Swiss Solvency Test: Technical Details

Schweizer Solvenz Test
Test suisse de solvabilité
Proba di solvibilità svizzera
瑞士偿付能力测试

Federal Office of Private Insurance
Brussels, 22 December 2005

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- Market Value Margin
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The SST Concept: Market Value Margin

Definition: The market value margin is the smallest amount of capital which is necessary in addition to the best-estimate of the liabilities, so that a buyer would be willing to take over the portfolio of assets and liabilities.

Idea: A buyer (or a run-off company) needs to put up regulatory capital during the run-off period of the portfolio of assets and liabilities

→ a potential buyer needs to be compensated for the cost of having to put up regulatory capital

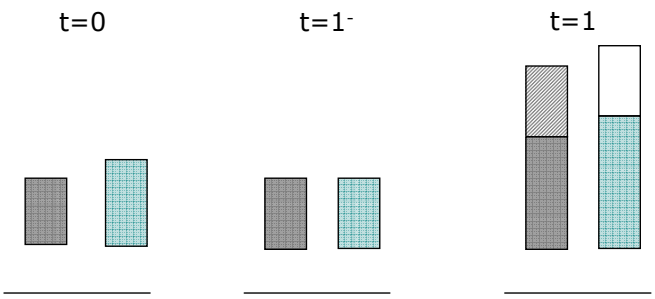
Market Value Margin = cost of capital of the present value of future regulatory risk capital associated with the portfolio of assets and liabilities

Problem: How to determine future regulatory capital requirement during the run-off of the portfolio of assets and liabilities?

-> Assumptions on the evolution of the asset portfolio are necessary

The SST Concept: Market Value Margin

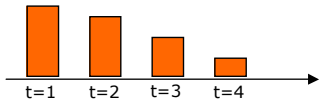
Concept: Insurer 1 is assumed to default at the end of year 0 ($t=1^-$).
Hypothetical insurer 2 takes over portfolio of assets and liabilities of insurer 1.



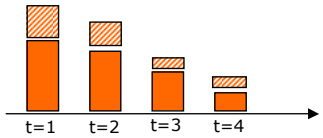
t=0, insurer 1 is a going concern, assets cover market value of liabilities + scr

At the end of year 0 ($t=1^-$), insurer 1 is insolvent, assets cover only market value of liabilities (best estimate + MVM)

At t=1, portfolio of insurer 1 is aggregated to portfolio of insurer 2



Future regulatory SCR requirements for insurer 2 without portfolio of insurer 1



Future regulatory SCR requirements for insurer 2 without portfolio of insurer 1

Additional regulatory capital requirements for insurer 2 after takver of portfolio of insurer 1

t=1

The SST Concept: Market Value Margin

Unkonwns: Insurer 2 taking over portfolio of insurer 1 at t=1 is not known -> diversification of portfolios of insurer 1 and 2 are not known

Within SST, it is assumed that portfolios of insurer 1 and 2 do not diversify. This is conservative but mostly true for life companies. Implicitly, this can be taken into account by setting Cost of Capital lower.

Since insurer 2 is unknown rsp. hypothetical, it is also difficult to set the MVM as the cost of future economic capital (in contrast to cost of regulatory capital) since then the future required capital would for instance be linked to the capital requirement of insurer 2 to keep a given rating (e.g. AA). However, a market average might be used instead (e.g. single A capital requirement-> this would likely increase the MVM since regulatory capital corresponds approx. to a BBB rating

-> For the SST, the simplifications are:

•Portfolios of insurer 1 and 2 do not diversify, hence additional future regulatory capital for insurer 2 is future regulatory capital of insurer 1

•Only regulatory capital is considered, not company specific economic capital

The SST Concept: Market Value Margin

Key Idea:

- The insurer setting up the market value margin should not be penalized if, after the transfer, the insurer taking over the portfolio does not minimize the regulatory risk capital requirements as fast as possible.
- The insurer taking over the portfolio of assets and liabilities should be compensated if the insurer setting up the market value margin invested in an illiquid asset portfolio.

Assets: Assume that initial asset portfolio is rebalanced such that it matches optimally the liabilities. The speed of the rebalancing is constrained by liquidity of assets (it takes longer to liquidate for real estate than for government bonds). The time until the optimal replicating asset portfolio is achieved depends on the asset mix.

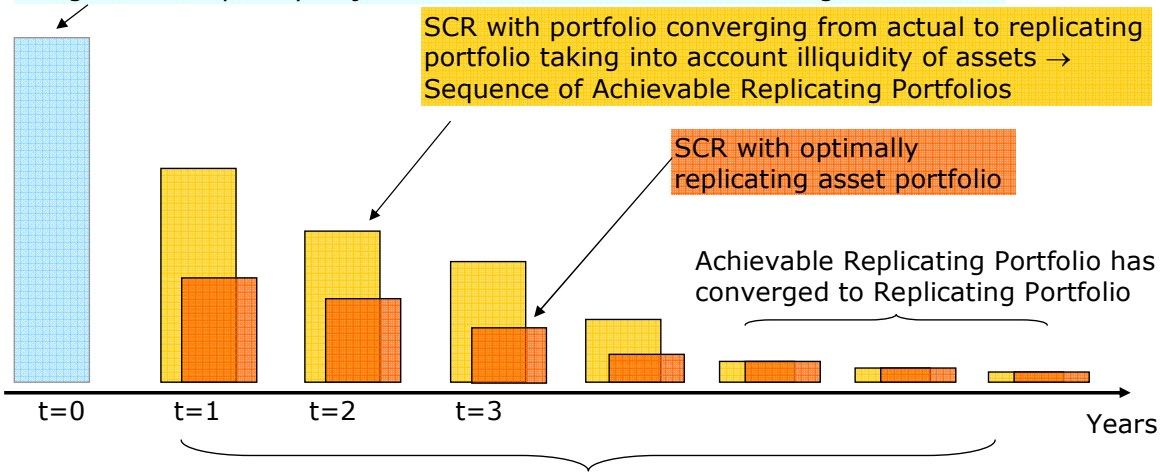
Liabilities: Assume no new business

The SST Concept: Market Value Margin

$$MVM = CoC \cdot \sum_{t \geq 1} SCR(t)$$

CoC: 6% over risk free

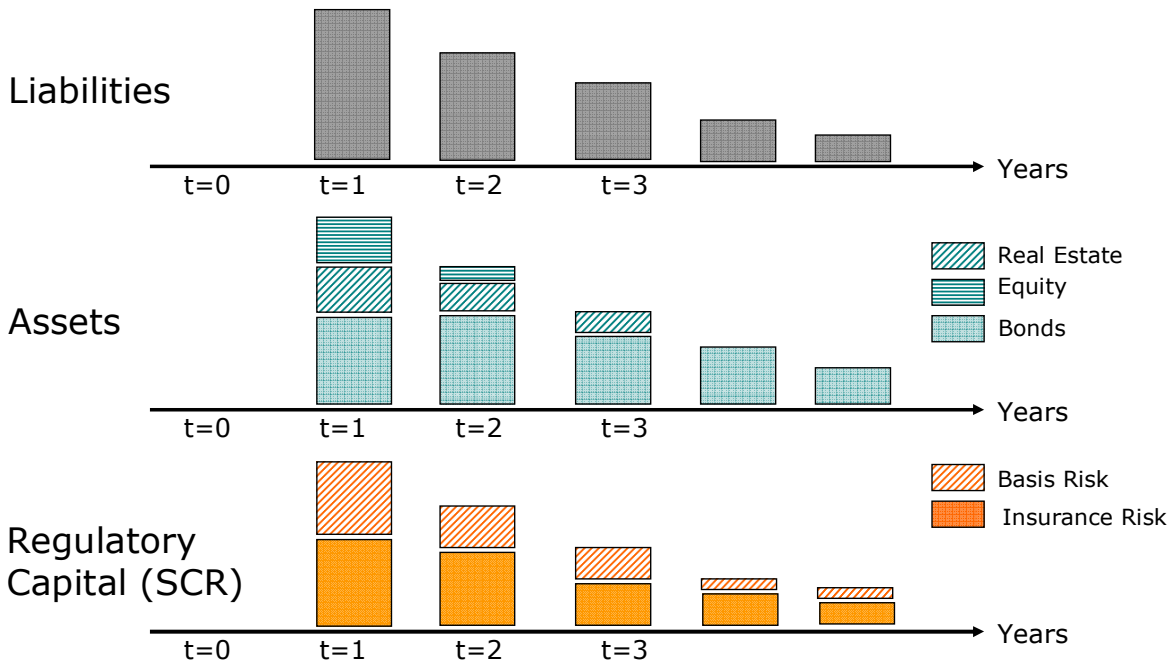
ES at t=0 does not enter calculation of the market value margin necessary at t=0 → risks taken into account for 1-year risk capital and market value margin are completely disjoint and there is no double-counting



SCR: 1-Period (e.g. 1 year) risk capital = Expected Shortfall of risk-bearing capital

Future SCR entering calculation of MVM at t=0

The SST Concept: Market Value Margin



The SST Concept: Market Value Margin

The illiquidity of assets is taken into account by the speed with which the given asset portfolio can be rebalanced to the optimal replicating portfolio

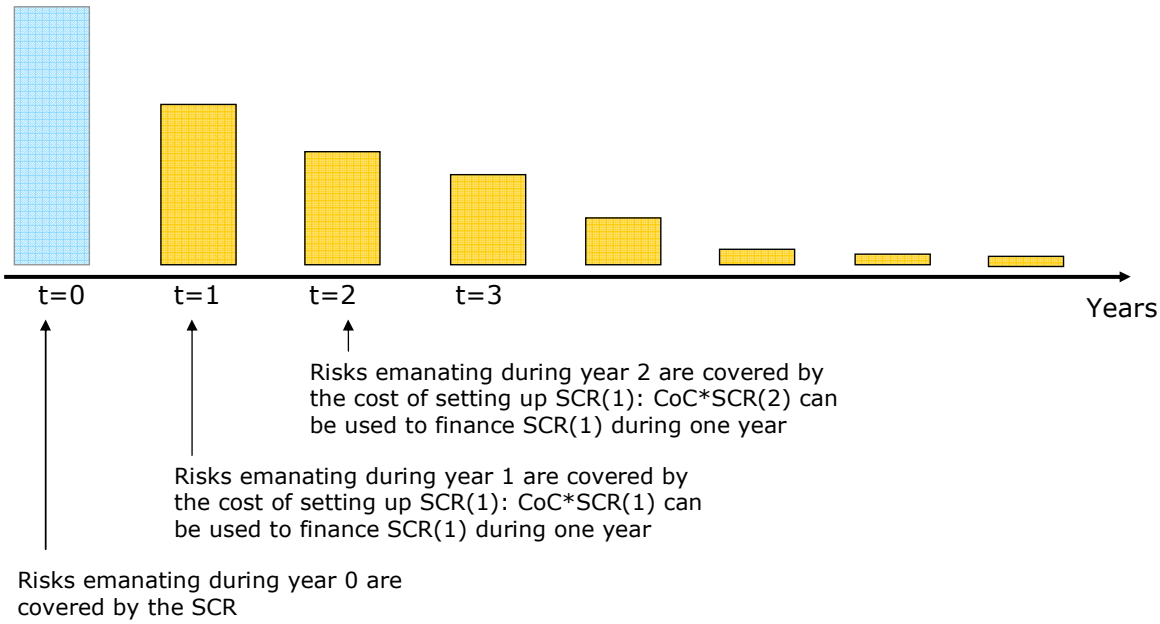
It can also be argued that the illiquidity of assets is already be taken into account by the market value of assets.

In that case the MVM can be calculated by assuming that the optimally replicating portfolio can be achieved already at t=1.

For the field test 2005, this would lead to an overall reduction in MVM of 20% (18% for life and 35% for nonlife).

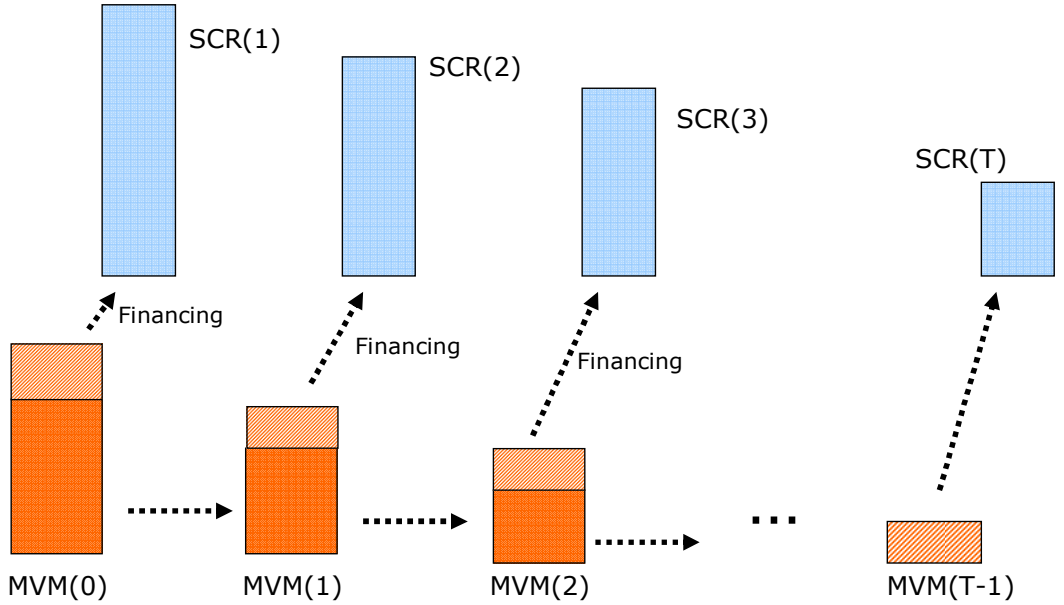
The SST Concept: Market Value Margin

Risks considered in the MVM:



The SST Concept: Market Value Margin

The initial MVM (MVM(0)) can be decomposed into parts financing future SCR necessary during the whole run-off (t=1,…,T) of the portfolio of assets and liabilities



The SST Concept: Market Value Margin

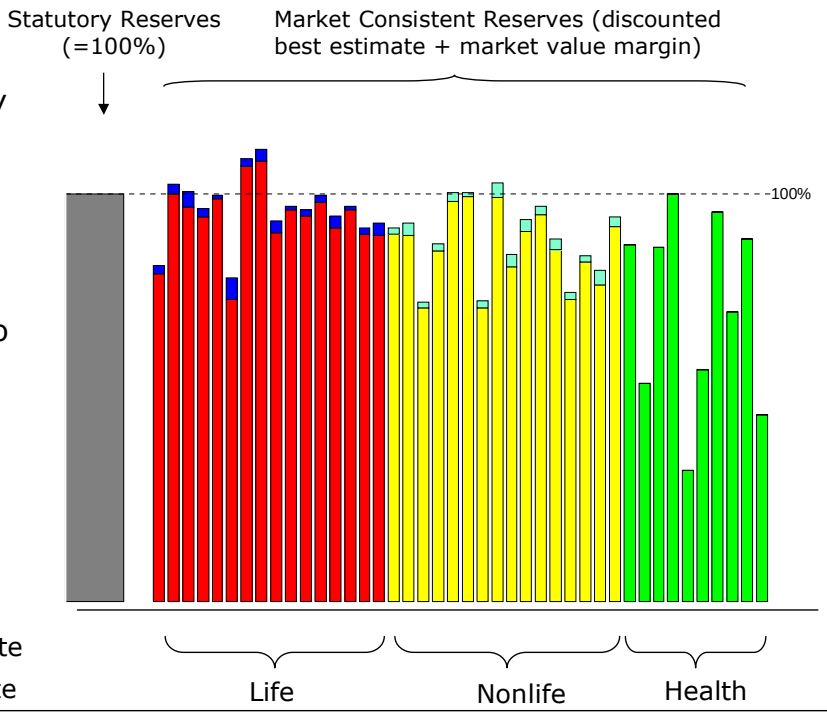
SST calculations used during field test 2005:

- Some companies project asset and liability portfolio for t=1, 2, 3, … for the whole run-off and do a full SST calculation at each t=1, 2, 3, … to arrive at future required regulatory capital.
- Some companies project run-off liabilities and assume that future regulatory capital SCR(t), t>0 is proportional to SRC(t=0)/L(t=0), e.g. that SCR(t)=L(t)*SCR(t=0)/L(t=0).
- Some companies split SCR(t) into a part relating to insurance and in a part relating to market and credit risk. Insurance risk is assumed to be proportional to liabilities and future market and credit risk is calculated assuming the asset portfolio converging to the optimal replicating portfolio.

Valuation Liabilities

The following graph shows how market consistent liabilities compare to statutory liabilities.

In most cases, market consistent valuation releases substantial amounts of hidden reserves to risk bearing capital



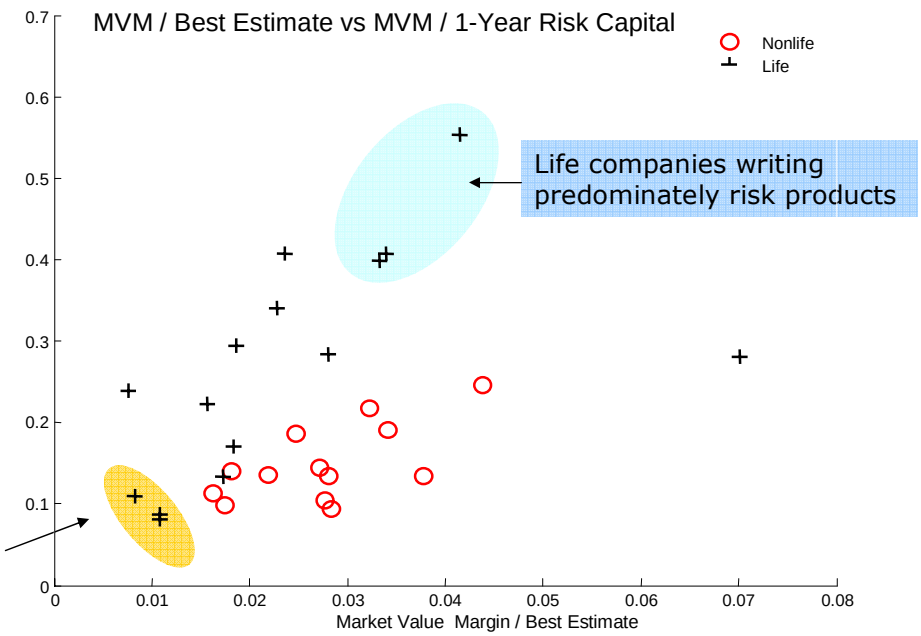
- Life MVM
- Life Best Estimate
- Nonlife MVM
- Nonlife Best Estimate
- Health Best Estimate

Market Value Margin

Market Value Margin / Best Estimate vs Market Value Margin / ES[RBC], based on provisional data of Field Test 2005

X-axis: MVM divided by best estimate of liabilities

Y-axis: MVM divided by 1-year risk capital (SCR)

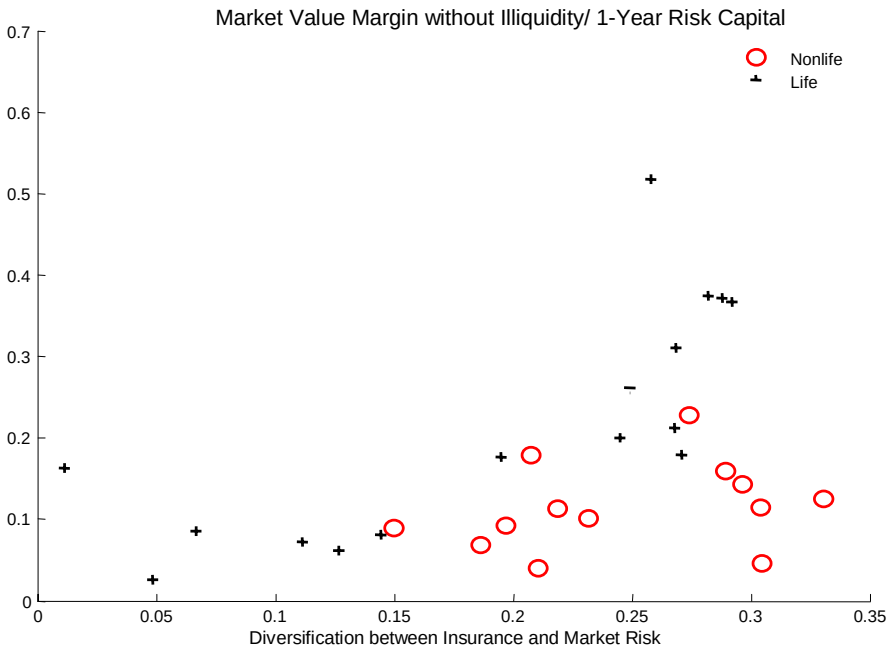


Market Value Margin

Diversification vs Market Value Margin / ES[RBC], based on provisional data of Field Test 2005

X-axis: Diversification between insurance and market risk

Y-axis: market value margin divided by 1-year risk capital



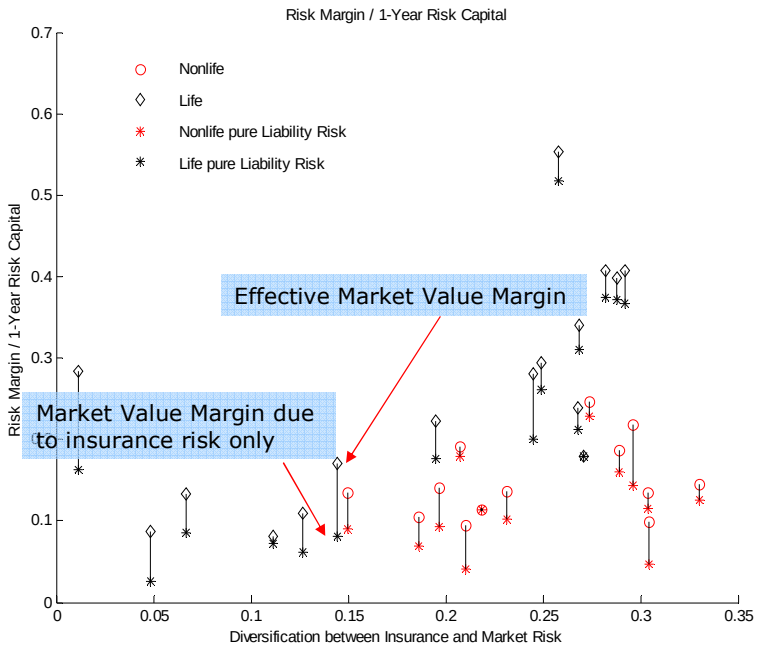
MVM: Effect of Illiquidity of Assets

The following graph shows a comparison of the actual market value margins which include the effect of illiquidity of assets with (theoretical) market value margins where assets are assumed to be completely liquid and where convergence to the optimal replicating asset portfolio were instantaneous

For some companies a substantial reduction of the MVM could be achieved by going over to a more liquid asset portfolio

Overall, the illiquidity of assets increases the MVM by approx. 20%

Diversification vs Market Value Margin / ES[RBC], based on provisional data of Field Test 2005



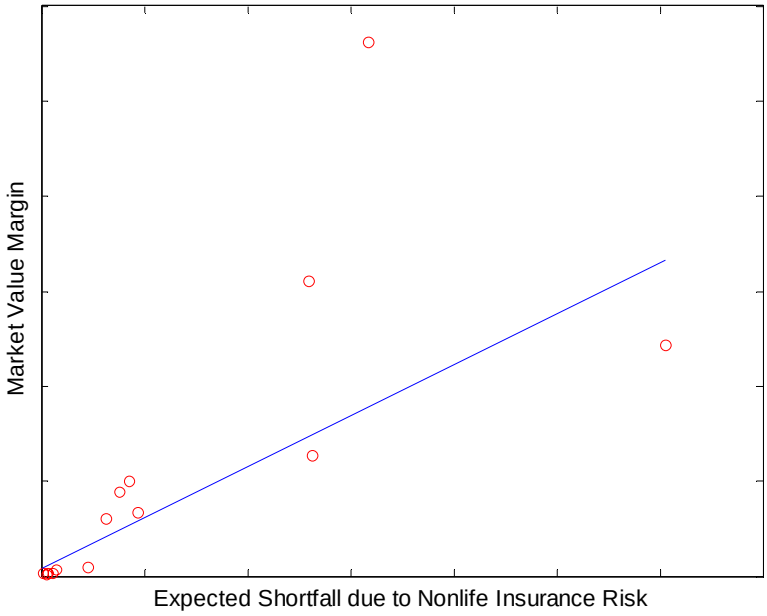
MVM vs ES: Nonlife

The graph shows a comparison of the MVM and expected shortfall due to insurance risk for nonlife companies. The expected shortfall has a confidence level of 99%.

The robust linear fit between ES and the MVM is:

MVM=CHF 4.4 Mio + 0.267*ES

The linear correlation is 0.711



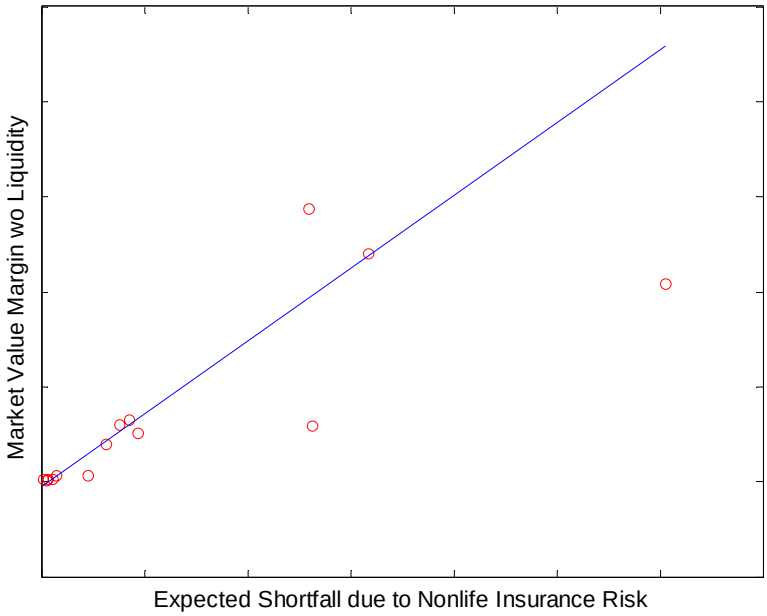
MVM without Liquidity vs ES: Nonlife

The graph shows a comparison of the MVM and expected shortfall due to insurance risk for nonlife companies. The expected shortfall has a confidence level of 99%.

The robust linear fit between ES and the MVM is:

MVM=- CHF 2.6 Mio + 0.383*ES

The linear correlation is 0.8



MVM vs ES: Life

The graph shows a comparison of the MVM and expected shortfall due to insurance risk for life companies. The expected shortfall has a confidence level of 99%.

The robust linear fit between ES and the MVM is:

MVM=CHF 15.6 Mio + 0.848*ES

The linear correlation is 0.985

MVM without Liquidity vs ES: Life

The graph shows a comparison of the MVM and expected shortfall due to insurance risk for life companies. The expected shortfall has a confidence level of 99%.

The robust linear fit between ES and the MVM is:

MVM=- CHF 0.3 Mio + 0.771*ES

The linear correlation is 0.984

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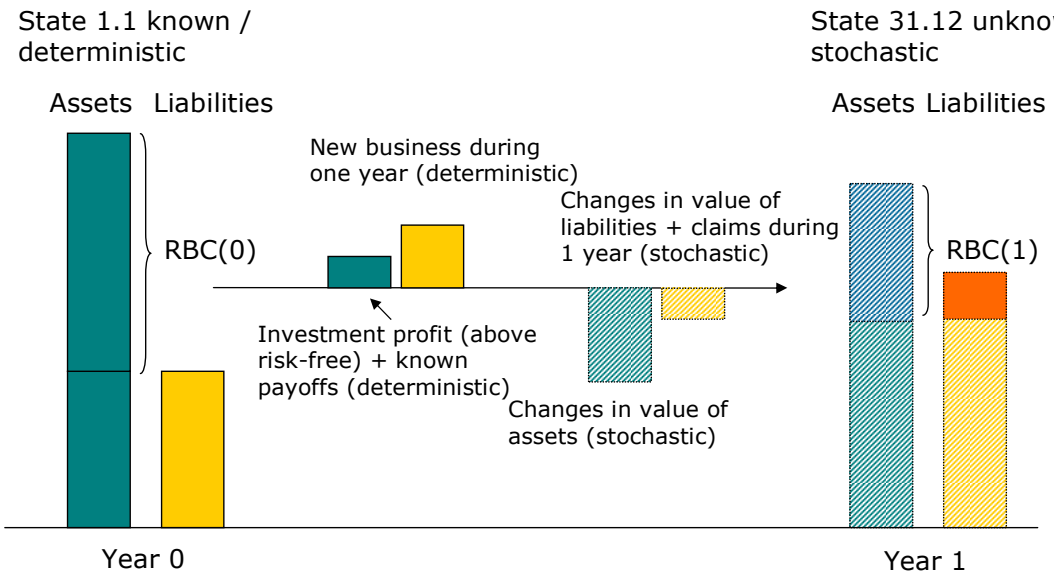
Change in Risk Bearing Capital



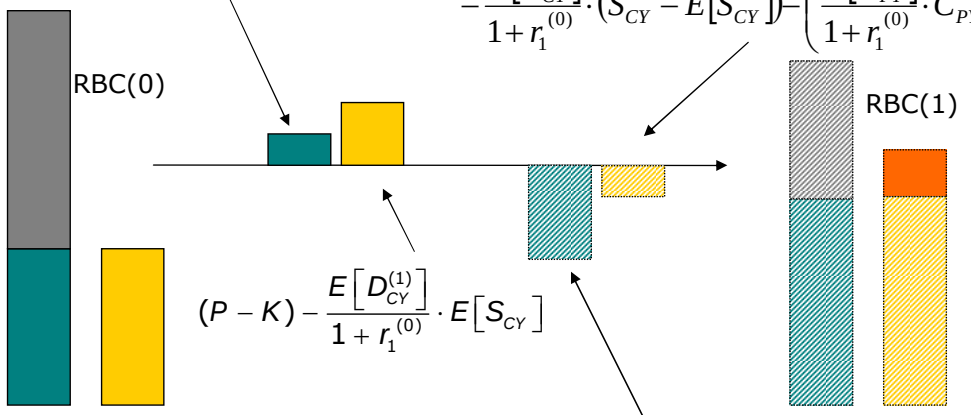
The SST requires the quantification of the randomness of risk bearing capital in one year (the probability distribution of RBC). From this follows the determination of target capital

RBC(0) should be such that at the end of the year, even when a large loss with P<1% occurs, the insurer's available RBC covers (on average) still the market value margin.

Change in Risk Bearing Capital

$$\frac{E[R_I]-r_1^{(0)}}{1+r_1^{(0)}}\cdot(A(0)-UPR+P-K)$$

$$-\frac{E[D_{CY}^{(1)}]}{1+r_1^{(0)}}\cdot(S_{CY}-E[S_{CY}])-\left(\frac{E[D_{PY}^{(1)}]}{1+r_1^{(0)}}\cdot C_{PY}-d_{PY}^{(0)}\right)\cdot R_{PY}^{(0)}$$



$$(P-K)-\frac{E[D_{CY}^{(1)}]}{1+r_1^{(0)}}\cdot E[S_{CY}]$$

$$\frac{R_I-E[R_I]}{1+r_1^{(0)}}\cdot(A(0)+(P-UPR)-K)-\frac{D_{CY}^{(1)}-E[D_{CY}^{(1)}]}{1+r_1^{(0)}}\cdot E[S_{CY}]-\frac{D_{PY}^{(1)}-E[D_{PY}^{(1)}]}{1+r_1^{(0)}}\cdot R_{PY}^{(0)}$$

Change in Risk Bearing Capital

$$\frac{RBC(1)}{1+r_1^{(0)}}-RBC(0)\approx$$

ALM risk

$$\frac{R_I-E[R_I]}{1+r_1^{(0)}}\cdot(A(0)+(P-UPR)-K)-\frac{D_{CY}^{(1)}-E[D_{CY}^{(1)}]}{1+r_1^{(0)}}\cdot E[S_{CY}]-\frac{D_{PY}^{(1)}-E[D_{PY}^{(1)}]}{1+r_1^{(0)}}\cdot R_{PY}^{(0)}$$

$$+\frac{E[R_I]-r_1^{(0)}}{1+r_1^{(0)}}\cdot(A(0)-UPR+P-K)$$ **Expected asset return over risk-free**

$$+(P-K)-\frac{E[D_{CY}^{(1)}]}{1+r_1^{(0)}}\cdot E[S_{CY}]$$ **Expected insurance (technical) result**

$$-\frac{E[D_{CY}^{(1)}]}{1+r_1^{(0)}}\cdot\underbrace{(S_{CY}-E[S_{CY}])}_{\text{Current Year Risk}}-\underbrace{\left(\frac{E[D_{PY}^{(1)}]}{1+r_1^{(0)}}\cdot C_{PY}-d_{PY}^{(0)}\right)\cdot R_{PY}^{(0)}}_{\text{Previous Year Risk}}$$

Insurance risk (deviation of technical result from expectation)

Expected Shortfall of Risk Bearing Capital

Definition. An insurer satisfies the SST when:

$$\mathbf{ES[RBC(1) \mid \mathcal{F}_0] \geq mvm,}$$

where mvm denotes the market value margin.

RBC(1) in function of terms known at t=0:

$$RBC(1) = (rbc(0) + r(0) + p - k)\cdot(1 + R_I) - S(1) - R(1)$$

rbc(0)=a(0) - R(0): Risk-bearing capital at t=0, a(0): assets at t=0, R(0): liabilities at t=0 (best-estimate)

p: Expected premium during [0,1] (Current year)

k: Expected costs during current year

S(1): Claim payments during current year

R(1): Liabilities at t=1

r(0): Liabilities at t=0

r_0: risk-free rate

upr: unearned premium reserve

R_I: Asset return

Notation simplified

Expected Shortfall of Risk Bearing Capital

$$RBC(1) = (rbc(0) + r(0) + p - k)(1 + RI) - S(1) - R(1)$$

$$ES[RBC(1) \mid \mathcal{F}_0] = ES[(rbc(0) + r(0) + p - k)(1+R_I) - S(1) - R(1)]$$

$$= ES[(rbc(0) + r(0) + p - k)(1 + r_0 - r_0 + R_I) - S(1) - R(1)]$$

$$rbc(0)(1+r0) + ES[(r(0)+p-k)(1+r_0-r_0+R_I) + rbc(0)(R_I-r_0) - S(1) - R(1)] \geq mvm$$

$$rbc(0) \geq -ES[(r(0)+p-k)(1+r_0-r_0+R_I) + rbc(0)(I-r_0) - S(1) - R(1)] \geq mvm$$

$$rbc(0) \geq -ES\left[\frac{(a(0)-upr+p-k)(1+I)-S(1)-R(1)}{1+r_0} - (a(0)-upr+r(0))\right] + \frac{mvm}{1+r_0}$$

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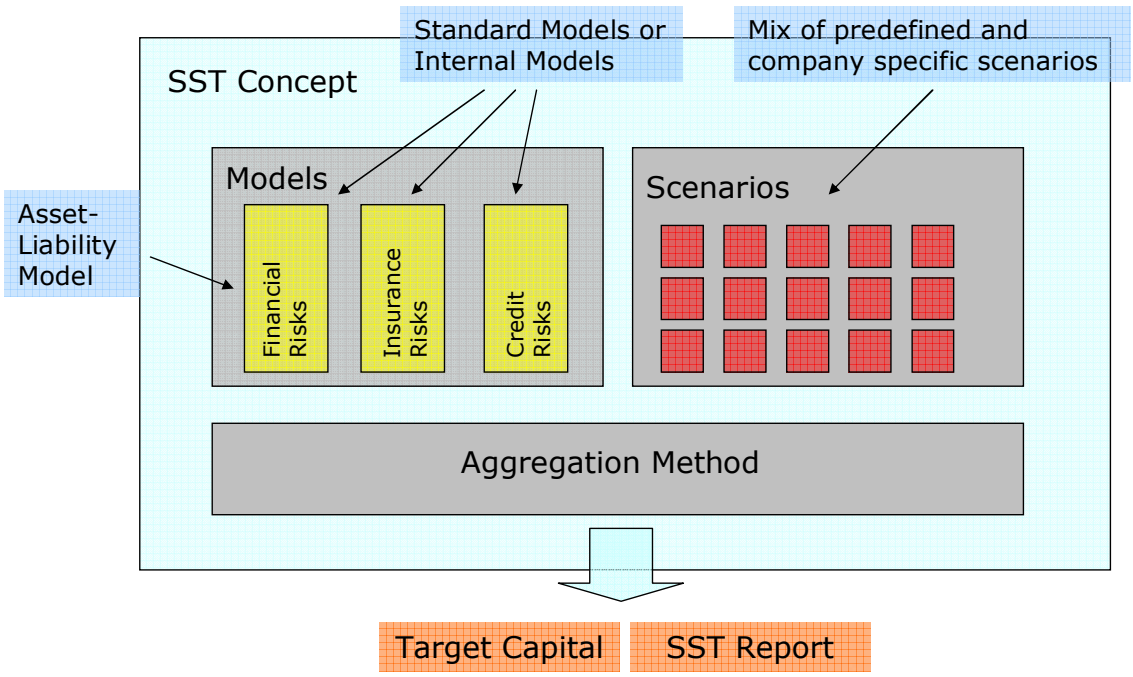
The SST Concept: General Framework



The SST Concept: Standard Models

- Market Risk
  - For many companies this is the most important risk (up to 80% of total target capital emanating from market risk)
  - Needs to be modeled with particular care
  - Most relevant are interest rate risk, real estate risk, spread risk, equity risk
  - Market risk model needs to take into account ALM
- Credit Risk
  - Credit risk is becoming more important as companies go out of equity and into corporate bonds
  - Many smaller and mid-sized companies do not yet have much experience in modeling credit risk
- Insurance Risk (Life)
  - For many life companies with predominantly savings product, pure life insurance risk is not too important
  - Life insurance risk is substantial for companies selling more risk products / disability
  - Model needs to capture optionalities and policyholder behavior
- Insurance Risk (Nonlife)
  - Premium-, reserving- and cat risk are important
  - A broad consensus on modeling exists among actuaries

More information under:

www.sav-ausbildung.ch

Standard Model: Market Risk

Financial market risk often dominates for insurers → adequate modeling of interest rate-, equity-,.. risks is key

Interest rate risk can not be captured solely by a duration number

Financial instruments have to be segmented sufficiently fine else arbitrage opportunities might be created

Regulatory requirements shouldn't force companies to disinvest totally from certain investment classes (e.g. shares, private equity)

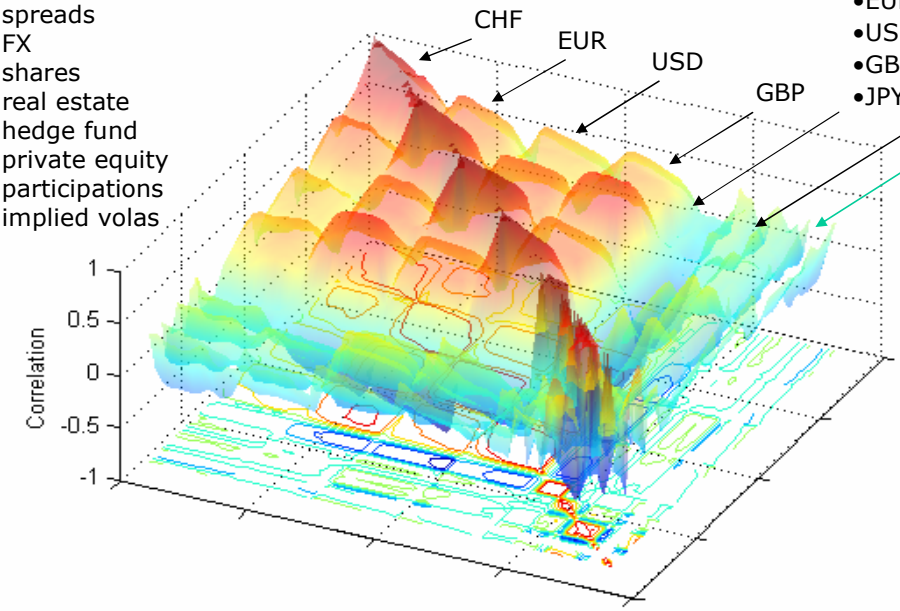
For SST, RiskMetrics type model with given risk factors and associated volatilities and correlation matrix is used together with scenarios

Scenarios

- Historical
  - Share crash (1987)
  - Nikkei crash (1990)
  - European FX-crisis (1992)
  - US i.r. crisis (1994)
  - Russia crisis / LTCM (1998)
  - Share crash (2000/2001)
- Default of Reinsurer
- Financial Distress
  - Equity drop
  - Lapse = 25%
  - New business = -75%
- Deflation

Standard Model: Market Risk

75 Risk Factors:
- 4*13 interest rate
- 4 spreads
- 4 FX
- 5 shares
- 4 real estate
- 1 hedge fund
- 1 private equity
- 1 participations
- 3 implied volas



FX
- EUR
- USD
- GBP
- JPY

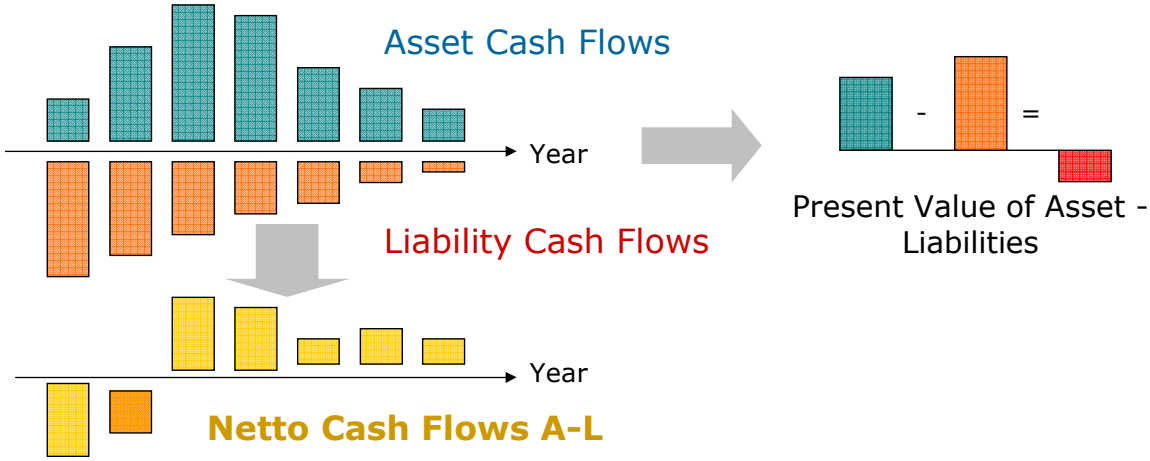
Spreads
- AAA
- AA
- A
- BAA

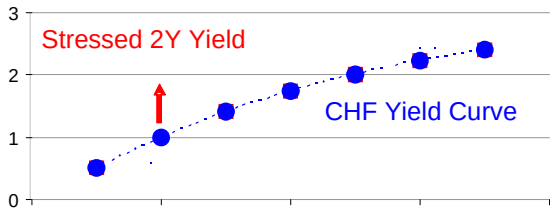
Equity
- Shares
  - CHF
  - EUM
  - USD
  - GPB
  - JPY
- Real Estate
  - IAZI
  - Commercial
  - Rüd Blass
  - WUPIX A
- Hedge Funds
- Private Equity

i.r. time buckets:1,…,10, 15,20,30+

The SST Concept: Cash Flow Based

Example: Sensitivity to 2 Year CHF Yield





Change of present value of net cash flow (assets-liabilities) due to change in the 2 year CHF yield

Standard Model: Market Risk

Companies need to calculate the sensitivities $df=(f_1,\ldots,f_k)$ w.r.t. the given risk factors (for Assets and Liabilities combined)

Then the total variance is given by $f^T \Sigma f$, where Σ is a given covariance matrix

Linear ansatz: $$\Delta RBC(1) = \nabla f\left(X(0)\right)\cdot \Delta X(1)$$

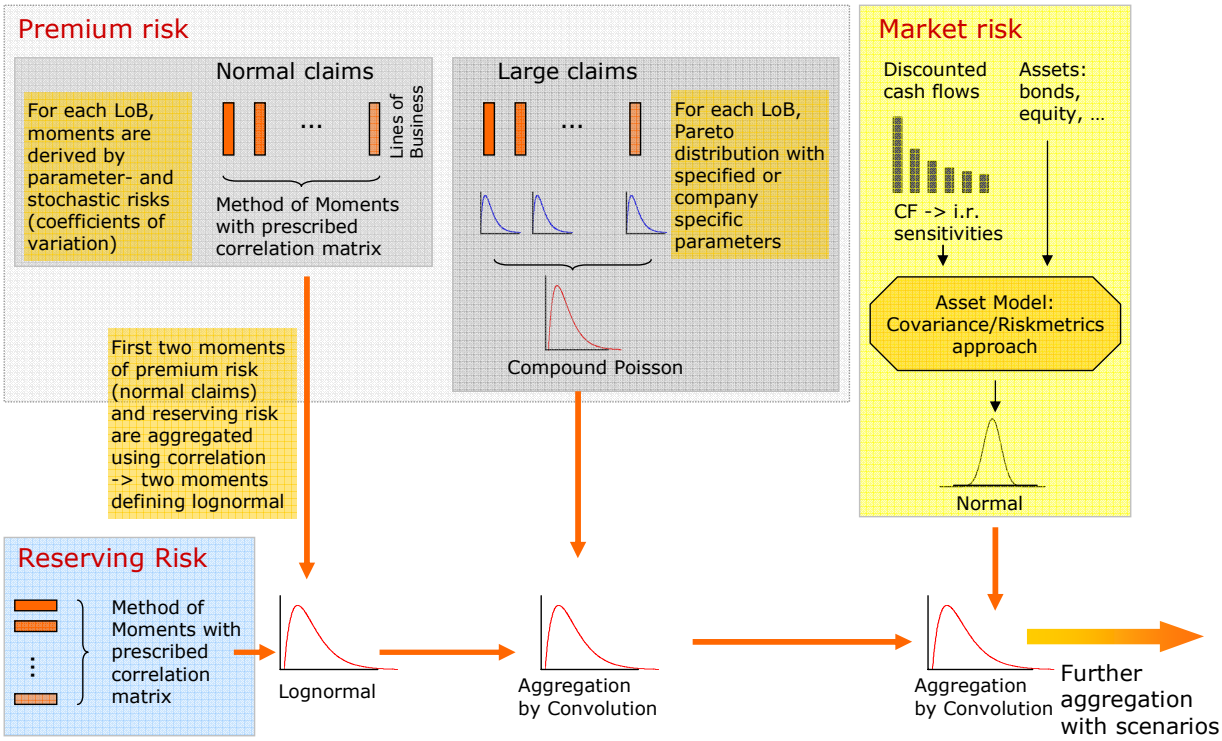
Sensitivity analysis: $$\partial x_i f\left(X(0)\right) = \frac{f\left(X(0)+\varepsilon_i e_i\right) - f\left(X(0)\right)}{\varepsilon_i}$$

Normality assumption: $$ES\left[\Delta RBC\right] = -\nabla f \cdot \mu + \sqrt{\nabla f^T \cdot \Sigma \cdot \nabla f}\,\frac{\phi\left(q_{1-\alpha}(Z)\right)}{\alpha}$$

For market risk scenarios, the risk factors (and the covariance matrix) can be appropriately stressed → all calculations can be done using the given sensitivities s (if we assume that linearization holds)

Advantage: Companies need only calculate sensitivity vector, all calculations can be implemented in a spreadsheet

Standard Model: Nonlife



Changes in Risk Bearing Capital

$$\frac{RBC(1)}{1+r_1^{(0)}} - RBC(0) \approx$$

ALM risk

$$\frac{R_I - E[R_I]}{1+r_1^{(0)}} \cdot (A(0) + (P - UPR) - K) - \frac{D_{CY}^{(1)} - E[D_{CY}^{(1)}]}{1+r_1^{(0)}} \cdot E[S_{CY}] - \frac{D_{PY}^{(1)} - E[D_{PY}^{(1)}]}{1+r_1^{(0)}} \cdot R_{PY}^{(0)}$$

$$+\frac{E[R_I] - r_1^{(0)}}{1+r_1^{(0)}} \cdot (A(0) - UPR + P - K)$$ **Expected asset return over risk-free**

$$+(P-K) - \frac{E[D_{CY}^{(1)}]}{1+r_1^{(0)}} \cdot E[S_{CY}]$$ **Expected insurance (technical) result**

$$-\frac{E[D_{CY}^{(1)}]}{1+r_1^{(0)}} \cdot \underbrace{(S_{CY} - E[S_{CY}])}_{\text{Current Year Risk}} - \underbrace{\left(\frac{E[D_{PY}^{(1)}]}{1+r_1^{(0)}} \cdot C_{PY} - d_{PY}^{(0)}\right) \cdot R_{PY}^{(0)}}_{\text{Previous Year Risk}}$$

Insurance risk (deviation of technical result from expectation)

Standard Model: Insurance Part

$$(P-K) - d_{CY}^{(0)} \cdot E[S_{CY}] - d_{CY}^{(0)} \cdot (S_{CY} - E[S_{CY}]) - d_{PY}^{(0)} (C_{PY} - 1) R_{PY}^{(0)}$$

- P: Earned Premium
- K: Cost
- $d_{CY}^{(0)}$: Discount factor for CY-claims
- $E[S_{CY}]$: Expected CY claims
- S_{CY}: CY claims — **CY Risk**
- $d_{PY}^{(0)}$: Discount factor for PY-claims
- $(C_{PY} - 1) R_{PY}^{(0)}$: Run-off result — **PY Risk**

$$= P - K - d_{CY}^{(0)} \cdot S_{CY} - d_{PY}^{(0)} \cdot (C_{PY} - 1) \cdot R_{PY}^{(0)}$$

= premiums less costs less discounted claim cost less discounted run-off result

= technical result

Standard Model: Insurance Part

$$\underbrace{P - K}_{\text{Assumed deterministic}} - \underbrace{d_{CY}^{(0)} \cdot S_{CY}}_{\textbf{Current Year Risk}} - \underbrace{d_{PY}^{(0)} \cdot (C_{PY} - 1) \cdot R_{PY}^{(0)}}_{\textbf{Previous Year Risk}}$$

Claims which occur during 1 year:

Within each Line of Business:

- Normal claims and large claims
- Catastrophes which affect different LoBs simultaneously

Reserving risks due to:

- Randomness (stochastic risk)
- Reassessment of reserves (parameter risk)

Standard Model: CY Risk Normal Claims

Normal Claims: "High frequency claims", different for each LoB.

Split Normal / Large claims is in standard-model defined, companies can adjust to their specific situation

For each LoB:

- **Estimate Parameter & Stochastic Risk due to normal claims**
- **Then aggregate using correlation matrix (→ first two moments define a Gamma distribution for normal claims)**

For each LoB i:

$$\text{CoeffVar}_i^2 = \frac{\text{Var}[C_i^N]}{\text{E}[C_i^N]^2} = \underbrace{\left(\text{CoeffVar}_i^{\text{param}}\right)^2}_{\text{due to Parameter Risk}} + \underbrace{\frac{1}{\lambda_i}\left(\overbrace{\text{CoeffVar}(Y_{i,j})^2}^{\text{Coefficient of Variation for a single claim in LoB i}} + 1\right)}_{\text{due to Stochastic Risk}}$$

Expected number of claims Yi,j in LoB j

$$Var\left[S_{CY}^{NS}\right] = \sum_{i=1} \text{Var}\left[S_{CY,i}^{NS}\right] + \sum_{\substack{i,j=1 \\ i \neq j}} \text{Cov}\left[S_{CY,i}^{NS}, S_{CY,j}^{NS}\right]$$

$$= \sum_{i=1} \left(\text{CoeffVar}_i \cdot \text{E}\left[S_{CY,i}^{NS}\right]\right)^2 + \sum_{\substack{i,j=1 \\ i \neq j}} \rho_{i,j} \cdot (\text{CoeffVar}_i \cdot \text{E}\left[S_{CY,i}^{NS}\right]) \cdot (\text{CoeffVar}_j \cdot \text{E}\left[S_{CY,j}^{NS}\right])$$

Standard Model: CY Risk Normal Claims

Within Standard Model: $CoeffVar_i$ for parameter risk and $coeffvar(Y_{i,j})$ for single normal claims for two different splits normal / large claims is given

LoB i	Parameter Risk $CoeffVar_i$	Stochastic Risk CoeffVar(Yi,j) Split at CHF 1 Mio	Stochastic Risk CoeffVar(Yi,j) Split at CHF 5 Mio
MFH	3.50%	7.00%	10.00%
MFK	3.50%	2.50%	2.50%
Sach	3.00%	5.00%	8.00%
Haftpflicht	4.50%	8.00%	11.00%
UVG	3.50%	7.50%	9.50%
Unfall ohne UVG	3.00%	4.50%	5.50%
Kollektiv Kranken	3.00%	2.50%	2.50%
Einzelkranken	5.00%	2.25%	2.25%
Transport	5.00%	6.50%	7.00%
Luftfahrt	5.00%	2.50%	3.00%
Finanz und Kaution	5.00%	5.00%	5.00%
Other	5.00%	5.00%	5.00%

Standard Model: CY Risk Normal Claims

For each LoB, each company has to:

- Define a split into normal and large claims
- Estimate the expected number of normal claims
- Estimate the expected normal claim amount
- If split normal/large is 1 or 5 Mio, then standard values can be used

	MFH	MFK	Sach	Haftpflich	UVG	Unfall ohne UVG	Kollektiv Kranken	Einzel Kranken	Trans-port	Luftfahrt	Finanz und Kaution	Andere
MFH	1	0.5		0.25	0.25	0.25						
MFK	0.5	1	0.25									
Sach		0.25	1	0.25								
Haftpflicht	0.25		0.25	1								
UVG	0.25				1	0.5	0.5					
Unfall ohne UVG	0.25				0.5	1	0.5					
Kollektiv Kranken					0.5	0.5	1	0.25				
Einzel Kranken							0.25	1				
Transport									1			
Luftfahrt										1		
Finanz und Kaution											1	
Andere												1

Correlations between normal claims: Based on historical experience and actuarial gut-feeling

Standard Model: CY Risk Large Claims

Large claims: Large single claims and accumulation of claims due to a single event

For each LoB j: Total amount due to large claims is modeled as Compound Poisson with single claims $Y_{i,j}$ being Pareto distributed and number of claim N_j being Poisson. Then

$$S_{CY,i}^{LC} = \sum_{j=1}^{N_i} Y_{i,j}^{LC}$$

Further assumption: S_{CYj} are independent → Total amount due to large claims over all LoB is again Compound Poisson

Standard Model: CY Risk Large Claims

Pareto Distribution:

$$F_{Y_{i,j}^{GS}}(y) = P(Y_{i,j}^{GS} \le y) = \begin{cases} 0 & y < \beta, \\ 1 - \left(\frac{y}{\beta}\right)^{-\alpha_i} & y \ge \beta. \end{cases}$$

Smallest claim possible: β → threshold parameter

Shape parameter α: The smaller α, the more heavy-tailed. If α<k, k-th moment does not exist anymore

For numerical calculations the cut-off point of the distribution is very important

Table with standard parameters for companies lacking sufficient data

LoB	α b=1 Mio	α b=5 Mio	Cut off Point
MFH	2.50	2.80	Illimité
MFK			Marktet Share * 1.5 Mrd. CHF
Sach	1.40	1.50	Company specific estimation of largest possible claim
Haftpflicht	1.80	2.00	Company specific estimation of largest possible claim
UVG inkl UVGZ	2.00	2.00	Illimité
Unfall ohne UVG			CHF 50 Mio
Kollektiv Kranken	3.00	3.00	Company specific estimation of largest possible claim
Einzelkranken	3.00	3.00	Company specific estimation of largest possible claim
Transport	1.50	1.50	2 * largest possible sum at risk
Luftfahrt			not modeled as mostly reinsured in pool
Finanz und Kaution	0.75	0.75	Company specific estimation of largest possible claim
Andere	1.50	1.50	Company specific estimation of largest possible claim

Standard Model: Previous Year Risk

PY Risk: Reserving Risk, due to uncertainty of run-off result

Assumption: $C_{PY}*R_{PY}^{(0)}$ lognormal, with expectation $C_{PY}*R_{PY}^{(0)} \rightarrow E[C_{PY}]=1$

Randomness of C_{PY} due to parameter and stochastic risk

Stochastic Risk: due to randomness of single claims → company specific estimation from historical run-off result. Determine for each LoB (where all historical data is on best-estimate basis)

Parameter Risk: Estimates of parameters uncertain which affect all provisions of a LoB, level of total provisions incorrectly chosen.

Notation:

$R_{PY}^{(0)}$ best estimate of PY liabilities at t=0,

$C_{PY}* R_{PY}^{(0)}$ re-evaluation of $R_{PY}^{(0)}$ at t=1 (r.v.),

($(1 - C_{PY}) * R_{PY}^{(0)}$ = run-off result)

Standard Model: Previous Year Risk

Total Variance for each LoB

$$Var(C_{PY,i} \cdot R_{PY,i}^{(0)}) = Var_P(C_{PY,i} \cdot R_{PY,i}^{(0)}) + Var_Z(C_{PY,i} \cdot R_{PY,i}^{(0)})$$

$$Var_P(C_{PY,i} \cdot R_{PY,i}^{(0)}) = \left(R_{PY,i}^{(0)} \cdot Vko_P(C_{PY,i})\right)^2$$

Stochastic Risk: Company specific estimation based on best-estimate time-series

Parameter Risk: Parameters given for standard model:

MFH	3.50%
MFK	3.50%
Sach	3.00%
Haftpflicht	4.50%
UVG	3.50%
Unfall ohne UVG	3.00%
Kollektiv Kranken	3.00%
Einzelkranken	5.00%
Transport	5.00%
Luftfahrt	5.00%
Finanz und Kaution	5.00%
Andere	5.00%

Total variance over all LoB: Assumes independence:

$$Var(C_{PY} \cdot R_{PY}^{(0)}) = \sum_i Var(C_{PY,i} \cdot R_{PY,i}^{(0)})$$

Independence assumption might be changed in future → can be easily changed by introducing correlation

Standard Model: Life

Assumptions: The risk factors are normal distributed with given volatilities. The change of risk bearing capital in function of the risk factors is linear → The distribution over all risk factors is again (multivariate) normal distributed

Risk Factors:	Volatility	
	Indiv.	Group
•Mortality	5%	5%
•Longevity (trend)	10%	10%
•Disability	10%	20%
•Reactivation	10%	10%
•Lapse	25%	25%
•Option Exercise	10%	10%

Volatility: Describes changes of risk factors within one year due to parameter-uncertainty

Stochastic risk will be included using company specific data if relevant

The volatilities have been set during discussions with specialist and represent a best-guess

Standard Model: Life

Correlations between risk factors for field test 2005:

Split into individual and group business. Full correlation between individual and group business risk factors, except for lapse

	Einzel						Gruppen					
	Sterblichkeit	Langlebigkeit	i(x)	r(x)	Storno	Optionsausübung	Sterblichkeit	Langlebigkeit	i(x)	r(x)	Storno	Optionsausübung
Sterblichkeit	1	0	0	0	0	0	1					
Langlebigkeit	0	1	0	0	0	0		1				
i(x)	0	0	1	0	0	0			1			
r(x)	0	0	0	1	0	0				1		
Storno	0	0	0	0	1	0.75					1	0.5
Optionsausübung	0	0	0	0	0.75	1					0.5	1
Sterblichkeit	1						1	0	0	0	0	0
Langlebigkeit		1					0	1	0	0	0	0
i(x)			1				0	0	1	0	0	0
r(x)				1			0	0	0	1	0	0
Storno					1	0.5	0	0	0	0	1	0.75
Optionsausübung					0.5	1	0	0	0	0	0.75	1

Standard Model: Life

The model is simple and transparent: the company has to determine sensitivities with respect to life insurance risk factors and then can use correlation matrix and volatilities to arrive at distribution for life insurance risk

The normality assumption allows easy aggregation with market risk

Correlations between market risk factors

$$\begin{pmatrix} M & C_{M,IG} \\ C_{M,IG}^T & \begin{pmatrix} I & C_{I,G} \\ C_{I,G}^T & G \end{pmatrix} \end{pmatrix}$$

Correlations between market risk factors and insurance risk factors (individual and group business)

For field test 2005, $C_{M,IG}=0$, but in future correlation between market risk and insurance risk can easily be included (e.g. correlation between lapse and interest rate)

Correlations between life insurance risk factors (within individual (I), within group (G) and between individual and group $C_{I,G}$

Standard Model: Life

The Model can easily be extended to take into account life branches by extending correlation matrix:

C_i: Correlations between risk factors within branch i

$$\begin{pmatrix} C_1 & D_{12} & \cdots & D_{1n} \\ D_{21} & C_2 & \ddots & D_{2n} \\ \vdots & \ddots & \ddots & \vdots \\ D_{n1} & D_{n2} & \cdots & C_n \end{pmatrix}$$

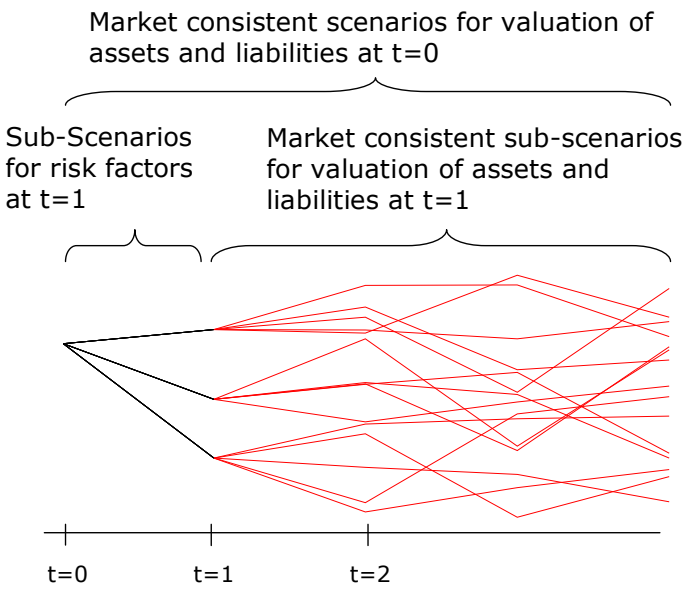
D_{ij}: Correlations between risk factors of branch i and branch j

Correlations between mortality and disability of different branches within Europe can be set high (e.g. 1, 0.75 or 0.5).

The complexity in life insurance emanates more from valuation than from risk modeling (at least for large companies)

Standard Model: Life

If risk measurement and valuation framework needs to be consistent, the modeling becomes computationally more complex:



Large and midsized life companies writing substantial embedded options will likely develop or implement consistent frameworks for valuation and risk measurement

If a simplifies approach will be chosen it has to be shown to FOPI that it leads to conservative estimates

Standard Model: Life

Experiences from field tests:

- Market consistent valuation of options and guarantees is a challenge;
- Integration of valuation and risk quantification framework will lead to complex modeling frameworks;
- The distinction between reserves and provisions can become artificial:
  - Under going concern conditions, performance bonus has to be provisioned for;
  - Under financial distress condition, bonus provision might become risk bearing;
- For the regulator, it will be key to take into account company specific contract features in a consistent way (e.g. contractual features which allow for change in guaranteed i.r. etc.).

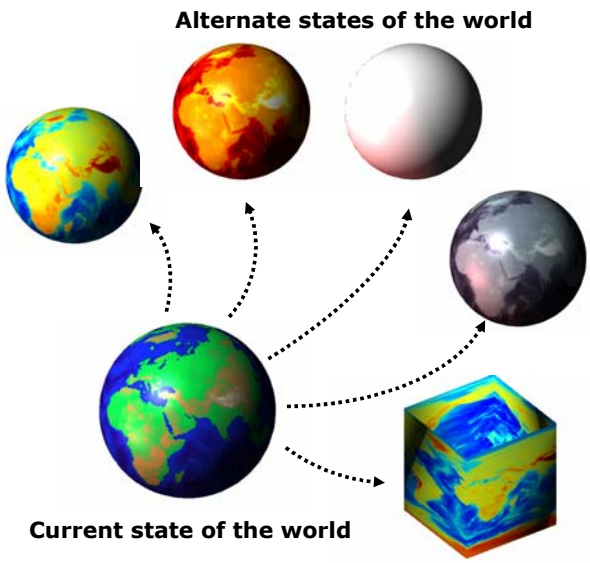
Contents

- Market Value Margin
- SCR
- The SST Standard Models
- Scenarios
- Risk Bearing Capital

The SST Concept: Scenarios

"Ersatz experience is a better guide to the future than the real past and present", Hermann Kahn in *On Thermonuclear War*

Scenarios can be seen as thought experiments about possible future states of the world. Scenarios are not forecasts, in that they need not predict the future development, but rather should illuminate possible but perhaps extreme situations. Scenarios are also different from sensitivity analysis where the impact of a (small) change of a single variable is evaluated.



Standard Model: Aggregation with Scenarios

Assumption: During normal years, analytical models without scenarios are valid (described by a probability distribution F_0), during exceptional years, additional losses due to events described in scenarios occur, causing a shift in the 'pre-scenario' distribution.

Scenario i, i=1,…,n occurs with probability p_i and causes an additional loss of c_i ($c_i<0$)

The probability of a normal year is $p_0=1-p_1-\ldots-p_n$

The probability distribution of the risk during a year with aggregated scenarios is:

$$F(x) = \sum_{i=0}^{n} p_i \cdot F_i(x) = \sum_{i=0}^{n} p_i \cdot F_0(x - c_i)$$

F(x) is the weighted mean of shifted distributions $F_0(.-c_i)$, i=1,…,n, where $c_0=0$.

The SST Concept: Scenarios

Historical Scenarios: Stock Market Crash 1987, Nikkei Crash 1989, European Currency Crisis 1992, US Interest Rates 1994, Russia / LTCM 1998, Stock Market Crash 2000

Financial Distress: Increase of i.r., lapse, no new business, downgrading of company,…

Deflation: decrease of i.r.

Pandemic: Flu Pandemic with given parameters (e.g. number of death, sick-days, etc.)

Longevity

Reserving: Provisions have to be increased by 10%

Hail (Swiss specific): Given footprints

Default of Reinsurer: Reinsurer to which most business has been ceded defaults

Industrial Accident: Accident at chemical plant

Personal Accident: large accident during company outing or mass panic in soccer stadium

Anti-selection for Health Insurers: all insured with age < 45 lapse

Collapse of a dam (Swiss specific)

Terrorism

Global Scenarios (for groups&reinsurers)

Property Cats (earthquake, windstorm)

Special Line Cats: Aviation (2 planes collide, marine event, energy event, credit&surety event

The SST Concept: Scenarios

Example: Pandemic (Spanish Flu 1918/1919)

AKG Photo

	Kinder	Gesunde Erwachs. (15-49)	Gesunde Erwachs. (50-65)	Ältere	Erwachs. mit hohem Risiko (15-65)	Erwachs. mit hohem Risiko (>66)	Personen im Gesundheit swesen	Total
Bevölkerung	1'249'000	3'155'000	1'080'000	700'000	383'000	328'000	269'000	**7'164'000**
Anzahl Kranke	1'001'136	2'242'890	485'603	228'701	226'314	107'163	173'252	**4'465'059**
Arztvisiten	508'549	966'972	210'059	123'902	128'886	66'497	78'093	**2'082'958**
Hospitalisierung	2'928	13'287	1'884	2'824	8'317	2'570	1'411	**33'221**
Betttage	20'555	25'592	6'404	25'641	76'694	58'961	8'857	**222'704**
Tote	4'831	10'295	3'521	3'072	4'995	14'190	1'096	**42'000**
verlorene Arbeitstage	0	8'519'486	1'836'142	0	921'977	0	849'512	**12'127'117**

Insurer and reinsurers have to calculate effect of flu pandemic based on company specific portfolio (market share, exposure to high risk group, (e.g. nurses etc.))

The scenario is based on a publication by FOPH

Scenarios: Default of Reinsurers

To model the effect of the default of reinsurers on the capital requirement for cedants within a simple regulatory model is a hard problem

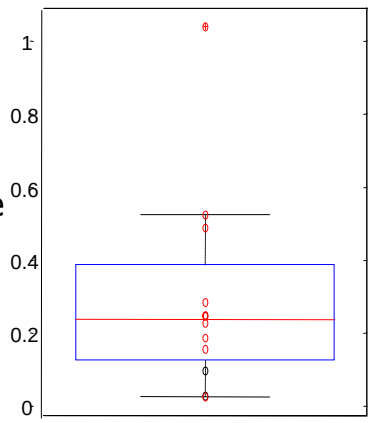
Assumption for the SST Standard Model:

- All reinsurers default together
- The probability of this event is given by the default probability of the reinsurer to which most business is ceded

-> The loss at default is too conservative and the probability of event is likely to low

If a company wants a more risk-specific modelling of the effect of the default of a reinsurer, an internal model has to be used

Effect of Reinsurance Scenarios in Relation to Risk Bearing Capital



Effect of Scenario as Fraction of RBC

Scenarios: Default of Reinsurers

Under the scenario a company has to quantify the risk that:

- Loss of expected payments of a reinsurer for already incurred claims
- Loss due to the default of a reinsurer simultaneously with a large claim

The loss under the scenario is equal to:

- The maximum of
  - Expected Shortfall of the large claim distributions gross less Expected Shortfall of the large claims distribution net → Takes into account the risk that the reinsurer defaults simultaneously with a large claim
  - Scenario 1 (gross) less Scenario 1 (net)
  - …
  - Scenario n (gross) less Scenario n (net)

  } Takes into account the risk that the reinsurer defaults simultaneously with a catastrophe
- + Reinsurance premium for XL for normal claims → Loss of reinsurance premium
- + Claim reserves (gross) less Claim reserves (net) → Takes into account the risk of loss of future payments from a reinsurer for already incurred claims

Probability of the scenario: Default probability of the reinsurer to which most business is ceded (according to premium)

Scenarios: Default of Reinsurers

Effect of credit risk of reinsurers on capital requirements:

- Adds between 0.02% and 8% to required capital depending on business ceded and reinsurers default probability (using Expected Shortfall)
- If VaR is used as risk measure for capital requirements, the effect of the credit risk of reinsurers is between 0.02% and 3.5%.

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SST Concept: Risk Bearing Capital

Capital needs to be risk-bearing also in case of financial distress

Risk Bearing Capital: Core Capital + Lower and Upper Additional Capital:

Core Capital:

- Excludes dividends, own shares, immaterial assets, latent real estate tax
- Loans which can be converted into share capital of the company and similar innovative financial instruments can be used as core capital given regulatory approval
- Supervisory approval should be required before such capital can be repurchased/redeemed or otherwise reduced in amount.

Lower Additional Capital: Hybrid capital with fixed maturity date of at least 5 years

Upper Additional Capital: Hybrid capital without maturity date (e.g. perpetual subordinated loans)

Art. 48 Kernkapital

1 Zur Ermittlung des Kernkapitals wird die statutarische Bilanz in eine Marktwertbilanz mit marktnaher Bewertung der einzelnen Positionen übergeführt. Die Marktwertbilanz wird nach den Richtlinien der Aufsichtsbehörde erstellt.

2 Das Kernkapital berechnet sich aus der Differenz zwischen marktnah bewerteten Aktiven und marktnah bewertetem Fremdkapital unter Abzug von:

a) vorgesehenen Dividenden;

b) eigenen Aktien, die sich im unmittelbaren Besitz des Versicherungsunternehmens befinden;

c) immateriellen Vermögenswerten;

d) latenten Liegenschaftssteuern.

3 Das Versicherungsunternehmen kann mit Zustimmung der Aufsichtsbehörde Anleihen, die nur in Aktienkapital des Versicherungsunternehmens umgewandelt werden können, und ähnliche innovative Finanzinstrumente an das Kernkapital anrechnen.

SST Concept: Risk Bearing Capital

Limits:

- Lower Additional Capital up to 50% of core capital
- Additional Capital up to 100% of core capital

Exceptions:

The supervisor can allow a parent-daughter combination to not allocate capital to the daughter, if certain conditions are met.

Die Aufsichtsbehörde kann ein Versicherungsunternehmen von der Bedeckung des Zielkapitals mit risikotragendem Kapital teilweise befreien, falls:

a. das Versicherungsunternehmen die Tochter eines anderen Versicherungsunternehmen ist;

b. das andere Versicherungsunternehmen für sich ebenfalls das risikotragende Kapital und das Zielkapital berechnet, und diese Berechnung von der Aufsichtsbehörde überprüft werden kann;

c. die Summe der risikotragenden Kapitalien der Tochter und des anderen Versicherungsunternehmens nicht kleiner ist als die Summe der Zielkapitalien der Tochter und des anderen Versicherungsunternehmens;

d. die Tochter vom anderen Versicherungsunternehmen eine Garantie oder eine Rückversicherungsdeckung erhält, deren Höhe mindestens der Differenz des Zielkapitals und des risikotragenden Kapitals der Tochter entspricht;

e. die Garantie oder die Rückversicherungsdeckung rechtlich in der Schweiz durchsetzbar ist und die Tochter oder das andere Versicherungsunternehmen den Nachweis erbringt, dass der allfällige Kapitalfluss der unter Buchstaben b genannten Garantie oder Deckung nicht durch eine Behörde oder Instanz behindert werden kann;

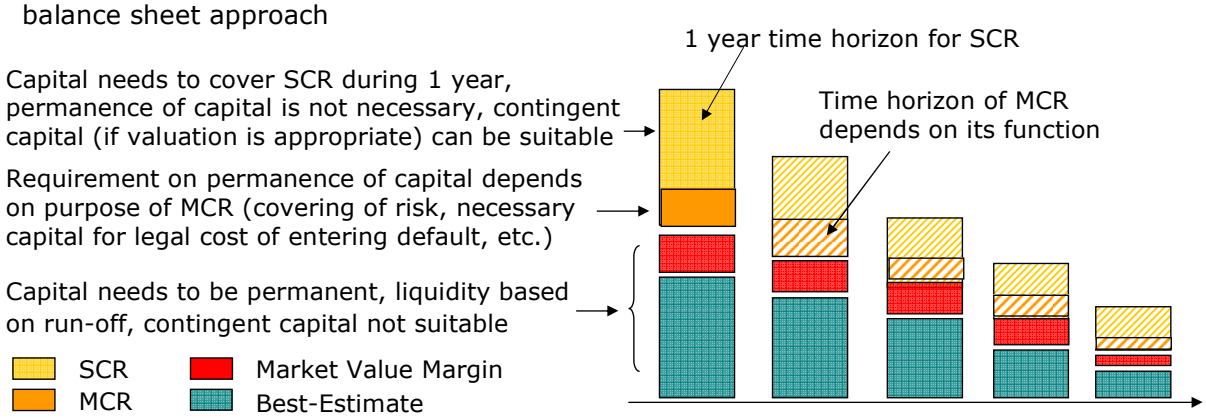
f. triftige ökonomische Gründe für die Nichtbedeckung des Zielkapitals der Tochter vorliegen; und

g. die Interessen der Versicherten gewahrt sind.

Capital

Capital represents the economic resources held or controlled by an insurer after deducting the resources necessary to satisfy its obligations. (IAIS)

- Properties of eligible capital have to be determined based on the purpose capital serves (e.g. covering of risk capital, of provisions etc.): Eligibility of capital for SST will be based on principles
- Requirements on permanence, availability and liquidity of capital should depend on risks covered by capital
- Equity, hybrid capital, contingent capital etc. should not be excluded a priori in a total balance sheet approach



Capital

- Risk and capital management have to be integrated
- Within a risk-based, total balance sheet solvency framework, the distinction between on-balance sheet and off-balance sheet items is largely artificial
- Contingent capital solutions have to be captured by the solvency framework
- Limits on use of different forms of capital have to be based on sound economic reasons
- Tier 1/Tier 2 approach and limits can lead to distortions away from optimal capital structure
- Within the SST, it will be imperative that properties of different forms of capital are appropriately treated both quantitatively (e.g. by quantifying relevant risks, availability in case of financial distress etc.) and qualitatively (e.g. by having adequate capital management strategy)

Notation

A(0)	market value of assets at t=0
UPR	unearned premium reserve (at t=0)
P	estimate for premiums earned during year
K	estimate for costs during year
R_I	Asset returns during year (r.v.)
$D_{CY}^{(1)}$	discount factor at t=1 for the CY claims (r.v)
$r_1^{(0)}$	risk free interest for one year duration at t=0
S_{CY}	claims during year (Current Year), r.v.
$D_{PY}^{(1)}$	discount factor for PY-claims at t=1, r.v.
$d_{PY}^{(0)}$	discount factor at t=0
$R_{PY}^{(0)}$	best estimate of PY liabilities at t=0
$C_{PY} * R_{PY}^{(0)}$	re-evaluation of $R_{PY}^{(0)}$ at t=1 (r.v.),
	($(1 - C_{PY}) * R_{PY}^{(0)}$ = run-off result)