Modelling multiple long tail liability lines

Get the complete perspective

Insureware

Innovative Statistical Solutions for P&C Insurance

Contents

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Get the complete perspective

1. Introduction and summary

In order to calculate and assess risk metrics for long tail liabilities, a modelling framework that can describe the salient statistical features of the data in a succinct, yet complete, fashion is required. Model specification error is mitigated if simulated triangles from the optimal model are indistinguishable, in respect of the salient statistical features, from the real data.

The framework presented here for modelling multiple loss development arrays (segments or LOBs for example) captures:

- trends in the three time directions (accident, development, and calendar);
- distributions of the volatility around the trends;
- process (volatility) correlation between loss development arrays; and
- parameter correlation within and between loss development arrays.

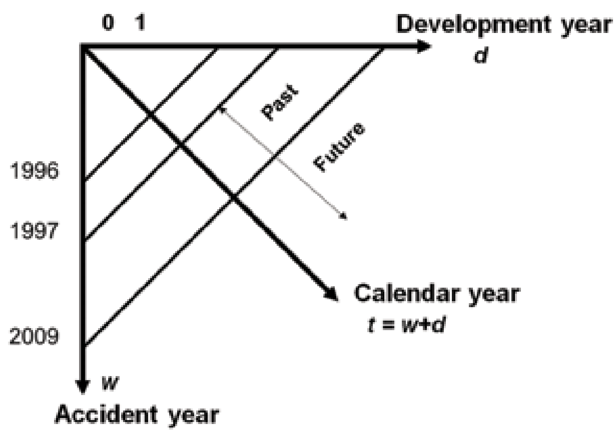
Modelling or forecast scenario assumptions are transparent, auditable, and verifiable.

Case studies are provided which demonstrate the power, flexibility, and wide applicability of this modelling framework to produce creative solutions to long-tail liability risk management.

1.1. Modelling framework

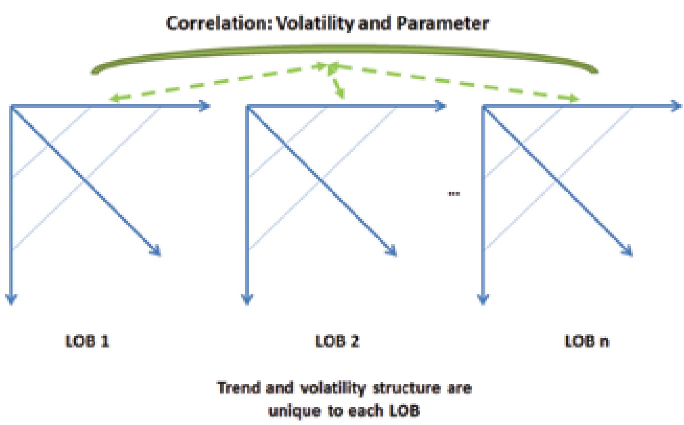
The Probabilistic Trend Family (PTF) modelling framework describes the trends in each direction (development, accident, and calendar) along with the volatility around the trends. Within this framework, an optimal model is identified that captures the trends in the three directions along with the volatility around those trends.

The following diagram depicts the three directions with arguments d, w, and t. Since t = w+ d, it is axiomatic that any calendar year trend projects onto the development year and accident year directions.



The Multiple Probabilistic Trend Family (MPTF) modelling framework is an extension of the PTF modelling framework where correlations between LOBs are included to describe the relationship within and between LOBs. These correlations are data driven and are unique to each company's portfolios. An MPTF model is designed from the identified PTF models for each segment and includes the correlation between the segments or LOBs.

A single composite model can describe all the long-tail liabilities in a company's portfolio.



The PTF and MPTF models address the individual features that are found in the data – there is no a priori specification where trends (or volatility) changes occur. Trends are fully interpretable and are able to be related to events occurring in the business (whether driven by internal or external drivers). Each cell of the loss development array is related by the trend structure on a log scale. Correlations between the distributions, whether within or between segments (or LOBs), are incorporated directly in the model.

1.2. Wealth of information in ICRFS-Plus™

All the ICRFS-Plus™ tables and graphic displays based on the identified (optimal) composite model, in the MPTF modelling framework for multiple LOBs (or segments), can be replicated in matter of seconds as a result of Insureware's extremely fast computational algorithms. 'What if' analyses can be considered and results obtained very quickly.

One double click loads the identified model and reveals pictorially the volatility structure of each long tail LOB and their inter-relationships (correlation structures). Critical financial information including reserve distributions by accident year, calendar year and total for each LOB and the aggregate of all LOBs, reserve distribution correlations between LOBs, risk capital allocation by LOB and calendar year, T-V@Rs and V@Rs for different time horizons, and more can be computed approaching real time (seconds). A company-wide report for long-tail liability lines can be created with a single report template.

The identified model fits correlated log-normal distributions to each observation in the data triangles. Similarly, correlated log-normal distributions are projected for each future cell. Complete control is retained over future assumptions (in any direction) including parameter uncertainty (and volatility about trends); all assumptions are explicit and auditable. The MPTF modelling framework provides a sound and solid statistical foundation for conducting 'what if' scenarios in respect of reserving, pricing, Solvency II and IFRS 4 analyses, reinsurance analyses, and many other applications.

The probabilistic framework initialises data updates with the prior model structure. This provides effortless monitoring of stability and an early warning system for changes in trends.

1) Forecast distributions for each future cell, for each segment (or line of business) for any aggregation across segments.
2) Reserve forecast distribution correlations between LOBs by total, accident year, and calendar year.
3) Summary tables by accident year, including one-year ahead statistics (equivalently, variation in mean ultimates one-year hence).
4) Summaries by calendar year.
5) Risk capital allocation by calendar year and accident year.
6) Graphs of ultimates versus accident year and future liability stream versus calendar year.
7) Summaries by Line of Business; means and CVs.
8) Aggregate distributions by accident year (simulated from predicted correlated log-normals), calendar year, and total - including Value-at-Risk (V@Rs) and Tail-Value-at-Risk (T-V@Rs) - for each segment and any aggregation.
9) Economic balance sheet that includes: Solvency II risk metrics, risk capital calculations and graphs.
10) Distributions for the aggregate, and each segment, for future underwriting (accident) years used for pricing.

The following information, critical for the calculation of Solvency II metrics, is supplied:

- Probability distributions of the paid losses by calendar year (k=1,…,n), and their correlations for each LOB and the aggregate of all LOBs where complete run-off is achieved at the ultimate calendar year n.
- Probability distributions of the paid losses conditional on the first calendar year's losses being at the 99.5th percentile; that is, the year is 'in distress' with a 1/200 year event.

The MPTF modelling framework provides the required distributions. Thus, any risk measure can be computed, including Value-at-Risk (V@R) for calendar year k, for each LOB, and the aggregate of all LOBs.

ICRFS-Plus™ contains the unique PTF and MPTF modelling frameworks. Data, models, forecast scenarios, and links to reports all reside in a relational database. The database is a repository for all triangle groups (containing triangles, premiums, exposure measures, models and reports etc.) indexed by line of business, group member, territory and/or any other user-defined criteria.

1.3. Case studies

The remainder of this document consists of a series of case studies illustrating the depth and breadth of applications of the ICRFS-Plus™ MPTF modelling framework for long-tail liability risk management.

Section 2: Company M

Company M consists of three Lines of Business split into various segments and cost components. The MPTF modelling framework is used to connect the models for the individual cost components. Results are presented in aggregate (all Lines of Business) as well as by line and cost component – all using the optimal single composite model identified in the MPTF modelling framework.

This study showcases the ICRFS-Plus™ MPTF modelling framework and covers the following topics:

- Forecast scenarios encompassing various aggregations across cost components and LOBs;
- Complete reserve distribution analysis,
    - Allocation by Line of Business and Segment;
    - Summaries by accident year (including variation in mean ultimates one year hence);
    - Summaries by calendar year;
    - Quantiles (percentiles), V@R and T-V@R tables;
- Future underwriting years distributions and risk metrics;
- Combined (reserve and future underwriting years) distributions, V@Rs and T-V@Rs, and risk diversification;
- Economic Balance Sheet, Solvency II and IFRS4 metrics,
    - One-year risk horizon,
    - Ultimate year risk horizon, and
- Reserve releases based on conservative forecast scenarios and monitoring.

Section 3: Companies A and B: Credibility modelling

Company A and B are both casualty treaty syndicates. Company A's data are sparse compared to Company B, resulting in some critical trend parameters not being able to be estimated with a good level of precision. Some of these parameters are estimated by pooling strength from Company's A data (and model). That is, Company's A data is used to credibility adjust the model for Company B. Process volatility is not credibility adjusted as it is (typically) intrinsic to the LOB. The identified MPTF composite model for Company A and B is used to forecast distributions for each company and the aggregate.

Section 4: Company S: Losses and Recoveries

As with Company M, Company S writes a large portfolio of Motor and other LOBs. LOBs are split into various loss development array components. For the two Motor LOBs, recoveries also apply. The MPTF modelling framework is used to model both losses and recoveries. Loss distributions are presented net of recoveries by subtracting the projections for recoveries from the losses.

Section 5: A.M. Best Schedule P: BH, SR, and the Industry

In this section, two companies, BH and SR, are compared using A.M. Best Schedule P data. Calendar year trends in the company's LOBs are shown to be unique and distinct from each other and the industry.

Section 6: Worker's Compensation Segments: SAD and SAM

These two segments of Worker's Compensation are shown to be closely related in accident year trend structure. The mean ultimates move synchronously. There is a functional relationship in mean ultimates that is approximately linear. This relationship is stronger than volatility correlation.

The process (volatility) correlation, after the trends are adjusted for, is only 0.25 and reserve distribution correlation is only 0.086! Relationships in mean ultimates are not process correlation - see also "Understanding correlations and common drivers" brochure.

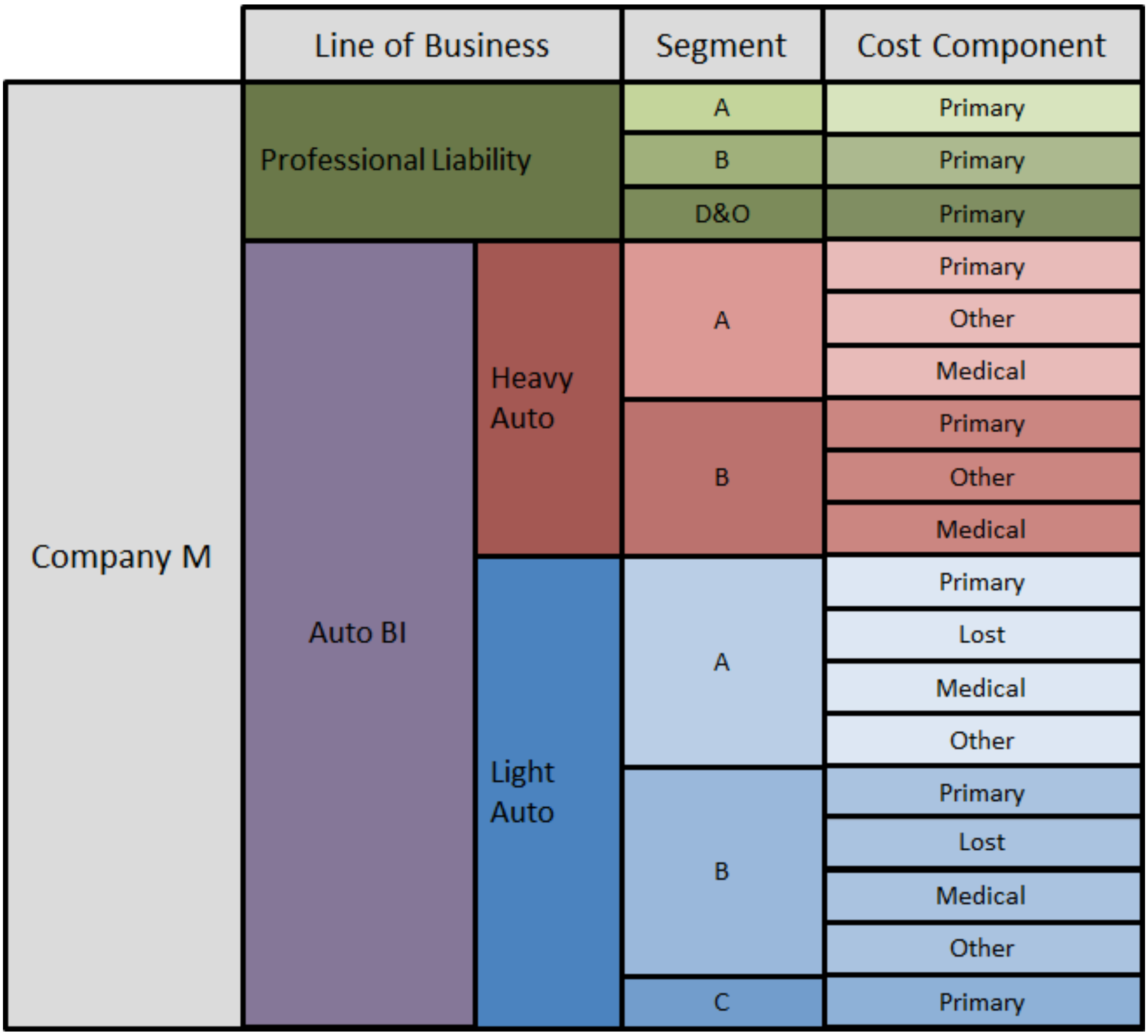
In respect of forecasting future accident (underwriting) years, the relationship between the accident year trends is important. Selection of future assumptions must be cognisiant of this relationship.

2. Company M: Reserve, Solvency II, Risk capital allocation, pricing future years, and more

This case study illustrates the following topics in the context of Company M – a large company writing Motor and Professional Liability Insurance:

- Correlation: process (volatility), parameter and reserve distribution
- Combinations of forecasts to create summaries in aggregate, by line of business , and by cost component
- Risk capital allocation: by line of business, by calendar year, or by accident year
- Complete reserve, future underwriting year, and combined (reserve + future underwriting year distributions.)
- Monitoring and releasing reserves
- Solvency II metrics
- Combined, reserve, and future underwriting risk

Company M consists of three lines of business: Light Auto, Heavy Auto and Professional Liability. These three lines are split into several segments and cost components as detailed below. When modelling the cost components, eighteen paid loss arrays comprise the composite model.

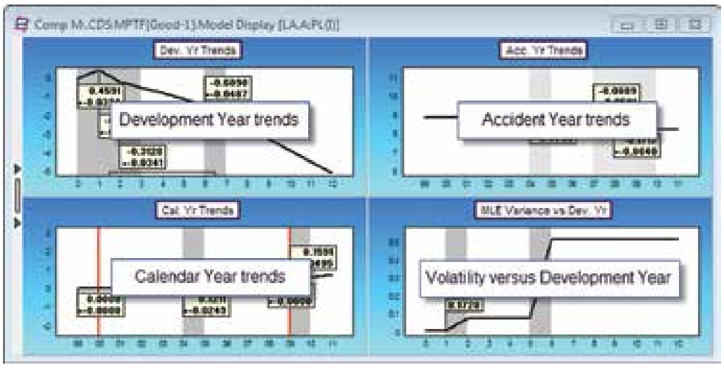


From the identified composite model at the component level, aggregates at any upper layer can easily be created. A composite model is designed for the whole company's long tail liabilities with a complete view into any layer and cost component.

2.1. Model displays

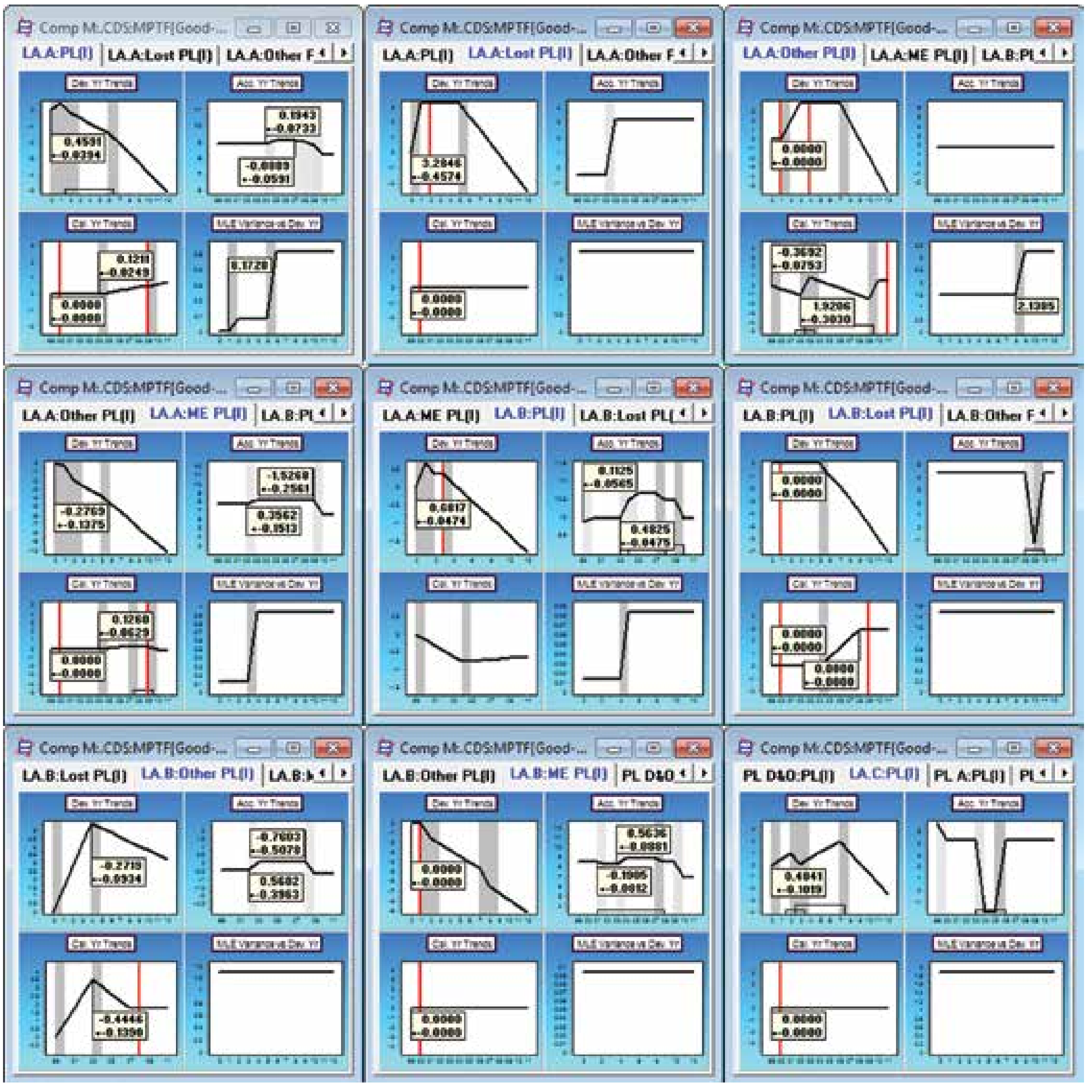
A probabilistic trend family (PTF) model is identified for each loss component. The PTF model describes the trends in the three directions (development, accident, and calendar) along with the volatility around the trends. The identified PTF models are then connected via correlations measured from the data in the Multiple Probabilistic Trend Family (MPTF) framework.

The model displays for the eighteen cost components are summarised below, grouped by LOB. All model displays are laid out as detailed in the following graph.

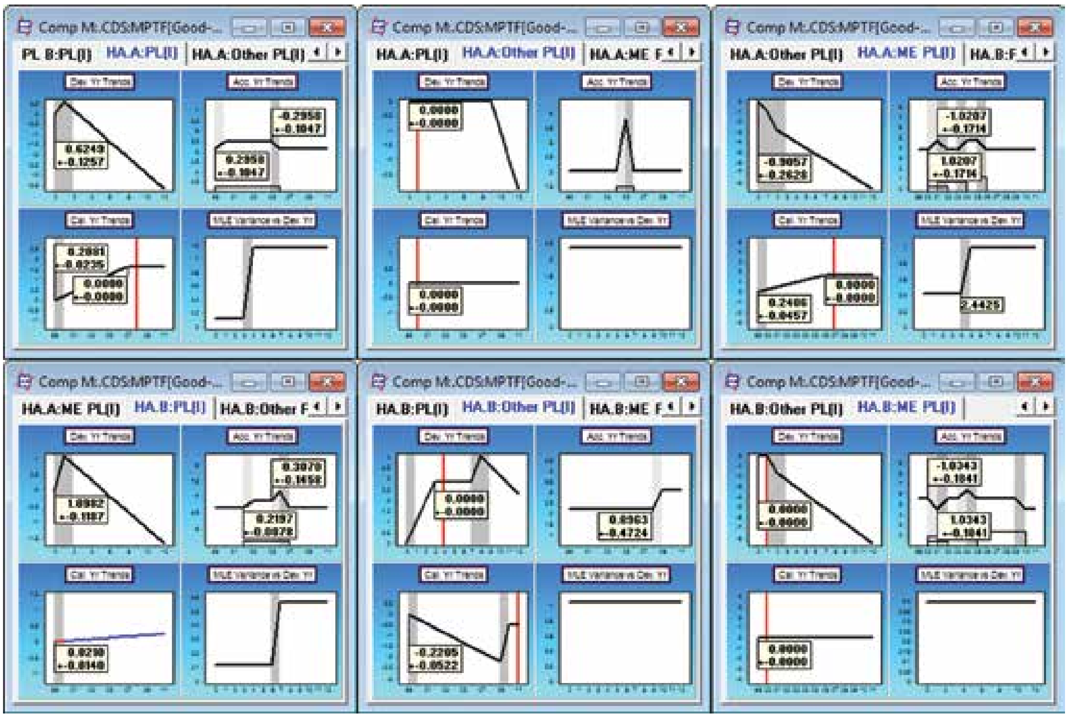


The trends (development, accident, and calendar) and volatility are unique to each component. Relative to exposure adjustment, economic inflation may be expected to be common between the components, however it is clear that social inflation is very different (calendar year trends are social + economic inflation).

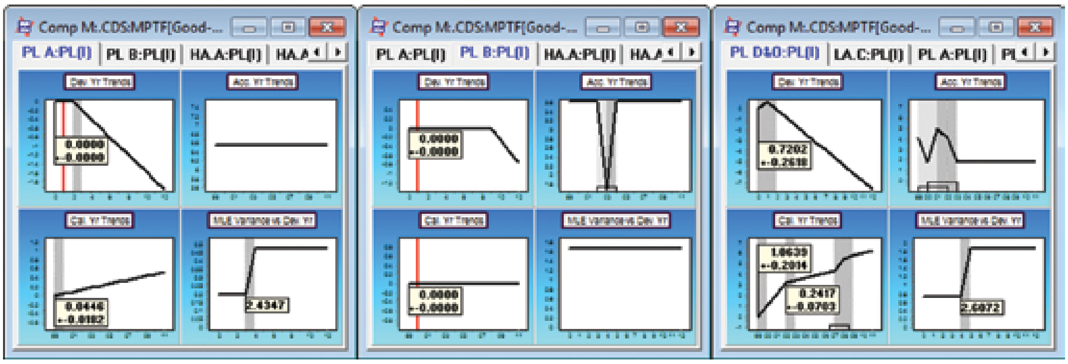
Light Auto



Heavy Auto



Professional Liability



The model displays for each component show different development year, accident year, and calendar year trends for each piece. Some cost component's development trends decrease almost immediately (Light Auto: A:PL(I), Heavy Auto: A:ME, Prof Liab. D&O), other cost components do not decay many years into the payment stream (Light Auto: A: Other, Heavy Auto: A: Other, PL B:PL(I)).

Similarly, calendar year trends vary significantly across cost components and between the three Lines of Business.

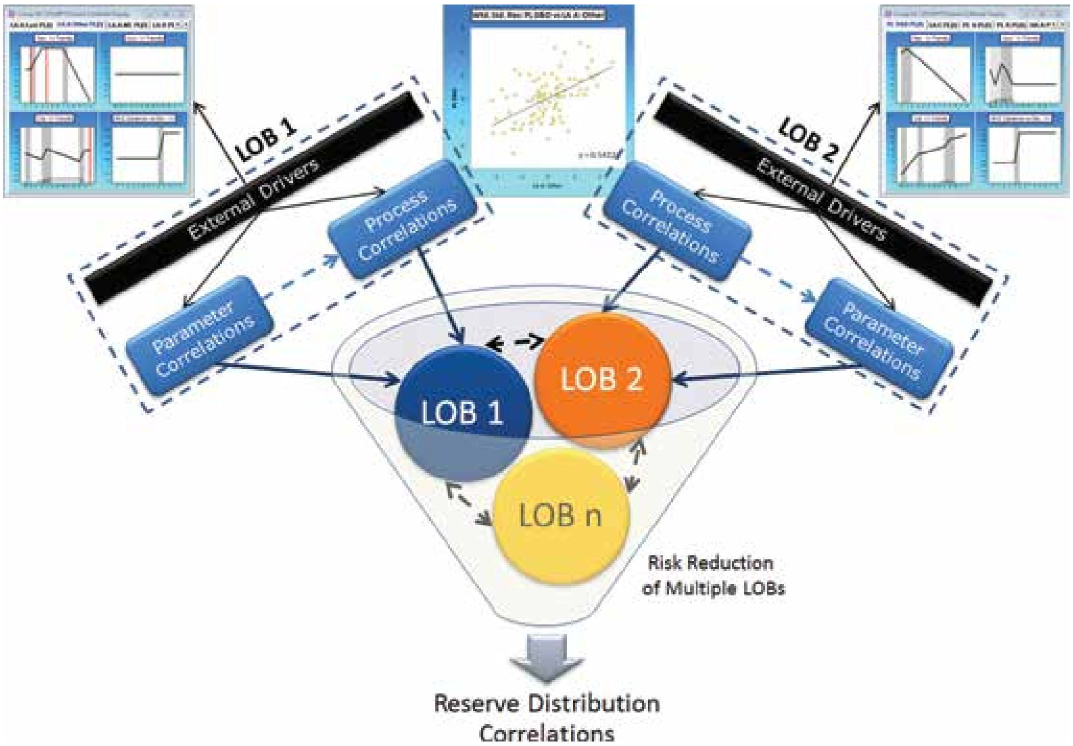
In general, the model identified for each component is statistically optimal for the cost component. However, statistically insignificant trends can be included in a model (eg: HA: B PL(I)) where the actuary believes these trend assumptions more appropriately describe the trends in the business.

The critical feature of identifying trends in all three directions, along with the volatility around the trends, allows the actuary to make informed decisions about both trends measured in the model along with indications of future emerging trends.

2.2. Correlations between LOBs

There are three types of correlations between Lines of Business:

- Process (volatility) correlation,
- Parameter correlation, and
- Reserve distribution correlation.



Process correlation is the correlation in the pure volatility component of the liabilities. This is measured after all trends have been accounted for.

Parameter correlation can arise from the action of external effects, but is also induced via process correlation because estimation of model parameters depends on data subject to correlated random effects. If the trend structure is identical for two lines of business the process correlation will have no impact on parameter uncertainty (this is necessary otherwise data could be duplicated and have lower parameter uncertainty than the original data with no true gain of information).

Reserve distribution correlations between calendar year liability streams are a function of process variability and parameter uncertainty; higher parameter uncertainty results in higher reserve distribution correlations.

Correlation should be measured from the data in order to determine each company's unique interline correlation. Taking these into account results in alterations in parameter and volatility estimates and hence in reserve distributions. These effects cannot be replicated by the imposition of off-the-shelf correlation matrices or copulas. Correlation is an intrinsic component of a good model.

2.2.1. Impact of correlation

Two lines are (positively) correlated when their results tend to consistently miss their target values in the same way. This is what should concern business planners, because it affects the unpredictable component of the forecasts. What is predictable, when it includes common trend patterns, does not count towards correlation, because its effects are already incorporated into the model and forecast. A forecast must include a volatility measure, ideally in the form of a loss distribution but at least in the form of a standard deviation.

Modelling multiple Lines of Business in the Multiple Probabilistic Trend Family modelling framework leads to significant aggregate risk diversification credit. The level of diversification is dependent on the correlations between the Lines of Business.

For further information on correlations, see the "Understanding correlations and common drivers" brochure.

Process correlation

Comp M:.CDS:MPTF[Good-1]:Weighted Residual Covariances Between Datasets

Covariances | Correlations | Final Covariances | Final Correlations

Final Weighted Residual Correlations Between Datasets

	LA.A:PL(I)	LA.A:Lost PL(I)	LA.A:Other PL(I)	PL D&O:PL(I)	LA.A:ME PL(I)	LA.B:ME PL(I)	LA.B:PL(I)	LA.B:Lost PL(I)	HA.A:Other PL(I)	LA.B:Other PL(I)	LA.C:PL(I)	PL A:PL(I)	HA.B:Other PL(I)
LA.A:PL(I)	1	0.483365											
LA.A:Lost PL(I)	0.483365	1											
LA.A:Other PL(I)			1	0.541239									
PL D&O:PL(I)			0.541239	1									
LA.A:ME PL(I)					1	0.288433							
LA.B:ME PL(I)					0.288433	1							
LA.B:PL(I)							1						
LA.B:Lost PL(I)								1	0.298319				
HA.A:Other PL(I)								0.298319	1				
LA.B:Other PL(I)										1			
LA.C:PL(I)											1		
PL A:PL(I)												1	0.245560
HA.B:Other PL(I)												0.245560	1

Clusters have been set
4 iterations were executed

The vast majority of the process correlations are zero (and not displayed). There are several groups of cost components with significant process correlations with another group – these groups are highlighted above. While some process correlations are within LOBs (like LA.A with LA.A:Lost) others are between LOBs (LA.B:Lost with H.A:Other).

The net result is significant diversification credit between LOBs – the process correlations between the three LOBs are very low.

Process correlation between LOBs			
	Light Auto	Heavy Auto	Prof Liability
Light Auto	1.000	0.089	0.119
Heavy Auto	0.089	1.000	0.033
Prof Liability	0.119	0.033	1.000

Parameter correlation

Parameter correlations are calculated between all parameters. Below we illustrate an extract of the parameter correlation table for the calendar year (iota) parameters.

Comp M:.CDS:MPTF[Good-1]:Parameter Covariances and Correlations

Covariances | Correlations

All | Gammas | Alphas | Iotas

Iota Correlations

		LA.A:PL(I)		LA.A:Other PL(I)		LA.A:ME PL(I)	
Dataset	Period	2004~2008	2009~2011	1999~2002	2002~2003	2004~2007	2007~2008
LA.A:PL(I)	2004~2008	1	0.122522	0.000000	0.000000	0.000000	0.000000
LA.A:PL(I)	2009~2011	0.122522	1	0.000000	0.000000	0.000000	0.000000
LA.A:Other PL(I)	1999~2002	0.000000	0.000000	1	-0.653453	0.000000	0.000000
LA.A:Other PL(I)	2002~2003	0.000000	0.000000	-0.653453	1	0.000000	0.000000
LA.A:ME PL(I)	2004~2007	0.000000	0.000000	0.000000	0.000000	1	-0.400153
LA.A:ME PL(I)	2007~2008	0.000000	0.000000	0.000000	0.000000	-0.400153	1

Reserve distribution correlations

Reserve distribution correlations are typically much less than process (or parameter) correlations. In fact, reserve distribution correlations are driven by parameter correlation (not process correlation). If parameter correlations are low, then reserve distribution correlations will also be low. These correlations are presented in the section on forecast results.

2.3. Aggregate forecast results

All forecast scenarios presented below correspond to a reasonable scenario which typically continues with, or resumes, positive calendar year trends (and their uncertainties) observed in the data. The specification of future forecast scenario assumptions is entirely within the control of the actuary.

Below multiple aggregations are covered in the tabs:

- All lines is the sum of the LOBs: Light Auto, Heavy Auto, and Prof. Liab. (Professional Liability);
- Aggregate is the sum of the individual cost components;
- All Auto is the sum of Light Auto and Heavy Auto.
- Light Auto and Heavy Auto are the sums of their respective loss components;
- The remaining tabs correspond to projections, by cell and totals, for the respective cost components.

Accident Period vs Development Period

Black values: Fitted means

Blue values: Observed losses

Red/Burgundy values: Standard deviations(*)

	Cal. Per. Total	0	1	2	3	4	5	6	7	8	9	20	Outstanding	Ultimate
2004	194,057	39,087	67,841	44,401	42,248	37,945	31,981	25,621	18,887	14,021	10,631	853	60,855	374,887
	212,455	41,729	79,405	37,776	45,618	38,947	10,745	33,843	20,810	3,554	2,684	283	7,725	7,725
	239,360	47,681	82,669	55,185	53,158	44,635	38,417	30,647	23,086	17,183	13,037	1,021	97,073	449,882
	243,728	44,845	83,311	60,898	46,263	51,077	46,291	20,023	6,346	4,406	3,363	342	12,008	12,008
2006	286,452	58,529	88,521	60,882	54,779	48,903	40,905	33,404	25,952	18,701	13,989	1,068	138,132	469,171
	262,783	54,747	94,971	50,010	53,304	40,334	37,722	10,274	7,092	5,079	3,683	358	17,738	17,738
2007	327,506	53,350	93,631	60,583	57,135	49,329	42,092	34,694	26,628	19,158	14,216	1,054	182,492	489,595
	345,155	52,868	88,716	65,800	56,382	48,548	11,859	11,344	8,439	5,437	3,901	357	23,331	23,331
2008	368,454	49,335	82,878	56,180	52,371	45,622	36,150	32,518	24,758	17,585	[illegible]	[illegible]	212,180	448,172
	347,689	50,519	75,934	47,101	81,438	10,564	11,560	11,688	8,530	5,382	[illegible]	[illegible]	26,515	26,515
2009	374,012	46,180	82,523	55,549	51,496	43,584	37,301	31,871	24,611	18,214	[illegible]	[illegible]	260,211	446,542
	379,005	45,228	83,455	57,849	10,712	10,298	11,599	11,846	8,673	5,608	3,630	331	30,374	30,374
2010	379,751	30,294	58,861	42,437	38,033	33,698	29,489	23,833	18,405	13,063	9,181	703	237,958	339,262
	378,701	29,531	71,783	11,116	10,309	8,881	10,993	8,960	8,873	4,041	2,577	259	28,393	28,393
2011	369,897	32,769	64,595	46,190	41,823	35,938	31,530	25,662	18,877	13,401	9,428	721	317,141	354,101
	380,579	36,958	15,473	12,452	11,066	10,370	11,994	10,272	7,151	4,233	2,726	288	37,304	37,304
	Total Fitted/Actual		2012	2013	2014	2015	2016	2017	2018	2019	2020	2031	Total Reserve	Total Ultimate
Cal. Per.	3,137,057		338,621	273,946	225,727	182,493	143,926	111,260	82,289	61,204	45,904	721	1,603,933	4,732,609
Total	3,128,879		32,195	29,352	27,288	24,950	21,469	17,194	11,880	8,403	6,445	288	115,501	115,501

1 Unit = $1,000; Forecast Scenario: Reasonable Combination +AY2012

(*) Standard deviations in each cell (red) are standard deviations of log-normal distributions when examining an individual segment (in this case cost component), but are the standard deviation of the sum of correlated log-normal distributions, otherwise. Burgundy standard deviations are always the sum of correlated log-normal distributions.

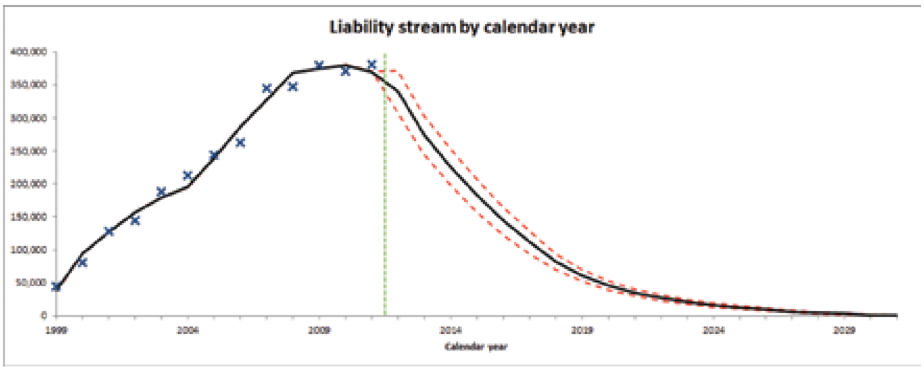
The mean of the total reserve (reasonable forecast scenario) for the aggregate of all the segments is 1.604B (highlighted: green). The corresponding standard deviation (highlighted: yellow) of the reserve distribution is 115.5M.

The future calendar year payment stream is shown and the comparison between last observed values (blue numbers) and fitted values (black numbers) for the individual cells and calendar year totals 2007-2011 (say) can be made with the projected figures for calendar years 2012-2014. Means are black. The red and burgundy standard deviations correspond to standard deviations of the projected distributions. For the All Lines tab, an aggregate of multiple LOBs, all standard deviations are the standard deviations of the sum of correlated log-normal distributions.

For each cost component, the identified composite model and the associated forecast scenarios project log-normal distributions (and their correlations) for each cell for each segment

The liability stream by calendar year (important for asset-liability matching) is reasonable and consistent with expectations of future losses for this company.

The liability stream means for past calendar years (1999~2011), future years (2012~2031), and the future liability stream means +_ one standard deviation (dashed lines) are shown below. The actual losses for the calendar years are marked for 1999~2011.



2.3.1. Reserve forecasts by LOB

Reserve Breakdown by LOB

	Paid To 2011	Incurred To 2011	CRE 2011	Mean Outstanding	Mean Ultimate	Std Dev
LightAuto	2,681,599	3,253,000	571,401	1,287,534	3,969,133	90,615
HeavyAuto	235,034	337,871	102,837	116,671	351,706	13,886
Prof Liab.	212,043	367,648	155,606	135,811	347,853	34,636
Total	3,128,676	3,958,519	829,844	1,540,016	4,668,692	98,981

1 Unit = $1,000
Forecast scenario: Reasonable Combination

Summary statistics for the reserve distributions are provided above for each LOB and the aggregate of the LOBs. The distributions can be further split into each cost component as illustrated in the next section.

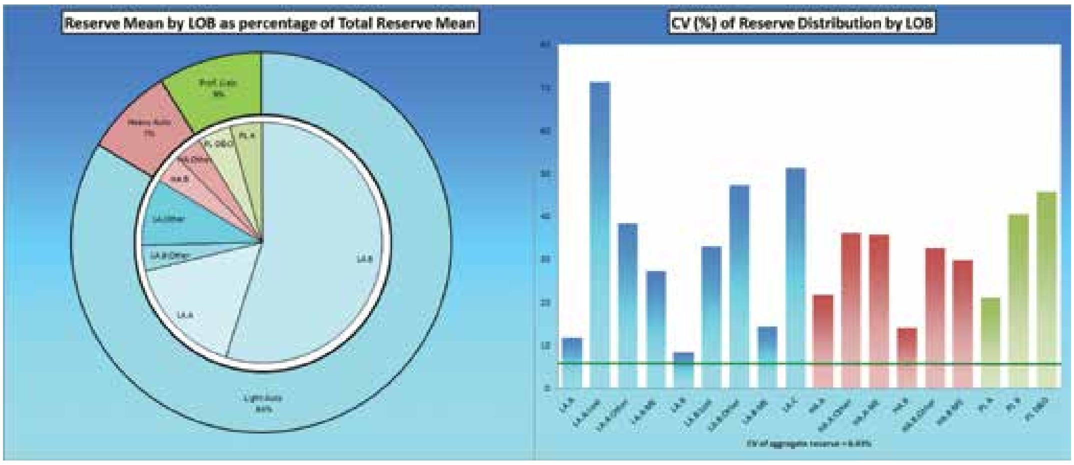
2.3.2. Reserve forecasts by cost component

Reserve Breakdown by LOB

	Paid To 2011	Incurred To 2011	CRE 2011	Mean Outstanding	Mean Ultimate	Std Dev
LA.A:PL(I)	643,791	796,519	152,728	290,653	934,444	64,152
LA.A:Lost PL(I)	44,158	67,247	23,089	46,151	90,309	33,036
LA.A:Other PL(I)	24,856	24,856	0	25,685	50,540	9,864
LA.A:ME PL(I)	83,413	83,413	0	2,206	85,619	603
LA.B:PL(I)	1,508,922	1,879,361	370,439	845,147	2,354,070	70,050
LA.B:Lost PL(I)	81,610	104,143	22,532	32,487	114,098	10,740
LA.B:Other PL(I)	80,626	80,626	0	53,222	133,848	25,089
LA.B:ME PL(I)	172,704	172,704	0	5,275	177,979	762
LA.C:PL(I)	41,518	44,131	2,613	26,716	68,233	13,678
PL D&O:PL(I)	133,900	230,562	96,662	69,675	203,574	31,820
PL A:PL(I)	72,735	131,088	58,353	65,108	137,843	13,787
PL B:PL(I)	5,408	5,998	590	1,348	6,756	547
HA.A:PL(I)	69,304	102,132	32,827	25,891	95,196	5,627
HA.A:Other PL(I)	4,296	4,296	0	915	5,211	329
HA.A:ME PL(I)	5,539	5,539	0	282	5,821	101
HA.B:PL(I)	139,609	209,618	70,009	82,936	222,545	13,350
HA.B:Other PL(I)	6,265	6,265	0	29,895	36,159	12,398
HA.B:ME PL(I)	10,022	10,022	0	343	10,365	102
Total	3,128,676	3,958,519	829,844	1,603,933	4,732,609	115,501

1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012

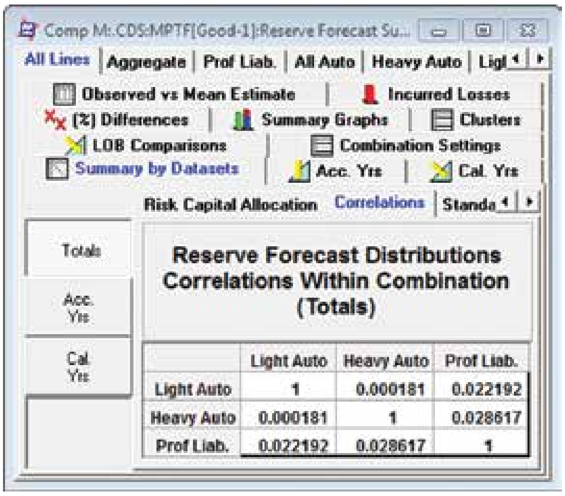
The breakdown of the total reserve to each cost component (grouped by LOB) is shown above. The majority of the total reserve (~71%) is allocated to the two lines: LA.B and LA.A. This is also shown in the pie chart below.



The outer ring (pie chart), shows the aggregation by LOB. The inner pie chart shows the distributions between cost components. Similarly, the coloured bars for the CV(%) on the right, also are grouped by LOB. The CV of the aggregate distribution is only 6.43% while many individual cost components have a CV exceeding 20%.

Reserve distribution correlations by LOB

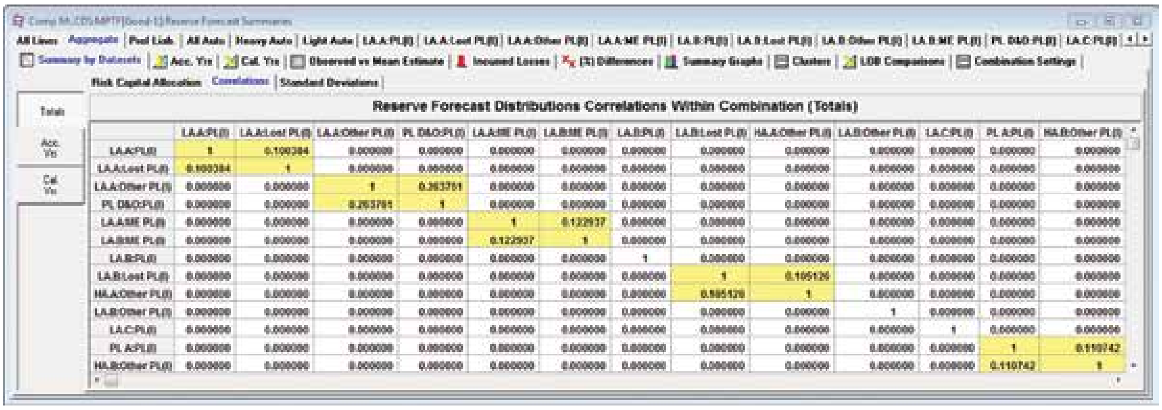
The reserve distribution correlations across the lines of business (not cost components) are very low. Similarly, the reserve distribution correlations are negligible. As such, significant diversification credit is gained from writing the three LOBs. This was evident from the low process correlations illustrated earlier.



Reserve Forecast Distributions Correlations Within Combination (Totals)

	Light Auto	Heavy Auto	Prof Liab.
Light Auto	1	0.000181	0.022192
Heavy Auto	0.000181	1	0.028617
Prof Liab.	0.022192	0.028617	1

Reserve distribution correlations by cost component

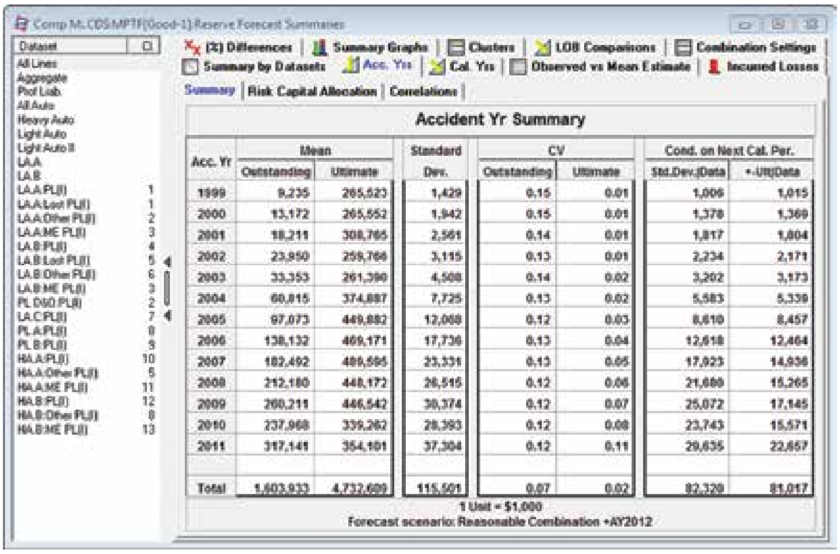


Reserve Forecast Distributions Correlations Within Combination (Totals)

	LA.A:PL(I)	LA.A:Lost PL(I)	LA.A:Other PL(I)	PL D&O:PL(I)	LA.A:ME PL(I)	LA.B:ME PL(I)	LA.B:PL(I)	LA.B:Lost PL(I)	HA.A:Other PL(I)	LA.B:Other PL(I)	LA.C:PL(I)	PL A:PL(I)	HA.B:Other PL(I)
LA.A:PL(I)	1	0.100384	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LA.A:Lost PL(I)	0.100384	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LA.A:Other PL(I)	0.000000	0.000000	1	0.263761	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
PL D&O:PL(I)	0.000000	0.000000	0.263761	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LA.A:ME PL(I)	0.000000	0.000000	0.000000	0.000000	1	0.122937	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LA.B:ME PL(I)	0.000000	0.000000	0.000000	0.000000	0.122937	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LA.B:PL(I)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
LA.B:Lost PL(I)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1	0.105126	0.000000	0.000000	0.000000	0.000000
HA.A:Other PL(I)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.105126	1	0.000000	0.000000	0.000000	0.000000
LA.B:Other PL(I)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1	0.000000	0.000000	0.000000
LA.C:PL(I)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1	0.000000	0.000000
PL A:PL(I)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	1	0.110742
HA.B:Other PL(I)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.110742	1

The reserve distribution correlations between cost components are predominantly zero with some correlations between lines with process correlation as estimated in the model. The lack of significant process correlation between cost components results in the low correlations between LOBs despite correlations between some cost components being high.

2.3.3. Accident year summaries (including variation in mean ultimates one year hence)



Accident Yr Summary

Acc. Yr	Mean Outstanding	Mean Ultimate	Standard Dev.	CV Outstanding	CV Ultimate	Cond. on Next Cal. Per. Std.Dev.|Data	Cond. on Next Cal. Per. +-Ult|Data
1999	9,235	265,523	1,429	0.15	0.01	1,006	1,015
2000	13,172	265,552	1,942	0.15	0.01	1,378	1,369
2001	18,211	308,765	2,561	0.14	0.01	1,817	1,804
2002	23,950	259,766	3,115	0.13	0.01	2,234	2,171
2003	33,353	261,390	4,508	0.14	0.02	3,202	3,173
2004	60,815	374,887	7,725	0.13	0.02	5,583	5,339
2005	97,073	449,882	12,068	0.12	0.03	8,610	8,457
2006	138,132	469,171	17,736	0.13	0.04	12,618	12,464
2007	182,492	489,595	23,331	0.13	0.05	17,923	14,936
2008	212,180	448,172	26,515	0.12	0.06	21,689	15,265
2009	260,211	446,542	30,374	0.12	0.07	25,072	17,145
2010	237,968	339,262	28,393	0.12	0.08	23,743	15,571
2011	317,141	354,101	37,304	0.12	0.11	29,635	22,657
Total	1,603,933	4,732,609	115,501	0.07	0.02	82,320	81,017

1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012

Variation in mean Ultimates conditional on next calendar year's data

The table above includes the one-calendar-year-ahead mean ultimate statistics (Cond. on Next Cal. Per.). These statistics provide:

- The conditional standard deviation of all possible mean ultimates (one year hence) is given in the rightmost column (+_Ult|Data).
- The second column from the right (Std.Dev.|Data) represents the mean standard deviation of the distribution of the ultimate conditional on next year's data. The reason it is lower than the standard deviation of the ultimate as at year end 2011 is a result of reduced parameter uncertainty and the forecasting horizon being shorter (when you are at the end of 2012).

The total variability in the ultimate is thus decomposed into the variability for the next calendar year's forecast (+_ Ult | Data) and the variability associated with the remaining years' forecast (Std.Dev | Data).

Prior to receiving the 2012 data (the next calendar year), the mean of all ultimates conditional on 2012 data is the mean ultimate as at year end 2011.

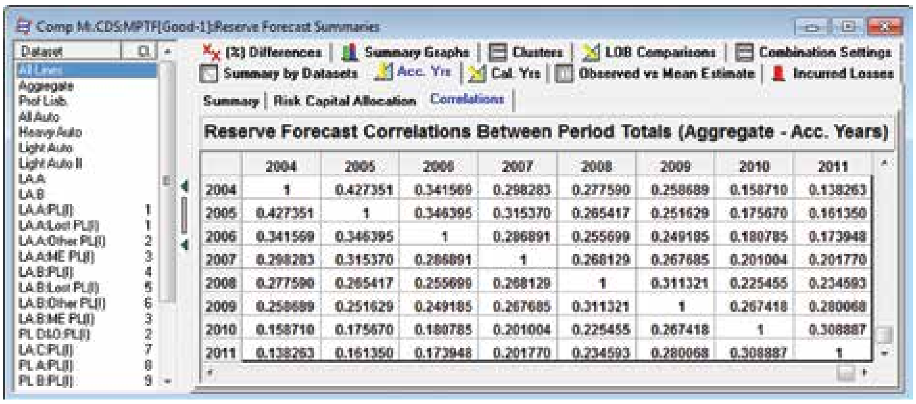
Accident year 2011 example

The projected mean ultimate at the start of 2012 is 354.1M. The variation in mean ultimate for this accident year is 22.7M. This means that the mean ultimate recalculated at the end of 2012 may vary by 22.7M or more from the earlier figure and still be consistent with the estimates above.

The 29.6M corresponds to the standard deviation of the ultimate distribution conditional on the calendar year 2012's data.

Note: $22.7^2 + 29.6^2 = 37.3^2$ – Pythagoras' theorem applies.

Correlations by accident year

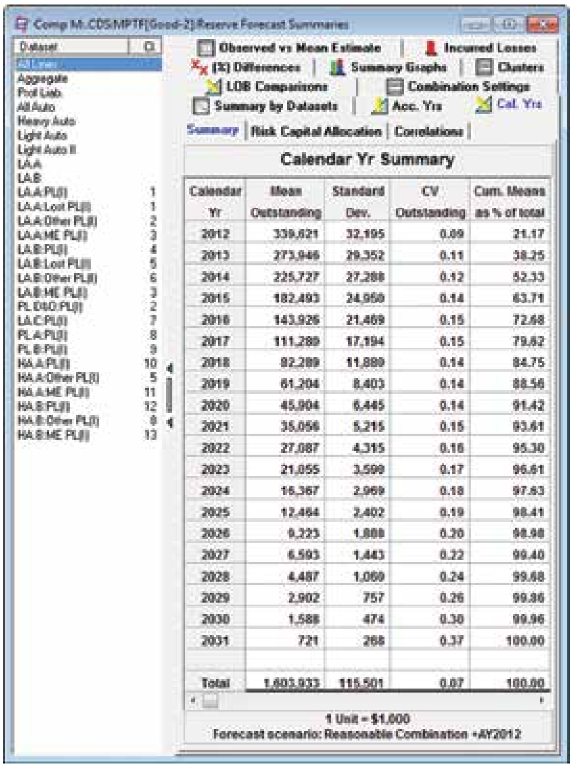


Reserve Forecast Correlations Between Period Totals (Aggregate - Acc. Years)

	2004	2005	2006	2007	2008	2009	2010	2011
2004	1	0.427351	0.341569	0.298283	0.277590	0.258689	0.158710	0.138263
2005	0.427351	1	0.346395	0.315370	0.265417	0.251629	0.175670	0.161350
2006	0.341569	0.346395	1	0.286891	0.255699	0.249185	0.180785	0.173948
2007	0.298283	0.315370	0.286891	1	0.268129	0.267685	0.201004	0.201770
2008	0.277590	0.265417	0.255699	0.268129	1	0.311321	0.225455	0.234593
2009	0.258689	0.251629	0.249185	0.267685	0.311321	1	0.267418	0.280068
2010	0.158710	0.175670	0.180785	0.201004	0.225455	0.267418	1	0.308887
2011	0.138263	0.161350	0.173948	0.201770	0.234593	0.280068	0.308887	1

Correlations are calculated between accident period totals for the different aggregations including all lines as well as each cost component.

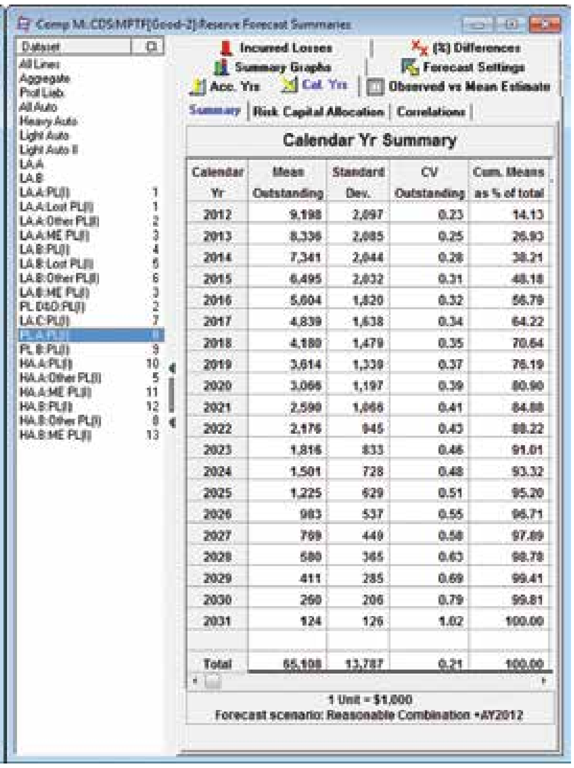
2.3.4. Calendar year summaries



Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Means as % of total
2012	339,621	32,195	0.09	21.17
2013	273,946	29,352	0.11	38.25
2014	225,727	27,288	0.12	52.33
2015	182,493	24,950	0.14	63.71
2016	143,926	21,469	0.15	72.68
2017	111,289	17,194	0.15	79.62
2018	82,289	11,889	0.14	84.75
2019	61,204	8,403	0.14	88.56
2020	45,904	6,445	0.14	91.42
2021	35,056	5,215	0.15	93.61
2022	27,087	4,315	0.16	95.30
2023	21,055	3,599	0.17	96.61
2024	16,367	2,969	0.18	97.63
2025	12,464	2,402	0.19	98.41
2026	9,223	1,888	0.20	98.98
2027	6,593	1,443	0.22	99.40
2028	4,487	1,069	0.24	99.68
2029	2,902	757	0.26	99.86
2030	1,588	474	0.30	99.96
2031	721	268	0.37	100.00
Total	1,603,933	115,501	0.07	100.00

1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012



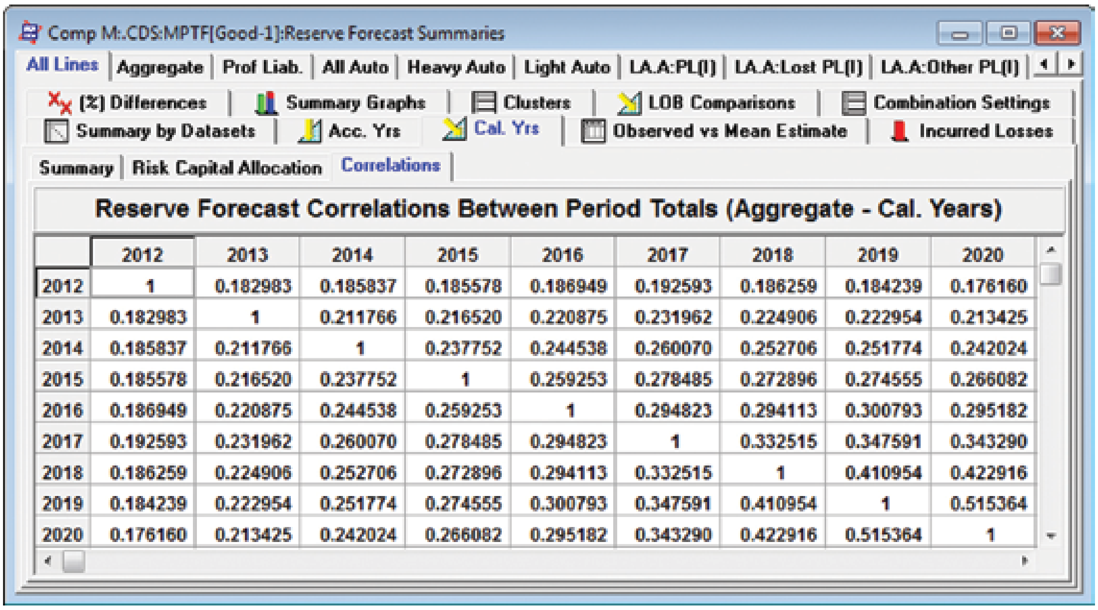
Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Means as % of total
2012	9,198	2,097	0.23	14.13
2013	8,336	2,085	0.25	26.93
2014	7,341	2,044	0.28	38.21
2015	6,495	2,032	0.31	48.18
2016	5,604	1,820	0.32	56.79
2017	4,839	1,638	0.34	64.22
2018	4,180	1,479	0.35	70.64
2019	3,614	1,339	0.37	76.19
2020	3,066	1,197	0.39	80.90
2021	2,590	1,066	0.41	84.88
2022	2,176	945	0.43	88.22
2023	1,816	833	0.46	91.01
2024	1,501	728	0.48	93.32
2025	1,225	629	0.51	95.20
2026	983	537	0.55	96.71
2027	769	449	0.58	97.89
2028	580	365	0.63	98.78
2029	411	285	0.69	99.41
2030	260	206	0.79	99.81
2031	124	126	1.02	100.00
Total	65,108	13,787	0.21	100.00

1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012

For the aggregate of all the lines (left), 50% of the mean liabilities are paid after two calendar years. For an individual line this is not necessarily the case – as illustrated for PL A (right) where it takes five years before 50% of the mean liabilities are paid out.

Correlations by calendar year



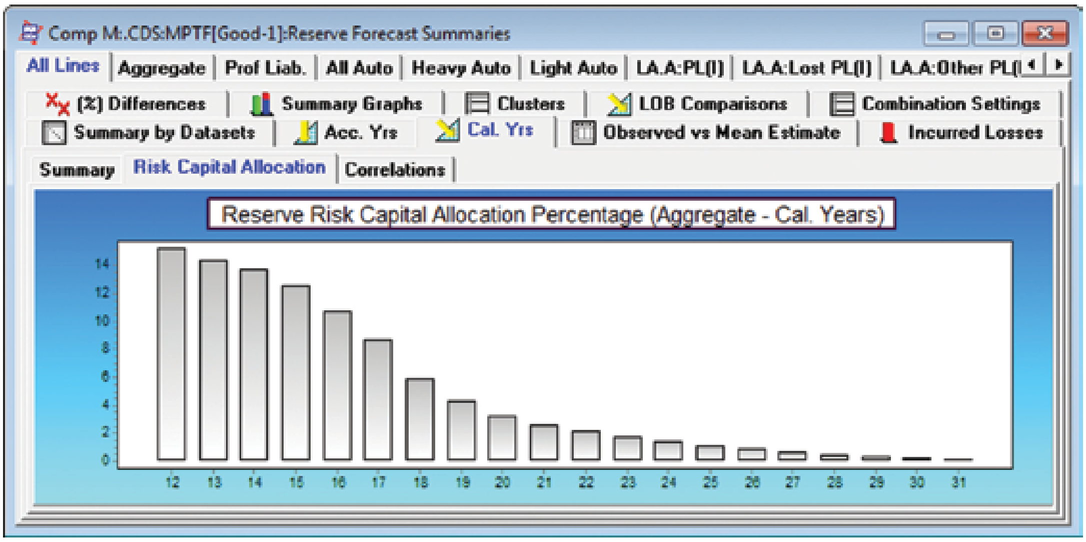
Reserve Forecast Correlations Between Period Totals (Aggregate - Cal. Years)

	2012	2013	2014	2015	2016	2017	2018	2019	2020
2012	1	0.182983	0.185837	0.185578	0.186949	0.192593	0.186259	0.184239	0.176160
2013	0.182983	1	0.211766	0.216520	0.220875	0.231962	0.224906	0.222954	0.213425
2014	0.185837	0.211766	1	0.237752	0.244538	0.260070	0.252706	0.251774	0.242024
2015	0.185578	0.216520	0.237752	1	0.259253	0.278485	0.272896	0.274555	0.266082
2016	0.186949	0.220875	0.244538	0.259253	1	0.294823	0.294113	0.300793	0.295182
2017	0.192593	0.231962	0.260070	0.278485	0.294823	1	0.332515	0.347591	0.343290
2018	0.186259	0.224906	0.252706	0.272896	0.294113	0.332515	1	0.410954	0.422916
2019	0.184239	0.222954	0.251774	0.274555	0.300793	0.347591	0.410954	1	0.515364
2020	0.176160	0.213425	0.242024	0.266082	0.295182	0.343290	0.422916	0.515364	1

As with accident years, total calendar year correlations are calculated for the different aggregations including all lines as well as each component.

Risk capital allocation by calendar year

Risk capital can be allocated between LOBs and across calendar years by the standard variance-covariance formula. That is, risk capital is allocated based on the LOB's contribution to the total variability. It is easy to extract the necessary tables to allocate risk capital using other methods if desired.



Mathematically, percentage risk capital allocation to the ith line, L, is:

$$A_i = \frac{\sum_j C_{ij}}{\sum_{ij} C_{ij}}$$

where C_{ij}, is the covariance of L_i and L_j.

The formula can be extended to include time (either calendar or accident period), by summation of the covariances across the relevant time period. Similarly, allocation across time periods for a single LOB can be readily considered by treating i,j as time indices rather than LOB indices.

2.4. Aggregate reserve distributions for the three LOBs (eighteen components)

The identified composite model predicts log-normal distributions, and their correlations, for each cell. Correlations are computed within and between segments, or, as in this case, cost components. Since there is no analytical closed distribution for the sum of correlated log-normals, simulations from the predicted correlated log-normals are conducted in order to obtain distributions of sums by accident year, calendar year, and totals for any segment and aggregation of segments. Quantiles (Percentiles), Value at-Risk (V@R) and Tail-Value-at-Risk (T-V@R) can then be computed for any sum.

Simulations can be applied to a single cost component, LOB or the aggregate of all LOBs. All simulations can be saved to text files facilitating easy importation into other software – eg: DFA products.

An extract of the simulations by calendar year for the aggregate of all the lines is displayed.

Comp M.:CDS:MPTF[Good-1]:All Lines:Reserve PALD Summary

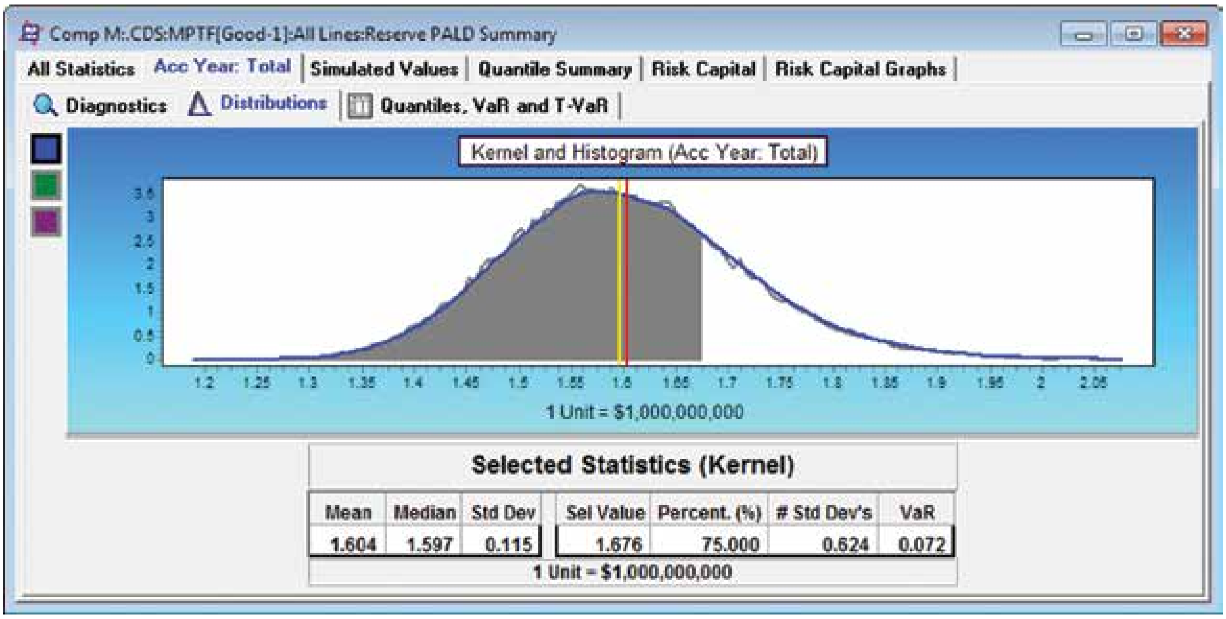
All Statistics | Cal. Yr: Total | Simulated Values | Quantile Summary | Risk Capital | Risk Capital Graphs

Simulated Values for Calendar Years

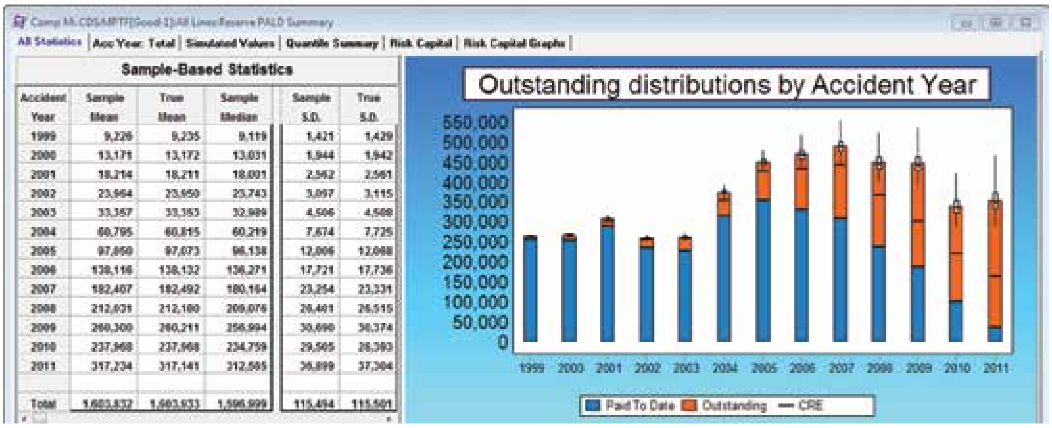
	2012	2013	2014	2015	2016		2031	Total
1	327,166	294,498	221,800	171,957	139,404		919	1,622,075
2	354,044	329,023	242,106	246,177	158,693		1,332	1,889,573
3	326,457	274,016	247,713	197,166	161,776		1,182	1,665,598
4	407,256	280,055	268,389	187,914	158,066		860	1,840,597
5	338,693	296,206	277,573	201,137	161,227		576	1,756,428
6	334,589	313,368	266,381	219,648	153,076		673	1,727,027
7	338,524	258,189	200,385	168,516	134,709		534	1,513,938
8	313,927	279,111	221,303	184,303	136,003		662	1,577,510
9	338,987	266,240	224,762	198,345	151,147		868	1,717,753

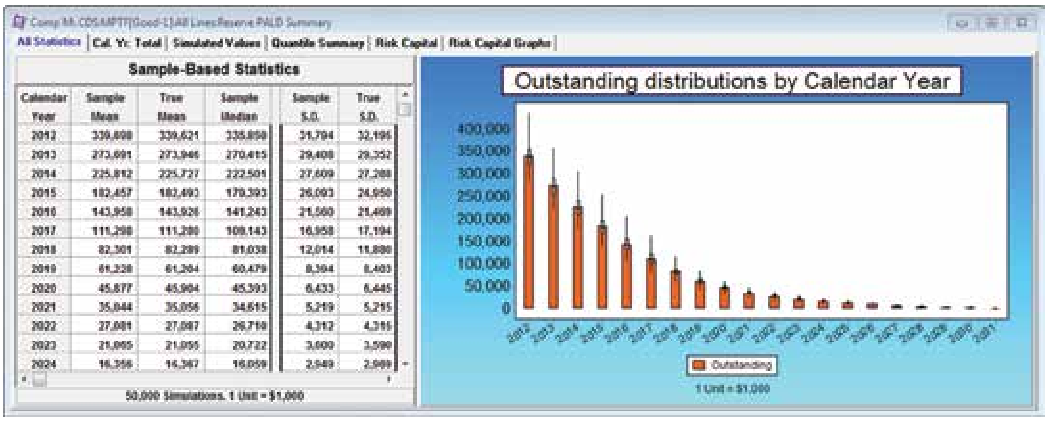
100,000 Simulations. 1 Unit = $1,000

The distribution of the total reserves, with the 75th percentile marked, is as follows:



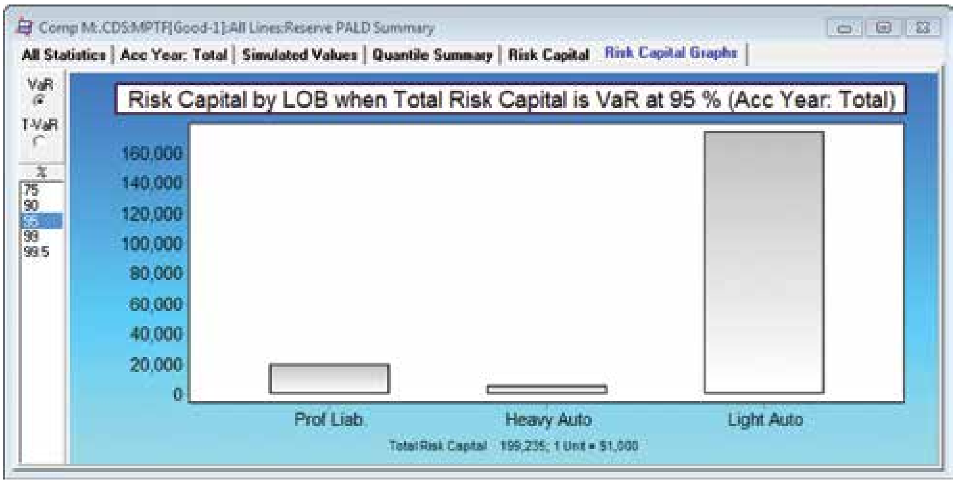
Distributions can also be viewed by accident year or calendar year. The distributions by accident year above also mark the CRE on the outstanding distribution so an idea of IBNR can be ascertained.



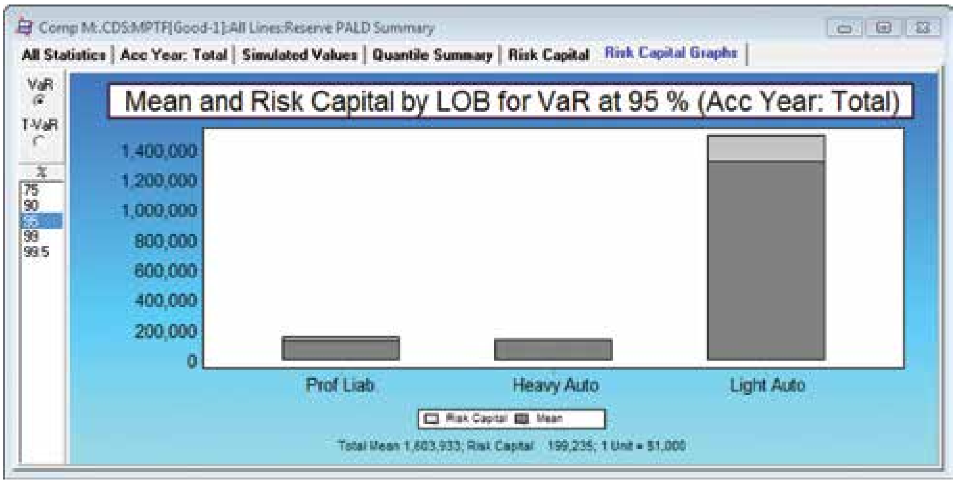


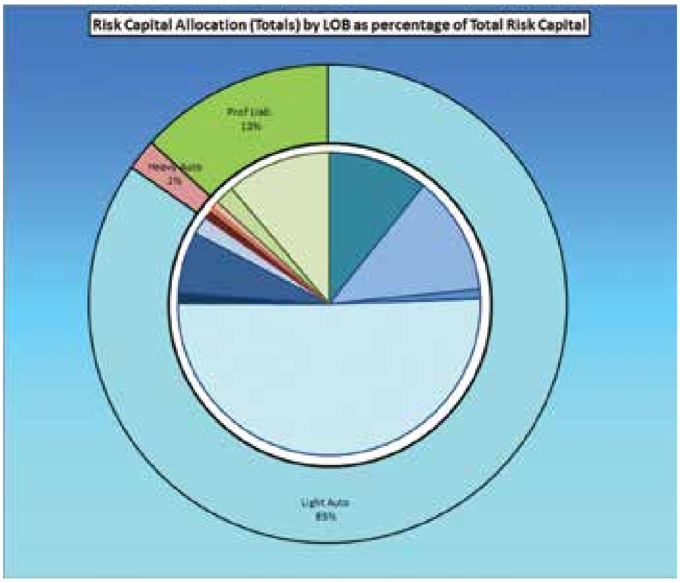
The outstanding (reserve) distributions by calendar year show the means along with the boxplots for each calendar year where the whiskers of the boxplots indicate the 1st and 99th percentiles.

2.5. Risk capital allocation by LOB and cost component



The risk capital allocation by LOB shows Light Auto takes the largest allocation of risk capital. This is a feature of the volume of the LOB being the largest (see graph below) rather than the line being more volatile. In fact, Light Auto is the least volatile of the three lines.

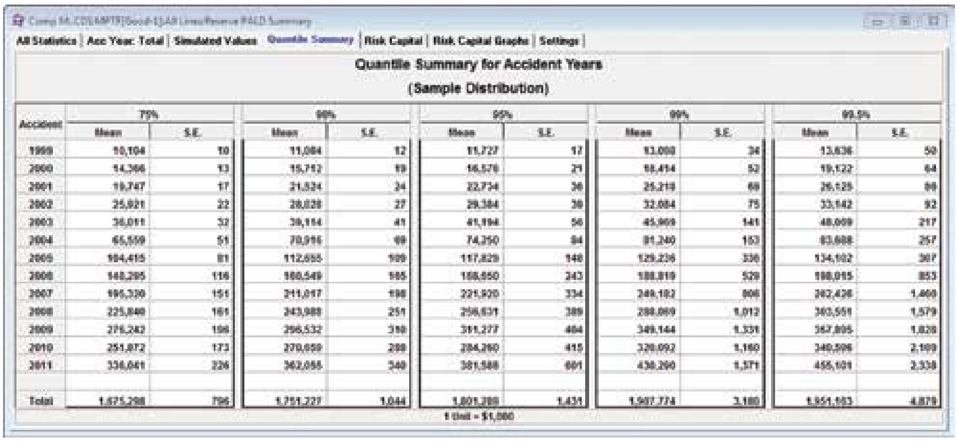




Risk capital allocation by LOB is shown below (outer ring). The inner ring demonstrates the allocation to each cost component (unlabelled).

2.6. Quantiles (percentiles), V@Rs and T-V@Rs for the aggregate of the three LOBs

Quantiles (percentiles) are calculated from the simulations at specified levels and are available by either accident year or calendar year. The tails of the distributions can then be considered as a basis for risk capital requirements (Value-at-Risk or Tail-Value-at-Risk) in total, by accident year, or by calendar year. Since the quantile itself is a statistic, the uncertainty associated with the quantile is also calculated - whether by accident year or by calendar year.

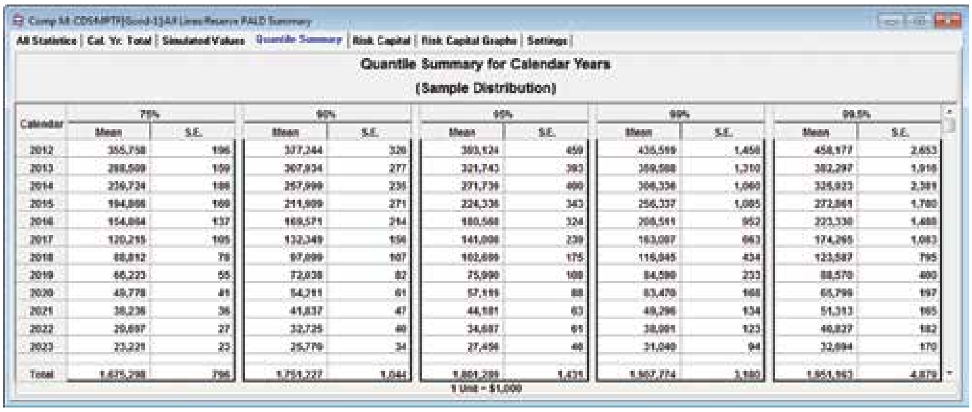


All Statistics | Acc Year: Total | Simulated Values | Quantile Summary | Risk Capital | Risk Capital Graphs | Settings

Quantile Summary for Accident Years
(Sample Distribution)

Accident	75%		90%		95%		99%		99.5%	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
1999	10,104	10	11,084	12	11,727	17	13,000	34	13,636	50
2000	14,366	13	15,712	19	16,578	21	18,414	52	19,122	64
2001	19,747	17	21,524	24	22,734	36	25,219	68	26,125	86
2002	25,021	22	28,028	27	29,384	38	32,084	75	33,142	92
2003	36,011	32	39,114	41	41,194	56	45,909	141	48,009	217
2004	65,559	51	70,916	69	74,250	84	81,240	153	83,688	257
2005	104,415	81	112,655	109	117,829	148	129,236	336	134,102	367
2006	148,295	116	180,549	165	188,650	243	188,819	529	198,015	853
2007	195,330	151	211,017	198	221,920	334	249,182	806	242,426	1,460
2008	225,840	161	243,988	251	256,631	389	288,069	1,012	303,551	1,579
2009	276,242	196	296,532	310	311,277	404	349,144	1,331	367,895	1,828
2010	251,872	173	270,650	288	284,260	415	320,092	1,160	340,596	2,109
2011	336,041	226	362,055	340	381,588	601	430,290	1,571	455,101	2,338
Total	1,675,298	796	1,751,227	1,044	1,801,289	1,431	1,907,774	3,180	1,951,103	4,879

1 Unit = $1,000

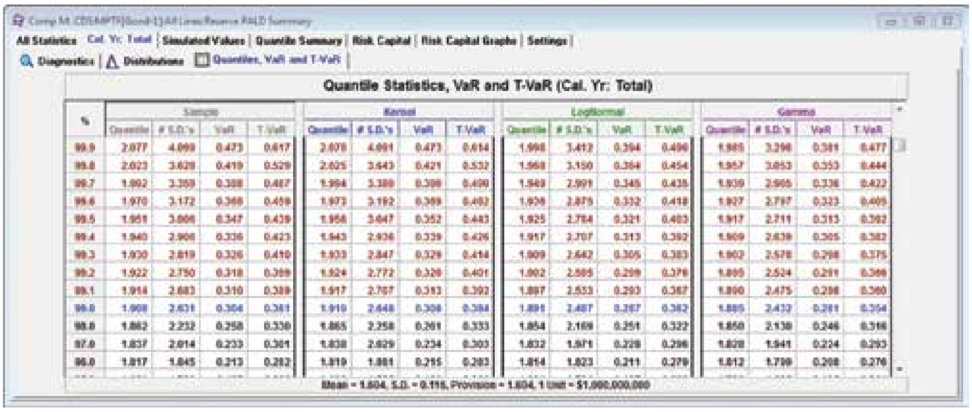


All Statistics | Cal. Yr: Total | Simulated Values | Quantile Summary | Risk Capital | Risk Capital Graphs | Settings

Quantile Summary for Calendar Years
(Sample Distribution)

Calendar	75%		90%		95%		99%		99.5%	
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
2012	355,758	196	377,244	320	393,124	459	436,599	1,456	458,977	2,653
2013	288,509	159	307,934	277	321,743	393	359,508	1,310	382,297	1,916
2014	236,724	186	257,999	235	271,739	400	306,336	1,060	326,923	2,381
2015	194,806	169	211,909	271	224,336	343	256,337	1,085	272,861	1,780
2016	154,064	137	169,571	214	180,568	324	208,511	952	223,330	1,480
2017	120,215	105	132,349	156	141,008	239	163,097	663	174,265	1,083
2018	88,812	78	97,099	107	102,699	175	116,045	434	123,587	795
2019	66,223	55	72,038	82	75,990	108	84,590	233	88,570	400
2020	49,778	41	54,211	61	57,119	88	63,470	166	65,799	197
2021	38,236	36	41,837	47	44,181	63	49,296	134	51,313	165
2022	29,697	27	32,725	40	34,687	61	38,001	123	40,827	182
2023	23,221	23	25,779	34	27,456	40	31,040	94	32,694	170
Total	1,675,298	796	1,751,227	1,044	1,801,289	1,431	1,907,774	3,180	1,951,163	4,879

1 Unit = $1,000



All Statistics | Cal. Yr: Total | Simulated Values | Quantile Summary | Risk Capital | Risk Capital Graphs | Settings

Diagnostics | Distributions | Quantiles, VaR and T-VaR

Quantile Statistics, VaR and T-VaR (Cal. Yr: 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	2.077	4.069	0.473	0.617	2.078	4.081	0.473	0.614	1.998	3.412	0.394	0.496	1.985	3.296	0.381	0.477
99.8	2.023	3.620	0.419	0.529	2.025	3.643	0.421	0.532	1.968	3.150	0.364	0.454	1.957	3.053	0.353	0.444
99.7	1.992	3.359	0.388	0.487	1.994	3.380	0.390	0.490	1.949	2.991	0.345	0.435	1.939	2.905	0.336	0.422
99.6	1.970	3.172	0.366	0.459	1.973	3.192	0.369	0.462	1.936	2.875	0.332	0.418	1.927	2.797	0.323	0.405
99.5	1.951	3.006	0.347	0.439	1.956	3.047	0.352	0.443	1.925	2.784	0.321	0.403	1.917	2.711	0.313	0.392
99.4	1.940	2.906	0.336	0.423	1.943	2.936	0.339	0.426	1.917	2.707	0.313	0.392	1.909	2.639	0.305	0.382
99.3	1.930	2.819	0.326	0.410	1.933	2.847	0.329	0.414	1.909	2.642	0.305	0.383	1.902	2.578	0.298	0.375
99.2	1.922	2.750	0.318	0.399	1.924	2.772	0.320	0.401	1.902	2.585	0.299	0.376	1.895	2.524	0.291	0.366
99.1	1.914	2.683	0.310	0.389	1.917	2.707	0.313	0.392	1.897	2.533	0.293	0.367	1.890	2.475	0.286	0.360
99.0	1.908	2.631	0.304	0.381	1.910	2.648	0.306	0.384	1.891	2.487	0.287	0.362	1.885	2.432	0.281	0.354
98.0	1.862	2.232	0.258	0.330	1.865	2.258	0.261	0.333	1.854	2.169	0.251	0.322	1.850	2.130	0.246	0.316
97.0	1.837	2.014	0.233	0.301	1.838	2.029	0.234	0.303	1.832	1.971	0.228	0.296	1.828	1.941	0.224	0.293
96.0	1.817	1.845	0.213	0.282	1.819	1.861	0.215	0.283	1.814	1.823	0.211	0.279	1.812	1.799	0.208	0.276

Mean = 1.604, S.D. = 0.115, Provision = 1.604, 1 Unit = $1,000,000,000

The full V@R and T-V@R table displays quantiles from 1 through 99 with various levels above 99 (shown are entries from 96 through 99.9). For each entry, V@R and T-V@R are calculated for the simulations (sample), and the kernel, log-normal, and gamma distributions. The kernel is a smoothed version of the sample and is used in risk capital calculations. The log-normal distribution and gamma distributions are the corresponding distributions with the projected mean and standard deviation for the selected period (total, calendar year or accident year). Generally both the log-normal and gamma distributions are a poor fit to the upper tail of the sample distribution - the simulated correlated log-normal distributions have a much heavier tail.

2.7. Economic Balance Sheet and Solvency II and IFRS 4 metrics: SCR, TP, and Risk Margins

Solvency II for long-tail liabilities requires precise calibration of Solvency Capital Funds to a mandated stress level over the one-year horizon. Calibration must be done for individual Lines of Business (LOB) as well as aggregates of multiple Lines of Business, and possibly under required ring-fencing rules.

Actuaries will need access to accurate and precise distributional information about future cash flows and their modifications under stress. Only a unified approach to reserving which treats trends, volatility and correlations under a single distributional paradigm can achieve this result.

For further information regarding Insureware's Solvency II one year risk horizon solution for long-tail liabilities please see "Solvency II - one-year and ultimate year risk horizons for long-tail liabilities".

2.7.1. One-year risk horizon

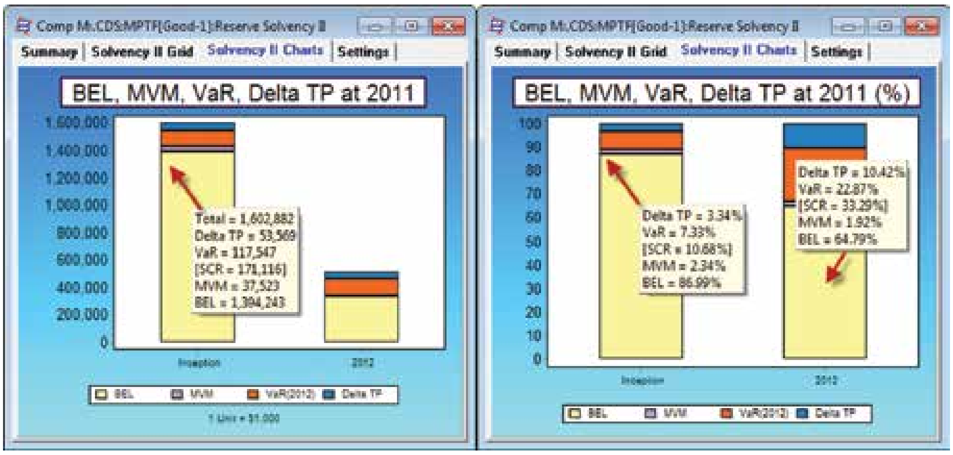
The SCR for the one-year risk horizon is the distress Value-at-Risk for the first year plus the change (Δ) in technical provisions in the subsequent years (suitably discounted), conditional on the first year being in distress. This definition satisfies the directives and advice provided by CEIOPS (now known as EIOPA).

$$SCR = VaR_{99.5\%}(1) + \Delta TP(2) + \Delta TP(3) + \ldots + \Delta TP(n);$$

where n is the number of years until run-off.

The first year being in distress impacts the subsequent years - the effect is measured by the ΔTP. Including the adjustments changes the estimates of SCR and MVM for the first year. Recursion is not required if only the first year in distress is considered.

Calculated in this way, the SCR is adequate to restore the balance sheet to a fair value of liabilities at the end of a distressed first year so that the portfolio can then be transferred or sold to a reinsurer. That is, the economic balance sheet has sufficient SCR and TP to sustain a first year in distress and be restored to its fair value at the beginning of the second year. This formulation satisfies the Solvency II summary metrics.



Economic Balance Sheet

Metrics Summary

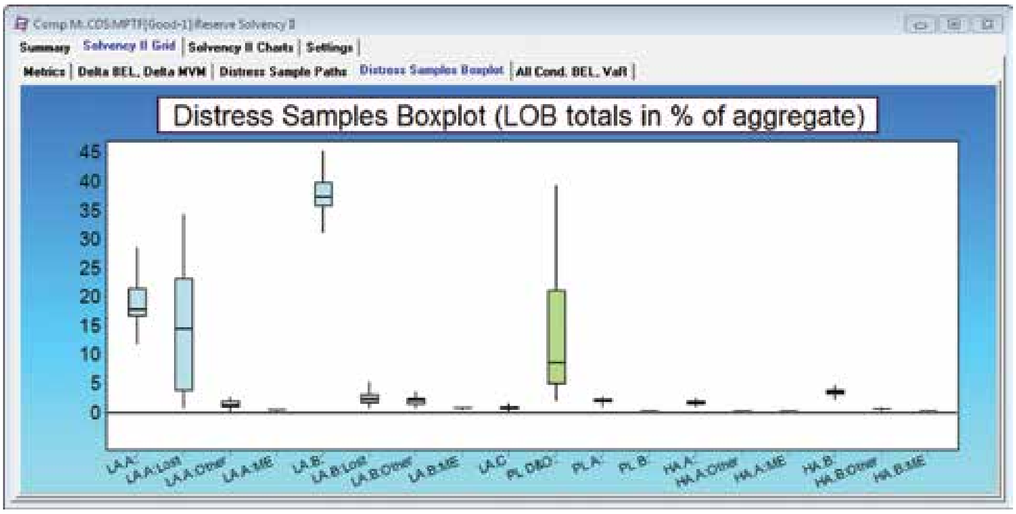
	Value	%
BEL	1,394,243	97.38
MVM	37,523	2.62
Technical Provision	1,431,766	100.00
VaR(2012)	117,547	68.69
Delta TP	53,569	31.31
SCR	171,116	100.00
Technical Provision	1,431,766	89.32
SCR	171,116	10.68
TP + SCR	1,602,883	100.00

1 Unit = $1,000

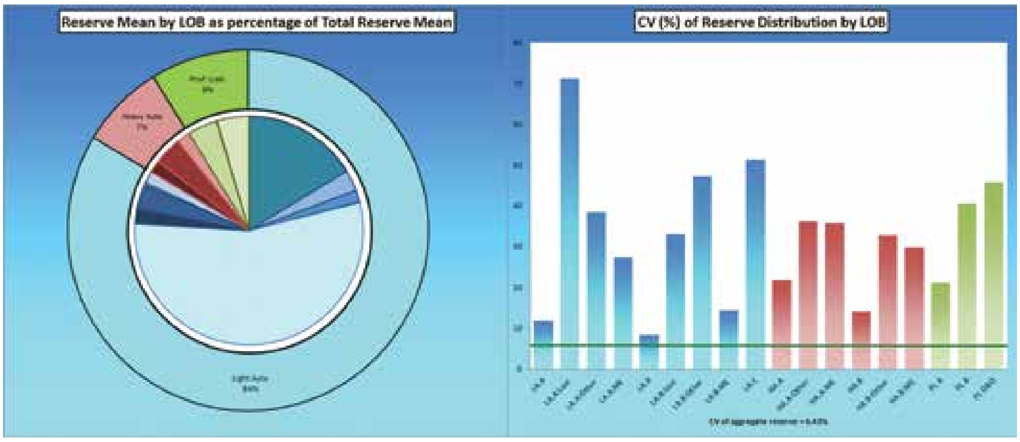
MVM, SCR and TP as % of BEL

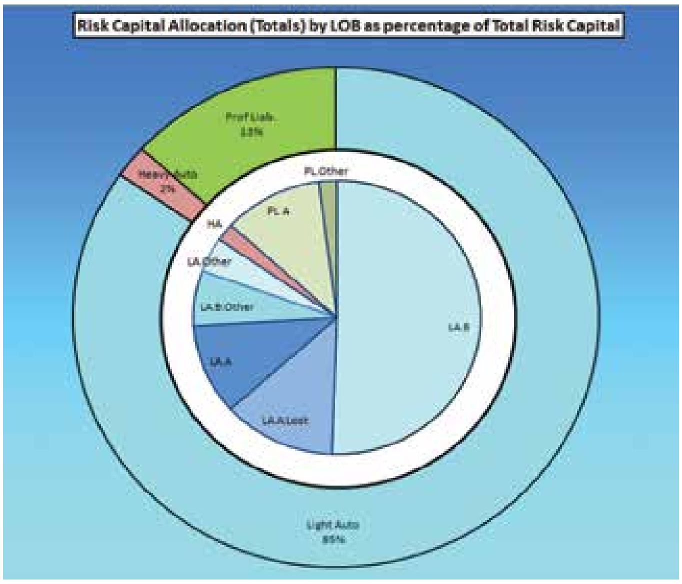
	% of BEL	% of Undisc. BEL
SCR	12.27	10.67
MVM	2.69	2.34
TP	102.69	89.27
MVM + SCR	14.96	13.01
TP + SCR	114.96	99.93

Solvency II summary metrics



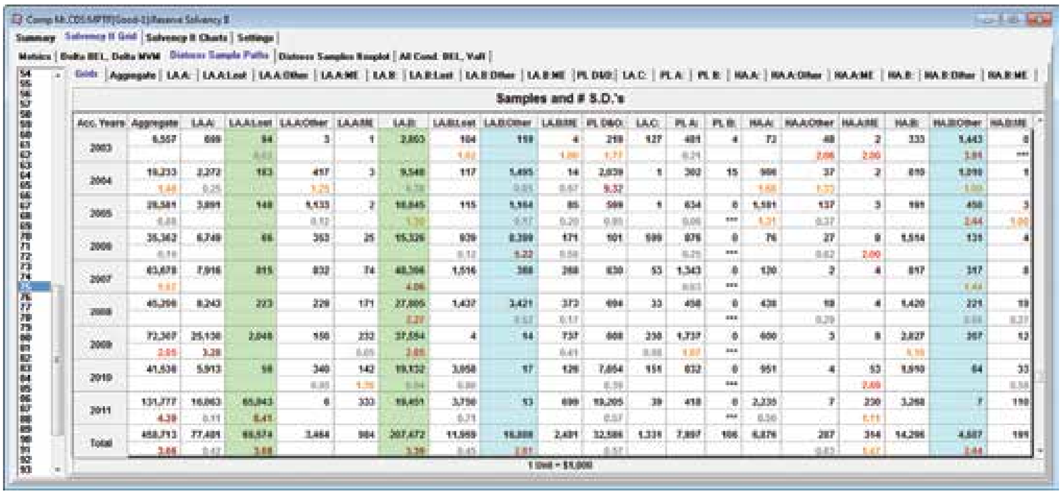
The bulk of the paid losses should the company be in distress in the next calendar year arises from the light auto portfolio (the largest). The professional liability portfolio takes the next largest allocation of capital.





Allocation of total risk capital is shown above – note that percentages less than 3% are aggregated together into the 'Other' category for each LOB. In the case of Heavy Auto, all allocations are less than 3%.

Lines contributing to distress



Samples and # S.D.'s

Acc. Years	Aggregate	LA.A	LA.A:Lost	LA.A:Other	LA.A:ME	LA.B	LA.B:Lost	LA.B:Other	LA.B:ME	PL D&O	LA.C	PL.A	PL.B	HA.A	HA.A:Other	HA.A:ME	HA.B	HA.B:Other	HA.B:ME
2003	6,557	699	94	3	1	2,803	104	159	4	219	127	481	4	72	48	2	333	1,443	0
			0.02				1.02		1.00	1.77		0.21			2.06	2.00		3.01	***
2004	19,233	2,272	183	417	3	9,548	117	1,495	14	2,039	1	302	15	906	37	2	819	1,290	1
	1.48	0.25		1.25		0.78		0.05	0.67	9.32				1.68	1.33			1.00	
2005	28,581	3,891	148	1,133	2	10,845	115	1,164	85	599	1	634	0	1,581	137	3	191	450	3
	0.48			0.12		1.30		0.37	0.29	0.05		0.06	***	1.21	0.37			2.44	1.00
2006	35,362	6,749	66	353	25	15,326	939	8,399	171	101	599	876	0	76	27	8	1,514	131	4
	0.16						0.12	5.22	0.58			0.25	***		0.62	2.00			
2007	43,678	7,916	815	832	74	40,398	1,516	388	268	830	53	1,343	0	130	2	4	817	317	8
	1.67					4.06						0.63	***					1.44	
2008	45,299	8,243	223	229	171	27,805	1,437	3,421	373	494	33	458	0	428	18	4	1,420	221	19
						3.22		0.52	0.17				***		0.29			0.84	0.27
2009	72,307	25,130	2,048	150	232	37,554	4	54	737	608	230	1,737	0	600	3	8	2,827	207	12
	2.05	3.28			0.05	2.85			0.41		0.88	1.07	***				1.10		
2010	41,538	5,913	58	340	142	19,132	3,058	17	126	7,054	151	632	0	951	4	53	1,910	64	33
				0.05	1.16	0.04	0.00			0.39			***			2.69			0.58
2011	131,777	16,063	65,043	6	333	19,491	3,750	53	699	19,205	39	418	0	2,235	7	230	3,268	7	198
	4.39	0.11	8.41				0.71			0.57			***	0.56		5.11			
Total	458,713	77,405	66,574	3,464	984	207,472	11,959	16,808	2,481	32,586	1,339	7,897	106	6,876	287	314	14,296	4,607	199
	3.06	0.42	3.88			3.29	0.45	1.87		0.57					0.83	1.47		3.44	

1 Unit = $1,000

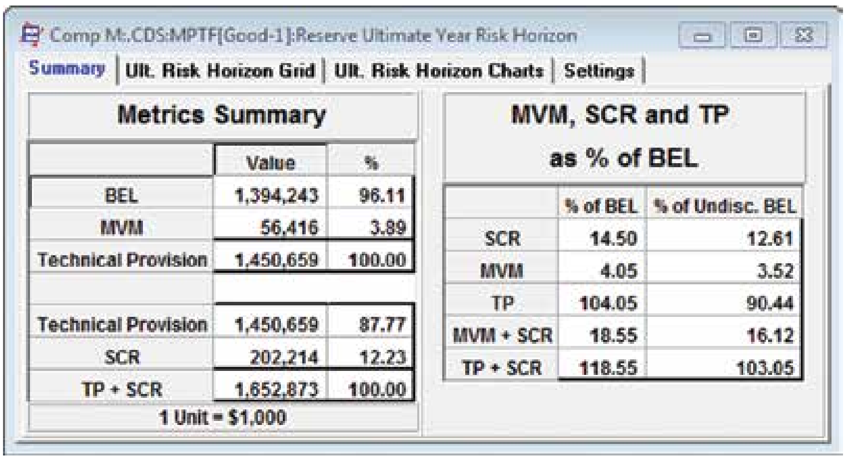
In the above table, the left-hand column is the simulation number in the distress band (the set of simulations reaching the distress threshold). It shows, for each simulation of a distress year, the contribution of each LOB to a distress event.

The lines marked in green (LA.A: Lost and LA:B) are much higher than their respective mean losses. The lines highlighted in blue are 'in distress' but do not contribute significantly to the total as their relative volume is low.

The secondary figures in the totals indicate the number of standard deviations above the mean the realised distress loss is (burgundy: >3 SDs, red > 2 SDs, orange > 1 SD; grey > mean). If the cell is empty then the loss is below the expected mean. Further details of Insureware's Solvency II solution for long-tail liabilities is available in "Solvency II - one-year and ultimate year risk horizons for long-tail liabilities".

2.7.2. Ultimate year risk horizon

The ultimate year risk horizon is typically calculated at a lower percentile (here 95%). The total risk capital at 95% is 202.2M. The MVM is calculated as well, but typically would not be required as the risk capital would be held internally.



Comp M.CDS:MPTF[Good-1]:Reserve Ultimate Year Risk Horizon

Summary | Ult. Risk Horizon Grid | Ult. Risk Horizon Charts | Settings

Metrics Summary

	Value	%
BEL	1,394,243	96.11
MVM	56,416	3.89
Technical Provision	1,450,659	100.00
Technical Provision	1,450,659	87.77
SCR	202,214	12.23
TP + SCR	1,652,873	100.00

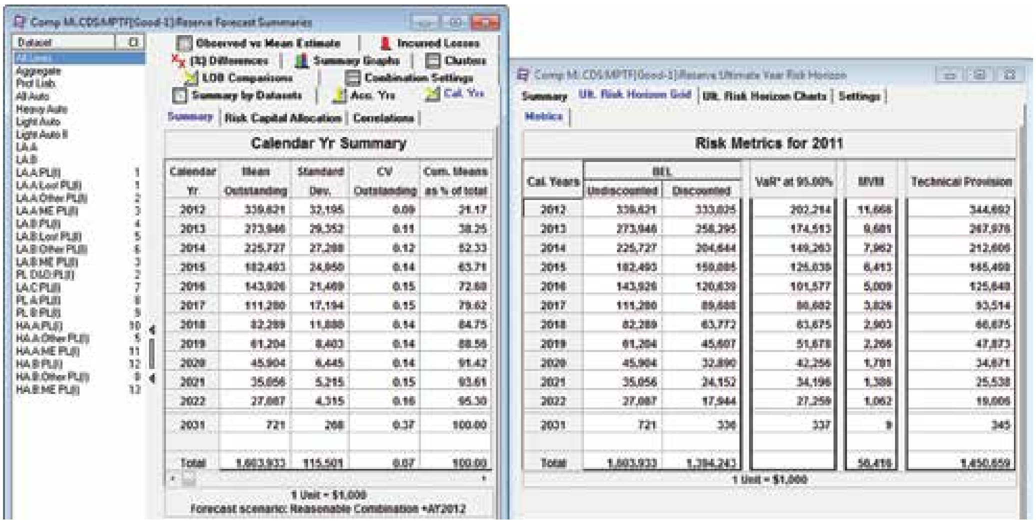
1 Unit = $1,000

MVM, SCR and TP as % of BEL

	% of BEL	% of Undisc. BEL
SCR	14.50	12.61
MVM	4.05	3.52
TP	104.05	90.44
MVM + SCR	18.55	16.12
TP + SCR	118.55	103.05

Ultimate year risk horizon summary metrics

The ultimate year risk horizon is always more costly than the one-year risk horizon since more capital is required to be held each year. Although MVM would typically not be required in practice, it is necessary to consider the cost associated with the higher level of risk capital - the majority of which will not be accessed during any given calendar year. If raising the risk capital in the ultimate year risk horizon paradigm, analysis of the allocation of risk capital by calendar year is critical for investment purposes.



Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Means as % of total
2012	339,621	32,195	0.09	21.17
2013	273,946	29,352	0.11	38.25
2014	225,727	27,288	0.12	52.33
2015	182,493	24,950	0.14	63.71
2016	143,926	21,469	0.15	72.60
2017	111,280	17,194	0.15	79.62
2018	82,289	11,880	0.14	84.75
2019	61,204	8,403	0.14	88.56
2020	45,904	6,445	0.14	91.42
2021	35,056	5,215	0.15	93.61
2022	27,087	4,315	0.16	95.30
2031	721	268	0.37	100.00
Total	1,603,933	115,501	0.07	100.00

1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012

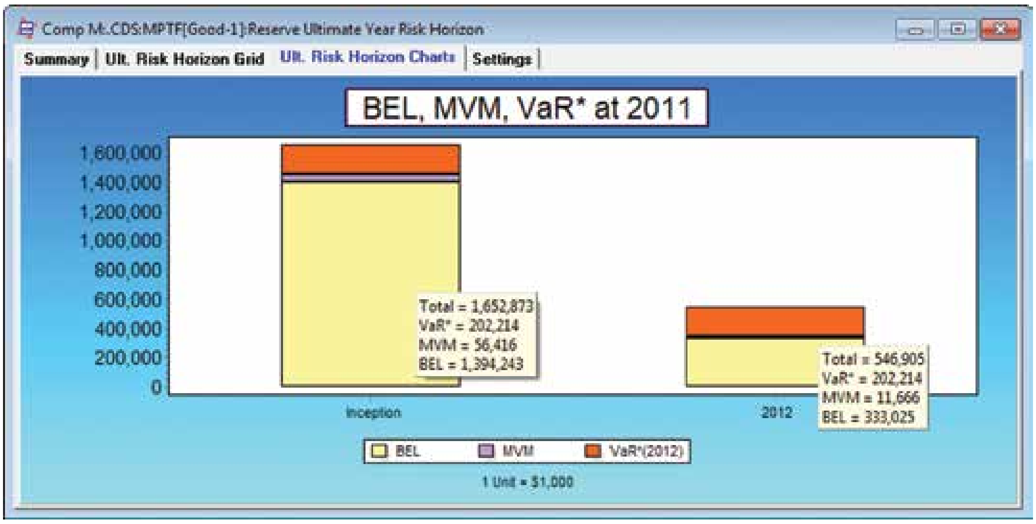
Risk Metrics for 2011

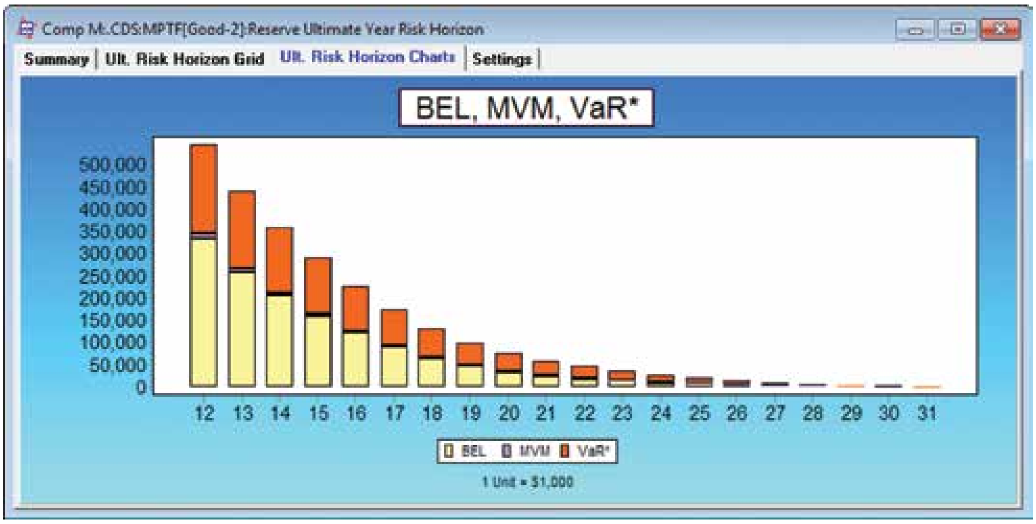
Cal. Years	BEL Undiscounted	BEL Discounted	VaR* at 95.00%	MVM	Technical Provision
2012	339,621	333,025	202,214	11,666	344,692
2013	273,946	258,295	174,513	9,681	267,976
2014	225,727	204,644	149,263	7,962	212,606
2015	182,493	159,085	125,035	6,413	165,498
2016	143,926	120,639	101,577	5,009	125,648
2017	111,280	89,688	80,682	3,826	93,514
2018	82,289	63,772	63,675	2,903	66,675
2019	61,204	45,607	51,678	2,266	47,873
2020	45,904	32,890	42,256	1,781	34,671
2021	35,056	24,152	34,196	1,386	25,538
2022	27,087	17,944	27,259	1,062	19,006
2031	721	336	337	9	345
Total	1,603,933	1,394,243		56,416	1,450,659

1 Unit = $1,000

The ultimate year risk horizon metrics (by calendar year: right) are closely related to the calendar year forecast summary (left). The calendar year liability stream standard deviations (and their correlations) drive the level of risk capital required to cover subsequent calendar years.

The economic balance sheet for the ultimate year risk horizon is shown below followed by the risk capital over calendar time.

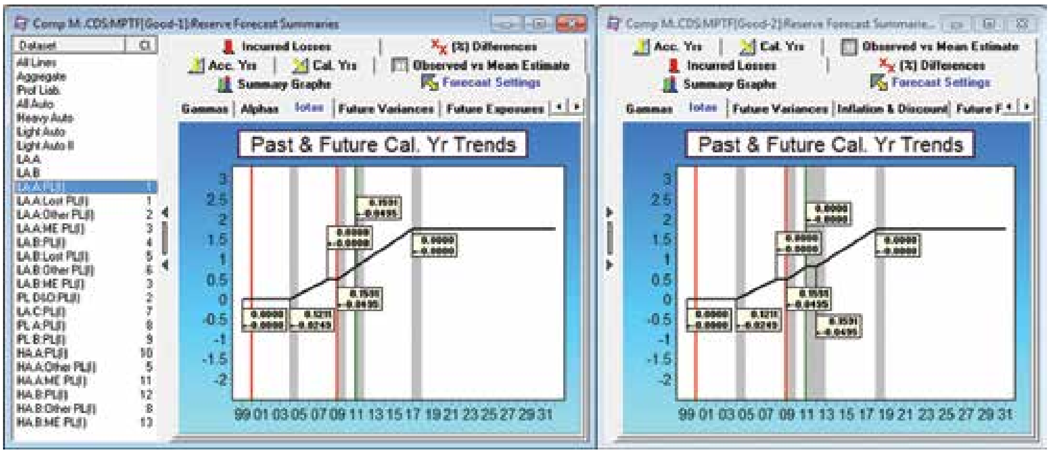


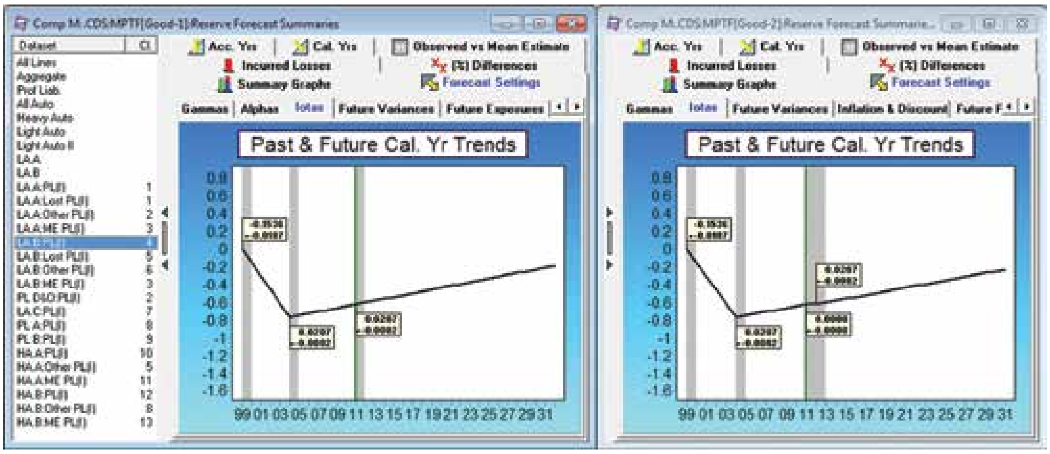


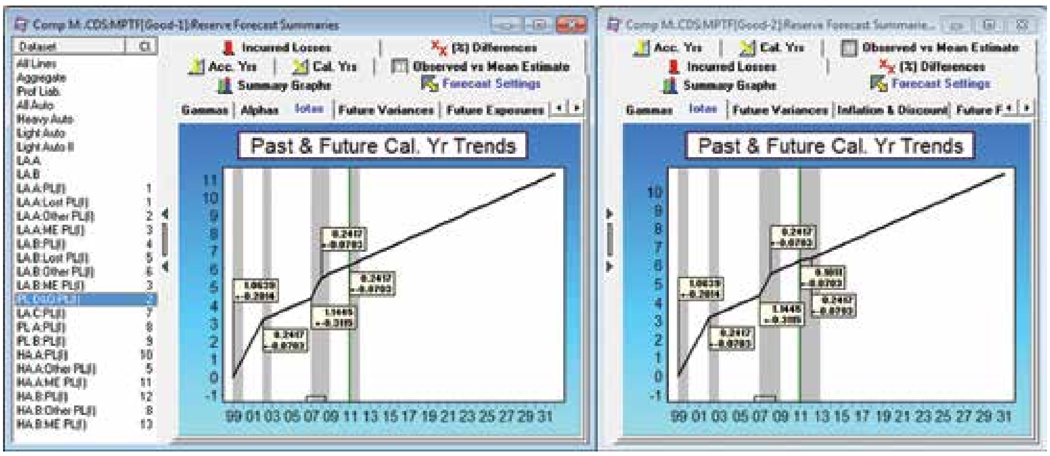
2.8. Updating, monitoring, and reserve releases

When deciding on forecast scenarios, we take the approach of considering reasonable scenarios going forward – scenarios that are conservative in terms of future liability stream, but not unreasonably so. By comparing these reasonable scenarios to more optimistic scenarios, we can determine the amount of reserves that could be released (subject to management strategy) from the reserves held should the more optimistic scenario play out next year.

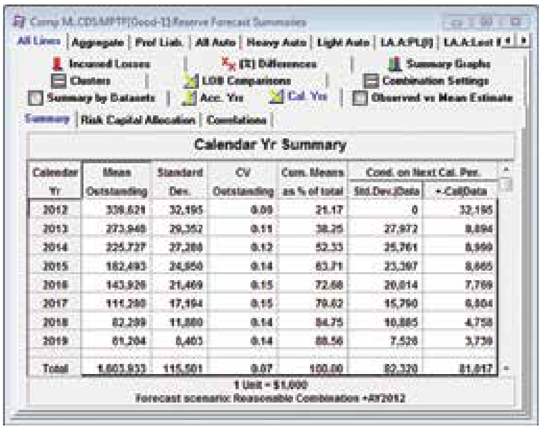
There are three cost components for which we create optimistic scenarios to illustrate the process. The original reasonable scenario is on the left, the more optimistic scenario on the right. Calendar trends to the left of the vertical green line are calendar year trends measured from the data; on the right of the green line are the calendar year trends assumed for the future.







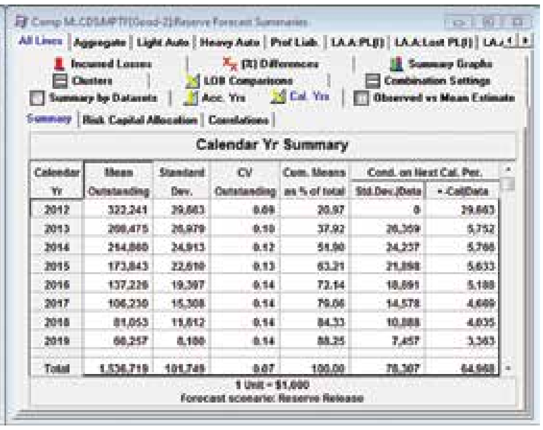
All trend parameters going forward have a mean and uncertainty associated with them. The distribution used for the parameters is a normal distribution. For example, the future calendar trend of 24.17%+_ 7.03% for PL D&O (bottom left) effectively implies that the parameter is a random draw from a normal distribution with mean 24.17% and standard deviation 7.03%. Scenarios going forward may vary parameter means, parameter uncertainty, or both.



Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Means as % of total	Cond. on Next Cal. Per. Std.Dev.|Data	Cond. on Next Cal. Per. +-Cal|Data
2012	339,621	32,195	0.09	21.17	0	32,195
2013	273,949	29,352	0.11	38.25	27,972	8,894
2014	225,727	27,288	0.12	52.33	25,761	8,990
2015	182,493	24,950	0.14	63.71	23,397	8,665
2016	143,926	21,469	0.15	72.68	20,014	7,769
2017	111,280	17,194	0.15	79.62	15,790	6,804
2018	82,289	11,880	0.14	84.75	10,885	4,758
2019	61,204	8,403	0.14	88.56	7,526	3,739
Total	1,603,933	115,501	0.07	100.00	82,320	81,817

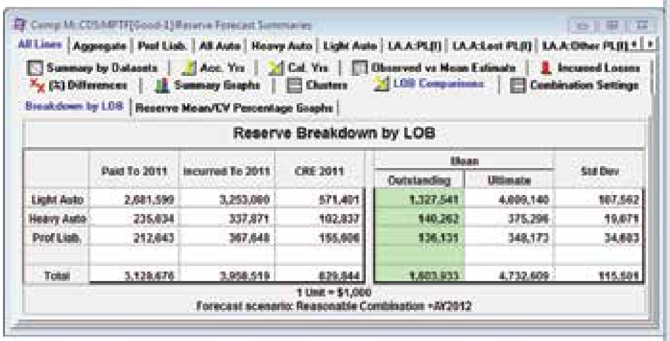
1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012



Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Means as % of total	Cond. on Next Cal. Per. Std.Dev.|Data	Cond. on Next Cal. Per. +-Cal|Data
2012	322,241	29,663	0.09	20.97	0	29,663
2013	208,475	26,979	0.10	37.92	26,359	5,752
2014	214,860	24,913	0.12	51.90	24,237	5,766
2015	173,843	22,610	0.13	63.21	21,898	5,633
2016	137,226	19,397	0.14	72.14	18,891	5,188
2017	106,230	15,308	0.14	79.06	14,578	4,669
2018	81,053	11,612	0.14	84.33	10,888	4,035
2019	60,257	8,180	0.14	88.25	7,457	3,363
Total	1,536,719	101,749	0.07	100.00	78,307	64,968

1 Unit = $1,000
Forecast scenario: Reserve Release



Reserve Breakdown by LOB

	Paid To 2011	Incurred To 2011	CRE 2011	Mean Outstanding	Mean Ultimate	Std Dev
Light Auto	2,681,590	3,253,000	571,401	1,327,541	4,009,140	107,562
Heavy Auto	235,034	337,871	102,837	140,262	375,296	19,071
Prof Liab.	212,043	367,648	155,606	136,131	348,173	34,603
Total	3,129,676	3,958,519	829,844	1,603,933	4,732,609	115,501

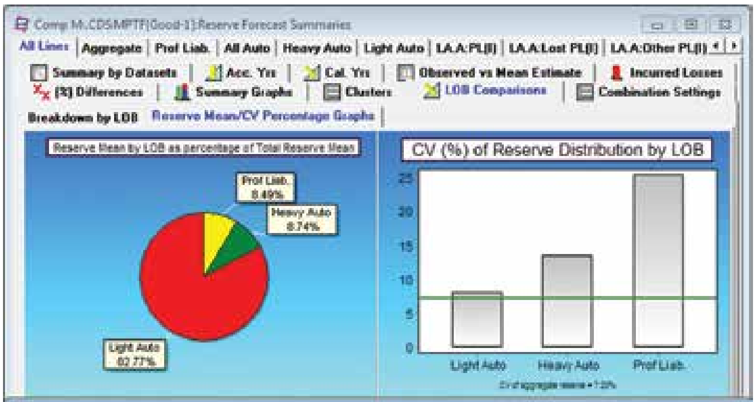
1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012

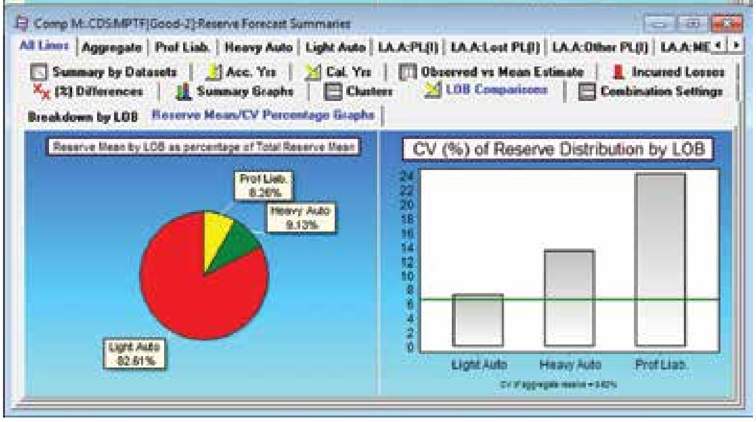
Reserve Breakdown by LOB

	Mean Outstanding	Mean Ultimate	Std Dev
Light Auto	1,269,468	3,951,067	94,085
Heavy Auto	140,262	375,296	19,071
Prof Liab.	126,989	339,032	30,897
Total	1,536,719	4,665,395	101,749

1 Unit = $1,000
Forecast scenario: Reserve Release

By comparing the means of the two distributions, we see that up to 67M could be released from the reserves should the more optimistic scenario arise next year. The same strategies can be applied in subsequent years so any reserve releases can be amortised over time.

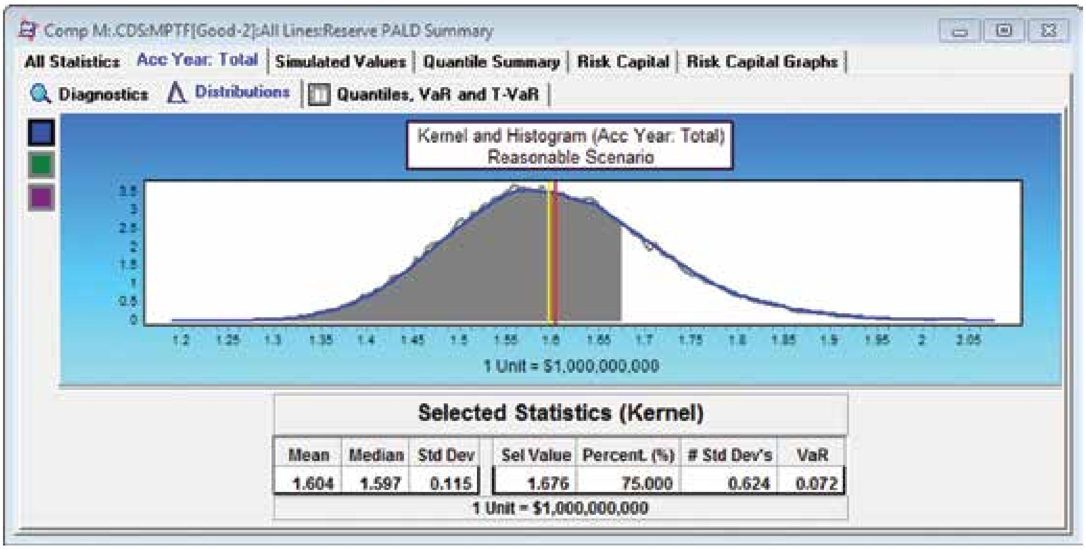




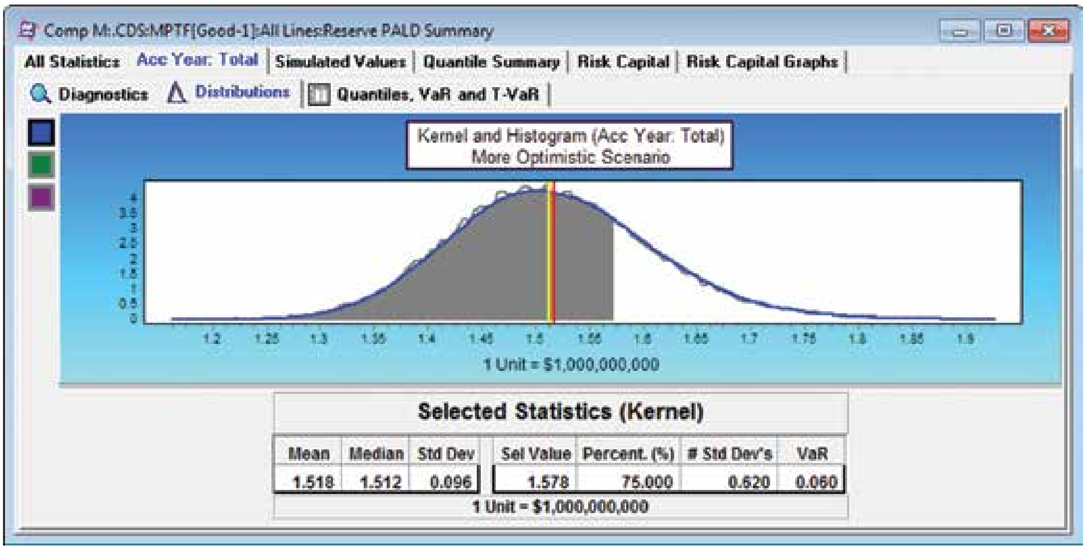
Top: Reasonable forecast; Bottom: Reserve release scenario

Further, we only consider the mean above, but we can immediately see that the volatility has also changed and is lower in the more optimistic scenario. Thus, risk capital can also be reduced if the more optimistic scenario arises. The corresponding reduction in risk capital can also be considered one year from now.

2.8.1 Risk capital release



Reasonable scenario



Reserve Release Scenario

If risk capital was considered at the 75th percentile, then, in addition to the difference in means (67M), up to 12M of risk capital can also be released. That is, the Value-at-Risk of 72M minus the Value-at-Risk of 60M. Equivalent calculations would be done if Tail-Value-at-Risk were used.

The implication of the above considerations is that risk capital management is an essential component of sensitivity analysis. Although a difference in means is one important (and influential) component of sensitivity analysis, risk capital levels are also of significant import and should not be overlooked. Above two scenarios were considered (a reasonable scenario versus a reserve release scenario), but in practice this can be extended to any number of forecast scenario assumptions.

2.9. Pricing future accident (or underwriting) years

In the MPTF (and PTF) modelling frameworks, the forecast scenario can extend to future accident (or underwriting) periods. Distributions are calculated for the aggregate of all the lines, each individual line, and each cost component. Pricing and allocation of risk capital charge can also be done by LOB or by cost component.

Total aggregate ultimate cost statistics for accident year 2012 for the three lines are as follows:

Comp M:.CDS:MPTF[Good-2]:Future Accident Period Forecast Table

All Lines | Aggregate | Prof Liab. | All Auto | Heavy Auto | Light Auto | LA.A:PL(I) | LA.A:Lost PL(I) | LA.A:Other PL(I) | LA.A:ME PL(I) | LA.B:PL(I) | LA.B:Lo

Accident Period vs Development Period

	Cal. Per. Total	0	1	2	3	4	5	6	7	8		20	Outstanding
2012	35,954	35,954	71,681	50,812	45,341	38,645	34,003	26,474	19,443	13,801		741	376,432
	7,140	7,140	19,159	14,570	12,320	11,147	13,604	10,987	7,622	4,562		279	46,692
			2013	2014	2015	2016	2017	2018	2019	2020		2032	Total Outstanding
Cal. Per. Total			71,681	50,812	45,341	38,645	34,003	26,474	19,443	13,801		741	376,432
			19,159	14,570	12,320	11,147	13,604	10,987	7,622	4,562		279	46,692

1 Unit = $1,000; Forecast Scenario: Reasonable Combination +AY2012

Comp M:.CDS:MPTF[Good-1]:Future Accident Period Forecast Table

Aggregate | Prof Liab. | All Auto | Heavy Auto | Light Auto | LA.A | LA.B | LA.A:PL(I) | LA.A:Lost PL(I) | LA.A:Other PL(I) | LA.A:ME PL(I) | LA.B:PL(I) | LA.B:Lo

Accident Period vs Development Period

	Cal. Per. Total	0	1	2	3	4	5	6	7	8	9	20	Outstanding
2012	10,013	10,013	18,653	12,409	10,721	9,292	8,080	7,363	3,992	2,169	1,182	2	85,302
	1,343	1,343	3,015	4,240	3,921	3,698	3,533	6,784	3,652	1,981	1,083	2	19,716
			2013	2014	2015	2016	2017	2018	2019	2020	2021	2032	Total Outstanding
Cal. Per. Total			18,653	12,409	10,721	9,292	8,080	7,363	3,992	2,169	1,182	2	85,302
			3,015	4,240	3,921	3,698	3,533	6,784	3,652	1,981	1,083	2	19,716

1 Unit = $1,000; Forecast Scenario: Reasonable Combination +AY2012

Above are the forecast means and standard deviations for the next accident year for the individual component Light Auto A (LA A). The black values are the fitted means, the red values are standard deviations of the correlated log-normal distributions. The burgundy values are correspond to the sum of the correlated log-normal distributions (outstanding column) and the standard deviations of the log-normal distributions by calendar period total (since there is only one cell to sum).

The total aggregate reserve distribution is comprised of the three lines as follows:

Comp M:.CDS:MPTF[Good-2]:Future Forecast Su...

All Lines | Aggregate | Prof Liab. | All Auto | Heavy Auto | Ligl

Summary by Datasets | Acc. Yrs | Cal. Yrs | Clusters | LOB Comparisons | Combination Settings

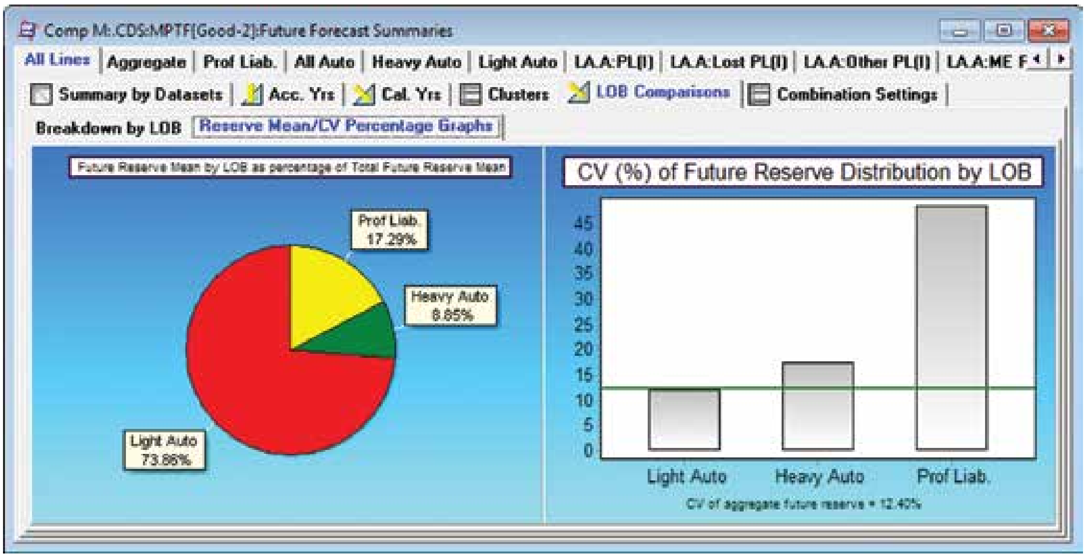
Breakdown by LOB | Reserve Mean/CV Percentage Graphs

Future Breakdown by LOB

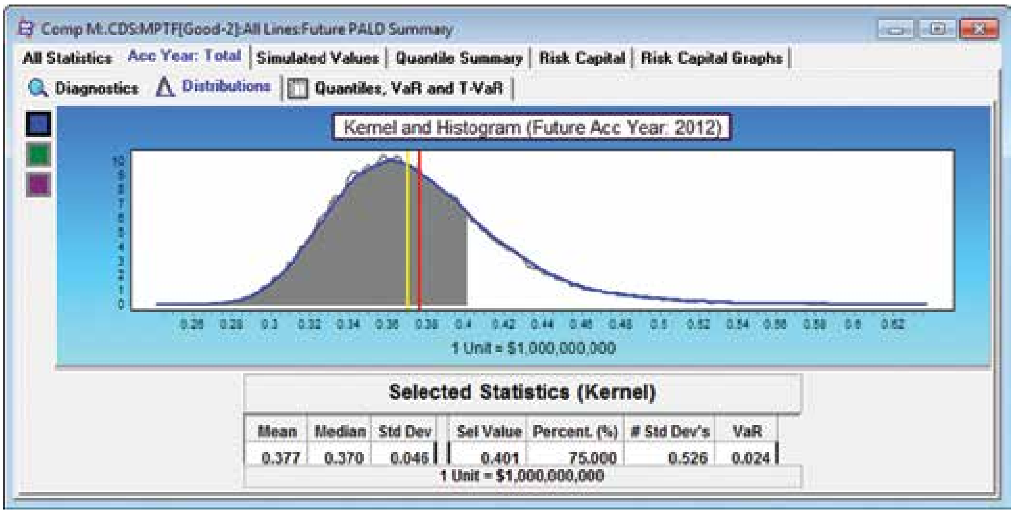
	Mean		Std Dev
	Outstanding	Ultimate	
Light Auto	278,017	278,017	33,211
Heavy Auto	33,316	33,316	5,796
Prof Liab.	65,100	65,100	31,561
Total	376,432	376,432	46,692

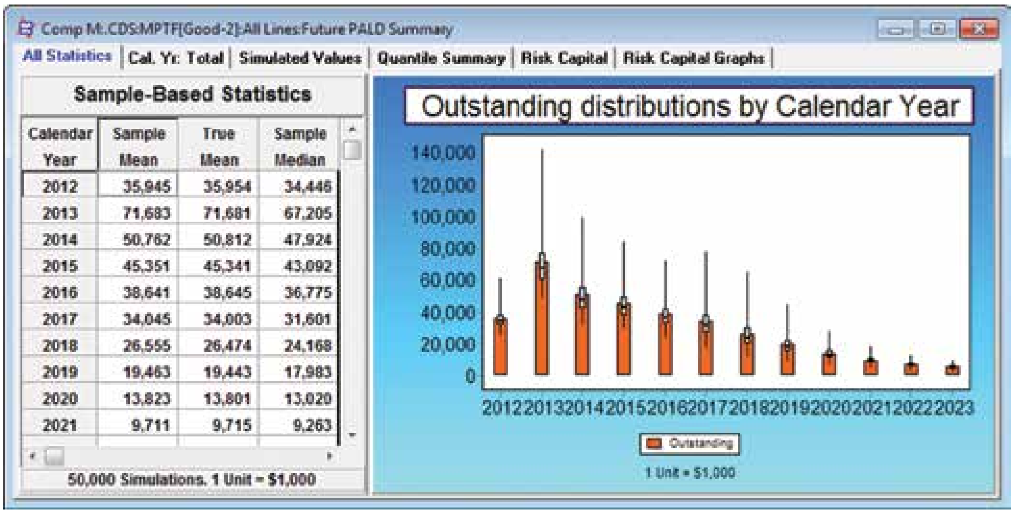
1 Unit = $1,000
Forecast scenario: Reasonable Combination +AY2012

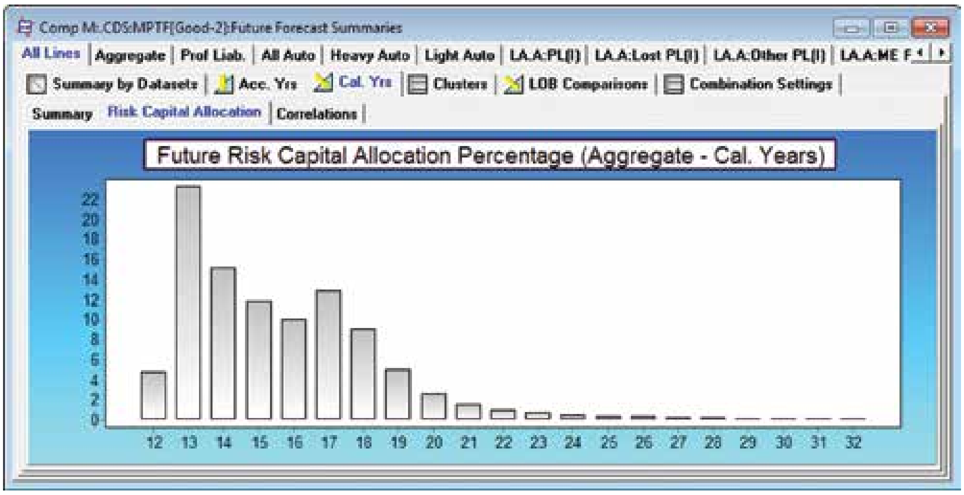
The relative means and CVs are shown below for the next accident year (2012).



The entire distribution can be considered and the risk capital calculated for the aggregate outstanding distribution. Risk capital can be allocated by LOB, by accident year, or by calendar year (the latter being important for asset-liability matching).

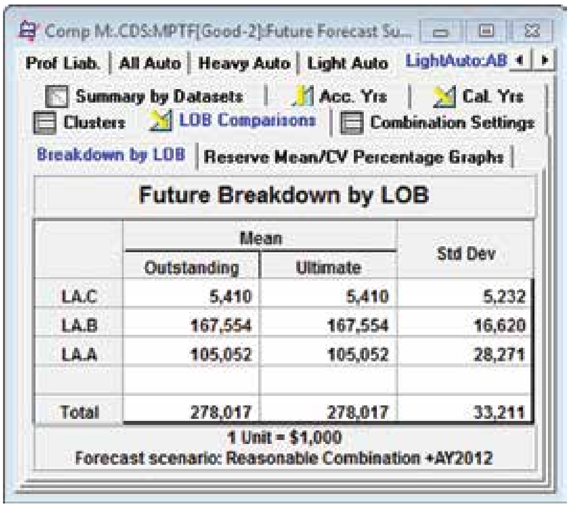






Future risk capital allocation percentage (according to the variance-covariance formula) is shown above.

Similarly, Light Auto (278M) above can be split into the three segments comprising this line:


Comp M:CDS:MPTF[Good-2]:Future Forecast Su...

Prof Liab. | All Auto | Heavy Auto | Light Auto | LightAuto:AB

Summary by Datasets | Acc. Yrs | Cal. Yrs | Clusters | LOB Comparisons | Combination Settings

Breakdown by LOB | Reserve Mean/CV Percentage Graphs

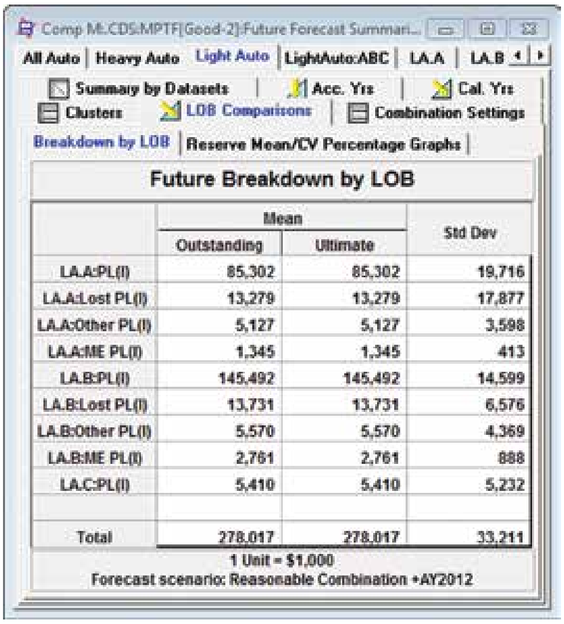
Future Breakdown by LOB

	Mean		Std Dev
	Outstanding	Ultimate	
LA.C	5,410	5,410	5,232
LA.B	167,554	167,554	16,620
LA.A	105,052	105,052	28,271
Total	278,017	278,017	33,211

1 Unit = $1,000

Forecast scenario: Reasonable Combination +AY2012

or by cost component if this level of detail is required:


Comp M:CDS:MPTF[Good-2]:Future Forecast Summari...

All Auto | Heavy Auto | Light Auto | LightAuto:ABC | LA.A | LA.B

Summary by Datasets | Acc. Yrs | Cal. Yrs | Clusters | LOB Comparisons | Combination Settings

Breakdown by LOB | Reserve Mean/CV Percentage Graphs

Future Breakdown by LOB

	Mean		Std Dev
	Outstanding	Ultimate	
LA.A:PL(I)	85,302	85,302	19,716
LA.A:Lost PL(I)	13,279	13,279	17,877
LA.A:Other PL(I)	5,127	5,127	3,598
LA.A:ME PL(I)	1,345	1,345	413
LA.B:PL(I)	145,492	145,492	14,599
LA.B:Lost PL(I)	13,731	13,731	6,576
LA.B:Other PL(I)	5,570	5,570	4,369
LA.B:ME PL(I)	2,761	2,761	888
LA.C:PL(I)	5,410	5,410	5,232
Total	278,017	278,017	33,211

1 Unit = $1,000

Forecast scenario: Reasonable Combination +AY2012

The summary statistics (means and standard deviations) are provided above for each cost component. As with the reserve distributions considered previously, simulations can be run at the cost component level in order to obtain a more complete picture of the future underwriting year distributions - whether in total, by accident year, or by calendar year.

2.10. Combined, reserve and underwriting risk

Comp M:CDS:MPTF[Good-1]:Combined Forecast Table

All Lines | Aggregate | Prof Liab. | AllAuto | HeavyAuto | LightAuto | LA.A:PL(I) | LA.A:Lost PL(I) | LA.A:Other PL(I) | LA.A:ME PL(I) | LA.B:PL(I) | LA.B:Lost PL(I) | LA.B:Other PL(I) | LA.B:

Accident Period vs Development Period

	Cal. Per. Total	0	1	2	3	4	5	6	7	8	9		20	Outstanding	Ultimate
2007	327,506	53,350	93,631	60,563	57,135	49,329	42,092	34,694	26,628	19,158	14,216		1,054	182,492	489,595
	345,155	52,866	86,716	65,000	56,382	46,140	11,850	11,344	8,439	5,437	3,901		357	23,331	23,331
2008	368,454	49,335	82,878	56,180	52,371	45,622	39,150	32,518	24,758	17,585	12,898		915	212,180	448,172
	347,680	50,519	76,834	47,101	61,438	10,564	11,560	11,680	8,530	5,382	3,765		310	26,515	26,515
2009	374,012	46,180	82,523	55,549	51,418	43,584	37,301	31,871	24,611	18,214	12,894		952	260,211	446,542
	379,005	45,228	83,455	57,849	10,712	10,290	11,590	11,846	8,673	5,698	3,630		331	30,374	30,374
2010	379,751	30,294	58,861	42,437	38,933	33,698	29,499	23,833	18,405	13,063	9,181		703	237,968	339,262
	370,701	29,531	71,763	11,116	10,268	9,881	10,093	8,960	6,873	4,041	2,577		259	28,393	28,393
2011	369,897	32,769	64,595	46,190	41,823	35,938	31,530	25,662	18,877	13,401	9,428		721	317,141	354,101
	380,579	36,959	15,478	12,452	11,060	10,370	11,994	10,272	7,151	4,233	2,720		268	37,304	37,304
2012	375,574	35,954	71,681	50,812	45,341	38,645	34,003	26,474	19,443	13,801	9,715		741	376,432	376,432
	33,586	7,140	19,159	14,570	12,320	11,147	13,604	10,987	7,622	4,562	2,959		279	48,692	48,692
			2013	2014	2015	2016	2017	2018	2019	2020	2021		2032	Total Reserve	Total Ultimate
Cal. Per. Total			345,628	276,539	227,834	182,571	145,282	108,763	80,647	59,704	44,771		741	1,980,365	5,100,041
			36,623	32,208	29,095	25,476	23,148	17,093	11,974	8,477	6,492		279	142,838	142,838

1 Unit = $1,000; Forecast Scenario: Reasonable Combination +AY2012

The section of the combined table highlighted in green comprises the projections for the reserve distribution. The future accident (underwriting) year is highlighted in blue. Projected distributions combining both the projected reserve and future underwriting year distributions are coloured in yellow. The totals in yellow include risk diversification between the reserve and future underwriting year loss distributions.

The future liability stream for the aggregate is reasonable compared to recent past payments. For instance, for 2009~2011 the payments are 379M, 370.7M, and 380.6M compared to the mean projected future calendar years 2012~2014 of 375.6M, 345.6M and 227.8M. Note the exposure for 2012 was assumed to be the same as 2011.

Risk capital is now considered at the 95th percentile and compared between combined, reserve, and underwriting risk. The selected percentile of 95% is arbitrary - any percentile can be used for comparison where the risk capital
is positive.

Risk diversification credit gained for Prof. Liab. and Light Auto particularly is illustrated above. Although Heavy Auto takes a higher percentage (marginally) when examining the combined risk, the total capital is still less (Combined 6.8M vs 7M from Reserve 5.7M + Underwriting 1.3M).

Comp M:CDS:MPTF[Good-1]:All Lines:Reserve PALD Summary

All Statistics | Acc Year: Total | Simulated Values | Quantile Summary | Risk Capital | Risk Capital Graphs

Risk Capital by LOB | Risk Capital as a Percentage of Mean by LOB

VaR / T-VaR

Risk Capital by LOB for VaR (Acc Year: Total)

LOB	Quantiles				
	75%	90%	95%	99%	99.5%
Light Auto	62,937	129,863	174,031	267,181	307,401
Heavy Auto	2,069	4,268	5,720	8,782	10,104
Prof Liab.	7,046	14,539	19,484	29,913	34,416
Aggregate	72,052	148,670	199,235	305,876	351,921

1 Unit = $1,000
Aggregate Risk Capital values are based on Provision equal to Mean.

The aggregate risk capital for various percentiles for the total reserve distribution is shown above. The 95% quantiles are highlighted and allocates the total of 199.2M to the three LOBs.

Comp M:CDS:MPTF[Good-2]:All Lines:Future PALD Summary

All Statistics | Acc Year: Total | Simulated Values | Quantile Summary | Risk Capital | Risk Capital Graphs

Risk Capital by LOB | Risk Capital as a Percentage of Mean by LOB

VaR / T-VaR

Risk Capital by LOB for VaR (Acc Year: Total)

LOB	Quantiles				
	75%	90%	95%	99%	99.5%
Light Auto	12,581	29,540	42,013	73,430	89,268
Heavy Auto	390	916	1,303	2,277	2,768
Prof Liab.	11,400	26,766	38,067	66,534	80,885
Aggregate	24,371	57,222	81,383	142,241	172,921

1 Unit = $1,000
Aggregate Risk Capital values are based on Provision equal to Mean.

The aggregate risk capital for various percentiles for the total future underwriting year distribution is shown above. The 95% quantiles are highlighted and distributes the total risk capital of 81.4M to the three LOBs.

Comp M:CDS:MPTF[Good-3]:All Lines:Combined PALD Summary

All Statistics | Acc Year: Total | Simulated Values | Quantile Summary | Risk Capital | Risk Capital Graphs

Risk Capital by LOB | Risk Capital as a Percentage of Mean by LOB

VaR / T-VaR

Risk Capital by LOB for VaR (Acc Year: Total)

LOB	Quantiles				
	75%	90%	95%	99%	99.5%
Light Auto	71,133	148,665	199,584	301,303	342,296
Heavy Auto	2,421	5,060	6,793	10,256	11,651
Prof Liab.	15,252	31,876	42,793	64,603	73,393
Aggregate	88,806	185,601	249,171	376,161	427,339

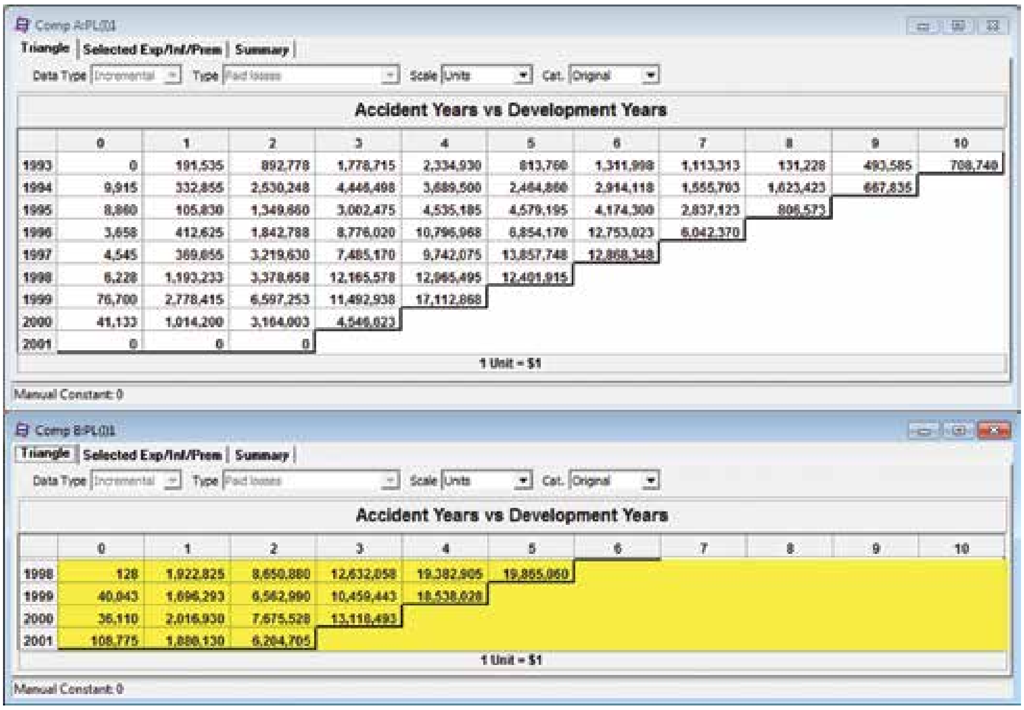
1 Unit = $1,000
Aggregate Risk Capital values are based on Provision equal to Mean.

The combined risk capital for various percentiles of the total reserve and future underwriting year distribution is shown above. The 95% quantiles are highlighed and calculates the total risk capital for the combined distribution of 249.2M. The 249.2M for the combined capital is less than the sum of the two individual risk capital calculations (199.2M + 81.4M). This illustrates the effect of risk diversification when considering reserve and future underwriting risk as a joint problem. Risk capital is sub-additive.

3. Company's A and B: Credibility modelling

Consider data from two casualty treaty syndicates titled Company A and Company B. The treaties for Company B comprise a new portfolio and data are only available from 1998~2001.

Company A is considering purchasing Company B to extend its portfolio. Since the losses are written only between 1998 and 2001, only these data are made available from Company B.



Comp A:PL(I)1

Triangle | Selected Exp/Inf/Prem | Summary

Data Type Incremental Type Paid losses Scale Units Cat. Original

Accident Years vs Development Years

	0	1	2	3	4	5	6	7	8	9	10
1993	0	191,535	892,778	1,778,715	2,334,930	813,760	1,311,998	1,113,313	131,228	493,585	708,740
1994	9,915	332,855	2,530,248	4,446,498	3,689,500	2,464,860	2,914,118	1,555,703	1,623,423	667,835	
1995	8,860	105,830	1,349,660	3,002,475	4,535,185	4,579,195	4,174,300	2,837,123	806,573		
1996	3,658	412,625	1,842,788	8,776,020	10,796,968	6,854,170	12,753,023	6,042,370			
1997	4,545	369,855	3,219,630	7,485,170	9,742,075	13,857,748	12,868,348				
1998	6,228	1,193,233	3,378,658	12,165,578	12,965,495	12,401,915					
1999	76,700	2,778,415	6,597,253	11,492,938	17,112,868						
2000	41,133	1,014,200	3,164,003	4,546,023							
2001	0	0	0								

1 Unit = $1

Manual Constant: 0

Comp B:PL(I)1

Triangle | Selected Exp/Inf/Prem | Summary

Data Type Incremental Type Paid losses Scale Units Cat. Original

Accident Years vs Development Years

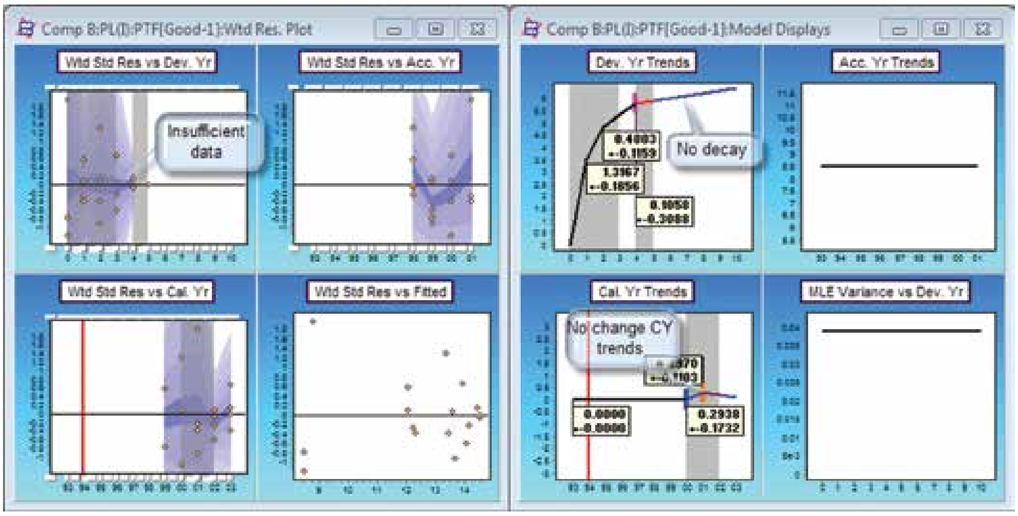
	0	1	2	3	4	5	6	7	8	9	10
1998	128	1,922,825	8,650,880	12,632,058	19,382,905	19,865,060					
1999	40,043	1,696,293	6,562,990	10,459,443	18,538,028						
2000	36,110	2,016,930	7,675,528	13,118,493							
2001	108,775	1,888,130	6,204,705								

1 Unit = $1

Manual Constant: 0

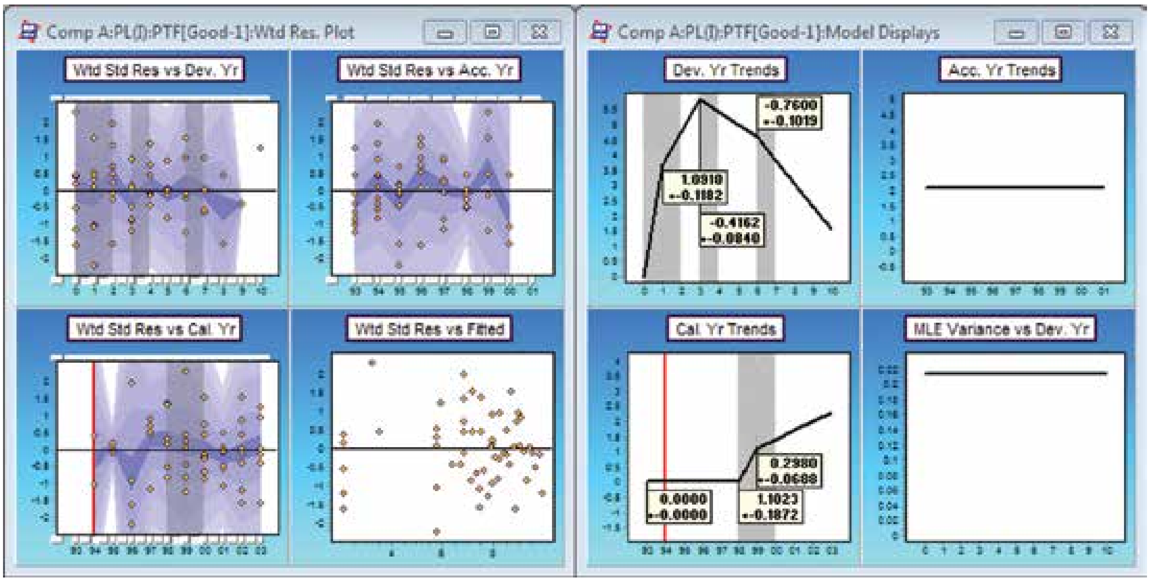
3.1. Model displays

A model for Company B using just the data available for Company B is as follows:

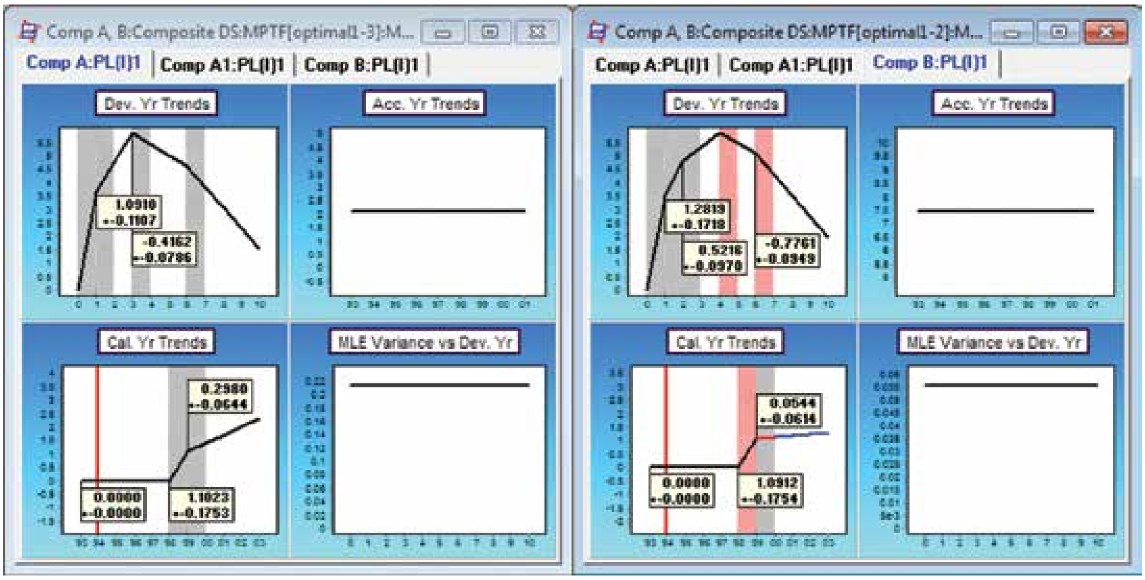


It is immediately apparent that there is insufficient data to determine when the final development trend starts decaying. Further, it is impossible to detect a significant change in calendar year trends for 2000~2001, 2001+.

The model for company A, on the other hand, demonstrates clear changes in development year and calendar year trends as follows – note the final development trend decay.



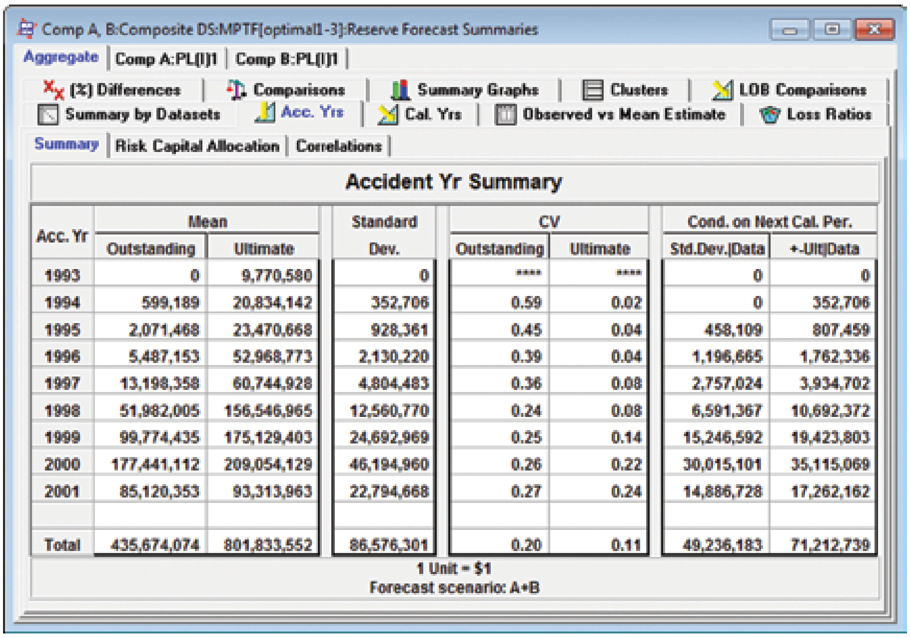
We now develop a model for Company B's data using Company A's model.



The original model for Comp A is shown on the left. The model on the right for Comp B. The red bars are trends set to be in common with Comp A1 [a duplicate(*) of Comp A]. The final development trend decays are constrained to the parameters estimated for Comp A. The calendar year trend assumption is not significantly different from zero, but is not optimised to zero in the model due to the high volatility and the small data sample. Further, the calendar year trend in company B is not set to be the same calendar year trend as in Company A as the estimates of the parameters (A: 0.298+_0.0644 and B: 0.0544+_0.0614) are very different. Parameters are only credibility adjusted where it is reasonable to do so; the adjustments must be statistically sound.

(*) Duplication is necessary so the final projections can consist of Company A and the credibility adjusted Company B. In this way, company A's estimates are independent of Company B's credibility adjustments.

3.2. Aggregate forecast results

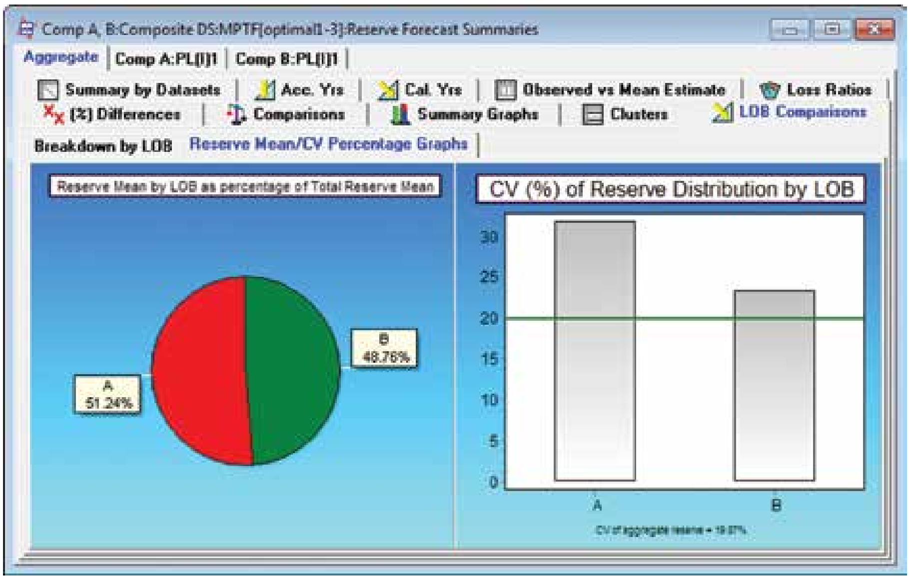


Comp A, B:Composite DS:MPTF[optimal1-3]:Reserve Forecast Summaries

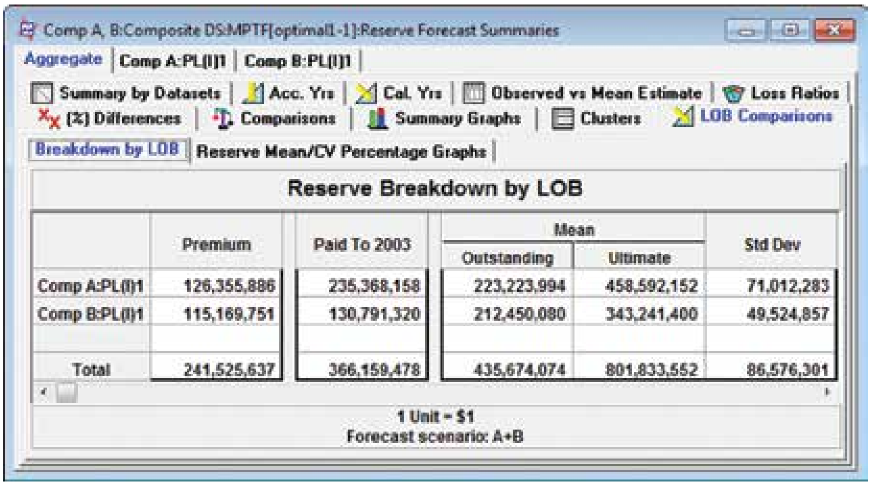
Accident Yr Summary

Acc. Yr	Mean Outstanding	Mean Ultimate	Standard Dev.	CV Outstanding	CV Ultimate	Cond. on Next Cal. Per. Std.Dev.|Data	Cond. on Next Cal. Per. +-Ult|Data
1993	0	9,770,580	0	****	****	0	0
1994	599,189	20,834,142	352,706	0.59	0.02	0	352,706
1995	2,071,468	23,470,668	928,361	0.45	0.04	458,109	807,459
1996	5,487,153	52,968,773	2,130,220	0.39	0.04	1,196,665	1,762,336
1997	13,198,358	60,744,928	4,804,483	0.36	0.08	2,757,024	3,934,702
1998	51,982,005	156,546,965	12,560,770	0.24	0.08	6,591,367	10,692,372
1999	99,774,435	175,129,403	24,692,969	0.25	0.14	15,246,592	19,423,803
2000	177,441,112	209,054,129	46,194,960	0.26	0.22	30,015,101	35,115,069
2001	85,120,353	93,313,963	22,794,668	0.27	0.24	14,886,728	17,262,162
Total	435,674,074	801,833,552	86,576,301	0.20	0.11	49,236,183	71,212,739

1 Unit = $1
Forecast scenario: A+B



The Comp B outstanding reserve is the same magnitude as for Comp A. The reduction in volatility by adding this portfolio with Comp A is not immaterial – the projected losses for Comp B are substantially less volatile.



Comp A, B:Composite DS:MPTF[optimal1-1]:Reserve Forecast Summaries

Reserve Breakdown by LOB

	Premium	Paid To 2003	Mean Outstanding	Mean Ultimate	Std Dev
Comp A:PL(I)1	126,355,886	235,368,158	223,223,994	458,592,152	71,012,283
Comp B:PL(I)1	115,169,751	130,791,320	212,450,080	343,241,400	49,524,857
Total	241,525,637	366,159,478	435,674,074	801,833,552	86,576,301

1 Unit = $1
Forecast scenario: A+B

4. Company S: Losses and recoveries

Company S writes six lines of business: Private Motor, Commercial Motor, Professional Indemnity, Employers Liability, and Commercial Property. As with Company M, these lines of business are split into various components and, in the case of Private Motor and Commercial Motor, include recoveries.

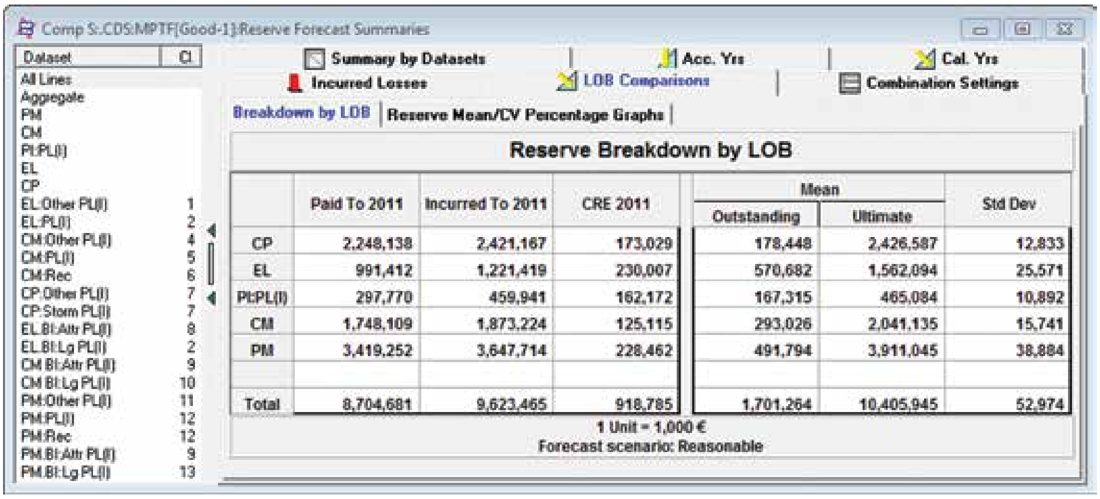
Recoveries are modelled in the same fashion as loss components. However, unlike the loss components, recoveries are subtracted from the total forecasts. That is, all forecasts are net of recoveries.

	Line of Business	Segment	Component
Company S	Professional Indemnity (PI)	PI	Primary
	Commercial Property (CP)	CP	Storm
			Other
	Employer's Liability (EL)	Non-BI	Primary
			Other
		Bodily Injury (BI)	Attrition
			Large
	Commercial Motor (CM)	Non-BI	Primary
			Other
			Recoveries
		Bodily Injury (BI)	Attrition
			Large
	Private Motor (PM)	Non-BI	Primary
			Other
			Recoveries
		Bodily Injury (BI)	Attrition
			Large

From the identified composite model at the component level, aggregates at any upper layer can easily be created. A composite model is designed for the whole company with a complete view into any layer and cost component including the subtraction of recoveries.

4.1. Aggregate forecast results

The breakdown of the company's' portfolio into the five LOBs, net of recoveries, is shown below.



Reserve Breakdown by LOB

	Paid To 2011	Incurred To 2011	CRE 2011	Mean: Outstanding	Mean: Ultimate	Std Dev
CP	2,248,138	2,421,167	173,029	178,448	2,426,587	12,833
EL	991,412	1,221,419	230,007	570,682	1,562,094	25,571
PI:PL(I)	297,770	459,941	162,172	167,315	465,084	10,892
CM	1,748,109	1,873,224	125,115	293,026	2,041,135	15,741
PM	3,419,252	3,647,714	228,462	491,794	3,911,045	38,884
Total	8,704,681	9,623,465	918,785	1,701,264	10,405,945	52,974

1 Unit = 1,000 €
Forecast scenario: Reasonable

The percentage each line takes of the total reserve mean, along with the relative CVs for each line, are displayed in the graphs below. Note the CV of the aggregate reserve is only 3.11%.

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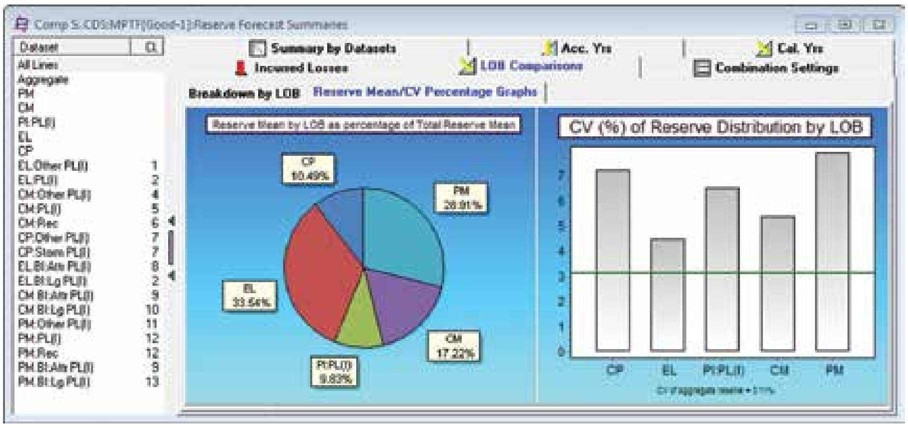
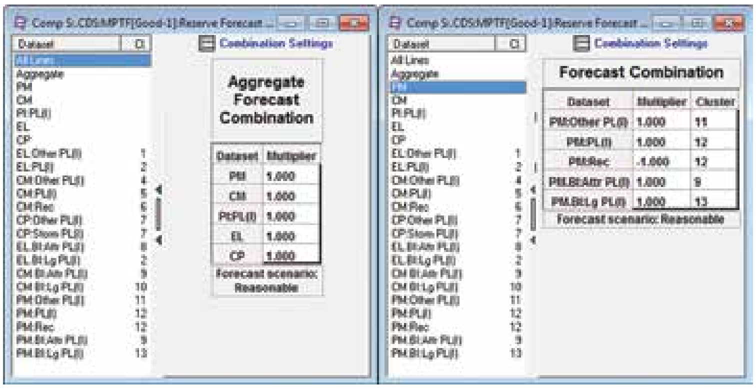


Forecast scenarios can be created for the aggregate of forecast combinations. Below are the multipliers to create each forecast scenario for the aggregate of all the lines (Left) from the LOBs and the multipliers to forecast the LOB PM (note the negative for Recoveries [Rec]).



	1			2			3		
	PM:Other			PM:PL(I)			PM.BI:Attrition		
Acc. Yr	Mean		Standard	Mean		Standard	Mean		Standard
	Outstanding	Ultimate	Dev.	Outstanding	Ultimate	Dev.	Outstanding	Ultimate	Dev.
2002	0	138,692	0	6	50,469	2	8	57,896	5
2003	1	156,566	0	15	54,766	4	36	82,906	17
2004	8	271,800	2	48	85,839	11	167	111,490	60
2005	51	310,707	13	167	142,035	36	897	162,404	280
2006	176	281,581	40	387	133,370	76	2,803	195,436	484
2007	440	210,091	94	697	103,895	98	5,541	148,941	755
2008	618	165,989	111	1,434	85,961	156	16,404	120,627	2,154
2009	945	140,987	160	3,286	73,150	353	29,645	103,051	3,907
2010	2,167	129,034	382	7,002	68,818	679	63,840	125,655	8,809
2011	32,725	151,922	8,945	40,954	78,971	4,180	155,109	178,540	22,090
Total	37,131	1,957,371	8,961	53,995	877,273	4,836	274,451	1,286,945	34,924

	4			5			1 + 2 + 3 + 4 - 5		
	PM.BI:Large			Recoveries			PM: Aggregate		
Acc. Yr	Mean		Standard	Mean		Standard	Mean		Standard
	Outstanding	Ultimate	Dev.	Outstanding	Ultimate	Dev.	Outstanding	Ultimate	Dev.
2002	335	18,914	60	0	37,294	0	349	228,677	60
2003	832	32,773	132	0	51,339	0	883	275,672	133
2004	2,038	31,376	290	4	58,997	1	2,257	441,509	296
2005	5,569	52,183	720	51	85,074	15	6,633	582,255	773
2006	7,126	34,838	917	136	72,914	32	10,356	572,309	1,040
2007	12,139	32,427	1,493	233	66,303	46	18,584	429,052	1,678
2008	36,912	52,784	4,580	494	55,251	50	54,874	370,108	5,065
2009	42,166	51,570	5,211	1,097	39,717	80	74,946	329,042	6,524
2010	19,948	20,324	3,262	3,475	47,987	246	89,482	295,844	9,424
2011	28,429	28,664	4,695	23,788	51,521	1,991	233,429	386,577	24,628
Total	155,495	355,853	13,771	29,278	566,397	2,017	491,794	3,911,045	38,884

The above tables show the allocation to each line and recoveries. While the means are additive, the standard deviation for the aggregate is calculated using the correlation matrix.

4.1.1. Summaries by accident year and calendar year

Comp S:.CDS:MPTF[Good-1]:Reserve Forecast Summaries

Accident Yr Summary

Acc. Yr	Mean Outstanding	Mean Ultimate	Standard Dev.	CV Outstanding	CV Ultimate	Cond. on Next Cal. Per. Std.Dev.|Data	Cond. on Next Cal. Per. +-Ult|Data
2002	3,455	810,307	378	0.11	0.00	192	326
2003	6,407	973,228	638	0.10	0.00	325	549
2004	11,277	1,116,748	961	0.09	0.00	481	833
2005	23,844	1,247,177	1,824	0.08	0.00	1,100	1,455
2006	46,998	1,263,212	2,850	0.06	0.00	1,620	2,345
2007	90,382	1,169,058	4,424	0.05	0.00	2,592	3,586
2008	207,329	1,068,074	9,332	0.05	0.01	4,819	7,992
2009	276,057	913,315	11,239	0.04	0.01	7,833	8,059
2010	364,746	870,663	14,757	0.04	0.02	9,570	11,233
2011	670,768	974,163	31,092	0.05	0.03	14,622	27,439
Total	1,701,264	10,405,945	52,974	0.03	0.01	26,830	45,677

1 Unit = 1,000 €
Forecast scenario: Reasonable

The breakdown by accident year and calendar year are shown above/below respectively. Calculations, including the one-year ahead conditional statistics, are available for the aggregate forecasts including those containing negative multipliers (ie recoveries).

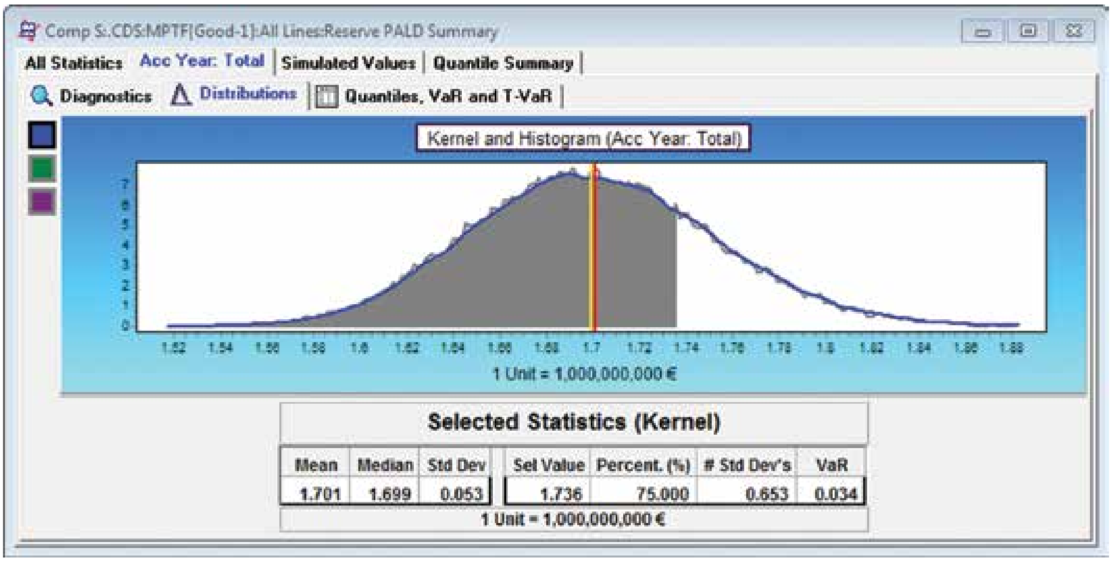
Comp S:.CDS:MPTF[Good-1]:Reserve Forecast Summaries

Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Means as % of total	Cond. on Next Cal. Per. Std.Dev.|Data	Cond. on Next Cal. Per. +-Cal|Data
2012	680,373	24,950	0.04	39.99	0	24,950
2013	403,673	15,607	0.04	63.72	13,117	8,457
2014	276,582	12,524	0.05	79.98	10,145	7,342
2015	173,632	9,302	0.05	90.18	7,533	5,457
2016	81,447	4,698	0.06	94.97	3,820	2,735
2017	39,999	2,642	0.07	97.32	2,162	1,518
2018	20,601	1,606	0.08	98.53	1,310	929
2019	10,908	974	0.09	99.17	777	587
2020	5,966	585	0.10	99.52	438	388
2021	3,374	377	0.11	99.72	271	263
2022	1,948	251	0.13	99.84	176	179
2023	1,145	171	0.15	99.91	119	123
2024	683	118	0.17	99.95	82	85
2025	410	81	0.20	99.97	57	58
2026	244	55	0.23	99.98	39	39
2027	143	36	0.25	99.99	26	26
2028	79	23	0.29	100.00	16	16
2029	40	13	0.33	100.00	10	9
2030	16	6	0.38	100.00	5	4
Total	1,701,264	52,974	0.03	100.00	26,830	45,677

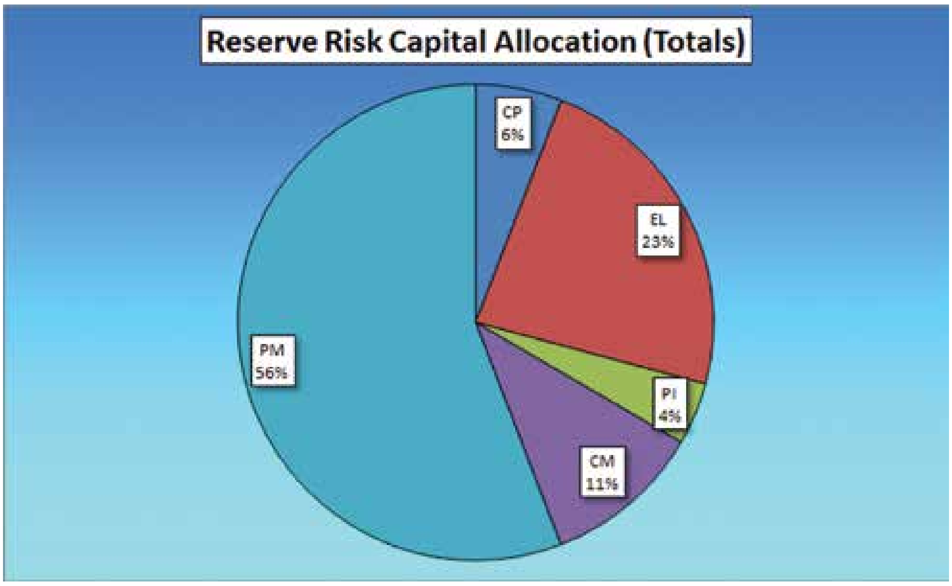
1 Unit = 1,000 €
Forecast scenario: Reasonable

4.2. Aggregate reserve distributions for the five LOBs (net of recoveries)



Simulations for the total reserve, net of recoveries, are calculated and the complete reserve distribution shown above. The value-at-risk at the 75th percentile is 3.4M □. All simulations can be exported to text files and imported into any other application of choice.

4.3. Risk capital allocation by LOB (net of recoveries)



The total risk capital percentage allocated to each LOB is displayed above where the variance-covariance formula was used to allocate capital. Recoveries are taken into consideration when allocating risk capital.

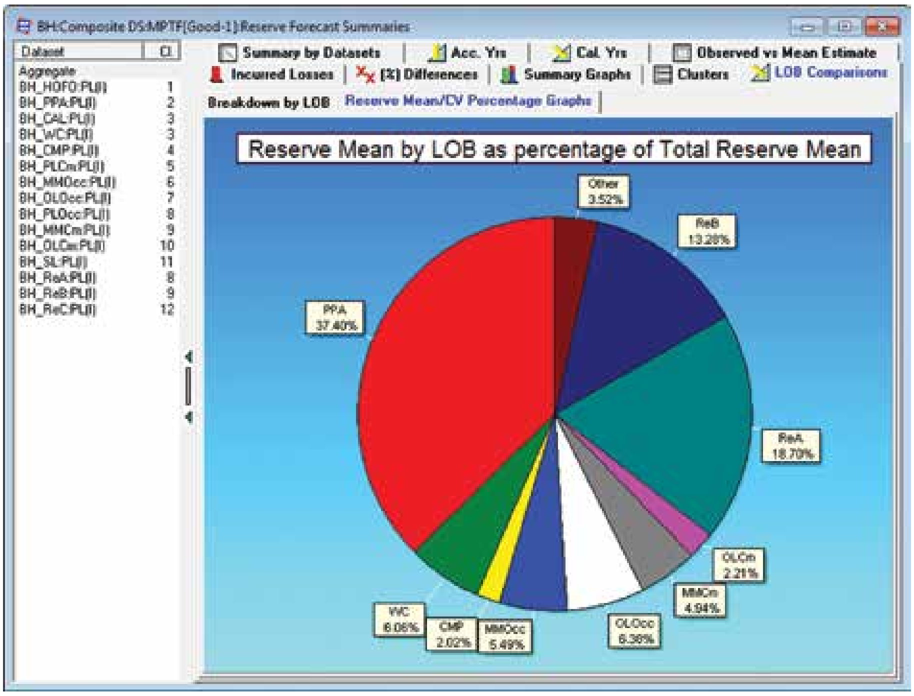
5. A.M. Best Schedule P: Berkshire Hathaway, Swiss Re, and the Industry

The A.M. Best Schedule P, NAIC Schedule P, or S&P SynThesis data can be imported into an ICRFS-Plus™ database.

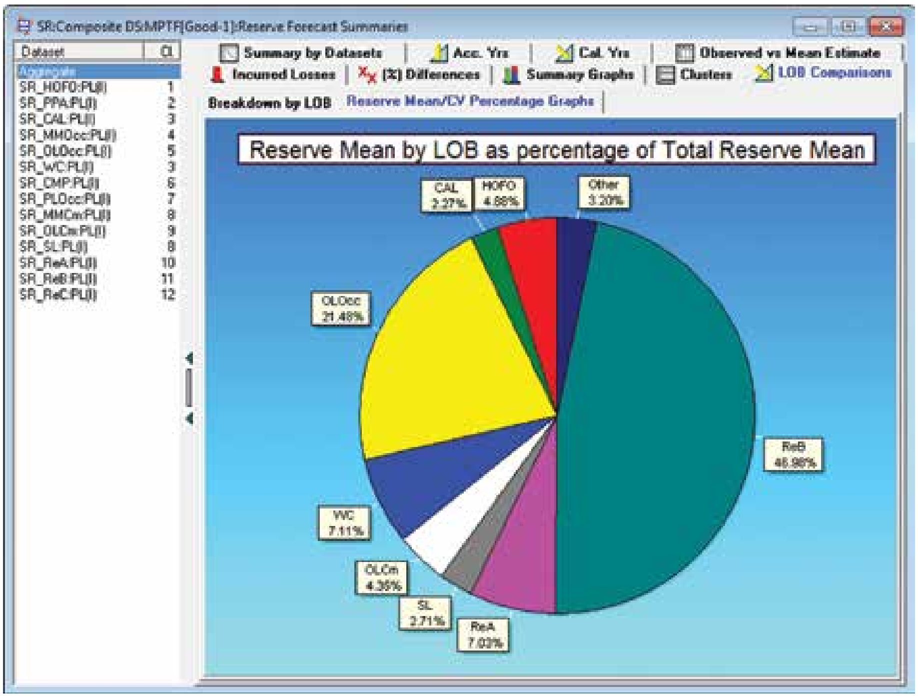
The unique technological power of ICRFS-Plus™ combined with A.M. Best's or NAIC Schedule P (USA) or S&P SynThesys (UK) data will give your company a strategic edge. Importing the data into an ICRFS-Plus™ database obtains all the data organisation, customisation, and modelling capabilities of ICRFS-Plus™. Gain a competitive advantage by comparing your company's intrinsic risk characteristics and loss costs with those of your competitors.

For instance, the composition of companies can be compared (here BH and SR):

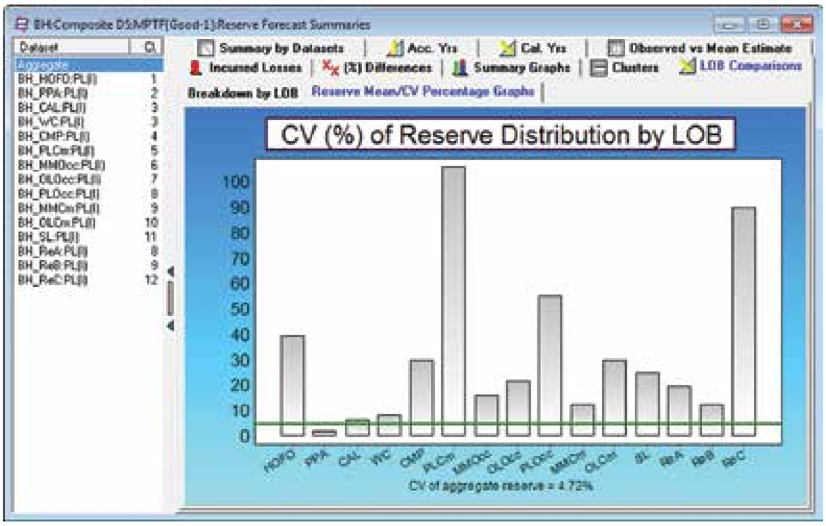
5.1. Total reserve mean by LOB (BH vs SR)

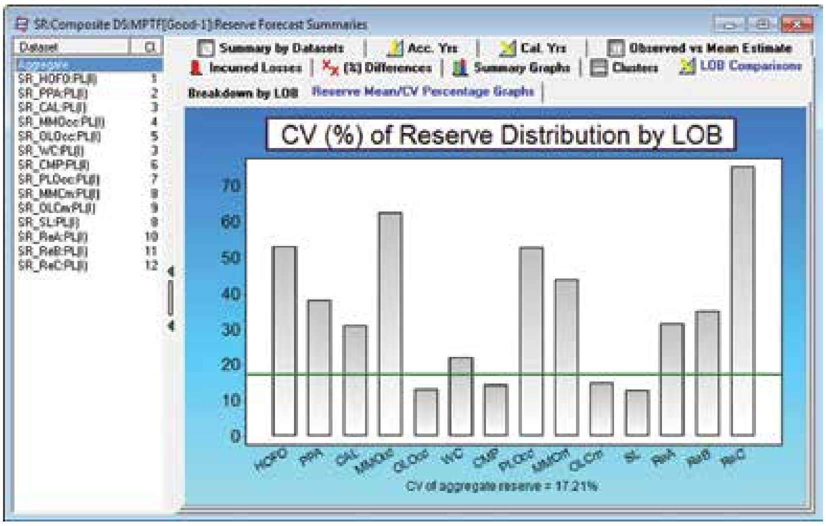


Company Berkshire Hathaway (BH) writes a large proportion of Primary Passenger Automobile (PPA), whereas Swiss Re (SR) writes a large proportion of Reinsurance portfolios (Re B and Re A consist of over 50% of the total reserve for SR).



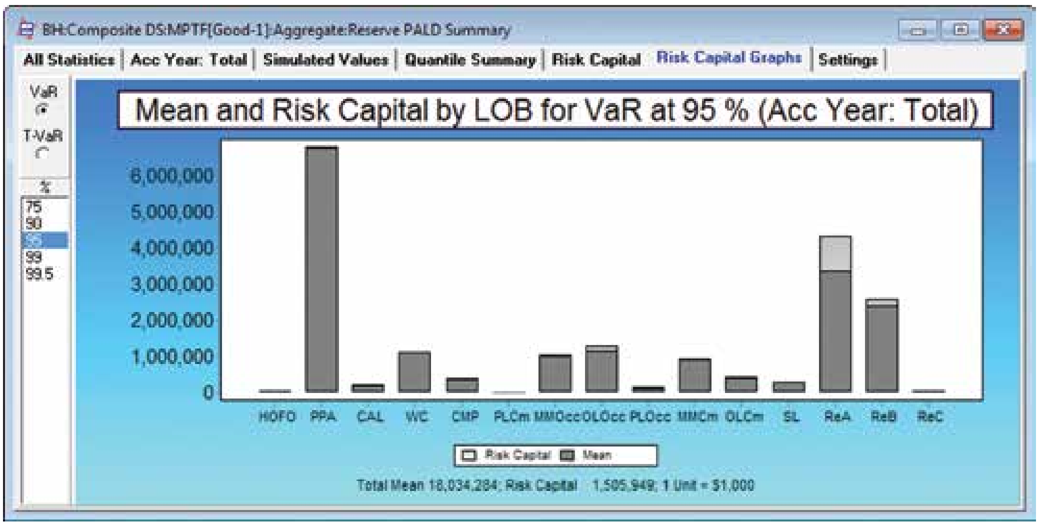
5.2. CV (%) of reserve distribution by LOB (BH vs SR)

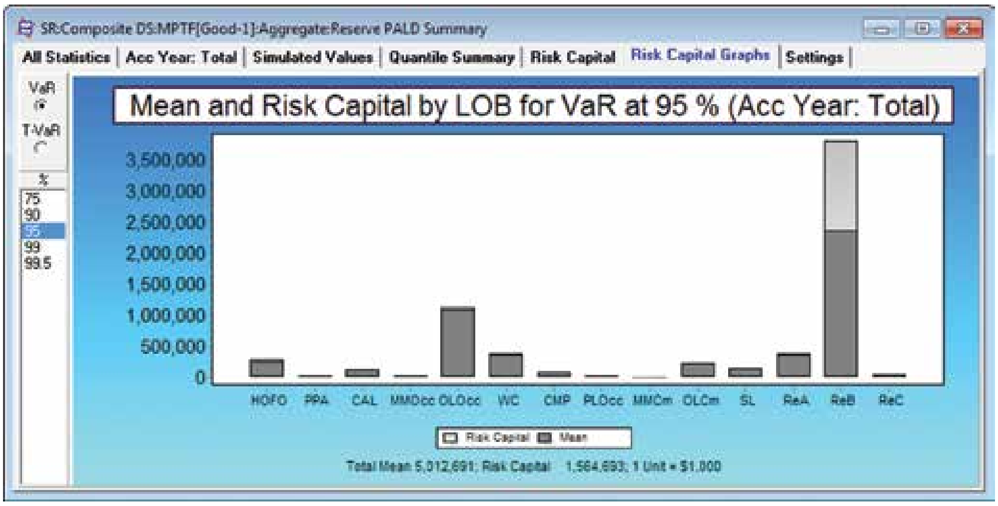




The CV of the aggregate reserve distribution is much higher for SR (17.2%) compared to BH (4.7%) – a feature of the large reinsurance portfolios.

5.3. Mean and risk capital by LOB (BH vs SR)

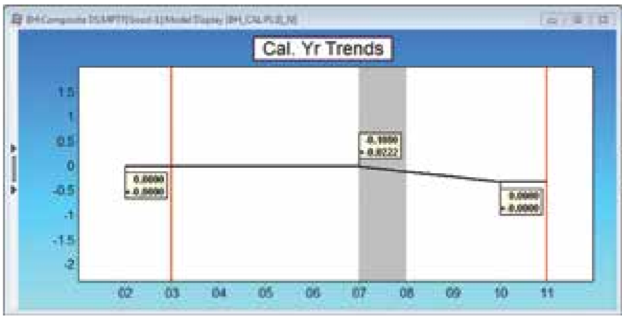




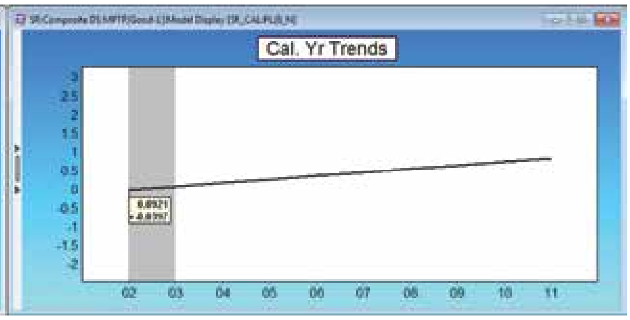
Company SR needs a significantly larger proportion of risk capital (relative to the mean) to reach the 95th percentile. The value-at-risk at the 95th percentile is almost the same for the two companies, but the total reserve mean for SR is one-third that of BH.

5.4. Calendar year trends in Commercial Auto Liability (CAL): BH vs SR vs Industry

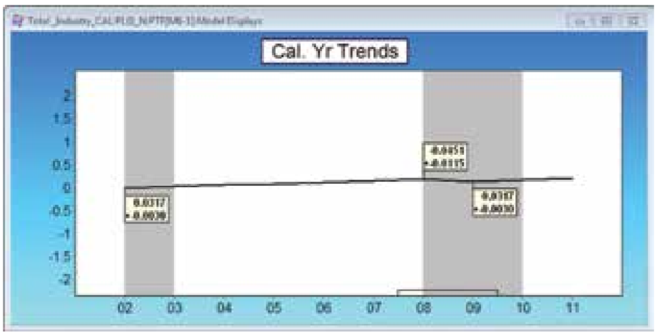
Commercial Auto Liability (CAL) lines were selected from the companies BH and SR along with the total CAL Industry. The calendar year trends for these two companies for the CAL line are displayed below followed by the calendar year trends identified in the total CAL industry data.



BH CAL



SR CAL

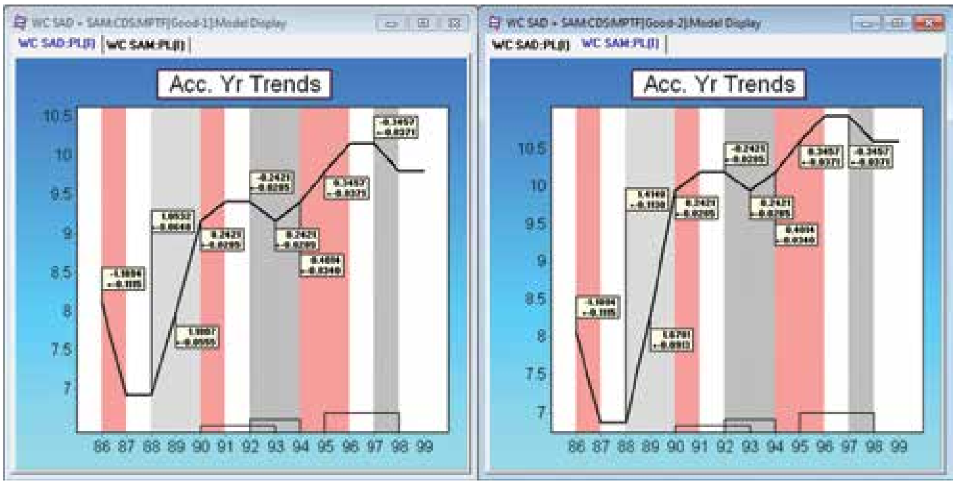


Total Cal Industry

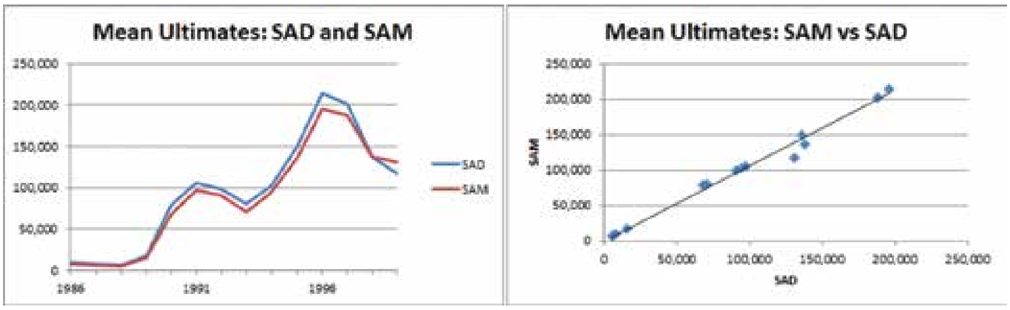
The calendar year trends are different for each company's CAL LOB and compared with the total CAL industry. The experience of each company is unique and an appropriate model which identifies the trends in the three directions along with the volatility around those trends is an absolute necessity for obtaining critical information about the business. Further, reasonable forecast scenario assumptions can only be made when information regarding past trends in the company's data are quantified. It is clear from the above that trends in the industry are not a reliable source of information for trends in an individual company.

6. Worker's compensation segments: SAD and SAM

Consider the following two segments of Worker's Compensation written in California: SAD (left) and SAM (right). The red bars indicate common parameters between the segments. The calendar and development year parameters differ slightly, but the accident year parameters move synchronously with the result that the mean ultimates vary synchronously.

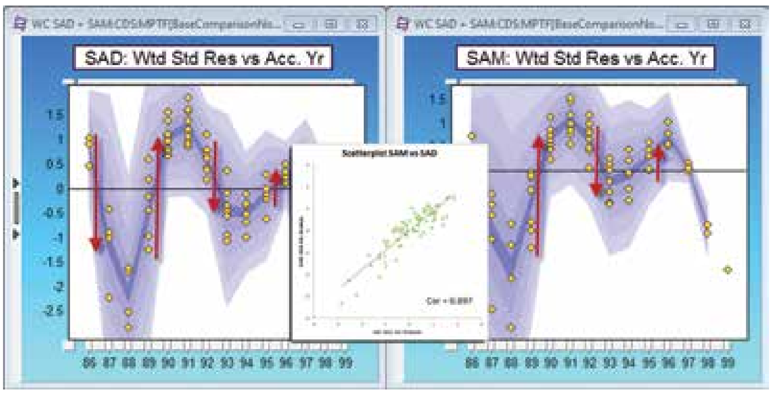


As discussed in "Understanding correlations and common drivers" , the similarity of the accident year mean ultimates does not imply volatility correlation. The mean ultimates move synchronously (left) and a graph of the mean ultimates of SAM versus the mean ultimates of SAD (right) shows an almost perfect linear relationship.



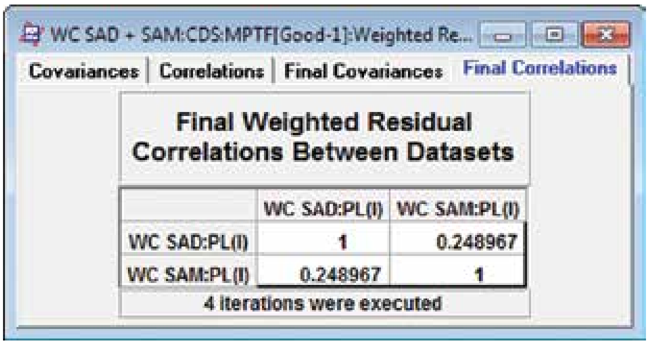
The linear relationship in mean ultimates is important when forecasting future underwriting (accident) years, but is not correlation in random effects (volatility). For instance, if the accident year level for one segment is expected to increase by 10%+_2%, then the other segment is also likely to increase by 10%+_2% in the same accident year.

The trends in the three directions must be quantified before measuring process (volatility) correlation. The 'correlation' between mean ultimates is then found best explained by similar trend adjustments in the model and forms the known effects. The process correlation is then correlation in randomness - the unknown effects.



Above, the residual displays with scatterplot (inset) for SAD and SAM are shown for a model which does ***not*** describe the accident year changes. The correlation (0.897) is very high, but it should be immediately apparent that this is not all correlation in randomness - there are distinct changes in level across the accident years (as indicated by the red arrows). These level changes, when quantified, comprise known effects and ensure the mean ultimates do move synchronously as they should.

In the model, with the accident year trends correctly fitted, the volatility correlation between the segments is related about 0.25. The result is that the mean ultimate losses (by accident year) move synchronously (and likely indicate common drivers), however the risk factors arising from volatility are not.



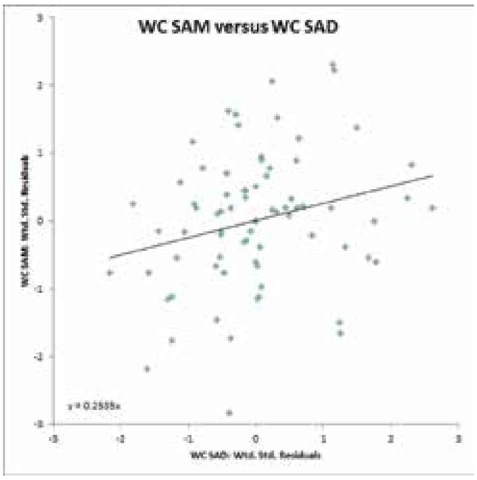
WC SAD + SAM:CDS:MPTF[Good-1]:Weighted Re...

Covariances | Correlations | Final Covariances | Final Correlations

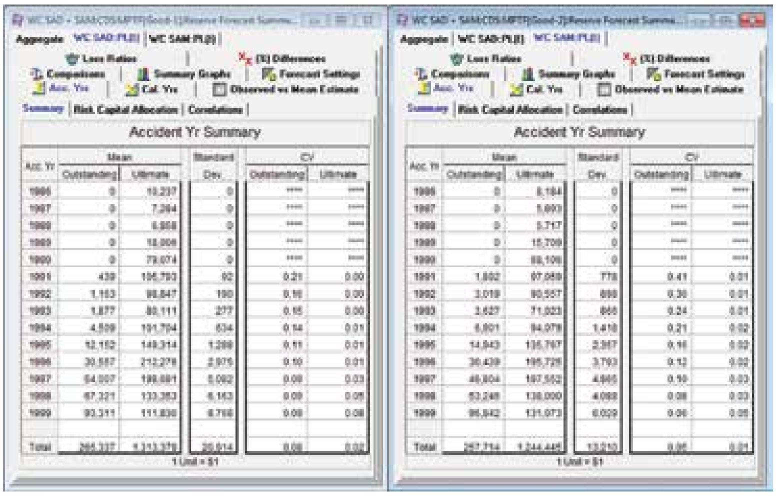
Final Weighted Residual Correlations Between Datasets

	WC SAD:PL(I)	WC SAM:PL(I)
WC SAD:PL(I)	1	0.248967
WC SAM:PL(I)	0.248967	1

4 iterations were executed



The summary tables by accident year for the two pieces with the correct volatility correlations are shown below.



Accident Yr Summary (WC SAD:PL(I))

Acc. Yr	Mean Outstanding	Mean Ultimate	Standard Dev	CV Outstanding	CV Ultimate
1986	0	10,237	0	****	****
1987	0	7,264	0	****	****
1988	0	6,858	0	****	****
1989	0	18,008	0	****	****
1990	0	79,074	0	****	****
1991	439	106,793	92	0.21	0.00
1992	1,153	98,847	190	0.16	0.00
1993	1,877	80,111	277	0.15	0.00
1994	4,509	101,704	634	0.14	0.01
1995	12,152	149,314	1,288	0.11	0.01
1996	30,587	212,278	2,975	0.10	0.01
1997	64,007	199,881	5,092	0.08	0.03
1998	67,321	133,363	6,163	0.09	0.05
1999	93,311	111,830	8,766	0.08	0.08
Total	285,337	1,313,378	20,814	0.08	0.02

1 Unit = $1

Accident Yr Summary (WC SAM:PL(I))

Acc. Yr	Mean Outstanding	Mean Ultimate	Standard Dev	CV Outstanding	CV Ultimate
1986	0	8,184	0	****	****
1987	0	5,693	0	****	****
1988	0	5,717	0	****	****
1989	0	15,709	0	****	****
1990	0	88,106	0	****	****
1991	1,802	97,059	778	0.41	0.01
1992	3,019	90,557	898	0.30	0.01
1993	3,627	71,023	866	0.24	0.01
1994	6,801	94,079	1,416	0.21	0.02
1995	14,943	136,767	2,367	0.16	0.02
1996	30,439	195,728	3,793	0.12	0.02
1997	46,804	187,552	4,865	0.10	0.03
1998	53,248	138,000	4,088	0.08	0.03
1999	96,842	131,073	6,029	0.06	0.05
Total	257,714	1,244,445	13,210	0.05	0.01

1 Unit = $1

The reserve distribution correlation is only 0.086! The reserve correlation is the correlation in the losses not explained by the means – and therefore is the critical measure when evaluating risk diversification. Models that do not capture the trends in the three directions in the data may indicate spurious correlations and erroneous conclusions. It is also important that the weighted standardised residuals of each model can be regarded as a random sample from a (normal) distribution. This way, the process (volatility) correlation can be measured correctly.

The common accident year drivers for the two segments are an important consideration for pricing future underwriting years. Both segments are expected to move in a similar fashion and this information must be included in any future forecast assumption - see “Understanding correlations and common drivers” for more details.

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