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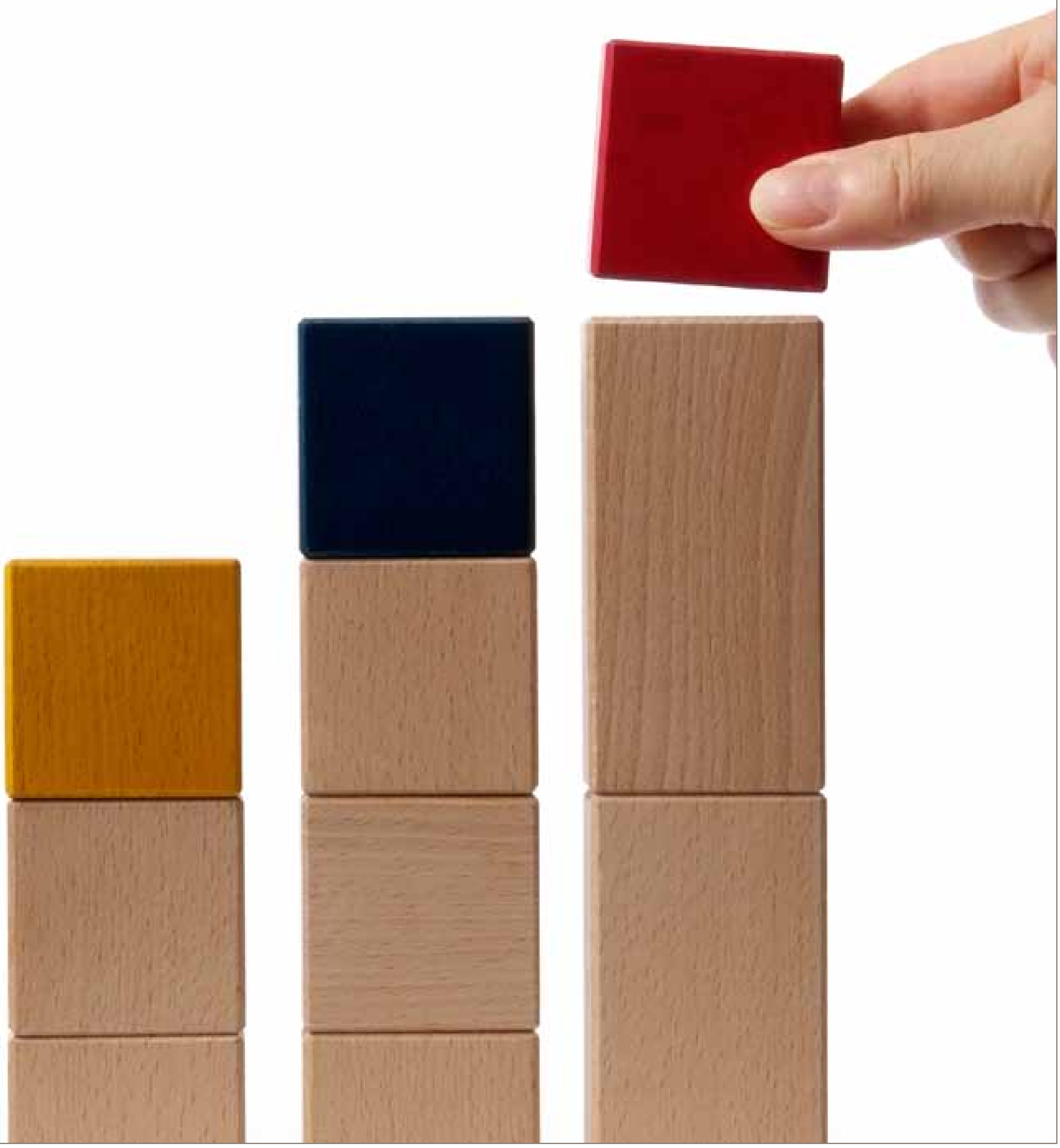
# Comparison of the standard formulae for life insurers under the Swiss Solvency Test and Solvency II



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# 1 INTRODUCTION

This Milliman research report is the first in a series which will focus on the Swiss Solvency Test (SST) and related topics. In this paper we examine in detail the similarities and differences between the key quantitative (Pillar 1) aspects of the standard formulae of SST and Solvency II, as specified in the fifth Quantitative Impact Study (QIS5). We also consider at a high level the qualitative (Pillar 2 and Pillar 3) aspects of each regime.

SST and Solvency II are both recently developed principles-based regulatory capital regimes, designed to replace the Solvency I capital regime which has formally been in place since the 2002 Life Directive.

Solvency II is due to be implemented from 1 January 2013. SST had a transitional period from 1 January 2008 until 1 January 2011 and is now the primary solvency test in Switzerland. In Switzerland, both the SST and Solvency I will continue to be calculated for the foreseeable future and the generally higher (in current market conditions) SST capital requirements have been phased in over the last five years.

It should be highlighted that, at the time of writing, the Solvency II framework remains in draft form and subject to change. Our best current understanding of the standard formula is based on the technical specification of QIS5. Throughout this paper, any references to the Solvency II standard formula are therefore based on the QIS5 technical specification.

This report focuses on life-insurance-related aspects. We do not discuss non-life or health insurance capital requirements in detail.

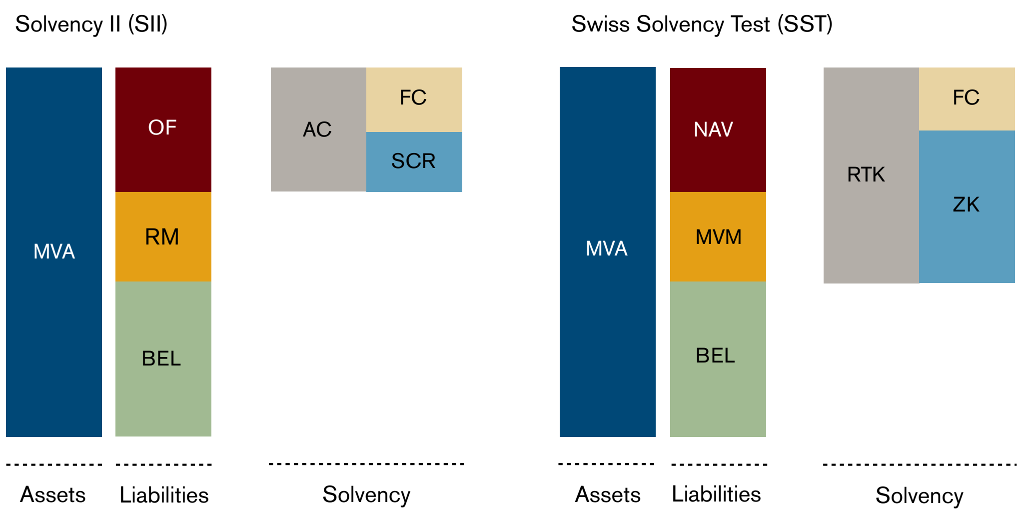
# 2 EXECUTIVE SUMMARY

## 2.1 Overview

The Swiss Solvency Test and Solvency II are both principles-based, economic- and risk-based solvency regimes.

For life insurers, the structure of the economic balance sheet is somewhat similar between the two regimes and is summarised in the following diagram:

**FIGURE 1**




*Note that the graph above is only used for illustration purposes. In reality the capital requirement between Solvency II and SST can be different, often significantly so.*

Please see the glossary for the above abbreviations.

Key points to note on the economic balance sheet include:

- Assets are generally taken at market value under both regimes.
- The general methodology used to determine best estimate liability is fundamentally similar under both regimes.
- Discount rates differ. QIS5 uses swap rates plus a liquidity premium less a deduction for credit risk within the swap rates, whereas SST uses government bond rates without liquidity premium or credit adjustment.
- The risk margin (Solvency II) and market value margin (SST) are both based on a cost of capital (CoC) approach with the capital measure being non-hedgeable risk capital and the cost being 6%.

**QIS5 uses swap rates plus a liquidity premium less a deduction for credit risk within the swap rates, whereas SST uses government bond rates without liquidity premium or credit adjustment.**

- Solvency II has a tiering system for own funds and admissibility limits on certain types of funds. SST does not have a formal tiering system but distinguishes between core capital (Kernkapital), supplementary capital (Ergänzendes Kapital) and additional core capital (Zusätzliches Kernkapital). Most sources of capital are core, although some hybrid debt and subordinate debt are not treated as core.

- For life insurers the SST balance sheet and capital requirements are gross of tax, whereas for Solvency II the balance sheet is net of tax. Furthermore, the solvency capital requirements (SCR) under Solvency II explicitly allows for the loss-absorbing effect of deferred taxation.

- Solvency II shows an explicit adjustment for the loss-absorbing capacity of technical provisions. This is the ability to change future discretionary policyholder participation to absorb losses. In SST future discretionary policyholder participation is not taken into account in the MVL and thus these future bonuses are fully loss absorbing.

### 2.2 Solvency measure

The solvency of an insurance undertaking is measured as:

- Solvency II – Ratio of available capital to required capital (AC/RC). Using Solvency II terminology this is own funds/SCR.

- SST – Ratio of risk-bearing capital to target capital (RTK/ZK). Note this ratio is somewhat similar to the ratio of (own funds + risk margin) / (SCR + risk margin) in Solvency II.

### 2.3 Risk measure

SST uses a tail value at risk / expected shortfall risk (TVaR) measure and a 99% confidence interval to calculate target capital, or 'Zielkapital' (ZK). Solvency II uses a value at risk (VaR) measure and a 99.5% confidence interval.

Both regimes use a one-year time horizon but the SST shocks are measured with reference to a change in risk-bearing capital (RTK), which is defined as discounted shocked RTK at time 1 – RTK at time 0, whereas Solvency II standard formula shocks are with reference to change in NAV, which is defined as shocked NAV at time 0 – base NAV at time 0. Thus SST in theory allows for the impact of one year's new business in its target capital. However, in practice it is our understanding that few companies actually allow for the new business.

The general method of calculating risk capital under Solvency II is to simply observe the change in NAV (as above) for a given number of stresses and aggregate this capital using correlation matrices. SST, however, observes the change in RTK (as above) from up and down shocks to a particular risk factor. From this it estimates the standard deviation and subsequently the tail VaR. These amounts are then aggregated using correlation matrices.

**The general method of calculating risk capital under Solvency II is to simply observe the change in NAV (as above) for a given number of stresses and aggregate this capital using correlation matrices. SST, however, observes the change in RTK (as above) from up and down shocks to a particular risk factor.**

### 2.4 Main risk categories

The Solvency II SCR allows for the following types of risk for life insurers:

- Life underwriting risk (SCRlife)

- Market risk (SCRmkt)

- Default risk (SCRdef)

- Operational risk (SCRop)

- Intangible asset risk (SCRintangibles)

The SST capital requirement allows for the following types of risk for life insurers:

- Life underwriting risk
- Market risk
- Credit risk
- Scenario risk, the risk the capital for the above risks changes in pre-defined scenarios

Thus SST does not allow for operational risk quantitatively; however, it must be fully described qualitatively in the SST report. Since there are no intangible assets on the SST balance sheet, there is no corresponding SCR.

**SST uses a Basel II approach to credit risk based on risk-weighted assets. Solvency II uses an approach based on loss-given defaults and probabilities of default.**

SST uses a Basel II approach to credit risk based on risk-weighted assets. Solvency II uses an approach based on loss-given defaults and probabilities of default.

The SST examines 77 market risk factors separately which correspond to risk factors of interest rate levels and volatilities, equity levels and volatilities, currency rate levels and volatilities, credit spreads and real estate. Solvency II examines the same risk factors but has no volatilities stresses. The QIS5 market risk module also has two additional sub-modules over the SST: asset concentration risk and liquidity premium risk.

QIS5 has the following life sub-modules: mortality, longevity, disability, lapses, expenses, annuity revision risk and life catastrophe (CAT) risk. SST examines the same risk factors but explicitly examines disability recovery rates separately and option take-up rates. SST does not consider annuity revision risk or CAT risk within the life sub-modules, although CAT risk is allowed for in the scenario add-on capital since there is a pandemic and a disability scenario.

# 3 GENERAL METHODOLOGY

## 3.1 Solvency measure

The solvency of an insurance undertaking is measured as:

- Solvency II – Ratio of available capital to required capital (AC/RC). Using Solvency II terminology this is own funds/SCR.

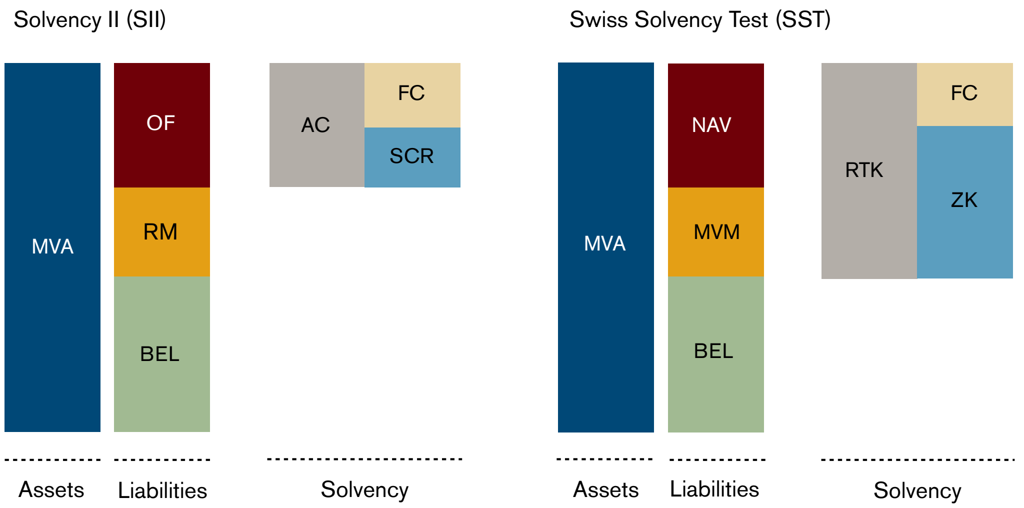
- SST – Ratio of risk-bearing capital to target capital (RTK/ZK). Note this ratio is somewhat similar to the ratio of (own funds + risk margin) / (SCR + risk margin) in Solvency II.

It is worth noting that if a company is solvent under the Solvency II regime (i.e, own funds / SCR > 100%) then the SST ratio of (own funds + risk margin) / (SCR + risk margin) would always be less than the Solvency II ratio of own funds / SCR.

## 3.2 Overview

The following graph illustrates an overall structure of the balance sheet under both regimes:

**FIGURE 2**




*Note that the graph above is only used for illustration purposes. In reality the capital requirement between Solvency II and SST can be different, often significantly so.*

## 3.3 Solvency II

- Available capital (AC), known as own funds (OF), is calculated as the difference between the market value assets (MVA) and the market value of liabilities (MVL).

- MVL = best estimate liability (BEL) + risk margin (RM).

- The risk margin is derived using a cost of capital approach and is based on risk capital allowing for life underwriting, operational and non-hedgeable market risks.

- SCR under the QIS5 standard formula is determined by stressing the balance sheet and measuring the impact that each stress has on the AC.

Stress tests use a modular approach in the standard formula in which the main risk categories are separated as market risks, underwriting risks, default risk, operational risk and intangible asset risk.

- To estimate the SCR, Solvency II requires the use of a value at risk (VaR) approach calibrated with a confidence level of 99.5%. This stress event is therefore equivalent to a one-in-200-year event. The VaR approach is implemented in the standard formula by obtaining a stress amount for each risk factor that is equivalent to a one-in-200-year event. The change in available capital can then be observed after recalculating with the given risk factor stressed.

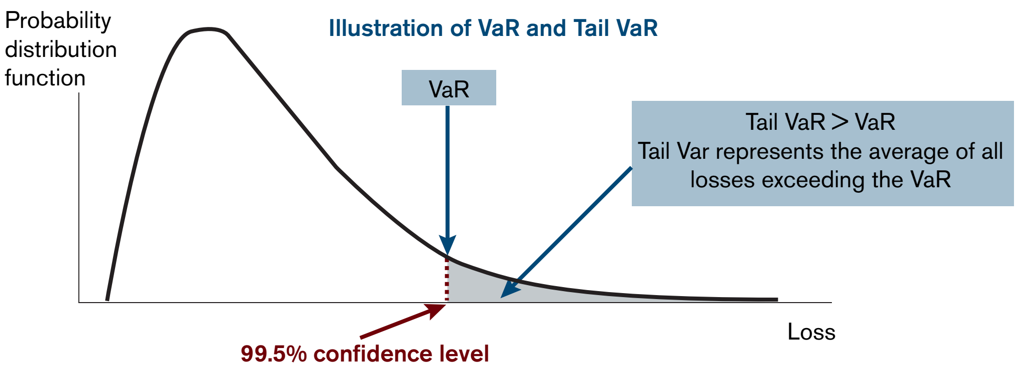
- Stress tests use a modular approach in the standard formula in which the main risk categories are separated as market risks, underwriting risks, default risk, operational risk and intangible asset risk.

- Market and underwriting risk modules in the standard formula are further subdivided into sub-risk modules. Different sub-modules are aggregated to allow for the effects of diversification and determine a BSCR figure.

- The final SCR figure is the result of adding the BSCR, SCRop and an adjustment for the loss-absorbing capacity of both deferred taxes and technical provisions.

The following diagram illustrates the difference between the VaR risk measure (used by Solvency II) and the tail VaR risk measure (used by SST, as described below):

**FIGURE 3**




*Source: CEA working paper on the risk measures VaR and TailVaR, November 2006*

### 3.4 Swiss Solvency Test

The goal of the SST is to obtain a picture of:

(a) The amount of risk borne by an insurance undertaking

(b) Its financial capacity to bear these risks

The amount of risk assumed is measured by the ZK, and the capacity to bear risks is measured by the RTK.

To determine the ZK, the SST requires the use of a tail VaR approach (as opposed to the VaR approach used by Solvency II). The ZK is defined as the maximum expected loss at a 99% confidence level. In other words, if the 1% event occurs, the expected loss will be the ZK. Please see the diagram above.

**To determine the ZK, the SST requires the use of a tail VaR approach (as opposed to the VaR approach used by Solvency II).**

The RTK is defined as the difference between the market value of assets (MVA) and the discounted best estimated value of liabilities (BEL); hence, the market value margin (MVM) is considered part of the available capital under the SST.

- MVL = best estimate liability (BEL) plus market value margin (MVM). MVM is equivalent to the risk margin under Solvency II and is derived using a CoC approach.
- To estimate the ZK, SST requires the use of a TVaR (measured as RTK's expected shortfall to the different risk factors) approach calibrated with a confidence level of 99.0%.
- ZK is determined by stressing the balance sheet and measuring the impact that each stress has on the RTK.
- ZK is calculated by combining distributions for several risk types. For instance, the base distribution of RTK is combined with the distribution in stress scenarios to calculate the overall underwriting and market ZK. To ease comparison with Solvency II, we present the ZK using a modular approach in which the main risk categories are separated as market risks, underwriting risks (we consider here only the life underwriting risks), credit risk and the scenario add-on capital.
- Market, credit and underwriting risk modules are further subdivided into the main risk factors. The aim is to calculate RTK's sensitivity to variances in the different risk factors. Each result is adjusted by the historic volatility of a given risk factor, and then correlated to arrive at the RTK's standard deviation.
- MVM is considered to be part of the overall ZK and is based on a cost of capital approach which allows for the run-off of life underwriting risks but assumes all market risk is hedgeable.
- As mentioned at the beginning of this chapter, under the SST regime the solvency position of an insurance undertaking is determined with the RTK/ZK ratio.
- It is worth pointing out that in general under the Solvency II standard model, the 99.5% stresses are pre-defined in the methodology. This means the stress is not company-specific but the result of the stress is. Under SST, in general stresses are performed to find a suitable risk distribution. From this the 99.0% stress is implicitly found and the impact of this calculated. This means that in contrast to Solvency II, under the SST standard model both the level of the stress and the impact of the stress are company-specific.

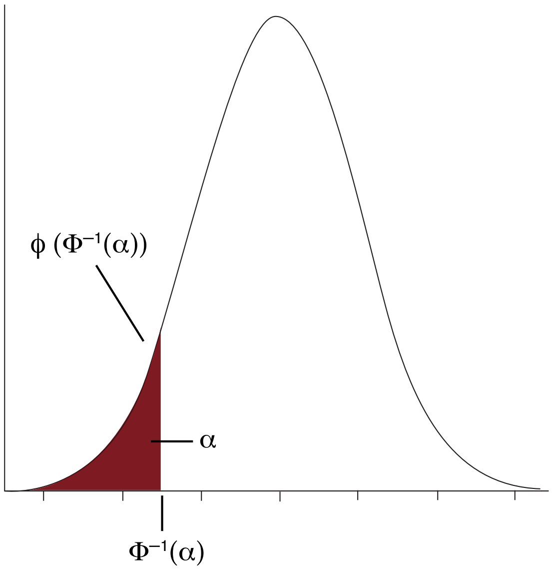
The SST standard model to determine the ZK has evolved. In former years a linear approximation for the change in RTK was used - the so called Delta-Normal approximation. Assuming multivariate normally distributed risk factors this results in an analytical approximation of the tail value at risk, which is as follows:

$$\textbf{TVaR} = \varphi(\Phi^{-1}(\alpha))\frac{1}{\alpha}\ \textbf{x Standard Deviation,}$$

where alpha $\alpha = 1\%$ is the confidence limit, $\varphi(x)$ is the probability density function of the normal distribution and $\Phi(x)$ is the cumulative distribution function.

This formula assumes the risk is normally distributed. The following chart illustrates the TVaR calculation:

**FIGURE 4**




In the above diagram, the value at risk is shown on the horizontal axis and the $\alpha$ x TVaR is shown as the value of the normal distribution function corresponding to this value. Thus, for the standard normal distribution, $\text{VaR} = \Phi^{-1}(\alpha)$ and $\text{TVaR} = \varphi(\text{VaR})\frac{1}{\alpha}$.

Additionally for a number of modules an estimate of the standard deviation is made given two equal and opposite shocks (normally of 10%) to the RTK. If we denote the change in RTK in the up shock of x% as $\Delta RTK_{x+}$ and the change in the down shock of –x% as $\Delta RTK_{x-}$, then the approximation is:

$$\textbf{Standard Deviation} = \frac{(\Delta RTK_{x+} - \Delta RTK_{x-})}{2x\%} \textbf{ x assumed historical volatility}$$

**In 2010 the Swiss regulator FINMA upgraded the SST standard model to the 'Delta-Gamma' approximation in order to include a second-order factor to take account of the non-linear dependencies of risk factors.**

As mentioned above, in 2010 the Swiss regulator FINMA upgraded the SST standard model to the 'Delta-Gamma' approximation in order to include a second-order factor to take account of the non-linear dependencies of risk factors. Theoretically a 77-by-77 matrix (77 is the number of market risk factors) of second-order cross partial derivatives must be computed to examine the distribution of RTK to the market risk factors. Although there are other methods for approximating quantiles in the Delta-Gamma approach, FINMA proposes to use Monte-Carlo simulation to determine an empirical distribution of the RTK. This distribution can then be used within the scenario add-on capital as the basis for aggregating the scenarios with the base distribution. See section 9 for more details.

# 4 AVAILABLE CAPITAL

## 4.1 Overview

Available capital under Solvency II (known as own funds) is the market value of assets (MVA) less the market value of liabilities (MVL), where MVL = BEL + RM.

Under SST, the risk-bearing capital is RTK = MVA – BEL. Equivalently, we can define available capital (AC) as AC = MVA – BEL – MVM and then RTK = AC + MVM.

Either way, the key components to consider in the evaluation of the base economic balance sheet under the regimes are MVA, BEL and RM/MVM. We consider each in turn below:

## 4.2 Asset valuation

Assets are generally taken at market value under both frameworks.

For Solvency II, reinsurance assets (i.e., the difference between net and gross of reinsurance BEL) are shown as separate assets on the economic balance sheet. The value of these assets is then adjusted for default risk, however. Under SST, net of reinsurance insurance liabilities are shown and unadjusted-for-default "reinsurance assets" are implicitly included in liabilities.

**For Solvency II, reinsurance assets (i.e., the difference between net and gross of reinsurance BEL) are shown as separate assets on the economic balance sheet. Under SST, net of reinsurance insurance liabilities are shown and unadjusted-for-default "reinsurance assets" are implicitly included in liabilities.**

On the Solvency II balance sheet some intangible assets may be held. Under SST, all intangible assets are inadmissible.

Under both regimes holdings in own shares do not form part of the balance sheet.

Under Solvency II the economic value of deferred tax assets is included. For life insurers under SST the deferred taxes are not taken into account since the entire SST is calculated gross of tax.

## 4.3 Best estimate liability valuation

Under both frameworks, the value of the technical liabilities is defined as the expected value (under risk-neutral probability measures, and including the value of options and guarantees) of the future contractually agreed payments, discounted at the risk-free interest-rate curve. In particular, the best estimate principle must be observed in this regard: the valuation does not contain any implicit or explicit margin for prudence.

The risk-free interest-rate curves for Swiss business are defined by Swiss authorities; equivalent risk-free interest-rate curves for EUR, USD and GBP business are made available by the supervisory authority. For the recent QIS5 exercise, the European Commission published the yield curves to be used.

Under Solvency II, the market value of deferred tax liabilities is included but not under SST.

In addition under SST there are several adjustments to liabilities:

- Tax on real estate gains / real estate transfer tax associated with valuation reserves for land and buildings is removed from deferred tax liabilities.

- Anticipated dividends and repayments of capital are treated as liabilities not equity.

- Non-eligible intra-group loans are removed.

Under both regimes, subordinated debt is part of the available capital, since it ranks below policyholder liabilities, and is thus available to cover solvency requirements. However, under Solvency II many forms of subordinated debt are likely to be treated as Tier 3 Capital, although other forms will be eligible for inclusion as Tier 2, either in their own right or through the transitional grandfathering arrangement. Tier 3 Capital cannot account for more than 15% of total available capital and this Tier 3 subordinated debt is subject to eligibility limits. Under SST there are no eligibility criteria.

Contract boundaries are also an area of significant debate. Under QIS5 a projection is generally carried out over the full period needed to run off the liability, but an individual contract's boundary may be deemed to occur before the termination date of the contract. QIS5 contract boundaries are determined with reference to the unilateral right of the insurer to alter or reject future premiums. More formally, "Where the insurance or reinsurance undertaking has a unilateral right to terminate the contract, a unilateral right to reject the premiums payable under the contract or an unlimited ability to amend the premiums or the benefits payable under the contract at some point in the future, any obligations which relate to insurance or reinsurance cover which would have been provided by the insurance or reinsurance undertaking after that date do not belong to the existing contract." Under SST, the Pillar 2 mandatory pensions business (BVG) is projected for 10 years and all other business until the liability is fully run off.

### 4.4 Risk adjustment

For Solvency II, the risk margin is calculated based on a cost of capital approach. In each future projection year the non-hedgeable risk capital must be determined, although a hierarchy of simplifications are permissible. An annual charge of 6% is then applied and the amounts are discounted to determine the risk margin.

Under Solvency II, the non hedgeable risk capital in any year is generally taken to be the aggregation of the following elements:

- SCRlife
- SCRhealth
- SCRop
- The non-hedgeable part of SCRmkt
- The non-hedgeable part of SCRdef, mainly the part arising from reinsurance arrangements

Under Solvency II the non-hedgeable capital may be projected forward using a number of methods, ranging from recalculating the non-hedgeable capital at each future year (in practice this approach is not often used because of the large number of runs and calculations needed to be performed), to projecting each sub-module using carriers, to projecting the overall non-hedgeable capital forward using the BEL run-off profile.

For the SST a similar approach is taken, based on the cost of future risk capital. The market value margin (MVM) is calculated using an annual capital charge of 6% and, as per Solvency II, the future risk capital may be determined using a variety of approaches.

**The risk capital under the SST is determined in a different manner to Solvency II.**

However, the risk capital under the SST is determined in a different manner to Solvency II.

The SST non-hedgeable capital is taken as the non-current insurance risk and the non-hedgeable ALM risk. Current year insurance risk relates to insurance risk in the current year, i.e., that allowed for in the one-year time horizon ZK. However, since the non-hedgeable ALM risk is determined with reference to the optimal replicating portfolio (a portfolio of tradable assets), this results in all ALM risks being hedgeable. Thus the SST MVM is only based on the run-off of the insurance underwriting risks.

# 5 REQUIRED CAPITAL: OVERVIEW

## 5.1 Solvency II required capital

The SCR under the Solvency II regime is the sum of the base solvency capital requirement (BSCR), the adjustments for the loss absorbency of deferred taxes and technical provisions (Adj) and the operational risk capital (SCRop). That is:

**SCR = BSCR + Adj + SCRop**

The BSCR in turn is determined by taking into account the solvency capital requirements generated by the following modules:

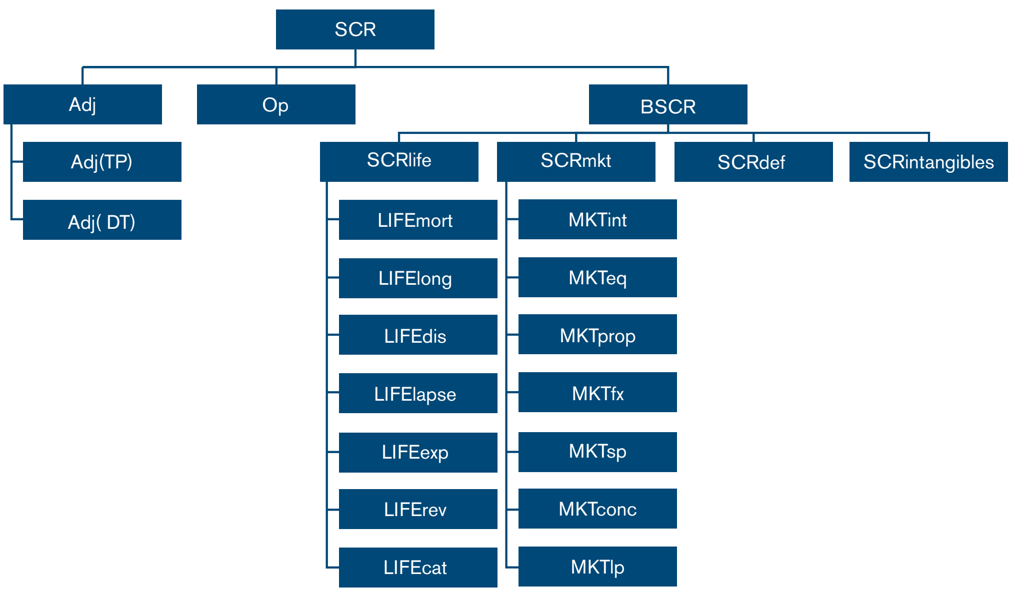
- Market risk
- Counterparty default risk (credit)
- Life underwriting risk
- Health underwriting risk
- Intangible asset risk

Some of these modules require a more detailed sub-module-based calculation, for example, the market risk module is split into sub-modules for equity risk, interest rate risk, etc. The methodology relating to each of the individual modules contributing to BSCR is described in the following sections.

The SCR structure for life insurers can be depicted as:

**The SCR under the Solvency II regime is the sum of the base solvency capital requirement (BSCR), the adjustments for the loss absorbency of deferred taxes and technical provisions (Adj) and the operational risk capital (SCRop).**

**FIGURE 6**




*Source: Based on QIS5 Technical Specifications*

**The ZK under the SST regime is defined as the market value margin (MVM) plus a solvency capital requirement ($ZK_{SCR}$).**

## 5.2 SST target capital

The ZK under the SST regime is defined as the market value margin (MVM) plus a solvency capital requirement ($ZK_{SCR}$). This capital requirement is calculated as the sum of a credit capital requirement ($ZK_{CRED}$) and an insurance and market capital requirement. The total insurance and market capital requirement is derived by aggregating separate insurance ($ZK_{LIFE}$, since we do not consider non-life capital requirements in this document) and market ($ZK_{MKT}$) requirements assuming zero correlation. This amount is then adjusted to allow for its change in pre-defined scenarios ($ZK_{SCEN}$). That is, the additional capital must be held to cover the potential fall in RTK in a number of pre-defined scenarios. The target capital can therefore be presented as:

$$ZK = ZK_{SCR} + \text{Market Value Margin} = \sqrt{(ZK_{LIFE}^2 + ZK_{MKT}^2)} + ZK_{SCEN} + ZK_{CRED} + MVM$$

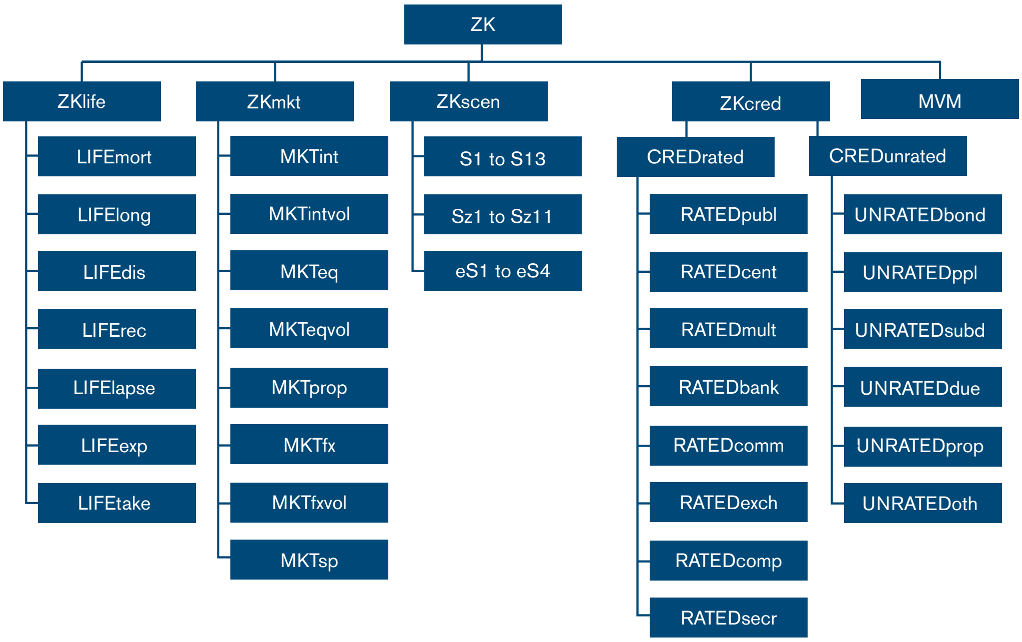
Therefore, comparing with the SCR in the previous section, the ZK takes into account the following risks (plus the market value margin allowance):

- Market risk
- Credit risk
- Life underwriting risk
- Scenario add-on risk capital

Some of these modules require a detailed risk-factor-based calculation. For example, the $ZK_{MKT}$ requires the use of more than 70 risk factors, including interest rate risks and volatilities, equity risks and volatilities, in order to calculate the expected loss. The methodology relating to each of the individual modules contributing to ZK is described in the sub-sections below.

The structure on page 15 has been included for the purpose of comparison with Solvency II, although it is not included in any of the SST documents. Similarly, the terminology, e.g., $LIFE_{MORT}$ or $ZK_{CRED}$, is not that officially used in the SST documentation.

**FIGURE 7**


ZK
ZKlife
ZKmkt
ZKscen
ZKcred
MVM
LIFEmort
LIFElong
LIFEdis
LIFErec
LIFElapse
LIFEexp
LIFEtake
MKTint
MKTintvol
MKTeq
MKTeqvol
MKTprop
MKTfx
MKTfxvol
MKTsp
S1 to S13
Sz1 to Sz11
eS1 to eS4
CREDrated
CREDunrated
RATEDpubl
RATEDcent
RATEDmult
RATEDbank
RATEDcomm
RATEDexch
RATEDcomp
RATEDsecr
UNRATEDbond
UNRATEDppl
UNRATEDsubd
UNRATEDdue
UNRATEDprop
UNRATEDoth

# 6 REQUIRED CAPITAL: LIFE INSURANCE RISK

Both the SST and Solvency II calculate a life insurance capital requirement by considering individual risk factors. These risk factors are generally the same under both regimes, although Solvency II considers an extra two explicit factors. The methodology follows the standard Solvency II and SST approaches respectively. In aggregating the capital amounts, Solvency II considers more risk factors to be correlated with one another.

The following risk factors are considered in Solvency II and the SST:

| RISK FACTOR | INCLUDED IN SOLVENCY II | INCLUDED IN SST |
|---|---|---|
| MORTALITY | YES | YES |
| MORBIDITY | YES | YES |
| RECOVERY RATES | WITHIN MORBIDITY SUB MODULE | YES |
| LONGEVITY | YES | YES |
| EXPENSES | YES | YES |
| LAPSES | YES | YES |
| LIFE CATASTROPHE | YES | N/A |
| ANNUITY REVISION | YES | N/A |
| OPTION TAKE-UP | WITHIN LAPSE SUB MODULE | YES |

Recovery Rates and Option Take-up are explicit sub-modules under the SST. However, in Solvency II these risk factors are tested within the Morbidity and Lapses sub-modules respectively. Additionally, economic-scenario-driven dynamic lapses should be included within the market modules of Solvency II. CAT and annuity revision risks are not explicitly tested under SST, although there are SST scenarios that simulate catastrophic events.

As mentioned in section 3.4, the SST standard model was recently upgraded to the Delta-Gamma approach. Although the regulator indicates that it should also include second-order derivatives with respect to the life underwriting parameters, we feel that it was introduced primarily for the 77 market risk factors. The design of the official SST template for 2011 (sheet "Sensitivitaeten Gamma_Market") seems to confirm this view. We therefore ignore the second-order derivatives for life risk in this chapter.

## 6.1 Risk methodology

Solvency II specifies shock scenarios that are applied to the base assumption for each specified risk factor. Valuations are then performed, generally in a stochastic environment, and the difference between the mean of the base net asset value and the mean stressed net asset value is the SCR in respect of that risk type:

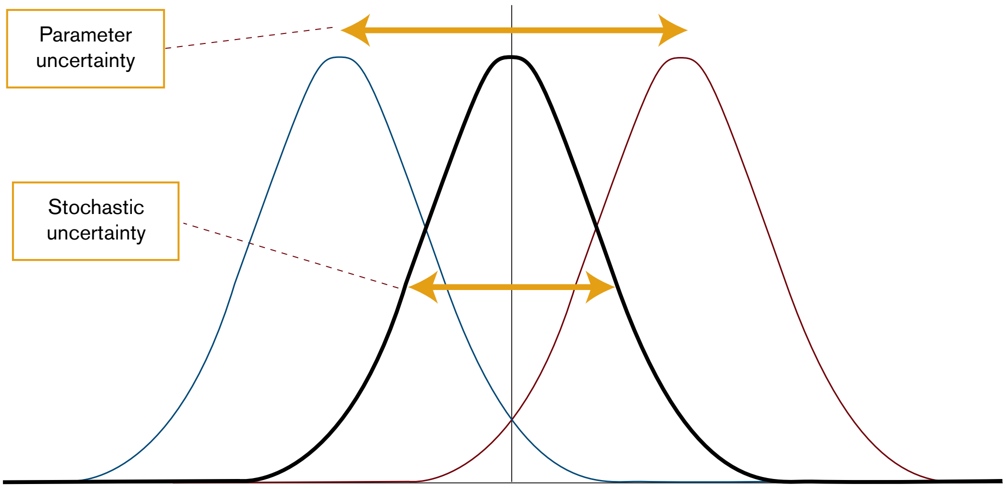
$$\text{Life}_{\text{risk type } i} = \text{MAX } \{0, \text{mean NAV}_{\text{stressed}} - \text{mean NAV}_{\text{base}}\}$$

The SST standard model for life underwriting risk allows for two types of risk for each risk factor:

- Parameter risk
- Stochastic risk

Parameter risk arises from the uncertainty in a parameter estimate, whereas stochastic risk arises from the inherent variation in that risk factor. This is illustrated well in the diagram below, which is adapted from the SST technical document:

**FIGURE 5**




BVG business (Pensions Pillar 2 business in Switzerland, i.e., mandatory private or occupational pension schemes) is treated separately, in that different correlation factors and assumed volatilities are used.

For parameter risk, the change in RTK in a positive and negative 10% stress for the given risk factor is measured. This result is then used to estimate the standard deviation and, subsequently, the TVaR using the standard method (see section 3.4). The standard historical volatilities used are as follows:

| RISK FACTOR | STANDARD DEVIATION |
|---|---|
| MORTALITY | 5% |
| LONGEVITY | 10% |
| DISABILITY | 10% (20% FOR BVG) |
| RECOVERY RATES | 10% |
| EXPENSES | 10% |
| LAPSES | 25% |
| OPTION TAKE-UP | 10% |

Secondly, the stochastic standard deviation must be calculated. The standard model uses the so-called Collective Risk Model to estimate the stochastic risk for each risk factor. This estimate is based on the expected number of claims (relating to the risk type), the variance of the distribution of a single claim and the assumption of a compound Poisson distribution. The stochastic risk tail value at risk is then calculated by transforming the standard deviation to the tail value at risk (see section 3.4 for details).

## 6.2 Risk Stresses

The individual risk stresses are as follows:

| RISK TYPE | RISK DRIVER | SOLVENCY II STRESS | SST STRESS |
|---|---|---|---|
| MORTALITY | DEATH RATE | -15% | +/- 10% |
| MORBIDITY | DISABILITY RATE (YEAR 1) | 35% | +/- 10% |
| | DISABILITY RATE (THEREAFTER) | 25% | +/- 10% |
| RECOVERY RATES | RECORVERY RATE | -20% | +/- 10% |
| LONGEVITY | MORTALITY IMPROVEMENT RATE | -20% | +/- 10% |
| EXPENSES | MAINTENANCE EXPENSES | -10% | +/- 10% |
| | EXPENSE INFLATION | 1% | N/A |
| LAPSES | LAPSE RATE | +/- 50% | +/- 10% |
| | MASS LAPSE | 30% | N/A |
| CAT | DEATH RATE (ADDITIVE) | 10% | N/A |
| REVISION | ANNUITIES PAID | 3% | N/A |

Note that for Solvency II the above rates are often subject to maximums to prevent, for example, a 50% increase in lapse rates increase absolute lapse rates to over 100%.

Note also that the SST stresses shown for comparison are the +/- 10% parameter risk shocks.

## 6.3 Risk aggregation

Under Solvency II, the individual sub-modules are aggregated using the following matrix to determine the $SCR_{life}$:

| | $LIFE_{mort}$ | $LIFE_{long}$ | $LIFE_{dis}$ | $LIFE_{lapse}$ | $LIFE_{exp}$ | $LIFE_{rev}$ | $LIFE_{CAT}$ |
|---|---|---|---|---|---|---|---|
| $LIFE_{mort}$ | 1 | -0.25 | 0.25 | 0 | 0.25 | 0 | 0.25 |
| $LIFE_{long}$ | -0.25 | 1 | 0 | 0.25 | 0.25 | 0.25 | 0 |
| $LIFE_{dis}$ | 0.25 | 0 | 1 | 0 | 0.5 | 0 | 0.25 |
| $LIFE_{lapse}$ | 0 | 0.25 | 0 | 1 | 0.5 | 0 | 0.25 |
| $LIFE_{exp}$ | 0.25 | 0.25 | 0.5 | 0.5 | 1 | 0.5 | 0.25 |
| $LIFE_{rev}$ | 0 | 0.25 | 0 | 0 | 0.5 | 1 | 0 |
| $LIFE_{CAT}$ | 0.25 | 0 | 0.25 | 0.25 | 0.25 | 0 | 1 |

Under the SST, the sub-module capital requirements for parameter risk and stochastic risk are aggregated to arrive at a total life parameter risk capital and a total stochastic risk capital. These are then aggregated again to derive the total capital requirement for life.

**Under the SST, the sub-module capital requirements for parameter risk and stochastic risk are aggregated to arrive at a total life parameter risk capital and a total stochastic risk capital. These are then aggregated again to derive the total capital requirement for life.**

The individual parameter and stochastic risk capital amounts are correlated using the following matrix. Most risk categories are thus assumed to be independent of one another.

| | $LIFE_{mort}$ | $LIFE_{long}$ | $LIFE_{dis}$ | $LIFE_{lapse}$ | $LIFE_{exp}$ | $LIFE_{rev}$ | $LIFE_{CAT}$ |
|---|---|---|---|---|---|---|---|
| $LIFE_{mort}$ | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| $LIFE_{long}$ | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| $LIFE_{dis}$ | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| $LIFE_{rec}$ | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| $LIFE_{exp}$ | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| $LIFE_{lapse}$ | 0 | 0 | 0 | 0 | 0 | 1 | 0.75 |
| $LIFE_{take}$ | 0 | 0 | 0 | 0 | 0 | 0.75 | 1 |

Since BVG business is measured and tested separately, the capital requirement between BVG and non-BVG business must also be aggregated. This is done using the following matrix, where M represents the 7-by-7 matrix given above:

| | BVG | NON BVG |
|---|---|---|
| **BVG** | **M** | **M** |
| **NON-BVG** | **M** | **M** |

It should be noted that the matrix M is very close to the identity matrix (the matrix with 1 along the leading diagonal and 0 otherwise), with the exception being the 75% correlation between lapses and option take-up.

The total life stochastic risk capital and the total Life parameter risk capital are then aggregated assuming zero correlation to arrive at $ZK_{LIFE}$. The following correlation matrix is used:

| | PARAMETER | STOCHASTIC |
|---|---|---|
| **PARAMETER** | **1** | **0** |
| **STOCHASTIC** | **0** | **1** |

# 7 REQUIRED CAPITAL: MARKET RISK

A major difference between Solvency II and SST on one hand and the Solvency I regime on the other is the market/asset-liability management (ALM) risk. The Solvency I regime takes no account of the risks arising from assets and the interaction between assets and liabilities. In this chapter we look at the key differences in allowance for market and ALM risk between QIS5 and the SST.

| RISK FACTOR | SOLVENCY II | SST |
|---|---|---|
| INTEREST RATES | YES | YES |
| INTEREST RATE VOLATILITY | NO | YES |
| EQUITY | YES | YES |
| EQUITY VOLATILITY | NO | YES |
| PROPERTY | YES | YES |
| CURRENCY | YES | YES |
| CURRENCY VOLATILITY | NO | YES |
| SPREADS | YES | YES |
| CONCENTRATION | YES | N/A |
| ILLIQUIDITY PREMIUM | YES | N/A |

The SST framework makes no allowance for illiquidity premiums, hence there is no liquidity premium risk factor. Concentration risk is deemed to be dealt with fully in the credit default risk module under the SST. The SST also has stresses based on volatilities. We note that the draft QIS5 technical specification contained such stresses but these were removed prior to the publication of the final QIS5 technical specification.

## 7.1 Risk methodology

Solvency II specifies shocks that are applied to the base values for each of the above risk factors. Valuations are then performed, generally in a stochastic environment, and the difference between the mean of the base net asset value and the mean stressed net asset value is the SCR in respect of that risk type:

$$LIFE_{\text{risk type } i} = \max(0, \text{mean } NAV_{\text{stressed}} - \text{mean } NAV_{\text{base}})$$

Under the SST, the market risk model in the standard model is based on the assumption that the change of the risk-bearing capital due to market risks can be described as a dependency on market risk factors. These market risk factors encompass interest rates over different terms and currencies, stock indices, currency exchange rates, real estate indices, bond spreads and implied volatilities.

Additionally, the sensitivities of the insurer's own portfolio must be identified. Sensitivities are the partial derivatives of the risk-bearing capital with respect to market risk factors. They are in general approximated by a difference quotient.

As previously mentioned in 2010, the FINMA upgraded the SST standard market model from the so called 'Delta-Normal' approach to the 'Delta-Gamma' approach. The Delta-Normal approach assumes the RTK sensitivity to the market can be described as a multivariate normal distribution and is essentially a first-order approximation. The Delta-Gamma approach builds on the Delta-Normal approach to include a second-order factor to take account of non-linearity between risk factors. This is a practical and computational issue. Theoretically, a 77-by-77 matrix (77 is the number of market risk factors) of second-order cross partial derivatives must be computed to examine the distribution of RTK to two market risk factors.

For the above reasons, the remainder of this chapter focuses on the Delta-Normal approach to the market sub-module.

While Solvency II estimates the SCR in terms of the change in the value of own funds as a consequence of the shock, SST uses an expected shortfall based on the TVaR methodology. That is, the change in RTK in a positive and negative stress for the given risk factor is observed.

## 7.2 Risk stresses

### *7.2.1 Interest rate risk ($MKT_{INT}$)*

For Solvency II, this sub-module assesses the impact that changes in the term structure of interest rates or interest rate volatilities have on the base net asset value. The QIS5 technical specification requires the following multiplicative changes to be applied to the yield curves:

| MATURITY (YEARS) | RELATIVE CHANGE $S_{UP}$ | RELATIVE CHANGE $S_{DOWN}$ |
|---|---|---|
| 1 | 70% | -75% |
| 2 | 70% | -65% |
| 3 | 64% | -56% |
| 4 | 59% | -50% |
| 5 | 55% | -46% |
| 6 | 52% | -42% |
| 7 | 49% | -39% |
| 8 | 47% | -36% |
| 9 | 44% | -33% |
| 10 | 42% | -31% |
| 11 | 39% | -30% |
| 12 | 37% | -29% |
| 13 | 35% | -28% |
| 14 | 34% | -28% |
| 15 | 33% | -27% |
| 16 | 31% | -28% |
| 17 | 30% | -28% |
| 18 | 29% | -28% |
| 19 | 27% | -29% |
| 20 | 26% | -29% |
| 21 | 26% | -29% |
| 22 | 26% | -30% |
| 23 | 26% | -30% |
| 24 | 26% | -30% |
| 25 | 26% | -30% |
| 30 | 25% | -30% |

The capital requirement for interest rate risk is derived from the type of shock that gives rise to the highest overall market capital requirement, including the loss-absorbing capacity of technical provisions. That is, the capital amounts for all other markets risks along with the interest rate down shock and separately the capital amounts for all other market risks along with the interest rate up shock are aggregated and the overall highest market SCR is chosen.

It is worth noting that the above shocks to the yield curve are to be quantified as a whole under Solvency II. In contrast, under SST, a number of independent changes to specific parts of the yield curve must be quantified separately. This represents one of the main differences between Solvency II and SST market risk modules.

**The above shocks to the yield curve are to be quantified as a whole under Solvency II. In contrast, under SST, a number of independent changes to specific parts of the yield curve must be quantified separately.**

Under SST, this assesses the impact that changes in the term structure of interest rates or interest rate volatilities have on the base risk-bearing capital. The shock has to be performed for the different currencies separately. In all cases below, the shock is set to +100 bps/-100 bps to the level of the different risk factors:

| RISK FACTOR | SHOCK (BPS) | VOLATILITY - CHF (BPS) | VOLATILITY - EUR (BPS) | VOLATILITY - USD (BPS) | VOLATILITY - GBP (BPS) |
|---|---|---|---|---|---|
| 1 YEAR ZEROS | 100 | 63.601 | 61.821 | 79.535 | 73.544 |
| 2 YEAR ZEROS | 100 | 70.145 | 72.089 | 101.134 | 84.306 |
| 3 YEAR ZEROS | 100 | 65.568 | 73.005 | 103.483 | 82.537 |
| 4 YEAR ZEROS | 100 | 62.902 | 73.127 | 104.608 | 79.624 |
| 5 YEAR ZEROS | 100 | 60.026 | 83.533 | 107.102 | 78.225 |
| 6 YEAR ZEROS | 100 | 58.753 | 70.433 | 103.799 | 76.444 |
| 7 YEAR ZEROS | 100 | 57.908 | 68.099 | 100.966 | 74.022 |
| 8 YEAR ZEROS | 100 | 57.577 | 65.936 | 98.733 | 72.362 |
| 9 YEAR ZEROS | 100 | 56.416 | 64.886 | 97.037 | 72.094 |
| 10-12 YEAR ZEROS | 100 | 54.140 | 63.542 | 94.811 | 69.607 |
| 13-17 YEAR ZEROS | 100 | 51.770 | 58.910 | 87.795 | 62.572 |
| 18-24 YEAR ZEROS | 100 | 55.944 | 60.940 | 82.253 | 59.199 |
| 25-50 YEAR ZEROS | 100 | 61.378 | 59.955 | 79.867 | 60.986 |

Note that the volatilities shown above are the historic volatilities of each of the risk factors, and are not the shocks to interest rate volatility (which are shown below in 7.2.2). These historic volatilities are used in determining the standard deviation and thus TVaR for each of the market risk factors. The historic volatilites are specified and updated by FINMA for each SST valuation date. For illustrative purposes we show those from the original Technical Specification throughout this chapter.

**There are no volatility stresses in the Solvency II framework. For SST, the shock is set as a +/- 1,000 bps change in implied volatility.**

### *7.2.2 Interest rate volatility risk ($MKT_{INT\text{-}VOL}$)*

There are no volatility stresses in the Solvency II framework. For SST, the shock is set as a +/- 1,000 bps change in implied volatility.

| RISK FACTOR | SHOCK (BPS) | VOLATILITY (BPS) |
|---|---|---|
| VOLATILITY | 1000 | 0.5 |

### *7.2.3 Equity Risk ($MKT_{EQ}$)*

For Solvency II, this market risk sub-module assesses the impact on the NAV of a fall in the value of equities. The QIS5 technical specifications set the level of the assumed fall as 30% (a base stress of 39% less a 9% symmetric adjustment) in the case of 'Global' equity, i.e., equities listed in regulated markets that are members of the EEA or OECD, and in 40% for 'Other' equity.

The overall equity sub-module risk capital is determined by aggregating the shocks for these two categories using the following matrix:

| | GLOBAL | OTHER |
|---|---|---|
| GLOBAL | 1 | 0.75 |
| OTHER | 0.75 | 1 |

For SST, a separate shock is performed for equities in each currency. Both an increase and decrease in the value of equities are considered, in order to derive a standard deviation estimate.

| RISK FACTOR | SHOCK (BPS) | VOLATILITY (BPS) |
|---|---|---|
| MSCI CHF SHARES | 1,000 | 0.164 |
| MSCI EMU SHARES | 1,000 | 0.188 |
| MSCI US SHARES | 1,000 | 0.150 |
| MSCI UK SHARES | 1,000 | 0.134 |
| MSCI JAPANESE SHARES | 1,000 | 0.161 |
| PACIFIC EXCLUDING JAPAN SHARES | 1,000 | 0.143 |
| SMALL CAP EMU SHARES | 1,000 | 0.177 |
| SHOCK TO HEDGE FUNDS | 1,000 | 0.300 |
| SHOCK TO PRIVATE EQUITY | 1,000 | 0.375 |
| SHOCK TO PARTICIPATIONS | 1,000 | 0.250 |

### *7.2.4 Equity volatility risk ($MKT_{EQ\text{-}VOL}$)*

There are no volatility shocks in the Solvency II framework. For SST, the shock is set as a 1,000 bps up and down change in equity implied volatility.

| RISK FACTOR | SHOCK (BPS) | VOLATILITY (BPS) |
|---|---|---|
| EQUITY VOLATILITY | 1000 | 0.564 |

### *7.2.5 Property risk ($MKT_{PROP}$)*

For Solvency II, this sub-module measures the immediate effect on the net value of assets and liabilities expected in the event of an instantaneous decrease of 25% in the value of all investments in real estate.

For SST, there are a number of property risk factors as set out in the table below. Again, both a positive and negative shock must be performed.

**For SST, there are a number of property risk factors. Again, both a positive and negative shock must be performed.**

| RISK FACTOR | SHOCK (BPS) | VOLATILITY (BPS) |
|---|---|---|
| SWX IAZI PERFORMANCE REAL ESTATE | 1,000 | 0.041 |
| COMMERCIAL DIRECT REAL ESTATE | 1,000 | 0.095 |
| RÜD BLASS REAL ESTATE INDEX | 1,000 | 0.069 |
| WUPIX A REAL ESTATE | 1,000 | 0.095 |

### *7.2.6 Currency risk ($MKT_{FX}$)*

For Solvency II, this sub-module assesses the change in the net asset value arising from changes in the level of currency exchange rates. The shock measures the impact of an increase (decrease) of 25% in the value of the currency considered against the local currency. Having calculated the change in NAV for each currency, the effects are summed to derive the overall requirement.

For SST, the currency level shocks are performed independently and as is usual both a positive and negative shock is required:

| CURRENCY RISK FACTOR | SHOCK (BPS) | VOLATILITY (BPS) |
|---|---|---|
| EUR | 1,000 | 0.033 |
| USD | 1,000 | 0.092 |
| GBP | 1,000 | 0.072 |
| JPY | 1,000 | 0.111 |

### 7.2.7 *Currency volatility risk ($MKT_{FX\text{-}VOL}$)*

There are no volatility shocks in the Solvency II framework. For SST, the shock is set as a 1,000 bps up and down change in implied volatility of the USD against the CHF.

| CURRENCY RISK FACTOR | SHOCK (BPS) | VOLATILITY (BPS) |
|---|---|---|
| USD | 1000 | 0.302 |

### 7.2.8 *Spread risk ($MKT_{SP}$)*

Spread risk results from the sensitivity of the value of assets and liabilities to changes of credit spreads over the risk-free interest-rate term structure. Spread risk exists on bonds, structured products and credit derivatives.

**Under Solvency II, a simplified method is used to calculate the spread risk. This involves approximations to estimate the change in the value of assets given changes in spread.**

Under Solvency II, a simplified method is used to calculate the spread risk. This involves approximations to estimate the change in the value of assets given changes in spread. The change in liabilities can then be observed by rerunning the model using the stressed values of the affected assets.

For bond spread risk the change in market value of assets with a particular rating are approximated by multiplying the duration by the market value by a spread factor. The spread factors used increase the lower the rating of the asset is and are shown below:

| ASSET TYPE | RATING | SPREAD SHOCK |
|---|---|---|
| BONDS - EEA GOVERNMENTS OR CENTRAL BANKS | ANY | 0.00% |
| BONDS - MULTILATERAL DEVELOPMENT BANK | ANY | 0.00% |
| BONDS - NON EEA GOVERNEMENTS OR CENTRAL BANKS | AAA | 0.00% |
| BONDS - NON EEA GOVERNEMENTS OR CENTRAL BANKS | AA | 0.00% |
| BONDS - NON EEA GOVERNEMENTS OR CENTRAL BANKS | A | 1.10% |
| BONDS - NON EEA GOVERNEMENTS OR CENTRAL BANKS | BBB | 1.40% |
| BONDS - NON EEA GOVERNEMENTS OR CENTRAL BANKS | BB | 2.50% |
| BONDS - NON EEA GOVERNEMENTS OR CENTRAL BANKS | B OR LOWER | 4.50% |
| BONDS - NON EEA GOVERNEMENTS OR CENTRAL BANKS | UNRATED | 3.00% |
| MORTGAGE COVERED BONDS | ANY | 0.60% |
| OTHER | AAA | 0.90% |
| OTHER | AA | 1.10% |
| OTHER | A | 1.40% |
| OTHER | BBB | 2.50% |
| OTHER | BB | 4.50% |
| OTHER | B OR LOWER | 7.50% |
| OTHER | UNRATED | 3.00% |
| PUBLIC SECTOR COVERED BONDS | ANY | 0.60% |

For SST, the following positive and negative shocks to corporate bond spreads are required:

| SPREAD RISK FACTOR RATING | SHOCK (BPS) | VOLATILITY (BPS) |
|---|---|---|
| AAA | 1000 | 34.134 |
| AA | 1000 | 31.444 |
| A | 1000 | 34.547 |
| BBB | 1000 | 39.968 |

### 7.2.9 Concentration risk ($MKT_{CONC}$)

Concentration risk is not explicitly required for the SST. However, for Solvency II, concentrations in assets with the same counterparty above a certain threshold (3% of total assets for AAA to A rated counterparties, otherwise 1.5% of total assets) are subject to a stress that examines a fall in value of these excess assets (i.e., those above the threshold). This is examined for each counterparty independently and then the total capital requirement is aggregated assuming independence between these counterparties.

### 7.2.10 Liquidity premium risk ($MKT_{IP}$)

The capital charge relating to illiquidity premium arises from the risk of a change in the value of technical provisions due to a decrease in the illiquidity premium.

The shock is a 65% fall in the value of illiquidity premium and the capital requirement for this sub-module is determined as the change in the net asset value as a consequence of applying this shock.

There is no equivalent shock under the SST, as liquidity premiums are included in the SST framework.

**Concentration risk is not explicitly required for the SST. However, for Solvency II, concentrations in assets with the same counterparty above a certain threshold are subject to a stress that examines a fall in value of these excess assets.**

## 7.3 Risk aggregation

Under Solvency II, the individual sub-modules are aggregated to produce the SCRmkt using the following matrices, depending on which gives the highest overall SCRmkt. Note that the first matrix is used with the interest up stress and the second with the interest rate down stress.

| INTEREST RATES UP | MKTint | MKTeq | MKTprop | MKTsp | MKTfx | MKTconc | MKTip |
|---|---|---|---|---|---|---|---|
| MKTint | 1 | 0 | 0 | 0 | 0.25 | 0 | 0 |
| MKTeq | 0 | 1 | 0.75 | 0.75 | 0.25 | 0 | 0 |
| MKTprop | 0 | 0.75 | 1 | 0.5 | 0.25 | 0 | 0 |
| MKTsp | 0 | 0.75 | 0.50 | 1 | 0.25 | 0 | -0.50 |
| MKTfx | 0.25 | 0.25 | 0.25 | 0.25 | 1 | 0 | 0 |
| MKTconc | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| MKTip | 0 | 0 | 0 | -0.50 | 0 | 0 | 1 |

| INTEREST RATES DOWN | MKTint | MKTeq | MKTprop | MKTsp | MKTfx | MKTconc | MKTip |
|---|---|---|---|---|---|---|---|
| MKTint | 1 | 0.50 | 0.50 | 0.50 | 0.25 | 0 | 0 |
| MKTeq | 0.50 | 1 | 0.75 | 0.75 | 0.25 | 0 | 0 |
| MKTprop | 0.50 | 0.75 | 1 | 0.50 | 0.25 | 0 | 0 |
| MKTsp | 0.50 | 0.75 | 0.50 | 1 | 0.25 | 0 | -0.50 |
| MKTfx | 0.25 | 0.25 | 0.25 | 0.25 | 1 | 0 | 0 |
| MKTconc | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| MKTip | 0 | 0 | 0 | -0.50 | 0 | 0 | 1 |

Under the SST the individual risk capital amounts for each risk factor are aggregated using a large 77-by-77 correlation matrix, which we don't reproduce here in the interest of space.

However, we make the following comments on the matrix:

- Correlations between interest rates in different currencies are all positive. CHF rates are more highly correlated with the EUR than the USD than GBP. The EUR rates are more highly correlated with the GBP than the USD than the CHF. USD rates are more highly correlated with EUR than the GBP than the CHF. Finally GBP rates are more correlated with the EUR than the USD than the CHF.

- All interest rate risk factors in all currencies have weak negative correlation with credit spreads, currency volatilities and equity volatilities. They also have weak positive correlation with equity and currency levels. For real estate the correlation to interest rates is weak, but both negative and positive depending on the property index.

- Spreads for different bonds within the same rating category are highly positively correlated, with correlations between 0.67 and 0.88. Spreads have weak negative correlation with shares and currency levels (apart from JPY which has positive correlation) and positive weak correlation with currency and equity volatility.

- Hedge funds, participations, interest rate volatility and private equity investments have no correlation with each other or any other risk factors.

- EUR has weak positive correlation with USD and GBP but almost zero correlation with JPY. USD has relatively strong positive correlation with GBP and less strong with JPY. Similarly, the GBP has low correlation with JPY. All currencies have generally low positive correlation with shares and real estate.

- The USD/CHF currency rate volatility and the equity volatility are generally weakly negatively correlated with most other risk factors.

- The different share indices display high positive correlation with each other and weaker positive correlation with real estate indices.

- With real estate indices there is perfectly correlation (i.e., 1) between commercial direct and the WUPIX A index, but other than that very low correlation with other indices.

# 8 REQUIRED CAPITAL: CREDIT RISK

## 8.1 Risk methodology

Under Solvency II, the counterparty default risk module makes allowance for possible losses due to unexpected default, or deterioration in the credit standing, of the counterparties and debtors. It also includes risk-mitigating contracts, such as reinsurance arrangements, securitisations and derivatives, and receivables from intermediaries, as well as any other credit exposures which are not covered in the spread market risk sub-module. Note that spread risk on bonds is covered in the spread market sub-module. Exposures are split into two types:

**Under Solvency II, the counterparty default risk module makes allowance for possible losses due to unexpected default, or deterioration in the credit standing, of the counterparties and debtors. It also includes risk-mitigating contracts, such as reinsurance arrangements, securitisations and derivatives, and receivables from intermediaries, as well as any other credit exposures which are not covered in the spread market risk sub-module.**

- Type I include:
  - Reinsurance arrangements
  - Securitisations and derivatives
  - Other risk-mitigating contracts
  - Cash at bank and other deposits credit if the number of independent counterparties is less than 15
  - Capital, initial funds and letters of credit if the number of independent counterparties is less than 15
- Type II include:
  - Receivables from intermediaries
  - Policyholder debtors, including mortgage loans
  - Cash at bank and other deposits credit if the number of independent counterparties exceeds 15
  - Capital, initial funds and letters of credit if the number of independent counterparties exceeds 15

The risk capital for Type I is calculated using a loss-given default (LGD) approach. For each asset the loss-given default is calculated as:

**Loss-given Default = LGD Factor x [ Asset Market Value + Market Value of Credit Risk Mitigating Instruments - Collateral]**

For a given rating class the total LGD is then computed as well as the total sum of the squares of the LGDs for each independent counterparty. Additionally, probability of default is specified for each counterparty. Using this information, the variance of the loss distribution is then calculated.

If the total LGD is less than five times the standard deviation of the loss distribution (5 SD), then the capital requirement is taken to be the LGD. However, if the LGD is between 5 SD and 20 SD, then the requirement is 5 SD and if the LGD is above 20 SD, then the requirement is simply 3 SD. Mathematically:

| | |
|---|---|
| **Capital Requirement = 3 SD** | **if SD < 5% LGD** |
| **Capital Requirement = MIN { LGD, 5 SD}** | **otherwise** |

The risk capital for Type II is calculated as the corresponding change in the NAV following specified falls in the level of Type II assets.

**The SST approach to credit risk is based on Basel II, the European banking supervisory regime. Assets are divided into 14 broad asset classes and their rating is taken into account. If there is no rating for a certain asset a proxy is used.**

The SST approach to credit risk is based on Basel II, the European banking supervisory regime. Assets are divided into 14 broad asset classes and their rating is taken into account. If there is no rating for a certain asset a proxy is used.

Within each asset class, assets are classified by:

- No credit risk mitigation technique in place
- Credit risk mitigation techniques (the relevant exposure is derived from the gross exposure, reduced by the effect of any collateral)

All the assets are weighted by the probability of default to calculate the equivalent risk-weighted asset (RWA). That is, for a given credit risk sub-module, assets are split according to credit class. Each credit rating/class is mapped to a risk weighting. Then the RWA is calculated:

**RWA = Risk Weight x [ Asset Market Value - Market Value of Credit Risk Mitigating Instruments]**

The total RWAs in a given sub-module are then summed and charged at 8% to derive the capital requirement for a given sub-module:

$$\mathbf{CRED_{SUB\text{-}MODULE} = 8\% \times sum\ of\ all\ RWAs}$$

### 8.2 SST risk factors

Under the SST the risk factors are the groups that the assets are divided into. These also form the sub-modules of the credit risk module and the exposure factors are:

- Central government and banks
- Public bodies
- Multinational development banks, the BIS and the IMF
- Banks and stockbrokers
- Community services
- Stock exchanges and clearing houses
- Companies
- Securitisations
- Individuals and small retail undertakings
- Unrated bonds
- Direct and indirect real estate
- Subordinated positions
- Overdue positions
- Other positions

## 8.3 Solvency II risk factors and stresses

For Type I exposures, the loss-given default factor needed in the LGD calculation is generally 90% apart from for reinsurance arrangements or securitisations where it is 50%.

The probabilities of default for a given counterparty depend on the counterparty's rating. If its unrated and subject to Solvency II, the probabilities are determined by the solvency ratio or the counterparty. These probabilities are summarised below:

| RATING | SOLVENCY RATIO | PROBABILITY OF DEFAULT |
|---|---|---|
| AAA | | 0.00% |
| AA | | 0.01% |
| A | | 0.05% |
| BBB | | 0.24% |
| BB | | 1.20% |
| B | | 6.04% |
| CCC OR LOWER | | 30.41% |
| UNRATED | >200% | 0.03% |
| UNRATED | >175% | 0.05% |
| UNRATED | >150% | 0.10% |
| UNRATED | >125% | 0.20% |
| UNRATED | >100% | 0.50% |
| UNRATED | >90% | 1.00% |
| UNRATED | >80% | 2.00% |
| UNRATED | <=80% | 10.00% |
| UNRATED | DOESN'T MEET MCR | 30.00% |
| UNRATED | NOT REGULATED BY SII | 10.00% |

For Type II exposures the following stresses are applied:

- 10% drop in value for receivables from intermediaries which are due for more than three months
- 85% drop in value for all other Type II exposures

## 8.4 SST risk weightings

For each rated asset, the credit rating is mapped to a rating class from 1 to 8 or the unrated class. The specification contains a table which maps credit ratings from various rating agencies to a rating class. For instance, for Standard & Poor's ratings, AAA to AA- are mapped to classes 1 to 2, A+ to A- is mapped to class 3, BBB to class 4, BB to class 5, B to class 6 and CCC to C to class 7. For unrated assets a single risk weighting is given.

**For each rated asset, the credit rating is mapped to a rating class from 1 to 8 or the unrated class. The specification contains a table which maps credit ratings from various rating agencies to a rating class.**

In the next subsections the mapping of rating class to risk weighting is given.

### *8.4.1 Central Governments and Banks (RATED$_{CENT}$)*

| | RATING CLASS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CENTRAL GOVERNMENT AND BANKS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | UNRATED | FIXED |
| CENTRAL GOVERNMENTS AND CENTRAL BANKS | 0% | 0% | 20% | 50% | 100% | 100% | 150% | 100% | |
| SWISS CONFEDERATION, SWISS NATIONAL BANK, EU, EU CENTRAL BANK | | | | | | | | | 0% |

### 8.4.2 Public Bodies ($RATED_{PUBL}$)

| PUBLIC BODIES | 1 | 2 | 3 | RATING CLASS 4 | 5 | 6 | 7 | UNRATED | FIXED |
|---|---|---|---|---|---|---|---|---|---|
| PUBLIC BODIES WITH RATINGS | 20% | 20% | 50% | 100% | 100% | 150% | 150% | 100% | |
| PUBLIC BODIES WITHOUT RATINGS | | | | | | | | | 50% |
| SWISS CANTONS WITHOUT RATING | | | | | | | | | 20% |

### 8.4.3 Multinational Development Banks, the BIS and the IMF ($RATED_{MULT}$)

| MULTINATIONAL DEVELOPMENT BANKS, THE BIS AND THE IMF | 1 | 2 | 3 | RATING CLASS 4 | 5 | 6 | 7 | UNRATED | FIXED |
|---|---|---|---|---|---|---|---|---|---|
| MUTILATERAL DEVELOPMENT BANKS | 20% | 20% | 50% | 50% | 100% | 100% | 150% | 50% | |
| IMF, BIS AND OTHERS DESIGNATED BY THE FEDERAL BANKING COMMISSION | | | | | | | | | 0% |

### 8.4.4 Banks and Stockbrokers ($RATED_{BANK}$)

| BANKS AND STOCKBROKERS | 1 | 2 | 3 | RATING CLASS 4 | 5 | 6 | 7 | UNRATED | FIXED |
|---|---|---|---|---|---|---|---|---|---|
| ORIGINAL MATURITY LESS THAN 3 MONTHS | 20% | 20% | 20% | 20% | 50% | 50% | 150% | 20% | |
| ORIGINAL MATURITY MORE THAN 3 MONTHS | 20% | 20% | 50% | 50% | 100% | 100% | 150% | 50% | |

### 8.4.5 Community Services ($RATED_{COMM}$)

| COMMUNITY SERVICES | 1 | 2 | 3 | 4 | 5 | 6 | 7 | UNRATED | FIXED |
|---|---|---|---|---|---|---|---|---|---|
| THOSE UNDER THE CONTROL OF BANKS | 20% | 20% | 50% | 100% | 100% | 150% | 150% | 100% | |
| DEPOSIT PROTECTION SCHEME OBLIGATIONS UNDER A | | | | | | | | | 50% |

### 8.4.6 Stock Exchanges and Clearing Houses ($RATED_{EXCH}$)

| STOCK EXCHANGES AND CLEARING HOUSES | 1 | 2 | 3 | RATING CLASS 4 | 5 | 6 | 7 | UNRATED | FIXED |
|---|---|---|---|---|---|---|---|---|---|
| STOCK EXCHANGES AND CLEARING HOUSES | 20% | 20% | 50% | 100% | 100% | 150% | 150% | 100% | |
| STOCK EXCHANGES AND CLEARING HOUSES PROVIDED THE CREDIT RISK IS DIRECT DEPENDENT ON A CENTRAL TRADING PARTNER WHICH IS GUARANTEED TO MAKE DELIVERY VIA AN EXCHANGE | | | | | | | | | 0% |

### 8.4.7 Companies ($RATED_{COMP}$)

| COMPANIES | 1 | 2 | 3 | 4 | 5 | 6 | 7 | UNRATED | FIXED |
|---|---|---|---|---|---|---|---|---|---|
| | | | | RATING CLASS | | | | | |
| COMPANIES | 20% | 20% | 50% | 100% | 100% | 150% | 150% | 100% | |

### 8.4.8 Securitisations ($RATED_{SECR}$)

| SECURITISATIONS | 1 | 2 | 3 | 4 | 5 | 6 | 7 | UNRATED | FIXED |
|---|---|---|---|---|---|---|---|---|---|
| | | | | RATING CLASS | | | | | |
| LONG TERM SECURITISATIONS | 20% | 20% | 50% | 100% | 350% | 1250% | 1250% | 1250% | |

### 8.4.9 Individuals and Small Retail Undertakings ($UNRATED_{PPL}$)

| INDIVIDUALS AND SMALL RETAIL UNDERTAKINGS | RISK WEIGHT |
|---|---|
| RETAIL POSITIONS WHERE THE VALUE WITHOUT COLLATERAL DOESN'T EXCEED CHF 1.5M OR 1% OF THE VALUE OF ALL RETAIL POSITIONS | 75% |
| OTHER RETAIL POSITIONS | 100% |

### 8.4.10 Unrated Bonds ($UNRATED_{BONDS}$)

| BONDS | RISK WEIGHT |
|---|---|
| ONSHORE BONDS | 20% |

### 8.4.11 Direct and Indirect Real Estate ($UNRATED_{PROP}$)

| DIRECT AND INDIRECT REAL ESTATE | RISK WEIGHT |
|---|---|
| RESIDENTIAL PROPERTIES UP TO 2/3 OF MARKET VALUE | 35% |
| RESIDENTIAL PROPERTIES ABOVE 2/3 OF MARKET VALUE | 50% |
| AGRICULTURAL PROPERTIES UP TO 2/3 OF MARKET VALUE | 100% |
| AGRICULTURAL PROPERTIES ABOVE 2/3 OF MARKET VALUE | 100% |
| OFFICES, BUSINESS PREMISES AND MULTI PURPOSE BUILDINGS UP TO 1/2 OF MARKET VALUE | 100% |
| LARGE PREMISES AND INDUSTRIAL BUILDINGS UP TO 1/3 OF MARKET VALUE | 100% |
| OTHER | 100% |

### 8.4.12 Subordinated Positions ($UNRATED_{SUBD}$)

| SUBORDINATED POSITIONS | RISK WEIGHT |
|---|---|
| SUBORDINATED POSITIONS WITH PUBLIC BODIES | TREATED LIKE NON SUBORDINATED |
| OTHER SUBORDINATED POSITIONS | |

### 8.4.13 Overdue Positions ($UNRATED_{DUE}$)

| OVERDUE POSITIONS | RISK WEIGHT |
|---|---|
| OVERDUE POSITIONS FROM PROPERTIES IN $UNRATED_{PROP}$ | 100% |
| UNSECURED POSITIONS WHERE THE OUTSTANDING AMOUNT IS AT LEAST 20% | 100% |
| UNSECURED POSITIONS WHERE THE OUTSTANDING AMOUNT IS LESS THAN 20% | 150% |

### 8.4.14 Other Positions ($RATED_{OTH}$)

| OTHER POSITIONS | RISK WEIGHT |
|---|---|
| LIQUID FINANCIAL RESOURCES | 0% |
| CREDIT EQUIVALENTS FROM PAYMENT AND ADDITIONAL MARGIN REQUIREMENTS | 100% |
| OTHER POSITIONS, INCLUDING ACCRUALS AND DEFERRALS | 100% |

## 8.5 Risk aggregation

Under Solvency II, the risk capital for Type I and Type II exposures is aggregated using the following correlation matrix:

| | TYPE I | TYPE II |
|---|---|---|
| TYPE I | 1.00 | 0.75 |
| TYPE II | 0.75 | 1.00 |

**Under the SST, the individual credit risk sub-modules are simply summed to get the combined capital requirement.**

Under the SST, the individual credit risk sub-modules are simply summed to get the combined capital requirement, since any diversification is assumed to be taken account of in the risk weightings used. Thus:

$$ZK_{CRED} = RATED_{PUBL} + RATED_{CENT} + RATED_{MULT} + RATED_{BANK} + RATED_{COMM} + RATED_{EXCH} + RATED_{COMP} + RATED_{SECR} + UNRATED_{BONDS} + UNRATED_{PPL} + UNRATED_{PROP} + UNRATED_{SUBD} + UNRATED_{DUE} + UNRATE_{DOTH}$$

# 9 REQUIRED CAPITAL: SCENARIO ADD-ON

## 9.1 Risk methodology

Another difference between Solvency II and SST is the role that scenario testing plays in SST. An additional component of the SST required capital is capital to cover insurance and market risks in a number of extreme scenarios ($ZK_{SCEN}$). These particular scenarios on the one hand increase the required capital (ZK) and on the other hand reveal to a greater extend the dependency of the RTK to risk factors in the long tail of the distribution.

**Another difference between Solvency II and SST is the role that scenario testing plays in SST. An additional component of the SST required capital is capital to cover insurance and market risks in a number of extreme scenarios.**

The scenario add-on capital is determined as the tail value at risk of the probability-weighted scenario impact on the RTK less the tail value at risk of the base case (the insurance and market risk capital before scenario add-on). Thus, the final insurance and market capital requirement is in fact simply a weighted tail value at risk across scenarios (including the base).

The weighted TVaR is determined by considering the distribution of the change in RTK from insurance and market risks. Then for each scenario the distribution is assumed to be the same shape but shifted to allow for the average loss in that scenario. The weighted average distribution across scenarios can then be determined.

## 9.2 Risk factors

The scenarios are as follows:

| CODE | SCENARIO | RELEVANT FOR LIFE INSURERS | PROBABILITY OF OCCURRENCE |
|---|---|---|---|
| | BASE | YES | [100% LESS SUM OF OTHERS] |
| ES1 | SELF-DEFINED SCENARIO | YES | [ENTITY SPECIFIC INPUT] |
| ES2 | SELF-DEFINED SCENARIO | YES | [ENTITY SPECIFIC INPUT] |
| ES3 | SELF-DEFINED SCENARIO | YES | [ENTITY SPECIFIC INPUT] |
| ES4 | SELF-DEFINED SCENARIO | YES | [ENTITY SPECIFIC INPUT] |
| SZ1 | EQUITY DROP -60% | YES | 0.1% |
| SZ2 | REAL ESTATE CRASH COMBINED WITH INCREASE IN INTEREST RATES | YES | 0.1% |
| SZ3 | STOCK MARKET CRASH (1987) | YES | 0.1% |
| SZ4 | NIKKEI CRASH (1990) | YES | 0.1% |
| SZ5 | EUROPEAN CURRENCY CRISIS (1992) | YES | 0.1% |
| SZ6 | US INTEREST RATE CRISIS (1994) | YES | 0.1% |
| SZ7 | LTCM (1998) | YES | 0.1% |
| SZ8 | STOCK MARKET CRASH (2000/2001) | YES | 0.1% |
| SZ9 | GLOBAL DEFLATION | YES | 0.1% |
| SZ10 | GLOBAL INFLATION | YES | 0.1% |
| SZ11 | FINANCIAL CRISIS 2008 | YES | 0.1% |
| S1 | LONGEVITY | YES | 0.5% |
| S2 | DISABILITY | YES | 0.5% |
| S3 | HEALTH DAILY ALLOWANCE FOR SICKNESS | | 0.5% |
| S4 | LAPSES | YES | 0.1% |
| S5 | UNDER RESERVING | | 0.5% |
| S6 | WORKS OUTING ACCIDENT | | 0.5% |
| S9 | INDUSTRIAL ACCIDENT | | 0.5% |
| S10 | PANDEMIC | YES | 1.0% |
| S11 | FINANCIAL DISTRESS | YES | 0.5% |
| S13 | TERRORISM | YES | 0.5% |

## 9.3 Risk stresses

### *9.3.1 S1 Longevity*
In this scenario it is assumed that mortality decreases twice as quickly as assumed in the base scenario. Clearly if no mortality improvement is modelled in the base scenario then this scenario will have no effect.

### *9.3.2 S2 Disability*
One of the following must be used:

- Increase in disability rates of 25% in first year and 10% thereafter

- Increase in disability rates of 25% in first year and average lengthening of disablement by one year

### *9.3.3 S3 Health Daily Allowance for Sickness*
- Increase in number of recipients of the daily allowance by 25%.

- The average duration of this benefit is doubled, subject to any contractual maximum.

### *9.3.4 S4 Lapses*
- Increase in interest rates for all durations and all currencies by 100 bps

- Relative increase in lapse rates of 50%

- Relative increase in option take up rates of 25%

### *9.3.5 S5 Under Reserving*
- Claims reserves increase by 10%.

### *9.3.6 S6 Works Outing Accident*
This is a bus accident, in which all passengers are insured by the relevant company. There are 50 people on the bus of which 15 die, 25 are 100% disabled and 10 are injured.

The claims that occur in this scenario are CH 20k per person and annuities for life for disabled people and widow's annuities for the dead.

### *9.3.7 S9 Industrial Accident*
This is an accident occurring in an industrial plant, namely an explosion in a chemical plant. It is modelled on incidents such as Schweizerhalle, Seveso and Toulouse.

The effects to model include increased mortality, disability and hospital treatment as well as damage to company property, and surrounding property and the environment.

### *9.3.8 S10 Pandemic*
This considers the worldwide spread of disease. It is modelled on pandemic such as Spanish Flu in 1918/1919, Asian Flu in 1957/1958 and Hong Kong Flu in 1968/1969.

Modelled effects are both biometric and market-based.

Biometric effects are taken from a public health study and are:

- Increased deaths
- Increased hospitalisation
- Increased number of days absent from work

The market effects are:

- Depreciation against CHF of the Japanese Yen by 10%, other Asian currencies by 35% and other emerging markets currencies by 25%
- Decreases in short- and long-term interest rates by duration for CHF, EUR, GBP, USD and JPY
- Increase in spreads of 75bp for AAA, 100bp for AA, 150bp for A, 200bp for BBB and 400bp for lower rated assets.
- Increase in pharmaceutical share prices by 25%
- Decrease in tourism and transport share prices by 50%
- Decrease of 25% for shares from the following sectors: luxury goods, construction, resources, oil and gas, banks, insurance, food

#### *9.3.9 S11 Financial Distress*

The following occur:

- The first year lapse rate becomes 25% and then reverts to normal.
- New business volumes reduce by 75%.
- Interest rates increase by 300 bps at all durations and for all currencies.
- All equities, hedge funds and real estate fall by 30%.

#### *9.3.10 S13 Terrorism*

The terrorism scenario is a repeat of the scenario from S1 to S11 and Sz1 to Sz11 that the company considers is most appropriate to represent a terrorism scenario.

Note that if Scenario $S_j$ is chosen, for example, then this is equivalent to doubling the probability of occurrence for Scenario j and ignoring Scenario S13.

The Sz-type scenarios are all market-based and thus are specified in terms of changes to the market risk factors.

### *9.3.11 Sz Scenarios*

The Sz-type scenarios are all market-based and thus are specified in terms of changes to the market risk factors (MRF), as follows. Note that interest rate and spread movements are additive and expressed as basis points. Other factors are multiplicative and expressed as percentages.

| MRF | | RISK FACTOR | SZ1 | SZ2 | SZ3 | SZ4 | SZ5 | SZ6 | SZ7 | SZ8 | SZ9 | SZ10 | SZ11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | CHF ZEROS | 1 Y | | | -219.0 | 156.3 | -181.3 | 110.9 | -53.9 | -146.3 | -60.0 | 60.0 | -228.0 |
| 2 | CHF ZEROS | 2 Y | | | -198.0 | 109.8 | -79.0 | 140.6 | -49.0 | -125.8 | -80.0 | 80.0 | -226.6 |
| 3 | CHF ZEROS | 3 Y | | | -159.0 | 117.7 | -73.5 | 150.9 | -46.0 | -108.5 | -95.0 | 95.0 | -205.3 |
| 4 | CHF ZEROS | 4 Y | | | -128.0 | 110.6 | -77.6 | 156.0 | -42.2 | -97.0 | -105.0 | 105.0 | -177.1 |
| 5 | CHF ZEROS | 5 Y | | | -104.0 | 99.4 | -79.6 | 154.8 | -37.5 | -88.8 | -120.0 | 120.0 | -159.6 |
| 6 | CHF ZEROS | 6 Y | | | -88.0 | 99.0 | -77.9 | 151.4 | -35.0 | -85.0 | -130.0 | 130.0 | -166.8 |
| 7 | CHF ZEROS | 7 Y | | | -79.0 | 98.5 | -76.2 | 147.9 | -31.1 | -78.4 | -140.0 | 140.0 | -145.1 |
| 8 | CHF ZEROS | 8 Y | | | -72.0 | 100.9 | -71.3 | 149.0 | -30.0 | -75.0 | -155.0 | 155.0 | -153.0 |
| 9 | CHF ZEROS | 9 Y | | | -67.0 | 102.0 | -68.8 | 150.3 | -30.0 | -72.0 | -160.0 | 160.0 | -144.3 |
| 10 | CHF ZEROS | 10-12 Y | | | -63.0 | 103.2 | -66.3 | 151.4 | -28.5 | -70.4 | -170.0 | 170.0 | -139.1 |
| 11 | CHF ZEROS | 13-17 Y | | | -55.0 | 106.9 | -66.2 | 160.0 | -25.0 | -57.3 | -180.0 | 180.0 | -120.8 |
| 12 | CHF ZEROS | 18-24 Y | | | -52.8 | 110.6 | -66.0 | 169.0 | -22.3 | -44.2 | -180.0 | 180.0 | -122.9 |
| 13 | CHF ZEROS | 25-50 Y | | | -50.6 | 113.0 | -65.0 | 171.0 | -55.6 | -46.5 | -200.0 | 200.0 | -134.6 |
| 14 | EUR ZEROS | 1 Y | | | -219.0 | 113.0 | 57.0 | 74.0 | -25.4 | -188.1 | -60.0 | 60.0 | -294.5 |
| 15 | EUR ZEROS | 2 Y | | | -198.0 | 129.0 | 64.0 | 116.0 | -44.9 | -163.2 | -80.0 | 80.0 | -298.4 |
| 16 | EUR ZEROS | 3 Y | | | -159.0 | 138.0 | 63.0 | 145.0 | -57.4 | -144.1 | -95.0 | 95.0 | -284.4 |
| 17 | EUR ZEROS | 4 Y | | | -128.0 | 145.0 | 58.0 | 156.0 | -61.2 | -118.0 | -105.0 | 105.0 | -256.4 |
| 18 | EUR ZEROS | 5 Y | | | -104.0 | 155.0 | 53.0 | 157.0 | -60.9 | -108.8 | -120.0 | 120.0 | -243.1 |
| 19 | EUR ZEROS | 6 Y | | | -88.0 | 162.0 | 47.0 | 153.0 | -66.2 | -92.7 | -130.0 | 130.0 | -222.3 |
| 20 | EUR ZEROS | 7 Y | | | -79.0 | 168.0 | 42.0 | 148.0 | -71.5 | -78.7 | -140.0 | 140.0 | -199.6 |
| 21 | EUR ZEROS | 8 Y | | | -72.0 | 173.0 | 36.0 | 143.0 | -68.9 | -70.4 | -155.0 | 155.0 | -184.5 |
| 22 | EUR ZEROS | 9 Y | | | -67.0 | 177.0 | 33.0 | 138.0 | -70.3 | -68.2 | -160.0 | 160.0 | -176.2 |
| 23 | EUR ZEROS | 10-12 Y | | | -63.0 | 178.0 | 29.0 | 134.0 | -70.1 | -62.4 | -170.0 | 170.0 | -170.8 |
| 24 | EUR ZEROS | 13-17 Y | | | -55.0 | 174.0 | 12.0 | 121.0 | -60.2 | -66.2 | -180.0 | 180.0 | -127.8 |
| 25 | EUR ZEROS | 18-24 Y | | | -52.8 | 171.8 | 9.8 | 118.8 | -50.7 | -85.1 | -180.0 | 180.0 | -139.2 |
| 26 | EUR ZEROS | 25-50 Y | | | -50.6 | 169.6 | 7.6 | 116.6 | -44.8 | -59.8 | -200.0 | 200.0 | -165.5 |
| 27 | USD ZEROS | 1 Y | | | -105.0 | 118.3 | 48.6 | 387.5 | -98.1 | -371.2 | -60.0 | 60.0 | -300.2 |
| 28 | USD ZEROS | 2 Y | | | -100.2 | 130.1 | 45.0 | 348.9 | -124.4 | -331.7 | -80.0 | 80.0 | -247.7 |
| 29 | USD ZEROS | 3 Y | | | -92.9 | 128.7 | 49.1 | 346.8 | -124.6 | -288.9 | -95.0 | 95.0 | -241.6 |
| 30 | USD ZEROS | 4 Y | | | -85.5 | 129.1 | 41.8 | 314.7 | -128.8 | -245.4 | -105.0 | 105.0 | -245.4 |
| 31 | USD ZEROS | 5 Y | | | -85.5 | 130.1 | 39.0 | 282.3 | -132.0 | -211.1 | -120.0 | 120.0 | -252.5 |
| 32 | USD ZEROS | 6 Y | | | -82.0 | 127.1 | 38.4 | 269.6 | -126.8 | -193.8 | -130.0 | 130.0 | -246.8 |
| 33 | USD ZEROS | 7 Y | | | -80.0 | 124.0 | 37.3 | 258.3 | -121.6 | -175.9 | -140.0 | 140.0 | -241.1 |
| 34 | USD ZEROS | 8 Y | | | -78.0 | 121.0 | 33.6 | 248.2 | -116.3 | -157.5 | -155.0 | 155.0 | -235.6 |
| 35 | USD ZEROS | 9 Y | | | 75.0 | 121.3 | 33.4 | 239.4 | -111.0 | -138.9 | -160.0 | 160.0 | -230.0 |
| 36 | USD ZEROS | 10-12 Y | | | -71.2 | 129.3 | 34.6 | 235.4 | -106.8 | -122.3 | -170.0 | 170.0 | -228.8 |
| 37 | USD ZEROS | 13-17 Y | | | -71.0 | 128.5 | 26.9 | 220.7 | -97.2 | -100.3 | -180.0 | 180.0 | -230.4 |
| 38 | USD ZEROS | 18-24 Y | | | -71.0 | 131.8 | 32.0 | 203.6 | -86.1 | -80.3 | -180.0 | 180.0 | -234.3 |
| 39 | USD ZEROS | 25-50 Y | | | -71.2 | 148.2 | 64.8 | 165.8 | -56.2 | -80.6 | -200.0 | 200.0 | -258.2 |
| 40 | GBP ZEROS | 1 Y | | | -228.0 | 251.6 | -131.0 | 323.4 | -98.6 | -177.7 | -60.0 | 60.0 | -493.8 |
| 41 | GBP ZEROS | 2 Y | | | -220.0 | 249.4 | -129.0 | 319.6 | -117.5 | -149.5 | -80.0 | 80.0 | -397.1 |
| 42 | GBP ZEROS | 3 Y | | | -212.0 | 247.2 | -127.0 | 315.8 | -117.9 | -128.7 | -95.0 | 95.0 | -333.0 |
| 43 | GBP ZEROS | 4 Y | | | -204.0 | 245.0 | -125.0 | 312.0 | -115.7 | -112.8 | -105.0 | 105.0 | -304.6 |
| 44 | GBP ZEROS | 5 Y | | | -202.8 | 242.8 | -123.0 | 308.2 | -109.9 | -107.6 | -120.0 | 120.0 | -279.0 |
| 45 | GBP ZEROS | 6 Y | | | -195.0 | 243.5 | -100.0 | 298.0 | -99.8 | -103.1 | -130.0 | 130.0 | -252.3 |
| 46 | GBP ZEROS | 7 Y | | | -187.2 | 244.2 | -97.0 | 287.8 | -90.6 | -95.9 | -140.0 | 140.0 | -235.0 |

| MRF | | RISK FACTOR | SZ1 | SZ2 | SZ3 | SZ4 | SZ5 | SZ6 | SZ7 | SZ8 | SZ9 | SZ10 | SZ11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | GBP ZEROS | 8 Y | | | -179.4 | 244.9 | -84.0 | 277.6 | -88.0 | -92.8 | -155.0 | 155.0 | -230.2 |
| 48 | GBP ZEROS | 9 Y | | | -171.6 | 245.6 | -71.0 | 267.4 | -92.2 | -80.0 | -160.0 | 160.0 | -221.5 |
| 49 | GBP ZEROS | 10-12 Y | | | -165.4 | 246.8 | -56.2 | 254.1 | -88.7 | -81.8 | -170.0 | 170.0 | -207.7 |
| 50 | GBP ZEROS | 13-17 Y | | | -159.2 | 247.5 | 70.0 | 220.0 | -79.1 | -86.3 | -180.0 | 180.0 | -127.1 |
| 51 | GBP ZEROS | 18-24 Y | | | -153.0 | 248.2 | 75.0 | 191.9 | -80.8 | -92.8 | -180.0 | 180.0 | -102.0 |
| 52 | GBP ZEROS | 25-50 Y | | | -146.8 | 248.9 | 80.0 | 185.0 | -120.0 | -105.7 | -200.0 | 200.0 | -85.6 |
| 53 | SPREADS | USD AAA | | | -47.0 | 66.0 | 15.0 | -22.4 | 78.2 | -18.0 | | | 151.9 |
| 54 | SPREADS | USD AA | | | -47.0 | 66.0 | 15.0 | 4.8 | 86.6 | -15.3 | | | 179.3 |
| 55 | SPREADS | USD A | | | -47.0 | 66.0 | 15.0 | -3.9 | 54.5 | 20.5 | | | 231.7 |
| 56 | SPREADS | USD BBB | | | -47.0 | 66.0 | 15.0 | -25.7 | 43.3 | 31.3 | | | 365.1 |
| 57 | CURRENCY | EUR | | | -1.8% | -9.3% | -7.3% | -4.5% | -3.6% | -6.4% | | | -12.6% |
| 58 | CURRENCY | USD | | | -11.1% | -20.1% | -7.4% | -16.3% | -8.7% | -13.3% | | | -19.3% |
| 59 | CURRENCY | GBP | | | -2.4% | -8.5% | -15.7% | -8.6% | -5.6% | -12.3% | | | -32.5% |
| 60 | CURRENCY | JPY | | | -3.5% | -20.6% | -8.1% | -10.9% | -5.8% | -19.9% | | | 28.1% |
| 61 | IMPLIED VOLATILITY | USD/CHF 3 M | 0.0% | | 12.0% | 40.0% | 15.0% | 40.0% | 9.0% | 32.4% | | | 161.4% |
| 62 | EQUITIES | MSCI CHF | -60.0% | | -23.2% | -26.4% | -5.8% | -18.5% | -28.4% | -35.7% | | | -38.8% |
| 63 | EQUITIES | MSCI EMU | -60.0% | | -38.7% | -25.6% | -0.4% | -11.0% | -22.5% | -42.1% | | | -50.3% |
| 64 | EQUITIES | MSCI US | -60.0% | | -21.2% | -13.8% | -1.1% | -7.3% | -13.9% | -32.2% | | | -48.4% |
| 65 | EQUITIES | MSCI UK | -60.0% | | -25.9% | -16.0% | -8.8% | -15.1% | -12.5% | -28.0% | | | -39.4% |
| 66 | EQUITIES | MSCI JP | -60.0% | | -12.6% | -46.4% | -4.9% | -8.3% | -18.7% | -33.2% | | | -49.8% |
| 67 | EQUITIES | PACIFIC EX JAPAN | -60.0% | | -15.3% | -44.1% | -4.4% | -7.8% | -15.6% | -31.7% | | | -48.4% |
| 68 | EQUITIES | SMALL CAP EMU | -60.0% | | -38.7% | -28.9% | -5.7% | -12.3% | -18.4% | -36.0% | | | -60.7% |
| 69 | IMPLIED VOLATILITY | VIX | | | 140.0% | 59.6% | 40.7% | 55.6% | 45.2% | 57.1% | | | 396.1% |
| 70 | REAL ESTATE | SWX IAZI PERFORMANCE | | -50.0% | 0.1% | -2.6% | -1.5% | -1.1% | -2.7% | -4.8% | | | -3.7% |
| 71 | REAL ESTATE | RÜD BLASS | | -50.0% | -3.1% | -2.2% | -1.1% | -21.5% | -3.9% | -7.8% | | | -10.8% |
| 72 | REAL ESTATE | WUPIX A | | -50.0% | -1.5% | -2.4% | -1.3% | -11.3% | -1.8% | -4.3% | | | -25.9% |
| 73 | REAL ESTATE | COMMERCIAL DIRECT | | -50.0% | -1.5% | -2.4% | -1.3% | -11.3% | -1.8% | -4.3% | | | -25.9% |
| 74 | HEDGE FUNDS | | -30.0% | | -5.0% | -0.8% | 0.5% | -3.6% | -11.3% | -1.9% | | | -28.0% |
| 75 | PRIVATE EQUITY | | -70.0% | | -25.1% | -28.7% | -4.4% | -11.5% | -18.6% | -34.1% | | | -64.3% |
| 76 | PARTICIPATIONS | | -65.0% | | -25.1% | -28.7% | -4.4% | -11.5% | -18.6% | -34.1% | | | -48.0% |
| 77 | IMPLIED VOLATILITY | YIELD | | | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | 20.0% | | | 122.7% |

### 9.3.12 Entity-specific scenarios

In addition to these specified scenarios, entities must come up with four entity-specific scenarios and estimate the probability of occurrence for each.

We believe the range of chosen scenarios divers dramatically but some typical examples include:

- Natural catastrophe events such as an earthquake
- Further economic scenarios, such as strongly increasing short-term interest rates combined with strongly decreasing long-term rates.

**In addition to these specified scenarios, entities must come up with four entity-specific scenarios and estimate the probability of occurrence for each.**

- Terrorism-related events
- Different operating assumptions for certain products, for instance BVG business.

### *9.3.13 Other scenarios*

Other scenarios are also required for the SST which do not directly affect the target capital. The results of these scenarios are typically included in the SST report.

**There is also another scenario which the SST technical document makes mention of (but not under the scenario add-on capital section). This examines a change in the assumed interest rate for BVG business.**

There is also another scenario which the SST technical document makes mention of (but not under the scenario add-on capital section). This examines a change in the assumed interest rate for BVG business. BVG business is usually valued using the so called 70/7/7 assumption – a BVG interest rate of 70% of the average of the previous seven-year yields on seven-year government bonds. The scenario examines a 120/7/7 assumption for the second and third year.

## 9.4 Risk aggregation

The above scenarios are assumed to be independent and mutually exclusive. Thus, the probability no scenario takes place (i.e., the base scenario occurs) is given by 1 - sum of the scenario probabilities.

The basic method for aggregating is to shift the base distribution for each scenario by an amount depending on the severity of the shock. These shifted distributions can then be aggregated by assuming a probability of occurrence for each scenario. The TVaR from the resulting combined distribution then gives the overall capital requirement for insurance and market risks after allowance for scenarios (i.e., $ZK - ZK_{CRED}$).

It is worth considering this scenario shifting in more detail.

For each Scenario j, the change in the RTK (i.e., the discounted value of the RTK at time 1 less the RTK at time 0) is calculated and given by $C_j$. Similarly, we denote the probability of occurrence of this scenario by $p_j$. These probabilities are given in the table in section 9.2.

We first need to approximate the TVaR in the base scenario. To do this, the cumulative distribution function of the base scenario is needed for a number of discrete points. This distribution in the base scenario (the base distribution) corresponds to the aggregate life underwriting and market risk distribution.

Let $F_0(x)$ be the base distribution function and let $S_j(x)$ be the distribution function conditionally that Scenario j occurs. It is an assumption in the standard model (see the Technical Document on the Swiss Solvency Test) that $S_j(x)$ is simply given by shifting $F_0(x)$ by the amount of the scenario, i.e., $S_j(x) = F_0(x- C_j)$. The overall distribution function F(x) is then a weighted average of the base distribution and the shifted distribution with the weights being the probabilities of occurrence. That is:

$$\mathbf{F(x) = p_0\ F_0(x) + \sum_j\ p_j \times S_j\ (x),}$$

where $p_0 := 1 - \sum_j p_j$. Given this distribution function, the VaR and TVaR can be computed. For discrete base distributions $F_0(x)$, FINMA offers an Excel workbook where the numerical details are already implemented.

Finally, we compute the scenario add-on capital as:

$$\mathbf{ZK_{SCEN} = TVaR_{SCEN} - TVaR_{BASE}}$$

Here $TVaR_{BASE}$ denotes the expected shortfall of the base distribution F0(x) and $TVaR_{SCEN}$ that of the overall distribution F(x).

Then, also note that $ZK = MVM + TVaR_{SCEN} + ZK_{CRED}$.

## 10 REQUIRED CAPITAL: OTHER COMPONENTS

Solvency II contains several additional SCR modules and sub-modules, as follows:

- Intangible asset SCR (SCRintangibles)
- Operational risk SCR (SCRop)
- Adjustment for the loss absorbency of deferred taxes (Adj(DT))
- Adjustment for the loss absorbency of technical provisions (Adj(TP))

None of these are included explicitly within the SST.

**Operational risk is not considered quantifiable by FINMA, but is commented in some detail on within the SST report that companies must submit annually.**

Operational risk is not considered quantifiable by FINMA, but is commented in some detail on within the SST report that companies must submit annually.

As mentioned in the valuation section, the SST is calculated entirely gross of tax and thus Adj(DT) is not applicable.

Under Solvency II, the loss-absorbing capacity of technical provisions, arising from the ability to vary discretionary benefits in stress scenarios, is presented explicitly. In fact, under Solvency II, each sub-module must be shown gross and net of this loss-absorbing capacity. Under the SST these discretionary benefits are implicit in both the ZK and RTK.

Under SST, intangible assets are not included in the MVA and thus no capital requirement is needed.

## 11 GROUP MODELLING

Under SST, a group is solvent if all of its Swiss subsidiaries and the holding company are solvent. Thus each subsidiary must perform a standalone SST. Under Solvency II, a group is solvent if the consolidated company is solvent.

The Solvency II standard formula allows for a "total balance sheet" approach, where assets and liabilities of subsidiaries are simply summed to determine the consolidated balance sheet. A similar approach is taken to the consolidated SCR, where individual shocks to the combined consolidated balance sheet are aggregated.

Under SST, all inter-group transactions, reinsurance and loans, known as capital and risk-transfer instruments (CRTIs) must be modelled explicitly, and thus a group model is required to capture the interactions of these instruments. In addition, the fungibility of capital within the group must be considered.

**Under SST, all inter-group transactions, reinsurance and loans, known as capital and risk-transfer instruments (CRTIs) must be modelled explicitly, and thus a group model is required to capture the interactions of these instruments.**

## 12 QUALITATIVE REQUIREMENTS

**At the moment, the SST does not specify any disclosure requirements to the general public. However, there is a requirement to produce a comprehensive SST report for the regulator.**

At the moment, the SST does not specify any disclosure requirements to the general public (financial analysts, investors, shareholders, rating agencies, etc.). However, there is a requirement to produce a comprehensive SST report for the regulator. FINMA, leaves it at the company's discretion to provide information on its SST, although a framework for the report is published on the SST website. FINMA claims that it should be easy to identify whether the disclosed information is based on SST's principles or in the company's own indicators. The framework requires information on many parts of the SST including:

- Description of the portfolio
- Change in the risk structure of the business since the last report
- Modelling changes
- Information on MVA
- Assumptions used to calculate BEL
- Liabilities cash flows
- Valuation of capital and risk-transfer instruments
- Information on the economic capital model used
- Description of the self-defined scenarios
- Information on the projection of future capital requirement used in determining the MVM
- Information on the aggregation used in the ZK
- Description of the SST ratio
- Description of other non-quantified risks, such as concentration and operational risks
- Comments and dependencies on the SST

We understand FINMA is trying to achieve consistency (one goal of which would be to gain equivalency with Solvency II) between SST and Solvency II and this consistency refers not only to quantitative requirements, but also to qualitative aspects.

At the time of writing, it is not necessary to audit SST information and procedures. Audit requirements for Solvency II are expected to be clarified under Pillar 3 regulations.

## 13 GLOSSARY

| | |
|---|---|
| AC | Available capital |
| Adj | Solvency II adjustments for the loss absorbing capacity of deferred tax and technical provisions |
| Adj (DT) | Solvency II adjustments for the loss absorbing capacity of deferred tax |
| Adj (TP) | Solvency II adjustments for the loss absorbing capacity of technical provisions |
| BEL | Best estimate liability |
| BSCR | Base solvency capital requirement |
| BVG | Swiss Pillar 2 pensions business, as stipulated under the Bundesgesetz über die berufliche Alters-, Hinterlassenen- und Invalidenvorsorge |
| FC | Free capital or free surplus |
| MVA | Market value of assets |
| MVL | Market value of liabilities |
| MVM | Market value margin |
| NAV | Net asset value |
| OF | Own funds |
| RM | Risk margin |
| RTK | Risikotragendes Kapital, risk-bearing capital |
| SCR | Solvency capital requirement |
| SCRop | Operational risk SCR |
| ZK | Zielkapital, target capital |

# 14 APPENDIX


## ACKNOWLEDGEMENTS

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- David Abollo
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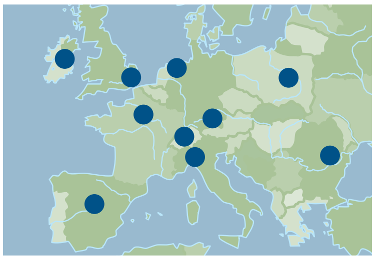


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