duration and credit rating.

4.113 The factor-based approach will be built from the market value of the instrument in question, and will take into account the credit rating of the instrument and its duration.

Corporate bond investments of European insurance undertakings

4.114 The corporate bond investments of European insurance undertakings are generally of high quality. QIS4 data shows that about 87% is invested in the three most senior rating classes (AAA, AA, and A according to Standard&Poor's nomenclature).

Rating class	
AAA	37.8%
AA	27.4%
A	22.2%
BBB	6.7%
BB	0.8%
B	0.5%
CCC or lower	0.1%
Unrated	4.6%

Table 1: Distribution of bond investments of European insurance undertakings (based on QIS4 data)

4.115 Durations of these investments tend to be higher in the more senior rating classes as evidence from QIS4 data shows.

Rating class	10th percentile	25th percentile	Median	75th percentile	90th percentile
AAA	1.1	2.7	4.4	6.3	8.9
AA	1.2	2.5	4.3	5.7	7.5
A	1.0	2.5	4.0	5.6	7.6
BBB	1.0	2.5	4.0	5.4	7.1
BB	1.0	1.9	3.7	5.5	6.7
B	0.8	1.9	3.3	4.8	6.4
CCC or lower	1.0	2.3	3.8	4.6	6.7
Unrated	0.8	1.2	3.0	4.0	6.0

Table 2: Durations of bond investments of European insurance undertakings (based on QIS4 data)

QIS4 calibration

4.116 In QIS4 the capital charge for spread risk for bonds was determined by multiplying the market value of the bond with its modified duration and a function F of the rating class of the bond. The values of this function F as well as caps and floors for the duration measure can be found in the following table.

Rating class	$F(Rating_i)$	Duration floor	Duration cap
AAA	0.25%	1	-
AA	0.25%	1	-

A	1.03%	1	-
BBB	1.25%	1	-
BB	3.39%	1	8
B	5.60%	1	6
CCC or lower	11.20%	1	4
Unrated	2.00%	1	4

Table 3: QIS4 calibration parameters for corporate bonds

4.117 In QIS4 the capital charge for spread risk for structured credit instruments was analogously determined by multiplying the market value of the instrument with its modified duration and a function G of the rating class of the instrument. The values of this function G as well as caps and floors for the duration measure can be found in the following table.

Rating class	**G(Rating$_i$)**	**Duration floor**	**Duration cap**
AAA	2.13%	1	-
AA	2.55%	1	-
A	2.91%	1	-
BBB	4.11%	1	-
BB	8.42%	1	5
B	13.35%	1	4
CCC or lower	29.71%	1	2.5
unrated	100.00%	1	1

Table 4: QIS4 calibration parameters for structured credit products

4.118 For credit derivatives, the QIS4 capital charge was determined as the change in the value of the derivative (i.e. as the decrease in the asset or the increase in the liability) that would occur following (a) a widening of credit spreads by 300% if overall this was more onerous, or (b) a narrowing of credit spreads by 75% if this was more onerous. A notional capital charge should then be calculated for each event. The capital charge should then be the higher of these two notional changes.

Data

4.119 Corporate Bond Total Return Indices from Merrill Lynch were used for the calibration. For the Eurozone, sub-indices covering both maturity buckets and rating classes are available since 1998 on a daily basis. For US-Dollar issues, sub-indices are available since 1988.

4.120 Annual spread changes were calculated using daily returns and a one-year rolling window. To exclude the effect of movements in the risk-free rate, the corporate bond sub-indices were discounted by the simultaneous change in the government bond sub-index for each maturity bucket. The remaining variability in the corporate bond index comes from changes in the spread.

4.121 Indices of structured credit products exhibit highly diverging performance patterns since the beginning of the crisis. It turned out that not only the tranche rating of a securitisation determines the price, but also (and even primarily) the type and quality of the assets in the securitised asset pool.

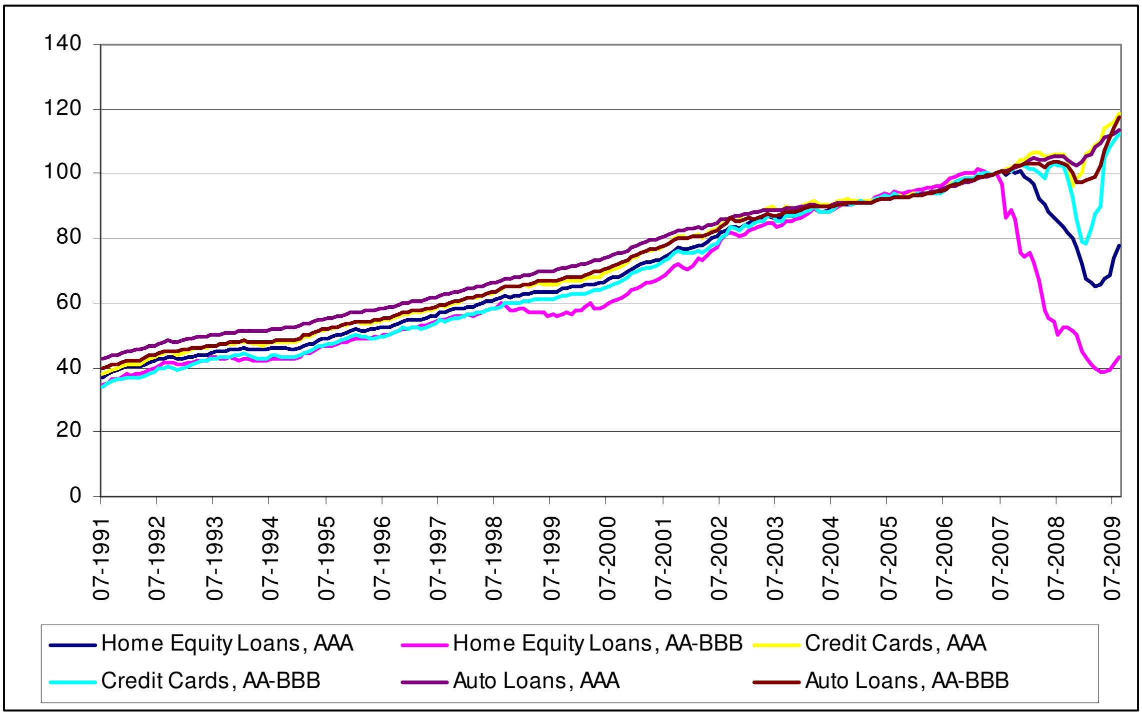


Figure 1: Merrill Lynch total return indices of various ABS structures (30/06/2007 = 100)

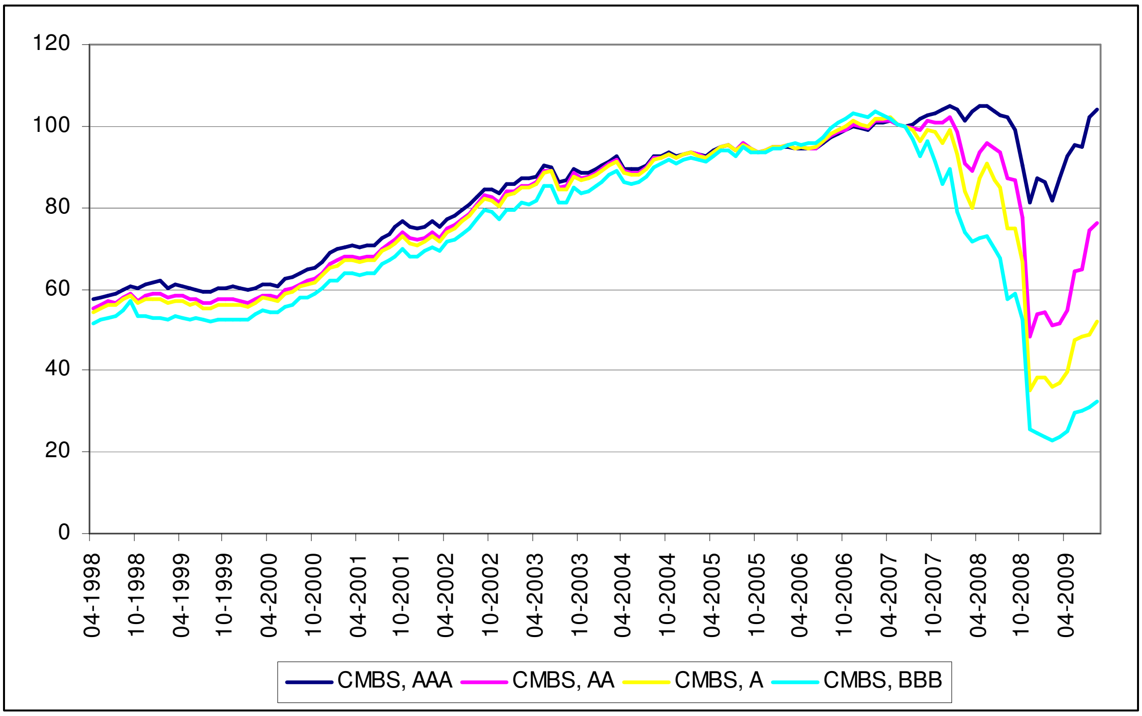


Figure 2: Merrill Lynch total return indices of various CMBS tranches (30/06/2007 = 100)

4.122 Hence, for structured credit products a model-based approach was used for the calibration. Based on the new rating methodology for Collateral Debt Obligations by Standard&Poor's, a set of hypothetical default rates for different rating classes and tenures of the assets within a securitised asset pool is used as model input. These default rates were calculated for highly diversified asset pools.[13]

Tenure (years)	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC**
1	0.8%	1.9%	4.3%	7.8%	19.8%	41.1%	64.7%
3	1.6%	3.1%	8.1%	15.9%	34.5%	59.7%	82.9%
5	2.3%	5.4%	11.6%	22.1%	43.4%	67.8%	88.4%
7	3.5%	7.4%	14.3%	27.5%	50.8%	73.6%	90.3%
9	4.7%	9.7%	17.4%	32.9%	56.6%	76.7%	91.9%

Table 5: Scenario Default Rates[14]

4.123 It should be noted that when deriving the calibration for the spread risk submodule, no ratings of structured credit instruments feed into the determination of the capital charge since such ratings were considered to

[13] Standard&Poor's: Update to Global Methodologies And Assumptions For Corporate Cash Flow CDO and Synthetic CDO Ratings, March 2009

[14] Standard&Poor's: Update to Global Methodologies And Assumptions For Corporate Cash Flow CDO and Synthetic CDO Ratings, March 2009

be one of the reasons for the current financial crisis.[15] Instead, ratings of the underlying assets are used which represents a look-through approach to the ultimate risks of a securitised asset. The specific characteristics of the structured credit instrument (especially the subordination of the tranche) feed in as additional inputs.

Results

4.124 The crudest way of calculating a parametric value-at-risk (VaR_{α}) is to multiply the estimate of the standard deviation of a given return series by the α-quantil of the standard normal distribution and subtract this product from the average return. However, this is only a valid procedure as long as the tail of the distribution declines fast enough (no "fat tails") and the shape of the distribution is symmetric around the mean. Unfortunately, credit spreads violate both assumptions; they are fat tailed (kurtosis) and exhibit significant negative event risk (skewness). To overcome those limitations, Zangari (1996)[16] and Favre and Galeano (2002)[17] came up with a modified VaR calculation that takes higher moments (skewness, kurtosis) of non-normal distributions into account through the use of a Cornish Fisher expansion, and collapses to a traditional VaR if the return stream follows a normal distribution.

4.125 For reasons of completeness, Annex I lists the values-at-risk based on a non-parametric (quantile) calculation. The comparison shows that the quantile approach tends to result in somewhat higher capital charges than the parametric Cornish Fisher approach for more senior rating classes – the opposite is true for lower rating classes.

Maturity Bucket (Years)	AAA	AA	A	BBB
1-3	2.2%	2.8%	8.7%	6.5%
3-5	4.2%	6.1%	12.7%	13.3%
5-7	6.7%	9.3%	19.4%	18.7%
7-10	7.4%	13.0%	25.5%	27.1%
10+	11.5%	19.1%	14.3%	27.5%[18]

Table 6: Cornish Fisher 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro corporate issues, investment grade

[15] Commission Staff Working Document accompanying the Proposal for a Regulation of the European Parliament and of the Council on Credit Rating Agencies – Impact Assessment, SEC(2008)2745, 12 November 2008

[16] Zangari, Peter: "A VaR Methodology for Portfolios that include Options", 1996, RiskMetrics Monitor, First Quarter, 4-12

[17] Favre, Laurent and Jose-Antonio Galeano: "Mean-Modified Value-at-Risk Optimization with Hedge Funds", Journal of Alternative Investment, Fall 2002, v 5

[18] The sub-index "BBB, 10+ years" is available only for the period January 2003 to July 2009.

4.126 For non-investment grade issues, the Merrill Lynch sub-indices do not provide a breakdown into maturity classes, instead Table 7 lists the VaRs for all maturities within a given rating class.

Maturity Bucket (Years)	**BB**	**B**	**C**	**BB-B**
All	35.4%	46.8%	64.1%	39.7%

Table 7: Cornish Fisher 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro corporate issues, non-investment grade

4.127 The spread risk calibration should not solely reflect the Euro corporate bond market, therefore further analysis was performed for US-Dollar issues.

Maturity Bucket (Years)	**AAA**	**AA**	**A**	**BBB**
1-3	7.1%	4.7%	8.6%	11.1%
3-5	8.8%	9.9%	14.2%	18.4%
5-7	11.3%	13.4%	17.9%	24.2%
7-10	11.7%	15.1%	18.4%	22.1%
10+	N/A	N/A	N/A	N/A

Table 8: Cornish Fisher 99.5% VaR of 1 year adjusted rolling return (since 1988), US-Dollar corporate issues, investment grade

Maturity Bucket (Years)	**BB**	**B**	**C**	**BB-B**
All	29.9%	39.0%	46.8%	34.8%

Table 9: Cornish Fisher 99.5% VaR of 1 year adjusted rolling return (since 1998), US-Dollar corporate issues, non-investment grade

4.128 Within the corporate bond universe, financials and non-financials show significantly different spread patterns (see Table 10 and Table 11). During the financial crisis, spreads of bank obligations have surged both in absolute terms and relative to non-financial obligations. In the period up to summer 2007, values-at-risk for AAA- and AA-rated obligations of financial issuers were actually smaller than those of non-financial issuers with the same rating.

All maturity buckets	**AAA**	**AA**	**A**	**BBB**
Financials	5.2%	8.5%	25.7%	41.5%
Non-	4.0%	4.2%	7.3%	14.2%

Financials				

Table 10: Cornish Fisher 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro financial and non-financial issues, investment grade

Maturity Bucket (Years)	**Financials, all investment grade rating classes**	**Non-Financials, all investment grade rating classes**
1-3	6.7%	3.6%
3-5	12.0%	7.9%
5-7	18.8%	12.1%
7-10	24.0%	14.5%
10+	20.7%	15.1%

Table 11: Cornish Fisher 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro financial and non-financial issues, investment grade

4.129 The Merrill Lynch corporate bond indices differ with respect to their weightings of financial and non-financial issues. For the AAA rating bucket, the share of financials is 93%; for AA, A and BBB ratings the weights of financials are 86%, 51% and 9%, respectively. Thus especially in more senior rating classes, the performance of corporate bond indices is determined mainly by the performance of financial issues.

Uniform stress

4.130 In order to derive the risk weights for bond holdings in the spread risk submodule, VaRs for Euro issuers and US-Dollar issuers are combined by assigning a 75% weight to the former one and a 25% weight to the latter one as a proxy for all non-Euro bond holdings.[19] The weighting should reflect the home bias in the investments of Eurozone insurance undertakings[20] which is partly due to restrictive asset allocation rules[21].

4.131 Table 12 shows the results for a combined portfolio of Euro and US-Dollar corporate bond investments (no diversification effects are taken into account as it is assumed that credit spreads narrow and widen in a similar manner across currency blocs).

4.132 For non-investment grade holdings, the sub-index BB-B has been chosen as a proxy. Given the only marginal holdings of European insurance undertakings in non-investment grade bonds, a further breakdown is not considered necessary.

Maturity Bucket	**AAA**	**AA**	**A**	**BBB**	**BB-B**

[19] The maturity class „10+ years" restates the Euro values as there are no corresponding US-Dollar sub-indices.

[20] See European Central Bank: "Potential Impact of Solvency II on Financial Stability", July 2007

[21] e.g. minimum investment amounts for matching liabilities in the same currency.

(Years)					
1-3	3.43%	3.28%	8.68%	7.65%	N/A
3-5	5.35%	7.05%	13.08%	14.58%	N/A
5-7	7.85%	10.33%	19.03%	20.08%	N/A
7-10	8.48%	13.53%	23.73%	25.85%	N/A
10+	11.50%	19.10%	14.30%	27.50%	N/A
All maturities	N/A	N/A	N/A	N/A	38.48%

Table 12: Combined VaR for a Euro/US-Dollar-Portfolio

4.133 Some adjustments to a small number of buckets ensure a smooth function of risk weights. These adjustments were mainly performed for the sub-index of rating class A which displayed higher losses than rating class BBB in the weeks following the Lehman bankruptcy in September 2008. The higher losses are largely due to the fact that in the A rating bucket some 50% of bonds were issued by financial firms while in the BBB bucket only 7% of the issues were from the financial sector.

	Risk weight old	Risk weight new
AA, 1-3 years	3.28%	4.50%
A, 1-3 years	8.68%	6.80%
A, 3-5 years	13.08%	11.50%
A, 5-7 years	19.03%	16.50%
A, 7-10 years	23.73%	21.50%
A, 10+ years	14.30%	24.00%

Table 13: Adjustment of selected risk weights

4.134 The smoothed risk weights of function F are summarised in Table 14.

4.135 Unrated issues are treated in a manner which reflects the treatment under Basel II in order to ensure cross-sectoral consistency. The standard 8% capital charge of the CRD feeds into the risk weight for the 0-2.9 years maturity bucket.

4.136 Unrated issues of credit institutions which are under the scope of the Capital Requirements Directive (2006/48/EC) should be treated as BBB-rated issues.

F(rating$_i$, maturity$_i$)	AAA	AA	A	BBB	BB or lower	Unrated
0-2.9 years	3.4%	4.5%	6.8%	7.7%	14.0%	8.0%
3-4.9 years	5.4%	7.1%	11.5%	14.6%	27.0%	15.0%
5-6.9 years	7.9%	10.3%	16.5%	20.1%	38.5%	21.5%
7-9.9 years	8.5%	13.5%	21.5%	25.9%	49.0%	27.5%

10+ years	11.5%	19.1%	24.0%	27.5%	52.0%	30.0%

Table 14: Final calibration proposal for function F

4.137

<u>Question to stakeholders</u>

CEIOPS would like to hear stakeholders' views on whether the treatment of other unrated positions (for example unrated loans to local and regional governments, loans on residential mortgages and unrated covered bonds) should be differentiated as it is possible under Basel II.

4.138 For structured credit, function G basically mirrors Table 5:

G(ratingdist$_i$, tenure$_i$)	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC or lower**
0-1.9 years	0.8%	1.9%	4.3%	7.8%	19.8%	41.1%	64.7%
2-3.9 years	1.6%	3.1%	8.1%	15.9%	34.5%	59.7%	82.9%
4-5.9 years	2.3%	5.4%	11.6%	22.1%	43.4%	67.8%	88.4%
6-7.9 years	3.5%	7.4%	14.3%	27.5%	50.8%	73.6%	90.3%
8+ years	4.7%	9.7%	17.4%	32.9%	56.6%	76.7%	91.9%

Table 15: Final calibration proposal for function G

4.139 Recovery rates are taken into account according to function R:

R(ratingdist$_i$)	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC or lower**
Recovery rate	50%	45%	40%	35%	30%	25%	20%

Table 16: Final calibration proposal for function R

4.140 When calculating Mkt_{sp}^{struct}, a cap of 100% of MV_i and a floor of 10% of MV_i are applied. The floor was determined based on a VaR calculation for the itraxx main index.[22] As this time series is only available since 2004, it is not used as the main input for the calibration of the spread risk submodule.

4.141 For credit derivatives a scenario-based approach is followed. According to CP 47, credit derivatives encompass credit default swaps (CDS), total return swaps (TRS), and credit linked notes (CLN), where:

- the (re)insurance undertaking does not hold the underlying instrument or another exposure where the basis risk between that exposure and the underlying instrument is immaterial in all possible scenarios; or
- the credit derivative is not part of the undertaking's risk mitigation policy.

[22] Refer to Annex II for details.

4.142 For credit derivatives, the capital charge Mkt_{sp}^{cd} 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) that would occur following (a) a widening of credit spreads by 600% if overall this is more onerous, or (b) a narrowing of credit spreads by 75% if this is more onerous. A notional capital charge should then be calculated for each event. The capital charge should then be the higher of these two notional changes.

Examples

4.143 Example 1 on bonds:

- Rating: AAA
- Maturity: 5 years (modified duration ~4.5 years)
- Capital charge (QIS4): Duration * F($Rating_i$)
  - 4.5 * 0.25% = 1.1%
- Capital charge (new): F($Rating_i$,$Maturity_i$)
  - 5.4%

4.144 Example 2 on bonds:

- Rating: A
- Maturity: 4 years (modified duration ~3.6 years)
- Capital charge (QIS4): 3.6 * 1,03% = 3.7%
- Capital charge (new): 11.5%

4.145 Example 3 on bonds:

- Rating: BB
- Maturity: 3 years (modified duration ~2.7 years)
- Capital charge (QIS4): 2.7 * 3.39 = 9.2%
- Capital charge (new): 27.0%

4.146 Example 4 on structured credit:

- Asset pool consisting of 50% BB-rated assets and 50% B-rated assets (=subprime)
- Tenure of the asset pool: 10 years
- Attachment/detachment point of the tranche held: 22% / 100% (supersenior tranche, usually AAA-rated before the crisis)
- Capital charge (QIS4): Duration * G($Rating_i$)
  - 8 * 2.13 = 17% (depending on exact duration, assumption is 8 years)
- Capital charge (new):
  - Step 1 – Calculation of default rate in asset pool: G($Ratingdist_i$,$Maturity_i$) = 50% * 56.6% + 50% * 76.7% = 66.7%

- Step 2 – Calculation of loss rate in asset pool: Default rate * R(Ratingdist$_i$) = 66.7% * (50% * 70% + 50% * 75%) = 48.3%
- Step 3 – Calculation of losses in invested tranche (=capital charge): given the waterfall structure of a structured credit product, the first 22% (attachment point of the tranche) of losses are borne by the investors of lower tranches; the remaining losses as a percentage of the total tranche size can be calculated as (loss rate – attachment point) / (detachment point – attachment point) = (48.3% - 22%) / (100% – 22%) = 33.7% (the model implies that for all lower tranches, with detachment points < 22%, the capital charge would be 100%)

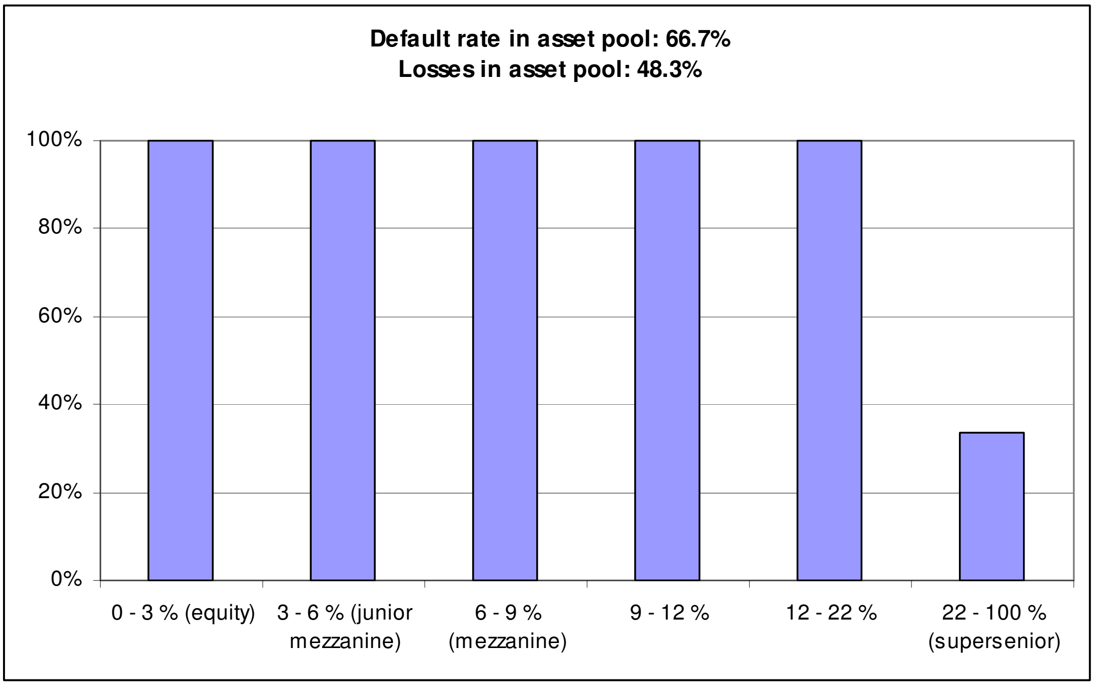


Figure 3: Capital charges for different tranches of a hypothetical subprime securitisation

4.147 Example 5 on structured credit:

- Asset pool consisting of 33% each in AA-, A- and BBB-rated assets (investment grade)
- Tenure of the asset pool: 7 years
- Attachment/detachment point of the tranche held: 9% / 12% (senior mezzanine tranche, usually A-rated before the crisis)
- Capital charge (QIS4): ~19% (depending on the exact duration, assumption is 6.5 years)
- Capital charge (new):
  - Default rate in asset pool: 16.4%
  - Loss rate in asset pool: 9.8%
  - Losses in invested tranche (=capital charge): 27.8% (again, the model implies that for all lower tranches, with detachment points < 9%, the capital charge would be 100%)

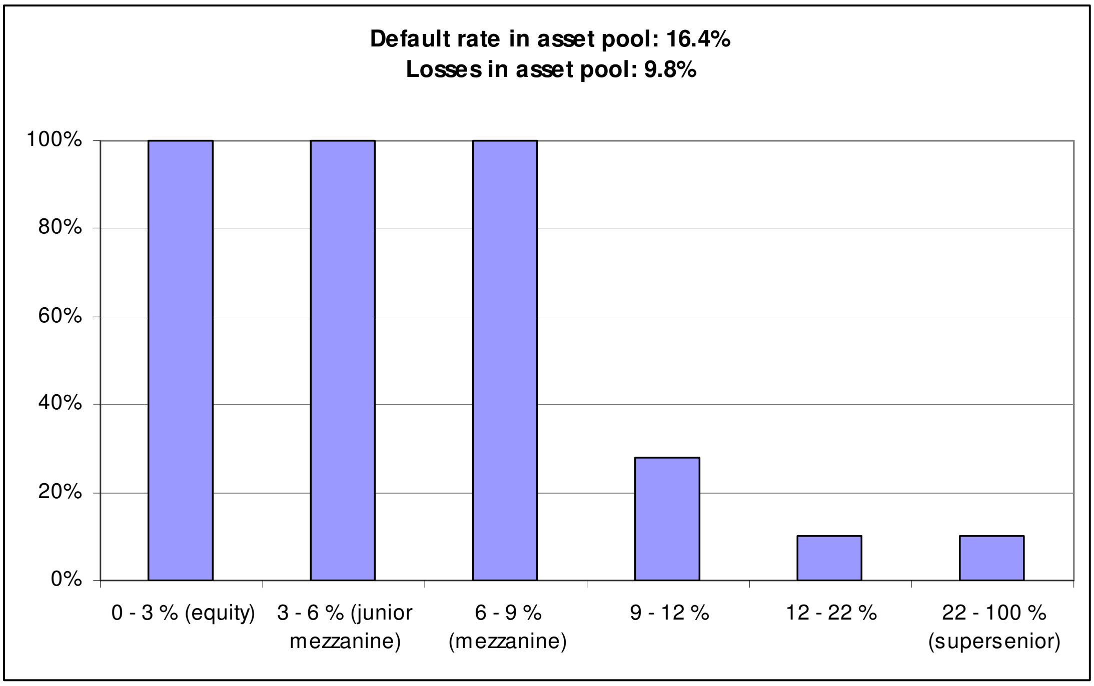


Figure 4: Capital charges for different tranches of a hypothetical investment-grade securitisation

4.148 Example 6 on structured credit:

- Asset pool consisting of 100% AAA-rated assets (highest investment grade)
- Tenure of the asset pool: 1 year
- Attachment/detachment point of the tranche held: 22% / 100% (senior tranche, usually AAA-rated before the crisis)

➢ Capital charge (QIS4): 2.13%

➢ Capital charge (new):

  - ➢ Default rate in asset pool: 0.8%
  - ➢ Loss rate in asset pool: 0.4%
  - ➢ Losses in invested tranche (=capital charge): 10.0% (10% floor applies)

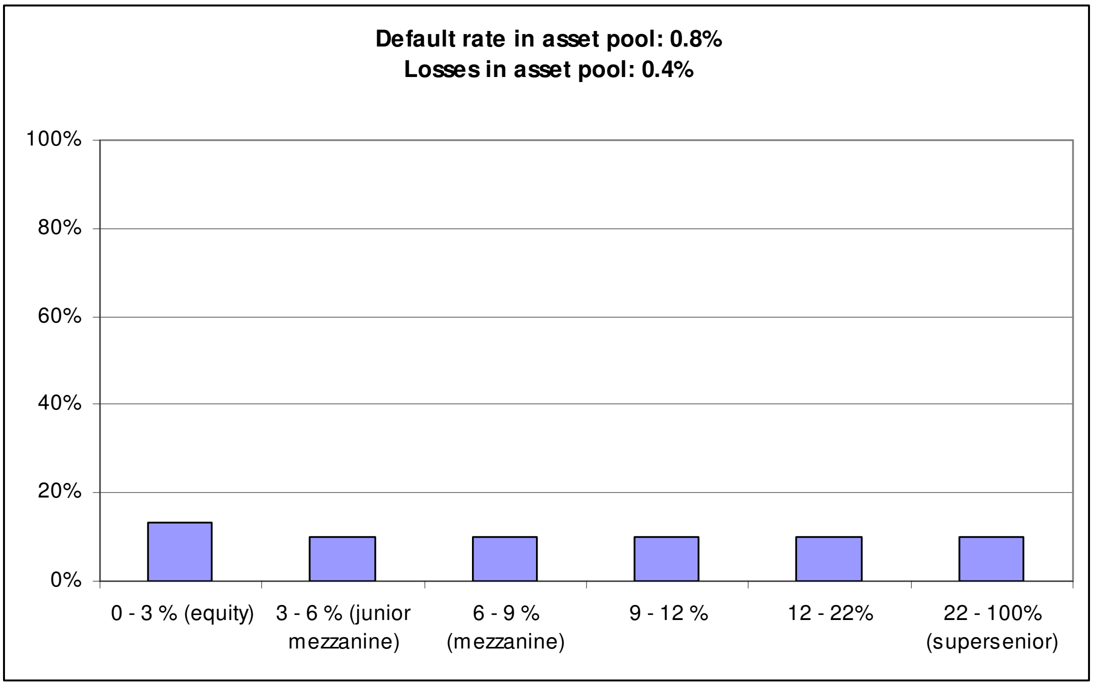


Figure 5: Capital charges for different tranches of a hypothetical securitisation of AAA-rated assets

4.149 Overall for corporate bonds, the capital charge as compared to QIS4 increases by a factor of approximately 3.5, based on the average rating distribution and median durations as outlined in Table 1 and Table 2.

4.5.2. CEIOPS' advice

Spread risk

4.150 Based on the assumptions contained in the explanatory text, CEIOPS has calibrated the sub-module according to 99.5% VaR and a one year time horizon.

4.151 For calculating the capital charge for spread risk, the following input is required:

MV_i	=	the credit risk exposure i as determined by reference to market values (exposure at default)
$rating_i$	=	for corporate bonds, the external rating of credit risk exposure i
$maturity_i$	=	for corporate bonds, the maturity of credit risk exposure i
$attach_i$	=	for structured credit products, the attachment point of the tranche held
$detach_i$	=	for structured credit products, the detachment point of the tranche held
$tenure_i$	=	for structured credit products, the average tenure of the assets securitised

ratingdist$_i$ = for structured credit products, a vector of the rating distribution in the asset pool securitised

4.152 In cases where there is no readily-available market value of credit risk exposure *i*, alternative approaches consistent with relevant market information might be adopted to determine MV_i. In cases where several ratings are available for a give credit exposure, generally the second-best rating should be applied.

4.153 The module delivers the following output:

Mkt_{sp} = capital charge for spread risk

$nMkt_{sp}$ = capital charge for spread risk including the risk absorbing effect of future profit sharing

4.154 The capital charge for spread risk is determined as follows:

$Mkt_{sp} = Mkt_{sp}^{bonds} + Mkt_{sp}^{struct} + Mkt_{sp}^{cd}$

where

Mkt_{sp}^{bonds} = capital charge for spread risk of bonds

Mkt_{sp}^{struct} = capital charge for spread risk of structured credit products

Mkt_{sp}^{cd} = capital charge for spread risk of credit derivatives

4.155 The capital charge for the spread risk of bonds is determined as follows:

$$Mkt_{sp}^{bonds} = \sum_i MV_i \bullet F(rating_i, maturity_i) + \Delta Liab_{ul}$$

where

$F(rating_i, maturity_i)$ = a function of the rating class and maturity of the credit risk exposure which is calibrated to deliver a shock consistent with VaR 99.5%

$\Delta Liab_{ul}$ = The overall impact on the liability side for policies where the policyholders bear the investment risk with embedded options and guarantees of the stressed scenario, with a minimum value of 0 (sign convention: positive sign means losses). The stressed scenario is defined as a drop in value on the assets (except government bonds issued by an EEA or OECD government in its local currency) used as the reference to the valuation of the liabilities by $F(rating_i, maturity_i)$, e.g. for a BBB-rated asset with a duration of 4 years this means a drop by 14.6%

4.156 The function F is determined as follows:

$F(rating_i, maturity_i)$	**AAA**	**AA**	**A**	**BBB**	**BB or lower**	**Unrated**
0-2.9 years	3.4%	4.5%	6.8%	7.7%	14.0%	8.0%
3-4.9 years	5.4%	7.1%	11.5%	14.6%	27.0%	15.0%
5-6.9 years	7.9%	10.3%	16.5%	20.1%	38.5%	21.5%
7-9.9 years	8.5%	13.5%	21.5%	25.9%	49.0%	27.5%
10+ years	11.5%	19.1%	24.0%	27.5%	52.0%	30.0%

4.157 The capital charge for the spread risk of bonds is determined as follows:

$$Mkt_{sp}^{struct} = \sum_i \frac{\left(MV_i \bullet G(ratingdist_i, tenure_i) \bullet (1 - R(ratingdist_i)) - attach_i\right)}{\det ach_i - attach_i}$$

where

$G(ratingdist_i, tenure_i)$ = a function of the rating class and tenure of the credit risk exposure within a securitised asset pool which is calibrated to deliver a shock consistent with VaR 99.5%

$R(ratingdist_i)$ = a function of the rating class of the credit risk exposure within a securitised asset pool which is calibrated to deliver a shock consistent with VaR 99.5%

4.158 The function G is determined as follows:

$G(ratingdist_i, tenure_i)$	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC or lower**
0-1.9 years	0.8%	1.9%	4.3%	7.8%	19.8%	41.1%	64.7%
2-3.9 years	1.6%	3.1%	8.1%	15.9%	34.5%	59.7%	82.9%
4-5.9 years	2.3%	5.4%	11.6%	22.1%	43.4%	67.8%	88.4%
6-7.9 years	3.5%	7.4%	14.3%	27.5%	50.8%	73.6%	90.3%
8+ years	4.7%	9.7%	17.4%	32.9%	56.6%	76.7%	91.9%

4.159 The function R is determined as follows:

$R(ratingdist_i)$	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC or lower**
Recovery rate	50%	45%	40%	35%	30%	25%	20%

4.160 When calculating Mkt_{sp}^{struct}, a cap of 100% of MV_i and a floor of 10% of MV_i are applied.

4.161 For credit derivatives, the capital charge Mkt_{sp}^{cd} 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) that would occur following (a) a widening of credit spreads by 600% if overall this is more onerous, or (b) a narrowing of credit spreads by 75% if this is more onerous. A notional capital charge should then be calculated for each event. The capital charge should then be the higher of these two notional changes.

Annex A Interest rate risk

The table below illustrates the results obtained from Principal Components Analysis for various interest rate term structures. The final column shows the stresses tested for this sub-module in QIS4.

	EUR GOV		EUR SWAP		GBP GOV		GBP SWAP		QIS 4		New Stresses	
in Years	**Up**	**Dn**	**Up**	**Dn**	**Up**	**Dn**	**GBP Up**	**GBP Dn**	**Up**	**Dn**	**Up**	**Dn**
0.25			78%	-77%			47%	-74%			94%	-87%
0.5			73%	-74%			52%	-71%			94%	-87%
1	86%	-79%	79%	-69%	55%	-87%	59%	-66%	94%	-51%	94%	-87%
2	85%	-65%	83%	-59%	53%	-73%	58%	-63%	77%	-47%	85%	-73%
3	78%	-54%	75%	-55%	50%	-63%	54%	-54%	69%	-44%	78%	-63%
4	70%	-49%	68%	-50%	49%	-56%	50%	-47%	62%	-42%	70%	-56%
5	64%	-45%	61%	-46%	49%	-50%	46%	-43%	56%	-40%	64%	-50%
6	60%	-41%	57%	-43%	47%	-46%	43%	-39%	52%	-38%	60%	-46%
7	58%	-38%	55%	-39%	44%	-42%	39%	-36%	49%	-37%	58%	-42%
8	55%	-35%	53%	-37%	41%	-39%	37%	-33%	46%	-35%	55%	-39%
9	53%	-33%	52%	-34%	37%	-36%	34%	-31%	44%	-34%	53%	-36%
10	51%	-31%	50%	-32%	34%	-33%	32%	-29%	42%	-34%	51%	-34%
11	49%	-29%			30%	-31%			42%	-34%	49%	-34%
12	47%	-28%			26%	-31%			42%	-34%	47%	-34%
13	45%	-27%			23%	-31%			42%	-34%	45%	-34%
14	43%	-27%			23%	-31%			42%	-34%	43%	-34%
15	42%	-27%	44%	-28%	22%	-31%	24%	-23%	42%	-34%	44%	-34%
16					21%	-32%			41%	-33%	41%	-33%
17					21%	-32%			40%	-33%	40%	-33%
18					20%	-32%			39%	-32%	40%	-32%
19					20%	-32%			38%	-31%	40%	-32%
20			40%	-33%	20%	-33%	19%	-21%	37%	-31%	40%	-33%
21					19%	-33%					39%	-33%
22					19%	-33%					39%	-33%
23					19%	-34%					38%	-34%
24					21%	-43%					37%	-43%
25					23%	-49%					37%	-49%
30			36%	-41%			15%	-22%			36%	-49%

Annex B Spread risk

I. Non-parametric (quantile) results of the calibration

Maturity Bucket	AAA	AA	A	BBB
1-3	2.5%	3.1%	11%	5.7%
3-5	4.9%	6.5%	14.7%	12.7%
5-7	8.0%	9.6%	21.3%	18.5%
7-10	7.9%	13.0%	27.1%	25.2%
10+	10.0%	18.1%	14.3%	N/A

Table 17: Empirical 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro corporate issues, investment grade

Maturity Bucket	BB	BB-B	BB	CCC
All	31.3%	38.2%	44.8%	57.8%

Table 18: Empirical 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro corporate issues, non-investment grade

Maturity Bucket	AAA	AA	A	BBB
1-3	4.0%	5.5%	13.1%	10.2%
3-5	9.9%	12.4%	19.3%	18.1%
5-7	11.5%	16.0%	21.7%	23.6%
7-10	11.1%	16.3%	20.2%	21.7%
10+	N/A	N/A	N/A	N/A

Table 19: Empirical 99.5% VaR of 1 year adjusted rolling return (since 1988), US-Dollar corporate issues, investment grade

Maturity Bucket	BB	BB-B	BB	CCC
All	30.2%	34.2%	38.6%	50.1%

Table 20: Empirical 99.5% VaR of 1 year adjusted rolling return (since 1998), US-Dollar corporate issues, non-investment grade

Maturity Bucket	AAA	AA	A	BBB
Financials, all maturities	5.3%	9.2%	30.2%	44.2%
Non-Financials, all maturities	3.9%	4.4%	7.2%	13.8%

Table 21: Empirical 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro financial and non-financial issues, investment grade

Maturity Bucket	Financials	Non-Financials
1-3	8.7%	3.1%
3-5	14.2%	7.2%
5-7	22.8%	12.2%
7-10	27.5%	13.5%

10+	20.0%	15.3%

Table 22: Empirical 99.5% VaR of 1 year adjusted rolling return (since 1998), Euro financial and non-financial issues, investment grade

II. Calibration results for structured credit products based on itraxx indices

	Cornish Fisher VaR	Empirical VaR
Main (5 years)	11.2%	9.9%
Main (10 years)	12.1%	10.8%
Crossover (5 years)	27.5%	23.1%

Table 23: Cornish Fisher and empirical 99.5% VaR of 1 year adjusted rolling return of itraxx indices (since June 2004)