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

SCR Standard Formula

Article 111b

Calibration of Market Risk Module

(former Consultation Paper 70)

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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 111 of the Solvency II Level 1 text.[2]

1.3. This paper follows CP47 which formed part of the second wave of CEIOPS advice and was finalised as DOC-40/09.

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 advice as they have been addressed in separate advice (see CEIOPS-DOC-65-10 and CEIOPS-DOC-70-10). In addition, for advice on simplifications to the standard formula, including the calibrations of these simplifications see CEIOPS-DOC-73-10.

1.5. The objective of this paper is to give 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 DOC-40/09.

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:

[1] See http://www.ceiops.eu/content/view/5/5/

[2] Directive 2009/138/EC of the European Parliament and of the Council of 25 November 2009 on the taking-up and pursuit of the business of Insurance and Reinsurance (Solvency II), Official Journal, L 335, 17 December 2009, http://eur-lex.europa.eu/JOHtml.do?uri=OJ%3AL%3A2009%3A335%3ASOM%3AEN%3AHTML.

[…]

(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 109.

[…]

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 111 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 and 304,, the symmetric adjustment mechanism and the appropriate period of time, expressed in the number of months, as referred to in Article 106, and the appropriate approach for integrating the method referred to in Article 304 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 CEIOPS-DOC-40-09.

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 some 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 CEIOPS-DOC-40-09.

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 CEIOPS-DOC-40-09, 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/yieldcurve/archive.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.

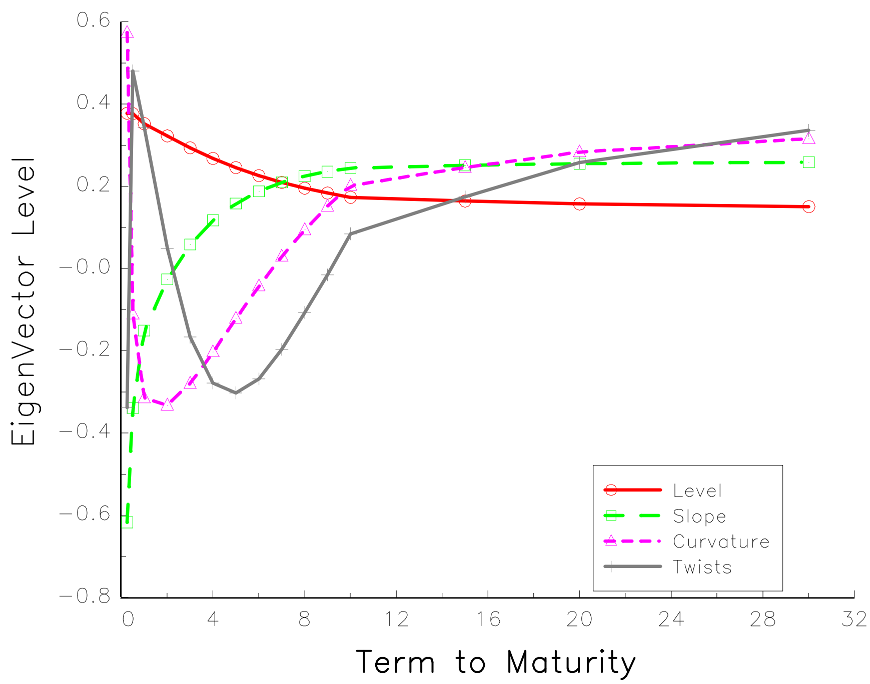
4.17 In the spirit of QIS4, the altered term structures are derived by multiplying the current interest rate curve by the upward and downward stress factors. These factors are defined across maturity and currency, as well as type of security.

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).

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.



[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.

4.22 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].

4.24 From this analysis, we obtain stressed rates at the 99.5% level as follows (with the QIS4 stresses also shown, for comparison):

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

4.25 It should be noted that the results shown above are obtained without recourse to any extrapolation methods. The data input to the PCA process consisted only of market observables; there was no artificial extension of incomplete yield curves where no long-term rates existed.

[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.

4.26 The data sets we have chosen for this analysis represent the deepest and most liquid markets for interest rate-sensitive instruments in the European area. Moreover, use of all four data sets together introduces a control against the uncertainties that could result from using just one data set in isolation. For example, using the longer data period available for the GBP government data introduces additional balance and a greater depth of information to the results by covering a wider range of economic conditions and points in the economic cycle than the other three data sets. There are other technical idiosyncrasies in each of the other data sets generating uncertainties that can be balanced out by combining the results from all four data sets appropriately.

4.27 We have therefore arrived at a single generalised stress for each of the up/down directions as follows:

- Linear interpolation has been used to fill in areas missing from the yield curve (for example between 10 and 15 year terms for the EUR swap results). Note, however, that no extrapolation has been performed.

- For each of up/down directions, the mean of the results from the four data sets has been taken.

- The resulting stress structures have been smoothed in order to avoid inconsistencies and to attempt to mitigate potential unintended consequences for the corresponding shocked yield and forward curves. The smoothing has focused on terms less than one year and on terms greater than 15 years, where the average is constructed from fewer data points and arguably the market data is subject to greater technical biases and inconsistencies.

4.28 This leads to the following term structure stresses, shown with the corresponding stresses from QIS4 for ease of comparison:

	QIS 4		Proposed stresses	
Maturity in Years	**Up**	**Dn**	**Up**	**Dn**
0.25			70%	-75%
0.5			70%	-75%
1	94%	-51%	70%	-75%
2	77%	-47%	70%	-65%
3	69%	-44%	64%	-56%
4	62%	-42%	59%	-50%
5	56%	-40%	55%	-46%
6	52%	-38%	52%	-42%
7	49%	-37%	49%	-39%
8	46%	-35%	47%	-36%
9	44%	-34%	44%	-33%
10	42%	-34%	42%	-31%
11	42%	-34%	39%	-30%
12	42%	-34%	37%	-29%
13	42%	-34%	35%	-28%
14	42%	-34%	34%	-28%
15	42%	-34%	33%	-27%
16	41%	-33%	31%	-28%
17	40%	-33%	30%	-28%
18	39%	-32%	29%	-28%
19	38%	-31%	27%	-29%
20	37%	-31%	26%	-29%
21			26%	-29%
22			26%	-30%
23			26%	-30%
24			26%	-30%
25			26%	-30%
30			25%	-30%

4.29 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.

4.30 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. As a pragmatic proposal, 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.

4.31 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.

4.32 Stakeholders have requested clarification as to how term structures other than those relating to nominal yields should be treated. We propose that this should be addressed at Level 3.

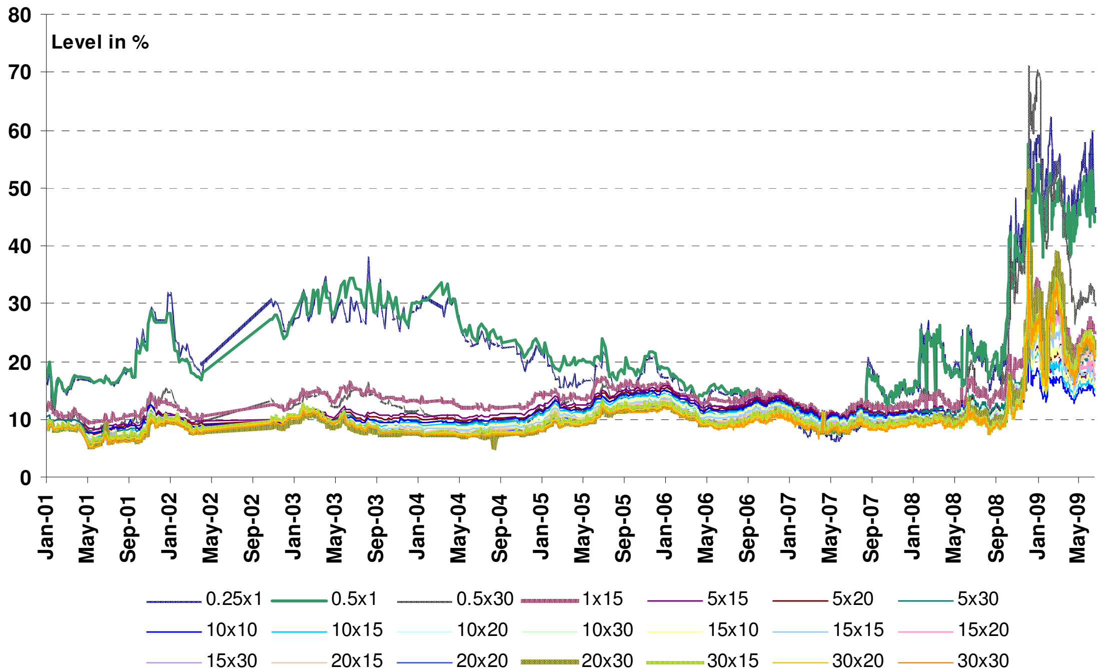
Shocks to interest rate volatilities

4.33 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.

4.34 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.

4.35 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. Stakeholder feedback to both CP70 and QIS4 has generally supported the relevance of interest rate volatility as a significant part of the risk profile to be included in the standard formula.

4.36 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).



4.37 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.

4.38 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.

4.39 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 multiplicative 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%

4.40 In addition, an analysis of the upward volatility stress leads to the following multiplicative 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%

4.41 For example in the case of the N x T -year implied volatility the rate in 12 months time in a downward stress scenario would correspond 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 a downward scenario, whilst the same contract experiences an upward shock of 95% in an upward scenario.

4.42 To avoid excessive complexity, this matrix can 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.

4.43 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 would therefore lead to the following (multiplicative) volatility stresses:

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

4.44 We have noted stakeholder comments that there is evidence to argue that mean reversion exists in interest rate volatility. Based on this premise, and bearing in mind potential procyclicality concerns as raised by stakeholders, we propose the interest rate volatility stress could instead be expressed as an additive stress.

4.45 Use of a multiplicative formulation carries the risk that in times of high volatility the stressed volatility levels could be excessively high and hence procyclical effects could result. However, we note that use of an additive stress formulation could equally carry risks: in this case the stressed volatility could be overly high (from a relative viewpoint) when volatility levels are low.

4.46 Taking data for 10 x 10 swaption volatility over the period from April 1998 to June 2009 leads to an average implied volatility of 13%. This would lead to an upward stressed volatility of 25% and a downward stressed volatility of 10%.

4.47 Hence a stress test defined using additive stress factors can be proposed as follows:

Up stress (additive)	12%
Down stress (additive)	-3%

4.48 As can be seen from the analysis above, the stresses relevant for different points on the volatility surface (and indeed, as mentioned above, for different moneyness) differ in magnitude. However, for the purposes of the standard formula we make the simplifying assumption that the stresses in 4.47 above apply to all interest rate volatilities.

4.49 The consultation text for this advice included a question to stakeholders as to the relevance of the downward volatility stress. Although the response was not unanimous, many stakeholders argued that the downward stress is relevant and should be retained, for example to deal with cases where risks re over-hedged.

4.50 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

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

4.51 When calculating the four capital charges, an allowance for diversification should be made by first calculating the charge based on the term structure stress, then calculating the charge based on the volatility stress, and combining the outputs using a correlation of 0% (in the case of an upward and a downward volatility stress).

4.52 As an example, to calculate the capital charge $Mkt_{int}^{Up}{}_{ivol}^{Up}$ 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 on moving to stressed volatility of (v+12)%, and then combine these with a correlation of 0%.

4.53 The correlation of 0% is proposed on the basis that, as stakeholders have pointed out, in practice the term structure and corresponding volatility are not perfectly correlated but changes in term structure do tend to correspond with increased volatility. The correlation is postulated on the basis of the 10x10 swaption used as the representative point for the calibration of volatility. However, the correlation may differ if other swap or option terms are chosen. In particular, a shorter term could induce a higher correlation.

4.54 This method of aggregation does not, however, allow for non-linearity in cases where (for example) a change in interest rates combined with a simultaneous increase in volatility could have greater impact on the value of an interest rate option or guarantee than the (diversified) sum of the two separate impacts.

4.2.2. CEIOPS' advice

Interest rate risk

4.55 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.

4.56 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.

4.57 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.

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

	QIS 4		Proposed stresses	
Maturity in Years	**Up**	**Dn**	**Up**	**Dn**
0.25			70%	-75%
0.5			70%	-75%
1	94%	-51%	70%	-75%
2	77%	-47%	70%	-65%
3	69%	-44%	64%	-56%
4	62%	-42%	59%	-50%
5	56%	-40%	55%	-46%
6	52%	-38%	52%	-42%
7	49%	-37%	49%	-39%
8	46%	-35%	47%	-36%
9	44%	-34%	44%	-33%
10	42%	-34%	42%	-31%
11	42%	-34%	39%	-30%
12	42%	-34%	37%	-29%
13	42%	-34%	35%	-28%
14	42%	-34%	34%	-28%
15	42%	-34%	33%	-27%
16	41%	-33%	31%	-28%
17	40%	-33%	30%	-28%
18	39%	-32%	29%	-28%
19	38%	-31%	27%	-29%
20	37%	-31%	26%	-29%
21			26%	-29%
22			26%	-30%
23			26%	-30%
24			26%	-30%
25			26%	-30%
30			25%	-30%

4.59 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%.

4.60 Based on the analysis set out earlier in this paper we propose interest rate volatility stresses of 12% in the upward direction and 3% in the downward direction, to be applied as additive stresses to implied volatility.

4.61 When calculating the capital charges for the four scenarios required per 4.57 above, a correlation of 0% should be assumed between the volatility stress event and the term structure stress event in each term structure/volatility stress pair.

4.3 Currency risk

4.3.1. Explanatory text

4.62 CEIOPS-DOC-40-09 proposed a scenario-based approach for calculating the capital charge for currency risk.

4.63 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 $Mkt_{fx,C}$.

4.64 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.

4.65 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.

4.66 In our analysis, we show that the risk at the 99.5^{th} 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.

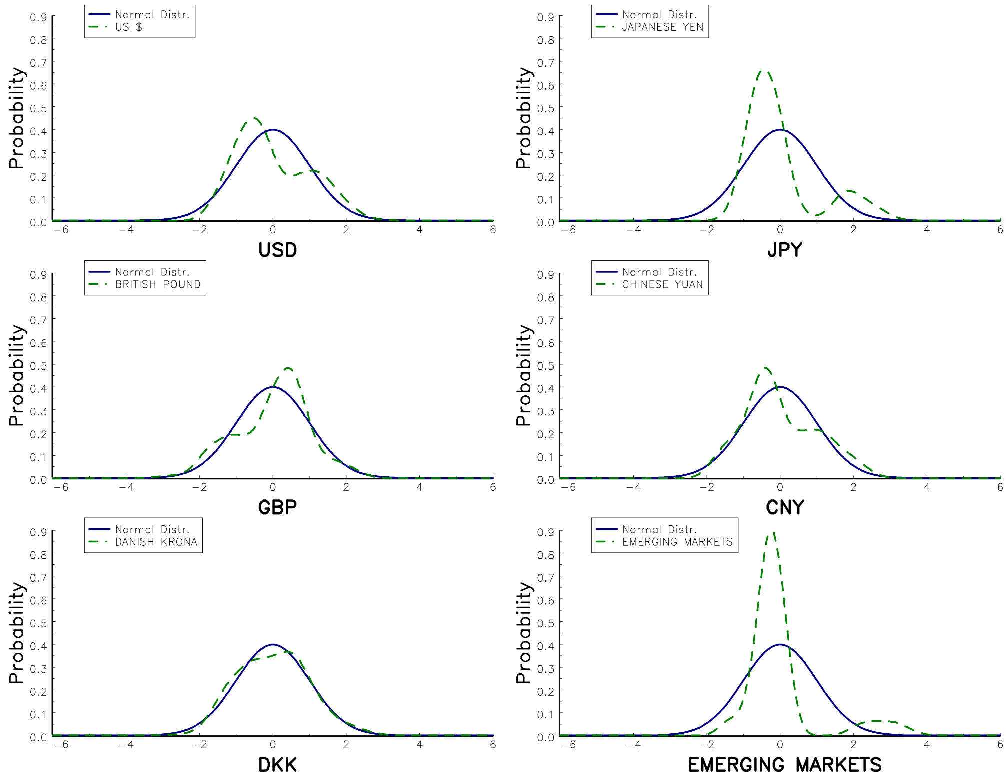
4.67 We use daily data to study the distribution of holding period rate of returns derived from EUR and GBP currency pairs. Our data sample, sourced from Bloomberg, covers a daily period from January 1971 to June 2009, a total of circa 10,000 observations across 14 currency pairs against GBP. In addition, 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).

4.68 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.

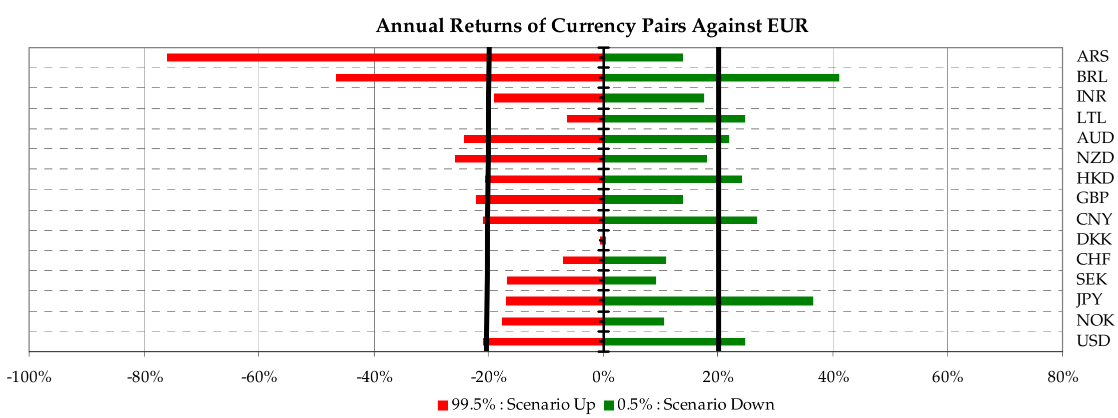
4.69 We estimate the full probability density and especially the lower percentiles using non-parametric methods as described in Silverman (1986). The figures below illustrate the standardised probability density functions of a representative sample of six currency pairs against EUR, which are implied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

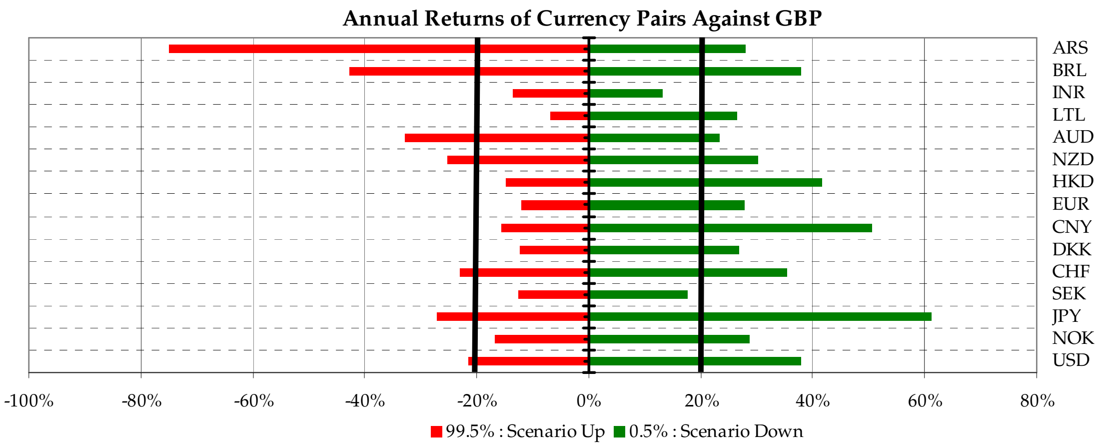
4.70 QIS3 and 4 define a symmetric stress factor on the assumption that the percentage changes in currency rates are normally distributed. A visual inspection of different standardised distributions, which are plotted against the normal distribution shows that the data does not adhere to the laws of 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 4.81 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.



4.71 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.





4.72 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.

4.73 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.

	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%		

4.74 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%.

4.75 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.

4.76 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.

4.77 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%

4.78 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%.

4.79 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%.

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

4.81 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.

4.82 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.

4.83 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%.

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

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[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]

4.85 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%.

4.86 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 any of EUR, Lithuanian litas or Estonian kroon	2.25%	*2.25%*[9]
Estonian Kroon against EUR or Lithuanian litas	0%	*15%*
Latvian lats against any of EUR, Lithuanian litas or Estonian kroon	1%	*15%*
Lithuanian litas against EUR or Estonian kroon	0%	*15%*
Latvian lats against Danish Krone	3.5%	*20%*
All other currency pairs	25%	*20%*

[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
[9] Note, the QIS4 stress quoted here and in the three rows below applied for pegged currencies vs EUR only

4.87 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.

4.3.2. CEIOPS' advice

Currency risk

4.88 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.

4.89 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 any of EUR, Lithuanian litas or Estonian kroon at ±2.25%

Estonian Kroon against EUR or Lithuanian litas at ±0%

Latvian lats against any of EUR, Lithuanian litas or Estonian kroon at ±1%

Lithuanian litas against EUR or Estonian kroon at ±0%

Latvian lats against Danish Krone at 3.5%

All other currency pairs at ±25%.

4.90 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

4.41. Explanatory text

4.91 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),

$$Mkt_{prop} = \Delta NAV \mid property\ shock.$$

4.92 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.

4.93 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).

4.94 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.

4.95 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.

4.96 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.

4.97 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.

4.98 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.

4.99 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)[10]. 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

[10] 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

property values is approximately half the volatility of the S&P 500 stock market index.

4.100 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.

4.101 Chao, Kawaguchi and Shilling (2003)[11] 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.

4.102 In fact, Booth and Marcato (2004)[12] 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.

4.103 Edelstein and Quan (2006)[13] 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.

4.104 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.

4.105 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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[11] 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

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

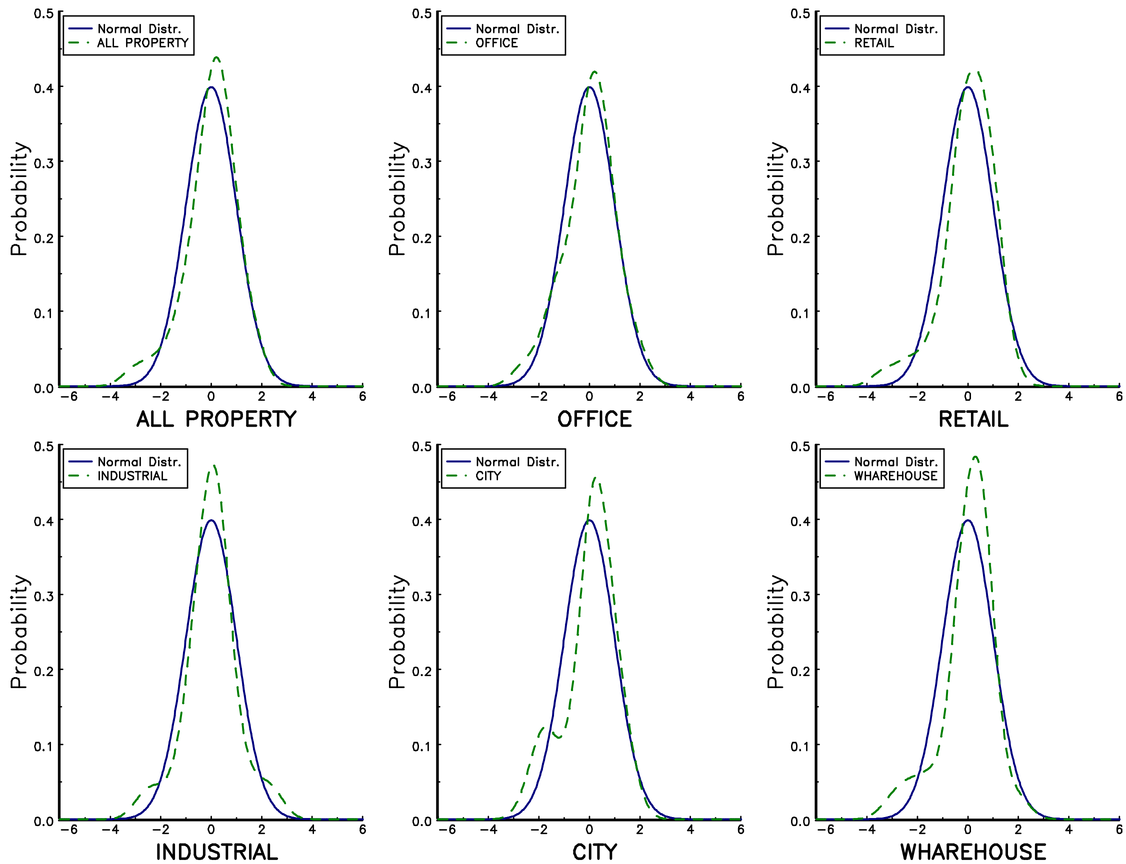
[13] Edelstein, R.H., & Quan, D. (2006), How Does Appraisal Smoothing Bias Real Estate Returns Measurement? , Journal of Real Estate Finance and Economics, 32, No.1

	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%**

4.106 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.

4.107 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.

4.108 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.



4.109 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.

4.110 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.

4.111 On the basis of our analysis of the smoothed data, we therefore recommend a 25% stress for property. No breakdown in different property classes is needed as the historical values at risk for the different classes do not diverge too much.

4.112 This stress compares with the stress of 20% tested in QIS4.

4.4.2. CEIOPS' advice

Property risk

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

4.114 For all types of property (e.g. offices, retail, industrial, warehouse, residential), the stress is 25%.

4.5. Spread risk

4.5.1. Explanatory text

4.115 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.

4.116 According to CEIOPS Doc 40/09 (former CP 47), the spread risk sub-module applies to:

- Bonds (including deposits with credit institutions),
- Loans guaranteed by mortgages,
- 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.

4.117 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.

4.118 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.

4.119 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.

4.120 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

4.121 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)

4.122 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

4.123 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

4.124 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

4.125 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

4.126 Issuers of currently actively traded bonds denominated in EUR were used to construct a portfolio with their respective CDS spreads. A list of those issuers for which CDS spreads were available can be found in Annex 1. The time series of CDS spreads covers the period from January 2007 until December 2009.

4.127 Annual spread changes were calculated using daily spreads, a 63 trading days (= 3 months) moving average filter, and a one-year rolling window for calculating the spread changes.

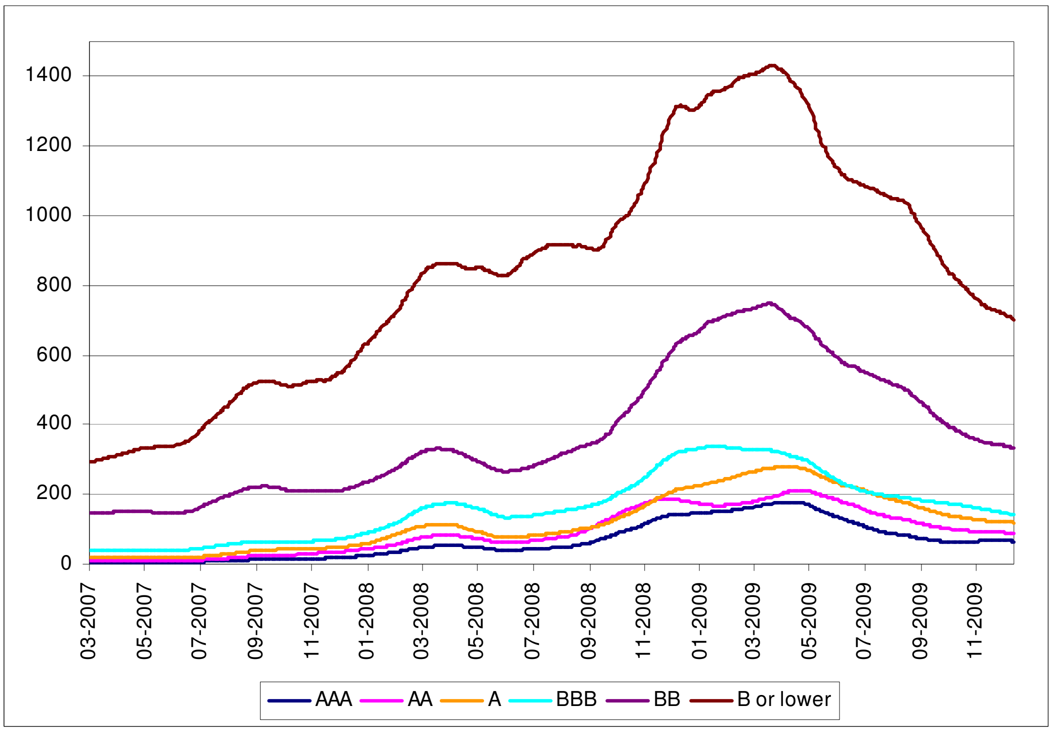


Figure 1: CDS spreads, 63 trading days moving average

4.128 The CDS spread series were put into rating buckets according to their rating as of the beginning of 2008. After that, a weighted average (see below) of the CDS spreads was calculated. This represents the CDS spread of a portfolio whose referencing bonds belonged to a certain rating class at the beginning of 2008, i.e. before the major spread move set in. On this portfolio a 63 trading days (= 3 months) moving average filter was applied to smooth possible (short-lived) spikes. The maximum one-year-change of this series was used as a measure for a 1-in-200 years event.

4.129 Within the rating buckets AA and A, some re-balancing was performed in order to avoid too strong effects of the CDS spread increases of financial issuers during the financial crisis. Though financials outnumber nonfinancials in these rating buckets, the calibration assumes a more balanced investment policy of insurance undertakings:

AAA	Financial issuers: 1 Non-financial issuers: 7	
AA	Financial issuers: 17 Non-financial issuers: 11	50%-50% split between financial and non-financial companies applied.
A	Financial issuers: 20 Non-financial issuers: 14	50%-50% split between financial and non-financial companies applied.
BBB	Financial issuers: 2 Non-financial issuers: 24	
BB	Financial issuers: 1 Non-financial issuers: 10	
B or lower	Financial issuers: 1 Non-financial issuers: 6	

4.130 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.

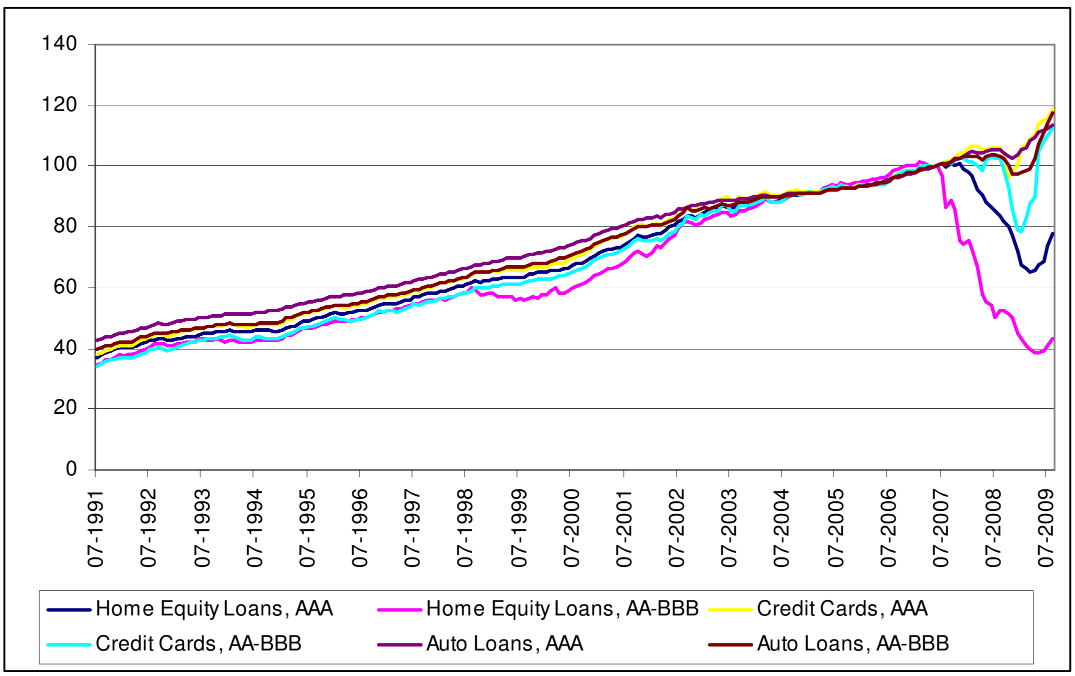


Figure 2: Merrill Lynch total return indices of various ABS structures (30/06/2007 = 100)

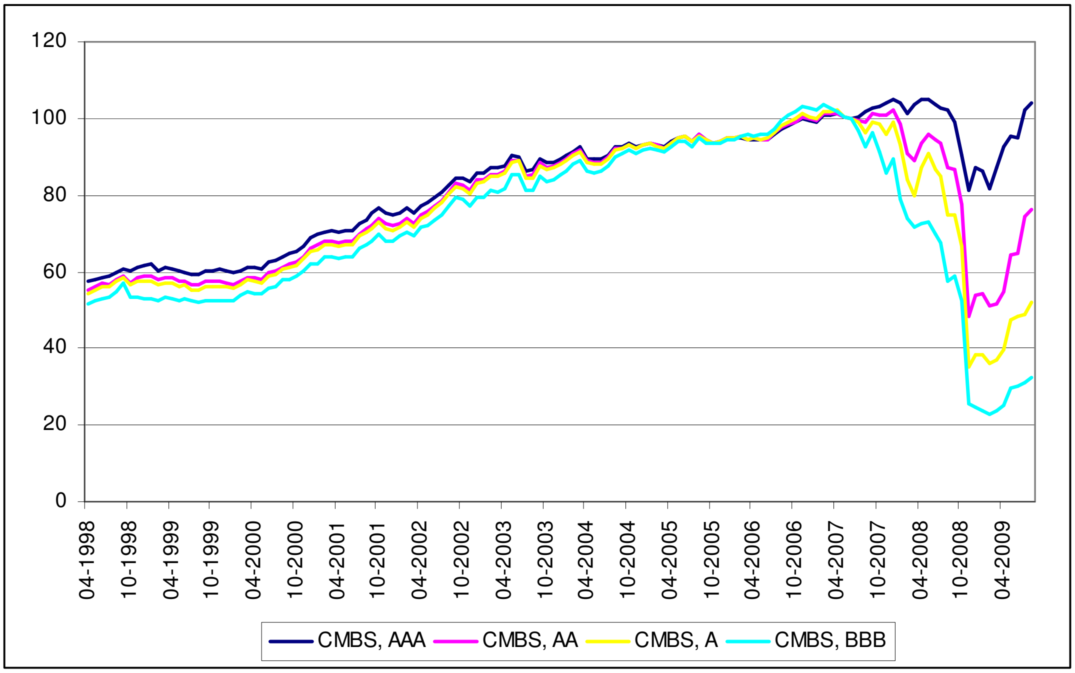


Figure 3: Merrill Lynch total return indices of various CMBS tranches (30/06/2007 = 100)

4.131 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.[14]

Tenure (years)	AAA	AA	A	BBB	BB	B	CCC
1	0.8%	1.6%	4.7%	8.1%	20.9%	41.5%	65.9%
3	1.6%	3.1%	8.1%	14.7%	34.1%	59.7%	83.3%
5	2.3%	5.0%	10.9%	20.2%	43.0%	68.2%	88.4%
7	3.5%	7.4%	14.0%	25.2%	50.4%	73.3%	90.7%
9	4.7%	9.7%	17.1%	30.2%	56.2%	77.1%	91.9%

Table 5: Scenario Default Rates[15]

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

[14] Standard&Poor's: Update to Global Methodologies And Assumptions For Corporate Cash Flow CDO and Synthetic CDO Ratings, 17 September 2009

[15] Standard&Poor's: Update to Global Methodologies And Assumptions For Corporate Cash Flow CDO and Synthetic CDO Ratings, 17 September 2009

be one of the reasons for the current financial crisis.[16] 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

4.133 The table below summarises the spread shocks for different rating classes. These shock factors will be multiplied with the modified duration of a bond in order to calculate the capital charge for spread risk of bonds.

$Mkt_{sp}^{bonds} = Duration * F(Rating_i)$

F(Rating$_i$)	**Rating class**
AAA	1.27%
AA	1.53%
A	1.77%
BBB	2.47%
BB	4.48%
B or lower	7.54%

Table 6: Calibration results for function F

4.134 A duration floor of 1 should be applied to all rating classes as well as duration caps for the lower rating classes, i.e. BB or lower.

4.135 For unrated bonds the issuer rating could be used as a proxy, if the unrated bond does not inhibit any specificities which detriment credit quality, e.g. subordination.

4.136 Variable interest rate bonds can be exposed to substantial spread risk. Therefore the modified duration used in the calculation of the capital charge should be equivalent to a fixed income bonds with coupon payments equal to the forward interest rate.

4.137 The final calibration of the function F($Rating_i$) looks as follows:

F(Rating$_i$)	**Rating class**	**Duration floor**	**Duration cap**
AAA	1.3%	1	-
AA	1.5%	1	-
A	1.8%	1	-

[16] 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

BBB	2.5%	1	-
BB	4.5%	1	8
B or lower	7.5%	1	6
Unrated	3.0%	1	-

Table 7: Final calibration proposal for function F

4.138 For structured credit, function G basically mirrors Table 5, amended by values for unrated assets which are based on the figures for BBB-rated assets with a similar mark-up as used in the sub-module for corporate bonds:

G(ratingdist$_i$, tenure$_i$)	**AAA**	**AA**	**A**	**BBB**	**BB**	**B**	**CCC or lower**	**Unrated**
0-1.9 years	0.8%	1.6%	4.7%	8.1%	20.9%	41.5%	65.9%	9.7%
2-3.9 years	1.6%	3.1%	8.1%	14.7%	34.1%	59.7%	83.3%	17.6%
4-5.9 years	2.3%	5.0%	10.9%	20.2%	43.0%	68.2%	88.4%	24.2%
6-7.9 years	3.5%	7.4%	14.0%	25.2%	50.4%	73.3%	90.7%	30.2%
8+ years	4.7%	9.7%	17.1%	30.2%	56.2%	77.1%	91.9%	36.2%

Table 8: 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**	**Unrated**
Recovery rate	50%	45%	40%	35%	30%	25%	20%	35%

Table 9: 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.[17] As this time series is only available since 2004, it is not used as the main input for the calibration of the spread risk sub-module.

4.141 If the originator of a structure credit product does not comply with the 5% net retention rate foreseen in the CRD (2006/48/EC), the capital charge for the product should be 100%, regardless of the seniority of the position.

4.142 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:

[17] Refer to Annex II for details.

- 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.

4.143 For credit derivatives, the capital charge Mkt_{sp}^{cd} is determined, after netting with offsetting corporate bond exposures, 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.

4.144 Exposures secured by real estate should receive a credit risk treatment that is consistent with the treatment under Directive 2006/48/EC, appendix VI section 9. Under spread risk, an additional category Mkt_{sp}^{re} should be introduced. Mkt_{sp}^{re} relates only to direct exposures to borrowers covered by real estate collateral. Exposures via structured products such as Mortgage Backed Securities and exposures through covered bonds do not fall within the scope of this submodule.

4.145 The capital charge for the spread risk of exposures secured by real estate is determined as follows:

$$Mkt_{sp}^{re} = 8\% \bullet \sum_i \left(RW_i^{\sec} \bullet Secured_i + RW_i^{un\sec} \bullet \max\left(Exposure_i - Secured_i ;0 \right) \right)$$

where

$Exposure_i$	= the total mortgage exposure to borrower *i*
$Secured_i$	= the fully and completely secured part of the exposure to borrower *i*, calculated as the part of the exposure covered by real estate collateral after application of the haircut
RW_i^{sec}	= the risk weight associated with the fully and completely secured part of the exposure to borrower *i*
RW_i^{unsec}	= the risk weight associated with the unsecured part of to exposure to borrower *i*

4.146 The fully and completely secured part of the exposure is that part of the mortgage exposure that is covered by real estate collateral, after application of a haircut to that collateral value. It should also meet the conditions given in Directive 2006/48/EC, appendix VI section 9.

4.147 The haircut to be applied to the value of real estate collateral is 25% for residential real estate and 50% for commercial real estate. Therefore, the fully and completely secured part of the exposure is equal to 75% of the value of residential real estate collateral, and 50% of the value of commercial real estate collateral.

4.148 The applicable risk weights are similar to the risk weights in Directive 2006/48/EC, appendix VI section 9. Any future changes in Directive 2006/48/EC on the risk weights in particular or on the Standardised

Approach treatment of exposures secured by real estate in general should also lead to changes in the calculation of Mkt_{sp}^{re}.

4.149 For residential property a risk weight of 35% applies to the fully and completely secured part of exposure *i* in the following circumstances:

(a) Exposures or any part of an exposure fully and completely secured, to the satisfaction of the competent authorities, by mortgages on residential property which is or shall be occupied or let by the owner, or the beneficial owner in the case of personal investment companies.

(b) Exposures fully and completely secured, to the satisfaction of the competent authorities, by shares in Finnish residential housing companies, operating in accordance with the Finnish Housing Company Act of 1991 or subsequent equivalent legislation, in respect of residential property which is or shall be occupied or let by the owner.

(c) Exposures to a tenant under a property leasing transaction concerning residential property under which the insurer is the lessor and the tenant has an option to purchase, provided that the competent authorities are satisfied that the exposure of the insurer is fully and completely secured by its ownership of the property.

4.150 If the secured part of exposure *i* does not fall within the circumstances stated in the previous paragraph, or if the conditions given in Directive 2006/48/EC, appendix VI section 9 are not met, it cannot be treated as fully and completely secured. In that case, a risk weight of 100% will be applied. The unsecured part of exposure *i* also receives a risk weight of 100%.

4.151 For commercial property a risk weight of 100% is applied to both the fully and completely secured part and the unsecured part.

4.152 Fully and completely secured exposures receive a risk weight of 0% if these exposures are guaranteed by an OECD or EEA government, and if these exposures are in the currency of the government. This applies to both residential and commercial real estate.

4.153 Note that the market value of exposures secured by real estate is generally subject to interest rate risk. These exposures should therefore also be included in the interest rate risk sub-module. Note further that property risk on the collateral value is already included in the Mkt_{sp}^{re} calculation, so that also including it in the property risk submodule would lead to double counting. The property risk submodule does therefore not apply to exposures secured by real estate.

Examples

4.154 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): Duration * F($Rating_i$)
  - 4.5 * 1.3% = 5.9%

4.155 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): 3.6 * 1.8% = 6.5%

4.156 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): 2.7 * 4.5% = 12.2%

4.157 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% * 56.2% + 50% * 77.1% = 66.7%
  - Step 2 – Calculation of loss rate in asset pool: Default rate * R($Ratingdist_i$) = 66.7% * (50% * 70% + 50% * 75%) = 48.6%
  - 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) = (48.6% - 22%) / (100% – 22%) = 34.1% (the model implies that for all lower tranches, with detachment points < 22%, the capital charge would be 100%)

4.158 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: 15.5%

  ➢ Loss rate in asset pool: 9.6%

  ➢ Losses in invested tranche (=capital charge): 20.6% (again, the model implies that for all lower tranches, with detachment points < 9%, the capital charge would be 100%)

4.159 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)

4.160 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

4.161 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.

4.162 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

$duration_i$ = for corporate bonds, the duration 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

4.163 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.

4.164 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

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

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

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

Mkt_{sp}^{re} = capital charge for spread risk of mortgage loans

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

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

where

$F(rating_i)$ = a function of the rating class 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 $F(rating_i)$, e.g. for a BBB-rated asset with a duration of 4 years this means a drop by 10.0%

4.167 The function F is determined as follows:

$$Mkt_{sp}^{bonds} = Duration * F(Rating_i)$$

$F(Rating_i)$	Rating class	Duration floor	Duration cap
AAA	1.3%	1	-
AA	1.5%	1	-
A	1.8%	1	-
BBB	2.5%	1	-
BB	4.5%	1	8
B or lower	7.5%	1	6
Unrated	3.0%	1	-

4.168 The capital charge for the spread risk of structured credit products is determined as follows:

$$Mkt_{sp}^{struct} = \sum_i MV_i \frac{\max(G(ratingdist_i, tenure_i) \bullet (1 - R(ratingdist_i)) - attach_i; 0)}{\det ach_i - attach_i}$$

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%

4.169 The function G is determined as follows:

$G(ratingdist_i, tenure_i)$	AAA	AA	A	BBB	BB	B	CCC or lower	Unrated
0-1.9 years	0.8%	1.6%	4.7%	8.1%	20.9%	41.5%	65.9%	9.7%
2-3.9 years	1.6%	3.1%	8.1%	14.7%	34.1%	59.7%	83.3%	17.6%
4-5.9 years	2.3%	5.0%	10.9%	20.2%	43.0%	68.2%	88.4%	24.2%
6-7.9 years	3.5%	7.4%	14.0%	25.2%	50.4%	73.3%	90.7%	30.2%
8+ years	4.7%	9.7%	17.1%	30.2%	56.2%	77.1%	91.9%	36.2%

4.170 The function R is determined as follows:

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

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

4.172 If the originator of a structure credit product does not comply with the 5% net retention rate foreseen in the CRD (2006/48/EC), the capital charge for the product should be 100%, regardless of the seniority of the position.

4.173 If a look-through on the level of securitised assets is not possible, the same stress as for the "equity, other" category should be applied to the structured product for which the look-through is not possible.

4.174 For credit derivatives, the capital charge Mkt_{sp}^{cd} is determined, after netting with offsetting corporate bond exposures, 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.

4.175 The capital charge for the spread risk of exposures secured by real estate is determined as follows:

$$Mkt_{sp}^{re} = 8\% \bullet \sum_i \left(RW_i^{\sec} \bullet Secured_i + RW_i^{un\sec} \bullet \max\left(Exposure_i - Secured_i ;0\right)\right)$$

where

Exposure$_i$ = the total mortgage exposure to borrower *i*

Secured$_i$ = the fully and completely secured part of the exposure to borrower *i*, calculated as the part of the exposure covered by real estate collateral after application of the haircut

RW_i^{sec} = the risk weight associated with the fully and completely secured part of the exposure to borrower *i*

RW_i^{unsec} = the risk weight associated with the unsecured part of to exposure to borrower *i*

4.176 The fully and completely secured part of the exposure is that part of the mortgage exposure that is covered by real estate collateral, after application of a haircut to that collateral value. It should also meet the conditions given in Directive 2006/48/EC, appendix VI section 9.

4.177 The haircut to be applied to the value of real estate collateral is 25% for residential real estate and 50% for commercial real estate. Therefore, the fully and completely secured part of the exposure is equal to 75% of the value of residential real estate collateral, and 50% of the value of commercial real estate collateral.

4.178 The applicable risk weights are similar to the risk weights in Directive 2006/48/EC, appendix VI section 9. Any future changes in Directive 2006/48/EC on the risk weights in particular or on the Standardised Approach treatment of exposures secured by real estate in general should also lead to changes in the calculation of Mkt_{sp}^{re}.

4.179 For residential property a risk weight of 35% applies to the fully and completely secured part of exposure *i* in the following circumstances:

a) Exposures or any part of an exposure fully and completely secured, to the satisfaction of the competent authorities, by mortgages on residential property which is or shall be occupied or let by the owner, or the beneficial owner in the case of personal investment companies.

b) Exposures fully and completely secured, to the satisfaction of the competent authorities, by shares in Finnish residential housing companies, operating in accordance with the Finnish Housing Company Act of 1991 or subsequent equivalent legislation, in respect of residential property which is or shall be occupied or let by the owner.

c) Exposures to a tenant under a property leasing transaction concerning residential property under which the insurer is the lessor and the tenant has an option to purchase, provided that the competent authorities are satisfied that the exposure of the insurer is fully and completely secured by its ownership of the property.

4.180 If the secured part of exposure *i* does not fall within the circumstances stated in the previous paragraph, or if the conditions given in Directive 2006/48/EC, appendix VI section 9 are not met, it cannot be treated as fully and completely secured. In that case, a risk weight of 100% will be applied. The unsecured part of exposure *i* also receives a risk weight of 100%.

4.181 For commercial property a risk weight of 100% is applied to both the fully and completely secured part and the unsecured part. A risk weight of 50% is applied to the fully and completely secured part *only* if the conditions given in Directive 2006/48/EC, appendix VI section 9 are met.

4.182 Fully and completely secured exposures receive a risk weight of 0% if these exposures are guaranteed by an OECD or EEA government, and if these exposures are in the currency of the government. This applies to both residential and commercial real estate.

4.183 Note that the market value of exposures secured by real estate is generally subject to interest rate risk. These exposures should therefore also be included in the interest rate risk submodule. Note further that property risk on the collateral value is already included in the Mkt_{sp}^{re} calculation, so that also including it in the property risk submodule would lead to double counting. The property risk submodule does therefore not apply to exposures secured by real estate.

Annex: Spread risk

I. Issuers used for CDS spread calculations

AAA	AA	A
EXXON	AMERICAN INTL GROUP	AIR LIQUIDE SA
GE	ASTRAZENECA	AIR PRODUCTS & CHEMICALS
JOHNSON	AUST & NZ BANKING GROUP	AMERICAN GENERAL FINANCE
NOVARTIS	BANCA INTESA SPA	AXA SA
PFIZER	BANK OF AMERICA CORP	BANCO ESPIRITO SANTO SA
RABOBANK	BASF SE	BANCO POPOLARE SCARL
TOYOTA	BP	BANQUE ACCORD SA
UPS	CITIGROUP INC	BRISA FINANCE BV
	CREDIT AGRICOLE (LONDON)	CAJA ZARAGOZA ARAGON & R
	DEUTSCHE BANK AG	CARGILL INC
	DEXIA CREDIT LOCAL	CARREFOUR SA
	ELECTRICITE DE FRANCE	COMMERZBANK AG
	ENI SPA	CREDIT SUISSE LONDON
	GDF SUEZ	EDP FINANCE BV
	GOLDMAN SACHS GROUP INC	ENEL-SOCIETA PER AZIONI
	ING VERZEKERINGEN NV	ERSTE GROUP BANK AG
	INVESTOR AB	FORTUM OYJ
	MORGAN STANLEY	FRANCE TELECOM
	NATIONAL AUSTRALIA BANK	HENKEL AG & CO KGAA
	PROCTER & GAMBLE CO/THE	HSH NORDBANK AG
	ROYAL DUTCH	MCDONALD'S CORP
	SAMPO BANK PLC	MERRILL LYNCH & CO
	SANOFI AVENTIS	MONTE DEI PASCHI SIENA
	SIEMENS	NATIONAL GRID PLC
	SOCIETE GENERALE	RAIFF ZENTRALBK OEST AG
	TOTAL	RCI BANQUE SA
	UBS AG JERSEY BRANCH	SNS BANK NEDERLAND
	WESTPAC BANKING CORP	ST GEORGE BANK LIMITED
		TELIASONERA AB
		TEXTRON INC
		UBI BANCA SPCA
		UNICREDIT SPA
		VODAFONE GROUP PLC
		VOLKSWAGEN FIN SERV AG
		WESTLB AG

BBB	BB	B or lower
BAYER AG	EVONIK DEGUSSA	COGNIS
BERTELSMANN AG	FRESENIUS	CONTINENTAL AIRLINES
BOUYGUES SA	INTERNATIONAL POWER	FCE BANK
BRITISH TELECOM PLC	LADBROKE	FIRST DATA
CASINO GUICHARD PERRACH	PERNOD RICARD	NIELSEN CO BV
COMPAGNIE DE ST GOBAIN	SMURFIT KAPPA	TOYS R US
DEUTSCHE LUFTHANSA AG	TDC A/S	VIRGIN MEDIA FINANCE PLC
DONG ENERGY A/S	TUI	WIND ACQUISITION FINANCE SA
FORTUNE BRANDS INC		
GECINA		
KINGFISHER PLC		
KONINKLIJKE KPN NV		
LAFARGE SA		
LVMH MOET-HENNESSY		
PORTUGAL TELECOM INT FIN		
PPR		
PUBLICIS GROUPE SA		
REXAM PLC		
ROHM & HAAS COMPANY		
SLM CORP		
SWEDISH MATCH AB		
TELECOM ITALIA SPA		
TELENOR ASA		
UPM-KYMMENE CORP		
VEOLIA ENVIRONNEMENT		
VIVENDI		

Annex 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 10: Cornish Fisher and empirical 99.5% VaR of 1 year adjusted rolling return of itraxx indices (since June 2004)