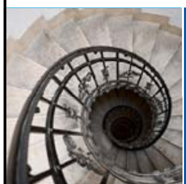
GUY CARPENTER



One year Reserve Risk under Solvency II

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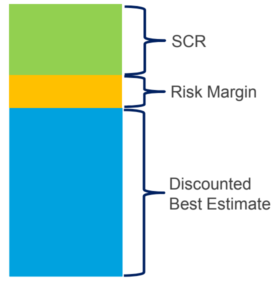
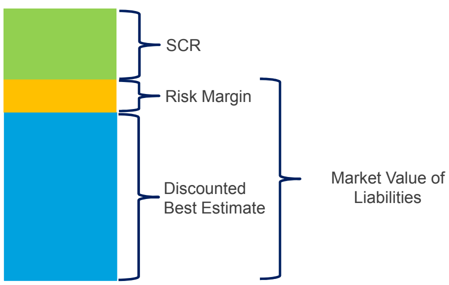
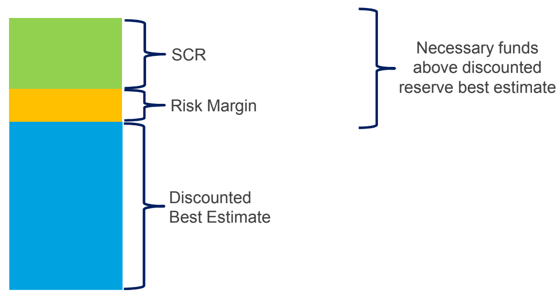
Solvency II – Reserve Risk



Solvency II – Reserve Risk



Solvency II – Reserve Risk



Solvency II View – Market Value of Reserves

Market Value of Reserves = Discounted Best Estimate + Risk Margin

Solvency II View – Risk Margin

Risk Margin = $\sum_{t=0}^{n} \frac{SCR_t (CoC - r_f)}{(1 + r_f)^t}$

Solvency II View - SCR

SCR = Total Capital needed to support reserves

How much Solvency Capital to support these reserves?

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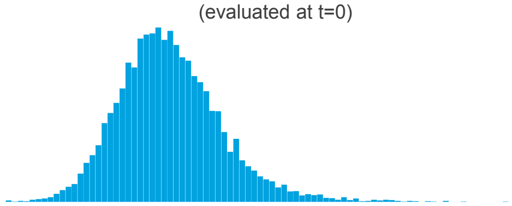
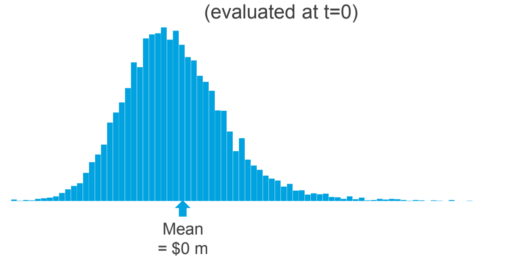
Distribution of potential 1 yr change in ult loss outcomes (evaluated at t=0)



How much Solvency Capital to support these reserves?

Distribution of potential 1 yr change in ult loss outcomes (evaluated at t=0)



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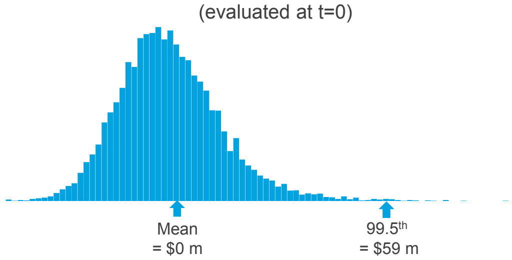

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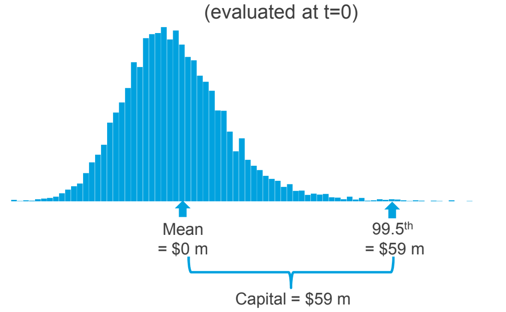
Distribution of potential 1 yr change in ult loss outcomes (evaluated at t=0)



Solvency II View

SCR = $(R_1^{MV} + Pd_0 - R_0^{MV})_{99.5\%\ VaR}$

Solvency II View: Issues?

Market Value of Reserves = Discounted Best Estimate + Risk Margin

Risk Margin = $\sum_{t=0}^{n} \frac{SCR_t(CoC - r_f)}{(1+r_f)^t}$

SCR = $(R_1^{MV} + Pd_0 - R_0^{MV})_{99.5\%\ VaR}$

Solvency II View: Issues?

SCR = $(R_1^{MV} + Pd_0 - R_0^{MV})_{99.5\%\ VaR}$

SCR is a function of Market Value of Reserve

Solvency II View: Issues?

SCR = $(R_1^{MV} + Pd_0 - R_0^{MV})_{99.5\%\ VaR}$

SCR is a function of Market Value of Reserve

Risk Margin is a function of SCR

Risk Margin = $\sum_{t=0}^{n} \frac{SCR_t(CoC - r_f)}{(1+r_f)^t}$

Solvency II View: Issues?

SCR = $(R_1^{MV} + Pd_0 - R_0^{MV})_{99.5\%\ VaR}$

SCR is a function of MV Reserve

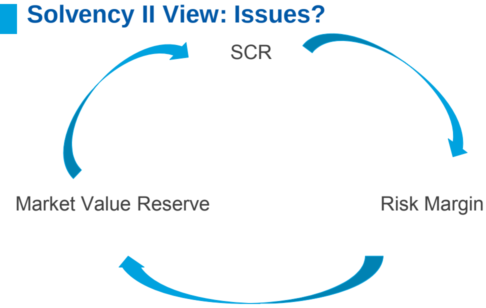
Risk Margin is a function of SCR

Risk Margin = $\sum_{t=0}^{n} \frac{SCR_t(CoC - r_f)}{(1+r_f)^t}$

MV Reserve is a function of Risk Margin

Market Value of Reserves = Discounted Best Estimate + Risk Margin

Solvency II View: Issues?



These are not mutually compatible

Solvency II View: Solution

In calculating SCR, ignore the Risk Margin's effect on best estimate of liabilities

-QIS V

Solvency II View: Solution

SCR is calculated as a function of only the 'best estimate' component of reserve, and **not** the risk margin

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Solvency II View: Solution

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In calculating SCR, ignore the Risk Margin's effect on best estimate of liabilities

-QIS V

Solvency II View: Solution

SCR is calculated as a function of only the 'best estimate' component of reserve, and **not** the risk margin

SCR = $(R_1^{MV} + Pd_0 - R_0^{MV})_{99.5\%\,VaR}$

SCR ≈ $(R_1^{BE} + Pd_0 - R_0^{BE})_{99.5\%\,VaR}$

In calculating SCR, ignore the Risk Margin's effect on best estimate of liabilities

-QIS V

SCR(0) = $VaR_{99.5th}$ (Res_1+Pd_1- Res_0)

How do we calculate 1 year change in ult loss?

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1. Res_0 (Reserve at time 0) is already determined & fixed

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How do we calculate 1 year change in ult loss?

1. Res_0 (Reserve at time 0) is already determined & fixed
2. add a diagonal using stochastic method (Bootstrap, GLM, etc.)

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How do we calculate 1 year change in ult loss?

1. Res_0 (Reserve at time 0) is already determined & fixed
2. add a diagonal using stochastic method (Bootstrap, GLM, etc.)
3. estimate ultimate at t=1 to find Res_1

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1. Res_0 (Reserve at time 0) is already determined & fixed
2. add a diagonal using stochastic method (Bootstrap, GLM, etc.)
3. estimate ultimate at t=1 to find Res_1
4. Repeat 10,000 times and find the 99.5th worst outcome of $(Res_1+Pd_1- Res_0)$

Example - Paid Loss Triangle

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	
2007	1,145,100	1,973,772	2,546,717	2,936,780		
2008	1,114,794	2,046,425	2,706,828			
2009	939,356	1,991,169				
2010	827,331					
ATA Factors	1.87	1.29	1.13	1.10		

Tail	Tail StDev
1.100	0.049

Example - Paid Loss Triangle with Chain Ladder Res_0

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	2,874,691
2007	1,145,100	1,973,772	2,546,717	2,936,780	3,226,402	3,549,042
2008	1,114,794	2,046,425	2,706,828	3,067,996	3,370,558	3,707,614
2009	939,356	1,991,169	2,568,408	2,911,107	3,198,197	3,518,016
2010	827,331	1,549,426	1,998,604	2,265,274	2,488,673	2,737,541
					Tail	
ATA Factors	1.87	1.29	1.13	1.10	1.10	

Tail	Tail StDev
1.100	0.049

Res_0 =$5.3m

Simulation1 - Paid Loss Triangle with next diagonal added

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	2,901,627
2007	1,145,100	1,973,772	2,546,717	2,936,780	3,103,909	
2008	1,114,794	2,046,425	2,706,828	3,075,801		
2009	939,356	1,991,169	2,565,033			
2010	827,331	1,579,697				
ATA Factors	1.88	1.29	1.13	1.08	1.11	

Simulation1 - Paid Loss Triangle with Res_1

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	2,901,627
2007	1,145,100	1,973,772	2,546,717	2,936,780	3,103,909	3,446,293
2008	1,114,794	2,046,425	2,706,828	3,075,801	3,308,254	3,673,178
2009	939,356	1,991,169	2,565,033	2,909,988	3,129,909	3,475,161
2010	827,331	1,579,697	2,036,960	2,310,898	2,485,543	2,759,717
ATA Factors	1.88	1.29	1.13	1.08	1.11	

$Pd_1 + Res_1$ =\$4.9m

Simulation2 - Paid Loss Triangle with next diagonal added

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	3,157,531
2007	1,145,100	1,973,772	2,546,717	2,936,780	3,201,771	
2008	1,114,794	2,046,425	2,706,828	3,054,728		
2009	939,356	1,991,169	2,605,135			
2010	827,331	1,486,669				
ATA Factors	1.86	1.29	1.13	1.09	1.21	

Simulation2 - Paid Loss Triangle with Res_1

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	3,157,531
2007	1,145,100	1,973,772	2,546,717	2,936,780	3,201,771	3,868,472
2008	1,114,794	2,046,425	2,706,828	3,054,728	3,341,827	4,037,691
2009	939,356	1,991,169	2,605,135	2,948,061	3,225,135	3,896,701
2010	827,331	1,486,669	1,924,721	2,178,081	2,382,788	2,878,953
ATA Factors	1.86	1.29	1.13	1.09	1.21	

$Pd_1 + Res_1$ =\$6.2m

Simulate 10,000 Times

Res_0 = \$5.3m

Mean Pd_1+Res_1 = \$5.3m

99.5% Var (Pd_1+Res_1) = \$8.2m

Calculate SCR(0)

Res_0= \$5.3m

99.5% Var (Pd_1+Res_1)= \$8.2m

SCR_0 = \$8.2m – \$5.3m = \$2.9m

SCR(1) = $VaR_{99.5th}$ ($Res_2+Pd_2- Res_1$)

SCR(t) = best estimate of the Capital Requirement at t, as of t = 0.

SCR(1) = $VaR_{99.5th}$ (Res_2+Pd_2- Res_1)

1. Add a diagonal using stochastic method
2. Estimate ultimate at t=1 to find Res_1

SCR(1) = $VaR_{99.5th}$ (Res_2+Pd_2- Res_1)

1. Add a diagonal using stochastic method
2. Estimate ultimate at t=1 to find Res_1
3. Add another diagonal using stochastic method (which includes the yellow diagonal as 'actual')

SCR(1) = $VaR_{99.5th}$ (Res_2+Pd_2- Res_1)

1. Add a diagonal using stochastic method
2. Estimate ultimate at t=1 to find Res_1
3. Add another diagonal using stochastic method (which includes the yellow diagonal as 'actual')
4. Estimate ultimate at t=2 to find Res_2

SCR(1) = $VaR_{99.5th}$ (Res_2+Pd_2- Res_1)

1. Add a diagonal using stochastic method
2. Estimate ultimate at t=1 to find Res_1
3. Add another diagonal using stochastic method (which includes the yellow diagonal as 'actual')
4. Estimate ultimate at t=2 to find Res_2
5. Repeat 10,000 times and find the 99.5^{th} worst outcome of (Res_2+Pd_2- Res_1)

Simulation1 - Paid Loss Triangle with next diagonal added

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	2,901,627
2007	1,145,100	1,973,772	2,546,717	2,936,780	3,103,909	3,412,220
2008	1,114,794	2,046,425	2,706,828	3,075,801	3,251,678	
2009	939,356	1,991,169	2,565,033	2,902,384		
2010	827,331	1,579,697	2,011,362			
ATA Factors	1.88	1.29	1.13	1.07	1.10	

Simulation1 - Paid Loss Triangle with Res_2

Acc. Yr.	12	24	36	48	60	60-72
2006	925,818	1,714,064	2,143,075	2,378,764	2,613,355	2,901,627
2007	1,145,100	1,973,772	2,546,717	2,936,780	3,103,909	3,412,220
2008	1,114,794	2,046,425	2,706,828	3,075,801	3,251,678	3,590,983
2009	939,356	1,991,169	2,565,033	2,902,384	3,102,162	3,425,866
2010	827,331	1,579,697	2,011,362	2,280,322	2,437,282	2,691,607
ATA Factors	1.88	1.29	1.13	1.07	1.10	

Pd_2 + Res_2 =$2.8m

Simulate 10,000 Times

Mean Res_1 = \$3.1m

Mean (Pd_2+Res_2) = \$3.1m

99.5% Var (Pd_2+Res_2) = \$5.2m

Calculate SCR(1)

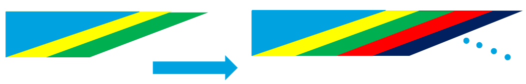
Mean Res_1 = \$3.1m

Mean (Pd_2+Res_2) = \$3.1m

99.5% Var (Pd_2+Res_2) = \$5.2m

SCR_1 = (\$5.2m – \$3.1m) = \$2.1m

$SCR(n) = VaR_{99.5th} (Res_{n+1}+Pd_{n+1} - Res_n)$



Continue procedure for each year until triangle is fully paid out…

Simulate 10,000 Times

$m		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Res + pd	Mean	5.28	3.08	1.67	0.78	0.24
	99.5% VaR	8.20	5.17	3.17	1.63	0.69
Res	Mean	3.07	1.66	0.78	0.24	-
	99.5% VaR	5.27	3.12	1.72	0.63	-
Pd	Mean	2.21	1.41	0.89	0.54	0.24
	99.5% VaR	2.93	2.05	1.45	1.00	0.69

Using SCR's, calculate Risk Margin

Year	SCR	Risk Margin	Discount (r_i)	PV Paid BE
0	2.92	0.18	1.00	2.21
1	2.10	0.12	0.96	1.36
2	1.50	0.08	0.92	0.82
3	0.85	0.05	0.89	0.48
4	0.44	0.02	0.85	0.21
Total @ t=0	**2.92**	**0.45**		**5.07**

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4	0.44	0.02	0.85	0.21
Total @ t=0	**2.92**	**0.45**		**5.07**

SCR = \$2.92m = $(R_1^{BE} + Pd_1 - R_0^{BE})_{99.5\% VaR}$

Using SCR's, calculate Risk Margin

Year	SCR	Risk Margin	Discount (r_t)	PV Paid BE
0	2.92	0.18	1.00	2.21
1	2.10	0.12	0.96	1.36
2	1.50	0.08	0.92	0.82
3	0.85	0.05	0.89	0.48
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Total @ t=0	**2.92**	**0.45**		**5.07**

SCR = \$2.92m = $(R_1^{BE} + Pd_0 - R_0^{BE})_{99.5\%\ VaR}$

Risk Margin = \$0.45m = $\sum_{t=0}^{n} \frac{SCR_t(CoC - r_f)}{(1+r_f)^t}$

Using SCR's, calculate Risk Margin

Year	SCR	Risk Margin	Discount (r_t)	PV Paid BE
0	2.92	0.18	1.00	2.21
1	2.10	0.12	0.96	1.36
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Total @ t=0	**2.92**	**0.45**		**5.07**

SCR = \$2.92m = $(R_1^{BE} + Pd_0 - R_0^{BE})_{99.5\%\ VaR}$

Risk Margin = \$0.45m = $\sum_{t=0}^{n} \frac{SCR_t(CoC - r_f)}{(1+r_f)^t}$

PV Best Est. Reserve = \$5.07m = $\sum_{x=0}^{n} \left(\frac{Pd_x}{(1+r_f)^x}\right)$

Using SCR's, calculate Risk Margin

Year	SCR	Risk Margin	Discount (r_t)	PV Paid BE
0	2.92	0.18	1.00	2.21
1	2.10	0.12	0.96	1.36
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Total @ t=0	**2.92**	**0.45**		**5.07**

Market Value of Reserve = Discounted Best Est. + Risk Margin

Market Value of Reserve = \$0.45m + \$5.07m = **\$5.5m**