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Autorité fédérale de surveillance des marchés financiers FINMA
Autorità federale di vigilanza sui mercati finanziari FINMA
Swiss Financial Market Supervisory Authority FINMA

Standard Model Insurance

Technical description of the SST standard model captives

31 october 2020

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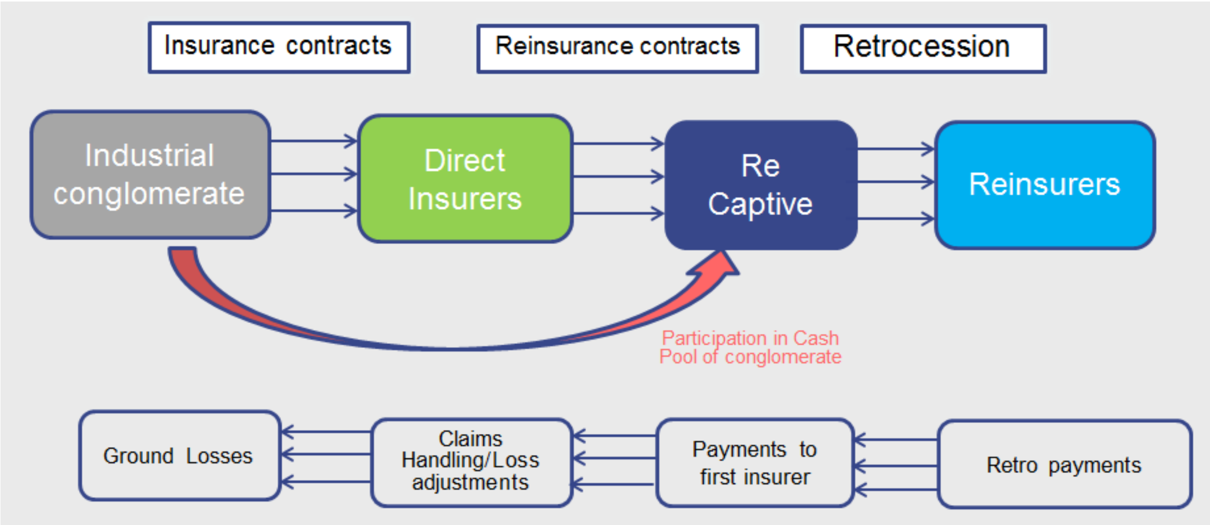
Contents

1 Aim

This technical description defines the standard model for reinsurance captives (in the sequel: *captive model*) according to article 50b ISO (*AVO/OS*) and is intended for reinsurance captives (in the sequel: *captives*) subject to the Swiss solvency test (SST). Any changes other than typos relative to the technical description of the SST standard model captives as of 31 October 2019 are in dark blue.

The following figure illustrates the various companies involved in a reinsurance captive agreement and shows the place of a reinsurance captive legal entity. A reinsurance captive (i.e. with C3 licence) reinsures only the business originating from its parent company via fronting carriers.



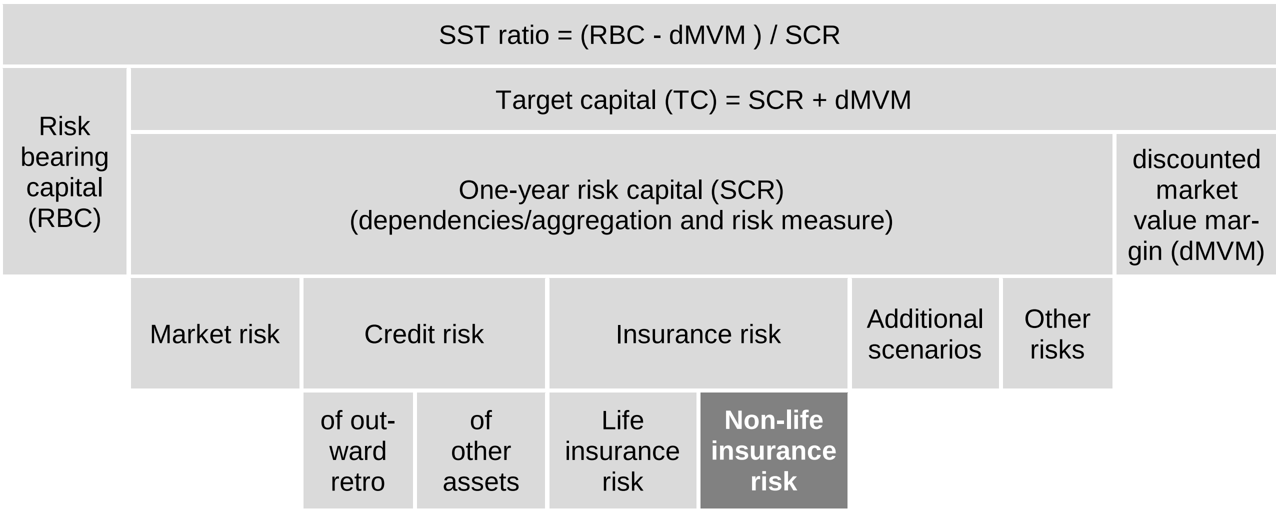
From a risk perspective, common reinsurance captives differ from standard reinsurance companies as follows:

- Reinsurance contracts are usually known by the reinsurance captive at the beginning of the year.
- There is a strong connection between the reinsurance captive and its parent (industrial conglomerate); detailed information about the ground losses are available to the reinsurance captive.
- For a reinsurance captive participation in a cash pool is likely.

Owing to the special risk situation of reinsurance captives and their parent companies, which are the only insured parties, the captive model is kept simple. In case the captive model is not sufficient to capture the risk situation adjustments to the model or other alternatives have to be considered. For example, the aggregation of own scenarios would be one possibility. Another possibility would be the application of another standard model, in particular StandRe. Note that model choice or changes to the model are subject to FINMA agreement before use, see art. 50*d* para. 1 ISO (*AVO/OS*). In particular, this may result in a company-specific adjustment to the captive model (cf. margin nos 107-109 FINMA Circ. 17/3 "SST").

2 Scope

The captive model covers the non-life insurance risk of captives, which is illustrated by the dark grey box in a typical SST model, see figure below. For the modules for market risk, credit risk and aggregation please refer to the dedicated technical documentations on the SST page of the FINMA website[1].



This technical description provides

- the description of the captive model;
- guidance on the positions of the SST balance sheet related to the inward reinsurance and outward retrocession business of the captive;
- formulas for calculating the discounted market value margin;
- guidance on input coming from the captive model for the other modules, e.g. interest risk on the insurance liability cash flows and spread risks in the market risk model due to reinsurance and retrocession agreements.

3 Captives insurance business

Insurance business means here inward reinsurance and outward retrocession of a captive. This section explains in which positions this is reflected in the SST balance sheet. A glossary for items related to captive business is provided. Moreover, a reporting requirement of the portfolio into a standardised segmentation is defined that is independent of the risk model.

[1] These can be downloaded at www.finma.ch > Supervision > Insurers > Cross-sectoral tools > Swiss Solvency Test (SST)

3.1 SST balance sheet

The following indicates in which positions insurance business of a captive has to be reported in the SST balance sheet. See margin nos 18 to 21 of FINMA Circ. 17/3 "SST" for the scope of the SST balance sheet.

Name	Number in SST balance sheet	Position number (Kontenplan)	Description in the SST balance sheet of the corresponding position	Explanation
Assets				
Retro receivables	115)	110200100XXX	Forderungen gegenüber Versicherungsgesellschaften: abgegebene	Receivables from retrocessionaires for retrocession claims payments for already paid reinsurance claims
Retro recoverables	101)	106203000BE	Aktive Rückversicherung: Schadenversicherungsgeschäft	Receivables from retrocessionaires for retrocession claims payments for not yet paid reinsurance claims
Reinsurance premium receivables	116)	110200200XXX	Forderungen gegenüber Versicherungsgesellschaften: übernommene	Receivables from cedants (or intermediaries) for reinsurance premium payments
Reinsurance deposits	88)	104000000MCV	1.4 Depotforderungen aus übernommener Rückversicherung	Receivables from cedants (or intermediaries) for reinsurance premium deposits

Liabilities				
Reinsurance reserves	150)	201203000BE	Aktive Rückversicherung: Schadenversicherungsgeschäft	Obligations towards cedants for inward reinsurance claims payments (gross)
Retro premium liabilities	185)	Diverse Konti	Sonstige Verbindlichkeiten aus dem Versicherungsgeschäft	Obligations towards retrocessionaires for retrocession premium payments
Retro deposit liabilities	182)	206000000MCV	2.6 Depotverbindlichkeiten aus abgegebener Rückversicherung	Obligations towards retrocessionaires for retrocession premium deposits

3.2 Glossary

We define the following terms for the insurance business of a captive in alphabetical order:

- **Accident year (occurrence year)**: losses occurring (and premiums earned) in the corresponding calendar year. This is (only) from inward reinsurance contracts that are in force for some period in the calendar year and may include contracts on risks attaching basis and on losses occurring basis.
  - **Current accident year (CY)** refers to the period from t_0 to t_1
  - **Prior accident years (PY)** refers to the period before t_0
- **Earned business**: existing business with losses having occurred in the prior accident years
- **Existing business**: business incepted until t_0
- **Gross loss**: losses ceded to captive gross of outward retrocession
- **Inception/incepting:** refers to the coverage period in the sense of margin no 20 of FINMA Circ. 17/3 "SST"
- **Inward reinsurance**: refers to all assumed inward business of a captive. In the SST balance sheet it is denoted by the term active reinsurance.
- **LOB**: line of business
- **Material/materiality**: as defined in the FINMA circular 2017/3 "SST", margin nos. 15 and 16
- **Net loss**: losses ceded to captive net of outward retrocession
- **New business**: business incepting between t_0 and t_1
- **Outstanding losses**: includes all outstanding loss payments, regardless of whether they are reported or not ("ultimate view"). Includes in particular case reserves, ACR (additional case reserves), IBNyR (incurred but not yet reported), IBNER (incurred but not enough reported) and the corresponding claims adjustment expenses (ULAE and ALAE).

- **Outward retrocession**: this terms is used to refer to all outward reinsurance protection of a captive (i.e. retrocession)
- **SST currency**: as defined in the FINMA circular 2017/3 "SST", margin nos. 25 to 27. (In order to use a currency other than the provided default SST currencies, the captive must apply for a company-specific adjustment according to margin nos 107-109 of FINMA Circ. 17/3 "SST".)
- t_0 (or $t = 0$): reference date of the SST calculation
- t_1 (or $t = 1$): end of the one-year period starting from the reference date
- **Underwriting year**: losses arising (and premiums) from any inward reinsurance contract written (i.e. incepting) in the corresponding one year period. This may include contracts on risks attaching basis and on losses occurring basis. (Note that the SST balance sheet and the modelling are supposed to be in line with margin no 20 of FINMA Circ. 17/3 "SST".)
- **Unearned business**: existing business with losses occurring in the current or future accident years
- **Ultimate losses (at time t)**: sum of cumulated paid at time t and outstanding losses
    - **Best estimate of ultimate losses (at time t)**: sum of cumulated paid at time t and best estimate of outstanding losses conditional the available information at time t
    - **Final ultimate losses** (at time t): cumulated paid losses at time t when the best estimate of outstanding losses conditional the available information at time t equals 0, i.e. settled losses

3.3 Reserves and premiums reporting requirement

Net reserves (reinsurance reserves minus retro recoverables) at t_0 and net expected premiums have to be reported in the prescribed reporting segmentation, possibly through appropriate proxies, as published in the SST-Captives-Template[2]. Note that here the reporting of undiscounted values is requested.

4 The one-year change in risk-bearing capital

4.1 Introduction to cash flows and best estimates

4.1.1 Discounting

The SST reference time for discounting is t_0, the start of the current year. The risk-free yield curve specified by FINMA for SST currency (see margin no 46 of Circ. FINMA Circ. 17/3 "SST") is denoted by $\{r_k\}_{k\geq 1}$. For instance, r_2 denotes the annual risk free interest rate for maturity at time t_2 starting

[2] This is exacly the "RE_reserves_and_premiums" sheet in the SST-StandRe-Template, and corresponding detailed explanations can be found in the technical description for the SST standard model reinsurance (StandRe), Section 3. The prescribed reporting segmentation defines LOBs, geographical regions and types of contracts.

from time t_0 and indicates a two-year term. Accordingly, the corresponding discount factors from t_k to t_0 are written

$$\nu_0 := 1,\ \nu_1 = \frac{1}{1+r_1}\ ,\nu_2 = \frac{1}{(1+r_2)^2}\ ,\dots,\nu_k = \frac{1}{(1+r_k)^k}\ ,\dots$$

Further, we extend the notation of interest rates by writing $R_{j,s}$ for $0 \le j < s$: it means maturity at time t_s starting from time t_j , a term of $k = s - j$ years. Capital letters emphasise the stochasticity viewed from t_0 for $j > 0$ and for instance $R_{1,3}$ denotes the two-year term risk free interest rate starting from t_1 until maturity t_3. For $j = 0,\ k = s$ and $R_{0,k} = r_k$ is deterministic.

We assume (as simplifying independence assumption on interest rates) the following relations:

$$E\big((1+R_{1,k+1})^k\big) = \frac{(1+r_{k+1})^{k+1}}{1+r_1}$$

Writing and assuming $\nu_{1,k+1} = 1/E\big((1+R_{1,k+1})^k\big) \approx E\big(1/(1+R_{1,k+1})^k\big)$ for the expected discount factors from time t_{k+1} to time t_1, it follows that:

$$\nu_{1,2} = \frac{\nu_2}{\nu_1}\ ,\nu_{1,3} = \frac{\nu_3}{\nu_1}\ ,\dots\nu_{1,k+1} = \frac{\nu_{k+1}}{\nu_1},\dots$$

The above can for example be used for discounting of a cash flow $CF^{(t_1)} = \{CF_2, CF_3, \dots\}$ outstanding at time t_1 (we will show two cases: discounting to t_1 and discounting to t_0). In this notation the superscript (t_1) indicates that future cash flows after t_1 are considered. The sequence begins with CF_2 which represents the sum of all cash-inflows and cash-outflows between t_1 and t_2. It is assumed as a simplification that cash-inflows and cash-outflows are concentrated at the end of the respective time interval.

Assuming deterministic discounting, the value of this total cash flow discounted to time t_1 is given by:

$$\nu_{1,2}\cdot CF_2 + \nu_{1,3}\cdot CF_3 + \cdots = \sum\nolimits_{k\ge 1} \frac{\nu_{k+1}}{\nu_1}\cdot CF_{k+1}$$

and the same total cash flow discounted to time t_0 is given by

$$\nu_2\cdot CF_2 + \nu_3\cdot CF_3 + \cdots = \sum\nolimits_{k\ge 1} \nu_{k+1}\cdot CF_{k+1}$$

4.1.2 Best estimate of a cash flow

We denote with $CF^{(u)} = \{CF_{u+1}, CF_{u+2}, \dots\}$ an undiscounted cash flow outstanding at time $u \ge 0$ (by convention $u = 0$ meaning t_0, $u = 1$ meaning t_1, etc.). For a given time $t \ge 0$, we define $\nu_{t,s} = \frac{\nu_s}{\nu_t}$ for $s \ge 0$ as the discount factor from time s to time t and write $\mathcal{F}_t$ for the information known until time t.

We denote by

$$BE_t^{(u)} = BE_t\big(CF^{(u)}\big)$$

the discounted best estimate at time t of an underlying cash flow CF outstanding at time u, defined by:

$$
\begin{aligned}
BE_t^{(u)} &= \nu_t \cdot E\left(\sum_{k\geq 1+u-t} \nu_{t,t+k} \cdot CF_{t+k} \middle| \mathcal{F}_t \right) = E\left(\sum_{k\geq 1+u-t} \nu_{t+k} \cdot CF_{t+k} \middle| \mathcal{F}_t \right) \\
&= E\left(\sum_{j\geq 1+u} \nu_j \cdot CF_j \middle| \mathcal{F}_t \right)
\end{aligned}
$$

Note that we use discounting to time t_0 in our definition, see factor ν_t at the first equality above.If $u = t$ and the underlying cash flow is for business in scope of the balance sheet at time t, this provides as a special case of the above the classical best estimate reserves in the SST balance sheet at time t:

$$
BE_t^{(t)} = E\left(\sum_{k\geq 1} \nu_{t+k} \cdot CF_{t+k} \middle| \mathcal{F}_t \right) = E\left(\sum_{j\geq t+1} \nu_j \cdot CF_j \middle| \mathcal{F}_t \right)
$$

and if $u < t$, one has a decomposition into cash flows between u and t and the corresponding reserves in the SST balance sheet at time t:

$$
BE_t^{(u)} = \sum_{j=u+1}^{t} \nu_j \cdot CF_j + BE_t^{(t)}
$$

If the undiscounted cash flow $CF^{(u)} = \{CF_{u+1}, CF_{u+2}, \dots\}$ is further decomposed into N_L segments by using the superscript ℓ for a segment (a segment is e.g. a LOB), i.e. $CF^{\ell,(u)} = \{CF_{u+1}^{\ell}, CF^{\ell}{}_{u+2}, \dots\}$ for $\ell = 1, \dots, N_L$ and $CF_{u+k} = \sum_{\ell=1}^{N_L} CF_{u+k}^{\ell}$ for $k \geq 1$, then the corresponding discounted best estimates add:

$$
BE_t^{(u)} = \sum_{\ell=1}^{N_L} BE_t^{\ell,(u)}
$$

and for each ℓ it would be preferable to use discount factors of the currency underlying the segment ℓ, which can possibly differ from the SST currency.

Where an undiscounted best estimate is needed, we use the notation (N) for "nominal" in superscript $BE_t^{(N),(u)} = BE_t^{(N)}\left(CF^{(u)}\right)$ and this is defined by setting all ν_js to one in the above formulas.

The risk resulting from the stochasticity of the interest risks is modelled in the market risk module of the SST, see also section 9 in this document. Within the insurance risk we assume deterministic discounting, i.e. we consider expected cash flow patterns and expected yield curves as basis for the discount factors. The interest rate risk is solely considered in the market risk module.

Unless otherwise stated, in the following sections amounts are deterministically discounted to time t_0 (the reference date of the SST calculation) and expressed in SST currency.

4.2 One-year change in scope

The captive model quantifies the one-year change (from time t_0 to t_1) in the risk-bearing capital related to non-life insurance risk.

Remark: In line with margin no. 60 of FINMA Circ. 17/3 "SST", the one-year risk capital for the SST is given by the **negative** of the Expected Shortfall ES_α, where the Expected Shortfall corresponds in the continuous case to the mean of the α lowest outcomes, with $\alpha \ll 1$. In this representation, losses are negative numbers. For the parts of the captive model where losses S are represented as positive numbers, we define the right-hand expected shortfall as $ES^{1-\alpha}(S) \coloneqq -ES_\alpha(-S)$. The following properties hold:

i. If $S \leq T,\ ES^{1-\alpha}(T) \geq\ ES^{1-\alpha}(S)$;

ii. $ES^{1-\alpha}(S+T) \leq\ ES^{1-\alpha}(S) +\ ES^{1-\alpha}(T)$;

iii. $ES^{1-\alpha}(a \cdot S) = a \cdot\ ES^{1-\alpha}(S)$ if $a > 0$; and

iv. $ES^{1-\alpha}(S+a) =\ ES^{1-\alpha}(S) - a$.

The scope of the one-year risk capital for insurance risk consists of all insurance business related cash flows outstanding at time t_0 for the business assumed by the captive which incept until time t_1. The cash flow consists in all relevant premiums, losses and expenses net of outward retrocession and inception is meant according to margin no 20 of the FINMA Circ. 17/3 "SST".

We use the notation " $\rightarrow t_0$ " for the business incepted until time t_0 and " $\rightarrow t_1$ " for the business incepted until time t_1 .

Writing $BE_t^{\rightarrow s,(u)} = BE_t\left(CF^{\rightarrow s,(u)}\right)$ for the discounted best estimate at time t of an underlying cash flow CF outstanding at time u for the business incepted until time s, the one-year change in the risk-bearing capital related to non-life insurance risk is expressed as:

$$BE_{t_1}^{\rightarrow t_1,(t_0)} - BE_{t_0}^{\rightarrow t_o,(t_0)} = BE_{t_1}^{\rightarrow t_1} - BE_{t_0}^{\rightarrow t_0}$$

omitting $(u) = (t_0)$ in the notation on the right-hand side of the equation.

Remark: Using $BE_{t_1}^{\rightarrow t_1,(t_0)} = v_1 \cdot CF_{t_1}^{\rightarrow t_1} + BE_{t_1}^{\rightarrow t_1,(t_1)}$ it can be shown that this change corresponds to the one year change in risk bearing capital due to insurance risk: see formulas (5), (16), (17) and (18) of the technical description for the SST standard model non-life insurance.

Writing further " $t_0 \rightarrow t_1$ " for the business incepted between t_0 and t_1 (referred to also as new business), the above one-year change can be decomposed into a term that represents the one-year change in best estimate for the same cash flows and the same business incepted until t_1 (whence, by definition of best estimate, with mean zero i.e. centered), and another term that represents the expected non-life insurance result of the new business, as follows:

$$BE_{t_1}^{\rightarrow t_1} - BE_{t_0}^{\rightarrow t_0} =\ BE_{t_1}^{\rightarrow t_1} + BE_{t_0}^{t_0 \rightarrow t_1} - BE_{t_0}^{t_0 \rightarrow t_1} - BE_{t_0}^{\rightarrow t_0} = \left(BE_{t_1}^{\rightarrow t_1} - BE_{t_0}^{\rightarrow t_1}\right) + BE_{t_0}^{t_0 \rightarrow t_1}$$

where we define the term $BE_{t_0}^{t_0 \rightarrow t_1}$ as

- expected non-life insurance result = net expected premiums minus net expected discounted losses minus expected expenses of the new business typically computed by plan figures (cf. margin no. 34 of FINMA Circ. 17/3 "SST").

The captive model assumes that premiums and operating expenses are deterministic or can be modeled deterministically. Loss dependent expenses (e.g. ALAE, ULAE, sliding scale commissions, etc.) should be modelled within the losses. Thus, the remaining of the captive model provides a distribution for $Z^{NL\text{-}insurance\text{-}risk}$ defined as

- *centered non-life insurance risk*[3] equals the one-year change of best estimate from cash flow arising only from losses equals $BE_{t_1}^{\to t_1} - BE_{t_0}^{\to t_1}$.

The distribution reflects events occurring during the current one-year period, i.e. between t_0 and t_1. The distribution models new claims but also takes any new information like court decisions, which can have an impact on the business in scope, into account.

Unless otherwise stated, distributions and expectations are meant to be related to the information available at time t_0.

Note that the word "risk" refers to different objects according to the context: a random variable; the corresponding distribution; the corresponding stand-alone capital requirement from the expected shortfall at the prescribed confidence level $1 - \alpha$.

5 Reserve risk and premium risk

The captive model provides separate distributions for reserve risk and premium risk and gives assumptions for their aggregation.

More precisely, we first introduce a partition of the business in scope, i.e. incepted until t_1. Then we explain how this is related to the one year change $Z^{NL\text{-}insurance\text{-}risk}$. In this way we introduce proper definitions of reserve risk and of premium risk, respectively. The latter is again split into CY risk and URR risk.

5.1 Partition of the business

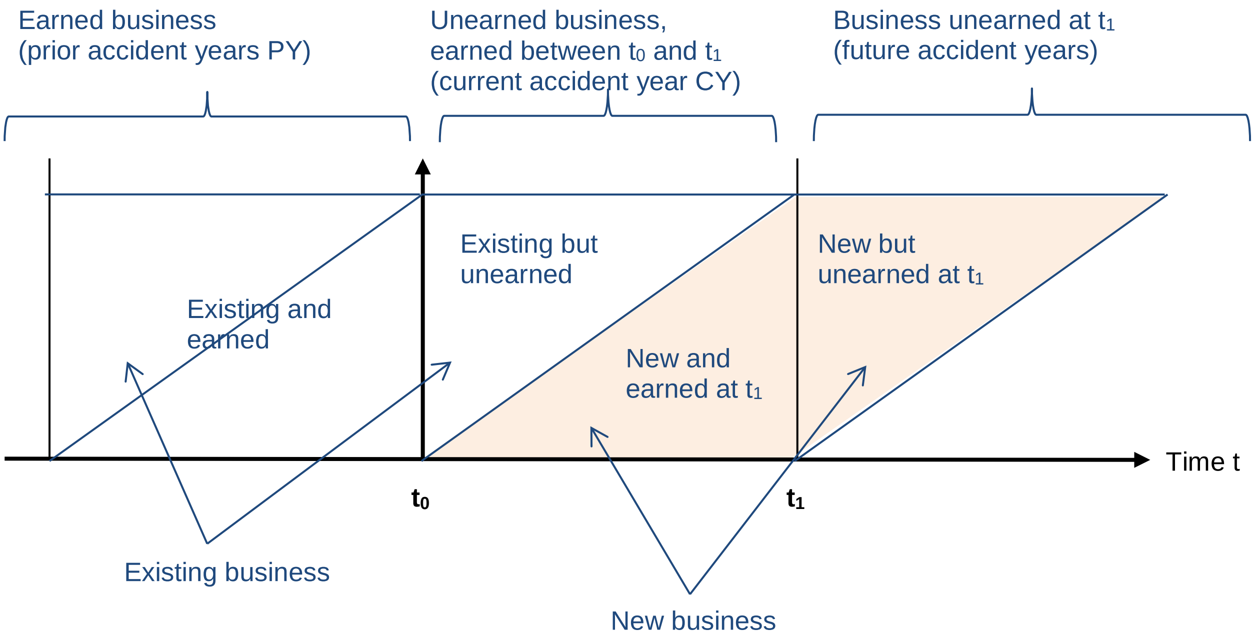
The partition of the *business incepted until* t_1 in five sets denoted $\{"ex\text{-}e"; "ex\text{-}u\text{-}e_1"; "ex\text{-}u_1"; "new\text{-}e_1"; "new\text{-}u_1"\}$ is as follows:

- *existing, earned* ***(ex-e)***: business incepted until t_0 and earned at time t_0;
- *existing, unearned* ***(ex-u)***: business incepted until t_0 and unearned at time t_0. This will be earned at a latter time and thus can be further split into an earned at t_1 and unearned at t_1 parts:
    - o *existing, unearned, earned*(t_1) ***(ex-u-e₁)***; and

[3] The word "risk" designs by abuse different objects according to the context: a random variable, the corresponding distribution, the corresponding stand-alone capital requirement from the expected shortfall at the prescribed confidence level $1 - \alpha$.

- o *existing, unearned, unearned(t_1) = existing, unearned(t_1)* ***(ex-u1)***
- *new :* business incepted between t_0 and t_1. Can be further split into:
  - o *new, earned(t_1)* ***(new-e1)***; and
  - o *new, unearned(t_1)* ***(new-u1)***.

This is illustred for typical one-year contracts in the following representation:



5.2 Definition of reserve risk and premium risk

From the partition above, by linearity of expectations and assuming implicitly linear and unbiased related estimators, the following decomposition of the one-year change holds:

$$Z^{NL\text{-}insurance\text{-}risk} = BE_{t_1}^{\to t_1} - BE_{t_0}^{\to t_1} = \left(BE_{t_1}^{ex-e} - BE_{t_0}^{ex-e}\right) + \left(BE_{t_1}^{ex-u-e_1} - BE_{t_0}^{ex-u-e_1}\right) + \left(BE_{t_1}^{new-e_1} - BE_{t_0}^{new-e_1}\right) + \left(BE_{t_1}^{ex-u_1} - BE_{t_0}^{ex-u_1}\right) + \left(BE_{t_1}^{new-u_1} - BE_{t_0}^{new-u_1}\right)$$

From this, we define

- $Z^{reserve\text{-}risk} = \left(BE_{t_1}^{ex-e} - BE_{t_0}^{ex-e}\right)$, the reserve risk (also named PY risk); and
- $Z^{premium\text{-}risk} = Z^{CY\text{-}risk} + Z^{URR\text{-}risk}$, the premium risk, where
  - o $Z^{CY\text{-}risk} = \left(BE_{t_1}^{ex-u-e_1} - BE_{t_0}^{ex-u-e_1}\right) + \left(BE_{t_1}^{new-e_1} - BE_{t_0}^{new-e_1}\right)$ defines the CY risk, and
  - o $Z^{URR\text{-}risk} = \left(BE_{t_1}^{ex-u_1} - BE_{t_0}^{ex-u_1}\right) + \left(BE_{t_1}^{new-u_1} - BE_{t_0}^{new-u_1}\right)$ defines the URR risk

PY stands for *previous year*, CY for *current year* and URR for *unexpired risk reserve*.

Remark 1: $E\left(BE_{t_1}^{\to t_1}\right) = BE_{t_0}^{\to t_1}$ and the same holds for e.g. $E\left(BE_{t_1}^{ex-e}\right) = BE_{t_0}^{ex-e}$.

Remark 2: The decomposition above plus the expected non-life insurance result is the formula (21) of the technical description for the SST standard model non-life insurance.The following table provides the correspondance:

Above formula of technical description for the SST standard model captives (this document)	Formula (21) of technical description for the SST standard model non-life insurance
expected non-life insurance result term excluded	expected non-life insurance result term included
deterministic discounting	stochastic discounting
implicit discount factors (representation of discounted amounts)	discount factors shown explicitly and representation of undiscounted amounts
symbols for cash flows ourstanding at t_0	where applicable, decomposition into cash-in and cash-out between t_0 and t_1 and cash flows outstandings at t_1
$ex\text{-}e$	PY, t_0
$ex\text{-}u\text{-}e_1$	$CY, Bestand$
$new\text{-}e_1$	CY, Neu
$ex\text{-}u_1$	URR, t_0
$new\text{-}u_1$	URR, Neu

6 Reserve risk model

The reserve risk model provides a distribution for X^{PY} defined by $X^{PY} = -Z^{reserve\text{-}risk}$, i.e. we work in this section with loss variables.

By default net values are used, but the captive can choose gross values whenever conservative.

The captive defines an appropriate set of LOBs regarding its written business, the previous years' LOBs or shortened PY-LOBs, providing the decomposition $X^{PY} = \sum_{\ell \in PY\text{-}LOB} X_\ell^{PY}$. The captive model assumes comonotonicity between PY-LOBs. This implies

$$-ES_\alpha(-X^{PY}) = \sum_{\ell \in PY\text{-}LOB} -ES_\alpha(-X_\ell^{PY})$$

Writing $X_\ell^{PY} = BE_{t_1}(Y_\ell^{PY,t_0}) - BE_{t_0}(Y_\ell^{PY,t_0})$ with Y_ℓ^{PY,t_0} denoting outstanding losses (as positive values) at time t_0 for business incepted the previous years of PY-LOB ℓ and earned until t_0, the captive model assumes that $BE_{t_1}(Y_\ell^{PY,t_0})$ of the given PY-LOB ℓ is modelled by a log-normal distribution.

The log-normal distribution has the following properties: Assume Y is a lognormal distributed random variable with parameters μ_{lnorm} and σ_{lnorm}, i.e. $\left(\log(Y) - \mu_{lnorm}\right)/\sigma_{lnorm}$ is standard normal distributed. Writing μ_Y, σ_Y and $CV_Y = \sigma_Y/\mu_Y$ for mean, standard deviation and coefficient of variation of Y, respectively, the parameters of the lognormal distribution are given by $\mu_{lnorm} = \log(\mu_Y) - 0.5 \cdot \sigma_{lnorm}^2$ and $\sigma_{lnorm} = \sqrt{\log(1 + CV_Y^2)}$. Moreover, if $Y' = d \cdot Y$ with $d > 0$, then Y' is lognormally distributed with parameters $\mu'_{lnorm} = \mu_{lnorm} + \log(d)$ and $\sigma'_{lnorm} = \sigma_{lnorm}$. This property is used for discounting, where $d > 0$ is a deterministic discount factor.

It follows that the distribution of $BE_{t_1}(Y_\ell^{PY,t_0})$ is specified by its mean, given by $BE_{t_0}(Y_\ell^{PY,t_0})$, and by its standard deviation or equivalently its coefficient of variation, CV_ℓ. For estimating the latter, two approaches are available in the captive model (the second being referred as the *simplified* PY risk approach):

- The CV_ℓ is estimated by the captive and the calculation has to be explained. An additional model uncertainty of 5% has to be used, i.e. $CV_\ell = \sqrt{(CV_{estimated})^2 + 0.05^2}$. The CV_ℓ is estimated on basis of non discounted figures. The possibilities offered by the reserve risk tool of StandRe, see "Reserve risk tool" folder of StandRe where the related documentation is provided, can be used as a benchmark or for a selected method, if appropriate.
- The default value for CV_ℓ is set to 10%. (This approximately corresponds to $-ES_\alpha(-X^{PY}) \approx 0.3 \cdot R$ where R is the discounted reserves at t_0.)

Discounting in the PY-LOB ℓ, typically to compute the discounted value $BE_{t_0}(Y_\ell^{PY,t_0})$ from its non discounted value, is performed by the deterministic discount factor

$$d_\ell^{PY} = \sum_{k \geq 1} v_k \cdot \pi_k^{PY,\ell}$$

where $\pi_1^{PY,\ell}, \pi_2^{PY,\ell}, \ldots$ is an expected incremental payment pattern ($\sum_{k\geq 1} \pi_k^{PY,\ell} = 1$) provided by the captive. Payments are expected to be in the underlying currency of the LOB that might be different than the SST currency; for the mapping FX currencies into the set of currencies CHF, EUR, USD and GPD, please refer to the *Mappingregeln* of the *Technische Beschreibung Maktrisiko*. Accordingly, discount factors v_k should be those of this LOB currency. However, discount factors corresponding to the SST currency can be used if this simplification is not material.

7 Premium risk model

In principle the captive model neglects the URR risk as simplifying assumption, i.e. $Z^{URR\text{-}risk} = 0$ (see also section 7.3). Thus, the premium risk model provides a distribution for X^{CY} defined by $X^{CY} = -Z^{CY\text{-}risk}$, i.e. we work in this section with loss variables for the current year risk.

The captive defines an appropriate set of LOBs regarding its unearned business, the current year LOBs or shortened CY-LOBs, providing the decomposition $X^{CY} = \sum_{\ell \in CY\text{-}LOB} X_\ell^{CY}$. The CY-LOBs may differ from the PY-LOBs if necessary. The captive model assumes independence between CY-LOBs.

We write $X_\ell^{CY} = BE_{t_1}\left(Y_\ell^{CY,t_0}\right) - BE_{t_0}\left(Y_\ell^{CY,t_0}\right)$ with $Y_\ell^{CY,t_0} = Y_\ell^{CY}$ denoting outgoing cash flows (as positive values) outstanding at time t_0 , for business earned between t_0 and t_1, from unearned existing business and new business, in the LOB ℓ. For CY, the captive model assumes modelling of ultimate instead of best estimate at time t_1 , that is $X_\ell^{CY} \approx Y_\ell^{CY} - BE_{t_0}\left(Y_\ell^{CY}\right) = d_\ell^{CY} \cdot \left(\tilde{Y}_\ell^{CY} - BE_{t_0}\left(\tilde{Y}_\ell^{CY}\right)\right)$ where tilde denotes an undiscounted net value and the discount factor d_ℓ^{CY} is defined as d_ℓ^{PY} but with the corresponding payment pattern for new losses. For CY risk two approaches are available in the captive model (the second being referred as the *simplified* CY risk approach):

- ground up modelling based on ground up losses of the parent company, for deriving the distribution of $\tilde{Y}_\ell^{CY}$ (see section 7.1); or
- conservative maximal possible loss (MPL) modelling (see section 7.2).

7.1 Ground up modelling

Here the CY insurance risk X_ℓ^{CY} of a CY-LOB ℓ is modelled based on the ground-up losses of the parentcompany.

The ground-up losses consist of attritional losses or large losses, both modelled by a frequency-severity approach:

- attritional losses are assumed to have a Poisson-distributed frequency N^a and a Gamma-distributed undiscounted severity Y^a;
- large losses are assumed to have a Poisson-distributed frequency N^l and a Pareto-distributed undiscounted severity Y^l;
- all random variables N^a, Y_1^a, Y_2^a, ..., N^l, Y_1^l, Y_2^l, ... are independent.

The undiscounted net losses $\tilde{Y}^{CY}$ of the reinsurance captive are obtained by applying the reinsurance and retrocession structures to the ground-up losses using simulations. These structures can be modelled by an aggregation function $f: \mathbb{R}^{\mathbb{N}} \rightarrow \mathbb{R}$ with

$$\tilde{Y}^{CY} = f(N^a, Y_1^a, Y_2^a, \dots, N^l, Y_1^l, Y_2^l, \dots).$$

A non-exhaustive list of examples for aggregation functions is given below:

Name	Aggregate loss to the captive
Annual aggregate limit (AAL)	$\min\left(\sum_{i=1}^{N^a} Y_i^a + \sum_{i=1}^{N^l} Y_i^l, AAL\right)$
Each and every loss limit (EEL)	$\sum_{i=1}^{N^a} \min(Y_i^a, EEL) + \sum_{i=1}^{N^l} \min(Y_i^l, EEL)$
Annual aggregate deductible (AAD)	$\max\left(\sum_{i=1}^{N^a} Y_i^a + \sum_{i=1}^{N^l} Y_i^l - AAD, 0\right)$
Each and every loss deductible (EED)	$\sum_{i=1}^{N^a} \max(Y_i^a - EED, 0) + \sum_{i=1}^{N^l} \max(Y_i^l - EED, 0)$
Quota share $\rho \in (0,1)$	$\rho \cdot \left(\sum_{i=1}^{N^a} Y_i^a + \sum_{i=1}^{N^l} Y_i^l\right)$

The above examples are valid for plain traditional reinsurance structures without loss sensitive features. Loss sensitive conditions in reinsurance structures, like paid reinstatements, swing rates or sliding scale conditions, loss corridors or multi-year-structures with material impact on recoveries need also to be taken into account.

The corresponding ground up parameters have to be estimated:

- the frequency $E(N^a)$ of attritional losses which can be estimated by the average number of historical attritional losses frequencies. The same applies mutatis mutandis to the large losses frequency $E(N^l)$. Expected changes in the frequency due to risk of change (e.g. law changes, behaviour changes, etc.) need to be taken into account.
- the expected attritional losses severity $E(Y_i^a)$ which can be estimated by the average historical normal claims. The corresponding standard deviation $sd(Y_i^a)$ is obtained in a similar way;
- the large loss threshold x_0 and Pareto shape α which can be obtained based on data and using actuarial expert judgement.

Historical data used for the estimation of parameters have to be adjusted such that they are comparable over time. For instance, incurred losses should be adjusted according to the corresponding inflation.

The remainder deals with situations where the above cannot be directly applied.

Case: Only aggregate data for attritional losses are available

It might be the case that historical attritional losses (paid and incurred) and the number of attritional losses are only available on a yearly aggregate basis. This means that only the historical realisations of the random variables $Y^a = \sum_{i=1}^{N^a} Y_i^a$ and N^a are available. In that case the following procedure has to be applied:

- The expected number of claims $E(N^a)$ together with the mean $E(Y^a)$ and standard deviation $sd(Y^a)$ of the aggregate claim amount can be estimated.
- The mean $E(Y_i^a)$ and the standard deviation $sd(Y_i^a)$ of a single loss are derived by using the following formulas:

$$E(Y^a) = E(N^a) \cdot E(Y_i^a) \quad \text{and} \quad Var(Y^a) = E(N^n) \cdot Var(Y_i^a) + E(Y_i^a)^2 \cdot Var(N^a).$$

Case: Over-dispersion or highly frequent losses

The frequency distribution is assumed to be Poisson. In case of over-dispersion (i.e. $Var(N) > E(N)$ which is usually the case if the number of losses is large) this assumption may be violated and the frequency has to be modelled by a negative binomial distribution instead of a Poisson distribution. In this case, the variance $Var(N^a)$ or $Var(N^l)$ needs to be estimated, too.

If there are several portfolios with a high number of losses, dependencies between the portfolios may be important and can no longer be neglected. In this case a company specific adjustment should be considered.

7.2 Maximal possible loss modelling

For a given CY-LOB ℓ with a maximal possible loss M, it is assumed that the loss amount M is almost surely reached. As a simplification, no discounting effect is taken into account.

The centred insurance risk is given by the maximum possible net loss M minus the expected net loss L of the CY-LOB ℓ:

$$X_\ell^{CY} = M - L.$$

7.3 Multi-year contracts

Although the following description refers to inward reinsurance business, it applies analogously to outward retrocessions. Additionally, it is assumed that the direct insurance contracts covered are on an occurrence basis (i.e. accident-year point of view). Other attachment bases of direct insurance contracts covered can be dealt with analogously.

The captive model assumes that all claims can be modelled ground-up on an accident-year base. Moreover, it is assumed that the coverage period of all contracts (coverage on an accident-year base) coincides with a single calendar year. If this is not the case, the following transformations (or a combination of them) could be applied:

Scaling of the claims frequency: If a contract covers six months only (or two years), it could be modelled as a contract covering one year, but with half (double) of the original claims frequency.

Splitting of contracts: A contract covering two years could be split into two independent contracts of which each concerns only one year. In particular, this method must be used if the premium of the underlying contract is already partly earned (based on an accident-year view).

In general, such scaling or splitting should be risk-based, but in most cases a pro rata temporis approach may be a good approximation.

The two transformations described may not be applicable in case of non-linear contract conditions such as term aggregate limits or deductibles. In such cases, FINMA will accept prudent splits of those conditions. For instance, a term aggregate deductible may be reduced by a prudent estimation of the total incurred loss of all claims already known.

Finally, if contracts are split such that at the end of the CY there is still some unearned and not modelled business left, the simplified approach to the MVM may no longer be appropriate

8 Aggregation into the non-life insurance risk

From previous sections we have derived a model for the distribution of X^{PY} and another for X^{CY}.

The captive model assumes that X^{PY} and X^{CY} are comonotonic, which yields a distribution to the non-life insurance risk

$$Z^{NL\text{-}insurance\text{-}risk} = -X^{PY} - X^{CY} + [\textit{exp. non-life ins. result}]$$

The non-life (stand-alone) one-year risk capital at confidence level $1-\alpha$ is given by

$$-ES_{\alpha}(-Z^{NL\text{-}insurance\text{-}risk}) = ES^{1-\alpha}(X^{PY}) + ES^{1-\alpha}(X^{CY}) - [\textit{exp. non-life ins. result}]$$

In the above formula the expected shortfall ES_{α} is defined as at margin no 58 of FINMA Circ. 17/3 "SST". For a loss variable X we define the *right hand* expected shortfall by

$$ES^{1-\alpha}(X) \coloneqq -ES_{\alpha}(-X) = \frac{1}{\alpha}\int_{1-\alpha}^{1} q_u(X)\, du$$

where $q_u = q_u(X) = \inf\{\, x \mid P[X \le x] \ge u \,\}$ denotes the u-quantile of X. If X is continuous, this is the mean of the α highest outcomes: $ES^{1-\alpha}(X) = E(X|X > q_{1-\alpha})$. This transformation is necessary since variables for losses are usually mirrored to the positive axis and modelled with distributions which are defined on the positive axis only, see also section 4.2.

9 Input from the captive model into other modules

The captive model covers solely the non-life insurance risk of a captive and additionally it provides inputs to other modules. This section describes necessary inputs from insurance business which are required for the calculation of the market risk and which are necessary for the aggregation with the other risk categories, like market risk and credit risk. This section also explains the computation of the market value margin (MVM) from the inputs of the captive model.

9.1 Cash flows from insurance business

Cash flows from insurance business are requested for the market risk model, in particular in relation to FX and spread risk.

The outline is as follows: The positions of the SST balance sheet as described in Section 3.1 are grouped to produce net figures. Payment patterns of the captive model are then used to produce the suitable cash flows. This is the same approach as in StandRe, cf. the detailed explanations given in the technical description for the SST standard model reinsurance (StandRe), Section 8.2.

9.2 Market value margin (MVM)

According to the technical description for the SST standard model aggregation and market value margin, the market value margin discounted to t_0 is defined by

$$v_1 \cdot MVM_{t_1} = CoC \cdot \sum_{k \geq 1} v_{k+1} \cdot SCR_{t_k}$$

where CoC is the cost of capital rate prescribed by FINMA and SCR_{t_k} is the expected one-year risk capital at t_k, i.e. for the period t_k to t_{k+1}.

As a simplifying assumption, the captive model assumes that the non-hedgeable market risk, the credit risk of outward retrocession and possible scenarios are neglected in the calculation of the MVM as explained below. Alternatively the captive can compute its MVM by the method of StandRe and follow the assumptions of that method, see also the technical description for the SST standard model reinsurance (StandRe), Section 8.3.

The following explains the method and assumptions behind the computation of SCR_{t_k} for $k \geq 1$ in the MVM for captives.

For this we define a convenient partition of the cash flows outstanding at time t_k for $k \geq 1$ regarding the business in scope defined at Section 5 as follows:

<table>
<tr><td colspan="5">Partition of business in scope of SST along existing business at t_0 (i.e. incepted until t_0)
and new business between t_0 and t_1</td></tr>
<tr><td colspan="3">regarding time t_0, for one-year risk from t_0 to t_1</td><td colspan="2">regarding time $t_k \geq t_1$, for one-year risk from t_k to t_{k+1}</td></tr>
<tr><td>Reserve risk</td><td>PY</td><td>existing at $t = 0$ and earned at $t = 0$</td><td>existing at $t = 0$ and earned at $t = 0$</td><td rowspan="5">PY_k</td></tr>
<tr><td rowspan="7">Premium risk</td><td rowspan="2">CY</td><td>existing at $t = 0$ and un-earned at $t = 0$ but earned at $t = 1$</td><td>existing at $t = 0$ and unearned at $t = 0$ but earned at $t = 1$</td></tr>
<tr><td>new between $t = 0$ and $t = 1$ and earned at $t = 1$</td><td>new between $t = 0$ and $t = 1$ and earned at $t = 1$</td></tr>
<tr><td rowspan="5">URR</td><td rowspan="5">existing at $t = 0$ and un-earned at $t = 1$

new between $t = 0$ and $t = 1$ and unearned at $t = 1$</td><td>existing at $t = 0$ and unearned at $t = 1$ but earned at $t = k$</td></tr>
<tr><td>new between $t = 0$ and $t = 1$ and un-earned at $t = 1$ but earned at $t = k$</td></tr>
<tr><td>existing at $t = 0$ and unearned at $t = k$ but earned at $t = k + 1$</td><td rowspan="2">CY_k</td></tr>
<tr><td>new between $t = 0$ and $t = 1$ and un-earned at $t = k$ but earned at $t = k + 1$</td></tr>
<tr><td>existing at $t = 0$ and unearned at $t = k + 1$</td><td>URR_k</td></tr>
</table>

As a simplifying assumption, the captive model neglects the hatched boxes of this partition referring to the URR. It means for $k \geq 1$ that $SCR_{t_k} = SCR_{t_k}^{PY_k}$, i.e. the CY_k risk and URR_k risk are neglegted, and that PY_k risk comes only from PY and CY.

Additional simplifying assumptions are $SCR_{t_k} = SCR_{t_k}^{PY} + SCR_{t_k}^{CY}$ (i.e. PY and CY are comonotone), and further partitioning in PY-LOBs and CY-LOBs it is assumed that:

$$SCR_{t_k} = \sum_{\ell \in PY\text{-}LOB} SCR_{t_k}^{PY,\ell} + \sum_{\ell \in CY\text{-}LOB} SCR_{t_k}^{CY,\ell}$$

The following expressions of the expectations by LOB ℓ for cash flows outstanding at t_k are applied later on:

$$E\left(BE_{t_k}^{(N),PY,\ell,(t_k)}\right) = BE_{t_0}^{(N),PY,\ell} \cdot \sum\nolimits_{j \geq k+1} \pi_j^{PY,\ell}, \quad E\left(BE_{t_k}^{PY,\ell,(t_k)}\right) = BE_{t_0}^{(N),PY,\ell} \cdot \sum\nolimits_{j \geq k+1} \nu_j \cdot \pi_j^{PY,\ell}$$

$$E\left(BE_{t_k}^{(N),CY,\ell,(t_k)}\right) = BE_{t_0}^{(N),CY,\ell} \cdot \sum_{j\geq k+1} \pi_j^{CY,\ell}, \quad E\left(BE_{t_k}^{CY,\ell,(t_k)}\right) = BE_{t_0}^{(N),CY,\ell} \cdot \sum_{j\geq k+1} \nu_j \cdot \pi_j^{CY,\ell}$$

$BE_{t_0}^{(N),PY,\ell}$, the best estimate of reserves for PY business at time t_0 and the corresponding incremental expected payment pattern $\pi_j^{PY,\ell}$ are given by the reserve risk model. $BE_{t_0}^{(N),CY,\ell}$, the expected losses for new business in the current year and the corresponding payment pattern $\pi_j^{CY,\ell}$ are given by the premium risk model. Related discount factors to time t_0 are calculated from the inputs as follows $d_\ell^{PY} = \sum_{j\geq 1} \nu_j \cdot \pi_j^{PY,\ell}$ and $d_\ell^{CY} = \sum_{j\geq 1} \nu_j \cdot \pi_j^{CY,\ell}$.

We can now provide a formula computing $SCR_{t_k}^{PY,\ell}$ (and similarly $SCR_{t_k}^{CY,\ell}$) for each PY-LOB ℓ. The captive model assumes:

$$\nu_k \cdot SCR_{t_k}^{PY,\ell} = \delta_k^{PY,\ell} \cdot SCR_*^{PY,\ell}$$

where

$$\delta_k^{PY,\ell} = \frac{E\left(BE_{t_k}^{PY,\ell,(t_k)}\right)}{BE_{t_0}^{PY,\ell}} = \frac{\sum_{j\geq k+1} \nu_j \cdot \pi_j^{PY,\ell}}{\sum_{j\geq 1} \nu_j \cdot \pi_j^{PY,\ell}} = 1 - \frac{\sum_{j=1}^{k} \nu_j \cdot \pi_j^{PY,\ell}}{d_\ell^{PY}}$$

is a run-off factor based on discounted best estimates and $SCR_*^{PY,\ell}$ is an auxiliary one-year risk capital at t_0 as explained further below.

Writing $\mu_\ell^{PY} = BE_{t_0}^{PY,\ell}$ and CV_ℓ^{PY} for the mean and coefficient of variation selected in the PY-LOB ℓ of the reserve risk model, we assume that

$$SCR_*^{PY,\ell} = (f_{1-\alpha}(CV_\ell^{PY}) - 1) \cdot \mu_\ell^{PY} \cdot d_\ell^{PY}$$

where, writing Φ for the cumulative standard normal distribution, the factor $f_{1-\alpha}(CV)$ for the risk measure expected shortfall at confidence level $1-\alpha$ and given a coefficient of variation *CV* is defined by:

$$f_{1-\alpha}(CV) = \frac{1}{\alpha} \cdot \left(1 - \Phi\left(\Phi^{-1}(1-\alpha) - \sqrt{\log(1+CV^2)}\right)\right)$$

Remark: If $X = d \cdot (Y - E(Y))$ with Y lognormally distributed and coefficient of variation CV_Y and with $d > 0$ (here d is a discount factor), the following property holds:

$$ES^{1-\alpha}(X) = d \cdot (f_{1-\alpha}(CV_Y) - 1) \cdot E(Y);$$

for the derivation, see formula (145) of the technical description for the SST standard model non life.

It follows that the formula for the discounted MVM used in the captive model is given by:

$$
\begin{aligned}
\nu_1 \cdot MVM_{t_1} &= CoC \cdot \sum_{k\geq 1} \nu_{k+1} \cdot \left(\sum_{\ell \in PY\text{-}LOB} SCR_{t_k}^{PY,\ell} + \sum_{\ell \in CY\text{-}LOB} SCR_{t_k}^{CY,\ell} \right) \\
&\approx CoC \cdot \sum_{k\geq 1} \left(\sum_{\ell \in PY\text{-}LOB} \nu_k^{Curr_\ell} \cdot SCR_{t_k}^{PY,\ell} + \sum_{\ell \in CY\text{-}LOB} \nu_k^{Curr_\ell} \cdot SCR_{t_k}^{CY,\ell} \right)
\end{aligned}
$$

where for $\ell \in PY\text{-}LOB$

$$
\nu_k^{Curr_\ell} \cdot SCR_{t_k}^{PY,\ell} = \mu_\ell^{PY} \cdot \left(f_{1-\alpha}\left(CV_\ell^{PY}\right) - 1\right) \cdot \sum_{j \geq k+1} \nu_j^{Curr_\ell} \cdot \pi_j^{PY,\ell}
$$

and for $\ell \in CY\text{-}LOB$

$$
\nu_k^{Curr_\ell} \cdot SCR_{t_k}^{CY,\ell} = \mu_\ell^{CY} \cdot \left(f_{1-\alpha}\left(CV_\ell^{CY}\right) - 1\right) \cdot \sum_{j \geq k+1} \nu_j^{Curr_\ell} \cdot \pi_j^{CY,\ell}
$$

The $Curr_\ell$ is the currency of the underlying LOB ℓ and the second line of the formula is implemented in the captive model.

10 IT implementation

10.1 Description of the SST-Captives-Template

The Excel workbook SST-Captives-Template is intended for all parameters and some computations related to the captive model. We explain the purpose and possible special feature of each worksheet in the following.

All values have to be entered in million SST currency throughout the template.

1. *Intro_SM_Captive*

   This sheet states the purpose of the template and contains the change log.

2. *CA_prescribed_parameters*

   This sheet contains the FINMA prescribed parameters like yield curves and FX exchange rates. Parameters related to the 31 December are updated in January: please check that you are using the updated parameters. In case a company specific currency has to be used for some segments, please input here the related yield curve and exchange rate.

3. *CA_reserves_and_premiums*

   This is a reporting sheet for providing a standardized overview of the captive portfolio. The data have to be entered by the company starting from column N. The information in this sheet is not linked directly to the risk calculation. Nonetheless material differences with the information used for the risk calculation should be explained, in particular if totals are concerned. If necessary, details may be found in the StandRe documentation (same reporting requirement as StandRe).

4. *CA_model_used*

   Here company specific information on the model used and the choice of the SST currency have to be entered.

5. *CA_losses_history*

   In this sheet the company specific historical loss information have to be entered. Please note that on the right hand of this worksheet large losses have to be reported.

6. *CA_PY_insurance_risk*

   Here is the the PY risk parameters as described in section 6 have to be entered by PY-LOB by the company

7. *CA_CY_insurance_risk*

   The CY risk parameters by CY-LOB according to section 7 above have to be entered in this worksheet. The input of CY-LOBs and the model applied by CY-LOB has to be provided in the first table. Below, in the second table all relevant model parameters of each CY-LOB have to be entered. The aggregation of the CY-LOBs is either performed in the R-Tool if the portfolio of the company allows for using this facility (see section 10.2), or by the simulation engine chosen by the company.

8. *CA_expected_result*

   In this worksheet the company needs to enter all the relevant information for the calculation of the expected insurance result

9. *CA_payment_pattern_and_MVM*

   In this worksheet the payment pattern by LOB have to be entered. The first table is provided for the CY payment pattern, 2nd table below is provided for the PY pattern.

   Moreover the calculation of the MVM according to section 9.2 is automatically performed in this sheet.

10. *CA_insurance_cash_flows*

    In this sheet the cash flows steeming from the insurance business of the captive for the market risk model are calculated, partially based on inputs from other worksheets and partially based on additional input by the company, see section 9.1 above.

11. *CA_input_SST_Template*

    Inputs which are required by the SST-Template from the captive model are made available in this sheet and have to be copied into the SST-Template. Each section of this sheet correspond to a specific sheet of the SST-Template. Further explanations are to be found directly in this sheet, in particular regarding the aggregation of PY risk and CY risk into insurance risk and regarding the decomposition of insurance risk into PY risk and CY risk shown in the FDS.

10.2 Features in *R-tool*

For the implementation of the *R-Tool* please consult the section *System requirements of the executable version* in the document *IT Notes*.

The captive specific features in the *R-Tool* for the calculation of the insurance risk include the following

- Modelling of PY-risk by PY-LOB with reserves and coefficient of variation as inputs, see section 6
- Modelling of CY-risk by CY-LOB (with indicator for the CY-LOB model: ground-up loss or maximal possible loss, see section 7)
  - by CY-LOB modelled by ground-up loss approach according to the specification in the template:
    - As frequency severity model for normal claims with frequency (Poisson), mean and standard deviation for the gamma distribution as inputs
    - As frequency severity model for large claims with frequency (Poisson), shape and threshold (scale) for the Pareto distribution as inputs
  - by CY-LOB of maximal possible loss model as a deterministic distribution with maximum net loss and expected net loss as input
- Aggregation to a yearly loss distribution by CY-LOB is done with modelling of the following reinsurance structures by CY-LOB for ground–up modelling, see section 7.1, in this order:
  - EED-conditions
  - EEL-conditions
  - AAD-conditions
  - AAL-conditions
  - QS after application of the previous contract conditions as described above
- Aggregation of the net losses across the LOBs for PY comonotonically, see section 6
- Aggregation of the net losses across the LOBs for CY independently, see section 7
- Aggregation of PY and CY comonotonic, see section 8

Disclaimer

- Reinsurance conditions across several LOBs cannot be calculated by the tool
- The effect of reinstatement premiums is neglected in the calculation (in case these are considerable, they should increase the net loss and to be modelled outside the tool)
- The effect of sliding scale commissions and profit commissions have been neglected in the implementation (in case they change considerable the result, the tool cannot be used)
- The tool assumes that the reinsurance contracts are applied in the order given above. If the actual order differs, it needs to be analysed whether the tool can or cannot be used.
- Reinsurance conditions are only applied to CY claims
- For PY claims the default option of this model is that net reserves are the basis for the modelling.

With the above conditions it should be possible to model the inward reinsurance structure of captives. In some cases it might also be possible to model the outward reinsurance. If this is not the case then the captive needs to model the insurance loss outside of the template.

11 Execution

Step 1:

- Chose the SST-Currency in the sheet *General Inputs* of *SST-Template.*
- Complete the sheets *SST Balance Sheet* and *RBC* for computing the RBC.
  - See *Technical description for the SST balance sheet and FDS*, and for insurance business related positions the section 3.1 above.
- Complete the sheet *Differences_Stat_SSTBalance* as a reporting requirement.

Step 2:

- Complete *SST-Captives-Template.xlsx*
  - See section 10.1 above
- Facultative: use of *Reserve risk tool* separately for computing the coefficient of variation of PY-LOBs

Step 3:

- Copy figures from sheet *CA_input_SST_Template* of *SST-Captives-Template* into the corresponding sheets of the *SST-Template* (By doing this, the SST-Template is populated with the insurance business related figures.)
- For instructions on what needs to be copied where in the *SST-Template*, see the sheet *CA_input_SST_Template* which is structured in sections according to the sheets of the *SST-Template.* Mind the red warning in this sheet if you use the *R-Tool* with default option (cf. step 5, remark 2 below).

Step 4:

- Complete the remaining applicable sheets of the *SST-Template*
  - See *Technical description for the SST standard model market risk*, *Technical description for the SST standard model credit risk*, and where applicable *Technical description for the scenarios*
  - Mind the concentration scenarios to aggregate if applicable, see *Technical description for the scenarios*

Step 5:

- Use the *SST-Dashboard* (*R-Tool*) through the executable *SST_Dashboard_setup_x86.zip* for 32 bits Windows OS, respectively *SST_Dashboard_setup_x86.zip* for 64 bits Windows OS.
  - See *IT Notes* and *Technical description for the SST balance sheet and FDS*
  - This step produces the output file of the SST calculation *Fundamental_Data.xlsx.*

- *Remark 1*: The *R-Tool* performs mainly the simulations for aggregating the risks which would be difficult to be implemented in in Excel stand-alone. In particular:
  - For insurance risk of captives: aggregation from LOBs parameters into the non-life insurance risk distribution via simulations
  - For market risk: see *Technical description for the SST standard model market risk*
  - Aggregation of risk categories using a dependency structure: see *Technical description for the SST standard model aggregation and MVM*

- *Remark 2*: The non-life insurance risk distribution of a captive is taken into account by one of the two options, which should lead to the same result:
  - Default option: In the sheet *Non Life* of *SST-Template,* select « captive ». Then the *R-Tool* will produce the required non-life risk distribution by simulation from the parameters input in the sheet *Non Life.*
  - Alternative option: In the sheet *Non Life* of *SST-Template,* select « simulations » or « cumulative distribution function », and enter the corresponding simulations or cumulative distribution function obtained by your external tool in this sheet.

  If the alternative option is used, please explain why.

  If « captive » is selected (default option), the decomposition of insurance risk into PY risk and CY risk shown in the FDS is computed by the *R-Tool* from the parameters of the captive model.

Step 6

- Perform consistency and plausibility verifications, with focus on the main risk drivers of the captive.