Institute and Faculty of Actuaries

On the Lifetime and One-Year Views of Reserve Risk, with Application to IFRS 17 and Solvency II Risk Margins

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Reserving Seminar 2018

Agenda

- Part 1 – The traditional lifetime view of risk
- Part 2 – The one-year view of Solvency II (and beyond)
- Part 3 – Cost-of-capital risk margins for Solvency II
- Part 4 – IFRS 17 risk adjustments
  - Techniques
  - Aggregation and Diversification
  - Reinsurance

England, PD, Verrall, RJ, and Wüthrich, MV (2018). On the Lifetime and One-Year Views of Reserve Risk, with Application to IFRS 17 and Solvency II Risk Margins. Available at SSRN: https://ssrn.com/abstract=3141239

Reserve Risk: The traditional lifetime view

Summary

- Considers risk over the remaining lifetime of the liabilities
- Early work focused on the standard deviation of the outstanding reserves, given a model
  - Including parameter and process uncertainty
- Given a model, simulation techniques can be used to obtain a full distribution of outstanding liabilities and their associated cash flows
  - Bootstrapping, or MCMC techniques
  - Many advantages over a purely analytic approach

Examples include:

- Mack's model
- ODP models
- Lognormal models
- Gamma models
- etc

Example: Taylor & Ashe Data

Results Summary

Accident Period	DY 1	DY 2	DY 3	DY 4	DY 5	DY 6	DY 7	DY 8	DY 9	DY10	Chain Ladder Reserves	Mack Prediction Error	Mack Prediction Error %
	Development Period												
AY 1	357,848	1,124,788	1,735,330	2,218,270	2,745,596	3,319,994	3,466,336	3,606,286	3,833,515	3,901,463	0	0	0.00%
AY 2	352,118	1,236,139	2,170,033	3,353,322	3,799,067	4,120,063	4,647,867	4,914,039	5,339,085		94,634	75,535	79.82%
AY 3	290,507	1,292,306	2,218,525	3,235,179	3,985,995	4,132,918	4,628,910	4,909,315			469,511	121,699	25.92%
AY 4	310,608	1,418,858	2,195,047	3,757,447	4,029,929	4,381,982	4,588,268				709,638	133,549	18.82%
AY 5	443,160	1,136,350	2,128,333	2,897,821	3,402,672	3,873,311					984,889	261,406	26.54%
AY 6	396,132	1,333,217	2,180,715	2,985,752	3,691,712						1,419,459	411,010	28.96%
AY 7	440,832	1,288,463	2,419,861	3,483,130							2,177,641	558,317	25.64%
AY 8	359,480	1,421,128	2,864,498								3,920,301	875,328	22.33%
AY 9	376,686	1,363,294									4,278,972	971,258	22.70%
AY 10	344,014										4,625,811	1,363,155	29.47%
Total											**18,680,856**	**2,447,095**	**13.10%**

Taylor & Ashe Data

Bootstrapping Mack's Model (Undiscounted) *

Accident Period	Chain Ladder Reserve	Analytic Prediction Error	Analytic Prediction Error %	Bootstrap Prediction Error	Bootstrap Prediction Error %
AY 1	0	0	0	0	0.00%
AY 2	94,634	75,535	79.82%	75,648	79.97%
AY 3	469,511	121,699	25.92%	121,622	25.92%
AY 4	709,638	133,549	18.82%	133,411	18.80%
AY 5	984,889	261,406	26.54%	261,311	26.53%
AY 6	1,419,459	411,010	28.96%	410,643	28.94%
AY 7	2,177,641	558,317	25.64%	557,417	25.58%
AY 8	3,920,301	875,328	22.33%	875,944	22.34%
AY 9	4,278,972	971,258	22.70%	971,783	22.71%
AY 10	4,625,811	1,363,155	29.47%	1,366,322	29.54%
Total	**18,680,856**	**2,447,095**	**13.10%**	**2,450,608**	**13.12%**

An advantage of the simulation approach is that we have a full distribution of the reserves (and their associated cash-flows), from which we can obtain any statistic of interest.

A further advantage is that the procedure can be generalised beyond the chain ladder model

Note: the analytic and simulated results are very close

** 500,000 simulations*

Reserve Risk: The one-year view of Solvency II

Summary

- Under Solvency II, reserving risk takes on a different meaning. It considers the distribution of the profit/loss on the (estimated) reserves over a 1 year time horizon
- On an undiscounted basis for a single origin period (ignoring risk margins), the profit/loss is the change in the (estimated) ultimate claims over a 1 year time horizon
- Clearly, this is different from the traditional actuarial view of reserve risk, which considers the distribution of the outstanding liabilities over their lifetime
- However, the two views can be reconciled…

Merz-Wüthrich (2008)
Standard Deviation of the One-Year Ahead Run-off Result

Merz-Wüthrich (2008)

Using the same assumptions as Mack's model over the lifetime of the liabilities, Merz and Wüthrich derived formulae for the standard deviation of the profit/loss over a one-year time horizon

- This is useful for Solvency II

For a particular origin year, let:

- The opening reserve estimate be R_0
- The reserve estimate after one year be R_1
- The payments in the year be C_1
- The run-off result (claims development result) be:

$$CDR_1 = R_0 - C_1 - R_1 = U_0 - U_1$$

- Where estimated ultimate claims at the start and end of the year are U_0 and U_1

Merz-Wüthrich (2008)
Standard Deviation of the One-Year Ahead Run-off Result

Accident Period	Chain Ladder Reserve	Mack Prediction Error	Mack Prediction Error %	Merz-Wüthrich RMSEP	Merz-Wüthrich RMSEP %
AY 1	0				
AY 2	94,634	75,535	79.82%	75,535	79.82%
AY 3	469,511	121,699	25.92%	105,309	22.43%
AY 4	709,638	133,549	18.82%	79,846	11.25%
AY 5	984,889	261,406	26.54%	235,115	23.87%
AY 6	1,419,459	411,010	28.96%	318,427	22.43%
AY 7	2,177,641	558,317	25.64%	361,089	16.58%
AY 8	3,920,301	875,328	22.33%	629,681	16.06%
AY 9	4,278,972	971,258	22.70%	588,662	13.76%
AY 10	4,625,811	1,363,155	29.47%	1,029,925	22.26%
Total	18,680,856	2,447,095	13.10%	1,778,968	9.52%

Merz-Wüthrich (2014): The Full Picture

Standard deviation of a sequence of 1 Yr ahead CDRs

	Future Period										
Accident Period	FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	FY 7	FY 8	FY 9	Sqrt(Sum of Squares)	Mack St. Err.
AY 1											
AY 2	75,535									75,535	75,535
AY 3	105,309	60,996								121,698	121,699
AY 4	79,846	91,093	56,232							133,549	133,549
AY 5	235,115	60,577	82,068	51,474						261,407	261,406
AY 6	318,427	233,859	57,825	82,433	51,999					411,009	411,010
AY 7	361,089	328,989	243,412	59,162	85,998	54,343				558,317	558,317
AY 8	629,681	391,249	359,352	266,320	64,443	94,166	59,533			875,328	875,328
AY 9	588,662	554,574	344,763	318,493	236,576	56,543	83,645	52,965		971,258	971,258
AY 10	1,029,925	538,726	511,118	317,142	293,978	218,914	51,661	77,317	49,055	1,363,155	1,363,155
Total	**1,778,968**	**1,177,727**	**885,178**	**607,736**	**428,681**	**267,503**	**128,557**	**96,764**	**49,055**	**2,447,095**	**2,447,095**

Merz-Wüthrich (2014)

The Full Picture

Merz-Wüthrich (2014)

- Extended their formulae to give the standard deviation of the profit/loss over a sequence of one year horizons until the liabilities are extinguished
- Allows the lifetime view to be partitioned into a sequence of 1 year views, which is a fascinating result

Limitations

- The M-W formulae only consider the SD of the CDR
  - What do we do if we want other risk measures (eg Value at Risk @ 99.5% etc)
- Also, the formulae are only appropriate under Mack's assumptions for the chain ladder model (no tail)
  - What do we do if we want to generalise the model or consider other assumptions?
- Answer: Simulate to provide a predictive distribution

Results from Applying the "Actuary-in-the-Box"

Standard deviation of a sequence of 1 Yr ahead CDRs

Accident Period	Future Period FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	FY 7	FY 8	FY 9	Sqrt(Sum of Squares)	Mack St. Err.
AY 1											
AY 2	75,648									75,648	75,648
AY 3	105,367	60,886								121,694	121,622
AY 4	80,004	91,037	56,196							133,590	133,411
AY 5	235,031	60,605	82,136	51,474						261,359	261,311
AY 6	318,042	233,925	57,922	82,621	52,036					410,805	410,643
AY 7	360,456	328,504	243,435	59,163	86,055	54,250				557,632	557,417
AY 8	630,439	392,007	360,203	266,596	64,500	94,216	59,698			876,666	875,944
AY 9	588,080	554,967	345,154	318,752	237,005	56,679	83,682	53,065		971,475	971,783
AY 10	1,031,456	540,295	513,208	318,563	294,733	219,839	52,058	77,578	49,241	1,366,395	1,366,322
Total	**1,779,509**	**1,179,316**	**887,310**	**609,061**	**430,002**	**268,439**	**128,951**	**97,085**	**49,241**	**2,449,725**	**2,450,608**

Results from Applying the "Actuary-in-the-Box"

Value at Risk @ 99.5% of 1 Yr ahead CDRs

(Obtained using minus the 0.5th percentile of the distribution of the CDR at each time period)

Accident Period	Future Period FY 1	FY 2	FY 3	FY 4	FY 5	FY 6	FY 7	FY 8	FY 9
AY 1									
AY 2	195,445								
AY 3	274,132	157,161							
AY 4	208,646	237,838	145,347						
AY 5	622,286	157,868	215,113	134,032					
AY 6	847,663	619,676	150,891	215,088	134,798				
AY 7	963,673	875,128	641,692	153,812	224,561	140,861			
AY 8	1,707,440	1,054,445	962,241	707,010	169,250	248,062	156,094		
AY 9	1,619,833	1,520,197	929,218	860,693	633,913	149,633	220,954	139,089	
AY 10	2,993,318	1,522,633	1,434,921	880,000	811,236	603,022	140,511	209,369	132,721
Total	**4,868,731**	**3,161,151**	**2,376,627**	**1,626,023**	**1,144,731**	**717,806**	**338,957**	**257,370**	**132,721**

An advantage of the simulation approach is that we have a full distribution of the CDRs, from which we can obtain any statistic of interest.

A further advantage is that the procedure can be generalised beyond the chain ladder model

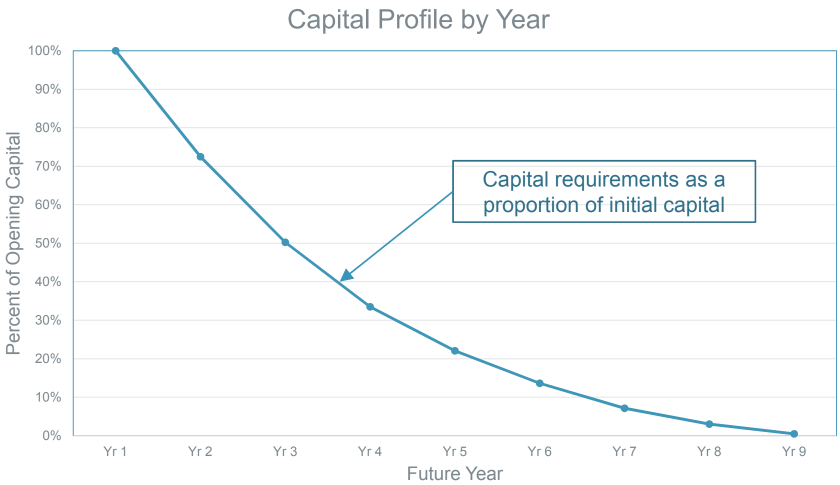
Cost-of-Capital Risk Margins: Example

1. Obtain opening capital requirement
2. Obtain future capital requirements
3. Multiply by assumed cost-of-capital rate (6%) to give projected cost-of-capital
4. Discount (@3%) and sum

Future Year	Projected Reserve	Projected Capital Requirement	Capital Profile	Projected Cost of Capital	Discounted Cost of Capital
0	17,381,602	4,868,731	100.0%	292,124	283,615
1	12,598,695	3,528,999	72.5%	211,740	199,585
2	8,735,034	2,446,756	50.3%	146,805	134,348
3	5,818,790	1,629,891	33.5%	97,793	86,888
4	3,834,408	1,074,050	22.1%	64,443	55,589
5	2,364,307	662,262	13.6%	39,736	33,278
6	1,239,956	347,322	7.1%	20,839	16,944
7	521,786	146,157	3.0%	8,769	6,923
8	85,285	23,889	0.5%	1,433	1,099
9	0	0	0.0%	0	0
Total					818,269

C-o-C Risk margin

The Capital Profile
"Best estimate" basis



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Cost-of-Capital Risk Margins:
Obtaining the future capital requirements

PRA Supervisory Statement SS5/14 (April 2014):

- *"Firms should not approximate the future Solvency Capital Requirements used to calculate the risk margin as proportional to the projected best estimate unless this has been shown not to lead to a material misstatement of technical provisions."*
  - Is there a good basis for an approximation?

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Setting Capital and Obtaining a "Capital Profile"

- From a theoretical perspective, setting capital requires 4 items:
  - Risk profile
  - Risk measure
  - Risk tolerance criterion
  - Time horizon

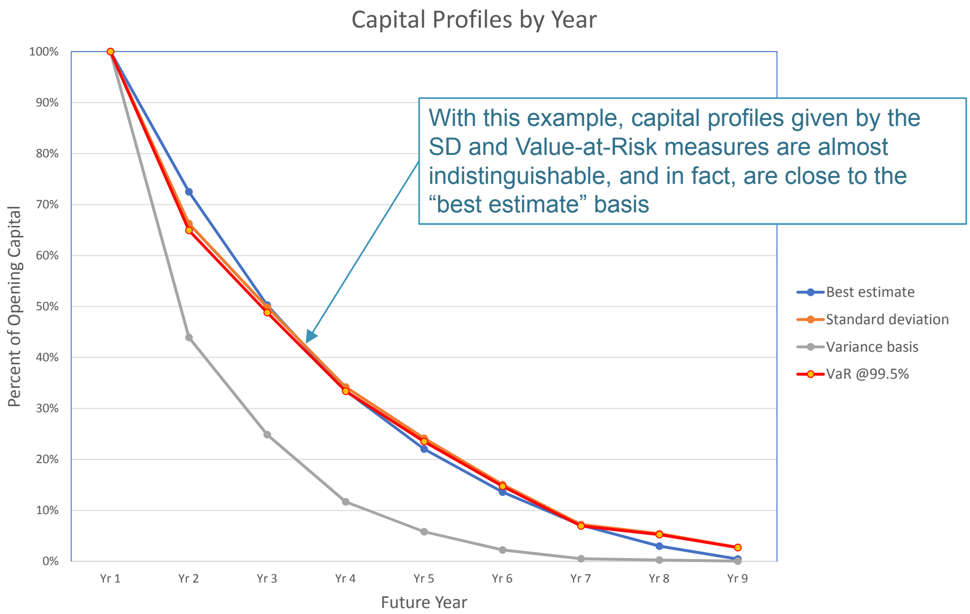
- For example, given a distribution of profit/loss over one year (or beyond):
  - Value at Risk @ *y*%
  - Multiple k_1 of standard deviation
  - Multiple k_2 of variance
  - *Etc*
- Or replace distribution of profit/loss with distribution of net assets
- Merz-Wüthrich (2014) used multiples of SD and variance applied to the distribution of the CDR

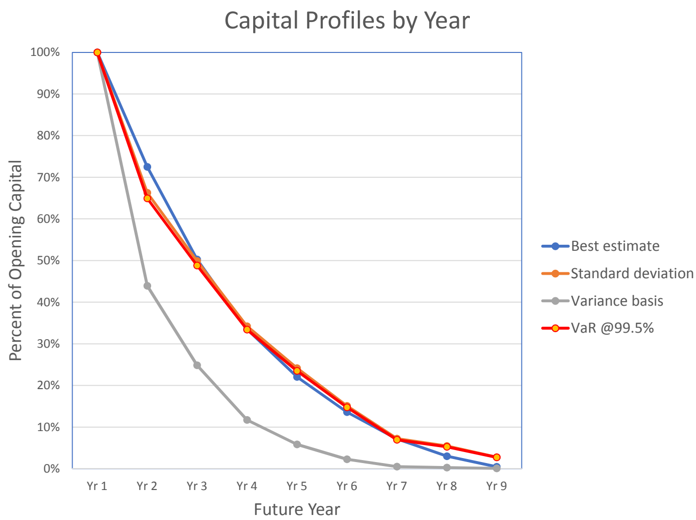
Obtaining a "Capital Profile" for Solvency II

Capital Amounts *	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Best Estimate	4,868,731	3,528,999	2,446,755	1,629,891	1,074,050	662,262	347,322	146,157	23,889
Standard deviation	4,868,731	3,226,604	2,427,678	1,666,389	1,176,485	734,447	352,811	265,624	134,725
Variance	4,868,731	2,138,334	1,210,505	570,344	284,287	110,791	25,566	14,492	3,728
VaR @99.5%	4,868,731	3,161,151	2,376,627	1,626,023	1,144,731	717,806	338,957	257,370	132,721

Capital Profile	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9
Best Estimate	100%	72%	50%	33%	22%	14%	7%	3%	0%
Standard deviation	100%	66%	50%	34%	24%	15%	7%	5%	3%
Variance	100%	44%	25%	12%	6%	2%	1%	0%	0%
VaR @99.5%	100%	65%	49%	33%	24%	15%	7%	5%	3%

** Opening capital for 'best estimate' basis set to be same as VaR @ 99.5%. Multiples of SD and Variance set to give same opening capital as VaR @ 99.5%, however, the mutipliers are irrelevant since they cancel when creating the 'capital profile'*





Basis *	**Risk Margin**
Best Estimate	818,269
Standard deviation	822,017
Variance	523,808
VaR @99.5%	809,722

** Using the same Opening Capital amount*

Application to Cost-of-Capital Risk Margins

1. For Solvency II at least, VaR @ 99.5% applied to a sequence of distributions of the 1 yr-ahead CDRs is an appropriate risk measure for reserve risk capital requirements
2. A recursive “actuary-in-the-box” approach is suitable for obtaining the distributions
3. However, VaR @ 99.5% is an extreme percentile, and requires a large number of simulations for stability
4. Interestingly, “capital profiles” given by standard deviation and VaR measures are almost indistinguishable
5. A standard deviation measure requires far fewer simulations for stability
6. So use a standard deviation measure as a proxy, instead of VaR @ 99.5%
7. In some cases, an analytic formula giving the SD of the CDRs may be sufficient without simulation at all (eg Merz-Wüthrich: the full picture)
8. Any initial capital amount can be “plugged-in” (eg using a capital model)
9. Then use a “capital profile” obtained using risk measures applied to a sequence of distributions of the CDR to estimate future capital requirements
10. This will be more justifiable than a profile obtained using “best estimates”, or could justify using a “best estimate” profile as a proxy

Summary

What needs to be done

"An entity shall adjust the estimate of the present value of the future cash flows to reflect the compensation that the entity requires for bearing the uncertainty about the amount and timing of the cash flows that arises from non-financial risk." **(Para 37)**

What needs to be disclosed

"An entity shall disclose the confidence level used to determine the risk adjustment for non-financial risk. If the entity uses a technique other than the confidence level technique for determining the risk adjustment for non-financial risk, it shall disclose the technique used and the confidence level corresponding to the results of that technique." **(Para 119)**

Questions

- Lifetime view or one-year view of Solvency II?
- IFRS 17 mentions a risk measure (confidence level), but what is the risk profile?
- Net or Gross discounted future cash flows (or both)?
- How will reinsurance programmes be taken into account?
- What level of aggregation will be used? Portfolio/legal entity/holding company?
- If calculated at a higher level, how will risk adjustments be allocated back (if required). Will equivalent "confidence levels" be required at a lower level?
- If calculated at a lower level and summed, how will diversification be taken into account in a sensible way, and how will the equivalent "confidence level" be ascertained?

Core principles

"An entity shall estimate the expected value (ie the probability-weighted mean) of the full range of possible outcomes", plus "a risk adjustment for non-financial risk"

- Stochastic reserving for everything?
- It's fulfilment cash-flows, which implies **the traditional lifetime view of risk**, not the one-year view of Solvency II

"The risk adjustment for non-financial risk for insurance contracts measures the compensation that the entity would require to make the entity indifferent between:
- *(a) fulfilling a liability that has a range of possible outcomes arising from non-financial risk; and*
- *(b) fulfilling a liability that will generate fixed cash flows with the same expected present value as the insurance contracts."*

- Looks like the risk adjustment is an attempt to obtain a "market value" of the liabilities
- Unfortunately, a market does not exist (except for private transactions)
- Use "mark-to-model" as a proxy

IFRS 17 Risk Adjustment Techniques

"IFRS 17 does not specify the estimation technique(s) used to determine the risk adjustment for non-financial risk." (B91)

Approach 1

- Use a risk measure applied to a distribution of the discounted fulfilment cash-flows
  - Confidence Level (Value at Risk)
  - Conditional Tail Expectation (Tail Value at Risk)
  - Wang's Proportional Hazards Transform*

Approach 2

- Use a Cost-of-Capital approach

* Note: Wright (1997) proposed using Wang's proportional hazards transform for calculating a prudential margin (ie risk adjustment)

IFRS 17 Risk Adjustment Techniques

- VaR, TVaR and PHT are related and all require the same risk profile (distribution). Once that risk profile is obtained, all can be calculated easily (in a simulation environment)
  - Let's assume the risk profile is the distribution of discounted fulfilment cash-flows over their lifetime
- All 3 risk measures can be expressed as a weighted average of the simulations, but with different weights
- Bootstrapping/MCMC techniques (with copulae for applying dependencies) are useful for obtaining the risk profile
  - See England and Verrall (2002, 2006)

- Given a simulated distribution, sort the simulations in ascending order, then calculate a weighted average where:
  - VaR at a given percentile: there is a single weight at the simulation representing the percentile ("confidence") level, zero elsewhere.
  - TVaR at a given percentile: all simulations above the given percentile are given equal weight, with zero elsewhere.
  - PHT with a given parameter: each simulation has a different weight, where the weights are monotonically increasing
- The IFRS 17 risk adjustment is then the risk measure less the mean

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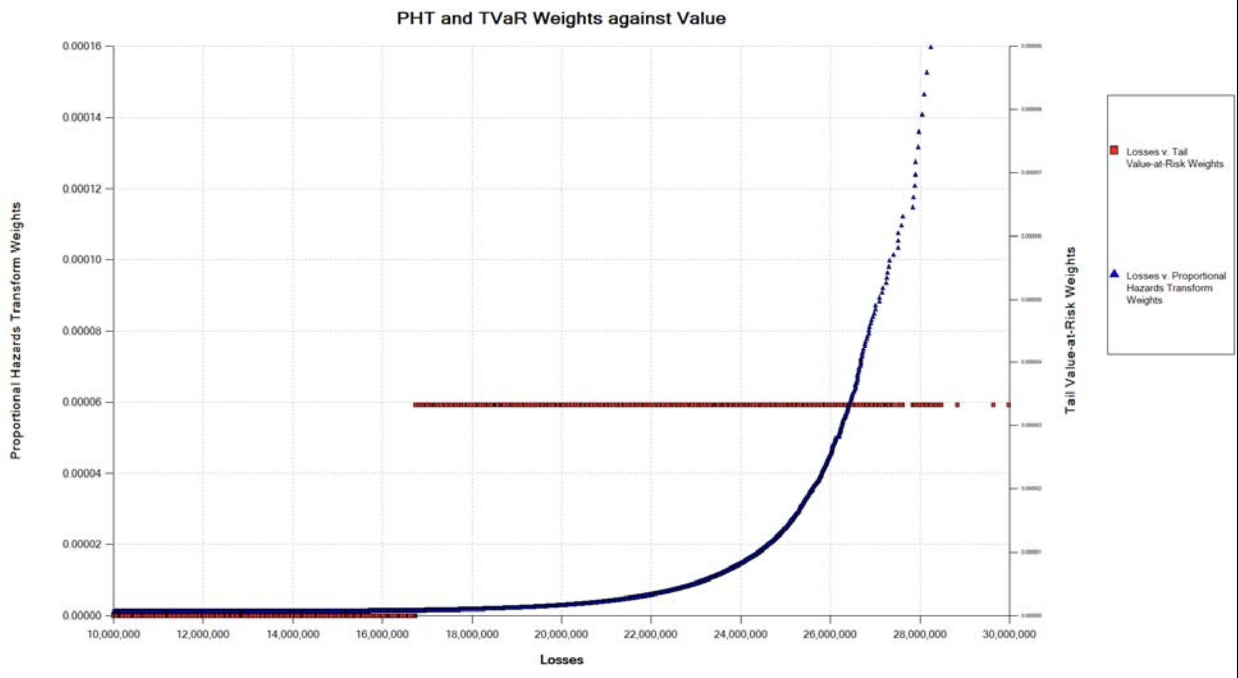


VaR, TVaR and PHT: Characteristics

Value at Risk

- VaR is from a single simulation. Could be subject to considerable volatility (especially at higher percentiles).
- Has a range from the minimum to the maximum simulated values
- Some commentators observe that VaR does not adequately pick up skewness/extremes
- VaR is NOT a coherent risk measure, and does not obey the sub-additivity property, so it is not generally useful for allocations to lower levels

Tail Value at Risk

- Uses equal weights above a given percentile level
- Potentially better at catching skewness/extremes
- Note it is still an *equal* weight above a given percentile
- Has a range from the mean to the maximum simulated value
- TVaR is a coherent risk measure, and as such obeys the sub-additivity property, so is potentially useful for allocations to lower levels

Proportional Hazards Transform

- Uses increasing weights across all simulations
- Better at catching skewness/extremes
- Has a range from the mean to the maximum simulated value
- PHT is a coherent risk measure, and as such obeys the sub-additivity property, so is potentially useful for allocations to lower levels

** See Artzner, Delbaen, Eber and Heath (1999) for a discussion of coherent risk measures*

VaR, TVaR and PHT: Example

	Value at Risk	Tail Value at Risk	Proportional Hazards Transform
Risk Tolerance *	75.00%	40.00%	1.85
Best Estimate (Disc)	17,382,445	17,382,445	17,382,445
Risk Adjustment	1,467,959	1,431,203	1,456,272
Total	18,850,404	18,813,648	18,838,717
Risk Adjustment %	8.45%	8.23%	8.38%

** Risk tolerances selected to give approximately similar results only*

Obtaining Equivalence Between Cost-of-Capital, VaR, TVaR, and PHT approaches

	Cost-of-Capital (Best estimate basis)	Value at Risk	Tail Value at Risk	Proportional Hazards Transform
Risk Tolerance *		65.4%	21.7%	1.44
Best Estimate (Disc)	17,381,682	17,382,445	17,382,445	17,382,445
Risk Adjustment	818,269	818,591	818,344	816,826
Total	18,199,871	18,201,036	18,200,789	18,199,271
Risk Adjustment %	4.71%	4.71%	4.71%	4.70%

** Risk tolerances selected to give approximately similar results only*

The "confidence level" corresponding to the cost-of-capital technique is 65.4%

With this example, the Cost-of-Capital risk adjustment looks quite low (or the distribution used for the cash-flow risk profile is too wide)

Level of Aggregation

(B88) Because the risk adjustment for non-financial risk reflects the compensation the entity would require for bearing the non-financial risk arising from the uncertain amount and timing of the cash flows, the risk adjustment for non-financial risk also reflects:

(a) the degree of diversification benefit the entity includes when determining the compensation it requires for bearing that risk; and

(b) both favourable and unfavourable outcomes, in a way that reflects the entity's degree of risk aversion.

Note that diversification benefits should be reflected, but neither the level of aggregation nor the methods used for quantifying diversification are specified.

Note also that "risk" correctly considers favourable and unfavourable outcomes. That is, we need a risk profile of all outcomes around the "probability weighted mean".

It is important to remember that a risk adjustment is required for "groups of contracts" (Paras 29 and 32), although it is unclear at what level disclosure is required.

Level of Aggregation

Method 1: Create aggregate distribution at the highest reporting level, then apply risk measure	Method 2: Create risk adjustments at lower levels, then sum the risk adjustments and apply a "diversification benefit"
• Given (simulated) distributions of fulfilment cash flows at lower levels, combine the distributions with dependencies (using copulae) to provide an overall aggregate distribution • Apply a risk measure (VaR, TVaR or PHT) to the aggregate distribution, and obtain the risk adjustment (or use CoC) at the aggregate level • Allocate the risk adjustment back to lower levels – Different allocation methods will give different results – It is possible to apply methods that are naturally additive	• Given (simulated) distributions of fulfilment cash flows at the lowest level, apply the given risk measure to give risk adjustments at the lowest level • Sum the risk adjustments to give an overall risk adjustment before diversification • Attempt to allow for "diversification" in some arbitrary way, and allocate back
This approach is logical, statistically sound, and obeys the principles behind insurance. It is the aggregate distribution that is important.	**Although this approach is popular, it is unsatisfactory and lacks statistical rigour (except in some contrived examples)**

Level of Aggregation

Consider the following:

1. A monoline insurer operating in a single country

   Straightforward. Create an aggregate distribution of fulfilment cash flows and apply risk measure

2. An insurer writing many lines of business operating in a single country

   Straightforward. Create an aggregate distribution of fulfilment cash flows (with dependencies) and apply risk measure. Allocate to line of business/portfolio/group.

3. An insurance group with multiple legal entities, but operating in a single country

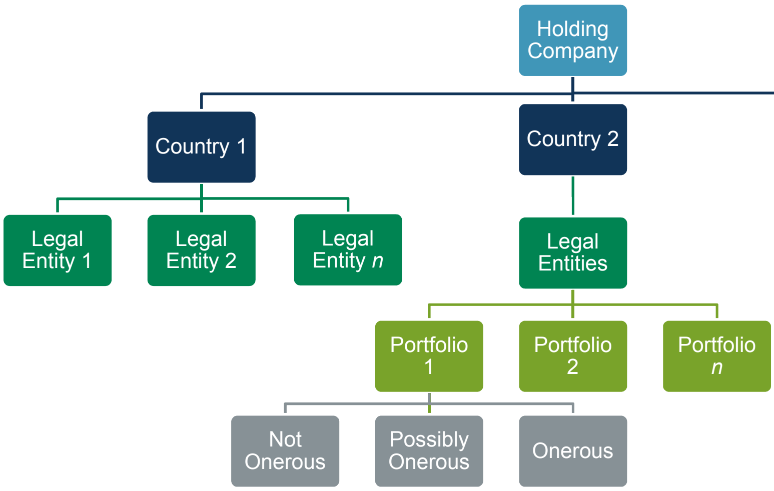
   Slightly harder since each legal entity will need its own accounts. Create an aggregate distribution of fulfilment cash flows (with dependencies) at the holding company level and apply risk measure. Allocate to legal entity level in a way that takes account of diversification at the holding company level.

   Could also create aggregate distributions and apply risk measure at legal entity level, then sum risk adjustments, ignoring further diversification, depending on beliefs.

4. A multi-national insurance group, with many legal entities

   Like (3), but more complicated. Different jurisdictions may have different accounting regimes (not IFRS 17), or local interpretations. There may be rules around fungibility of "capital", implying that diversification across legal entities/countries is not possible.

Level of Aggregation



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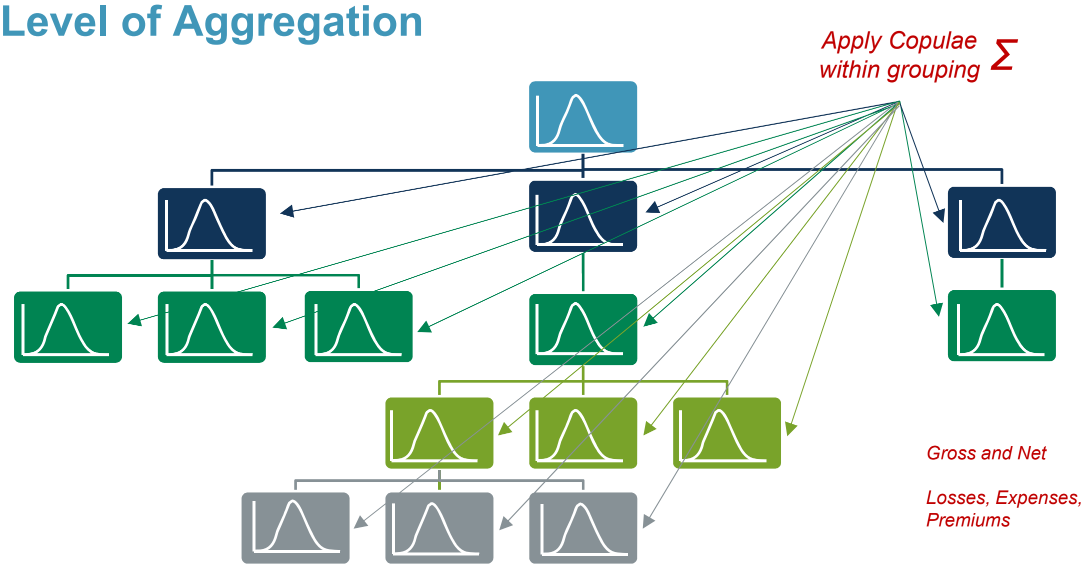
Level of Aggregation



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Reinsurance

- An explicit risk adjustment for reinsurance is required
  - Calculate using distribution of reinsurance cash-flows, or use gross and net distributions of the underlying and take the difference?
  - Either way, a distribution of the reinsurance cash-flows is required
- This hints at modelling the reinsurance programmes, contract by contract, year of account by year of account
- Modelling all reinsurance programmes could be a lot of work, and requires individual claims data
- **The traditional approach of using aggregate gross triangles and simulating an approximate net to gross ratio looks increasingly inadequate**

Reinsurance modelling for risk adjustments?

- Use triangle approaches (eg bootstrapping) for attritional claims
- Develop open large claims (and claims that could become large) to their ultimate position stochastically
- Obtain cash-flows for the development of large claims
- Pass simulated large claims through the non-proportional reinsurance programmes (quota share is easy) and net down
- Take care over aggregates etc for which knowledge of the sum of existing closed claims is required
- Remember re-instatement premiums
- Obtain total reinsurance cashflows across all contracts and years of account, and subtract from gross cash-flow distributions to obtain a net distribution

Conclusions

- Approaches to estimating the risk adjustment under IFRS 17 using a risk measure applied to the distribution of fulfilment cash flows are straightforward to apply
  - Given a distribution of the fulfilment cash flows, select a risk measure and risk tolerance level
- The cost-of-capital method is more complex and requires additional variables, assumptions, and sensitivities
  - Opening capital requirement
  - Future capital requirements
  - Cost of capital rate
  - Discount rate
- Note that under IFRS 17, the time horizon for capital is the lifetime of the fulfilment cash flows.
  - This is different from Solvency II, so Solvency II risk margins should not be used for IFRS 17
  - See England, Verrall and Wüthrich (2018)
- **Under IFRS 17, the equivalent "confidence level" has to be disclosed anyway, so why bother with the "Cost-of-Capital" approach at all?**
- Reinsurance and issues around aggregation and diversification introduce significant challenges

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Questions

Comments

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