



Lecture on claim reserving with Rapp

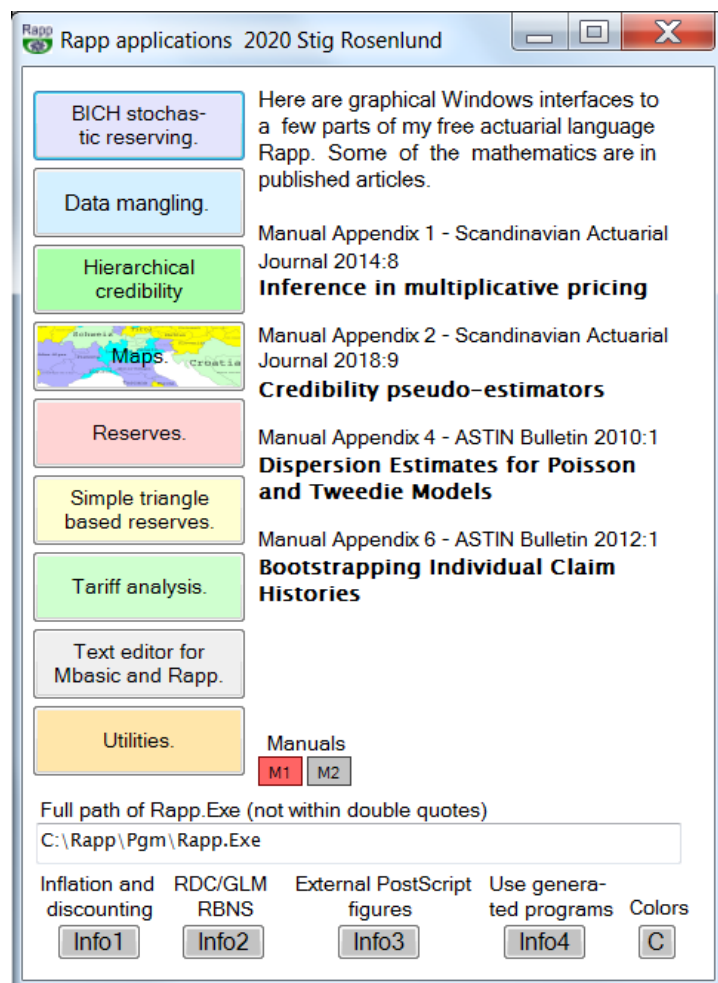
2020 March 19, Stig Rosenlund

This file: <http://www.stigrosenlund.se/Rlecture-eng-2020-v1.pdf>

About me: PhD in Mathematical Statistics at the University of Göteborg in 1983. Actuary at the Swedish insurance company Länsförsäkringar 1983-2009. After retirement in 2009, I have resumed my research, now focusing on insurance mathematics. I have in the 2010's had four papers published - one in claim reserving, one in credibility and two in tariff analysis. I plan to publish yet another article in credibility in the 2020's.

In parallell with my research I have developed the programming language Rapp, which implements my own and many other methods.

This lecture is about claim reserving with Rapp. Rapp covers the most common reserving methods and one that I made.



First about Rapp in general. Rapp is a programming language that I have developed from 1984 and am still developing. It is freeware. You find the Rapp package by googling Stig Rosenlund. After the Finnish artist with the same name you find my site, Stig Rosenlunds hemsida.

Rapp is designed specifically for actuarial use, but has also some general mathematical-statistical capabilities. A graphic shell for some applications is included. Rapp.Exe and Rappmenus.Exe are the whole software. In addition the Rapp package has many files with fictitious data and other help files. To the left is the start menu of Rappmenus, the graphic shell.

Rapp is freeware and its source is in the open domain on my site.

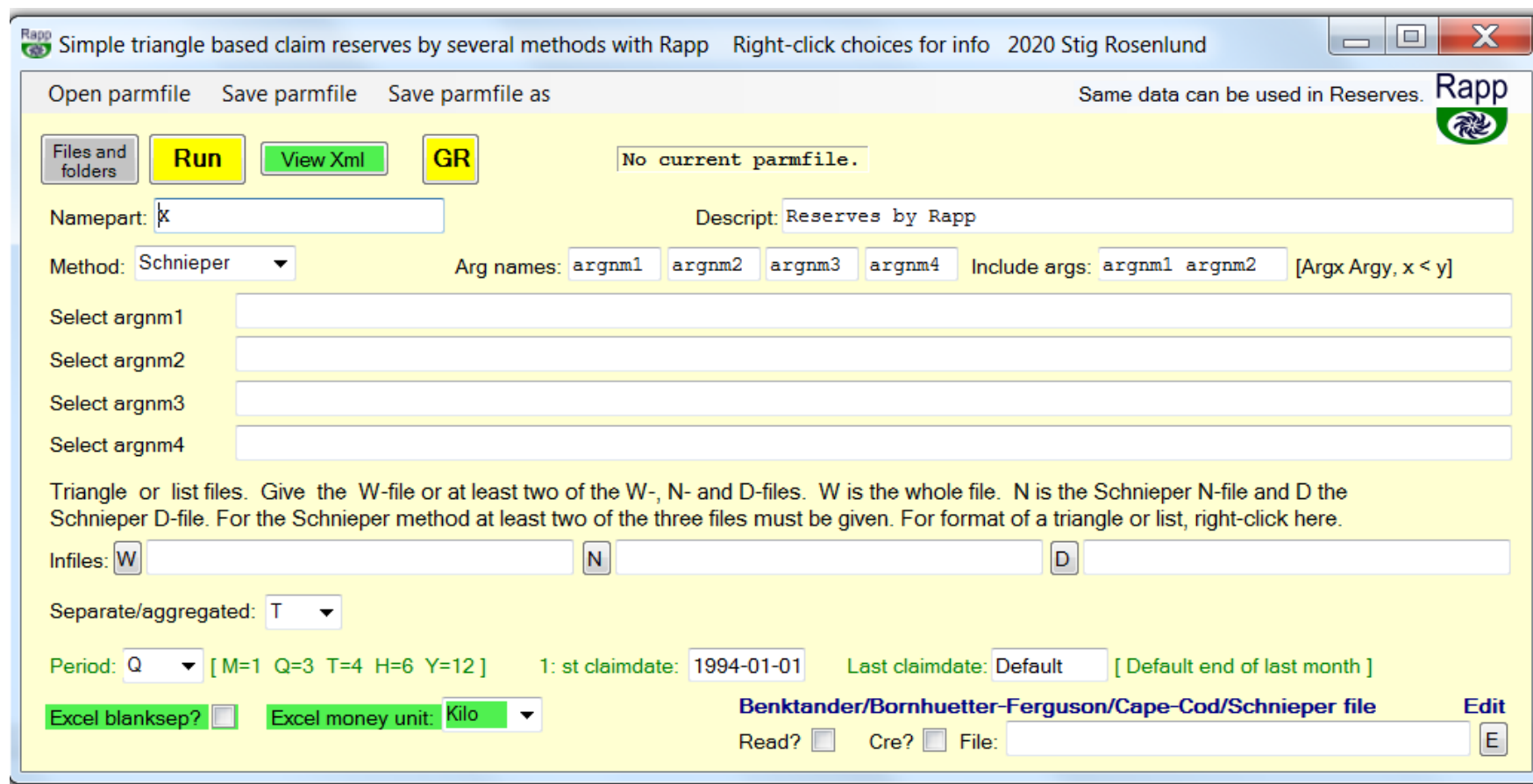
I will start with the menu Simple triangle based reserves, with no advanced features. The frequently used methods

- Benktander (alias Benktander-Hovinen)
- Bornhuetter-Ferguson
- Cape-Cod
- Chainladder
- Schnieper

are available there. I will demonstrate Chainladder and Schnieper. Then I will show how to transfer the parameters to the menu Reserves, which has many advanced options such as discounting in different ways. There you can also use my method RDC, which requires detailed data that cannot be summarized to triangles. RDC is described in an appendix in my article:

Rosenlund, S. (2012). Bootstrapping Individual Claim Histories. *ASTIN Bulletin* **42** (1), 291-324.

There is described how to evaluate RDC and other methods with respect to mean square prediction error. This lecture will not delve into this. I have held lectures on it. Here is one: <http://www.stigrosenlund.se/matstat/Rlecture.pdf>
 Start Rappmenus and enter Simple triangle based reserves. It looks like this.



The screenshot shows the 'Simple triangle based claim reserves by several methods with Rapp' window. The title bar includes the Rapp logo, the window title, and the name '2020 Stig Rosenlund'. The interface has a menu bar with 'Open parmfile', 'Save parmfile', and 'Save parmfile as'. Below the menu bar is a toolbar with buttons for 'Files and folders', 'Run' (yellow), 'View Xml' (green), and 'GR' (yellow). A status bar at the top right says 'Same data can be used in Reserves.' and the Rapp logo.

The main area contains several input fields and controls:

- Namepart:** A text box containing 'x'.
- Descript:** A text box containing 'Reserves by Rapp'.
- Method:** A dropdown menu set to 'Schnieper'.
- Arg names:** Four text boxes labeled 'argnm1', 'argnm2', 'argnm3', and 'argnm4'.
- Include args:** Two text boxes labeled 'argnm1' and 'argnm2'.
- Select argnm1, Select argnm2, Select argnm3, Select argnm4:** Four empty text boxes.
- Infiles:** Three text boxes labeled 'W', 'N', and 'D'.
- Separate/aggregated:** A dropdown menu set to 'T'.
- Period:** A dropdown menu set to 'Q'.
- 1: st claimdate:** A text box containing '1994-01-01'.
- Last claimdate:** A text box containing 'Default'.
- Excel blanksep?:** A checkbox.
- Excel money unit:** A dropdown menu set to 'Kilo'.
- Benktander/Bornhuetter-Ferguson/Cape-Cod/Schnieper file:** A text box.
- Read?, Cre?, File:** Three checkboxes.

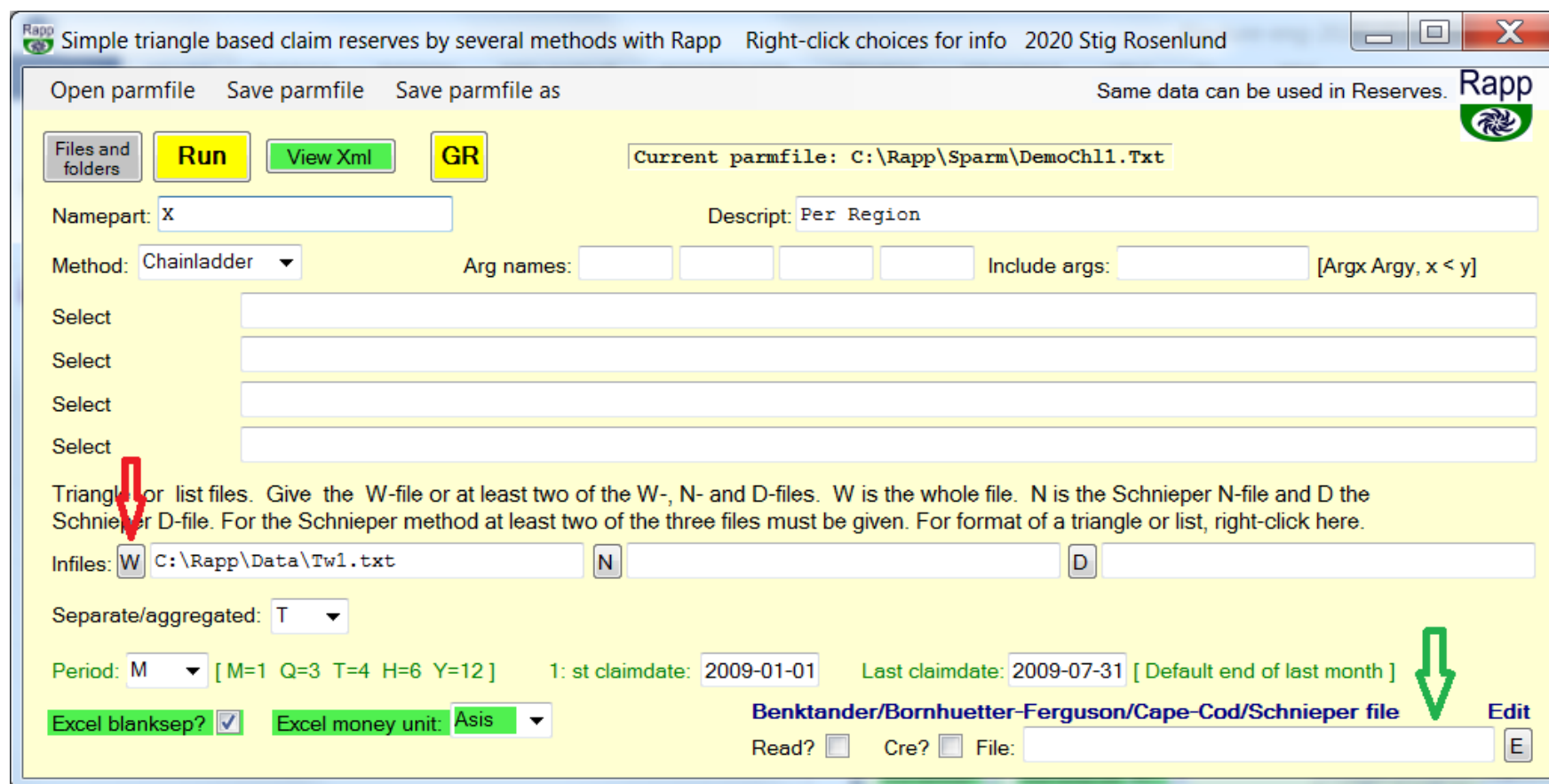
At the bottom right, there is an 'Edit' button.

The first look. Some example parameters are filled in. Right-click on the buttons and text boxes to see what they mean.

Namepart will be part of the file names.

Descript will appear as header text.

For now, leave aside the arguments argnm1 etc, i.e. possible background variables for break-down of the report. We click **Open parmfile** up left. This opens a Windows explorer list. Choose DemoChl1.Txt. This is the simplest of the applications in the zipfile with the Rapp package. All input files are simple text files (.txt).

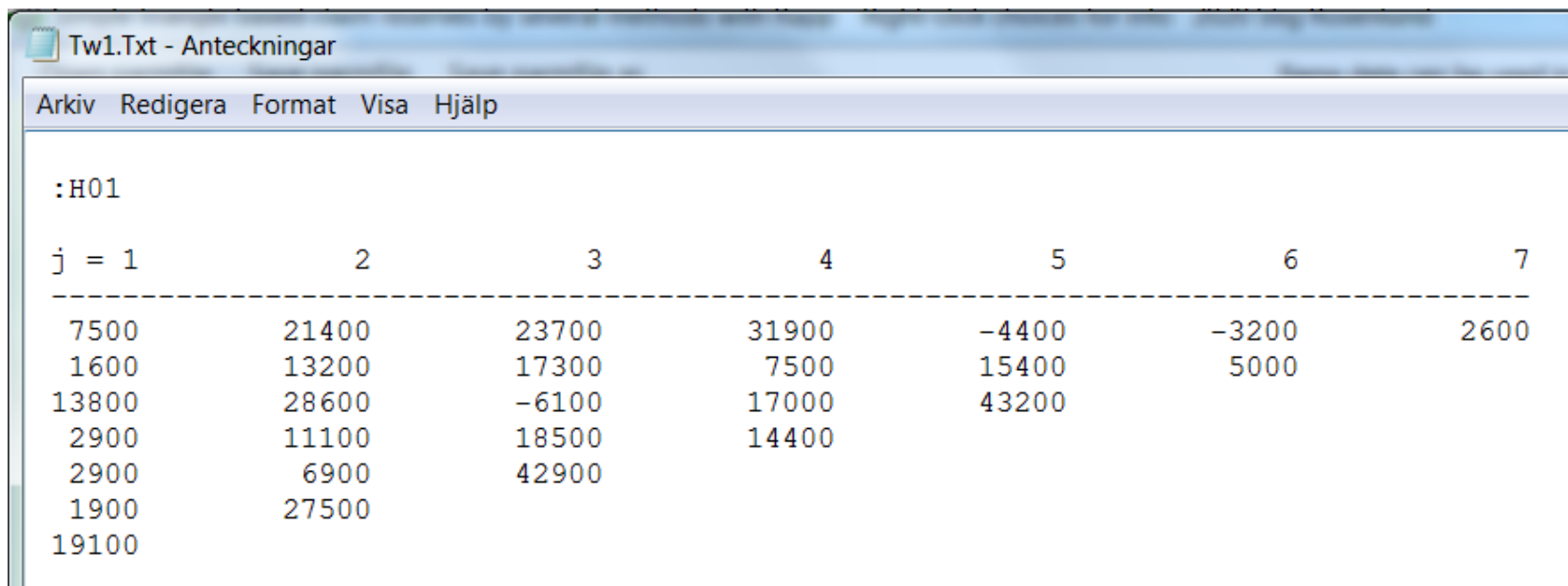


The screenshot shows the Rapp software interface. The title bar reads "Simple triangle based claim reserves by several methods with Rapp Right-click choices for info 2020 Stig Rosenlund". The interface includes a menu bar with "Open parmfile", "Save parmfile", and "Save parmfile as". Below the menu bar, there are buttons for "Files and folders", "Run", "View Xml", and "GR". The "Current parmfile" is set to "C:\Rapp\Sparm\DemoChl1.Txt". The "Namepart" is "X" and the "Descript" is "Per Region". The "Method" is set to "Chainladder". There are input fields for "Arg names" and "Include args". Below these are four "Select" buttons. A red arrow points to the "Open parmfile" button. The "Infiles" section shows "W" selected with the file "C:\Rapp\Data\Tw1.txt". There are also input fields for "N" and "D". The "Separate/aggregated" dropdown is set to "T". The "Period" dropdown is set to "M" with a list of values [M=1 Q=3 T=4 H=6 Y=12]. The "1: st claimdate" is "2009-01-01" and the "Last claimdate" is "2009-07-31" with a note "[Default end of last month]". There are checkboxes for "Excel blanksep?" (checked) and "Excel money unit" (set to "Asis"). At the bottom, there is a link "Benktander/Bornhuetter-Ferguson/Cape-Cod/Schnieper file" and an "Edit" button. A green arrow points to the "Edit" button.

A fictitious triangle file, part of the Rapp package, is written at the W button. Click it to edit the file (red arrow).

This is simple, but for other methods than Chainladder a file with entries per argument-value and claimperiod is needed (green arrow).

After pressing W the infile opens in Notepad. Here it is in triangle form.



:H01						
j = 1	2	3	4	5	6	7
7500	21400	23700	31900	-4400	-3200	2600
1600	13200	17300	7500	15400	5000	
13800	28600	-6100	17000	43200		
2900	11100	18500	14400			
2900	6900	42900				
1900	27500					
19100						

Only the data lines starting with 7500 and ending with 19100 are necessary. The rest is for your documentation.

These data can also be in list form.

Next page shows an example.

: H01

i	j	amount
1	1	7500
1	2	21400
1	3	23700
1	4	31900
1	5	-4400
1	6	-3200
1	7	2600
2	1	1600
...		

With a colon as first character on a line you start a new combination of argument values. Here H01 might denote a sales region. After that you can write type of business, such as consumer insurance. These argument values shall contain no blanks and shall be separated by one or more blanks. The first colon-initiated line is the same in a triangle form infile.

The layout is free; have as many blanks between numbers, and as many lines that cannot be interpreted as data lines, as you wish. Decimal point and decimal comma are both accepted.

Now let us make a report in Excel. Just push the yellow button **Run**, and then the green button **View Xml** to see the result in Excel. The output is in format xml, which is a text format. Save it as .xls if you wish.

Output on next page.



Main sheet Chainladder

A	B	C	D	E	F	G	H
1	2020-02-13	S. Reserve calculus with Chainladder. Per Region.					
2							
3							
4	Obj data: Infile C:\Rapp\Data\Tw1.txt, claim dates 20090101 - 20090731.						
5	Highest payment period index (1,2,...) included in object data: 7.						
6	Reserving method:						
7	Chainladder method.						
8							
9							
10	Segm: Tot						
11	Increment values real and fitted, payments, Chainladder						
Period i/j	1	2	3	4	5	6	7
200901 1	7 500	21 400	23 700	31 900	-4 400	-3 200	2 600
200902 2	1 600	13 200	17 300	7 500	15 400	5 000	2 029
200903 3	13 800	28 600	-6 100	17 000	43 200	1 286	3 306
200904 4	2 900	11 100	18 500	14 400	14 329	816	2 098
200905 5	2 900	6 900	42 900	24 307	23 528	1 339	3 444
200906 6	1 900	27 500	25 762	25 443	24 627	1 402	3 605
200907 7	19 100	67 849	76 189	75 245	72 832	4 146	10 662
20							
21	Accumulated values real and fitted, payments, Chainladder						
Period i/j	1	2	3	4	5	6	7
200901 1	7 500	28 900	52 600	84 500	80 100	76 900	79 500
200902 2	1 600	14 800	32 100	39 600	55 000	60 000	62 029
200903 3	13 800	42 400	36 300	53 300	96 500	97 786	101 092
200904 4	2 900	14 000	32 500	46 900	61 229	62 045	64 143
200905 5	2 900	9 800	52 700	77 007	100 535	101 874	105 318
200906 6	1 900	29 400	55 162	80 605	105 232	106 634	110 239
200907 7	19 100	86 949	163 138	238 383	311 215	315 361	326 023
30							
31							
Claimperio d	Paid	IbnsPaid	TotClcost				
200901 1	79 500	0	79 500				
200902 2	60 000	2 029	62 029				
200903 3	96 500	4 592	101 092				
200904 4	46 900	17 243	64 143				
200905 5	52 700	52 618	105 318				
200906 6	29 400	80 839	110 239				
200907 7	19 100	306 923	326 023				
40	Total	384 100	464 244	848 344			
41							

Chainladder

Mack



Sheet Mack with Mack standard errors

A	B	C	D	E
1	2020-02-13	S. Reserve calculus with Chainladder. Per Region.		
2				
3				
4	Chainladder standard errors according to Thomas Mack.			
5	The standard error of Chainladder reserve estimates:			
6	Recursive calculation and inclusion of a tail factor.			
7	Astin Bulletin. Vol. 29. No 2. 1999. 361-366.			
8	The standard error applies to total as well as reserve.			
9				
Claimper i		Known+IBNS	IBNS	Standard error
200901 1		79 500	0	0
200902 2		62 029	2 029	1 643
200903 3		101 092	4 592	10 215
200904 4		64 143	17 243	29 304
200905 5		105 318	52 618	41 577
200906 6		110 239	80 839	90 005
200907 7		326 023	306 923	247 305
18	Total	848 344	464 244	302 201
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				

Chainladder

Mack



How does Rapp know what the names of the claimperiods shall be? From the fields 1:st claimdate and Last claimdate. The periods are one month long, since you wrote M in the field **Period** down left. Other possible values are Q, T, H and Y, for Quarter, Tertial, Halfyear and Year. This does not affect the numbers, only the texts. However, you can transfer your parameters to the complex menu **Reserves**, where all kinds of discounting are possible. There you can give a fixed interest rate or monthly varying ones. The period length is thus important in that menu.

Arguments

The report is for one triangle only. But you can have as input data several triangles with up to four arguments, which describe the parts of your business the triangles refers to. Of these you can choose one or two on which to break down the report.

On the next page is shown the beginning of a file with triangles for Region and LofBus (Line of Business). The data are lined up in straight columns, but that is not necessary; the numbers can be ragged.



Tw2.Txt - Anteckningar											
Arkiv Redigera Format Visa Hjälp											
: 07 02											
1154869	866904	914911	759049	570432	420314	310727	210007	113480	42980	14645	3551
915174	899449	778616	761364	542108	404250	271200	190419	123123	46520	13469	
881321	832191	852534	762917	571742	445778	316996	185706	104552	41427		
978317	887595	868805	726953	473488	374842	285407	200887	112257			
957778	744238	759673	740133	537435	406442	302438	209712				
1125051	867341	835157	874560	552761	416161	285309					
1150195	812247	779303	820949	530889	370754						
920624	742497	711754	597459	466118							
932854	756694	802235	748162								
891662	759337	782881									
941762	850581										
924221											
: 07 05											
1004778	909205	856579	719714	501414	324688	237959	164336	94745	39057	15449	3449
983827	890710	833001	676317	467144	290788	219639	147059	91365	34967	16037	
1065606	834015	845325	685544	514546	386859	275085	181894	102427	37727		
1133977	935567	947332	812081	595346	429527	279549	193519	97942			
997009	829028	843200	675368	499635	390080	281620	190717				
1022907	918124	860182	813900	539475	362327	237486					
1080821	901089	859650	737378	566963	429767						
1059620	826906	757131	663692	509690							
1090910	937175	920180	787310								
964701	922504	802535									
1171381	924929										
1175578											
: 07 07											
2994415	2581002	2468307	2288608	1643030	1222214	940741	628683	350678	152169	77088	17433
2866626	2610835	2573665	2264619	1672325	1196776	870830	589446	338503	150365	45945	
3247602	2614876	2682913	2204372	1585060	1162416	808658	536246	319112	117546		
3161291	2517134	2541143	2200572	1520427	1143044	803212	508993	298870			
2828390	2425594	2485450	2245463	1656914	1221119	876147	576822				

Two arguments describe each triangle. The first triangle is for Region 07 and LofBus 02.



You state these argument names in the menu:

Simple triangle based claim reserves by several methods with Rapp Right-click choices for info 2020 Stig Rosenlund

Open parmfile Save parmfile Save parmfile as Same data can be used in Reserves. Rapp

Files and folders Run View Xml GR Current parmfile: C:\Rapp\Sparm\DemoCh12.Txt

Namepart: y Descript: Per Region and LineOfBusiness

Method: Chainladder Arg names: Region LOfBus Include args: Region LOfBus [Argx Argy, x < y]

Select Region

Select LOfBus

Select

Select

Triangle or list files. Give the W-file or at least two of the W-, N- and D-files. W is the whole file. N is the Schnieper N-file and D the Schnieper D-file. For the Schnieper method at least two of the three files must be given. For format of a triangle or list, right-click here.

Infiles: W C:\Rapp\Data\Tw2.txt N D

Separate/aggregated: S1

Period: M [M=1 Q=3 T=4 H=6 Y=12] 1: st claimdate: 2012-01-01 Last claimdate: 2012-12-31 [Default end of last month]

Excel blanksep? ☒ Excel money unit: Asis Benktander/Bornhuetter-Ferguson/Cape-Cod/Schnieper file Edit

Read? ☐ Cre? ☐ File: E

At **Arg names** (red arrow) you write the names of at most four arguments.
 At **Include args:** (green arrow) you write the arguments for break down of the report.

Break-down on arguments

Now choose the break-down of the report at **Separate/aggregated** (blue arrow). Your choices are

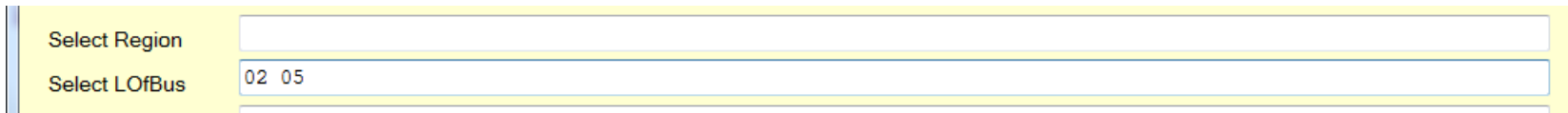
- T aggregated to a total
- S1 break-down on the first argument Region, and a total
- S2 break-down on the second argument LofBus, and a total
- S3 break-down on all combinations of Region and LofBus, and a total
- S4 as S3 but with partial totals over all LofBus for each Region

The predicted values in the partial total blocks of S4 will differ from the blocks of S1, since S1 computes Chainladder on the total triangle, while S3 and S4 compute Chainladder on the separate triangles.

With only Region at **Argnames** and **Include args:**, only T and S1 are valid.

Select data

For each of up to four arguments you can select data in boxes. Example:



Select Region	
Select LOfBus	02 05

The syntax for this is given if you right-click one of the boxes. Generally in Rappmenu right-click gives (almost) all necessary info.

You might of course prefer to select data before entering Rappmenus with a language such as R or SAS.

The Schnieper method

I assume you know this method, so you know that you need exposure. If nothing is known about the insurance policies, take the number of reported claims in the first development period. Create a file with dummy values:



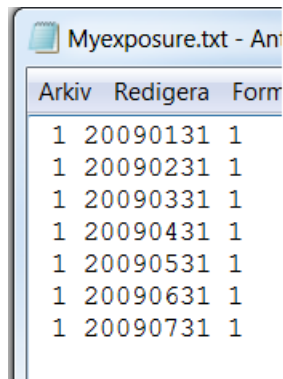
Period: M [M=1 Q=3 T=4 H=6 Y=12] 1: st claimdate: 2009-01-01 Last claimdate: 2009-07-31 [Default end of last month]

Excel blanksep? ☒ Excel money unit: Asis

Benktander/Bornhuetter-Ferguson/Cape-Cod/Schnieper file Edit

Read? ☐ Cre? ☒ File: C:\Rapp\Data\Myexposure1.txt E

A check at **Cre** will create the file at **Run**. Then click the Edit button **E** to fill in values:



Arkiv	Redigera	Form
1	20090131	1
1	20090231	1
1	20090331	1
1	20090431	1
1	20090531	1
1	20090631	1
1	20090731	1

Replace the 1:s in the last column with real values.

Save the file, uncheck **Cre** and check **Read**. Run again.

The procedure is the same for Benktander etc.

If you already had a file, write its name and make sure that **Read** is checked.



	A	B	C	Formelfält	E	F	G	H	I	J
1	2020-02-24	S. Reserve calculus with Schnieper. Per Region and LineOfBusiness.								
2										
3										
4		Obj data: Infile C:\Rapp\Data\Tw1.txt/C:\Rapp\Data\Tn1.txt/C:\Rapp\Data\Td1.txt, claim dates 20090101 - 20090731.								
5		Highest payment period index (1,2,...) included in object data: 7.								
6		Reserving method:								
7		Schnieper method of D- and N-triangles. Exposure file: Default computation (see manual).								
8		Liu & Verrall (2009) analytical prediction errors claim period 3 - 7:								
9		9114	25760	34363	36568	41084				
10										
11										
12		Segm: Tot								
13		Increment values real and fitted, payments, Schnieper								
14	Period i/j	1	2	3	4	5	6	7		
15	200901 1	7 500	21 400	23 700	31 900	-4 400	-3 200	2 600		
16	200902 2	1 600	13 200	17 300	7 500	15 400	5 000	3 149		
17	200903 3	13 800	28 600	-6 100	17 000	43 200	-1 136	2 000		
18	200904 4	2 900	11 100	18 500	14 400	17 412	1 128	2 973		
19	200905 5	2 900	6 900	42 900	18 381	18 706	-664	2 203		
20	200906 6	1 900	27 500	18 727	18 164	18 450	-309	2 355		
21	200907 7	19 100	23 149	17 803	18 731	19 119	-1 234	1 957		
22										
23		Accumulated values real and fitted, payments, Schnieper								
24	Period i/j	1	2	3	4	5	6	7		
25	200901 1	7 500	28 900	52 600	84 500	80 100	76 900	79 500		
26	200902 2	1 600	14 800	32 100	39 600	55 000	60 000	63 149		
27	200903 3	13 800	42 400	36 300	53 300	96 500	95 364	97 364		
28	200904 4	2 900	14 000	32 500	46 900	64 312	65 439	68 412		
29	200905 5	2 900	9 800	52 700	71 081	89 788	89 124	91 327		
30	200906 6	1 900	29 400	48 127	66 290	84 740	84 432	86 787		
31	200907 7	19 100	42 249	60 052	78 783	97 902	96 668	98 625		
32										
33										
34	Claimperiod	Paid	IbnsPaid	TotClcost						
35	200901 1	79 500	0	79 500						
36	200902 2	60 000	3 149	63 149						
37	200903 3	96 500	864	97 364						
38	200904 4	46 900	21 512	68 412						
39	200905 5	52 700	38 627	91 327						
40	200906 6	29 400	57 387	86 787						
41	200907 7	19 100	79 525	98 625						
42	Total	384 100	201 064	585 164						

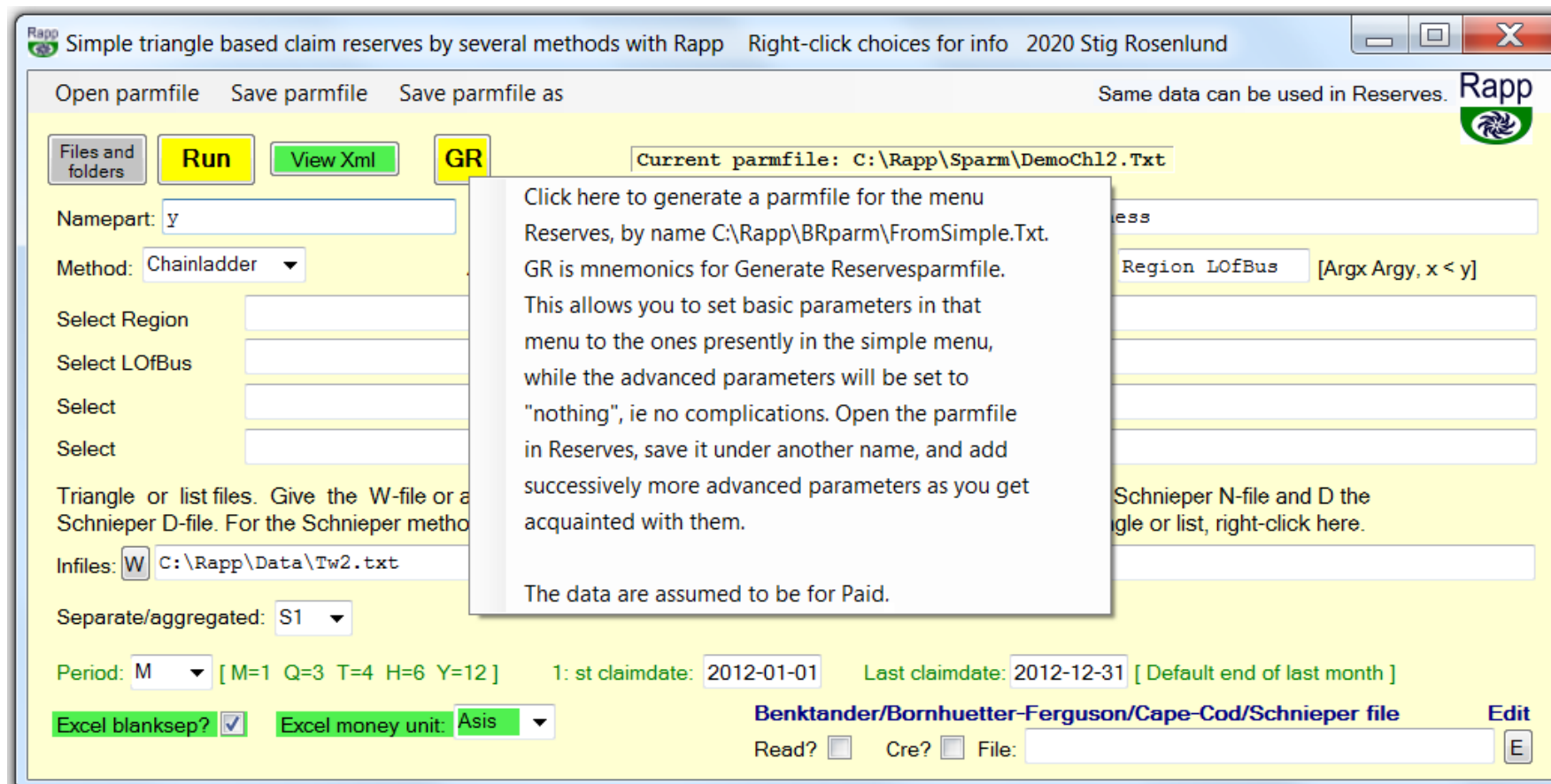
The beginning of the sheet shows the Liu & Verrall prediction errors.

I will not treat the other methods Benktander (Benktander-Hovinen) etc. in the following.

Transferring your parameters to the menu Reserves

Say you wish to compute tails or discount your reserves to 'Now' = End of last claimperiod, and to 'Then' = Middle of respective claimperiod.

Then transfer the simple menu to **Reserves** with the yellow fourth button **GR**, meaning Generate Reservesparmfile. Here I have right-clicked on it.





Close the simple menu and open Reserves. Open FromSimple.Txt and save it immediately as DemoCh2. You will see the following.

The upper part is the same as in the simple menu. But the lower part has a bewildering set of parameters.

The first complication is that you can write names for files with changes in Incurred, which means either a payment or a change in the reserve set by the claimhandler. But let us forget about that and say we only have payment data, as here. The roll-down box **Sim/Paid/Incurred** will then not matter - the results will be as if it were set to P.

(Red oval)

The second complication is that you can have detailed data, which would have many millions of lines for a not too small company. But we can forget about that also, for now.

Small/Top/All claims: requires detailed data. **Munich Chainladder?** requires both Paid and Incurred. So we forget also about these.

Different groups of parameters have different colors, described under button **Colors** in the first menu. I will deal with the following groups.



Discounting rates in percent per year

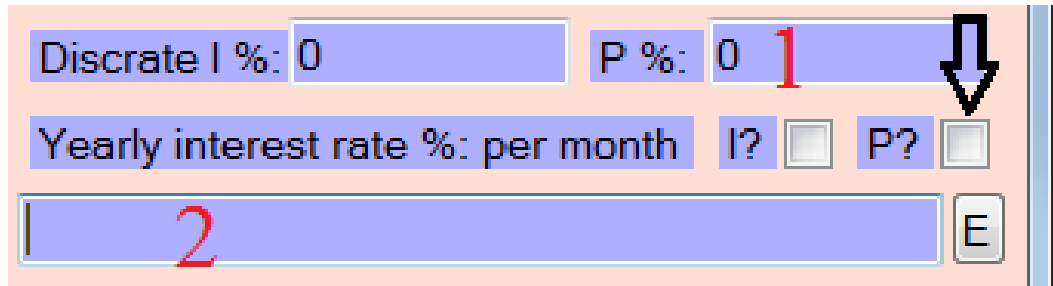


Inflation correction parameters



Tail parameters

In this part of the menu I put numbers 1 and 2 on the interest rate fields.



The screenshot shows a menu interface with several input fields and buttons. The 'Discrate I %' field contains '0'. The 'P %' field contains '0' followed by a red '1'. A black arrow points down to the 'P %' field. Below this, the 'Yearly interest rate %' is set to 'per month'. There are checkboxes for 'I?' and 'P?'. At the bottom, a large input field contains a red '2', and an 'E' button is to its right.

1. Yearly interest rate percent for discounting of known increments to the middle of each claimperiod before computation of reserves.
2. A text file with interest rates per month.

If you write 5 at **1** for example, then all increments are discounted with 5 percent per year from the middle of the payment period to the middle of the claimperiod when the claims on that line in the triangle occurred. Then reserves are computed, under the assumption that future interest rates will also be 5 percent.

If you write the name of a file at **2**, it shall contain lines with month and the interest rate in effect that month, for example 201911 4.3. Months are written in the form YYYYMM. The difference to **1** is that reserves are computed from undiscounted increments. You might want to do that with a fixed interest rate – in that case make a file with all rates the same. All

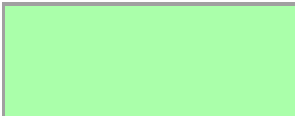
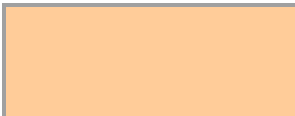
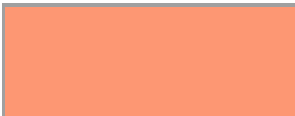
months in the past and the future that the increments quadrat (triangle and predicted values) covers must be covered. Also future months for a tail, if one is predicted, must be covered.

Check the box at the arrow. Create or edit the file with the E button.

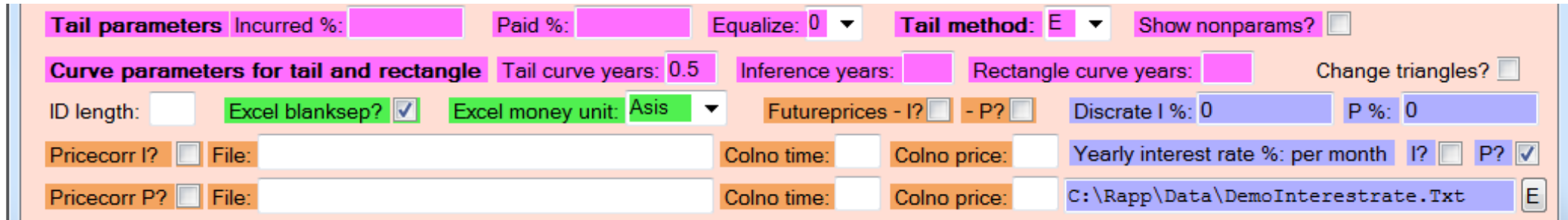
The output Excel file will in both cases show undiscounted payments as well as discounted to both of

'now' = end of latest claim period in the triangle

'then' = middle of claim period when the claims occurred

	Detail	Total	
Coloring:			Paid values undiscounted
			Paid values discounted to 'now'
			Paid values discounted to 'then'

Before the output I will demonstrate inflation correction and tail computation.



The screenshot shows the Rapp software interface with the following parameters:

- Tail parameters:** Incurred %: [empty], Paid %: [empty], Equalize: 0, Tail method: E, Show nonparams? ☐
- Curve parameters for tail and rectangle:** Tail curve years: 0.5, Inference years: [empty], Rectangle curve years: [empty], Change triangles? ☐
- Other parameters:** ID length: [empty], Excel blanksep? ☒, Excel money unit: Asis, Futureprices - I? ☐, - P? ☐, Discrete I %: 0, P %: 0, Pricecorr I? ☐, File: [empty], Colno time: [empty], Colno price: [empty], Yearly interest rate %: per month, I? ☐, P? ☒, Pricecorr P? ☐, File: [empty], Colno time: [empty], Colno price: [empty], C:\Rapp\Data\DemoInterestrate.Txt, E

Here an interest rate file is used. Brown labels denote inflation correction, where you can write a text file with price indices such as CPI. You can correct for past inflation, and also for future inflation if you check after **Futureprices**. Find out the details about this by right-click.

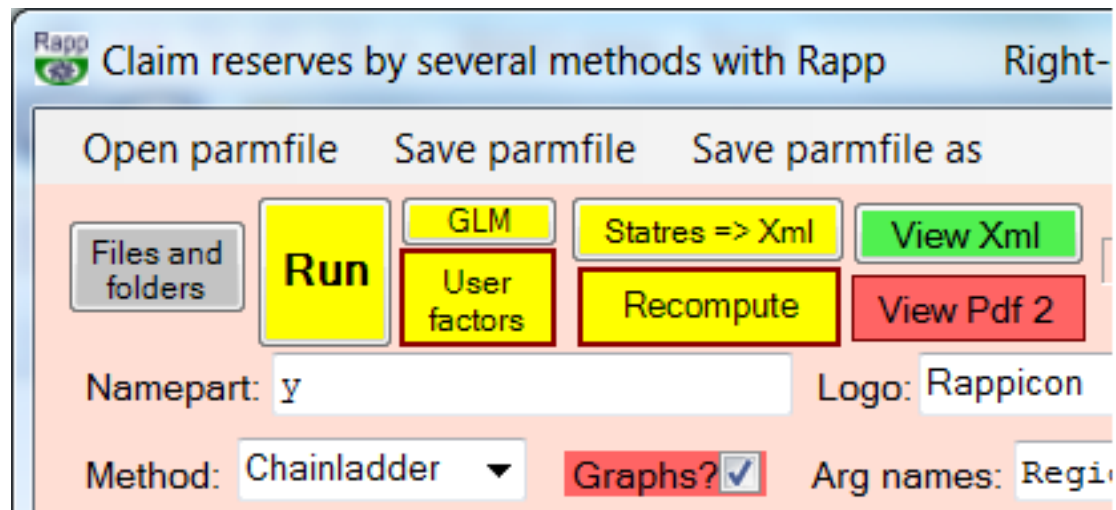
Tail method: E instructs Rapp to use an exponential tail. Read about other method by right-click and in the Rapp manual. **Tail curve years: 0.5** means that six more months are assumed to have payments. In all 18 months, since the period is month. Find out about the other parameters by right-click.

Output showing the total over all regions on next page. Such output for each region will be above that shown here.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	2020-02-25,	S. Reserve calculus with Chainladder. Paid ----- Per Region and LineOfBusiness.												
132														
133	Region: Total													
134	Increment values real and fitted, payments, Chainladder													
135	Period i/j	1	2	3	4	5	6	7	8	9	10	11	12	Tail
136	201201 1	9 301 758	7 925 503	7 570 866	7 556 090	5 419 568	3 979 298	2 951 502	2 033 691	1 130 833	484 657	230 512	61 362	333 390
137	201202 2	8 916 908	7 893 841	7 511 470	7 367 784	5 191 723	3 795 413	2 809 815	1 876 989	1 116 788	525 244	228 217	59 726	324 126
138	201203 3	9 444 671	8 005 894	7 801 404	7 472 963	5 396 361	3 871 254	2 792 116	1 886 814	1 131 895	482 801	232 799	61 452	332 943
139	201204 4	9 510 854	7 872 859	7 844 250	7 731 778	5 478 512	4 041 340	2 896 682	1 976 958	1 138 343	510 786	237 060	62 578	337 889
140	201205 5	8 965 786	7 584 869	7 646 577	7 369 728	5 322 602	3 904 683	2 843 684	1 894 346	1 106 150	490 820	227 675	60 100	324 970
141	201206 6	9 393 544	8 091 722	7 589 720	7 549 178	5 440 616	3 978 118	2 763 943	1 950 738	1 134 509	502 976	233 036	61 513	333 692
142	201207 7	9 159 533	7 781 034	7 380 231	7 594 833	5 335 770	3 893 744	2 803 239	1 908 585	1 109 015	490 568	226 568	59 802	327 204
143	201208 8	9 007 177	7 645 565	7 182 768	6 936 788	5 151 746	3 747 502	2 710 379	1 846 377	1 074 063	476 458	220 932	58 319	315 657
144	201209 9	9 430 346	7 841 779	7 625 334	7 735 216	5 368 363	3 920 583	2 834 691	1 930 413	1 122 186	496 946	229 873	60 677	330 586
145	201210 10	8 681 397	7 453 846	7 285 230	7 083 209	5 088 234	3 716 017	2 688 063	1 831 514	1 065 816	473 250	219 737	58 006	312 821
146	201211 11	9 657 357	7 809 466	7 757 608	7 578 051	5 446 329	3 977 512	2 874 931	1 957 131	1 136 911	502 555	231 875	61 201	335 757
147	201212 12	9 223 845	7 808 842	7 562 999	7 413 336	5 326 690	3 890 151	2 812 885	1 915 711	1 113 813	493 434	228 376	60 282	327 940
148														
149	Accumulated values real and fitted, payments, Chainladder													
150	Period i/j	1	2	3	4	5	6	7	8	9	10	11	12	IncTail
151	201201 1	9 301 758	17 227 261	24 798 127	32 354 217	37 773 785	41 753 083	44 704 585	46 738 276	47 869 109	48 353 766	48 584 278	48 645 640	48 979 030
152	201202 2	8 916 908	16 810 749	24 322 219	31 690 003	36 881 726	40 677 139	43 486 954	45 363 943	46 480 731	47 005 975	47 234 192	47 293 918	47 618 044
153	201203 3	9 444 671	17 450 565	25 251 969	32 724 932	38 121 293	41 992 547	44 784 663	46 671 477	47 803 372	48 286 173	48 518 972	48 580 424	48 913 367
154	201204 4	9 510 854	17 383 713	25 227 963	32 959 741	38 438 253	42 479 593	45 376 275	47 353 233	48 491 576	49 002 362	49 239 423	49 302 001	49 639 889
155	201205 5	8 965 786	16 550 655	24 197 232	31 566 960	36 889 562	40 794 245	43 637 929	45 532 275	46 638 425	47 129 245	47 356 920	47 417 020	47 741 990
156	201206 6	9 393 544	17 485 266	25 074 986	32 624 164	38 064 780	42 042 898	44 806 841	46 757 579	47 892 088	48 395 064	48 628 100	48 689 614	49 023 305
157	201207 7	9 159 533	16 940 567	24 320 798	31 915 631	37 251 401	41 145 145	43 948 384	45 856 969	46 965 983	47 456 551	47 683 120	47 742 922	48 070 125
158	201208 8	9 007 177	16 652 742	23 835 510	30 772 298	35 924 044	39 671 546	42 381 926	44 228 303	45 302 365	45 778 823	45 999 755	46 058 074	46 373 731
159	201209 9	9 430 346	17 272 125	24 897 459	32 272 675	37 641 038	41 561 621	44 396 311	46 326 724	47 448 911	47 945 857	48 175 730	48 236 406	48 566 992
160	201210 10	8 681 397	16 135 243	23 420 473	30 503 682	35 591 915	39 307 932	41 995 995	43 827 509	44 893 325	45 366 575	45 586 312	45 644 318	45 957 139
161	201211 11	9 657 357	17 466 823	25 224 431	32 802 483	38 248 811	42 226 323	45 101 255	47 058 386	48 195 297	48 697 853	48 929 728	48 990 929	49 326 686
162	201212 12	9 223 845	17 032 687	24 595 686	32 009 022	37 335 712	41 225 863	44 038 748	45 954 459	47 068 272	47 561 706	47 790 082	47 850 364	48 178 304
163														
164	Method: Chainladder.													
165														
166	6 tail periods, 12 estimate devperiods / Paid (tail periods = # periods after last available development-period 12). Tail method: Exponential.													
167	Yearly interest-rate curve in file C:\Rapp\Data\DemoInterestrate.Txt for discounting of payments to 'now' = end of claimperiod 201212 and 'then' = Middle of claimperiod.													
168	Future payments assumed made medio each claimperiod. Future payments up to and including development-period 12 predicted with Chainladder.													
169	Quantities discounted to 'now' have redbrown background. Quantities discounted to 'then' have scarlet background.													
170														
171	Claimperiod	Paid	IbnsPaid	TailPaid	Ib+Ta/Paid	TotClcost	IbnsPaid	TailPaid	Ib+Ta/Paid	Paid	IbnsPaid	TailPaid	TotClcost	
172	201201 1	48 645 640	0	333 390	333 390	48 979 030	0	332 316	332 316	48 365 086	0	324 309	48 689 395	
173	201202 2	47 234 192	59 726	324 126	383 852	47 618 044	59 674	322 434	382 108	46 948 323	58 342	315 236	47 321 901	
174	201203 3	48 286 173	294 251	332 943	627 194	48 913 367	293 885	330 492	624 377	47 988 759	287 893	323 753	48 600 405	
175	201204 4	48 491 576	810 425	337 889	1 148 313	49 639 889	809 058	334 637	1 143 695	48 189 246	794 258	328 516	49 312 019	
176	201205 5	45 532 275	1 884 745	324 970	2 209 715	47 741 990	1 881 009	321 081	2 202 091	45 259 767	1 850 855	315 934	47 426 556	
177	201206 6	44 806 841	3 882 773	333 692	4 216 464	49 023 305	3 873 577	328 908	4 202 485	44 570 698	3 821 035	324 446	48 716 179	
178	201207 7	41 145 145	6 597 777	327 204	6 924 980	48 070 125	6 579 029	321 768	6 900 797	40 962 368	6 506 321	318 211	47 786 900	
179	201208 8	35 924 044	10 134 030	315 657	10 449 687	46 373 731	10 100 004	309 750	10 409 754	35 796 105	10 011 394	307 033	46 114 531	
180	201209 9	32 272 675	15 963 731	330 586	16 294 317	48 566 992	15 902 245	323 748	16 225 993	32 184 089	15 795 841	321 581	48 301 512	
181	201210 10	23 420 473	22 223 845	312 821	22 536 666	45 957 139	22 128 465	305 753	22 434 217	23 378 501	22 024 780	304 320	45 707 601	
182	201211 11	17 466 823	31 524 106	335 757	31 859 863	49 326 686	31 366 612	327 545	31 694 156	17 452 356	31 280 130	326 641	49 059 127	
183	201212 12	9 223 845	38 626 519	327 940	38 954 459	48 178 304	38 401 231	319 316	38 720 547	9 223 845	38 366 428	319 027	47 909 299	
184	Total	442 449 702	132 001 927	3 936 974	135 938 901	578 388 603	131 394 789	3 877 746	135 272 535	440 319 144	130 797 274	3 829 007	574 945 425	
185														
	Chainladder	Reverse	Paid	Mack	+									

Graphs

Now a final demonstration of what you can do to show your results, namely to make graphs in Pdf.



Check **Graphs?**

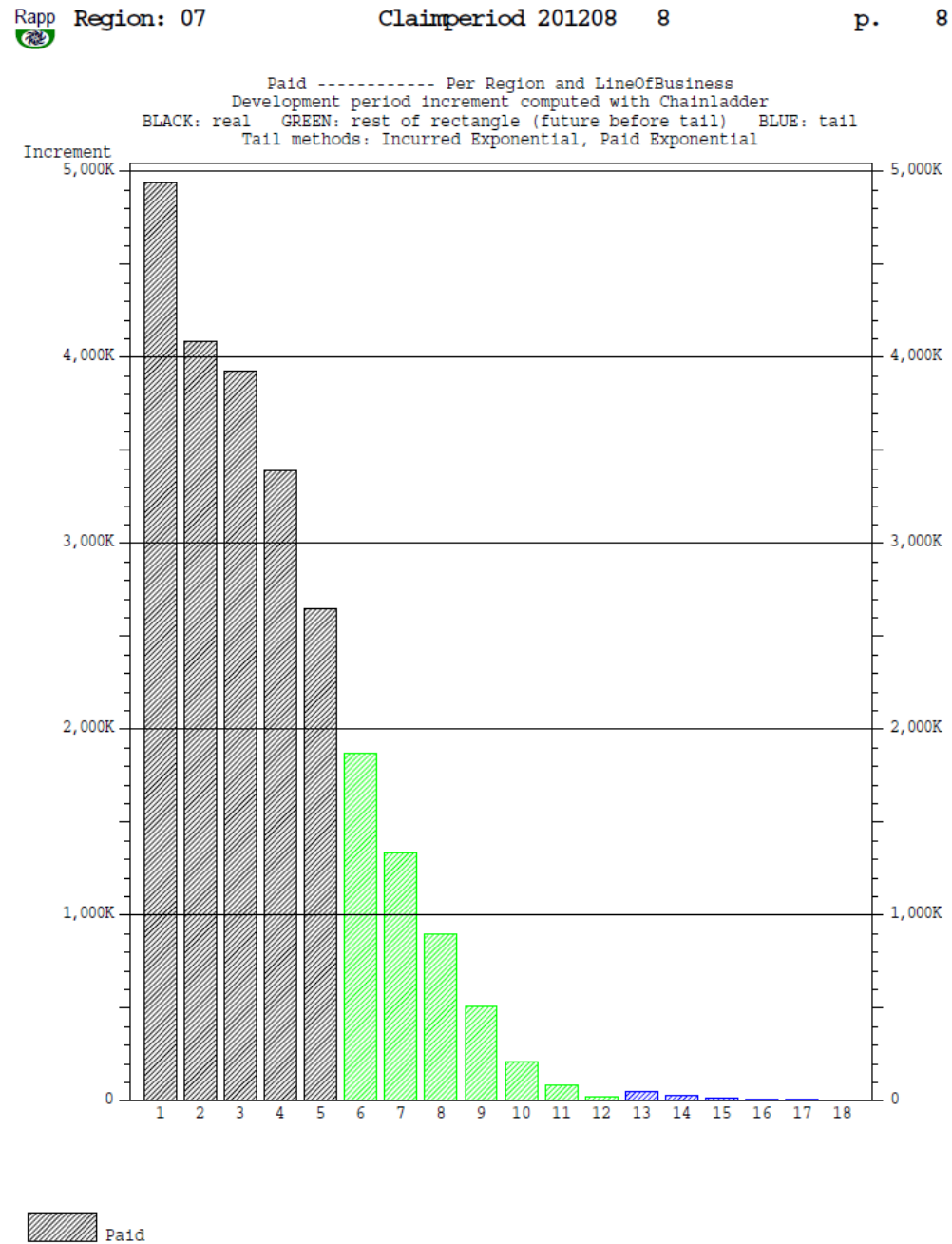
There are several graphs made. After Run, press **View Pdf 2** to see one.

One of the pages of Pdf 2 is shown on the next page. It illustrates increments with different colors for known, Chainladder predicted, and tails according to your parameters.



Lecture on claim reserving with Rapp

2020-03-19, Stig Rosenlund



The RDC method

RDC = Reserve by Detailed Conditioning. I developed this method in 2011 and it was published in 2012.

This detailed conditioning means that the method is suitable for when there are many claims in the history, for example in large consumer insurance lines.

The method requires a text file with individual payments. Each line shall have the unique claim ID, four arguments that can be dummies with values only of X's, a flag for 0/1 for small/top claim that can be only 0's, claim date, report date, paydate, settlement date and paid amount.

Example of lines with a header. (The header is not part of the data.)

ID	A1	A2	A3	A4	T	Claimdt	Reportdt	Paydt	Settledt	Payamount
02123455111234THEFT	02	01	L1	110	0	19940103	19940121	19940301	19940901	1234
02123455111234THEFT	02	01	L1	110	0	19940103	19940121	19940415	19940901	345

If you have another text file with changes in Incurred for the same claims, then you can get more info in your reports. But I will not go into that here.

There are some more technical requirements for these text files, which you can find in the manual Resvmane.pdf. This manual is accessed by the red button **Manual 1** down right, if you downloaded the Rapp package.

Since in a typical application suitable for RDC you will have several millions text lines, the method takes slightly more time than Chainladder with Rapp. But if you program the method yourself, using Python, R or SAS, then you will get very long waiting times.

Databases with each payment and each change in Incurred, from which files for RDC can be made, exist at large Swedish insurance companies. They are not unrealizable fantasies.

In claim reserving we use these concepts.

- IBNS Incurred But Not Settled
- RBNS Reported But Not Settled
- IBNR Incurred But Not Reported



With RDC you can split the IBNS reserve into RBNS and IBNR. You can also obtain individual RBNS reserves for each claim. Now open DemoRDC3.

At the red arrow is RDC from the dropdown box. At the green arrow is a file with 1,710,629 fictitious payments, part of the Rapp package. At the blue arrows is a checkmark and a file, that we shall fill with statistical RBNS reserves for each claim. The I file is not used.

The yellow arrow is where to put the statistical reserves into Excel.

You can smooth the statistical reserves' dependence on the arguments with GLM.

A monthly interest rate file is written and checked, which means that the statistical reserves will be undiscounted. With a fixed rate they will be discounted to the middle of the claimperiod for the claim, so they will be smaller.

There are several sheets dividing the IBNS into IBNR and RBNS.

P is for Payments. I is for IBNR. R is for RBNS. u is for undiscounted.

Q is for Quadrats.

- P-IR-u Undiscounted values summed
- P-IR-Q-u Undiscounted values in quadrats (triangles and predictions)
- P-IR Discounted values summed
- P-IR-Q Discounted values in quadrats (triangles and predictions)

Redbrown is for discounting to 'now' and scarlet for discounting to 'then'.

The sheet P-IR is shown on the next page.



	A		B		C		D		E		F		G		H		I		J		K	
1	2020-03-01, Paid Per Region and LineOfBusiness: IBNR- and RBNS-reserves																					
2	All triangle/rectangle values and all background colored integer numerics are in thousands.																					
3	Per segment and claimperiod discounted w rates in C:\Rapp\Data\Demointerestrates.Txt to mid of claimper. And to end of now.																					
4	----- IBNR ----- RBNS ----- -- TOTAL --- -- Reserves discounted to end of now ---																					
5	Segment	Claimper	i	ClaimNumber	MeanReserve	IBNR-Reserve	ClaimNumber	MeanReserve	RBNS-Reserve	IBNS-reserve	IBNR-reserve	RBNS-reserve	IBNS-reserve									
6	07	201201	1	0,00	0	0	4701,00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	07	201202	2	0,00	0	0	4723,00	0	18	18	0	18	18	0	18	18	0	18	18	0	18	
8	07	201203	3	0,00	0	0	4739,00	0	119	119	0	122	122	0	122	122	0	122	122	0	122	
9	07	201204	4	0,00	0	0	4670,00	0	334	334	0	340	340	0	340	340	0	340	340	0	340	
10	07	201205	5	0,00	0	0	4611,00	0	942	942	0	957	957	0	957	957	0	957	957	0	957	
11	07	201206	6	0,00	0	0	4860,00	0	1 803	1 803	0	1 828	1 828	0	1 828	1 828	0	1 828	1 828	0	1 828	
12	07	201207	7	0,00	0	0	4758,00	1	3 531	3 531	0	3 571	3 571	0	3 571	3 571	0	3 571	3 571	0	3 571	
13	07	201208	8	0,00	0	0	4622,00	1	5 388	5 388	0	5 435	5 435	0	5 435	5 435	0	5 435	5 435	0	5 435	
14	07	201209	9	0,00	0	0	4791,00	2	7 890	7 890	0	7 943	7 943	0	7 943	7 943	0	7 943	7 943	0	7 943	
15	07	201210	10	411,87	5	2 194	4157,00	2	9 400	11 594	2 204	9 445	11 649	0	9 445	11 649	0	9 445	11 649	0	9 445	
16	07	201211	11	1080,67	5	5 762	3628,00	3	10 219	15 980	5 778	10 247	16 025	0	10 247	16 025	0	10 247	16 025	0	10 247	
17	07	201212	12	1713,45	5	9 143	3082,00	4	11 321	20 464	9 151	11 331	20 483	0	11 331	20 483	0	11 331	20 483	0	11 331	
18	38	201201	1	0,00	0	0	4710,00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
19	38	201202	2	0,00	0	0	4687,00	0	59	59	0	61	61	0	61	61	0	61	61	0	61	
20	38	201203	3	0,00	0	0	4749,00	0	218	218	0	222	222	0	222	222	0	222	222	0	222	
21	38	201204	4	0,00	0	0	4681,00	0	494	494	0	504	504	0	504	504	0	504	504	0	504	
22	38	201205	5	0,00	0	0	4661,00	0	1 035	1 035	0	1 052	1 052	0	1 052	1 052	0	1 052	1 052	0	1 052	
23	38	201206	6	0,00	0	0	4647,00	0	2 004	2 004	0	2 032	2 032	0	2 032	2 032	0	2 032	2 032	0	2 032	
24	38	201207	7	0,00	0	0	4596,00	1	3 341	3 341	0	3 379	3 379	0	3 379	3 379	0	3 379	3 379	0	3 379	
25	38	201208	8	0,00	0	0	4705,00	1	5 153	5 153	0	5 199	5 199	0	5 199	5 199	0	5 199	5 199	0	5 199	
26	38	201209	9	0,00	0	0	4713,00	2	7 742	7 742	0	7 794	7 794	0	7 794	7 794	0	7 794	7 794	0	7 794	
27	38	201210	10	803,94	5	3 901	3817,00	2	7 606	11 507	3 919	7 641	11 561	0	7 641	11 561	0	7 641	11 561	0	7 641	
28	38	201211	11	1410,41	5	6 849	3296,00	2	8 067	14 916	6 868	8 089	14 957	0	8 089	14 957	0	8 089	14 957	0	8 089	
29	38	201212	12	1908,27	5	9 272	2665,00	3	8 905	18 177	9 281	8 913	18 193	0	8 913	18 193	0	8 913	18 193	0	8 913	
30	All segm	201201	1	0,00	0	0	9411,00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
31	All segm	201202	2	0,00	0	0	9410,00	0	77	77	0	79	79	0	79	79	0	79	79	0	79	
32	All segm	201203	3	0,00	0	0	9488,00	0	337	337	0	344	344	0	344	344	0	344	344	0	344	
33	All segm	201204	4	0,00	0	0	9351,00	0	828	828	0	844	844	0	844	844	0	844	844	0	844	
34	All segm	201205	5	0,00	0	0	9272,00	0	1 976	1 976	0	2 009	2 009	0	2 009	2 009	0	2 009	2 009	0	2 009	
35	All segm	201206	6	0,00	0	0	9507,00	0	3 807	3 807	0	3 860	3 860	0	3 860	3 860	0	3 860	3 860	0	3 860	
36	All segm	201207	7	0,00	0	0	9354,00	1	6 873	6 873	0	6 949	6 949	0	6 949	6 949	0	6 949	6 949	0	6 949	
37	All segm	201208	8	0,00	0	0	9327,00	1	10 541	10 541	0	10 634	10 634	0	10 634	10 634	0	10 634	10 634	0	10 634	
38	All segm	201209	9	0,00	0	0	9504,00	2	15 632	15 632	0	15 737	15 737	0	15 737	15 737	0	15 737	15 737	0	15 737	
39	All segm	201210	10	1215,81	5	6 095	7974,00	2	17 006	23 100	6 123	17 086	23 209	0	17 086	23 209	0	17 086	23 209	0	17 086	
40	All segm	201211	11	2491,08	5	12 611	6924,00	3	18 285	30 896	12 646	18 336	30 981	0	18 336	30 981	0	18 336	30 981	0	18 336	
41	All segm	201212	12	3621,72	5	18 415	5747,00	4	20 226	38 641	18 432	20 244	38 676	0	20 244	38 676	0	20 244	38 676	0	20 244	
42	Total	All clp		7328,61	5	37 120	105269,00	1	95 588	132 709	37 201	96 122	133 322									
	<	RDC	Reverse	P-IR-u	P-IR-Q-u	Paid	P-IR	P-IR-Q	ClaimNo	+	:	<										



More info is found by right-click on the various labels and boxes, and in the two manuals accessed by the red buttons at the bottom right of the menu Reserves.

Other capabilities of Rapp might be topics for future lectures.