The Actuarial Profession
making financial sense of the future

GIRO conference and exhibition 2010

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Solvency II & Long Tail Liabilities

12-15 October 2010

Introduction and Summary

- We provide our solution to the Solvency II one-year risk horizon, SCR, Technical Provisions (TP) (Fair Value Liabilities), Market Value Margins (Risk Margins) for the aggregate of long tail LOBs
- The solution is non-recursive, non-circular, tractable and satisfies all the directives (requirements)
- IFRS 4 requirements in respect of fungibility and ring-fencing is discussed
- Three types of correlations between LOBs
- How do we know if two LOBs have the same economic drivers?
- Is the economic inflation a principal driver of long tail liability calendar year trends?

Introduction and Summary

- Two LOBs written by the same company rarely have the same trend structure (including in the calendar year direction) and often process (volatility) correlation is either zero or very low. Reserve distribution correlation is often zero and if significant quite low.
- No two companies are the same in respect of trend structure, and process (volatility) correlation is often zero (for the ‘same’ LOB).
- No company is the same as the industry, unless it is a very large proportion of the industry.

- **All the above are demonstrated with real life data**.

Introduction and Summary

- SII metrics for the aggregate of real life six LOBs compared with SII metrics for the most volatile LOB to illustrate amongst other things risk diversification of SCR and (MVM component) of TP
- **Undiscounted reserves for the aggregate of six LOBs**

  = Technical Provisions +Solvency Capital Requirement (SCR)

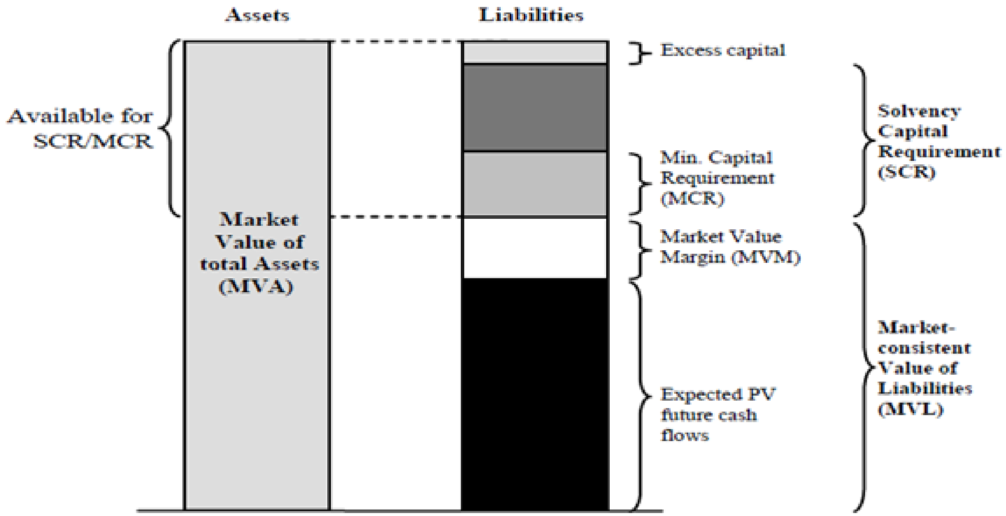
  = total liability in Economic Balance Sheet,

  using a risk free rate of 4% and a spread of 6%.
- **No need for additional capital in this example due to risk diversification!**
- **QIS5 allows for risk diversification credit**.
- **Conditions for consistent estimates of prior accident year ultimates and SII risk measures on updating. This will explain how to avoid model error "distress"**.

Introduction and Summary

- Which probability distributions are required to compute the various risk measures for the aggregate of multiple LOBs?
- VaRs and T-VaRs
- Process Variance versus Parameter Uncertainty
- Reserve risk, underwriting risk and the combined risk
- The ultimate year risk horizon- conceptually much simpler
- Calendar year Payment stream probability distributions
  - what are the drivers?

Solvency II – Economic Balance Sheet



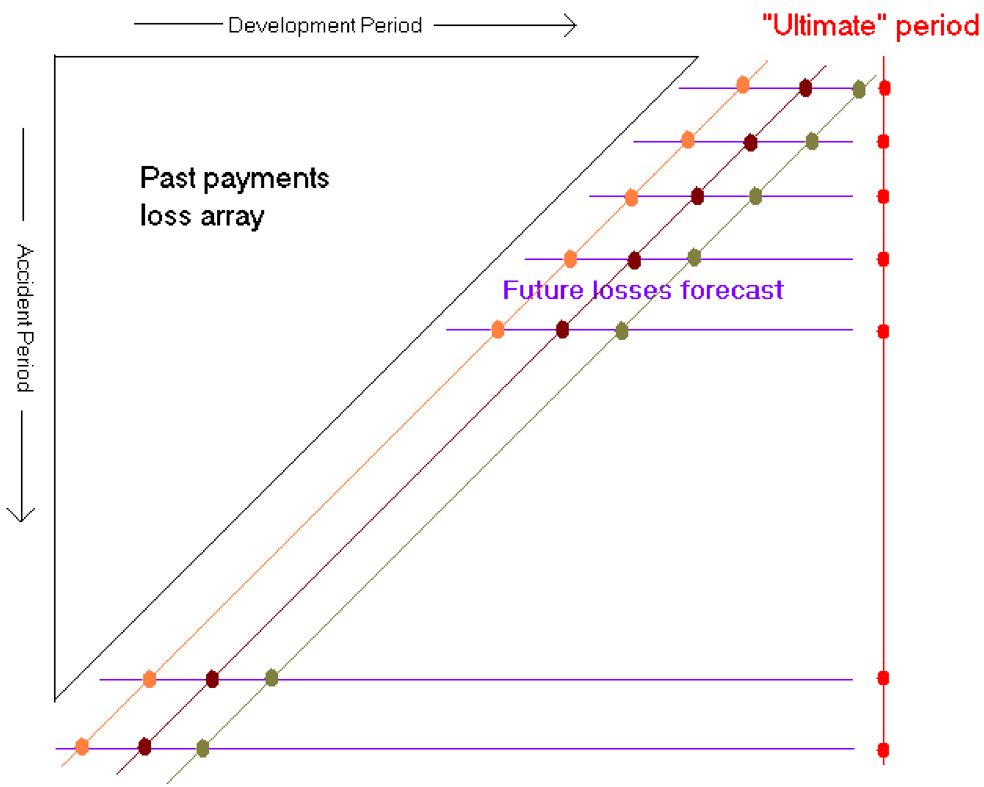
Solvency II aims to establish a solvency regime that is better matched to the true risks of an insurance company

Ann Hagen in "Solvency II : Brave new world:

"Doing the job

Under Solvency II, the way that work is carried out will change. For example, Solvency II is likely to require different actuarial techniques from the ones currently used. Technical provisions will be estimated as a probability-weighted average of expected future cash flows, taking into account the time-value of money and including a risk margin. Many of us are estimating claims reserves using traditional deterministic actuarial techniques, primarily relying on incurred claims data. Under Solvency II, not only will we need to discount these reserve estimates, requiring projected payment patterns, we will also need to demonstrate a deep understanding of the uncertainty of those reserves. We will additionally be required to apply the same approach to evaluating unexpired risk liabilities currently allowed for in the unearned premium reserves."

Actual payments are made by calendar year



Summing future losses along the calendar year axis produces projections of the cash-flow, and the actual calls on the reserves. This is the dimension in which solvency issues arise.

Using cell distributions and correlations we can compute the distributions for each future year's cash flow.

Solvency II one-year risk horizon: satisfies three conditions - Summary of decomposing the directives- What are the basic elements?

- Risk Capital is raised at the beginning of each year;
- The analyses are conditional on the first (next) calendar year being in distress (99.5%);
- At the end of the first year in distress, the balance sheet can be "restored" in such away that the company has sufficient technical provisions (fair value of liabilities) to continue business or to transfer the liabilities to another risk bearing entity.

Here follow some relevant articles that lead to above mentioned three conditions

The Concept of Risk - The Fair Value of Liabilities

The Solvency II Framework Directive

- **Article 76**: The value of technical provisions shall correspond to the current amount insurance and reinsurance undertakings have to pay if they were to transfer their insurance and reinsurance obligations immediately to another insurance or reinsurance undertaking
- **Article 77**: The value of technical provisions shall be equal to the sum of a Best Estimate and a Risk margin ….
- The Best Estimate shall correspond to the probability-weighted average of future cash-flows, taking into account the value of money (expected present value of future cash-flows), using the relevant risk-free interest rate term structure.

The Concept of Risk - The SCR

The Solvency II Framework Directive

Article 101: The Solvency Capital Requirement (SCR) shall... correspond to the Value-at-Risk (VaR) on the basis own funds[1)] ... subject to a confidence level of 99.5% over a one-year period.

- Initial Capital covers at least the potential change in the Fair Value under severe adverse conditions, represented by the 99.5% percentile of the range of possible Fair Values at the end of the selected solvency one-year time horizon; adverse conditions represent a distress scenario for the company.

1) Essentially, basis own funds defined as the excess of assets over liabilities, both assessed at market value (or capital market consistent value, where a market does not exist)

The Concept of Risk - The Fair Value of Liabilities

- The Best Estimate shall be gross, without deduction of the amounts recoverable from reinsurance contracts and special purpose vehicles. Those amounts shall be calculated separately … (Cf. article 81)
- The Risk Margin shall be such as to ensure that the value of the technical provisions is equivalent to the amount that insurance and reinsurance undertakings would be expected to require in order to take over and meet the insurance and reinsurance obligations. (Cost of providing amount of eligible own funds.)[1]

1) The cost of holding the SCR is assumed to attract a premium over the risk-free interest rate which is called the Cost of Capital

Definition of the One-Year Risk Horizon

For the one-year risk horizon, risk capital is raised at the beginning of each year.

- The cost of raising the risk capital, the **Market Value Margin (MVM)** or premium on the risk capital, also known as the **Risk Margin** is paid to the capital providers at the end of each year along with any unused risk capital.

- The sum of the MVMs and the Best Estimate of Liabilities (BELs) for each calendar year (>=2) is the **Technical Provision** (also referred to as **Fair Value of Liabilities**).

Definition of the One-Year Risk Horizon

- For an individual year (k; k>2), we can define:

  TP(k) = BEL(k) + MVM(k);

  where BEL(k) and MVM(k) are the Best Estimate of Liabilities and Market Value Margin for year k.
- Important note: for a future calendar year, k, BEL(k) and MVM(k) are additive; VaR(k) is not.

We present a tractable solution to the one-year risk horizon that is not recursive or circular.

The Concept of Risk - The SCR

The Solvency II Framework Directive

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1) Essentially, basis own funds defined as the excess of assets over liabilities, both assessed at market value (or capital market consistent value, where a market does not exist)

The Concept of Risk - The SCR

As detailed in the **Insurance ERM analysis of Solvency II**:

“The fair value balance sheet is one of the cornerstones of Solvency II, and its impact is not restricted only to the calculation of fair value assets and liabilities. The concept of market value margin (MVM), and the related one-year risk approach in the calculation of the solvency capital requirement (SCR), find their origin in this fair value driven approach: <u>re/insurance companies should have enough capital on their balance sheet to cover the risks that can emerge over a 12-month timeframe, and allow for a (theoretical) transfer of all (contractual) liabilities at the end of this balance-sheet period. This means that companies have to be able to calculate the impact of such shocks on their end-of-year balance sheets, and value these in such a way that they can be transferred to a third party.”</u>

Risk Capital – CEIOPS excerpts

Consultation paper 75: Undertaking specific parameters for SCR

http://www.ceiops.eu/media/files/consultations/consultationpapers/CP75/CEIOPS-L2-Advice-Undertaking-specific-parameters.pdf

- 3.55. The SCR is the difference between the basic own funds over the one year time horizon in the distressed scenario. **This implicitly suggests that undertakings should analyse the difference between all component parts of the technical provisions under the stressed scenario, including the risk margin.**

Definition of SCR

The above extracts lead to the following definition: the SCR for the one-year risk horizon is the Value-at-Risk for the first year plus the change in technical provisions (TP) in the subsequent years (suitably discounted), **conditional** on the first year being in distress.

$$SCR = VaR99.5\%(1) + \Delta TP(2) + \Delta TP(3) + \ldots + \Delta TP(n),$$

where n is the limit of run-off.

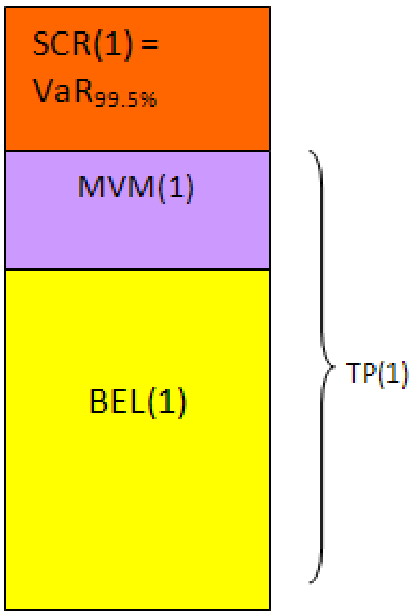
The Concept of Risk Horizon Perspective

Quantification Requirements- What do we need to compute SII metreics?

- For the calculation of the **Technical Provisions**, **Market Value Margins** and **SCR** for both the **One-year Risk Horizon** (and **Ultimate Year Risk Horizon**) for the aggregate of all long-tail LOB's and each LOB separately the following critical information is required:
  - Probability distributions of paid losses (liability stream) by **calendar year** (k =1,.,n) and their correlations, for each LOB and the **aggregate** of all LOB's
  - Probability distributions of total reserves for each LOB and the aggregate of all LOB's.
  - Probability distributions of the aggregate paid losses from calendar year k to calendar year n for each LOB and the aggregate of all LOB's. This is required for each k ranging from 1 to n, where complete run-off is achieved at the ultimate calendar year n
  - Conditional Probability distributions, conditional on the first (next) calendar year being in "distress".
- Armed with these distributions **<u>any risk measure can be computed</u>**, including VaR(k) for the paid losses (total loss) in calendar year k; and **Market Value Margins**, **Technical Provisions** and VaRs conditional on the first year in distress, for each LOB and the aggregate of all LOB's.

Risk Capital – One Year risk Horizon

Simplest Case: Only One Year Runoff



L_1 = projected losses for the year. This is a random variable.

$BEL(1) = {E(L_1)}/{(1+d)^{0.5}}$ Where d = interest rate. Losses are paid uniformly through year, so we discount for half a year.

$SCR(1) = VaR_{99.5\%}(L_1)$, i.e. $\Pr\big(L_1 \le E(L_1) + SCR(1)\big) = 0.995$

MVM(1) is the cost incurred in having risk fund of *SCR(1)* available for the year. It is paid to capital provider at end of year and so is discounted by a full year.

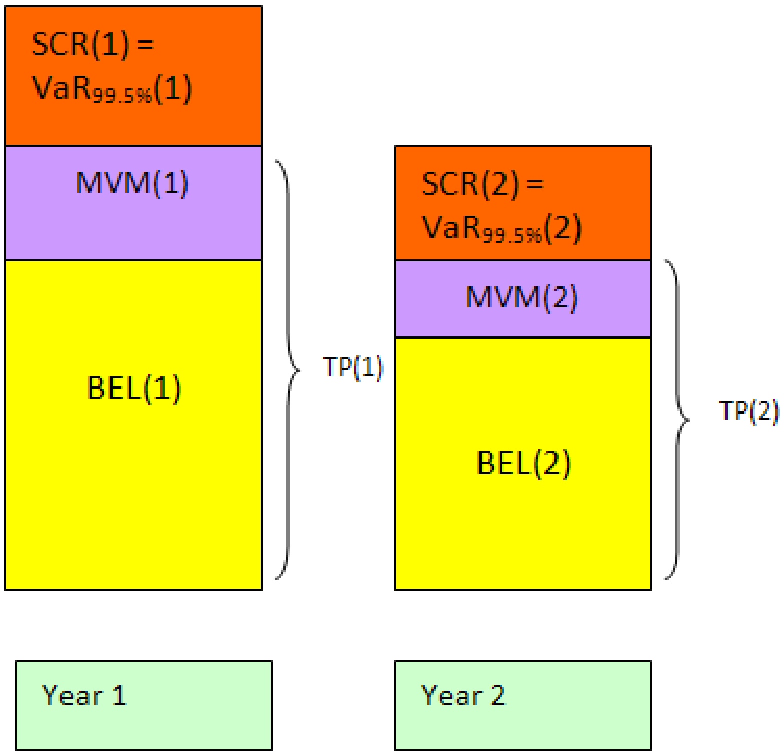
$MVM(1) = \frac{SCR(1)*s}{(1+d)}$, if the interest on the risk fund is paid directly to capital provider, or $MVM(1) = \frac{SCR(1)*(s+d)}{(1+d)}$, otherwise.

$TP(1) = BEL(1) + MVM(1)$. This is the Technical Provision and must be held in company own funds.

We will also let, *PV(k;d)*, or *PV(k)* be used to abbreviate the Present Value factor ${1}/{(1+d)^k}$

Risk Capital – One Year risk Horizon

Next Simplest Case: Two Year runoff, No correlation



$$BEL(1) = E(L_1) * PV(0.5)$$

$$BEL(2) = E(L_2) * PV(1.5)$$

$$MVM(1) = VaR_{99.5\%}(1) * s * PV(1)$$

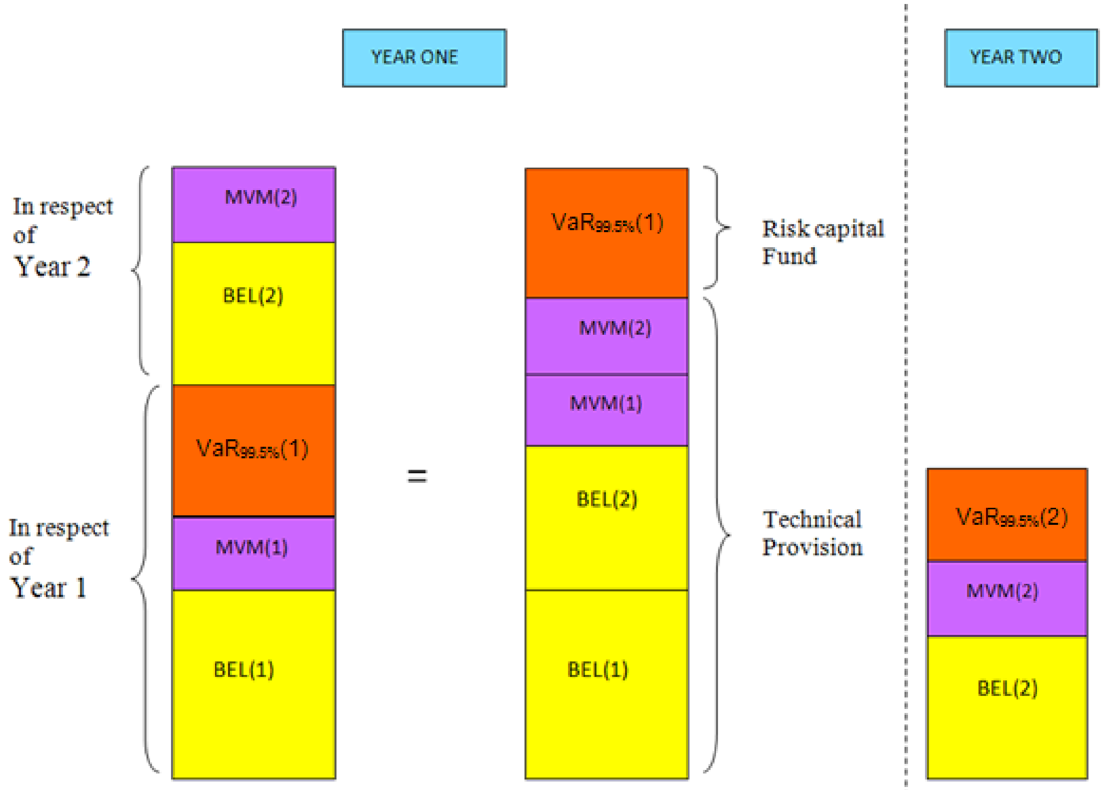
$$MVM(2) = VaR_{99.5\%}(2) * s * PV(2)$$

The Technical Provision (TP) at inception is the sum of the individual year TPs:

$$TP = TP(1) + TP(2)$$

This amount needs to be available in company own funds to ensure that losses can be met up to a 99.5% or 1/200 risk level in each year. Aggregate losses up to the value of the mean are met out of *BEL* funds, excess losses are met from the *SCR* fund, access to which is financed by *MVM*.

Risk Capital – One Year risk Horizon



Two-year picture of accounts: In year 1 we require reserves to meet paid loss liabilities for years 1 and 2 and we also need to able to fund the cost of access to the risk capital funds for years 1 and 2, however we only need access to the year 1 risk fund. When year 2 begins our accounts reset, since any cost over-runs from year 1 were paid out of the risk fund and do not degrade our prepared reserves for year 2. *Provided the loss over-run is below* RC(1) = $\mathrm{VaR}_{99.5}(L_1)$.

Risk Capital – One Year Horizon

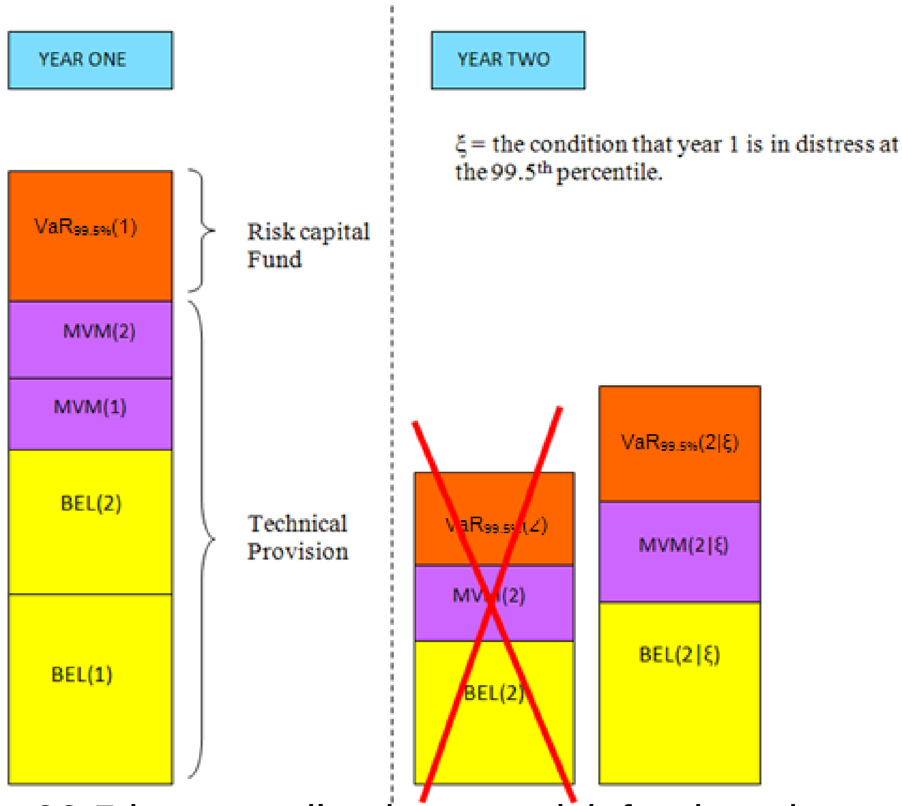
- This is fine, except for one thing:

  What if the distribution for the losses in year 2 has changed conditional on the losses in year one?

- Simply put, the previous picture assumes there is no correlation between the distributions for years 1 and 2. In other words, whatever the outcome observed after year 1 we are going to remain fixed on our previous course, full steam ahead

  Typically calendar year distributions are positively correlated. The correlations are driven by parameter uncertainty.

Risk Capital – One Year Horizon



If year 1 is in distress at the 99.5th percentile, then our risk fund carries us over into year 2, but the conditional distributions are now different. Year 2 now must be re-evaluated in the light of conditional distributions and these increase the size of the BEL and the MVM, the cost of holding the risk fund. We need to include these adjustments in the year 1 risk fund.

Two-year runoff with first year in distress

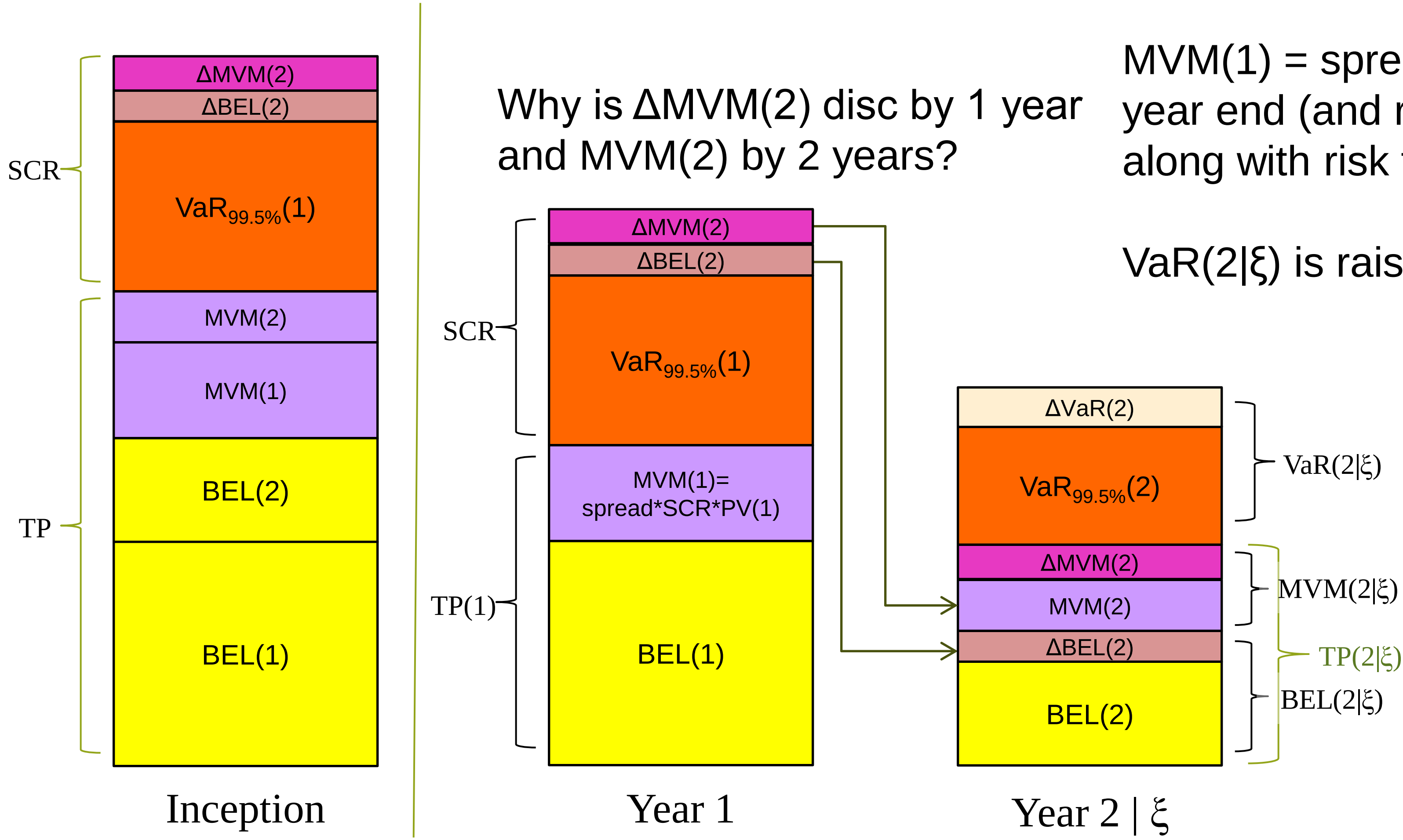
Let ξ = Year 1 in distress

VaR(1) is consumed.

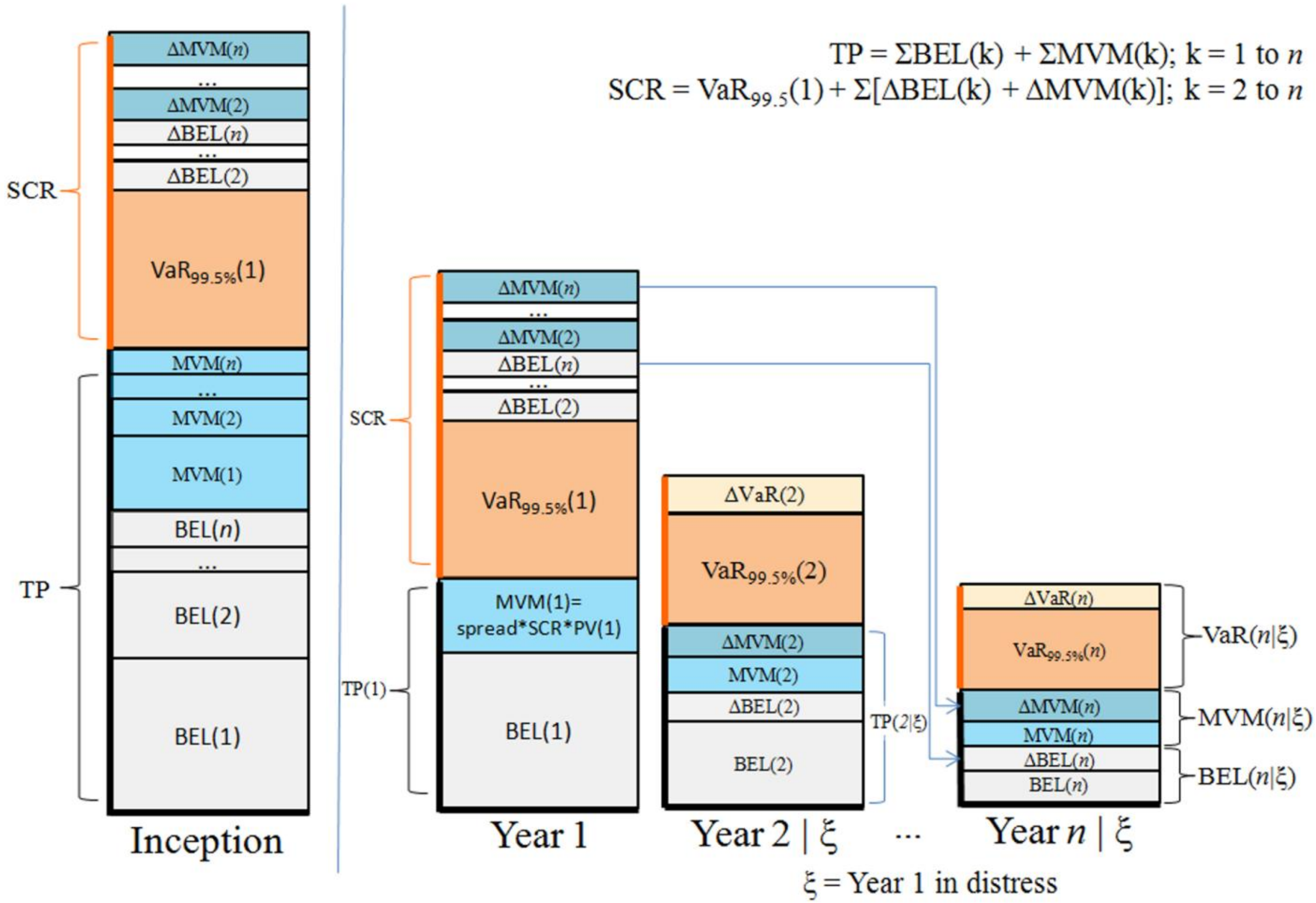
MVM(1) = spread*SCR at year end (and returned along with risk free rate).

VaR(2|ξ) is raised in year 2.

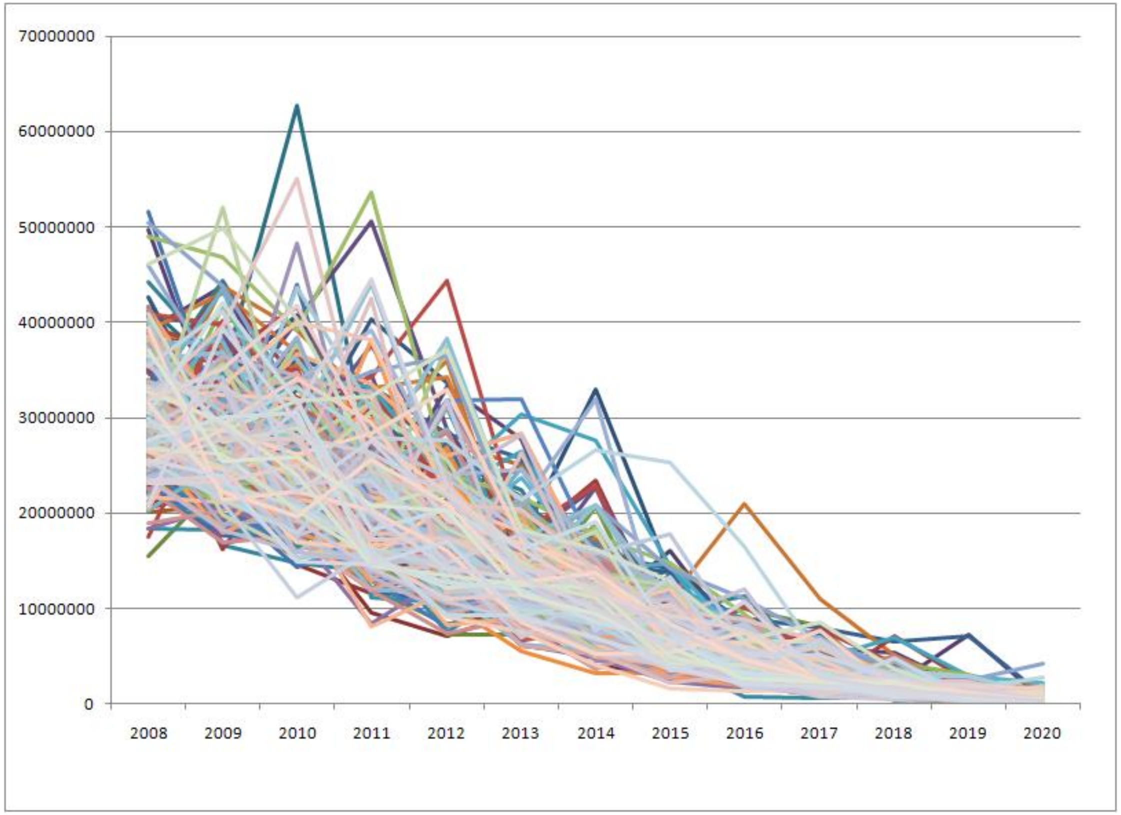
Why is ΔMVM(2) disc by 1 year and MVM(2) by 2 years?



N-year run-off (Correlated)

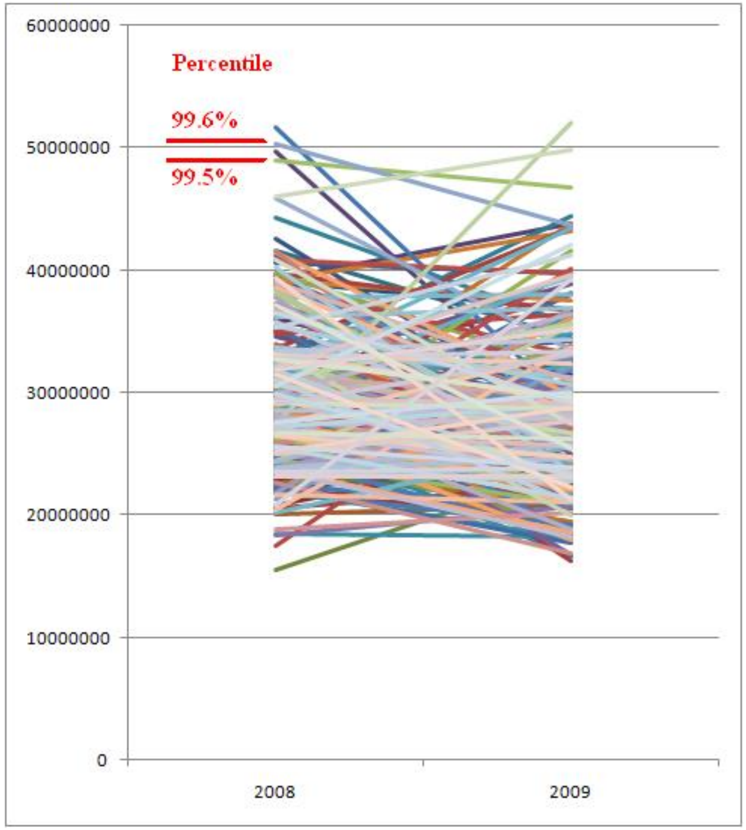


Conditional Statistics from Simulations



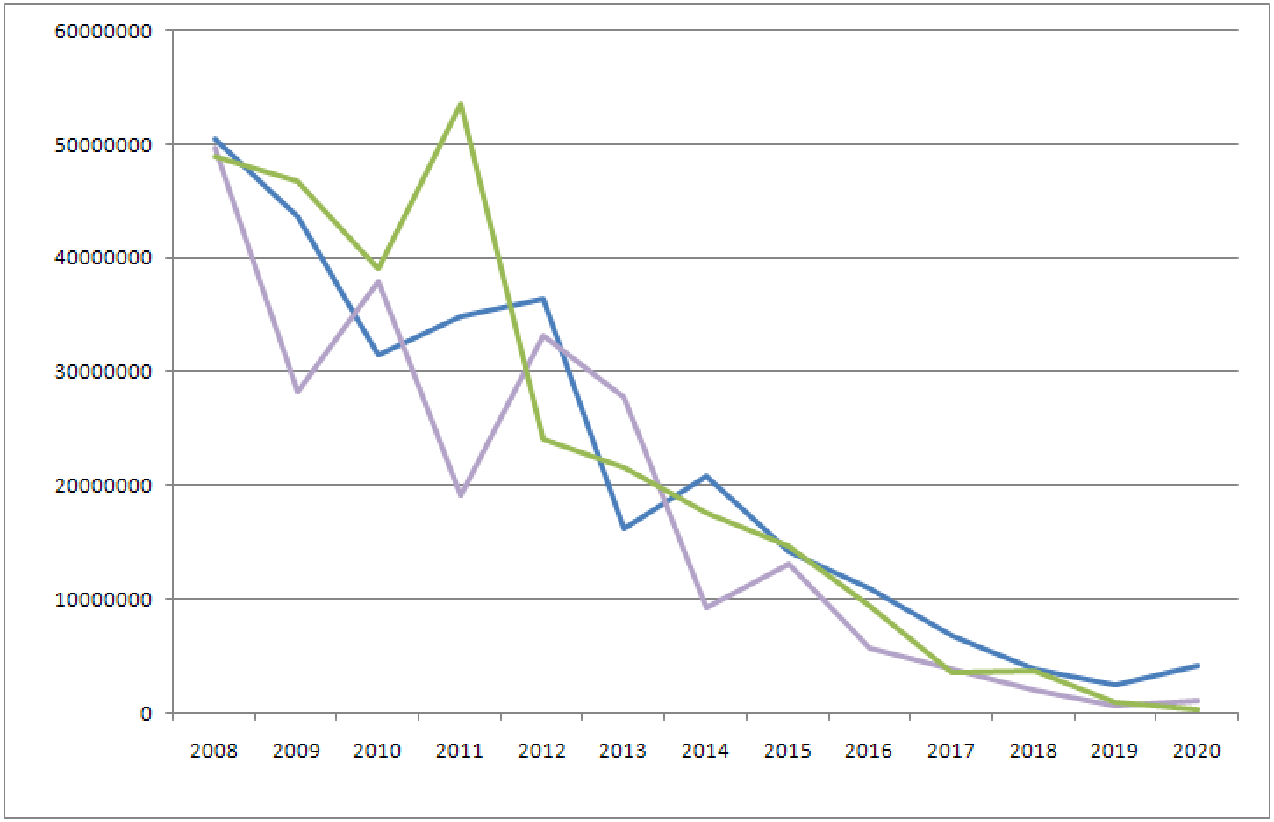
Begin with a large number of simulations of the entire forecast table. This provides an equal number of sample paths through all future calendar years.

Conditional Statistics from Simulations



Determine the sample paths corresponding to the distress scenario. If this is “next year at 99.5th percentile”, then these paths belong in the [99.5, 99.6) order interval.

Conditional Statistics from Simulations

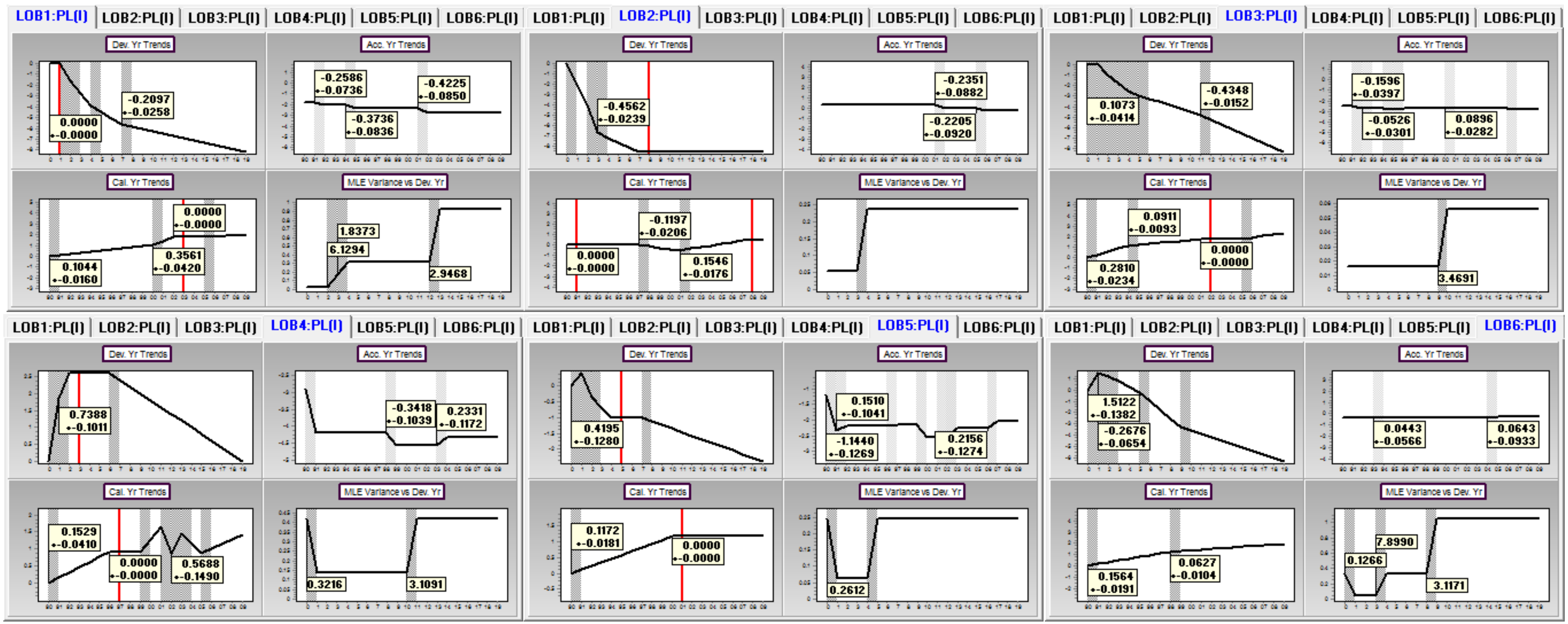


Restricting attention to only these sample paths we can then calculate any conditional statistic, such as BEL(k)|ξ, MVM(k)|ξ, VaR(k)|ξ etc.

SII metrics for the aggregate of six LOBs compared with SII metrics for the most volatile LOB- risk diversification of SCR and TP

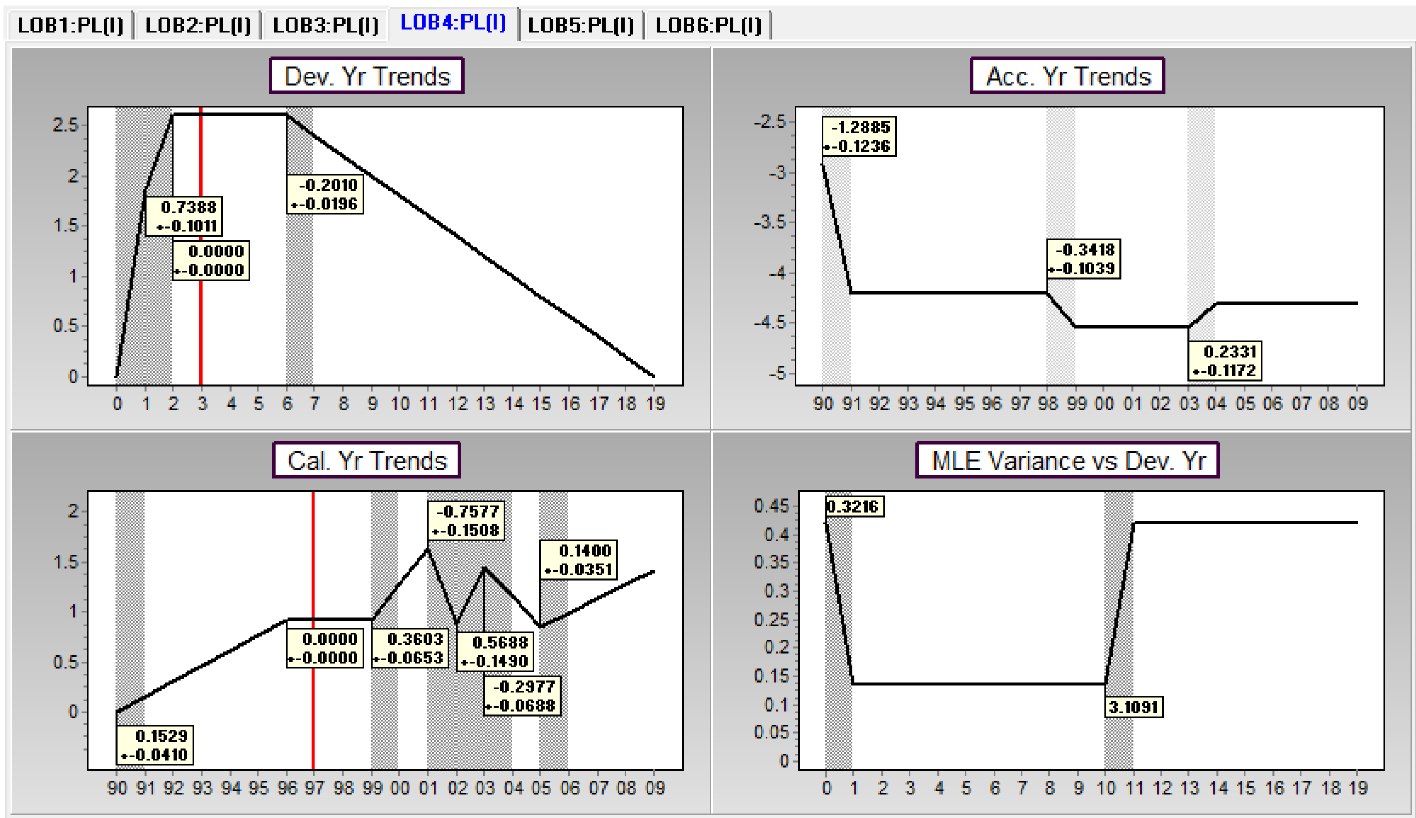
Trends and volatility are unique to each LOB

- LOB4 is the most volatile of the LOBs



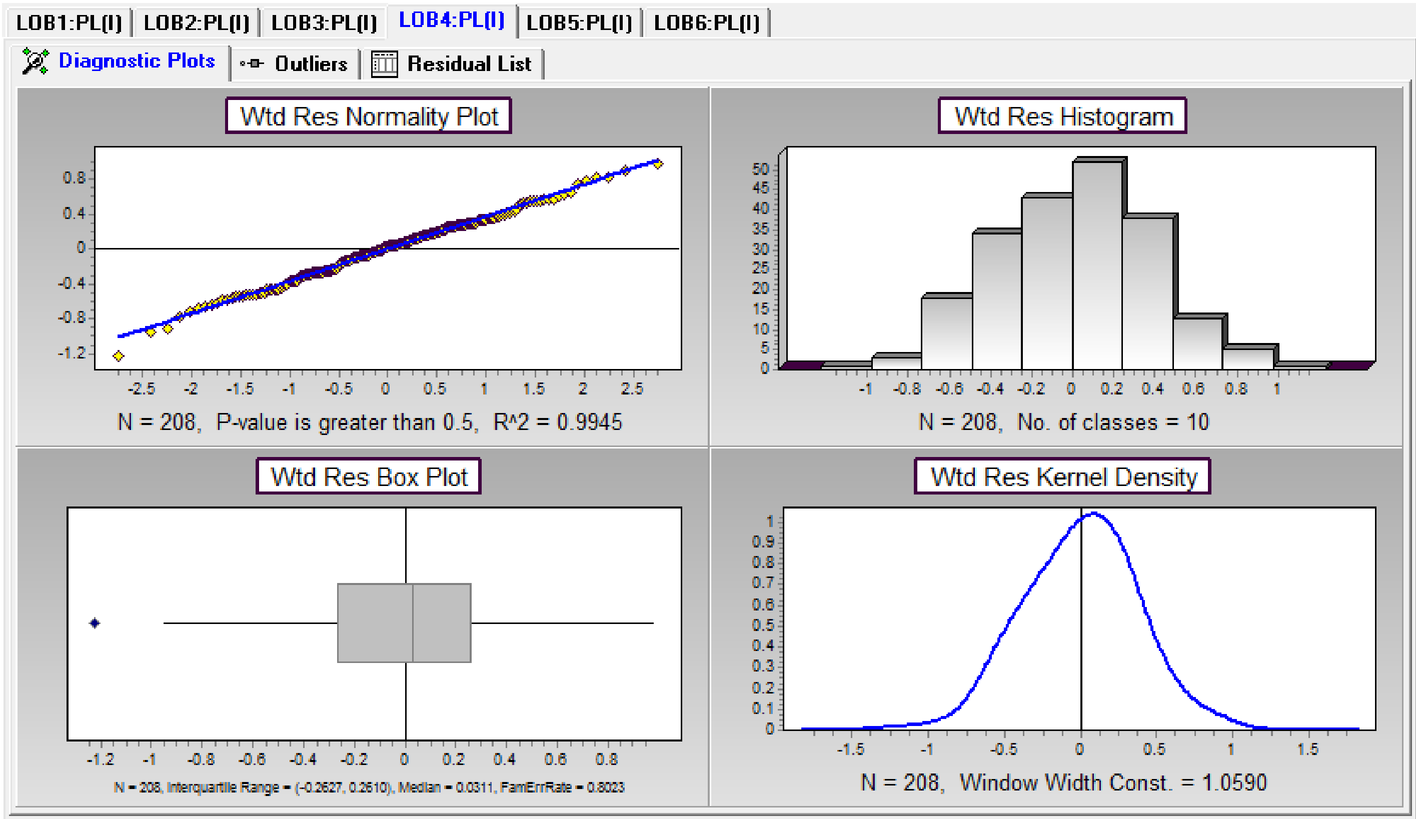
SII metrics for the aggregate of six LOBs compared with SII metrics for the most volatile LOB- risk diversification of SCR and TP

- Model for LOB 4



SII metrics for the aggregate of six LOBs compared with SII metrics for the most volatile LOB- risk diversification of SCR and TP

- Diagnostics for LOB4 illustrating normality satisfied



SII metrics for the aggregate of six LOBs compared with SII metrics for the most volatile LOB- risk diversification of SCR and TP

- Forecast table for LOB4
- Black:
  - Fitted mean
- Blue:
  - Observed
- Red:
  - Standard Deviation (log-normal)

Aggregate | LOB1:PL(I) | LOB2:PL(I) | LOB3:PL(I) | LOB4:PL(I) | LOB5:PL(I) | LOB6:PL(I)

Accident Period vs Development Period

	Cal. Per. Total	0	1	2	3	4	5	6	7	8
2004	3,048	16	68	162	186	214	247	284	268	254
	3,086	40	63	132	243	350	233	115	110	107
2005	2,127	14	87	209	240	276	319	368	347	329
	1,926	15	32	152	236	394	128	152	147	144
2006	2,318	16	102	246	283	326	376	435	411	389
	2,341	20	44	270	300	131	155	185	181	178
2007	2,559	20	127	305	352	406	470	543	514	487
	2,926	13	122	262	142	168	200	240	236	232
2008	2,864	21	137	329	380	439	508	588	557	528
	2,454	7	132	133	157	187	225	271	267	264
2009	3,243	24	155	372	430	498	577	669	634	602
	3,808	49	64	154	183	220	266	323	319	317
	Total Fitted/Paid		2010	2011	2012	2013	2014	2015	2016	2017
Cal. Per. Total	47,219		3,649	3,974	4,100	4,182	4,198	4,136	3,969	3,823
	47,449		594	732	861	996	1,128	1,246	1,334	1,429

1 Unit = $1,000

SII metrics for the aggregate of six LOBs compared with SII metrics for the most volatile LOB- risk diversification of SCR and TP

- Forecast table for the aggregate of the six LOBs
- Black:
  - Fitted mean
- Blue:
  - Observed
- Red:
  - Standard Deviation

Aggregate | LOB1:PL(I) | LOB2:PL(I) | LOB3:PL(I) | LOB4:PL(I) | LOB5:PL(I) | LOB6:PL(I)

Accident Period vs Development Period

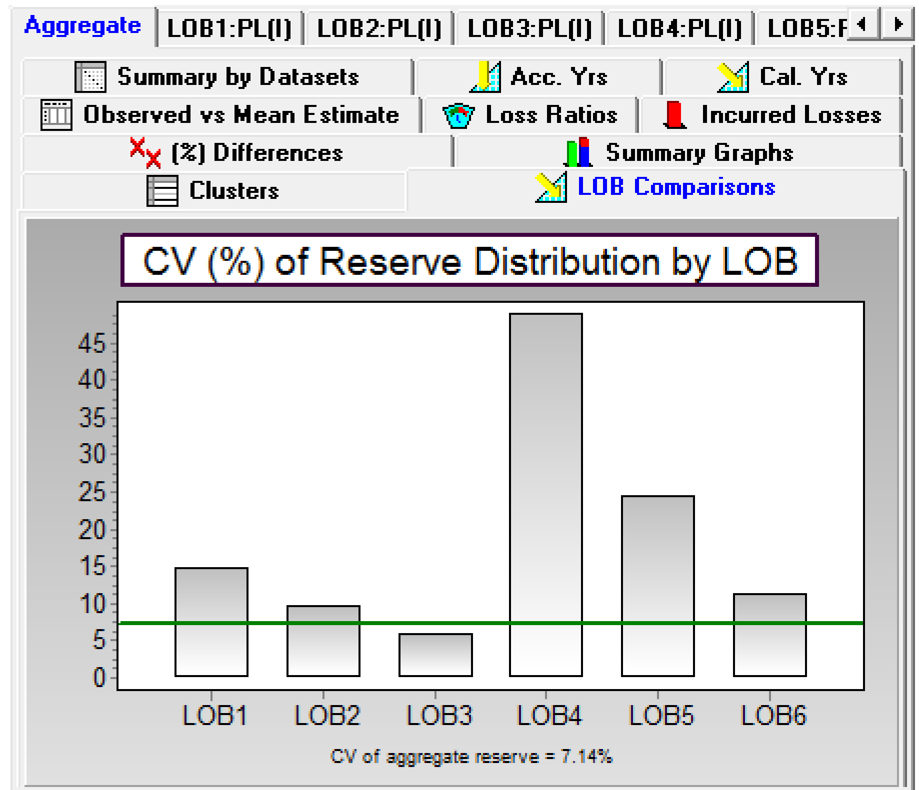
	Cal. Per. Total	0	1	2	3	4	5	6	7	8
2004	287,031	95,735	101,359	36,115	17,279	9,935	7,361	6,040	4,984	4,194
	271,241	94,027	112,007	39,137	17,635	12,810	6,816	741	621	536
2005	280,482	97,461	115,058	41,050	19,640	11,298	8,438	6,946	5,758	4,298
	277,690	77,596	127,377	39,731	22,406	10,942	1,059	871	738	548
2006	306,715	104,752	124,282	44,460	21,295	12,301	9,192	7,628	5,619	4,226
	362,204	142,541	128,978	46,573	17,422	1,592	1,175	985	718	541
2007	319,815	100,486	118,963	42,746	20,666	12,018	9,023	6,662	4,955	3,780
	323,149	100,455	116,901	38,555	2,638	1,597	1,176	852	638	502
2008	329,853	107,790	127,831	45,668	22,003	12,790	8,556	6,289	4,675	3,590
	348,822	122,154	114,366	5,190	2,822	1,754	1,138	812	612	496
2009	344,119	109,831	130,910	47,000	22,729	11,857	7,994	5,912	4,426	3,430
	311,387	100,708	14,562	5,455	2,950	1,642	1,078	780	603	506
	Total Fitted/Paid		2010	2011	2012	2013	2014	2015	2016	2017
Cal. Per.	4,601,940		243,927	118,931	76,350	51,163	37,784	28,882	22,533	18,015
Total	4,613,404		17,216	7,745	5,060	3,320	2,527	2,128	1,941	1,880

1 Unit = $1,000

SII metrics for the aggregate of six LOBs compared with SII metrics for the most volatile LOB- risk diversification of SCR and TP

- LOB4 is the most volatile of the six LOBs
- Aggregate CV is 7.14%

- Substantially more Solvency II risk capital required if LOB4 was written on its own. It has a CV of 49%



Liability stream by calendar year and calendar year correlations for the Aggregate of the six LOBs

Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Payment as % of total
2010	243,927	17,216	0.07	34.98
2011	118,931	7,745	0.07	52.04
2012	76,350	5,060	0.07	62.98
2013	51,163	3,320	0.06	70.32
2014	37,784	2,527	0.07	75.74
2015	28,882	2,128	0.07	79.88
2016	22,533	1,941	0.09	83.11
2017	18,015	1,880	0.10	85.70
2018	14,751	1,905	0.13	87.81
2019	12,378	1,978	0.16	89.59
2020	10,314	2,033	0.20	91.07

1 Unit = $1,000

Reserve Forecast Correlations Between Periods (Aggregate - Cal. Years)

	2010	2011	2012	2013	2014
2010	1	0.320725	0.318196	0.296910	0.2723
2011	0.320725	1	0.427020	0.407322	0.3785
2012	0.318196	0.427020	1	0.481196	0.4560
2013	0.296910	0.407322	0.481196	1	0.5027
2014	0.272319	0.378531	0.456023	0.502708	1
2015	0.236240	0.333324	0.411348	0.479875	0.5449
2016	0.193064	0.277063	0.352047	0.436870	0.5254
2017	0.153067	0.223763	0.294180	0.389858	0.4954
2018	0.118873	0.178258	0.243946	0.345492	0.4615
2019	0.092231	0.143331	0.205347	0.309547	0.4313
2020	0.073705	0.119437	0.179171	0.284797	0.4099

Liability stream by calendar year and calendar year correlations for LOB4- long tail with high correlations

LOB4:PL(I)

Loss Ratios | Incurred Losses | (%) Differences | Summary Graphs | Forecast Settings | Acc. Yrs | Cal. Yrs | Observed vs Mean Estimate

Summary | Risk Capital Allocation | Correlations | Correlations (logs)

Calendar Yr Summary

Calendar Yr	Mean Outstanding	Standard Dev.	CV Outstanding	Cum. Payment as % of total
2010	3,649	594	0.16	4.66
2011	3,974	732	0.18	9.74
2012	4,100	861	0.21	14.98
2013	4,182	996	0.24	20.32
2014	4,198	1,128	0.27	25.69
2015	4,136	1,246	0.30	30.97
2016	3,969	1,334	0.34	36.04
2017	3,823	1,429	0.37	40.93
2018	3,701	1,538	0.42	45.66
2019	3,595	1,651	0.46	50.25
2020	3,508	1,775	0.51	54.73

1 Unit = $1,000

LOB4:PL(I)

Loss Ratios | Incurred Losses | (%) Differences | Summary Graphs | Forecast Settings | Acc. Yrs | Cal. Yrs | Observed vs Mean Estimate

Summary | Risk Capital Allocation | Correlations | Correlations (logs)

Reserve Forecast Correlations Between Periods (LOB4:PL(I) - Cal. Years)

	2010	2011	2012	2013	2014
2010	1	0.494236	0.525858	0.545366	0.5563
2011	0.494236	1	0.601325	0.626761	0.6417
2012	0.525858	0.601325	1	0.678266	0.6966
2013	0.545366	0.626761	0.678266	1	0.7333
2014	0.556340	0.641704	0.696699	0.733333	1
2015	0.561181	0.648984	0.706382	0.745049	0.7703
2016	0.561237	0.650213	0.709177	0.749337	0.7761
2017	0.557348	0.646722	0.706616	0.747785	0.7757
2018	0.548954	0.637882	0.698039	0.739714	0.7683
2019	0.539896	0.628170	0.688370	0.730362	0.7595
2020	0.529035	0.616281	0.676201	0.718256	0.7478

One-year risk horizon
Aggregate of six LOBs

- Aggregate Solvency II capital required (**Technical Provisions + SCR**) is the same as undiscounted BEL

- Bulk of SCR is the VaR for next year (2010)

Summary | Solvency II Grid | Solvency II Charts | Settings

Metrics Summary

	Value	%
BEL	609,492	98.03
MVM	12,223	1.97
Technical Provision	621,715	100.00
VaR(2010)	49,160	73.46
Delta TP	17,761	26.54
SCR	66,922	100.00
Technical Provision	621,715	90.28
SCR	66,922	9.72
TP + SCR	688,637	100.00

1 Unit = $1,000

MVM, SCR and TP as % of BEL

	% of BEL	% of Undisc. BEL
SCR	10.98	9.60
MVM	2.01	1.75
TP	102.01	89.16
MVM + SCR	12.99	11.35
TP + SCR	112.99	98.75

- All calculations assume: risk free = 4% and spread = 6%

One-year risk horizon
LOB4

- Solvency II capital required (**Technical Provisions + SCR**) for LOB4 is substantially higher than for undiscounted BEL

Summary | Solvency II Grid | Solvency II Charts | Settings

Metrics Summary

	Value	%
BEL	52,713	85.28
MVM	9,101	14.72
Technical Provision	61,814	100.00
VaR(2010)	1,862	3.64
Delta TP	49,263	96.36
SCR	51,125	100.00
Technical Provision	61,814	54.73
SCR	51,125	45.27
TP + SCR	112,939	100.00

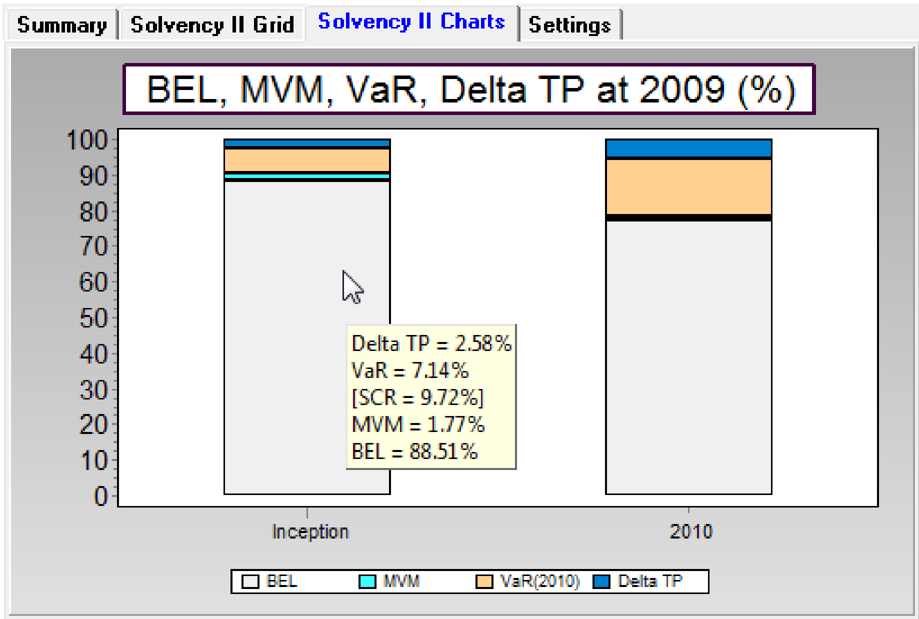
1 Unit = $1,000

MVM, SCR and TP as % of BEL

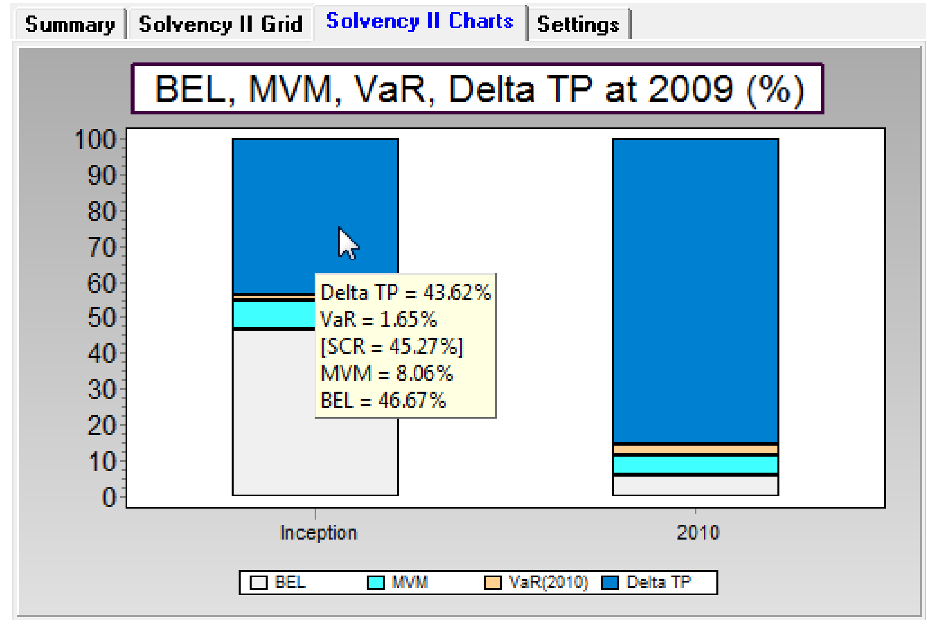
	% of BEL	% of Undisc. BEL
SCR	96.99	65.33
MVM	17.27	11.63
TP	117.27	78.98
MVM + SCR	114.25	76.96
TP + SCR	214.25	144.31

- Bulk of SCR is Delta TP – capital required to restore the balance sheet should the next year be in distress

One-year risk horizon
Comparing the aggregate of six LOBs with LOB4

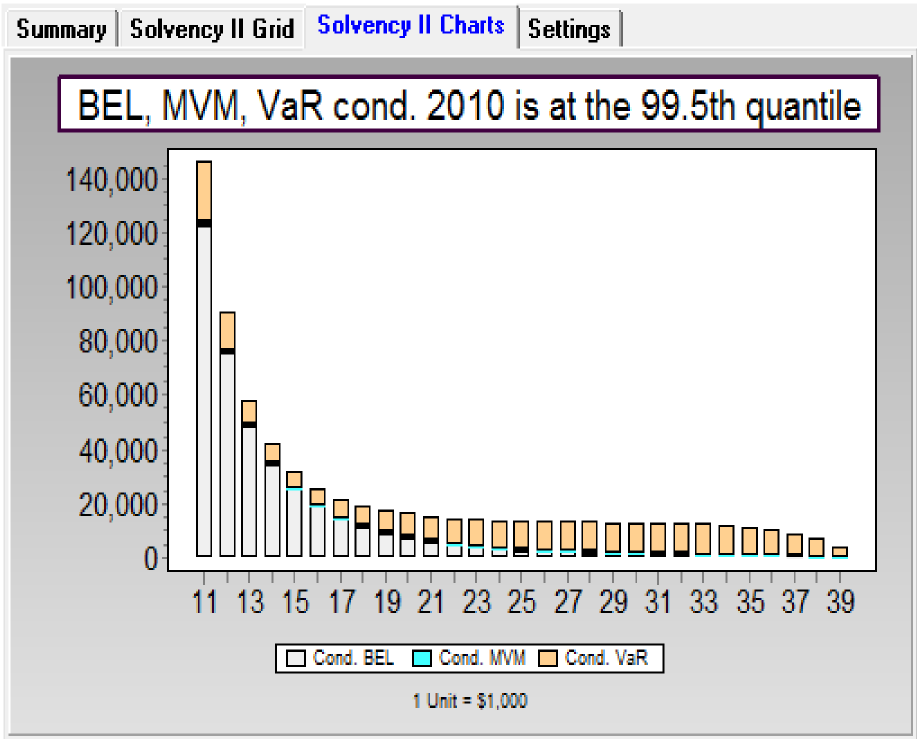


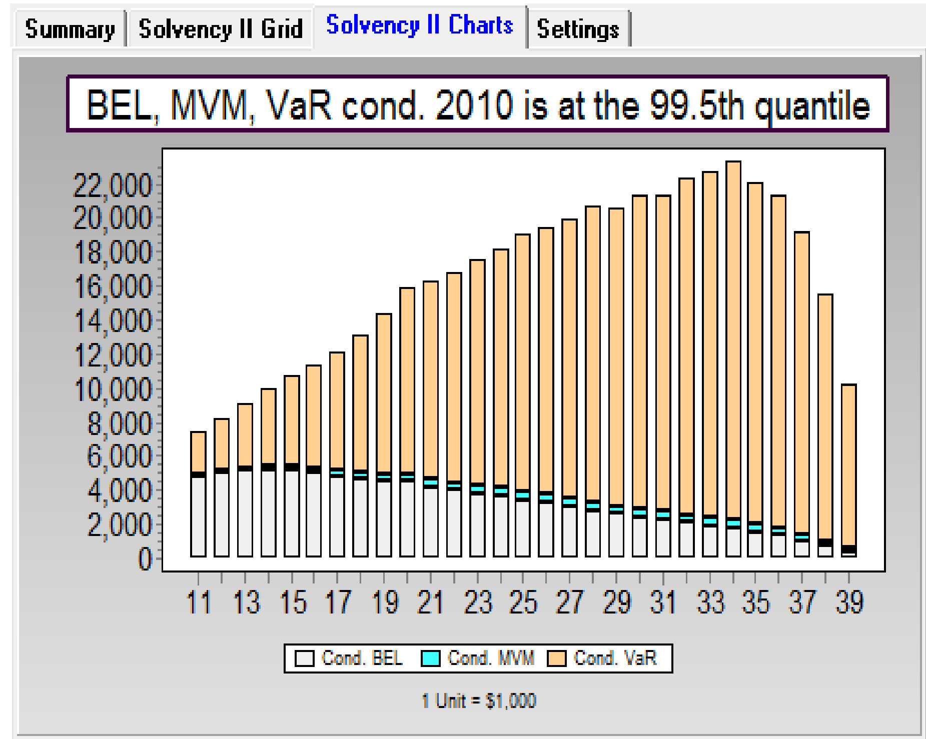
Aggregate of six LOBs



LOB4 only

One-year risk horizon
Comparing the aggregate of six LOBs with LOB4





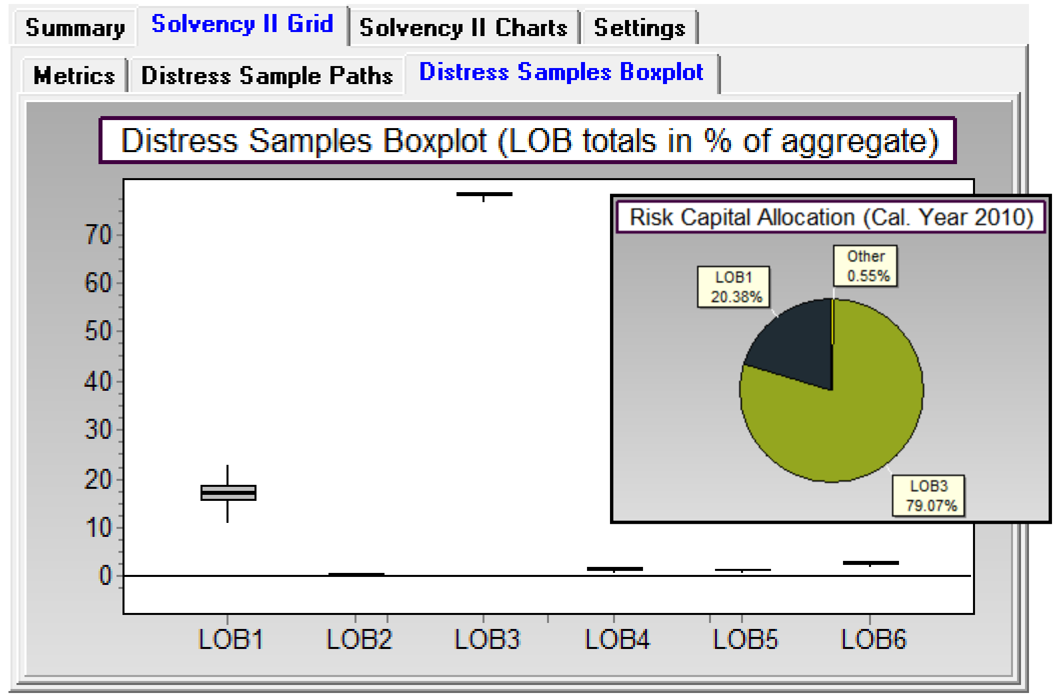
Aggregate of six LOBs

LOB4 only

One-Year risk horizon
Aggregate of six LOBs

Which LOB is in distress if the aggregate is in distress?

- **LOB3 and LOB1 are in distress if the aggregate is in distress**
- **Why? LOB3 and LOB1 have the bulk of the payments in the distress year (inset).**



Ultimate-year risk horizon
Aggregate of six LOBs

- MVM is calculated based on the VaR ‘to run-off’ for each calendar year
- MVM is around 10x the one-year risk horizon’s MVM

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

Metrics Summary

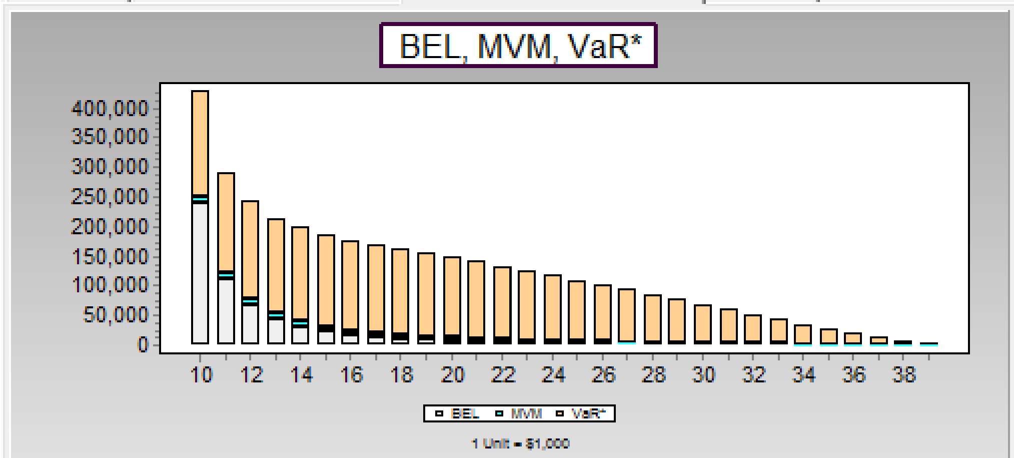
	Value	%
BEL	609,492	83.50
MVM	120,447	16.50
Technical Provision	729,939	100.00
Technical Provision	729,939	80.27
SCR	179,393	19.73
TP + SCR	909,332	100.00

1 Unit = $1,000

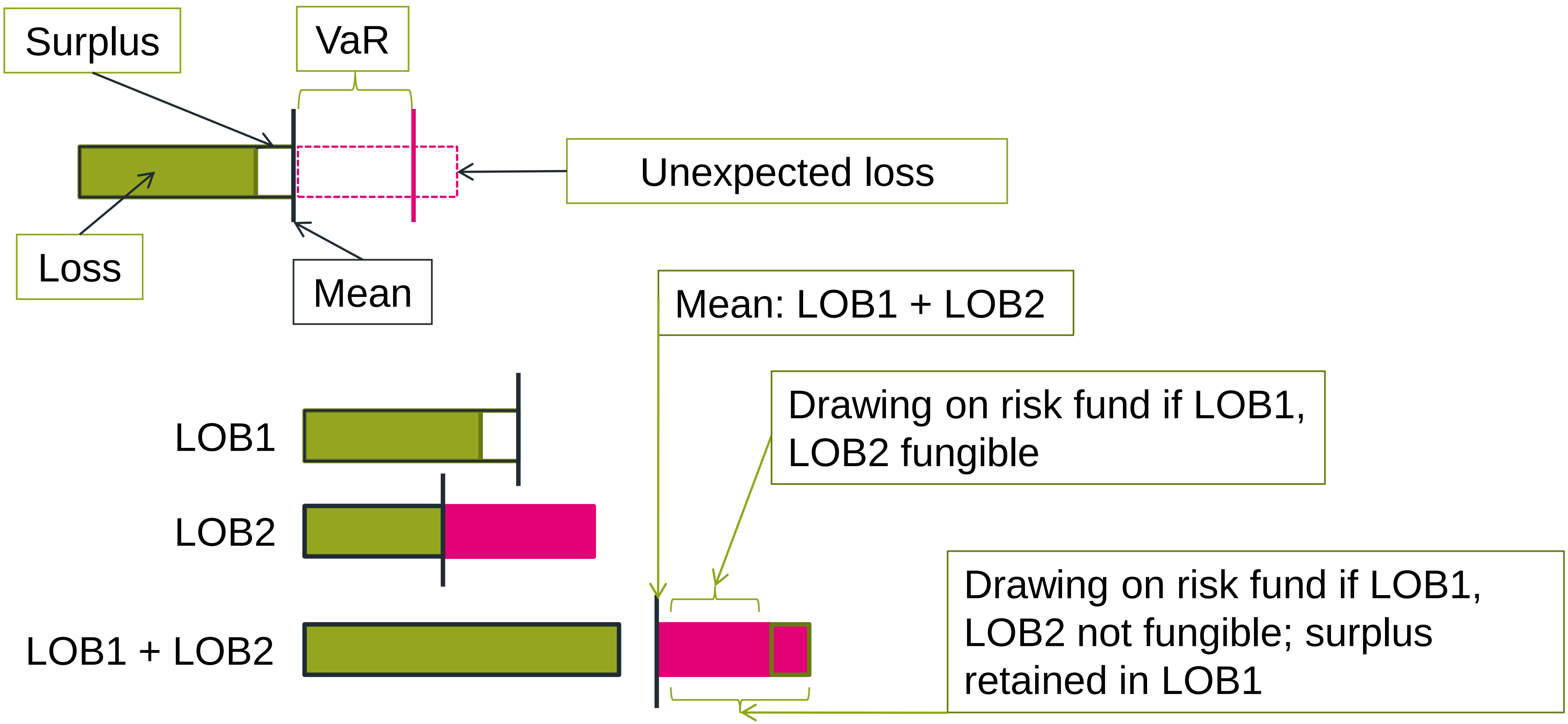
MVM, SCR and TP as % of BEL

	% of BEL	% of Undisc. BEL
SCR	29.43	25.73
MVM	19.76	17.27
TP	119.76	104.68
MVM + SCR	49.20	43.00
TP + SCR	149.20	130.40

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



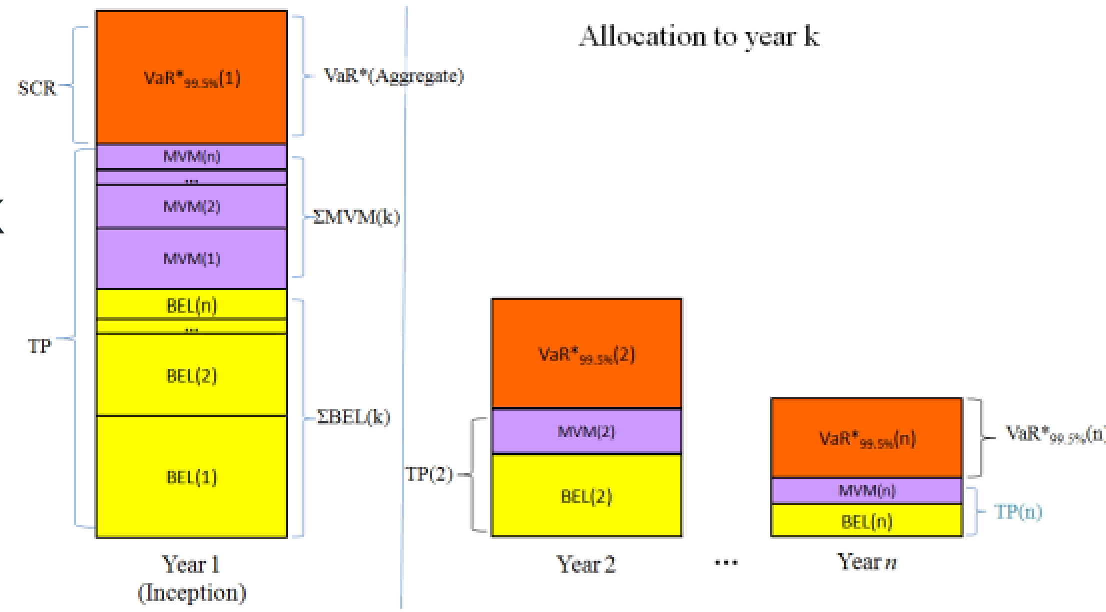
Fungibility and Ring-fencing by example – drawing on the risk fund



– In the case of fungibility the risk fund is smaller since it is expected to be supplemented by surpluses from other LOBs/portfolios.

Ultimate Year Risk Horizon

- Allocation of capital in the Ultimate Year Risk Horizon framework



Consistent estimates of prior year ultimates and Solvency II Risk Measures on updating

- Total reserve increases from year to year (with same accident (underwriting) exposure as previous year)
- What does a calendar year trend (inflation) of 5% imply in terms of estimates of prior year ultimates, loss reserves and premiums (per unit risk)?
- AXIOM

Calendar year trends (inflation) project (impact) both the prior and future accident (underwriting) years

Here is a simple example that illustrates the main ideas that reserve increases do not represent under-reserving. Indeed, they are necessary in order to maintain consistent estimates of prior year ultimates as the company writes new underwriting (accident) years).

Consistent estimates of prior year ultimates and reserve increases

- On a logarithmic scale the data were generated as follows

- Y(w,d) = 10 -0.3*d +0.05 (w+d-1) where w is the accident year 1,...,7 and d is the development year 0,..., 5.

- The numbers down each column increase by 0.05 on a log scale (approximately 5% annual). The numbers along each row decrease by 0.25 (=-0.3+0.05) on a log scale We have assumed that the paid losses run-off after five years. Even if this is the case for 1999, this may not be the case for subsequent accident years especially if inflation is 'high'

Consistent estimates of prior year ultimates on and SII metrics updating

Reserves and ultimates as at year end 2004

Accident Period vs Development Period									
Cal. Per. Total		0	1	2	3	4	5	Reserve	Ultimate
1999	22,026	22,026	17,154	13,360	10,405	8,103	6,311	0	77,359
2000	40,310	23,156	18,034	14,045	10,938	8,519	6,634	6,634	81,325
2001	55,736	24,343	18,958	14,765	11,499	8,955	6,974	15,930	85,494
2002	68,999	25,591	19,930	15,522	12,088	9,414	7,332	28,835	89,878
2003	80,639	26,903	20,952	16,318	12,708	9,897	7,708	46,631	94,486
2004	91,085	28,283	22,026	17,154	13,360	10,405	8,103	71,048	99,331
Total Fitted/Paid			2005	2006	2007	2008	2009	Total Reserve	Total Ultimate
Cal. Per. Total	358,796		66,022	46,251	30,589	18,112	8,103	169,078	527,873
1 Unit = $1									

Reserves and ultimates as at year end 2005

Accident Period vs Development Period									
Cal. Per. Total		0	1	2	3	4	5	Reserve	Ultimate
1999	22,026	22,026	17,154	13,360	10,405	8,103	6,311	0	77,359
2000	40,310	23,156	18,034	14,045	10,938	8,519	6,634	0	81,325
2001	55,736	24,343	18,958	14,765	11,499	8,955	6,974	6,974	85,495
2002	68,999	25,591	19,930	15,522	12,088	9,414	7,332	16,746	89,878
2003	80,639	26,903	20,952	16,318	12,708	9,897	7,708	30,313	94,486
2004	91,085	28,283	22,026	17,154	13,360	10,405	8,103	49,022	99,331
2005	95,755	29,733	23,156	18,034	14,045	10,938	8,519	74,691	104,424
Total Fitted/Paid			2006	2007	2008	2009	2010	Total Reserve	Total Ultimate
Cal. Per. Total	454,550		69,407	48,623	32,157	19,041	8,519	177,746	632,298
1 Unit = $1									

Consistent estimates of prior year ultimates on and SII metrics updating

Reserve and Ultimate as at year end 2004

Accident Year	Mean Reserve	Ultimate
1999	0	77,359
2000	6,634	81,325
2001	15,930	85,494
2002	28,835	89,878
2003	46,631	94,486
2004	71,048	99,331
Total	169,078	527,873

Reserve and Ultimate as at year end 2005

Accident Year	Mean Reserve	Ultimate
1999	0	77,359
2000	0	81,325
2001	6,974	85,495
2002	16,746	89,878
2003	30,313	94,486
2004	49,022	99,331
2005	74,691	104,424
Total	177,746	632,298

Ratio of year t ultimate to year t-1
1.051267467
1.051275745
1.051266156
1.051269499
1.051277438
1.051273016
1.051266279
Ratio of Reserves

N.B.

1. Estimtes of ultimate losses by accident year (1999- 2004) remain the same on update at end of 2005
2. The ratio of ultimate for year t to year t-1 is 1.05
3. Increase in total reserves from 2004 to 2005 is 1.05

Consistent estimates of prior year ultimates on and SII metrics updating

- Each year the company needs to increase its total reserves by at least 5%.
- The ultimates for prior accident years will remain consistent with each increase in total reserves.
- Each year the company needs to increase its premium (price) by at least 5%.
- Ultimates increase by at least 5% from one accident year to the next.
- These are not reserve upgrades

Consistent estimates of prior year ultimates on and SII metrics updating

- Mack and related methods give inconsistent estimates of prior year ultimates (on updating) and inaccurate liability streams by calendar year.

- Bootstrapping the wrong model does not improve the model.

This was all explained on Wednesday!

Conditional Statistics on next calendar period- volatility in ultimates on updating.

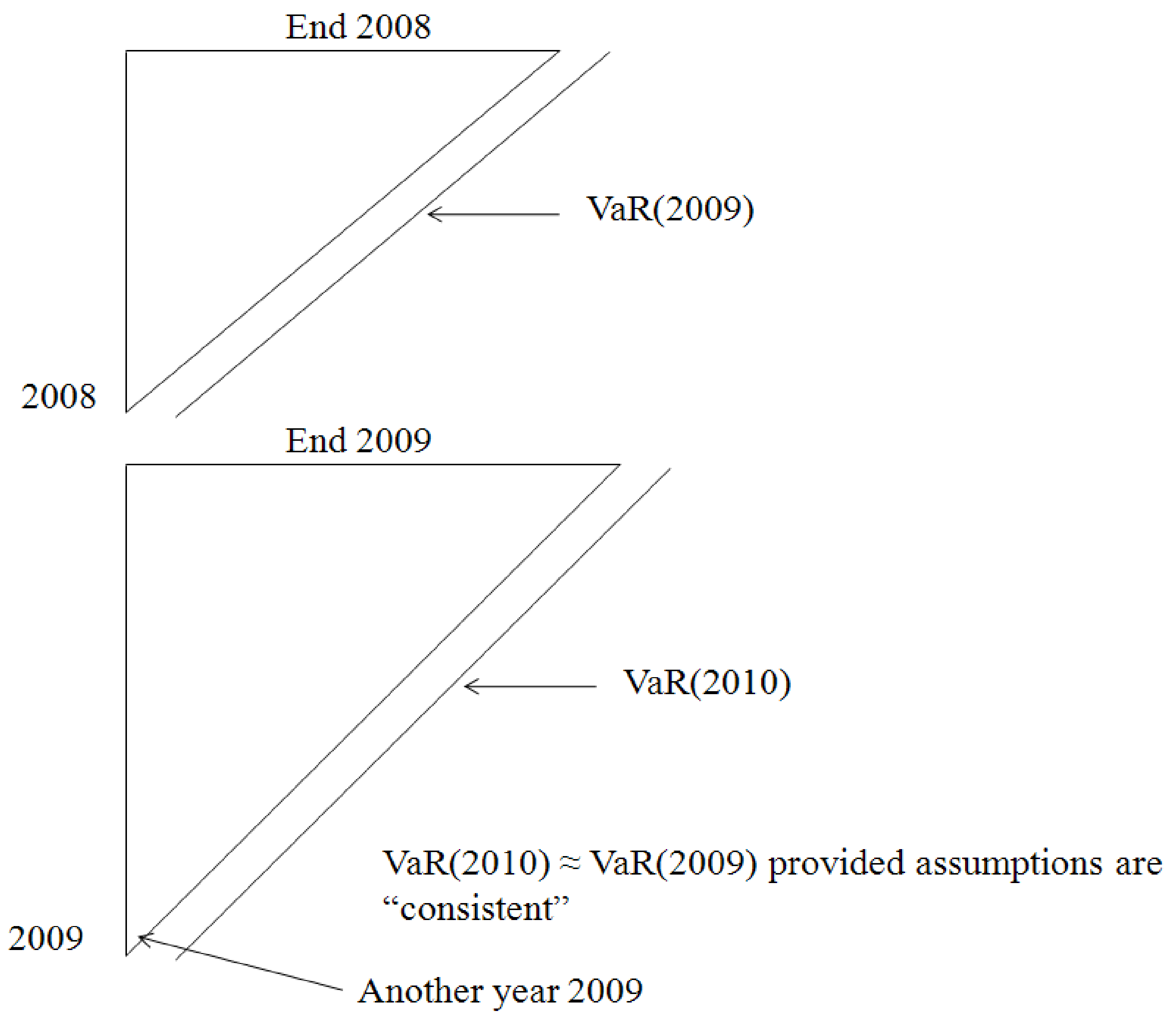
Summary | Correlations

Accident Yr Summary

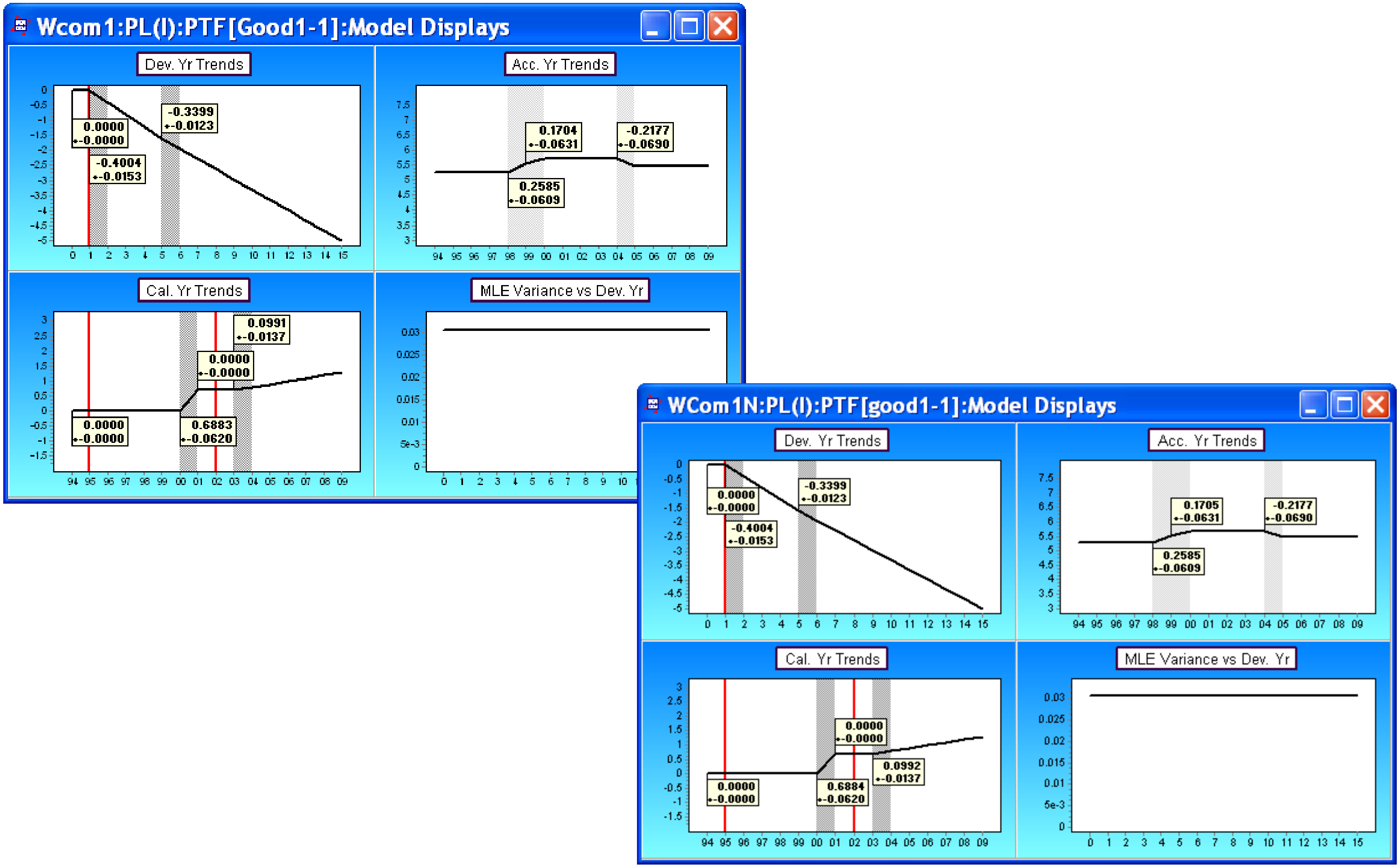
Acc. Yr	Mean		Standard	CV		Cond. on Next Cal. Per.	
	Outstanding	Ultimate	Dev.	Outstanding	Ultimate	Std.Dev.|Data	+-Ult|Data
1977	0	762,544	0	****	****	0	0
1978	15,636	904,658	563	0.04	0.00	0	563
1979	43,506	1,063,438	1,345	0.03	0.00	670	1,166
1980	80,544	1,082,678	2,346	0.03	0.00	1,299	1,954
1981	132,421	1,134,615	3,879	0.03	0.00	2,120	3,249
1982	197,504	1,142,118	6,832	0.03	0.01	3,600	5,806
1983	295,738	1,191,438	9,513	0.03	0.01	4,948	8,124
1984	533,391	1,557,619	17,902	0.03	0.01	9,135	15,396
1985	1,044,410	2,217,858	36,157	0.03	0.02	18,420	31,114
1986	1,812,559	2,823,737	64,160	0.04	0.02	33,062	54,986
1987	2,964,299	3,460,499	108,346	0.04	0.03	56,671	92,343
Total	7,120,007	17,341,201	234,706	0.03	0.01	113,886	205,224

1 Unit = $1

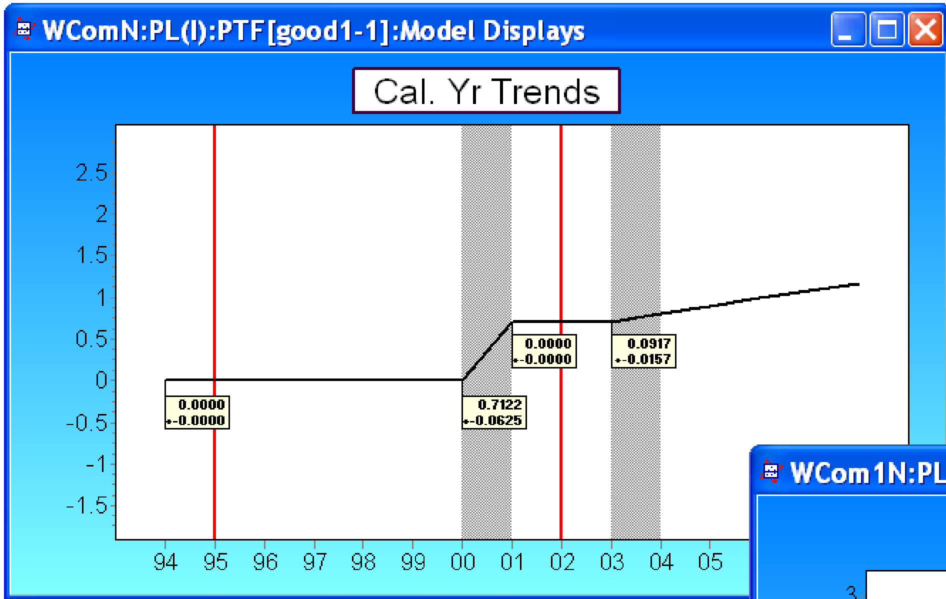
Updating and monitoring

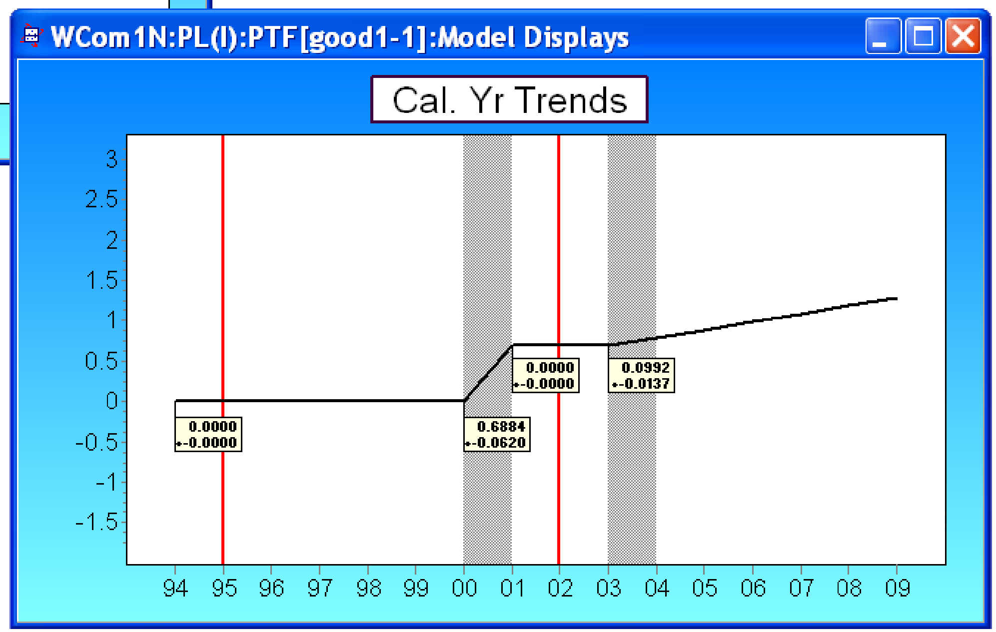


Consistent estimates of prior year ultimates on and SII metrics updating



Consistent estimates of prior year ultimates on and SII metrics updating





Consistent estimates of prior year ultimates on and SII metrics updating

WComN:PL(I):PTF[good1-1]:Reserve PALD Sum...

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

Sample-Based Statistics

Calendar Year	Sample Mean	True Mean	Sample Median	Sample S.D.	True S.D.
2009	49,588,575	49,589,909	49,357,193	4,444,220	4,447,017
Total	49,588,575	49,589,909	49,357,193	4,444,220	****

1,000,000 Si

WCom1N:PL(I):PTF[good1-1]:Reserve PALD Su...

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

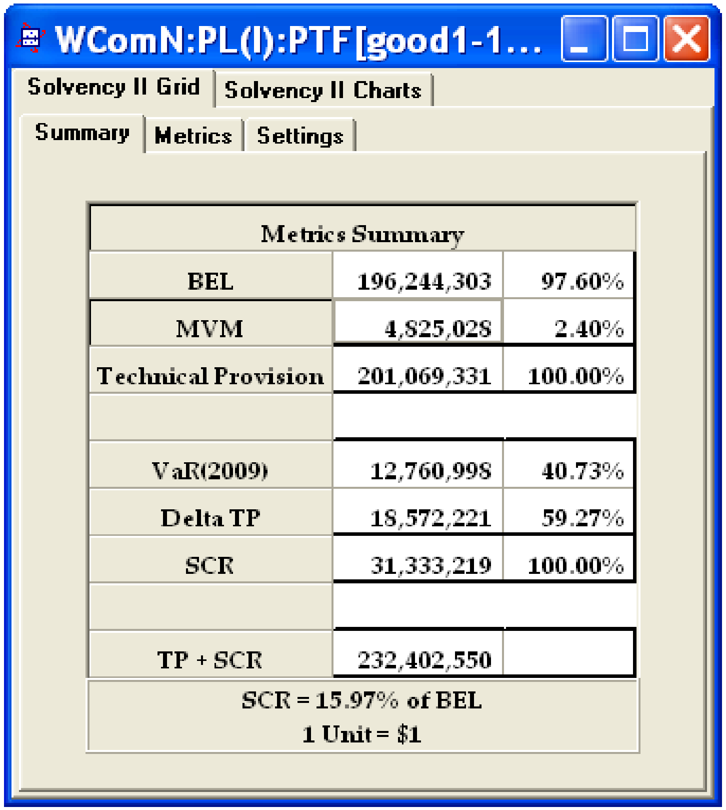
Sample-Based Statistics

Calendar Year	Sample Mean	True Mean	Sample Median	Sample S.D.	True S.D.
2010	54,455,322	54,454,922	54,207,893	4,778,194	4,770,103
Total	54,455,322	54,454,922	54,207,893	4,778,194	****

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

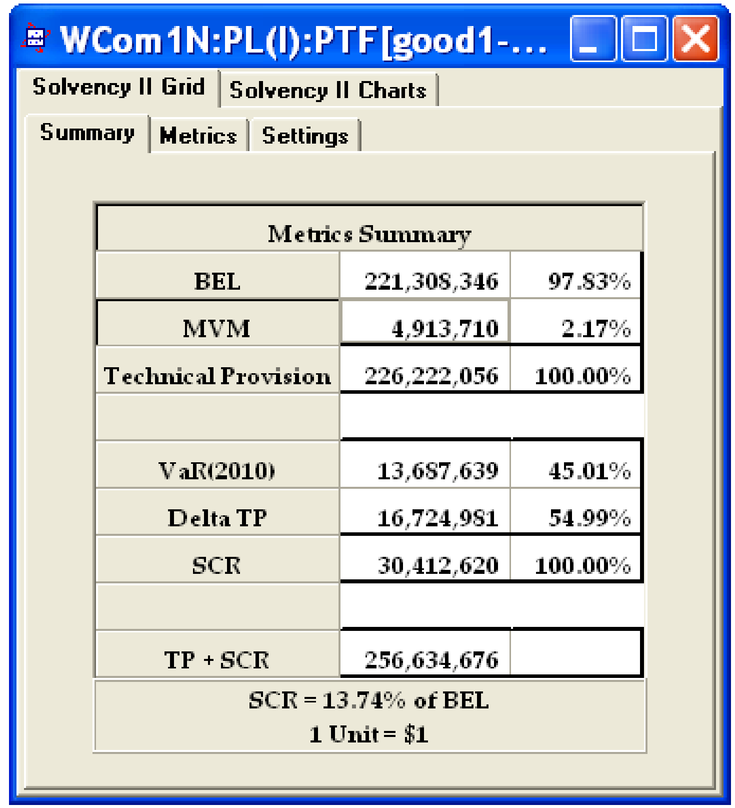
Mean Reserve for Calendar Year 2010 is approximately 10% higher than Mean reserve for 2009.

Consistent SII metrics on updating



Metrics Summary		
BEL	196,244,303	97.60%
MVM	4,825,028	2.40%
Technical Provision	201,069,331	100.00%
VaR(2009)	12,760,998	40.73%
Delta TP	18,572,221	59.27%
SCR	31,333,219	100.00%
TP + SCR	232,402,550	

SCR = 15.97% of BEL
1 Unit = $1

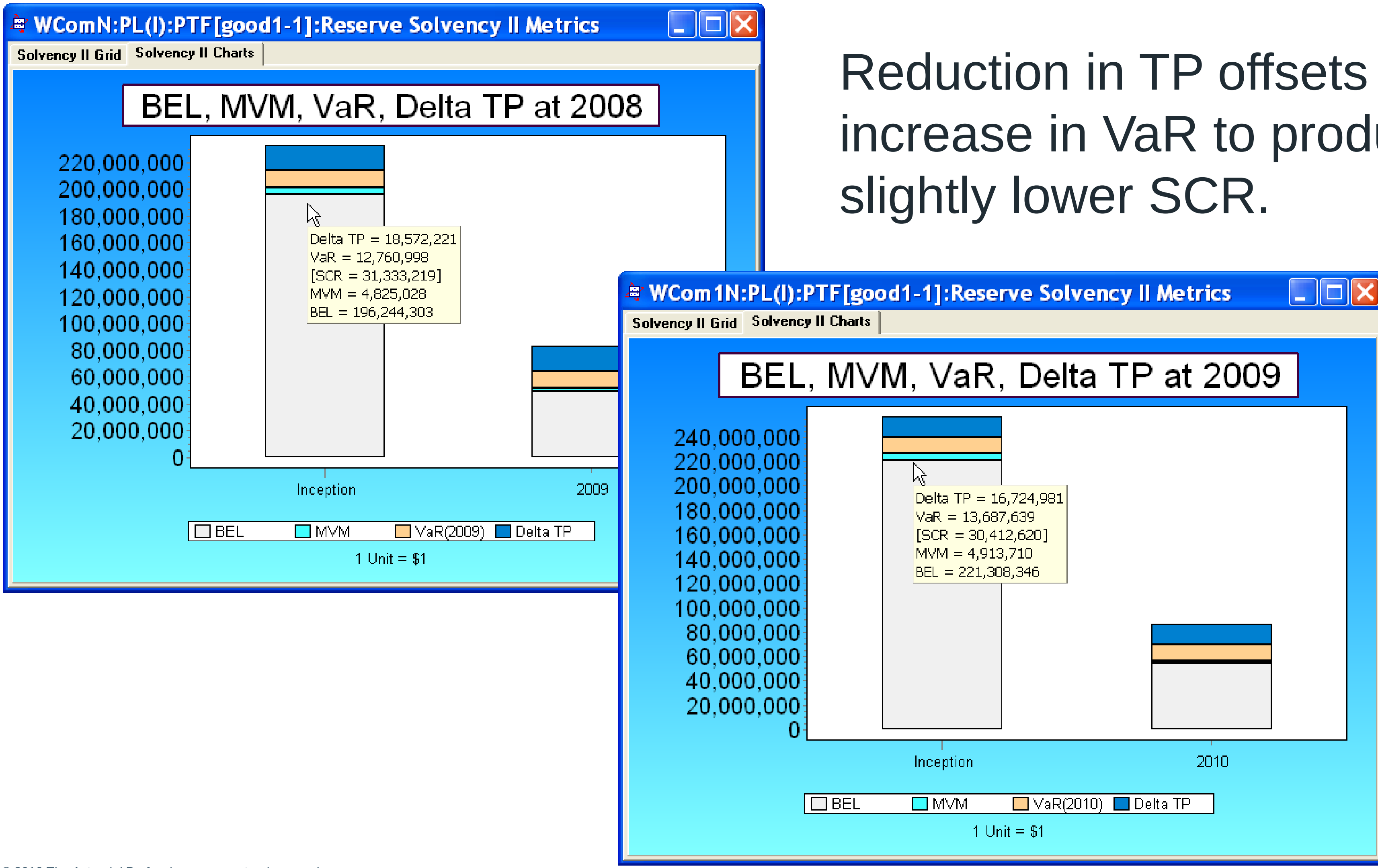


Metrics Summary		
BEL	221,308,346	97.83%
MVM	4,913,710	2.17%
Technical Provision	226,222,056	100.00%
VaR(2010)	13,687,639	45.01%
Delta TP	16,724,981	54.99%
SCR	30,412,620	100.00%
TP + SCR	256,634,676	

SCR = 13.74% of BEL
1 Unit = $1

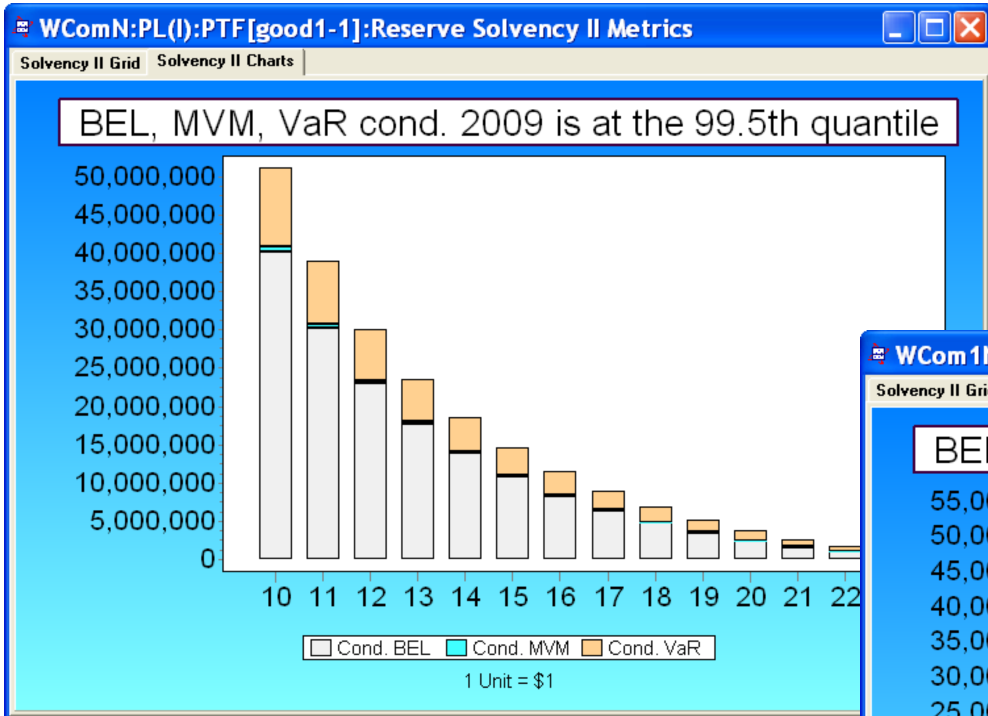
Solvency II calculations with no discounting: MVM for 2010 is almost the same as for 2009, and so is SCR.

Consistent SII metrics on updating

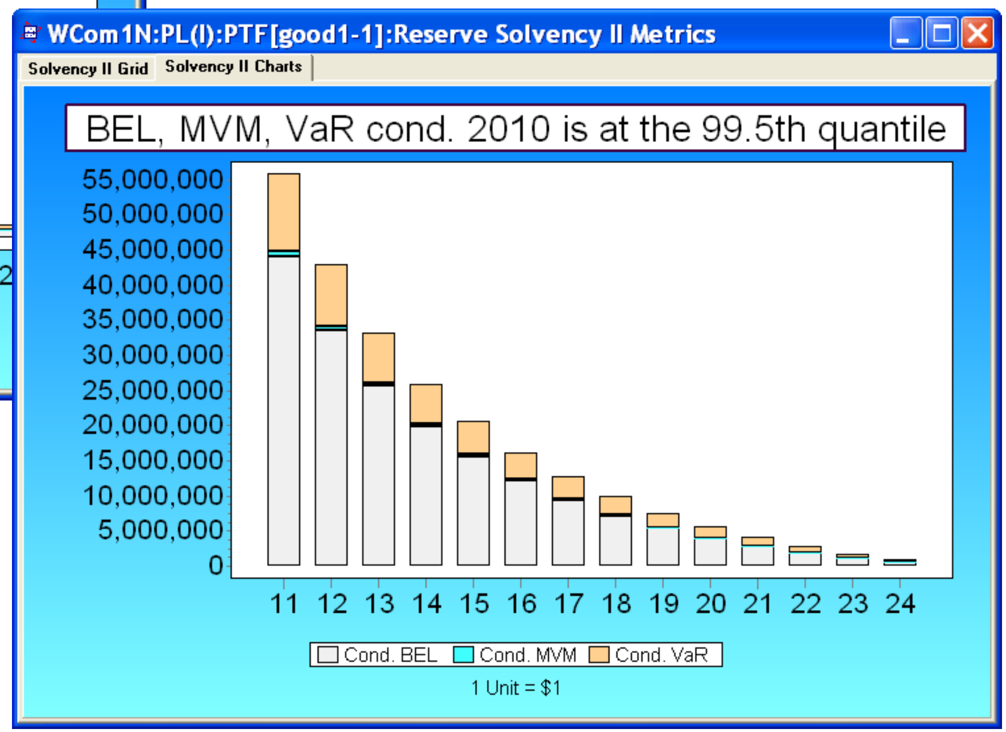


Reduction in TP offsets increase in VaR to produce slightly lower SCR.

Consistent SII metrics on updating



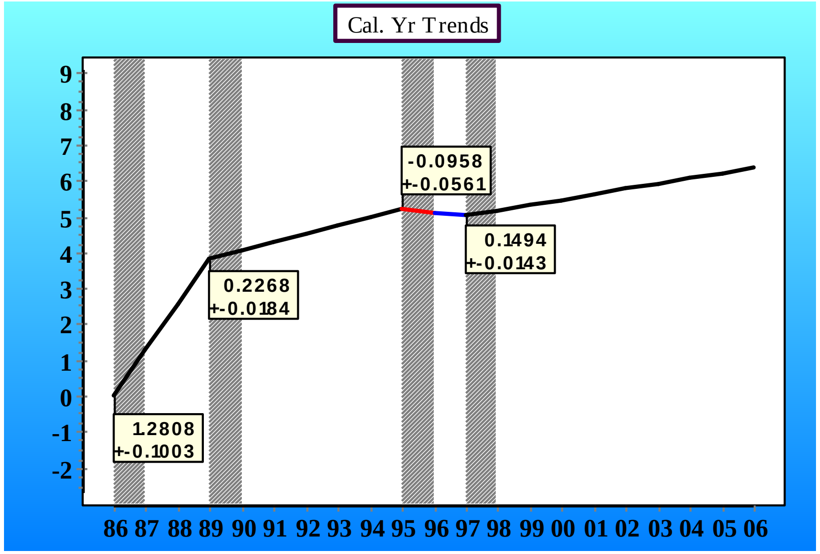
Break-down by future calendar year, shows same pattern but scaled up. Metrics based on the first year being at the 99.5th percentile.

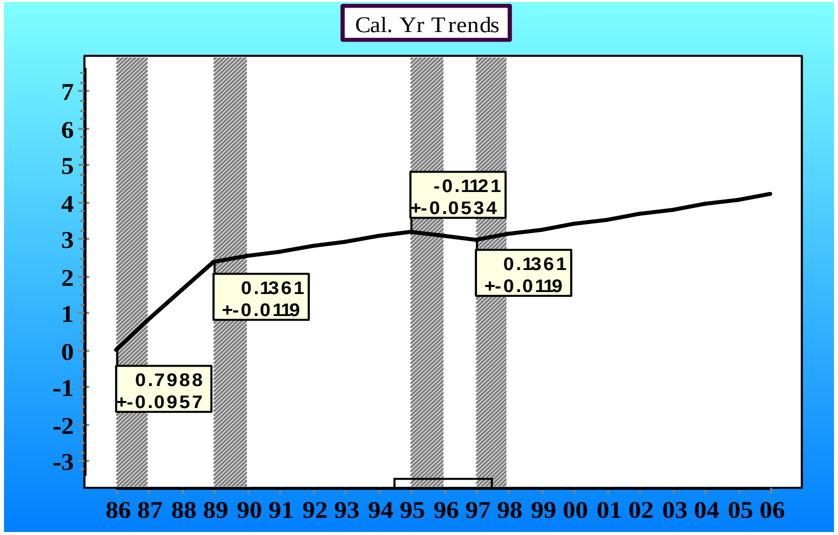


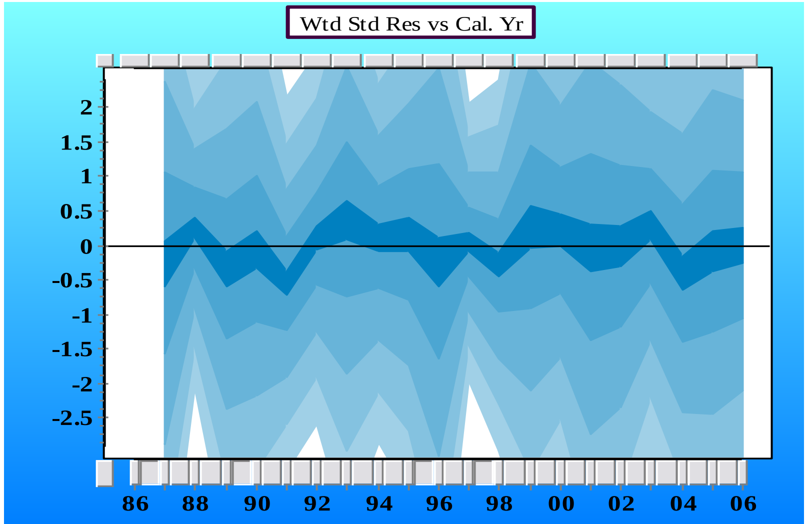
Two LOBs with common drivers- Example 1- same calendar year trend structure and high process correlation of 0.85

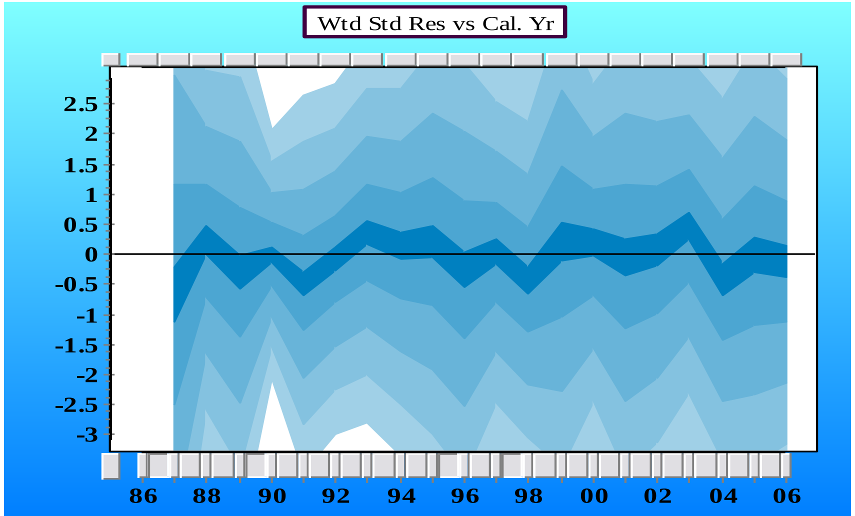
LOB A

LOB B



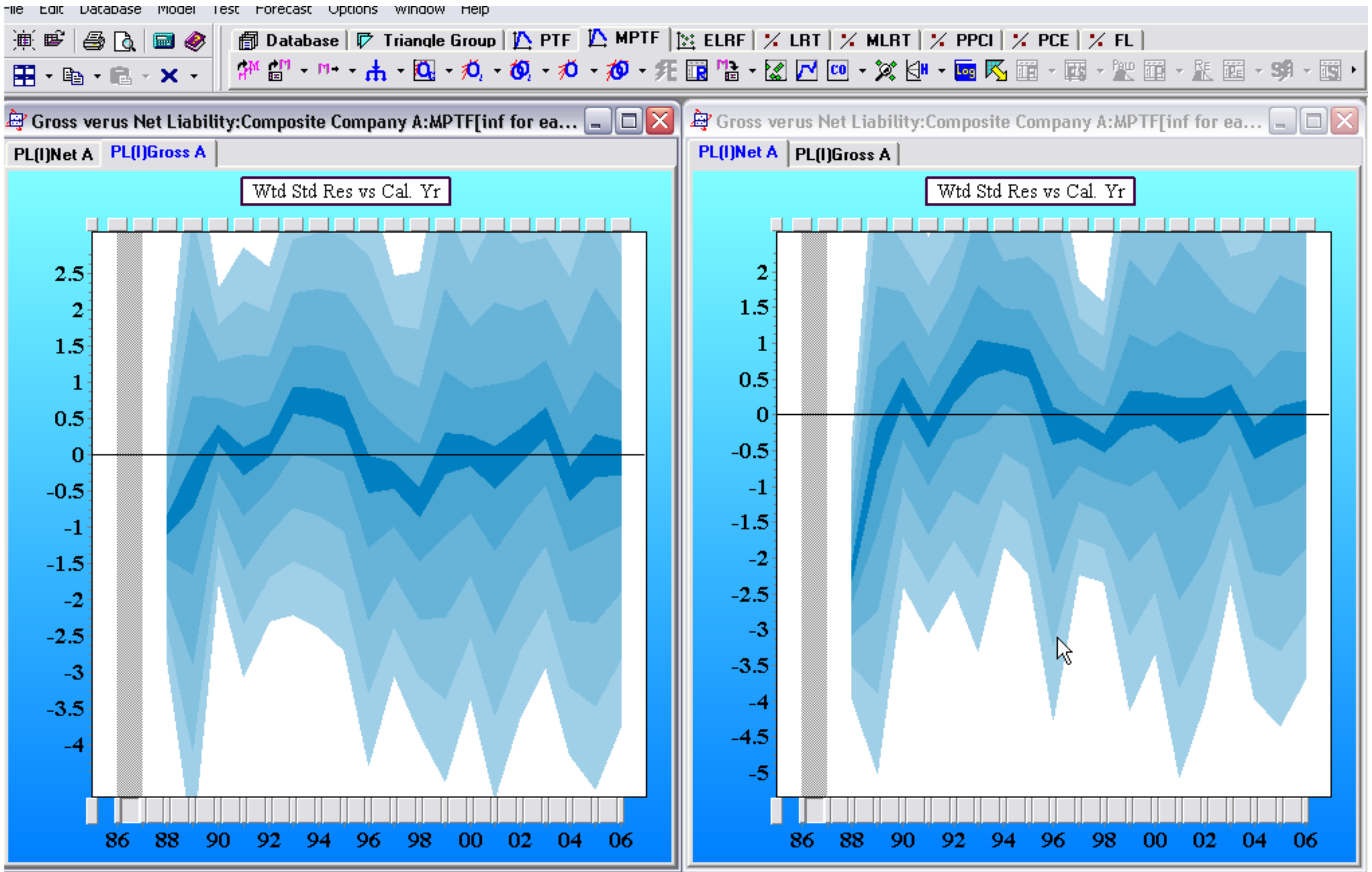






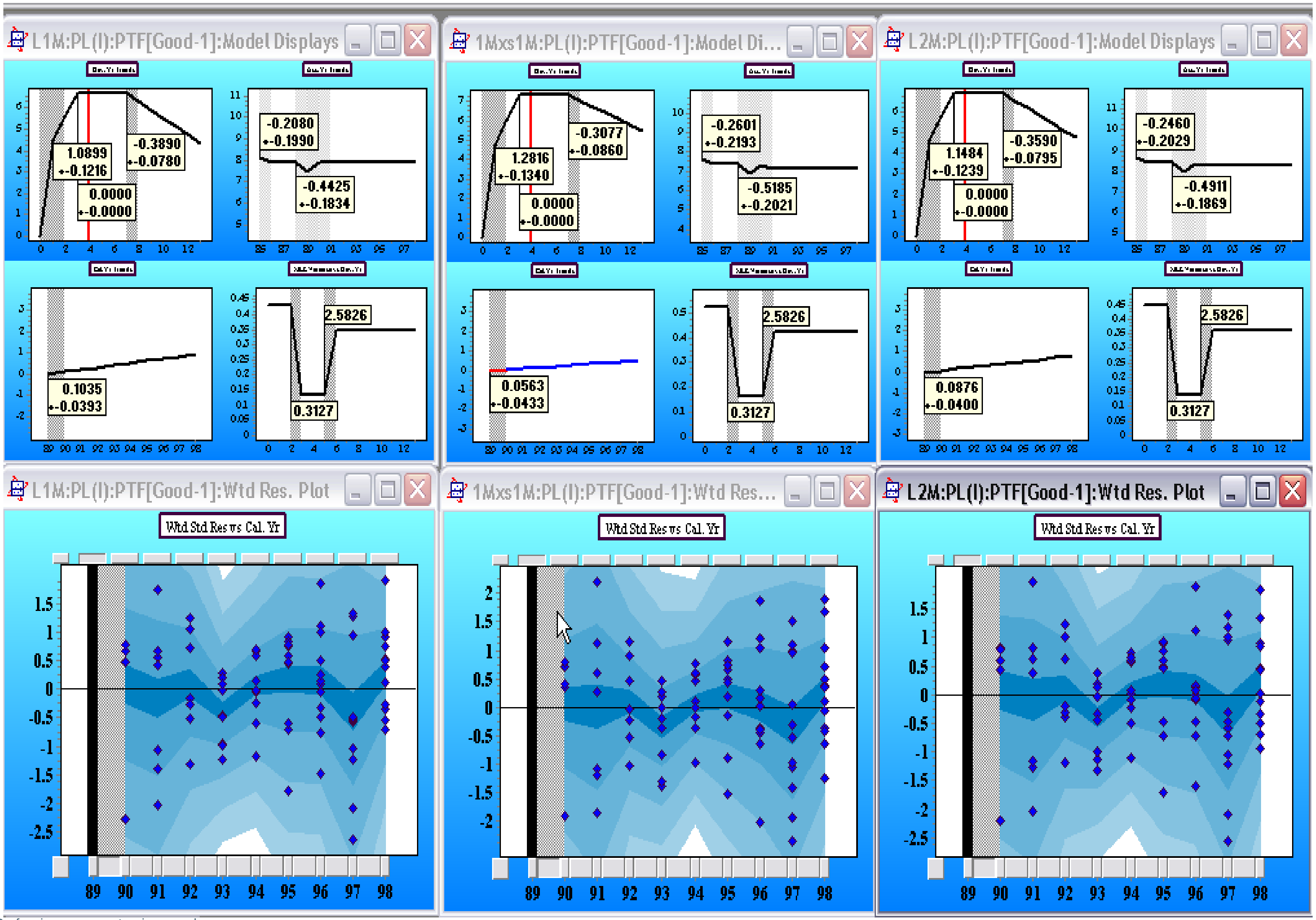
Two LOBs with common drivers- Example 1- same calendar year trend structure and high process correlation of 0.85

Process correlation adjusted for the average calendar year trend for each LOB = sum of trend correlation + process (volatility) correlation



Three LOBs with common drivers- Example 2

Identical trend structure and high process correlation exceeding 0.9!

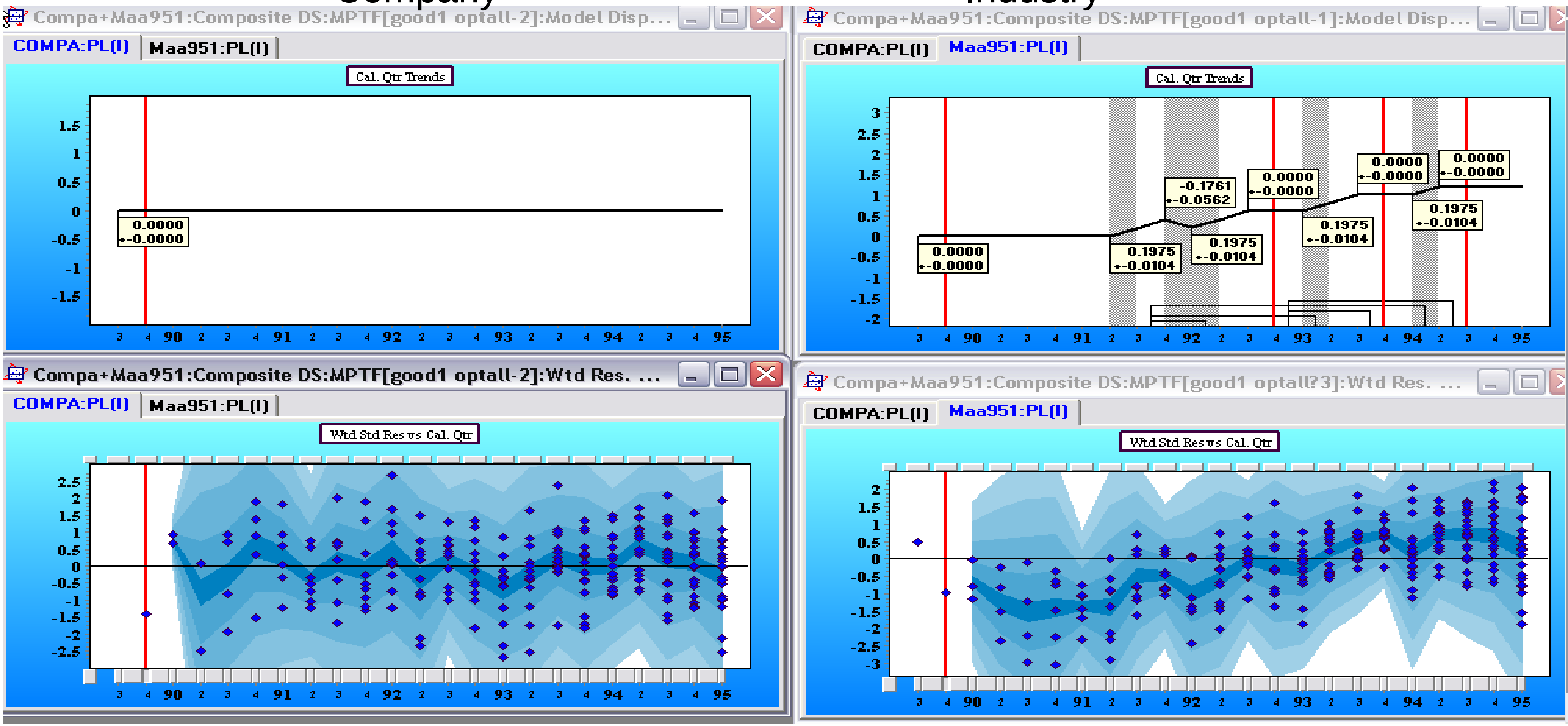


Process correlation, trend correlation, same trend structure and reserve distribution correlation

- The above two examples are <u>not</u> different LOBs!
- The first is E&O D&O gross and net of reinsurance
- The second example involves three layers of a medical malpractice LOB; Lim 1Million, Lim 2Million and 1Mxs1M. The triangles are additive.
- Two LOBs written by the same company rarely have the same calendar year trend structure and often process correlation is either zero or very low. Reserve distribution correlation is much lower.
- No two companies are the same and process correlation often zero (for the ‘same’ LOB)
- No company is the same as the industry

Small company (exposure) versus industry auto BI New South Wales Australia

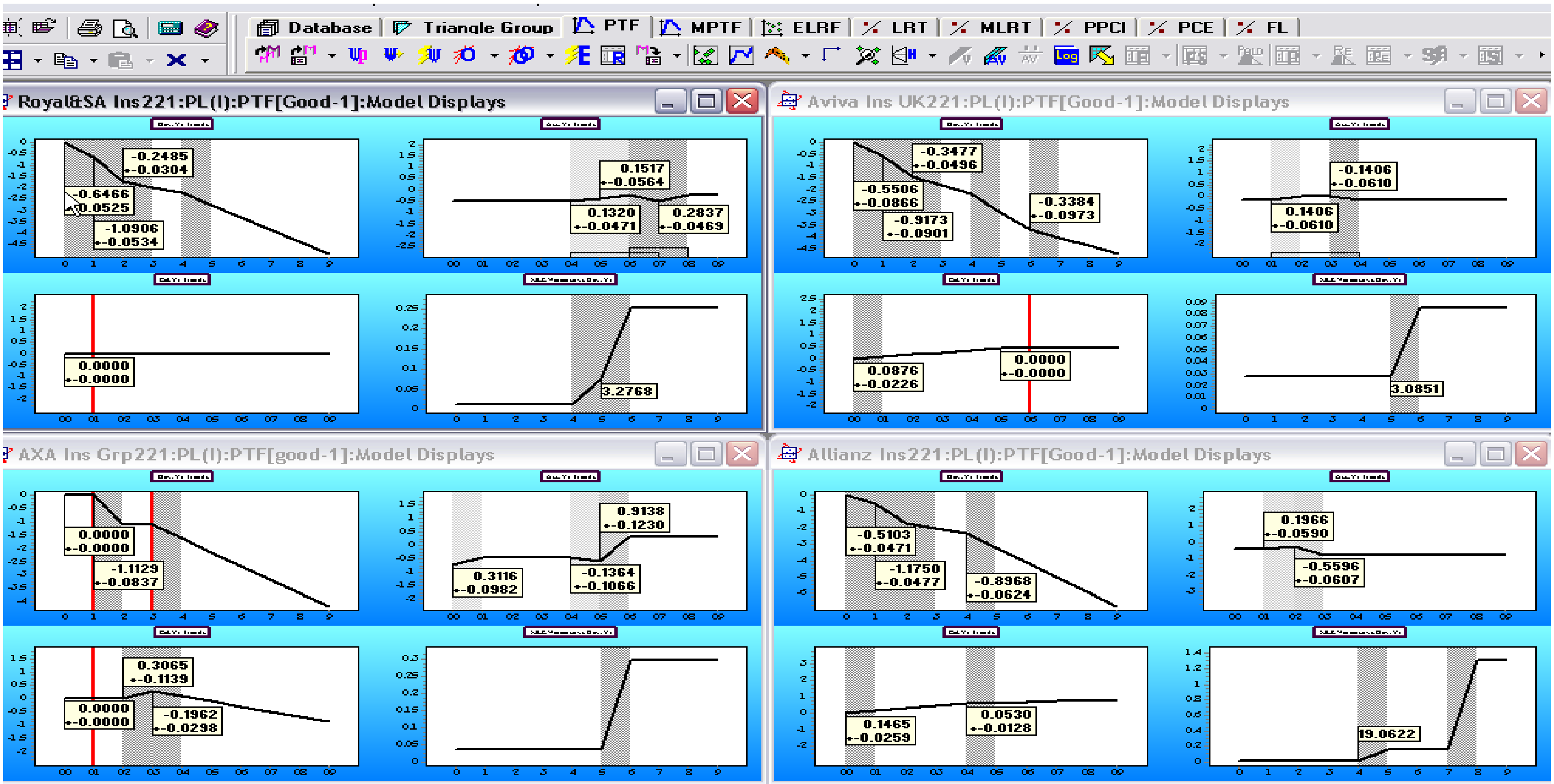
Company Industry



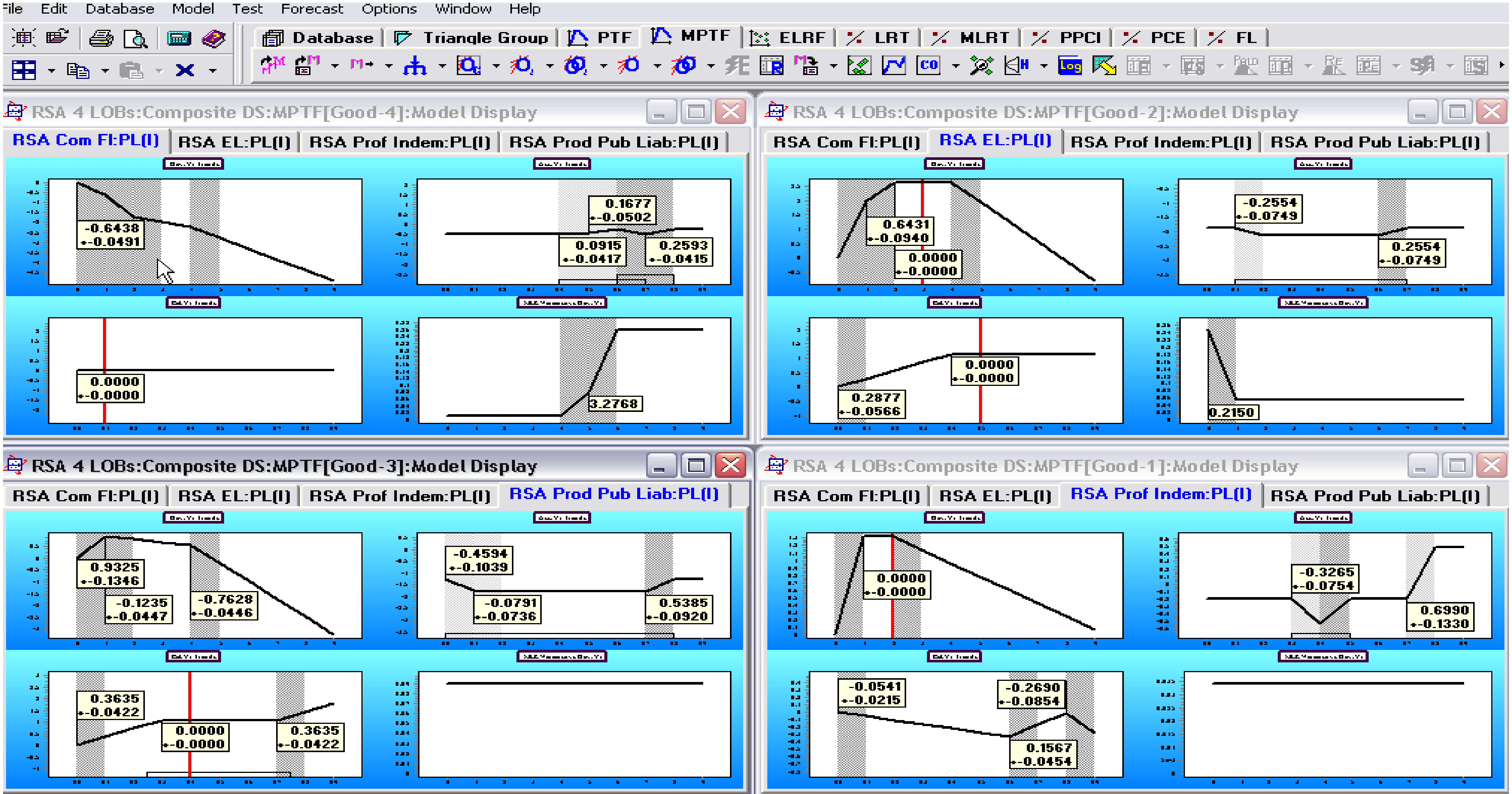
Calendar year trend for company is zero, whereas industry it is huge! (Company also has much higher process volatility)

S&P Syn Thesis 2010- RSA vs Allianz vs AXA vs Aviva Commercial:Fleets- each normalized by number claims reported in dev period zero

No two companies are the same in respect of trend structure!



S&P Syn Thesis 2010- RSA: Commercial Fleet vs Employers Liability vs Professional Indemnity vs Product and Public Liability- no relationships!



There are four types of correlations between LOBs

:

1. Process (volatility) Correlation (that is, correlation between two sets of residuals)

2. Parameter Correlations
3. Same trend structure (especially along the calendar years)
4. Reserve distribution correlations

#1 induces #2. However, #3 is the 'worst' kind of relationship you can have between two LOBs as it results in very little, if any, risk diversification. It means that in terms of future calendar year trends the two LOBs move together, that is, a trend change in one LOB means a trend change in the other LOB, and is tantamount to the two LOBs having the same drivers. If two LOBs satisfy #3, then #1 and #2 are close to 1.

Fortunately, #3 we have only observed between layers of the same LOB, between segments of the same LOB, and between net of reinsurance and gross data (of the same LOB). #1, #2, #3 induce #4. #4 is typically much less than #1 in the absence of #3.

It is important to recognize that you cannot measure the relationship between two LOBs unless you first identify the trend structure and process variability in each LOB. It is only in the Probabilistic Trend Family (PTF) modelling framework that you can identify a parsimonious model that separates the trend structure in the three directions from the process variability.