7 Reasons to ditch link ratios
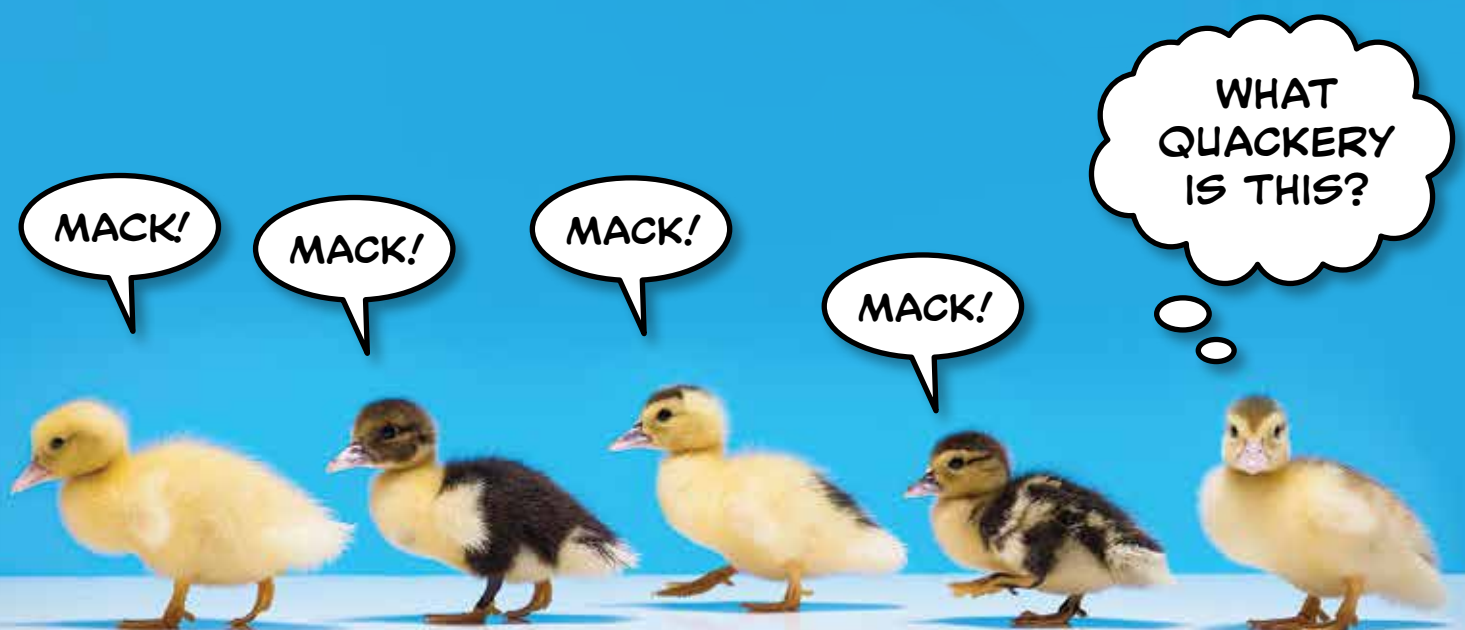
- Link ratios cannot measure calendar year social inflation
- The assumptions are rarely met by the data
- No insight into trends in the business
- Too slow to review
- No connection to the risk characteristics of the data
- No early warning system
- No way to determine whether an answer is good, bad, or ugly

MACK!

MACK!

MACK!

MACK!

WHAT QUACKERY IS THIS?

Insureware
Innovative Statistical Solutions for P&C Insurance

Extended Link Ratio Family (ELRF)

The Mack method is a regression formulation of volume weighted average link ratios (chain ladder). Other method variants can be included such as different weights, an intercept (Murphy) and an accident year trend for each development year. All these methods are included in the Extended Link Ratio Family (ELRF) modeling framework.

The regression formulation means the method can be tested statistically. If a company is using link ratio based methods, it is critical that actuaries verify the assumptions apply for the company's data.
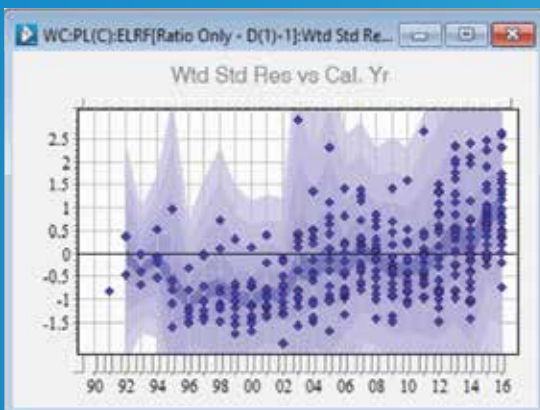
The ELRF modeling framework provides diagnostics for testing assumptions.

Residual plots versus development period, accident period and calendar period are also used to assess model specification error. Any patterns in the residual plots show features of the data that the method is not describing.
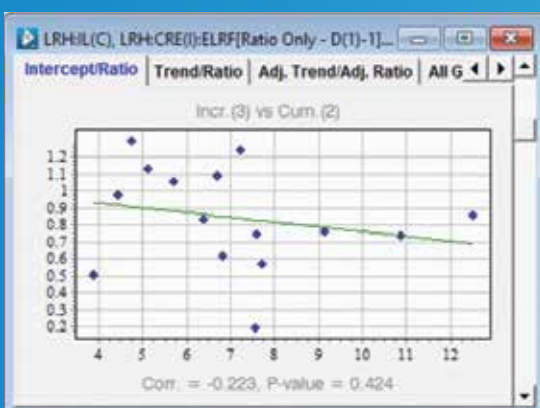
The significance of an intercept can be explicitly tested and diagnostically by viewing the Y versus X plot, and similarly for ratios in the presence of an intercept term.

Here there is no relationship between the incremental Incurred in development period 3 with the cumulative Incurred in development period 2. Link ratios do not have predictive power.

In this brochure we demonstrate, with case studies derived from real data, three simple examples where link ratio methods give gravely misleading results.

Probabilistic Trend Family (PTF)

In the Probabilistic Trend Family (PTF) modeling framework, we identify a parsimonious model describing the trends in the three directions (development, accident, and calendar), along with the volatility about the trend structure.

Unlike other actuarial solutions, a PTF model is not pre-defined but rather is tailored to each company's data. This enables the tool to extract the salient statistical features of any loss development array and produce meaningful results for all aspects of the liability distributions. Any modeling assumptions can be tested and verified that they are supported by the data.
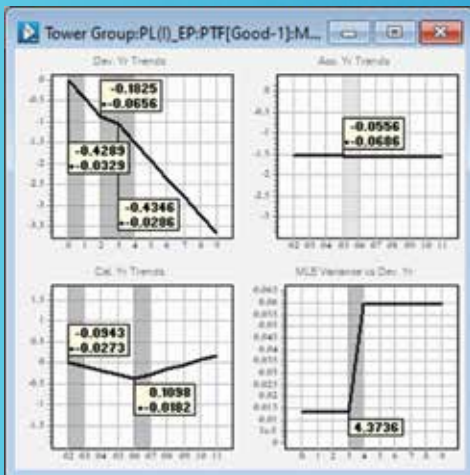
The identified model in the PTF modeling framework:
- measures calendar period trends (sum of economic and social inflation);
- separates trends from volatility and quantifies both;
- fits a probability distribution to every cell;
- forecasts distributions for every cell going forward;
- provides calendar year liability stream and its distributions, and other metrics;
- is NOT a method.

The PTF modeling framework gives insight into your business, extracting knowledge to make informed decisions. Foresight does not depend on lucky charms.

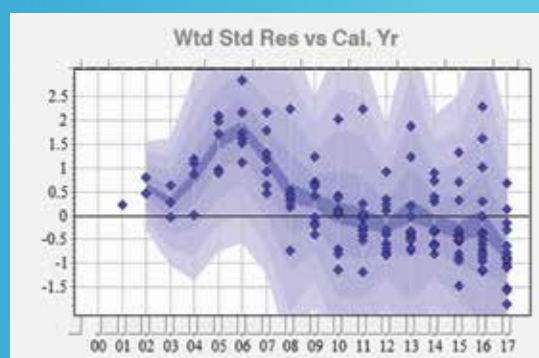In this brochure, we demonstrate, on the same case studies mentioned previously, how the PTF modeling framework gives the company critical risk information. Tower Group may still be around if their actuaries had invested in ICRFS™!

Link Ratio Methods residuals trend down: projections too *high*

Consider anonymized Paid Loss data for an Auto Insurance provider (segment: Bodily Injury). The data can be downloaded from: icrfs.me/7reasons

The display on the right shows a strong downward trend in the residuals (trend in data minus trend in method) versus calendar year.

This means a link ratio method will grossly overstate the reserve estimates. The Mack method (volume weighted average) gives a total reserve of 902M. The arithmetic average link ratios gives a total reserve of 1.16B.


On the left is the forecast table (incremental version) for the Mack method.

The company just paid 202M GBP in 2017 (blue numbers are observed) but the fitted mean value (black numbers) is much higher at 289M. Further, the method is projecting the company will pay 284M GBP in the next calendar year!

The method clearly provides false indications.

Incremental | Cumulative

Accident Period vs Development Period

	Cal.Per.Total.	0	1	2
2015	163,954	9,618	54,613	88,869
	160,899	9,618	75,810	62,653
2016	210,078	15,225	86,451	86,647
	216,417	15,225	68,255	15,012
2017	289,335	13,628	77,383	94,464
	201,780	13,628	11,493	19,398
Fitted/Observed			2018	2019
Cal. Yr Totals	1,629,546		284,355	241,747
	1,625,059		30,270	34,119

1 Unit = £1,000

The optimal model identified in the Extended Link Ratio Family (ELRF) modeling framework applied to the last five calendar years has trends, intercepts, and very few ratios (because they have no predictive power). The residuals are much improved (next page). The trends in the data are more in line with the trends in the method.
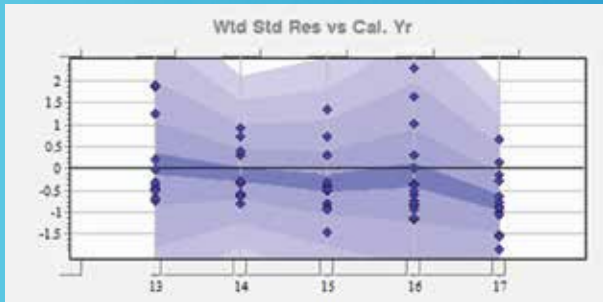
The total reserve mean projected from this identified model is 504M – around half the original Mack method projected mean reserve! This is a much better estimate of the reserve mean, but how do we know it's the best?

Let's see what is really going on

The identified model in the PTF modeling framework has calendar year trends as seen on the right. The calendar year trends are much lower more recently. Trends in other loss types (for instance: Case Reserve Estimates or Number of Claims Closed) can be related to the trends in the paid losses.

The actuary now has a narrative about the data.

Projections from the PTF model are much more realistic. The forecast scenario in PTF, using the 8.7%+_ calendar year trend, projects a mean payment of 223M GBP next year – much more in line with the recent history. The total mean reserve is 598M.

The actuary has control over all future trend assumptions in the PTF modeling framework. These can be related directly to the trends (or volatility) observed in the past – including CREs or NCC.

To get in the ballpark of the original forecasts of the Mack method, the future calendar year trend has to increase from the most recent 8.7%+_ calendar year trend to more than 25%+_ for the entire run-off period!

Link Ratio Methods residuals around zero: projections too *low*

Maybe you think using Incurred Losses gives better estimates than Paid Losses? Consider the Incurred Loss data from Best's Schedule P (2011) for Tower Group. The data can be downloaded from: **icrfs.me/7reasons**

On the right are residuals from the Mack method applied to the Incurred Losses. The zig-zag conflates what is going on.

The total mean reserve projected by the Mack method is: 1.059B. The held reserves by the company as of 2011 were 921.9M. By calculating chain ladder ratios excluding the 'high' calendar years of 2009 and 2011, the forecasted total reserve drops to 950M.

The held reserves were supported by link ratio methods.
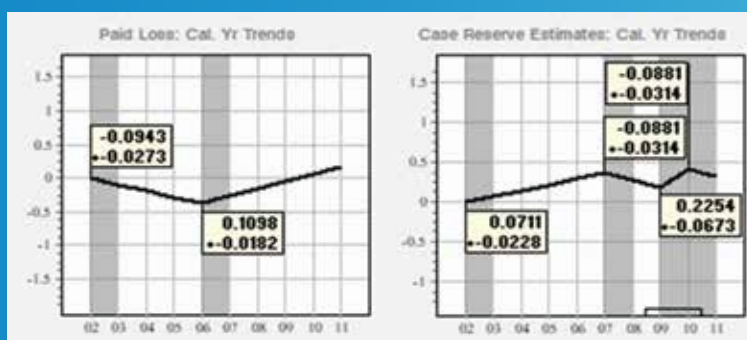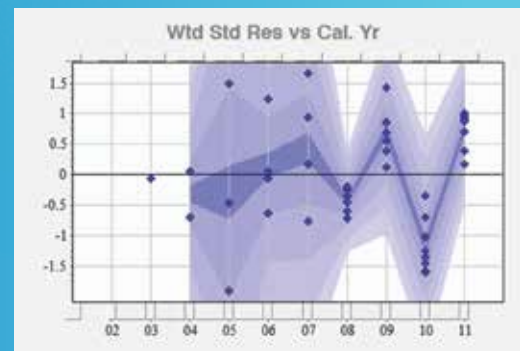
In the PTF modeling framework, Paid Losses and Case Reserves are modeled separately. Note the calendar year trends are not the same in the Paid Losses (left) and Case Reserves (right).

In order to reach the reserves held, the calendar year trend for the future has to change from +11%+_ to -16.85%+_ - a total difference in trend of nearly 28%!! This is impossible!

Without access to the PTF modeling framework, how would you know whether your projections are meaningful?

- Since 2006 the paid losses have been increasing 11%+_ faster than Earned Premium. This leads to an 11% increase in loss ratios (not reflected in the company's held ultimates).

- Since 2007 the Case Reserve Estimates have been fluctuating (thus the masking of trends in the Incurred Losses).

Accident Period vs Development Period						
	Cal. Per. Total	0	1	2	3	4
2007	219,293	111,061	80,663	58,661	54,577	40,347
	221,653	115,284	89,880	56,719	25,047	34,904
2008	316,836	152,248	110,608	80,460	74,870	55,355
	324,522	143,386	121,849	38,678	67,792	14,165
2009	432,067	194,065	141,026	102,614	95,502	70,616
	427,253	181,575	108,336	95,660	13,268	18,302
2010	523,492	197,170	143,320	104,312	97,099	71,803
	393,802	209,186	140,943	14,492	14,224	18,940
2011	675,179	277,671	201,890	146,980	138,840	101,201
	694,364	319,844	27,323	21,663	21,305	27,296
Fitted/Actual			2012	2013	2014	2015
Cal. Per.	2,645,737		512,550	394,896	317,782	232,166
Total	2,526,865		45,323	41,549	39,884	38,057

1 Unit = $1,000; Forecast Scenario: Data trend: 11%+_

Accident Period vs Development Period						
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	324,522	143,386	121,849	38,678	67,792	10,725
2009	432,067	194,065	141,026	102,614	72,304	40,476
	427,253	181,575	108,336	95,660	10,060	10,491
2010	523,492	197,170	143,320	78,973	55,656	31,159
	393,802	209,186	140,943	10,972	8,153	8,219
2011	675,179	277,671	152,849	84,246	59,382	33,249
	694,364	319,844	20,686	12,417	9,245	8,965
Fitted/Actual			2012	2013	2014	2015
Cal. Per.	2,645,737		388,046	226,348	137,902	76,276
Total	2,526,865		34,314	23,815	17,308	12,503

1 Unit = $1,000; Forecast Scenario: Reserves held: -16.85%+_

The forecast table on the left assumes the 11%+_ trend continues. The projections are increasing down the accident periods (eg: dev 4) just like the observed paid losses (blue numbers) in dev 0.

On the right is the forecast where the assumed future trend is set to -16.85%. Projected payments are decreasing down the accident periods (dev 4) despite the significant increases in observed paid losses and Earned Premium.

(Tower Group went into administration in the fourth quarter 2013).

Link Ratio Methods residuals trend up: projections too *low*

Consider anonymized Paid Loss data for a large Worker's Comp provider. The data can be downloaded from: icrfs.me/7reasons

The display on the right shows a strong upward trend in the residuals (trend in data minus trend in method) versus calendar year.

Any link ratio method will grossly understate the reserves – the trend in the method is less than the trend in the data. Using the Mack method (volume weighted average), the total reserve is 839M.

Wtd Std Res vs Cal. Yr
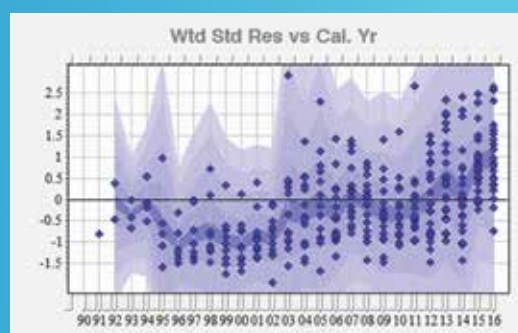
Incremental	Cumulative			
Accident Period vs Development Period				
	Cal.Per.Total.	0	1	2
2014	162,300	228	10,944	18,627
	179,707	228	14,998	27,366
2015	151,130	275	13,200	19,782
	181,395	275	15,895	3,810
2016	147,829	400	19,200	23,979
	188,415	400	3,537	6,058
	Fitted/Observed		2017	2018
Cal. Yr Totals	2,916,318		152,317	129,915
	2,732,505		9,023	9,309

1 Unit = $1,000

The company just paid 188M USD in 2016 (blue numbers are observed) and the method is projecting the company will pay 152M USD in the next calendar year (black numbers are fitted means).

The method clearly provides false indications.

If every successive year you take weighted average link ratios of the last four years,each year the estimates of the prior year ultimates will increase, and projections of the paid losses for the next year will be too low.

To illustrate this, estimate the four year weighted average each valuation period from 2011 through to 2016 and plot the prior year ultimates.

Assuming the same link ratio method is applied in each of the four years, the company is in catch up mode.

For this particular portfolio, the social inflation is very high.

Estimate of prior year ultimates at each valuation period

Link ratio type methods cannot measure social inflation.

The PTF modeling framework enables you to mitigate model specification risk and extract maximum information from the data.

The optimal PTF model, whose calendar year trends are displayed on the right, projects a total mean reserve of 1.309B if the trend of 21.46%+_ continues for several years.

Cal. Yr Trends
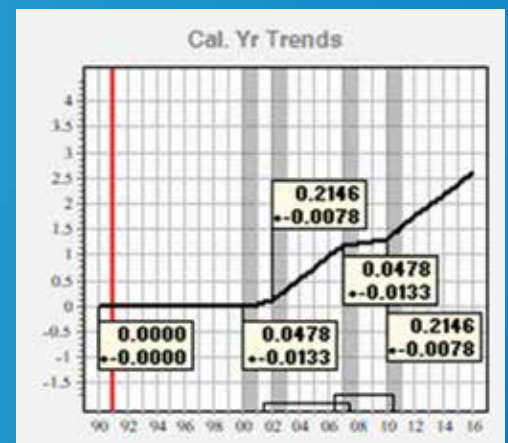
	Cal. Per. Total	0	1	2
2014	181,273	300	15,981	19,806
	179,707	228	14,998	27,366
2015	181,274	322	17,177	21,289
	181,395	275	15,895	3,467
2016	179,613	400	21,289	26,388
	188,415	400	3,467	4,319
Fitted/Actual			2017	2018
Cal. Per.	2,720,981		181,770	166,353
Total	2,732,505		10,721	10,627

WC:PL(I):PTF[Good-2]:Reserve Forecast Table

Accident Period vs Development Period

1 Unit = $1,000; Forecast Scenario: Reasonable

The company just paid 188M USD in 2016 and the PTF forecast scenario is projecting the company will pay 182M USD in the next calendar year (black numbers are fitted means). This forecast is clearly superior to the projection from the Mack method.

In-depth models
Get ICRFS™
See everything

ICRFS™ 2020 includes a data driven reinsurance module expressly designed for ADCs and LPTs. Benefits include: optimal retention strategies, efficient risk capital management, multiple contract management, reserve metrics net of reinsurance, and much more.

Mitigate model specification risk and see your business in a new light!

Insureware's platform

ICRFS™

can be implemented enterprise-wide in a few days and gives you:

- Long-tail liability Enterprise Risk Management
- Unparalleled insight and intelligence
- High powered analytics at ludicrous speed
- Structured databases for managing all risks
- ORSA and Solvency II metrics including the Economic Balance Sheet for the aggregate of multiple LoBs
- Single composite model for multiple LoBs
- Multiple aggregation at different levels of segmentation
- Reserve, pricing and reinsurance risk assessments
- Liability distributions and correlations by calendar year
- Risk capital allocation by LoB and calendar year
- Reserve Risk net of reinsurance contracts
- Graphical displays of identified models
    - Trends in three directions: including social inflation
    - Volatility about trends
    - Correlations
- Comprehensive model identification and validation tools
- Creative solutions for insoluble problems within a robust, yet flexible, framework
- ... and much more!

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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