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# StandRe Reserve Risk Tool

## User manual

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# Contents


**1 Purpose and RRT files ..... 4**

1.1 Introduction ..... 4

1.2 Files ..... 4

**2 Mathematical background ..... 5**

2.1 LSRM ..... 5

2.2 Chain-Ladder, Bornhuetter-Ferguson, Combined BF-CL ..... 6

2.2.1 Chain Ladder ..... 6

2.2.2 Bornhuetter-Ferguson ..... 7

2.2.3 Combined BF-CL ..... 8

**3 Setting up the RRT ..... 8**

3.1 Set up ..... 8

3.2 Detailed steps ..... 9

3.3 Trouble shooting ..... 10

**4 RRT calculation ..... 11**

4.1 Overview ..... 11

4.2 Sheet "Intro_RRT" ..... 11

4.3 Sheet "Input" ..... 11

4.3.1 Input data ..... 11

4.3.2 Comparison of input data ..... 12

4.4 Sheet "*Results*" ..... 12

4.4.1 Input and general ..... 12

4.4.2 Button "*Save spreadsheet as*" ..... 13

4.4.3 Button "*Calculate and copy-paste input & results*" ..... 13

4.4.4 Button "*Calculate without copy-paste (to compare)*" ..... 14

4.4.5 Button "*Save Excel as xlsx*" ..... 14

4.5 Sheets "*Combined BF-CL*", "*Chain-Ladder*", "*Bornhuetter-Ferguson*" ..... 14
4.6 Sheet "*Copy of input & selections*" ..... 15
4.7 Workflow illustration ..... 15
4.8 Other sheets ..... 17
4.8.1 Sheet "LSRM model parameter" ..... 17
4.8.2 Sheet "Covariance parameters" ..... 17

# 1 Purpose and RRT files



## 1.1 Introduction

This is the manual for the new version from 31 October 2020 of the Reserve Risk Tool (RRT) for StandRe. The underlying method has not changed since the prior version. Based on development triangles of paid or incurred losses, the RRT allows calculating the best estimate of the reserves and the standard deviation of the one-year change in the best estimate reserves (also known as the "claims development result") for the three reserving methods:

- Chain Ladder (CL),
- Bornhuetter-Ferguson (BF),
- "Combined Bornhuetter-Ferguson and Chain Ladder" ("Combined BF-CL").

In StandRe, the Combined BF-CL is the benchmark method for the calculation of the coefficients of variation (CV) for the "Attritional Events Reserve Risk" (AER) parameter segments. Results from the RRT can be copy-pasted into the SST-StandRe-Template.

The calculation is implemented in the "*StandRe_Reserve_Risk_Tool*" spreadsheet with macros, which needs to be linked to an Excel add-in (xla-file), which links to the calculation kernel (dll-file), as described in Sections 1.2 and 3. Add-in and calculation kernel implement a much more general framework for calculating reserve risk called Linear Stochastic Reserving methods[1] (LSRM) and are part of the package *LSRMTools*[2], a free to use (GNU 3 license) sample implementation of LSRM. The three methods considered, specifically the combined BF-CL, are simple special cases of the general framework.

## 1.2 Files

The following files are provided for the RRT:

(1) *StandRe_Reserve_Risk_Tool*: The RRT-spreadsheet template in Excel with macros, which is used to enter data, make manual selections and derive results.

(2) LSRMTools (version 2.1.2): folder that contains in particular:

[1] Dahms, René (2012). Linear stochastic reserving methods. ASTIN Bulletin, Vol. 42, 1–34. An updated version of the paper, called "LSRM.pdf", is included within *LSRMTools*.

[2] *LSRMTools.zip* (version 2.1.2) was downloaded from https://sourceforge.net/projects/lsrmtools in April 2017. The following legal disclaimer holds for using *LSRMTools*:

*Bitte beachten Sie bei der Verwendung der Software "LSRMTools" die Hinweise zur Urheberschaft (abrufbar im Dokument "License.txt") und die zugehörigen Lizenzbestimmungen (abrufbar im Dokument "COPYING"). Im Übrigen gelten bei der Verwendung der Publikationen zum Schweizer Solvenztest (SST) die Hinweise im Disclaimer zur Nutzung der Webseite der FINMA https://www.finma.ch/de/disclaimer/*

There is a new version from 11 January 2022 of *LSRMTools.zip* (version 2.1.3) on *https://sourceforge.net/projects/lsrmtools*. This new version has no impact on the StandRe reserve risk tool. For this reason, the FINMA-Website still contains the prior version.

- *LSRMTools\ExcelAddIns\LSRM_Tools_Dll.xla*: the Excel add-in. In the RRT-spreadsheet, the links need to be set to this file and the add-in needs to be declared (explained further below).

- *LSRMTools\bin64\LSRM_Dll.dll* and *LSRMTools\bin32\LSRM_Dll.dll*: contains the functions used for the LSRM. The links in the Excel add-in need to be set to the location of these two files (explained further below)

- *LSRMTools\Doc\LSRM.pdf*: updated version of the LSRM paper

- *LSRMTools\Doc\LSRMTools.pdf*: user manual for LSRM tools

(3) *StandRe_RRT_Manual*: this document.

# 2 Mathematical background

## 2.1 LSRM

LSRM is the abbreviation for a general framework for calculating reserve risk called Linear Stochastic Reserving methods. Details about LSRM can be found in the updated version of the LSRM paper *LSRM.pdf* (Section 1.2). The LRSM framework is much more general than what is used in the RRT.

Roughly speaking, LSRMs simultaneously consider a collection of $m = 0,1, \dots M$ incremental triangles with entries $S_{i,k}^m$ (claims paid or claims reported), where $i = 0,1, \dots, I$ denotes the accident or underwriting year and $k = 0,1, \dots, J$ the development year.

The first basic assumption of LSRMs is that for each triangle $m$ there exist exposures $R_{i,k}^m$, which are linear functions of the past entries of all triangles, such that the next year's expected development $S_{i,k+1}^m$ conditional on the past information is proportional to $R_{i,k}^m$, i.e.

$$E[S_{i,k+1}^m | \, past] = f_k^m \cdot R_{i,k}^m$$

The parameters $f_k^m$ are called development factors.

The second basic assumption of LSRMs is that the development of two triangles $m_1$ and $m_2$ is coupled via covariance parameters $\sigma_k^{m_1,m_2}$ and exposures $R_{i,k}^{m_1,m_2}$, i.e.

$$Cov\left[S_{i,k+1}^{m_1}, S_{i,k+1}^{m_2} | past\right] = \sigma_k^{m_1,m_2} \cdot R_{i,k}^{m_1,m_2}$$

where $R_{i,k}^{m_1,m_2}$ depends on the past of all triangles but not necessarily linearly.

The two assumptions look similar to Mack's Chain Ladder assumptions[3]. Note that in the RRT we use slightly different definitions for the development factors than in the more general LSRM context, and the covariances from above reduce to variances/ standard deviations, as explained in Section 2.2.

The development factors $f_k^m$ are estimated as a weighted mean of the observed development:

$$\hat{f}_k^m := \sum_{i=0}^{I-k-1} w_{i,k}^m \frac{S_{i,k+1}^m}{R_{i,k}^m}$$

The "default weights", which provides in some way optimal estimators, are given by:

$$w_{i,k}^m := \left( \sum_{h=0}^{I-k-1} \frac{R_{h,k}^m R_{h,k}^m}{R_{h,k}^{m,m}} \right)^{-1} \frac{R_{i,k}^m R_{i,k}^m}{R_{i,k}^{m,m}}$$

The covariance parameters are estimated by:

$$\hat{\sigma}_k^{m_1,m_2} := \frac{1}{Z_k^{m_1,m_2}} \sum_{i=0}^{I-k-1} \frac{w_{i,k}^{m_1} w_{i,k}^{m_2}}{R_{i,k}^{m_1,m_2}} \left( \frac{S_{i,k+1}^{m_1}}{R_{i,k}^{m_1}} - \hat{f}_k^{m_1} \right) \left( \frac{S_{i,k+1}^{m_2}}{R_{i,k}^{m_2}} - \hat{f}_k^{m_2} \right)$$

where $Z_k^{m_1,m_2}$ are normalizing constants that lead to unbiased estimators.

With these assumptions and estimators, the paper *LSRM.pdf* (Section 1.2) derives general formulas for calculating the standard deviation of the one-year change in the best estimate reserves (also known as "claims development result"). These formulas are used in the RRT for the special cases of LSRMs described in Section 2.2.

## 2.2 Chain-Ladder, Bornhuetter-Ferguson, Combined BF-CL

### 2.2.1 Chain Ladder

The Chain Ladder model introduced by Mack[4] is based on two assumptions that can be formulated in terms of LSRMs. For the LSRM formulation, only one triangle is used, where we use the common formulation in terms of cumulative triangles with entries $C_{i,k}$ instead of incremental triangles $S_{i,k}$, i.e.

$$C_{i,k+1} = C_{i,k} + S_{i,k+1}$$

The first assumption is that there exist development factors $f_k^{CL}$ such that

[3] Mack, Thomas (1993). Distribution-free calculation of the standard error of chain ladder reserve estimates. ASTIN Bulletin, Vol. 23/2, 213–225.

[4] Mack, Thomas (1993). Distribution-free calculation of the standard error of chain ladder reserve estimates. ASTIN Bulletin, Vol. 23/2, 213–225.

$$E\left[C_{i,k+1}|past\right] = f_k^{CL} \cdot C_{i,k}$$

In the LSRM notation, we have

$$f_k^{CL} = 1 + f_k^{CL,LSRM}$$

for the equivalent LSRM condition

$$E\left[S_{i,k+1}|past\right] = f_k^{CL,LSRM} \cdot R_{i,k}$$

where the "exposures" $R_{i,k} = C_{i,k}$ are given by the cumulative triangle $C_{i,k}$. The corresponding assumption on the variance is

$$Var\left[C_{i,k+1}|past\right] = Var\left[S_{i,k+1}|past\right] = (\sigma_k^{CL})^2 \cdot C_{i,k} = (\sigma_k^{CL})^2 \cdot R_{i,k}$$

Note that we must have $C_{i,k} \geq 0$ as the variance cannot be negative

The "individual observed development factors" $f_k^{CL,obs,i}$ for accident or underwriting year $i$ from development year $k$ to $k+1$ are

$$f_k^{CL,obs,i} = \frac{C_{i,k+1}}{C_{i,k}} = 1 + \frac{S_{i,k+1}}{R_{i,k}} = 1 + f_k^{CL,LSRM,obs,i}$$

In the RRT, the Chain Ladder development factors $f_k^{CL}$ are displayed as real numbers around $1.00$.

### 2.2.2 Bornhuetter-Ferguson

Here we use (in line with the LSRM) the Bornhuetter-Ferguson (BF) model of Mack[5] (in contrast to the alternative version in which the development pattern is derived by Chain Ladder). In terms of LSRMs, we have two triangles, the incremental paid or incurred claims development triangle with entries $S_{i,k} = S_{i,k}^0$ and an additional auxiliary triangle $S_{i,k}^1 = 1_{\{k=0\}} \cdot U_i^{pri}$. Here, $U_i^{pri}$ is the a priori ultimate for year $i$, i.e. the initial estimate for the total losses to the accident or underwriting year $i$. We require $U_i^{pri} \geq 0$.

In this model, the first assumption is that there exist development factors $f_k^{BF}$ (same definition in LSRM) such that

$$E\left[S_{i,k+1}|past\right] = f_k^{BF} \cdot U_i^{pri} = f_k^{BF} \cdot R_{i,k}$$

So the "exposure" $R_{i,k} = S_{i,0}^1 = U_i^{pri}$ is the a priori ultimate for year $i$. The above assumption means that, independently of the past realizations, the next incremental paid or reported claims amount is expected to be given by a ratio $f_k^{BF}$ of the a priori ultimate. The $f_k^{BF}$ can thus be thought to represent an incremental "development pattern". For this reason, the factors are displayed in the RRT as percentages, e.g. 15.7%.

[5] Mack, Thomas (2008). The prediction error for Bornhuetter-Ferguson. ASTIN Bulletin. Vol. 38, 87–103.

The corresponding assumption on the variance is

$$Var\left[C_{i,k+1}|past\right] = Var\left[S_{i,k+1}|past\right] = (\sigma_k^{BF})^2 \cdot U_i^{pri} = (\sigma_k^{BF})^2 \cdot R_{i,k}$$

The "individual observed development factors" $f_k^{BF,obs,i}$ for accident or underwriting year $i$ from development year $k$ to $k+1$ are

$$f_k^{BF,obs,i} = \frac{S_{i,k+1}}{U_i^{pri}} = \frac{C_{i,k+1} - C_{i,k}}{U_i^{pri}} = \frac{S_{i,k+1}}{R_{i,k}}$$

The development factors thus correspond to the percentage of the a priori ultimate that is incrementally paid or incurred in the corresponding development period.

### 2.2.3 Combined BF-CL

For the combined BF-CL, the development factors are assumed equal to

- the BF development factors $f_k^{BF}$ for the first development periods $k = 0,1, \dots, k_0 - 1$, with the a priori ultimates $U_i^{pri}$ as exposures;
- equal to the CL development factors $f_k^{CL}$ for the later development periods $k = k_0, k_0 + 1, \dots, J$, with the cumulative (paid or incurred) losses $C_{i,k}$ as exposures.

Here,

- $k_0 =$ number of years for the Bornhuetter-Ferguson method (Section 4.4)

In the RRT, the BF and CL development factors are displayed as percentages and real numbers around 1.00, respectively.

# 3 Setting up the RRT

## 3.1 Set up

See Section 1.2 for the files provided for the RRT. The files relevant for the setup are the RRT spreadsheet *StandRe_Reserve_Risk_Tool* and the folder *LSRMTools*. For the time being, it is expected that FINMA will not change contents of the folder *LSRMTools*.

In principle, the folder *LSRMTools* and the spreadsheet *StandRe_Reserve_Risk_Tool* can be saved to any location. However, it might work best if the local C drive is used, e.g. a subfolder of the desktop, specifically for the folder *LSRMTools*.

Subsequently, the setup consists of the following steps, which are explained in more detail below. Only step (a) is needed if the folder *LSRMTools* is already installed and set up (i.e. steps (b) and (c) have been done previously):

(a) Set the links in the spreadsheet *StandRe_Reserve_Risk_Tool.xlsm* to the location of the Excel add-in *LSRM_Tools_Dll.xla* (Section 1.2) within the folder *LSRMTools*. This step is specific to the spreadsheet and the location of *LSRM_Tools_Dll.xla*.

(b) In the Excel add-in overview (*File* → *Options* → *Add-ins*), declare in the Excel add-in *LSRM_Tools_Dll.xla* at the correct location of the file *LSRM_Tools_Dll.xla* (Section 1.2). This step is independent of the spreadsheet and depends on the location of *LSRM_Tools_Dll.xla*.

(c) In the Excel add-in *LSRM_Tools_Dll.xla* (which is displayed as *LSRM_Tools_Dll* in the VBA part of Excel, *Alt* + *F11*), in the code of the *DLLFunction_Declaration* module, set the correct path to the folder *LSRMTools* for the functions that are used by *LSRM_Tools_Dll.xla*. This step is independent of the spreadsheet and depends on the location of the folder *LSRMTools* (assuming the order within this folder has not changed).

## 3.2 Detailed steps

To achieve the above, perform the following steps in sequence:

**For (a)**:

(1) Open the spreadsheet *StandRe_Reserve_Risk_Tool.xlsm*, ignore messages, do not update links.

(2) In the header,

- go to *Data* → *Edit Links* → select "*LSRM_Tools_Dll.xla*"
- select "*Change source*" ("*Quelle ändern*") → select the applicable location of the file *LSRM_Tools_Dll.xla*. → press "OK" → press "Close"

**For (b)**:

(1) Go to *File* → *Options* → *Add-ins* → *Go* → select "*LSRM_Tools_Dll.xla*"

- delete or remove tick mark (or do nothing if "*LSRM_Tools_Dll.xla*" does not appear) → close
- save the spreadsheet *StandRe_Reserve_Risk_Tool.xlsm* & close it

(2) Open the spreadsheet *StandRe_Reserve_Risk_Tool.xlsm*, ignore messages,

- go to *File* → Options → *Add-ins* → *Go* → select "*LSRM_Tools_Dll.xla*" → set tick mark (or do nothing if "*LSRM_Tools_Dll.xla*" does not appear)

- "*Browse*" → go to applicable location of the file *LSRM_Tools_Dll.xla*.
- If there is a message about whether to "copy", deny the request. If the message is about "overwriting", accept the request.
- select "*LSRM_Tools_Dll.xla*" by setting the tick mark

**For (c)**:

(1) In the spreadsheet *StandRe_Reserve_Risk_Tool.xlsm*,

- open VBA (e.g. *Alt* + *F11*) → go to the project "*LSRM tools DLL (LSRM_Tools_Dll.xla)*" → go to "*Modules*" → open the module "*DLLFunction_Declaration*" by double clicking
- replace the path of the folder "*LSRM_Tools*" that is in the code with the applicable path (in the header, go to *Edit* → *Replace*, put the existing path in "*Find What:*" and the applicable path in "*Replace With:*" and click *Replace all*); this should make 193 replacements
- run the sub "*Save XLA*" at the bottom of the code of the module "*DLLFunction_Declaration*". E.g. by selecting the three lines of the sub and clicking "▷" ("*Run sub/Userform*").
- close VBA

(2) Potentially: save the spreadsheet *StandRe_Reserve_Risk_Tool.xlsm* and close it → open the spreadsheet *StandRe_Reserve_Risk_Tool.xlsm*

## 3.3 Trouble shooting

- Some cells display "LSRM not found": the installation should have worked, now you need to calculate.
- Some cells display ""#NAME": set the links in the spreadsheet to LSRM_Tools_Dll.xla by "For (a)" in Section 3.2. If this works, you will see "LSRM not found" in some cells and you might see "#VALUE!" on some cells. If it does not work, do "For (b)" and "For (c)" from Section 3.2.
- Some cells display "#VALUE!": this can be a common calculation error. Otherwise, you might have to do "For (b)" and "For (c)" from Section 3.2.
- If after starting Excel, the following message is shown, then it is easiest to change regional settings of your Windows to "English (UK)" or "German (Switzerland)".

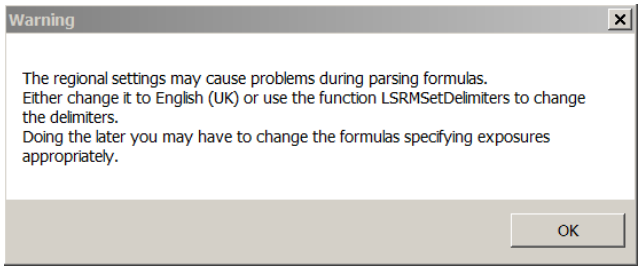


Figure 1: Regional settings

# 4 RRT calculation

## 4.1 Overview

In the following, we explain the steps for an RRT calculation, going through and explaining the relevant sheets of the *StandRe_Reserve_Risk_Tool* spreadsheet. Prior to this step, the spreadsheet needs to be linked to the LSRMTools package as explained in Section 3.

After calculation and analysis, when results are final, prior to submitting results to FINMA, make sure that in the sheet "*Results*" (Section 4.4) you press the button "*Calculate and copy-paste input & results*" (Section 4.4.3) so that the final results are copied. Then press the button "*Save Excel as xlsx*" (Section 4.4.5), which automatically produces an "xlsx" version of the spreadsheet, i.e. without macros, to be submitted to FINMA.

See Section 4.7 for a detailed illustration of the workflow.

## 4.2 Sheet "Intro_RRT"

Some general information to fill out and explanations of the color-coding. In the following, we concentrate on the light blue sheets.

## 4.3 Sheet "Input"

### 4.3.1 Input data

The main sheet to enter input data. Under "General information", specifications on the data analyzed are provided. All fields should be filled out correctly, as information is used elsewhere. In particular:

(a) "*Input triangle incremental or cumulative?*": development triangle data can be either incremental or cumulative. The selection here needs to be consistent with the actual form of the triangle data entered.

(b) Currency information and exchange rate: the information entered here is used to convert to SST currency so that the data then can be copy-pasted into the SST-StandRe-Template. Please use the three-digit name, e.g. "CHF". The exchange rate is the defined as the amount in SST currency for one unit of the parameter segment currency.

(c) "*Most recent reported year*", "*First reported year*": this information is used to define the range of accident or underwriting years for which the calculation should be performed and the dimensions of the development triangle considered. The most recent reported year is typically the most recent prior year.

Below this is the input data for the calculation:

(d) "*A priori ultimates*": vector of the a priori, i.e. initial best estimates of the total losses per accident or underwriting year. Used for BF and combined BF-CL.

(e) "*Most recent cumulative payments*": the most recent cumulative loss payments per accident or underwriting year, i.e. the non-discounted sum of the loss payments for that year up to and including the "most recent reported year"

(f) Claims development triangle, as applicable and selected under "general information", either of paid or incurred losses, per accident or underwriting year, and incremental or cumulative.

#### 4.3.2 Comparison of input data

Below the input data, the a priori ultimates and the claims development triangle are compared to the corresponding data that is stored in the sheet "*Copy of input & selections*", see Section 4.6. A cell in the comparison range is blank if the corresponding cells are identical. An "xxx" indicates that the cell in the sheet "*Copy of input & selections*" is non-blank and non-zero, but the corresponding cell in the sheet "*Input*" is blank or zero. Otherwise, the percentage difference between the cell in the sheet "*Copy of input & selections*" and the corresponding cell in the sheet "*Input*" is displayed.

Assume that the RRT spreadsheet has been filled out in the previous year and the input data and the selection have then been copy-pasted into the sheet "*Copy of input & selections*" using the button "*Calculate and copy-paste input & results*" (Section 4.4.3). Then this provides a comparison of the new data entered for the current year with the data entered the previous year.

## 4.4 Sheet "*Results*"

#### 4.4.1 Input and general

The sheet "*Results*" contains the buttons for performing the calculations and the overview of the results.

(a) "*Number of years for the Bornhuetter-Ferguson method*": this is the required input to specify the combined BF-CL method (Section 2.2).

(b) "*Use manual adjustments (if available)*": this field is "TRUE" by default and then implies that the user-made manual selections are used if there are such selections, and otherwise the default parameters are used. If the field is set to "FALSE", only default parameters are used, even if there are manual selections.

(c) "*Default add-on (for uncertainty on a priori ultimates)*": this field is intended to capture the uncertainty in the a priori ultimates and is by default set to 105%.

(d) "*Indicator that input has changed and recalc may be necessary*": if this field shows "TRUE" in red color, this is an indication that a recalculation may be necessary due to input changes.

(e) "*Time stamp of calculation*": calculation results are assigned a "time stamp" of the date and time the calculation is produced. (This is also used as the name of the instance of the object in the "LSRM class" and is used to identify that instance.)

(f) "*Output to SST-StandRe-Template*": this is an output form of the required output for the SST-StandRe-Template. Amounts are converted to SST currency where necessary.

Results of a specific calculation are displayed in the main part of the sheet for the three methods combined BF-CL, CL and BF, also separately for the different accident or underwriting years.

Calculations can be run either by pressing the button "with copy-paste" explained in Section 4.4.3 or the button "without copy-paste" explained in Section 4.4.4. With the former, the results are copied and pasted as values to the area to the right (as cells with the "pointy" pattern). This ensures that the calculation results are retained without recalculation also when closing the spreadsheet (or saving it as "xlsx", Section 4.4.5).

### 4.4.2 Button "*Save spreadsheet as*"

Pressing this button to "save as" the spreadsheet opens a message box with a proposed name given by the spreadsheet name followed by the one plus the "*most recent reported year*" (Section 4.3) and the parameter segment name (from "general information" in the sheet "*Input*"). The proposed name can be changed. The spreadsheet is saved with the selected name as a macro-enabled spreadsheet (".xlsm").

### 4.4.3 Button "*Calculate and copy-paste input & results*"

Pressing this button runs the calculation and copy-pastes the calculation results as values and with the formatting to the area to the right (as cells with "pointy" pattern). Further, the inputs (from the sheet "*Input*", Section 4.3) and the manual selections (from the sheets "*Combined BF-CL*", "*Chain-Ladder*", "*Bornhuetter-Ferguson*", Section 4.5) are copy-pasted as values with formatting into the

sheet "*Copy of inputs & selections*" (Section 4.6). This preserves these results and should thus be done in particular when the calculation is final.[6]

#### 4.4.4 Button "*Calculate without copy-paste (to compare)*"

Pressing this button runs the calculation (as in Section 4.4.3) but does not copy-paste anything. This can for example be used to compare the results of one calculation with the results from the preceding calculation, provided the latter have previously been copy-pasted to the area to the right.

#### 4.4.5 Button "*Save Excel as xlsx*"

Pressing this button produces an "xlsx" version of the spreadsheet, i.e. without macros, in the form that can be uploaded to the FINMA platform. Note that this does not delete macros, buttons etc.

### 4.5 Sheets "*Combined BF-CL*", "*Chain-Ladder*", "*Bornhuetter-Ferguson*"

These are the analysis sheets for the three methods combined BF-CL, CL and BF. Note that these sheets are only completely filled out once a calculate button in the sheet "*Results*" has been pressed (Section 4.4), so this needs to be done before analyzing these sheets.

**Triangles and weights**

The structure of each sheet is the same. It starts with the cumulative triangle corresponding to the data from the sheet "*Input*", followed by the triangle of the individual observed development factors calculated according to the method (BF or CL) for the corresponding development year (Section 2.2). Factors calculated by BF are displayed as percentages and factors calculated by CL as double.

The next triangle allows excluding individual observed development factors by setting the corresponding weight to zero (by default, all weights are equal to one).

**Model parameters and tail factor**

The rows below the weights triangle show the resulting parameters of the model (Section 2.2):

(a) development factors per development year (as applicable BF or CL);

(b) standard deviation parameters.

[6] Technically, pressing the button runs a VBA macro (*Alt + F11*, "Modul1", "Sub ReCalcAndCopyPaste()") which in particular runs the LSRM subroutine "*LSRMInit*" three times (because of cell formulas that refer to cells that are an output of the LSRM calculation). This produces an instance of the "LSRM class" whose identifier is the time stamp of the calculation (Section 3.3). All calculation results are functions on this object that are formulas starting with "LSRM" in the relevant cells.

The parameters that are estimated directly from the triangle are shown in light colors. The parameters to be used for the tail are dynamically shown in darker colors under the heading "tail". The subsequent parameters in the darkest colors should not be entered manually (the parameters shown there do not impact the result).[7]

The parameters are shown with and without manual weight selections. Manual parameter selections can be made (where justified) in the row headed "manual". Especially when input triangles are too short to capture to full development, a tail development factor (and uncertainty) should be selected. Any tail development and uncertainty should go into the development period headed by "tail". Please do not enter numbers for the later development periods. The row headed "selected" shows the final selection, which is equal to the manual selection if the corresponding cell is non-empty and otherwise equal to the default (with manual exclusions).

The row for the standard deviations headed "normalized (to dev factors)" shows a rough approximation that could give an indication of the modeled standard deviation (implied by the selected standard deviation parameters) of the individual observed development factors around the estimated development factors.[8]

**Completed triangle**

Below the model parameters, the (cumulative) claims triangle is completed using the selected development factors to predict the claims development not yet known.

Everything below the completed triangle, separated by a colored row, is auxiliary data used for the calculation that in most cases does not need to be reviewed.

## 4.6 Sheet "*Copy of input & selections*"

This sheet contains copies (as values with formatting) of the input data from the sheet "*Input*" (Section 4.3) and the selections from the sheets "*combined BF-CL*", "*Chain-Ladder*" and "*Bornhuetter-Ferguson*" (Section 4.5). From the latter it contains the "selected weights" triangle and the parameters (development factors and standard deviation parameters). The copies are produced when the button "*Calculate and copy-paste input & results*" is pressed (Section 4.4.3).

The previous input data (explicitly, a priori ultimates and claims development triangle, Section 4.3) that have previously been copied into this sheet is compared in the sheet "*Input*" (Section 4.3) with the current input data.

## 4.7 Workflow illustration

After the RRT is set up as explained in Section 3:

[7] Results using a tail factor may be slightly different from the results pre 31 October 2020.

[8] The mathematical assumptions of the methods do not allow a precise interpretation of the standard deviation parameters in these terms.

(1) Enter the required information in the sheets "*Intro_RRT*" (Section 4.2) and "*Input*" (Section 4.3).

(2) In the sheet "*Results*", press the button "*Save spreadsheet as*" (Section 4.4.2) to produce a version of the RRT for the year of analysis and the parameter segment considered.

(3) In the sheet "*Results*", select "*Number of years for the Bornhuetter-Ferguson method*", then press the button "*Calculate and copy-paste input & results*" (Section 4.4.3).

(4) Analyze data and results in the sheets "*combined BF-CL*", "*Chain-Ladder*" and "*Bornhuetter-Ferguson*" (Section 4.5) and make manual selection where required and justified, including tail factors.

(5) In the sheet "*Results*", where appropriate, change "*Number of years for the Bornhuetter-Ferguson method*", then press the button "*Calculate without copy-paste (to compare)*" (Section 4.4.4). Compare the results with the new selections to the results from the first calculation.

(6) If the results are final, press the button "*Calculate and copy-paste input & results*" (Section 4.4.3) in the sheet "*Results*". This ensures that input data, selections and results are retained.

(7) Copy-paste the results from "*Output to SST-StandRe-Template*" (Section 4.4.1) in the sheet "*Results*" to the SST-StandRe-Template.

(8) In the sheet "*Results*", press the button "*Save Excel as xlsx*" (Section 4.4.5) to produce a macro-free spreadsheet version to be submitted to FINMA.

"One year later":

(9) Open the xlsm-version of the RRT spreadsheet for the parameter segment from the previous year.

(10) Enter the required information in the sheets "*Intro_RRT*" (Section 4.2) and "*Input*" (Section 4.3).

(11) In the sheet "*Input*" (Section 4.3), compare the input data with the input from the previous year (from the sheet "") to check consistency.

(12) In the sheet "*Results*", press the button "*Save spreadsheet as*" (Section 4.4.2) to produce a version of the RRT for the new year of analysis and the parameter segment considered.

(13) In the sheet "*Results*", select "*Number of years for the Bornhuetter-Ferguson method*", then press the button "*Calculate without copy-paste (to compare)*" (Section 4.4.4).

(14) Compare the results for the current year to the results from the previous year. Etc.

## 4.8 Other sheets

### 4.8.1 Sheet "LSRM model parameter"

This sheet specifies the three methods "combined BF-CL", CL and BF in the general framework of LSRM.

### 4.8.2 Sheet "Covariance parameters"

This sheet contains the covariance parameters relevant for the general LSRM framework.