

# ELRF™

## Best's Schedule P 2019



# ELRF™ Best's Schedule P 2019

Exclusive to Best's Financial Suite - P/C, US subscribers

Insureware and AM Best have created ELRF™ Best's Schedule P 2019. This application, freely available with a Best's Financial Suite - P/C, US subscription, is pre-loaded with Best's Financial Suite - P/C, US data in an ICRFS™ structured database primed for Insureware's analytical tools.

## Structured access to Best's Financial Suite - P/C, US data

Secure the information you need fast!

Empowered with this application you will obtain:

- Offline access to Best's Financial Suite - P/C, US data and derived financial metrics in an ELRF™ structured database.
- Pre-calculated critical financial information:
  - o Reserves Held;
  - o %IBNR;
  - o Total Loss Ratio;
  - o Survival Ratios; and
  - o Much more!

Drill down by classification variables and sort metrics to glean hidden insights.

- All available Best's Financial Suite - P/C, US triangles:
  - o Paid losses;
  - o Case Reserve Estimates;
  - o Incurred Losses (not including BULK and IBNR);
  - o Bulk and IBNR;
  - o Number of Claims Reported; and
  - o Number of Claims Closed.

Acquire any Best's Financial Suite - P/C, US loss development array data for trend analysis instantly.

- Additional triangles:
  - o Reserves Held (CRE + BULK and IBNR); and
  - o Ultimates Held (Incurred Losses including BULK and IBNR).

Construct a complete picture of a company's reported liabilities, their holdings, and their financial positioning in the industry.

The screenshot displays the 'Best's Schedule P 2019: 33852 TGs total' window. It features a 'Triangle Groups' tab with a 'Tree View' and 'Query View'. The 'Tree View' on the left lists various metrics like 'Type of TG', 'Valuation Date', 'Sampling Period', 'Currency', 'Line of Business', 'Reserves Held', 'Ultimates Held', 'Survival Ratio', 'Adj Survival Ratio', 'Relative Survival Ratio', 'Loss Ratio', 'Total Earned Premium', 'Total Gross Earned Premium', '% IBNR', 'Aggregation', 'Diversions', and '% Premium ceded'. The main table shows a list of triangles with columns for 'Triangle Group', 'Line of Business', 'Reserves Held', 'Ultimates Held', 'Survival Ratio', 'Adj Survival Ratio', and 'Relative Survival Ratio'. The data is sorted by 'Survival Ratio' in descending order.

Triangle Group	Line of Business	Reserves Held	Ultimates Held	Survival Ratio	Adj Survival Ratio	Relative Survival Ratio
1st Atlantic Surety Co., 20032_Alt_10x10	Z-Alt L0B's Com...	142	521	3.09	2.43	0.99
1st Atlantic Surety Co., 20032_Alt_20x10	Z-Alt L0B's Com...	142	521	3.09	2.43	0.99
1st Auto & Casualty Ins Co., 11233_Alt_10x10	Z-Alt L0B's Com...	3,969	127,193	0.87	0.84	0.28
1st Auto & Casualty Ins Co., 11233_Alt_20x10	Z-Alt L0B's Com...	3,969	127,193	0.87	0.84	0.28
1st Auto & Casualty Ins Co., 11233_CAL_10x10	C-Commercial A...	292	2,408	1.07	1.01	0.40
1st Auto & Casualty Ins Co., 11233_CAL_20x10	C-Commercial A...	292	2,408	1.07	1.01	0.40
1st Auto & Casualty Ins Co., 11233_OLOcc_10x10	H1 Other Liabil...	151	509	4.08	2.95	0.90
1st Auto & Casualty Ins Co., 11233_OLOcc_20x10	H1 Other Liabil...	151	509	4.08	2.95	0.90
1st Auto & Casualty Ins Co., 11233_FPA_10x10	B-Private Pass...	3,233	61,236	0.72	0.68	0.33
1st Auto & Casualty Ins Co., 11233_FPA_20x10	B-Private Pass...	3,233	61,236	0.72	0.68	0.33
1st Auto & Casualty Ins Co., 11233_Short_10x10	Y-Short L0B's C...	293	63,040	-1.43	-1.42	-0.72
1st Auto & Casualty Ins Co., 11233_Short_20x10	Y-Short L0B's C...	293	63,040	-1.43	-1.42	-0.72
1st Choice Advantage Ins Co., 12427_Alt_10x10	Z-Alt L0B's Com...	5,061	62,262	2.00	1.99	0.64
1st Choice Advantage Ins Co., 12427_Alt_20x10	Z-Alt L0B's Com...	5,061	62,262	2.00	1.99	0.64
1st Choice Advantage Ins Co., 12427_CAL_10x10	C-Commercial A...	1,653	9,041	2.40	2.30	0.91
1st Choice Advantage Ins Co., 12427_CAL_20x10	C-Commercial A...	1,653	9,041	2.40	2.30	0.91

# Analytical tools including the Mack method and the bootstrap technique



Two modeling frameworks are included: the Extended Link Ratio Family (ELRF) and Link Ratio Techniques (LRT). The ELRF module formulates link ratio methods as regression estimators and extends them.

ELRF models include:

- Mack (regression formulation of volume weighted average, chain ladder);
- Exclusion of whole periods or individual points from estimations;
- Murphy;
- Bornhuetter-Ferguson; and
- Much more!

Within an interactive, intuitive, graphical interface.

Comprehensive diagnostic tests validate that assumptions made by link ratio and related methods are carried by the data - including the bootstrap technique.

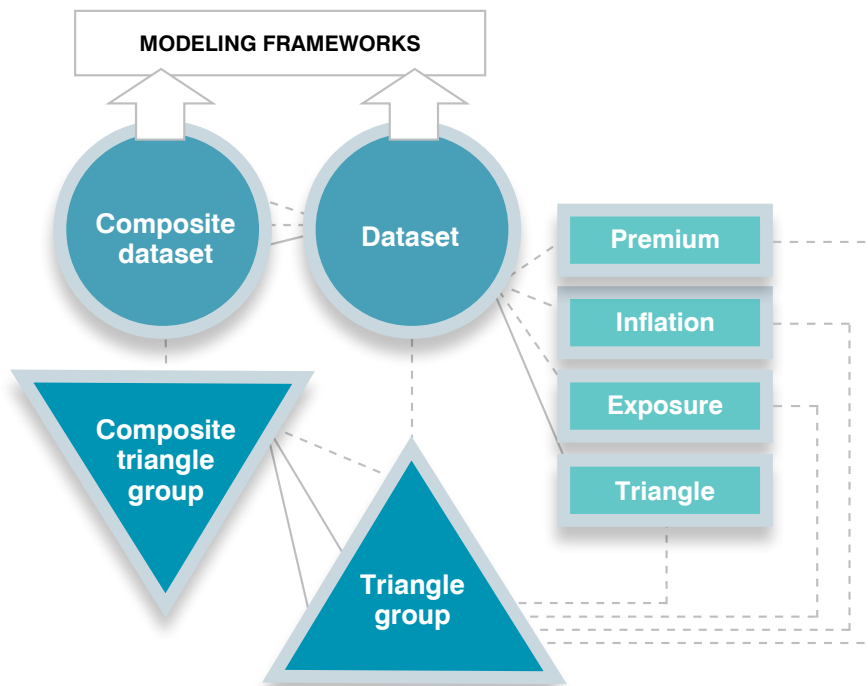
Link ratio techniques:

- Volume weighted average, Chain ladder;
- Arithmetic average;
- Last N diagonal weighted average;
- Two parameter smoothing;
- Three parameter smoothing;
- Bornhuetter-Ferguson; and
- Much more!

## ELRF™ Best's Schedule P 2019 data organization

Best's Financial Suite - P/C, US data are grouped by company and Line of Business into triangle groups.

In Insureware parlance, triangle groups contain data (triangles, premiums, exposures, models, and more) related to the same Line of Business – or other grouping category. These building blocks are then provided to the modeling frameworks for analysis.



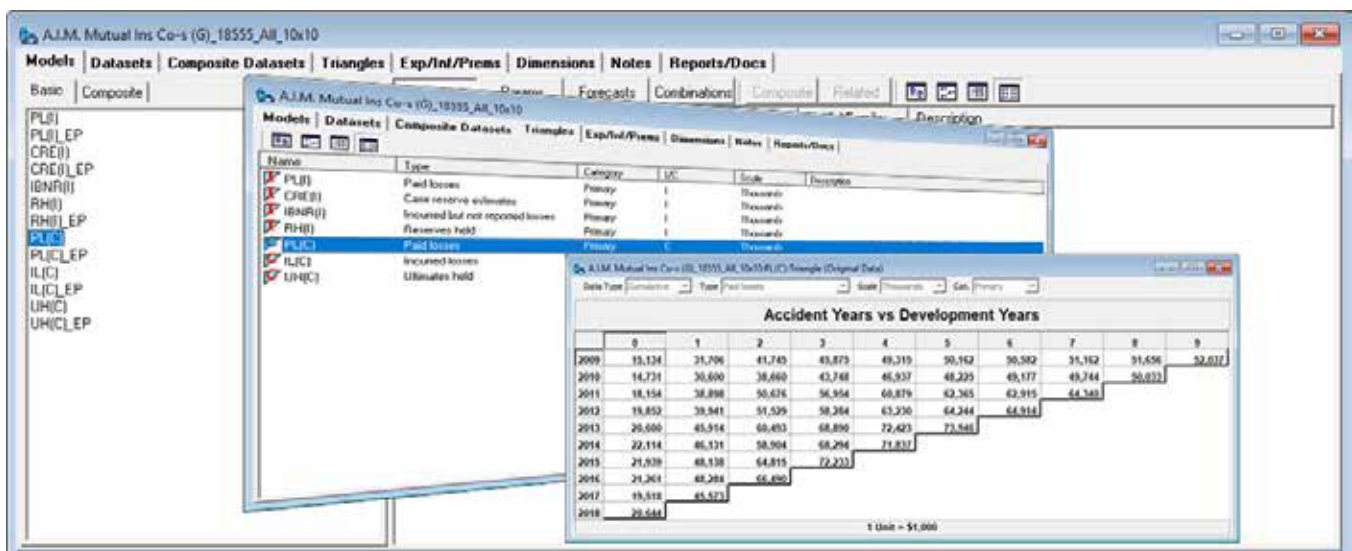
Triangle groups contain building blocks for easy analysis:

- Triangles (loss development arrays);
- Exposure, Inflation, Premium vectors; and
- Datasets which link triangles with [optional] exposure, inflation or premium vectors.

Net data are available in triangle format for ready analysis. The last calendar year of Gross data are stored in vector format where available).

### Inside a Triangle Group

Some contents of the triangle groups are shown below:





## Database navigation

Two main views are presented to enable quick access of information: tree view and query view. These two views are structurally similar, but activate different combinations of exploratory filters in the ELRF™ Best's Schedule P 2019 database.

## Navigation via Tree View

The tree view navigation panel empowers the user to drill down into the Best's Financial Suite - P/C, US data by selecting single values from any number of variable categories. Each subsequent filter further focuses the query.

For instance, the image below illustrates the sequential procedure to filter from the 30,000 triangle groups in the ELRF™ Best's Schedule P 2019 database to 70 triangle groups with particular characteristics.

The screenshots illustrate the sequential procedure to filter from the 30,000 triangle groups in the ELRF™ Best's Schedule P 2019 database to 70 triangle groups with particular characteristics:

1. Select a top level variable – here Line of Business.
2. Choose a subcategory – eg: B-Private Passenger Auto Liability.
3. Select Aggregation – AMB Group was chosen as the sub category.
4. Add the attribute Dimensions 10x10 to the filter.
5. Finally, choose Survival Ratios between  $2 < SR \leq 3$  to complete the query.
6. Sort by Reserves Held to order the companies from largest to smallest by held reserves.

The final screenshot shows a table with the following columns: Triangle Group, Line of Business, Reserves Held, Unretained Held, Survival Ratio, Adj Survival Ratio, Relative Survival Ratio, Adj Relative Survival Ratio, Loss Ratio, and Relative Loss Ratio. The table lists various insurance companies and their corresponding financial metrics.

1. Select a top level variable – here Line of Business.
2. Choose a subcategory – eg: B-Private Passenger Auto Liability.
3. Select Aggregation – AMB Group was chosen as the sub category.
4. Add the attribute Dimensions 10x10 to the filter.
5. Finally, choose Survival Ratios between  $2 < SR \leq 3$  to complete the query.
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In tree view, any sub-category can be included once and acts as a refinement of the previous query. Within a few mouse clicks, a small number of Best's Financial Suite - P/C, US triangle groups can be identified matching the attributes selected.

The results of tree view queries are shown immediately on selection of the filter. All operations are designed for maximum performance enabling analysts to obtain the data quickly and effortlessly.

## Navigation via Query View

The query view navigation panel provides a more flexible methodology of constructing queries into the ELRF™ Best's Schedule P 2019 database.

- Any variable can be searched with basic support for wild-cards;
- Single or multiple values can be selected from the same classification variable;
- Queries can be set to run automatically (default) or manually.

The screenshots illustrate the steps to construct a query in the ELRF Best's Schedule P 2019 Query View:

1. Select 'State' in the Triangle Groups list.
2. Select 'B-Private Passenger Auto Li', 'C-Commercial Auto/Truck Li', and 'Z-All LOBs Combined' in the Line of Business list.
3. Select 'AMB Group' and 'Unaffiliated Single Company' in the Aggregation list.
4. The resulting data table shows the following columns: Triangle Group, Line of Business, Reserves Held, Ultimate Held, Survival Ratio, Adj Survival Ratio, Relative Survival Ratio, Adj Relative Survival Ratio, Loss Ratio, and Relative Loss Ratio.

In the example shown above, a query is constructed to show triangle groups having the following features:

1. Display all triangle groups containing 'State' in their name.
2. Select the following three lines of business:
  - a. B-Private Passenger Auto Liability;
  - b. C-Commercial Auto/Truck Liability;
  - c. Z-All LOBs Combined.
3. Choose aggregation levels:
  - a. AMB Group;
  - b. Unaffiliated Single Company.
4. Finally, select only the triangle groups with 10x10 Dimensions.

Any variable column can be sorted as the user desires.



## Analytical tools:

- The Extended Link Ratio Family
  - Mack
  - The bootstrap technique, and
- Link Ratio Techniques

ELRF™ Best's Schedule P 2019 incorporates the Extended Link Ratio Family (ELRF) and Link Ratio Techniques (LRT) modules.

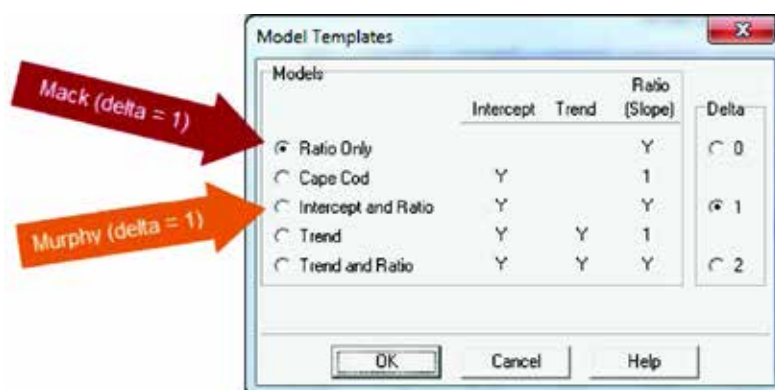
The default model in ELRF is the Mack method (equivalently volume weighted averages). This method is currently the most popular method in use amongst actuaries. It is a statistical regression formulation of the Link Ratio method known as the chain-ladder.

The bootstrap technique can be applied to any link ratio model in ELRF (including Mack).

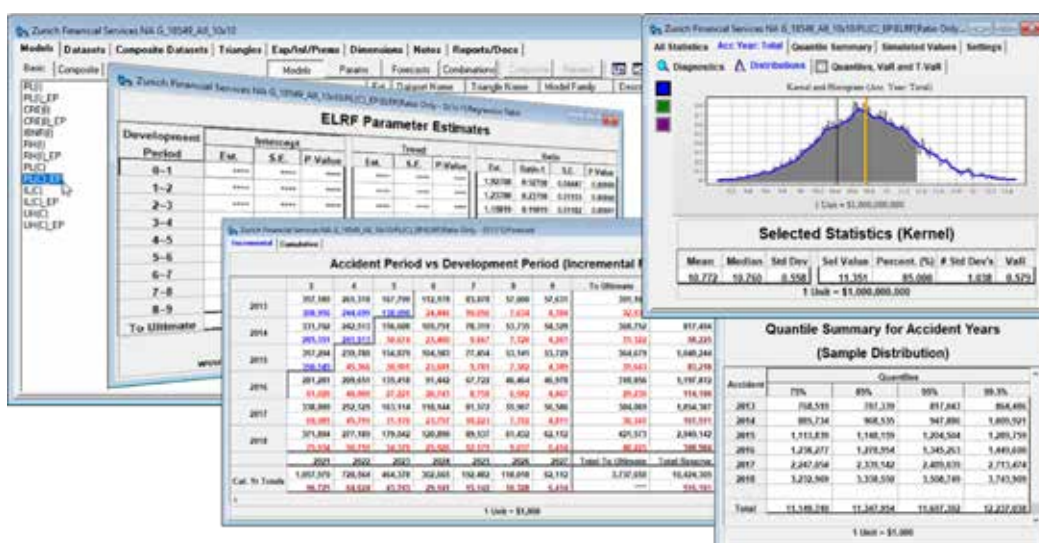
A ratio 'to ultimate' can also be specified.

## Extended Link Ratio Family (ELRF)

The Extended Link Ratio Family (ELRF) modeling framework formulates average link ratios as regression estimators and is extended to include intercepts (Murphy) and constant trends down each development year across accident years.



Any cumulative array, Incurred Losses, Paid Losses, Number of Claims Reported, and so forth can be analyzed in the ELRF modeling framework.



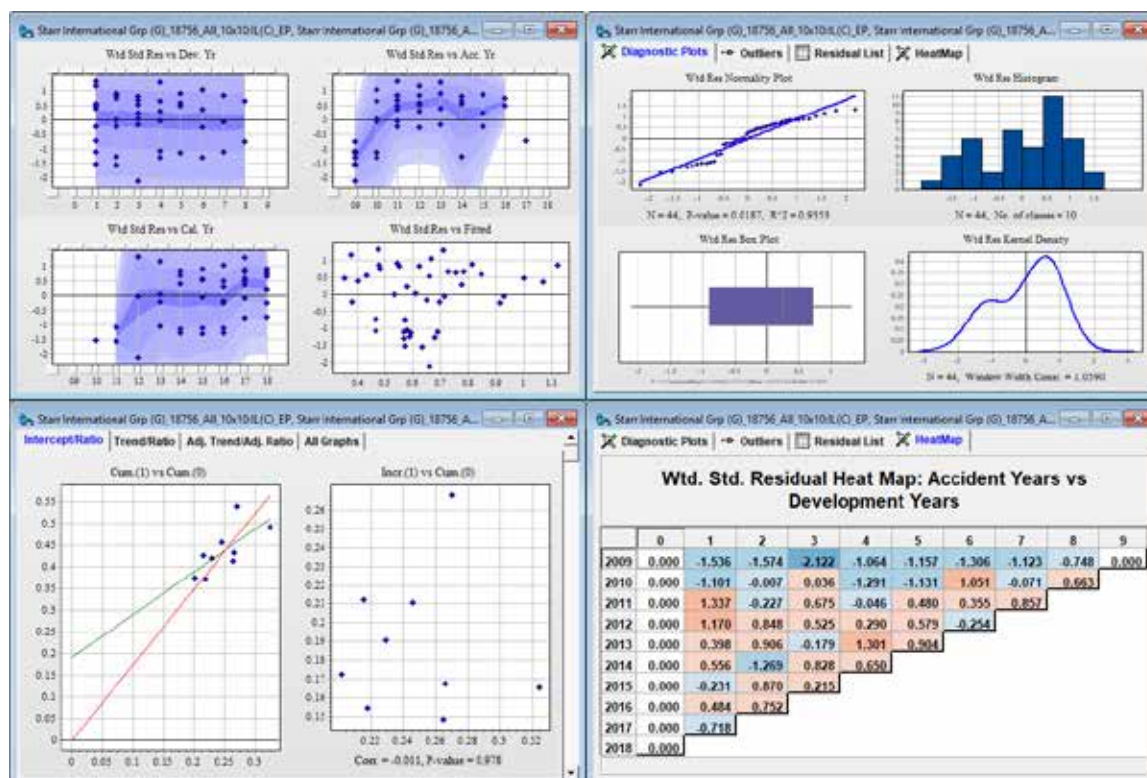
From dataset to estimating model parameters, calculating the forecast to running the bootstrap, the Extended Link Ratio Family (ELRF) is transparent, intuitive, and easy to use.



ELRF™ also contains a number of statistical model diagnostics that measure how well the respective model fits the data. These diagnostics are not as widely used in the actuarial community as they should be.

When using link ratio based methods, it is critical that actuaries verify that the corresponding assumptions apply for the data.

An illustration showing these diagnostics for the Mack method applied to a Paid losses dataset is provided below. The diagnostics all show that there are issues with the method: there is a clear change in the residuals in the calendar (and accident) direction [top-left], the residuals are not normally distributed [top-right], an intercept is required [lower-left], and structure remains in the residuals [lower-right].



It is now common to supplement the use of the Mack or other similar methods with additional techniques used to derived a loss distribution. The most commonly used of such methods is called the bootstrap technique. The ELRF module also includes a bootstrapping module that obtains loss distributions for pure link ratio models (including Mack).

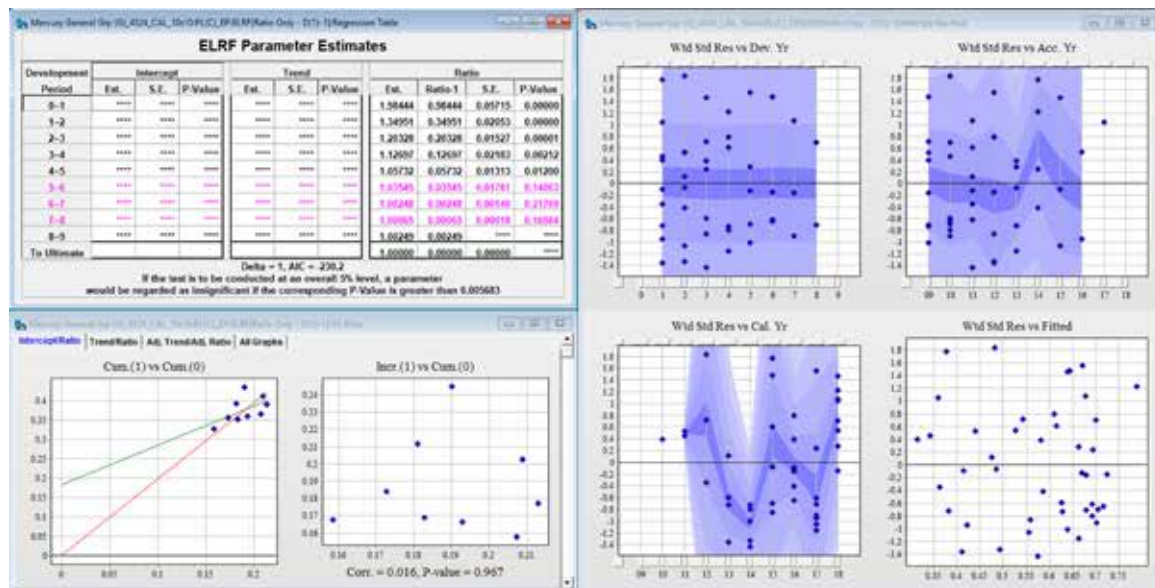
These analytical tools add significant power as:

- Standard actuarial methods are available within a flexible, easy to use graphical interface for all Best's Financial Suite - P/C, US loss triangle data;
- The ELRF™ database structure provides a complete warehousing solution for all associated data, models, and notes;
- Extensions of actuarial methods formulated within a regression framework allow more advanced application of the standard methods – including the bootstrap; and
- Comprehensive diagnostic tools are included to test whether models are appropriate for a company's data.

## Brief examples of analytical tools

Comprehensive diagnostic tools assess link ratio methods applied within a regression framework. Link ratio methods are extended to include intercepts and trends. It is insufficient to simply compute an answer, rather the diagnostics should be used to assess whether the answer obtained from the method(s) are credible.

For instance, consider the Mack method applied to this Best's Financial Suite - P/C, US data.



When the residuals (trends in the data – trends in the method) are plotted versus the three time dimensions (development, accident, and calendar) it is clear the residuals versus calendar year are very volatile. Further, the link ratios do not have predictive power (the correlation between the development periods 0 and 1 is not statistically significant).

The mean reserve (175M) produced by the Mack method when completing the square is likely too low. At the very least the actuaries using the Mack method (or any method) need to be able to support the projections from the method.

Accident Period vs Development Period (Incremental Forecast)														
	Cal.Per.Total	0	1	2	3	4	5	6	7	8	9	To Ultimate	Outstanding	Ultimate
2013	43,133	12,742	12,544	8,292	6,487	4,940	2,375	1,566	113	30	114	0	1,623	45,983
	38,415	12,742	10,982	8,189	6,995	2,532	2,719	1,760	127	14	5	0	1,775	1,775
2014	50,545	17,582	17,407	14,136	10,913	8,263	4,428	2,896	210	55	211	0	7,800	85,056
	42,680	17,682	22,763	13,237	11,390	12,175	2,225	2,929	213	24	19	0	3,753	3,753
2015	51,752	22,763	22,409	15,665	11,761	9,261	4,711	3,081	223	59	224	0	17,560	98,498
	68,950	22,763	22,056	13,036	15,083	3,995	2,471	3,237	235	26	15	0	6,044	6,044
2016	76,321	25,780	25,379	16,500	13,245	9,955	5,064	3,312	240	63	241	0	32,120	97,275
	75,572	25,780	21,430	17,945	2,727	4,368	2,697	3,525	256	29	19	0	7,402	7,402
2017	83,607	23,257	22,895	17,630	13,838	10,400	5,291	3,460	251	66	252	0	51,188	101,630
	75,560	23,257	27,185	3,042	2,935	4,618	2,846	3,709	269	30	22	0	9,014	9,014
2018	84,539	21,222	20,892	14,719	11,553	8,683	4,417	2,889	209	55	210	0	63,628	84,850
	97,787	21,222	4,313	3,274	3,838	4,480	2,732	3,506	252	28	30	0	12,202	12,202
Total Fitted/Observed	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total To Ultimate	Total Reserve	Total Ultimate		
Cal. Yr Totals	503,451	67,257	46,360	30,430	17,678	8,387	3,427	516	307	210	0	174,573	682,717	
	508,144	7,702	7,288	6,960	6,381	4,637	3,517	255	37	30	0	21,898	21,898	

1 Unit = \$1,000

The left most column shows the totals, by calendar year, for the fitted model mean (black numbers) and the observed losses (blue numbers). As indicated by the volatility in the residuals, the fitted means by calendar year oscillate at being above or below the observed values. Risk capital allocation would be important for this line.

The Mack method was applied to the Best's Financial Suite - P/C, US (2017) data for the same company and line of business for the previous year. The projected mean for the 2018 calendar year (excluding the first development period) is 60M. The observed losses in 2018 for accident year 2017 and prior years are 76.6M.

Mercury General Gap (G)\_4524\_CAL\_10x10PL(C)\_EP-ELRF(Ratio Only - D(T)-1)Forecast

Incremental Cumulative

**Accident Period vs Development Period (Incremental Forecast)**

	Cal.Per.Total.	0	1	2	3	4	5	6	7	8	9	To Ultimate	Outstanding	Ultimate
2012	40,972	10,538	10,005	6,584	4,660	2,834	1,521	1,058	37	48	1	0	1,144	36,713
	42,224	10,538	8,019	5,035	3,948	4,715	3,114	1,525	40	56	34	0	1,531	1,531
2013	43,844	12,742	12,098	8,418	6,304	4,003	1,954	1,291	45	59	1	0	3,350	44,791
	38,889	12,742	10,982	8,189	6,996	2,532	1,586	1,908	50	70	43	0	2,519	2,519
2014	49,955	17,682	16,788	14,350	10,603	6,696	3,384	2,237	78	102	2	0	12,498	77,578
	42,841	17,682	22,763	13,237	11,398	3,169	2,529	3,052	81	113	68	0	5,280	5,280
2015	59,639	22,763	21,612	15,902	11,428	7,128	3,603	2,381	83	109	2	0	24,732	82,587
	68,975	22,763	22,056	13,036	2,006	3,517	2,809	3,371	89	124	75	0	6,313	6,313
2016	74,216	25,780	24,477	16,751	12,634	7,881	3,983	2,632	91	120	2	0	44,093	91,303
	75,681	25,780	21,430	3,174	2,309	3,915	3,108	3,735	99	138	84	0	8,331	8,331
2017	81,100	23,257	22,081	16,086	12,133	7,568	3,825	2,528	88	115	2	0	64,426	87,683
	75,561	23,257	4,088	3,501	2,562	3,982	3,139	3,739	99	137	84	0	11,498	11,498
Total Firmed/Observed			2018	2019	2020	2021	2022	2023	2024	2025	2026	Total To Ultimate	Total Reserve	Total Ultimate
Cal. Yr Totals	457,927		60,072	40,616	25,946	14,069	6,643	2,729	209	117	2	0	150,405	607,695
	457,290		6,761	6,325	6,254	6,077	4,877	3,743	186	161	84	****	19,933	19,933

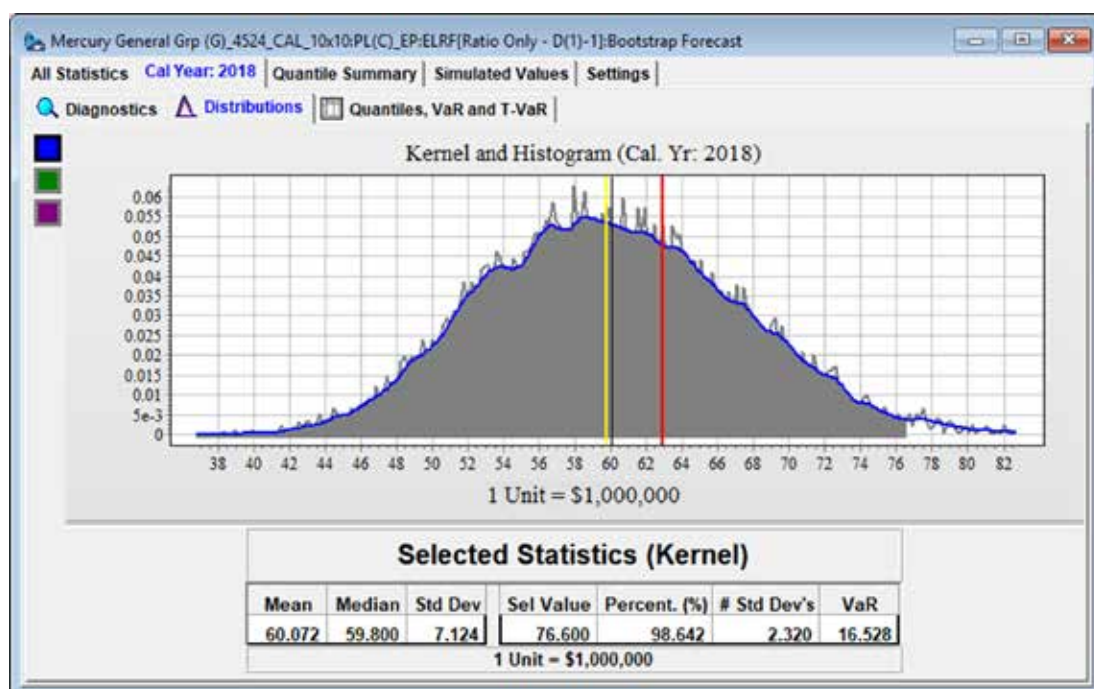
1 Unit = \$1,000

The projected mean, 60M, is much lower than the actual losses for the 2017 and prior years, 76.6M.

This was no hint in the 2017 data, after the Mack method was applied, that the losses for the next calendar year were going to deteriorate this way. One would want to hope that the reasons for the change in trend were understood by the actuarial team in advance.

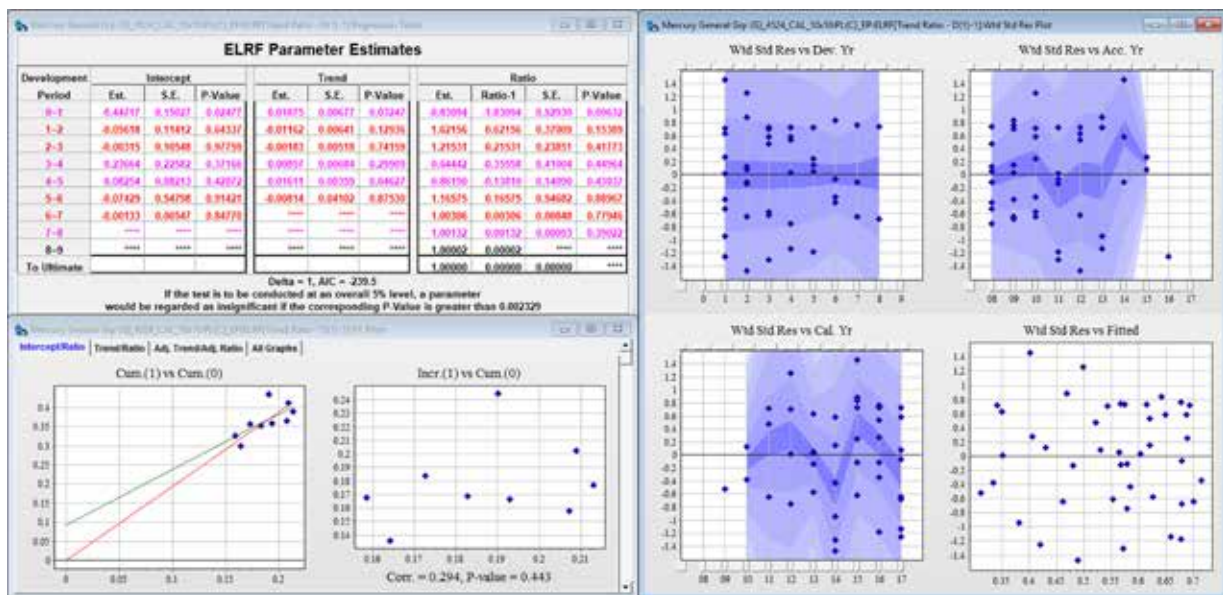
Just how bad is the 76.6M loss versus the projected Mack mean of 60M?

If the bootstrap is run for the Mack method on the 2017 data, and the simulations centered on the Mack mean, then the probability of observing a loss higher than 76.6M is about 2% (see below). If the Mack method had been applied in 2017 and used to set the reserves (and there was no hint of the losses coming in 2018), then the loss of 76.6M would have incurred a substantial loss of risk capital.





What if the average trend down each accident year is fitted along with intercepts, trends, and link ratios?



The residuals now appear random about a zero trend but still exhibit volatility. The total mean reserve projected from this model is 187M.

Mercury General Gp (0), 4524, CAL, 10x10PL(C), EP-ELRF(Trend Ratio - D(1)-1) Forecast

Incremental Cumulative

Accident Period vs Development Period (Incremental Forecast)

	Cal.Per.Total	0	1	2	3	4	5	6	7	8	9	To Ultimate	Outstanding	Ultimate
2012	41,404	10,538	7,257	6,314	4,546	3,984	3,029	462	42	47	1	0	553	36,122
	42,224	10,538	8,019	5,035	3,948	4,715	3,314	3,895	67	56	42	0	3,883	3,883
	38,952	12,742	12,407	7,195	6,057	4,631	5,053	109	55	61	1	0	5,280	46,721
2013	38,889	12,742	10,982	8,189	6,996	2,532	878	6,962	97	73	54	0	7,067	7,067
	47,315	17,682	19,688	13,426	10,242	3,658	7,180	1,129	112	102	2	0	12,181	77,261
	42,841	17,682	22,763	13,237	11,306	5,883	1,781	10,492	205	114	83	0	12,208	12,208
2014	61,506	22,763	21,346	12,871	10,715	7,941	10,718	155	122	115	2	0	29,768	87,623
	68,975	22,763	22,056	13,036	2,926	5,230	1,943	14,238	229	132	95	0	15,449	15,449
	74,995	25,780	25,059	11,294	10,441	12,419	14,350	-1,004	128	125	2	0	47,755	94,965
2015	75,681	25,780	21,430	3,332	4,184	6,375	2,652	20,300	270	145	105	0	21,776	21,776
	79,938	23,257	36,549	16,515	13,908	8,232	15,639	-44	178	150	2	0	91,130	114,387
	75,561	23,257	5,905	5,309	5,193	11,126	3,565	22,548	380	159	118	0	26,559	26,559
2016														
2017														
Cal. Yr Totals														

1 Unit = \$1,000

The difference between this estimate, 187M, and the Mack estimate, 175M, (13M) is not insubstantial relative to the total mean. Further, this is without taking into consideration a ratio to ultimate. Whichever total reserve amount is booked, a compelling narrative underscoring the choice is required.

However, if the full ELRF method was applied in 2017, then the losses observed in 2018 would still be higher than expected, but would not have been as adverse as if the Mack method was used.

The adverse development is not necessarily true adverse development but rather arises due to poor model selection.

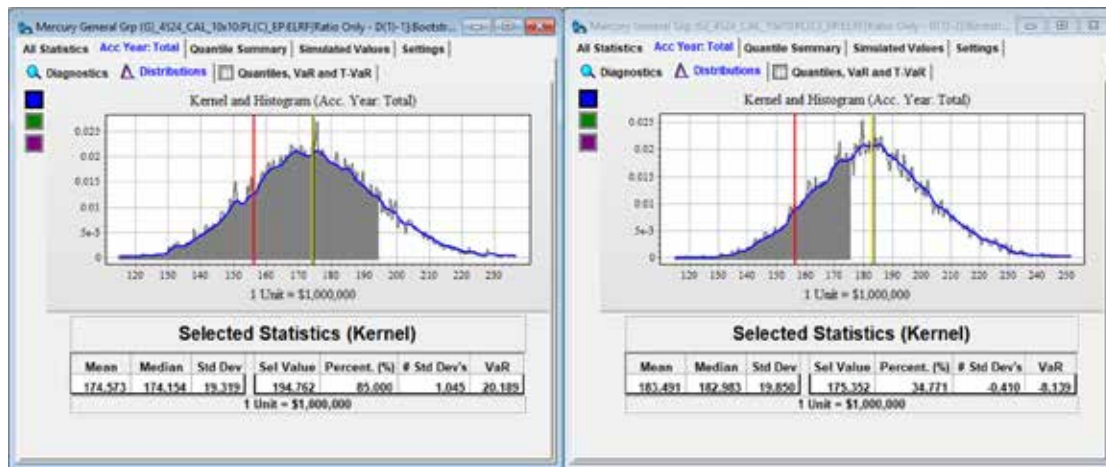
## The bootstrap technique

The bootstrap technique can be applied to any link ratio method. Further, the user can enter in suitable model means overwriting the projected means allowing the bootstrap sample distributions to be associated with arbitrary forecasts.



For instance, the bootstrap technique applied to the Mack method (left) shows the bootstrap sample with the Mack mean on the total. If instead, we use the means obtained from the full ELRF model (ratio, intercept and accident year trends) we can still run the bootstrap on the Mack residuals but use the means from this method instead. This produces the result on the right.

Simulations of the distributions can be examined by accident year, calendar year, or total (the latter is shown below).



In this way, we observe that the Mack method severely under predicts the loss reserve distribution arising from the bootstrap samples – assuming the full ELRF model is generating reasonable results.

Value-at-Risk (V@Rs) and Tail-Value-at-Risk (T-V@Rs) are calculated for bootstrap distributions. An example is given for the Mack method below.

Quantile Statistics, VaR and T-VaR (Acc. Year: Total)

%	Sample				Kernel				LogNormal				Gamma			
	Quantile	# S.D.'s	VaR	T-VaR	Quantile	# S.D.'s	VaR	T-VaR	Quantile	# S.D.'s	VaR	T-VaR	Quantile	# S.D.'s	VaR	T-VaR
99.9	229,537	2.845	54,964	60,531	229,718	2.854	55,137	61,137	233,281	3.040	58,728	67,230	238,605	2.900	56,632	63,559
99.5	228,357	2.784	53,784	59,287	228,321	2.782	53,748	59,179	231,291	2.936	56,718	65,321	228,808	2.807	54,235	61,828
99.4	226,871	2.707	52,298	58,290	226,781	2.698	52,128	58,192	229,627	2.890	55,854	63,745	227,313	2.738	52,740	58,435
99.3	224,671	2.593	50,096	57,225	225,039	2.612	50,405	57,650	228,284	2.776	53,631	62,599	226,031	2.654	51,458	59,242
99.2	223,662	2.541	49,088	56,275	223,893	2.553	49,348	56,562	226,958	2.712	52,385	61,424	224,906	2.605	50,333	58,191
99.1	222,658	2.485	48,085	55,431	222,952	2.504	48,384	55,680	225,848	2.654	51,275	60,179	223,962	2.553	49,329	57,267
99.0	222,239	2.467	47,666	54,680	222,880	2.458	47,507	54,474	224,647	2.602	50,274	59,238	222,994	2.506	48,421	56,427
98.0	215,730	2.130	41,157	49,285	215,867	2.137	41,294	49,408	218,027	2.249	43,454	52,873	216,762	2.184	42,189	50,757
97.0	211,842	1.929	37,269	45,504	212,049	1.940	37,475	46,077	213,818	2.031	39,245	48,990	212,873	1.962	38,360	47,181
96.0	209,430	1.804	34,852	43,426	209,465	1.806	34,892	43,447	210,710	1.871	36,137	46,149	209,981	1.833	35,408	44,585
95.0	207,236	1.691	32,663	41,483	207,345	1.696	32,772	41,628	208,219	1.742	33,645	43,889	207,649	1.712	33,071	42,500
94.0	205,427	1.597	30,854	39,861	205,547	1.603	30,974	39,967	206,123	1.633	31,556	42,003	205,679	1.610	31,106	40,768
93.0	203,957	1.521	29,384	38,484	203,972	1.522	29,399	38,477	204,385	1.539	29,732	40,377	203,963	1.521	29,390	38,263

Mean = 174,573, S.D. = 19,319, Percentile = 174,573, 1 Unit = \$1,000,000

In addition to the analyses above, Bornhuetter-Ferguson calculations are also available.

Bornhuetter-Ferguson & Expected Loss Ratio Forecast

Acc. Yr	Premium	Expected Loss Ratio (%)	Ultimate Ratio	Paid To Date	Exp. Loss Ratio Method			Link Ratio Method			Born Ferg Method		
					Ultimate	Outstanding	Ratio (%)	Ultimate	Outstanding	Ratio (%)	Ultimate	Outstanding	Ratio (%)
2009	75,285	68.11	1.000	51,232	51,279	47	68	51,232	0	68	51,232	0	68
2010	67,501	70.11	1.002	47,290	47,327	37	70	47,408	118	70	47,407	117	70
2011	61,470	68.40	1.003	41,801	42,043	242	68	41,932	131	68	41,932	131	68
2012	50,850	72.35	1.006	36,648	36,790	142	72	36,854	206	72	36,854	206	72
2013	66,069	68.78	1.041	44,160	45,442	1,282	69	45,983	1,823	70	45,961	1,801	70
2014	93,027	89.40	1.101	77,256	83,164	5,908	89	85,056	7,800	91	84,882	7,626	91
2015	108,962	84.29	1.241	72,938	91,849	18,911	84	90,498	17,560	83	90,760	17,822	83
2016	121,009	82.82	1.493	65,155	100,219	35,064	83	97,275	32,120	80	98,247	33,092	81
2017	128,480	84.82	2.015	50,442	108,972	58,530	85	101,630	51,188	79	105,128	54,886	82
2018	144,777	72.59	3.998	21,222	105,087	83,865	73	84,850	63,628	59	100,026	78,804	69
Total	917,431			508,144	712,172	204,028	78	682,717	174,573	74	702,630	194,486	77

1 Unit = \$1,000

## Link Ratio Techniques (LRT)

The standard link ratio methods as calculated automatically in the LRT module are:

- Chain Ladder (Volume Weighted Average)
- Arithmetic Average
- Geometric Average
- Average Without Min/Max
- Last N Diagonal Weighted Average
- Last N Diagonal Average
- Last N Diagonal Geometric Average
- Maximum Ratio
- Minimum Ratio
- Weighted Excluding High/Low
- Average Without Min/Max of Last N
- Weighted Average Without Min/Max of Last N
- Two parameter smoothing
- Three parameter smoothing

By default, N is set to be 4 periods, but N can be changed to any calculable value. A ratio 'to ultimate' can also be set.

## Brief examples of analytical tools

All commonly used standard actuarial methods are available. These methods can be applied to any data type including Incurred Losses (below) and Paid Losses. Smoothing techniques are also included.

Method	0-12	12-24	24-36	36-48	48-60	60-72	72-84	84-96	96-108	To Ultimate (24 Periods)
Standard Chain Ladder	1.43945	1.16231	1.09391	1.07417	1.02289	1.02423	1.00200	1.00052	1.00250	
Arithmetic Average	1.43889	1.16139	1.09295	1.07374	1.02319	1.02506	1.00202	1.00051	1.00250	
Geometric Average	1.43794	1.16055	1.09285	1.07300	1.02308	1.02479	1.00202	1.00051	1.00250	
Average Without Min/Max	1.43754	1.17031	1.09157	1.07351	1.02523	1.01329	1.00002	1.00051	1.00250	
Wtd. Average of Last 9	1.43945	1.16231	1.09391	1.07417	1.02289	1.02423	1.00200	1.00052	1.00250	
Average of Last 9	1.43889	1.16139	1.09295	1.07374	1.02319	1.02506	1.00202	1.00051	1.00250	
Geom. Average of Last 9	1.43794	1.16055	1.09285	1.07300	1.02308	1.02479	1.00202	1.00051	1.00250	
Maximum Ratio	1.52621	1.20679	1.12097	1.12219	1.04103	1.06642	1.00651	1.00091	1.00250	
Minimum Ratio	1.36101	1.06247	1.07272	1.02620	0.99925	1.00725	0.99953	1.00012	1.00250	
Weighted Ex High/Low	1.43760	1.17113	1.09193	1.07534	1.02524	1.01334	1.00002	1.00052	1.00250	
Average Without Min/Max of Last 9	1.43754	1.17031	1.09157	1.07351	1.02523	1.01329	1.00002	1.00051	1.00250	
Weighted Average Without Min/Max of Last 9	1.43760	1.17113	1.09193	1.07534	1.02524	1.01334	1.00002	1.00052	1.00250	
Judgement	1.43945	1.16231	1.09391	1.07417	1.02289	1.02423	1.00200	1.00052	1.00250	1.00000
Industry Data	1.42000	1.18000	1.09000	1.05000	1.03300	1.02000	1.01500	1.01000	1.01000	1.02265
2-par Smoothing	1.42643	1.20591	1.09943	1.04801	1.02318	1.01119	1.00541	1.00261	1.00126	1.00118
3-par Smoothing	1.43822	1.17175	1.08857	1.05158	1.03229	1.02124	1.01449	1.01017	1.00731	1.02265
Final Selection	1.43945	1.16231	1.09391	1.07417	1.02289	1.02423	1.00200	1.00052	1.00250	1.02265
Product	2.11689	1.47063	1.25527	1.15665	1.07679	1.05269	1.02779	1.02574	1.02521	1.02265

## Further information

To see the database and analytical tools in action please visit: [www.insureware.com](http://www.insureware.com)

If any modeling support is required for a particular segment by any Best's Financial Suite - P/C, US subscribers, Insureware can provide this support on a fee-for-service basis.

Contact [info@insureware.com](mailto:info@insureware.com) for more information.

## Introducing ICRFS™ Best's Schedule P 2019

You have ELRF™ Best's Schedule P 2019 and want more modeling power?

Insureware has created ICRFS™ Best's Schedule P 2019 for you.



This premium application from Insureware adds the innovative probabilistic modeling frameworks of ICRFS™ to the functionality of ELRF™ Best's Schedule P 2019.

The Probabilistic Trend Family (PTF) modeling framework enables analysts to describe the trends in the data in all time directions (development, accident, and calendar) along with the volatility around those trends. The Multiple Probabilistic Trend Family (MPTF) modeling framework extends this further by also including correlations between lines of business – measured from the data.

A comparison of the list of features can be found below.

Data and modeling frameworks	ELRF™ Best's Schedule P 2018	ICRFS™ Best's Schedule P 2018	Data and modeling frameworks	ELRF™ Best's Schedule P 2018	ICRFS™ Best's Schedule P 2018
<b>Database</b>			<b>Extended Link Ratio Family (ELRF)</b>		
Best's Financial Suite - P/C, US data by LoB and total	Yes	Yes	Mack	Yes	Yes
Associated key fields	Yes	Yes	Murphy	Yes	Yes
Industry Totals	Yes	Yes	Trends (down accident years) and intercepts	Yes	Yes
<b>Critical financial information including:</b>			Optimisation	Yes	Yes
Reserves and Ultimates Held	Yes	Yes	Bornhuetter-Ferguson	Yes	Yes
Gross and Net Premium	Yes	Yes	Bootstrap	Yes	Yes
%IBNR	Yes	Yes	Quantiles, V@Rs, and T-V@Rs	Yes	Yes
Total Loss Ratios	Yes	Yes	<b>Probabilistic Trend Family (PTF)</b>		
Survival Ratios	Yes	Yes	Full trend identification (including calendar)		Yes
Ratios relative to industry	Yes	Yes	Volatility quantification		Yes
<b>All Best's Financial Suite - P/C, US triangles</b>			Modeling wizard		Yes
Paid Losses	Yes	Yes	One year ahead statistics (CDR)		Yes
Case Reserve Estimates	Yes	Yes	Liability stream		Yes
Incurred Losses (not including BULK and IBNR)	Yes	Yes	Risk capital by Acc. or Cal. Year		Yes
Bulk and IBNR	Yes	Yes	Reinsurance		Yes
Premium	Yes	Yes	Variation in Mean Ultimate		Yes
Number of Claims Reported	Yes	Yes	Quantiles, V@Rs, and T-V@Rs		Yes
Number of Claims Closed	Yes	Yes	<b>Multiple Probabilistic Trend Family (MPTF)</b>		
<b>Additional Triangles</b>			Full trend identification (including calendar)		Yes
Reserves Held	Yes	Yes	Volatility quantification		Yes
Ultimates Held	Yes	Yes	Correlations		Yes
<b>Link Ratio methods</b>			One year ahead statistics (CDR)		Yes
Link Ratio Techniques (LRT)	Yes	Yes	Liability stream		Yes
Aggregate Link Ratio Techniques (ALRT)	Yes	Yes	Risk capital by Acc. or Cal. Year		Yes
Payment Per Claim Incurred (PPCI)	Yes	Yes	Reinsurance		Yes
Projected Case Estimates (PCE)	Yes	Yes	Variation in Mean Ultimate		Yes
Bornhuetter-Ferguson (BF)	Yes	Yes	Solvency II one-year ahead metrics		Yes
Fisher-Lange (FL)	Yes	Yes	Ultimate year risk horizon metrics		Yes

ICRFS™ Best's Schedule P 2019 empowers you to answer questions like:

- Are our company's loss costs similar to our competitors?
- How do our company's trends, risk diversification, and loss ratios rank in the industry?
- What correlations should be used to calculate our risk diversification?
- Which companies could be targeted for reinsurance or acquisition?
- What Lines of Business contribute to distress in the event of a 1/200 event next calendar year?





## About Insureware

Insureware is not your typical long-tail liability risk management firm: we are R&D focused. Our team of world-class statisticians originated many of the ideas that the industry now aspires to. They have published numerous papers not only in actuarial journals but also in preeminent statistical journals. Insureware creates and supports the only comprehensive, enterprise wide, long-tail liability risk management software in the world.

Insureware has advised on a wide-range of insurance matters including:

- Reserve due diligence;
- Mergers and Acquisitions;
- Assessing risk capital and Solvency II capital requirements for submissions to regulators and rating agencies;
- Underwriting and pricing; and
- Reinsurance transactions.

Insureware creates unique collaborative partnerships with each client. The partnership facilitates the growth of incomparable knowledge, benefits, and applications.

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