SOLVENCY II'S ONE-YEAR TIME HORIZON:

A REFINED APPROACH FOR NON-LIFE RISK MARGINS

BY **MARK SHAPLAND**

MARK SHAPLAND is Principal & Consulting Actuary at Milliman.

European results published by EIOPA at year-end 2018 for the solo Non-Life insurance companies during financial year 2017 show that the risk margins account for 5,7% of the Technical Reserves, which is a total of over €36B.

While the standard formula is predominantly used for these calculations, 79 Non-Life entities (out of a total of 1.598) use a full or partial internal model, implying they are making their own evaluation of their reserving risk.

A COMPLEX QUANTIFICATION

Traditionally, reserving risk considers risk over the remaining lifetime of liabilities (i.e., ultimate time horizon) and early models designed to quantify this risk focused on the standard deviation of the outstanding reserves, including uncertainty for both parameter risk and process risk. Under Solvency II, reserving risk takes on a different meaning, based on the change in the estimated ultimate loss over a 1-year time horizon, which accounts for the payments during the 1-year time horizon and the consequences for future payments (i.e., the change in reserves) after the 1-year time horizon. A number of models – most notably those developed by Mack in 1993 and later refined by Merz and Wüthrich – have provided insurers well-thought-out and documented approaches for determining reserve variability and estimating unpaid claims on an ultimate time horizon and 1-year time horizon, respectively.

A Capital Profile based on the runoff of a Mack model can be used directly for estimating an ultimate time horizon risk margin (which could also serve as the basis for a risk adjustment under IRFS 17).[1] In order to produce a Capital Profile for a 1-year time horizon risk margin as required under Solvency II, however, the runoff of the Merz and Wüthrich model requires some extra steps. ▶

1 The *Capital Profile* is defined as the runoff of required capital.

This is because a reconciliation between the two approaches used by Mack and Merz & Wüthrich shows that the full variance is not included in the unpaid claims runoff for the Merz-Wüthrich model beyond the first year. This is the intended result, but it is an outcome that, if overlooked, could lead insurers to underestimate their Solvency II risk margins.

These models focus exclusively on an accident-year perspective of claims development, which is natural given the common configuration of reserving data into accident-year triangles. Insurers however need a calendar year view to produce a capital profile for use in calculating a risk margin under Solvency II and a risk adjustment under IFRS 17.

THE STARTING POINT

Taking as a reference the main triangle studied in their paper[2] and comparing its runoff calculation for the Mack and Merz-Wüthrich models using the total rows from **Figures 1** and **2**, the results show the standard deviation for the 1-year time horizon is 72,7% of the standard deviation for the ultimate time horizon at valuation period 0. This makes sense since the 1-year time horizon only includes the parameter variance beyond the first diagonal.[3]

For the first year, the oldest accident period only contains a cell from the first diagonal (i.e., the 1-year time horizon) so the standard deviation of 75.535 is the same as for Mack. By summing all of the variances in the runoff for Merz-Wüthrich, the TOTAL column matches all of the Mack estimates (i.e., they reconcile).[4]

2 The data used for all the figures is from the well know Taylor & Ashe paper.

3 The covariance adjustment (*CVA*) row in Figures 1, 2,and 3 is the additional variance between periods included in the total row.

4 The TOTAL column in Figure 1 is calculated as the square root of the sum of the squares for the other columns.

FIGURE 1: CALENDAR YEAR RUNOFF OF MERZ-WÜTHRICH STANDARD DEVIATIONS ON A SAMPLE TRIANGLE

Runoff of Merz-Wüthrich Model – Standard Deviations by Time Window

Year	1	2	3	4	5	6	7	8	9	TOTAL
1	-	-	-	-	-	-	-	-	-	-
2	**75.535**	-	-	-	-	-	-	-	-	75.535
3	105.309	**60.996**	-	-	-	-	-	-	-	121.699
4	79.846	91.093	**56.232**	-	-	-	-	-	-	133.549
5	235.115	60.577	82.068	**51.474**	-	-	-	-	-	261.406
6	318.427	233.859	57.825	82.433	**51.999**	-	-	-	-	411.010
7	361.089	328.989	243.412	59.162	85.998	**54.343**	-	-	-	558.317
8	629.681	391.249	359.352	266.320	64.443	94.166	**59.533**	-	-	875.328
9	588.662	554.574	344.763	318.493	236.576	56.543	83.645	**52.965**	-	971.258
10	1.029.925	538.726	511.118	317.142	293.978	218.914	51.661	77.317	**49.055**	1.363.155
CVA	*1.025.050*	*676.444*	*449.236*	*288.887*	*164.691*	*92.828*	*57.595*	*24.085*	-	*1.353.961*
Total	**1.778.968**	**1.177.727**	**885.178**	**607.736**	**428.681**	**267.503**	**128.557**	**96.764**	**49.055**	**2.447.095**

This is the intended result for the Merz-Wüthrich model, but England, Verrall & Wüthrich suggest in their paper *On the Lifetime and One-Year View of Reserve Risk, with Application to IRFS 17 and Solvency II Risk Margins* that the runoff in **Figure 1** can be used with the cost of capital method to calculate the risk margin for Solvency II.

However, comparing the runoff of Merz-Wüthrich with the runoff for the Mack model in **Figure 2**, the 1-year time horizon standard deviations at the top of each column do not match the same values for Merz-Wüthrich. This is because the full variance is included for the first year, but beyond that year, only part of the variance is included in the runoff of the Merz-Wüthrich standard deviation.

A MODIFICATION

To address this point, an adjustment to the calendar year runoff of Merz-Wüthrich standard deviations can be made in order to arrive at runoff standard deviations for subsequent 1-year time horizons that reflect the full variability of an insurer's unpaid claims: both the process and parameter uncertainty. Stated differently, the calendar year runoff of standard deviation relevant for the risk margin calculation should include consecutive 1-year time horizon calibrations for as many years as there are development periods, each of which begins with a first projected period including process and parameter risk and remaining projected periods including parameter risk only. ▶

FIGURE 2: CALENDAR YEAR RUNOFF OF MACK STANDARD DEVIATIONS

Runoff of Mack Model – Standard Deviations by Valuation Period

Year	0	1	2	3	4	5	6	7	8
1	-	-	-	-	-	-	-	-	-
2	**75.535**	-	-	-	-	-	-	-	-
3	121.699	**74.931**	-	-	-	-	-	-	-
4	133.549	120.373	**74.041**	-	-	-	-	-	-
5	261.406	125.695	113.131	**69.186**	-	-	-	-	-
6	411.010	269.797	130.224	117.306	**71.982**	-	-	-	-
7	558.317	437.273	287.714	139.969	126.301	**78.029**	-	-	-
8	875.328	623.100	489.142	323.291	159.581	144.441	**90.307**	-	-
9	971.258	785.070	557.224	436.400	287.117	139.643	125.999	**77.826**	-
10	1.363.155	903.373	729.436	516.796	404.139	265.121	127.697	114.976	**70.421**
CVA	*1.353.961*	*1.039.055*	*773.477*	*556.945*	*384.712*	*263.965*	*170.358*	*79.424*	-
Total	**2.447.095**	**1.788.912**	**1.340.940**	**954.131**	**663.602**	**431.762**	**263.362**	**159.952**	**70.421**

The method for including the full variability is developed in the paper *Cash Flow and Unpaid Claim Runoff Estimates Using Mack and Merz-Wüthrich Models* (*Cash Flow and Unpaid Claim Runoff*) as the "Alternative" formula.[5]

In **Figure 3**, which shows results for the alternative formula, the top row for the runoff is identical to that for Mack. The total row values are different, but this result is expected since beyond the first diagonal only the conditional reserves are calculated based on the full variance in the first diagonal.

One way to think about the differences between these models is that the full variance cannot be included in the Merz-Wüthrich model if the goal is to have the runoff reconcile with the results from Mack. However, since the time horizon concept of Solvency II requires the full variance in the first diagonal of each runoff year, then the alternative formula seems like a better solution for calculations such as risk margins.

5 The paper can be downloaded here: **https://www.milliman-mind.com/shapland/**. Access to a free trial app to test out the calculations can be requested at **europeansoftware@milliman.com.**

FIGURE 3: CALENDAR YEAR RUNOFF OF ALTERNATIVE MODEL STANDARD DEVIATIONS

Runoff of Alternative Model – 1-Year Time Horizon Standard Deviations by Valuation Period

Year	0	1	2	3	4	5	6	7	8
1	-	-	-	-	-	-	-	-	-
2	**75.535**	-	-	-	-	-	-	-	-
3	105.309	**74.931**	-	-	-	-	-	-	-
4	79.846	100.806	**74.041**	-	-	-	-	-	-
5	235.115	68.535	93.353	**69.186**	-	-	-	-	-
6	318.427	240.563	67.590	95.673	**71.982**	-	-	-	-
7	361.089	336.607	255.033	70.558	102.361	**78.029**	-	-	-
8	629.681	400.731	374.947	284.965	79.593	116.320	**90.307**	-	-
9	588.662	562.933	356.774	334.233	253.564	69.171	101.939	**77.826**	-
10	1.029.925	544.418	521.865	329.305	308.794	234.466	62.194	92.663	**70.421**
CVA	*1.025.050*	*787.105*	*592.464*	*434.573*	*299.857*	*212.772*	*154.021*	*79.424*	-
Total	**1.778.968**	**1.258.989**	**987.439**	**713.534**	**521.112**	**353.057**	**214.796**	**144.746**	**70.421**

THE IMPACT

Drawing on calculations from *Cash Flow and Unpaid Claim Runoff*, the effect of the modification to the Merz-Wüthrich models can be seen in **Figure 4**. Starting with the runoff from the Merz-Wüthrich method and using the 99,5% Value at Risk (VaR) Capital Profile, an expected return of 6,0%, and a discount rate of 2,0%, the sum of the discounted cost of capital is 891.587, which is 4,8% of the unpaid claims.

This figure is significantly less than the total discounted cost of capital of 1.007.157, or 5,4% of the unpaid claims, using the same assumptions noted above but calculated using the alternative model shown in **Figure 5**.

To help calibrate the potential impact on the market, an alternative proxy for required capital, such as the commonly used runoff of the projected best estimate (*BE*) can be added to the mix. Using the same assumptions noted above, except for using BE Runoff Capital Profile, also significantly underestimates the risk margin as shown in ▶

FIGURE 4: COST OF CAPITAL FOR MERZ-WÜTHRICH MODEL USING A VAR CAPITAL PROFILE

Valuation Period	Unpaid Claims	Standard Deviation	99.5th Percentile	99,5% VaR	6,0% CoC	Discounted CoC
0	18.680.856	1.778.968	23.753.426	5.072.570	304.354	301.328
1	13.454.320	1.177.727	16.785.734	3.331.414	199.885	193.982
2	9.274.925	885.178	11.799.479	2.524.553	151.473	144.092
3	6.143.258	607.736	7.882.818	1.739.561	104.374	97.323
4	4.015.986	428.681	5.252.966	1.236.980	74.219	67.836
5	2.454.107	267.503	3.227.797	773.690	46.421	41.590
6	1.276.363	128.557	1.645.023	368.659	22.120	19.425
7	532.076	96.764	833.102	301.026	18.062	15.548
8	86.555	49.055	293.233	206.679	12.401	10.464
Total						**891.587**
					Percent of Unpaid Claims:	*4,8%*

FIGURE 5: COST OF CAPITAL FOR ALTERNATIVE MODEL USING A VAR CAPITAL PROFILE

Valuation Period	Unpaid Claims	Standard Deviation	99.5th Percentile	99,5% VaR	6,0% CoC	Discounted CoC
0	18.680.856	1.778.968	23.753.426	5.072.570	304.354	301.328
1	13.454.320	1.258.989	17.038.055	3.583.735	215.024	208.674
2	9.274.925	987.439	12.123.409	2.848.484	170.909	162.580
3	6.143.258	713.534	8.222.165	2.078.907	124.734	116.308
4	4.015.986	521.112	5.555.442	1.539.456	92.367	84.424
5	2.454.107	353.057	3.512.025	1.057.918	63.475	56.868
6	1.276.363	214.796	1.935.777	659.413	39.565	34.745
7	532.076	144.746	1.021.830	489.754	29.385	25.295
8	86.555	70.421	421.013	334.458	20.067	16.933
Total						**1.007.157**
					Percent of Unpaid Claims:	*5,4%*

Figure 6. More importantly, it produces a risk margin almost indistinguishable from the Merz-Wüthrich Model using a VaR Capital Profile.

A BIGGER RISK MARGIN

The example shows an additional 13% Risk Margin is required for the studied triangle, but this is just one sample. To help assess the potential impact on the market, 18 sample triangles for 2 lines of business were also tested using the same assumptions noted above.[6]

As shown in **Figure 7**, without adding any tail factors the impact on the risk margins using the alternative model compared to the Merz-Wüthrich model using a VaR Capital Profile ranged from 3,8% to 27,5% with an average of 13%, which is consistent with the example. Including tail factors (based on the data) increased the range to between a low of 6,6% and a high of 43,8% with an average of 20,9%.

While this refined approach is more likely to be used for internal models, if we assuming that the calibration of the standard formula is roughly consistent with Cost of Capital approach using either the Merz-Wüthrich VaR Capital Profile or the BE Runoff Capital Profile, we can extrapolate to the full European market as shown in **Figure 7**. The impacts shown are only on the Risk Margin, the impact on the Solvency Ratio should be much less significant.

6 The data includes 9 Private Motor and 9 Commercial Motor entities from the UK market PRA returns as at 31 December 2015.

FIGURE 6: COST OF CAPITAL USING A BE RUNOFF CAPITAL PROFILE

Valuation Period	Unpaid Claims	Standard Deviation	99.5th Percentile	99,5% VaR	6,0% CoC	Discounted CoC
0	18.680.856	100,0%	5.072.570	5.072.570	304.354,20	301.328
1	13.454.320	72,0%		3.653.365	219.202	212.729
2	9.274.925	49,6%		2.518.499	151.110	143.746
3	6.143.258	32,9%		1.668.131	100.088	93.327
4	4.015.986	21,5%		1.090.494	65.430	59.803
5	2.454.107	13,1%		666.384	39.983	35.821
6	1.276.363	6,8%		346.582	20.795	18.262
7	532.076	2,8%		144.479	8.669	7.462
8	86.555	0,5%		23.503	1.410	1.190
Total						**873.668**
					Percent of Unpaid Claims:	*4,7%*

FIGURE 7: COMPARISON OF MODEL IMPACTS ON EUROPEAN RISK MARGINS

	Alternative vs. Merz-Wuthrich Model			European Market Risk Margin		
Models Tested	**Low**	**High**	**Average**	**Low**	**High**	**Average**
No Tail Factors	3,8%	27,5%	13,0%	€ 37,4	€ 45,9	€ 40,7
Tail Factors	6,6%	43,8%	20,9%	€ 38,4	€ 51,8	€ 43,5