FAQ
CTU
ARY

FAQCTUARY 2020-1

HOW TO COMBINE MARKET AND INTERNAL MEDICAL INDEXES IN ORSA?

By Candy Mahirwe, Audrey Meganck, Michel Denuit and Julien Trufin

Detralytics

DISCLAIMER

The content of the FAQctuary's is for a pedagogical use only. Each business case is so specific that a careful analysis of the situation is needed before implementing a possible solution. Therefore, Detralytics does not accept any liability for any commercial use of the present document. Of course, the entire team remain available if the techniques presented in this FAQctuary required your attention.

Detralytics
Rue Belliard/Belliardstraat 2
1040 Brussels
www.detralytics.com
info@detralytics.eu

Contents

Chapter 1

Context

- For some health insurance companies, medical index does not seem to reflect the real evolution of their own medical expenses.
- Within the Standard Formula of the first pillar of Solvency II, the Risk related to medical inflation is covered within the Disability/Morbidity Sub-module of the Health SCR module.
- Insurance companies using the standard formula must as part of the Own Risk and Solvency Assessment (ORSA), which is part of Pilar 2 of Solvency II, assess the appropriateness of the standard formula and give their own view on this risk.
- The assessment of the risk within the first pillar, as well as the appropriateness exercise are both very dependent of the match between the company specific index and the market medical index.
- We propose here two options for calculating the risk of mismatch between market and company-specific medical indexes by using an internal model approach.
- Several scenarios are then illustrated by changing some assumptions about :
    - the correlation coefficient between the company and the market medical indices;
    - the volatility of the market indices.

Chapter 2

Medical index in an internal model

2.1 Model for indexes

We assume an autoregressive model AR(1) for company-specific I_t^C and market I_t^M medical indices:

$$I_t^C = I_{t-1}^C + \delta^C + \mathcal{E}_t^C$$
$$I_t^M = I_{t-1}^M + \delta^M + \mathcal{E}_t^M$$

for $t = 1, 2, 3, \ldots$, starting from $I_0^C = I_0^M = 1$, where

- δ^C is the yearly drift of the company-specific index;
- δ^M is the yearly drift of the market index;
- σ_C is the volatility in the company-specific index;
- σ_M is the volatility in the market index.

Here, the vectors $(\mathcal{E}_t^C, \mathcal{E}_t^M)$ are independent and obey the bivariate Normal distribution with mean vector $(0, 0)$, marginal variances σ_C^2 and σ_M^2, and covariance $\rho\sigma_C\sigma_M$.

In this setting, a unit payment at time 0 becomes I_t at time t, and the yearly inflation rate subject to the regulation introduced by the Royal Decree is

$$R_t = \frac{I_t}{I_{t-1}} - 1.$$

To recover the payment at time t, it suffices to compute

$$\prod_{j=1}^{t} (1 + R_j) = I_t.$$

2.2 Premium calculation at time 0

Let b_y be the yearly expected costs for a person aged y at time 0. These amounts are known at time 0 (i.e. at policy issue) and do not account for medical inflation. For simplicity, we assume that these amounts are paid at once, at the end of each year. As these costs are subject to inflation, the conditional expectation of the amount of benefits paid by the insurer at time t, for year $(t-1,t)$, given medical inflation, is $b_y I_t^C$.

Let ${}_kp_x$ denote the probability that a person aged x is still alive at age $x+k$. In general, this probability must account for lapses but we assume here that all contracts stay in force until death (as contracts comprise no surrender value, this is a conservative assumption). The insurer charges a yearly premium π_x, depending on the age x at policy issue (level premium), payable at the beginning of each period. Let i be the technical interest rate used to compute the yearly premium π_x. According to the equivalence principle, we have

$$\pi_x = \frac{\sum_{k=0}^{\omega-x} b_{x+k}(1+i)^{-(k+1)}{}_kp_x}{\sum_{k=0}^{\omega-x}(1+i)^{-k}{}_kp_x},$$

where ω is the ultimate integer age such that ${}_{\omega-x}p_x > 0$ and $p_\omega = 0$. Therefore, the reserve at time 0 is 0.

2.3 Solvency Capital Requirement

In this section, we present two options to compute the SCR by assuming that the company always applies the maximum authorized medical index to their premiums. The SCR is given for a single insured person. The total charge of capital for the company will be the sum of the SCR of each insured people since we deal with a systematic risk (undiversifiable risk).

2.3.1 Option 1

In this method, the best estimate at time 0 and at time 1 are calculated in a similar way by considering the observed inflation over the period $[0,1]$.

We have

$$SCR = VaR_{99.5\%}\left[BE_1 v(0,1) + b_x I_1^C v(0,1) - \pi_x - BE_0\right]$$

where

$$BE_0 = \sum_{k=0}^{\omega-x} b_{x+k} v(0,k+1){}_kp_x - \pi_x \sum_{k=0}^{\omega-x} v(0,k){}_kp_x$$

does not account for medical inflation (which is included ex post with the help of the medical index).

The best estimate at time 1 for a contract in force at that time is given by

$$\begin{aligned} BE_1 &= \sum_{k=1}^{\omega-x} b_{x+k} I_1^C v(1,k+1)_{k-1}p_{x+1} - \sum_{k=1}^{\omega-x} v(1,k)_{k-1}p_{x+1}\pi_x^{(1)} \\ &= \sum_{k=1}^{\omega-x} b_{x+k} I_1^C v(1,k+1)_{k-1}p_{x+1} - \sum_{k=1}^{\omega-x} v(1,k)_{k-1}p_{x+1}\pi_x\big(1+\min\big\{1.5R_1^M, R_1^M+2\%\big\}\big) \\ &= I_1^C \sum_{k=1}^{\omega-x} b_{x+k} v(1,k+1)_{k-1}p_{x+1} - \pi_x\big(1+\min\big\{1.5R_1^M, R_1^M+2\%\big\}\big) \sum_{k=1}^{\omega-x} v(1,k)_{k-1}p_{x+1}. \end{aligned}$$

where the premium $\pi_x^{(k)}$ is paid at time k, $k = 1, 2, \ldots$ and includes all past revaluations based on medical index, that is,

$$\pi_x^{(k)} = \pi_x \prod_{j=1}^{k} \big(1+\min\big\{1.5R_j^M, R_j^M+2\%\big\}\big).$$

2.3.2 Option 2

In this approach, the best estimates at time 0 and at time 1 are calculated in a similar way by considering the future inflation in the policyholder's and insurer's obligations.

We have

$$SCR = VaR_{99.5\%}\left[BE_1 v(0,1) + b_x I_1^C v(0,1) - \pi_x - BE_0\right]$$

where

$$\begin{aligned} BE_0 &= E\left[\sum_{k=0}^{\omega-x} b_{x+k} I_{k+1}^C v(0,k+1)_k p_x - \sum_{k=0}^{\omega-x} v(0,k)_k p_x \pi_x^{(k)}\right] \\ &= \sum_{k=0}^{\omega-x} b_{x+k} E\left[I_{k+1}^C\right] v(0,k+1)_k p_x - \sum_{k=0}^{\omega-x} v(0,k)_k p_x E\left[\pi_x^{(k)}\right] \\ &= \sum_{k=0}^{\omega-x} b_{x+k}\left(I_0^C + (k+1)\delta^C\right) v(0,k+1)_k p_x \\ &\quad -\pi_x \sum_{k=0}^{\omega-x} v(0,k)_k p_x E\left[\prod_{j=1}^{k}\big(1+\min\big\{1.5R_j^M, R_j^M+2\%\big\}\big)\right], \end{aligned}$$

with $\prod_{j=1}^{0} = 1$.

The best estimate at time 1 for a contract in force at that time is given by

$$\begin{aligned} BE_1 &= E\left[\sum_{k=1}^{\omega-x} b_{x+k} I_{k+1}^C v(1,k+1)_{k-1}p_{x+1} - \sum_{k=1}^{\omega-x} v(1,k)_{k-1}p_{x+1}\pi_x^{(k)} \middle| I_1^C, I_1^M\right] \\ &= \sum_{k=1}^{\omega-x} b_{x+k}(I_1^C + k\delta^C) v(1,k+1)_{k-1}p_{x+1} \\ &\quad -\sum_{k=1}^{\omega-x} v(1,k)_{k-1}p_{x+1}\pi_x E\left[\prod_{j=1}^{k}\big(1+\min\big\{1.5R_j^M, R_j^M+2\%\big\}\big)\middle| R_1^M\right]. \end{aligned}$$

Chapter 3

Numerical illustration

Let us now illustrate the two options described above by a numerical example. Ultimate age equal to $\omega = 113$ years (ultimate integer age according to the minimum legal mortality table XR). The technical interest rate i is equal to 1%.

3.1 Assumptions

We assume a company with $\delta_C = 2\%$ and σ_C=4% for which we will look at its position compared to the market. The following elements are calculated for the company:

- BE at time 0;
- BE at time 1;
- Ratio $\frac{BE_1}{\pi_x}$;
- SCR;

for policyholder's ages $x = 30$, 50 and 70 years.

Concerning the expected annual claim amounts, we use realistic structure of costs standardized at €100 for a 30-year-old person. The following table shows the annual premium in € per policyholder's age.

x **(years)**	30	50	70
π_x	136.24	176.27	221.62

Concerning the market parameters, we assume the values given in the table below.

δ_M	σ_M
1%	2%
2%	4%
3%	8%

The following scenarios will be considered for correlation coefficients $\rho = 0$, $\rho = 0.5$ and

Scenario 1	**Scenario** 2	**Scenario** 3
$\delta_M<\delta_C$ $\sigma_M<\sigma_C$	$\delta_M<\delta_C$ $\sigma_M=\sigma_C$	$\delta_M<\delta_C$ $\sigma_M>\sigma_C$
Scenario 4	**Scenario** 5	**Scenario** 6
$\delta_M=\delta_C$ $\sigma_M<\sigma_C$	$\delta_M=\delta_C$ $\sigma_M=\sigma_C$	$\delta_M=\delta_C$ $\sigma_M>\sigma_C$
Scenario 7	**Scenario** 8	**Scenario** 9
$\delta_M>\delta_C$ $\sigma_M<\sigma_C$	$\delta_M>\delta_C$ $\sigma_M=\sigma_C$	$\delta_M>\delta_C$ $\sigma_M>\sigma_C$

Table 3.1: Scenarios

$\rho = 1$. For example, scenario 7 corresponds to the situation in which $\delta_M = 3\%$ with δ_C set at 2% and $\sigma_M = 2\%$ with σ_C fixed at 4%.

3.2 Results

3.2.1 Results - Option 1

Tables 3.2, 3.3 and 3.4 show option 1 results in € . Specifically, we give the best estimate and SCR for all the scenarios presented in Table 3.1 and for $\rho = 0$, $\rho = 0.5$ and $\rho = 1$.

Scenario 1			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	628.45	335.61	120.57
$\frac{BE_1}{\pi_x}$	4.61	1.90	0.54
SCR	956.75	767.93	482.26

Scenario 2			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	653.42	356.13	133.29
$\frac{BE_1}{\pi_x}$	4.8	2.02	0.6
SCR	1,310.75	1,059.63	662.92

Scenario 3			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	716.63	408.1	165.51
$\frac{BE_1}{\pi_x}$	5.26	2.32	0.74
SCR	2,101.65	1,727.6	1,072.23

Scenario 4			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	529.44	254.21	70.11
$\frac{BE_1}{\pi_x}$	3.89	1.44	0.32
SCR	853.73	683.24	429.76

Scenario 5			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	559.15	278.64	85.25
$\frac{BE_1}{\pi_x}$	4.10	1.58	0,38
SCR	1,207.73	974.95	610.42

Scenario 6			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	625.40	333.10	119,02
$\frac{BE_1}{\pi_x}$	4.6	1.89	0.54
SCR	1,998.63	1,642.91	1,019.72

Scenario 7			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	434.06	175.81	21.5
$\frac{BE_1}{\pi_x}$	3.19	0.1	0.01
SCR	750.72	598.56	377.25

Scenario 8			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	467.18	203.04	38.39
$\frac{BE_1}{\pi_x}$	3.42	1.15	0.17
SCR	1,104.72	890.26	557.91

Scenario 9			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	536.02	259.63	73.46
$\frac{BE_1}{\pi_x}$	3.93	1.47	0.33
SCR	1,895.62	1,558.23	967.22

Table 3.2: Option 1 - Scenarios with $\rho = 0$

Scenario 1			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	618.74	327.623	115.62
$\frac{BE_1}{\pi_x}$	4.54	1.86	0.52
SCR	704.22	570.65	357.1

Scenario 2			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	633.87	340.06	123.33
$\frac{BE_1}{\pi_x}$	4.65	1.93	0.56
SCR	871.70	705.44	441.51

Scenario 3			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	679.25	377.37	146.46
$\frac{BE_1}{\pi_x}$	4.99	2.14	0.66
SCR	$1,750.52$	$1,439.41$	893.43

Scenario 4			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	519.41	245.97	64.99
$\frac{BE_1}{\pi_x}$	3.81	1.4	0.29
SCR	601.21	485.96	304.59

Scenario 5			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	540.04	262.93	75.51
$\frac{BE_1}{\pi_x}$	3.96	1.49	$0,34$
SCR	768.69	620.75	389.01

Scenario 6			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	588.85	303.05	100.39
$\frac{BE_1}{\pi_x}$	4.32	1.72	0.45
SCR	$1,647.5$	$1,354.72$	840.93

Scenario 7			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	424.50	167.95	16.62
$\frac{BE_1}{\pi_x}$	3.12	0.95	0.08
SCR	498.19	401.28	252.09

Scenario 8			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	448.91	188.01	29.06
$\frac{BE_1}{\pi_x}$	3.3	1.07	0.13
SCR	665.67	536.07	336.51

Scenario 9			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	500.63	230.531	55.42
$\frac{BE_1}{\pi_x}$	3.67	1.31	0.25
SCR	1544.49	1270.04	788.43

Table 3.3: Option 1 - Scenarios with $\rho = 0.5$

Scenario 1			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	603.58	315.17	107.89
$\frac{BE_1}{\pi_x}$	4.43	1.79	0.49
SCR	342.96	264.93	169.98

Scenario 2			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	604.31	315.77	108.27
$\frac{BE_1}{\pi_x}$	4.44	1.79	0.49
SCR	297.86	255.69	156.74

Scenario 3			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	623.13	331.23	117.86
$\frac{BE_1}{\pi_x}$	4.57	1.88	0.53
SCR	$1,224.33$	$1,017.31$	$628,92$

Scenario 4			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	504.56	233.77	57.43
$\frac{BE_1}{\pi_x}$	3.7	1.33	0.26
SCR	274.28	208.48	134.98

Scenario 5			
x (years)	30	50	700
BE_0	514.31	209.27	56.58
BE_1	511.31	239.31	60.87
$\frac{BE_1}{\pi_x}$	3.75	1.36	$0,27$
SCR	194.84	171.01	104.24

Scenario 6			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	534.6	258.46	72.74
$\frac{BE_1}{\pi_x}$	1.92	3.47	0.33
SCR	$1,121.31$	932.62	576.42

Scenario 7			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	410.14	156.14	9.30
$\frac{BE_1}{\pi_x}$	3.01	0.89	0.04
SCR	205.61	152.02	99.98

Scenario 8			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	421.78	165.72	15.24
$\frac{BE_1}{\pi_x}$	3.1	0.94	0.07
SCR	91.82	86.32	51.74

Scenario 9			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	447.69	187.02	28.45
$\frac{BE_1}{\pi_x}$	3.29	1.06	0.13
SCR	$1,018.3$	847.94	523.91

Table 3.4: Option 1 - Scenarios with $\rho = 1$

3.2.2 Results - Option 2

Tables 3.5, 3.6 and 3.7 show option 2 results in € . Specifically, we give the best estimate and SCR for all the scenarios presented in Table 3.1 and for $\rho = 0$, $\rho = 0.5$ and $\rho = 1$.

Scenario 1			
x (years)	30	50	70
BE_0	$2,643.42$	$1,163.25$	351.69
BE_1	$2,707.35$	$1,262.07$	389.81
$\frac{BE_1}{\pi_x}$	19.87	7.16	1.76
SCR	931.61	785.78	487.22

Scenario 2			
x (years)	30	50	70
BE_0	$3,092.62$	$1,386.89$	429.60
BE_1	$3,190.06$	$1,513.74$	477.43
$\frac{BE_1}{\pi_x}$	23.42	8.59	2.15
SCR	1333, 61	$1,253.39$	697.63

Scenario 3			
x (years)	30	50	70
BE_0	$4,466.84$	$2,096.99$	669.57
BE_1	$3,523.95$	$2,596.89$	734.75
$\frac{BE_1}{\pi_x}$	25.87	14.73	3.32
SCR	$16,354.41$	$2,397.69$	$1,156.03$

Scenario 4			
x (years)	30	50	70
BE_0	-808.92	-624.67	-219.58
BE_1	-733.29	-522.68	-189.53
$\frac{BE_1}{\pi_x}$	-5.38	-2.97	-0.86
SCR	940, 9	816, 91	487.81

Scenario 5			
x (years)	30	50	70
BE_0	-146.28	-290.55	-105.49
BE_1	-35.60	-157.70	-65.23
$\frac{BE_1}{\pi_x}$	-0.26	0.89	-0.29
SCR	$1,440.49$	1287.41	702.94

Scenario 6			
x (years)	30	50	70
BE_0	$1,709.51$	617.57	185.31
BE_1	$1,930.74$	804.94	245.03
$\frac{BE_1}{\pi_x}$	14.17	4.57	1.11
SCR	$3,108.55$	$2,338.74$	$1,194.47$

Scenario 7			
x (years)	30	50	70
BE_0	$-4,550.45$	-2515.45	-804.14
BE_1	$-4,466.1$	$-2,410.14$	-782.68
$\frac{BE_1}{\pi_x}$	-32.78	-13.67	-3.53
SCR	925.78	842.12	481.27

Scenario 8			
x (years)	30	50	70
BE_0	514.31	209.27	56.58
BE_1	$-3,530.62$	$-1,922.96$	-620.86
$\frac{BE_1}{\pi_x}$	$-25,92$	-10.91	-2.80
SCR	$1,527.45$	$1,309.18$	704.07

Scenario 9			
x (years)	30	50	70
BE_0	$-1,355.84$	-961.95	-315.97
BE_1	$-1,165.61$	-769.71	-263.43
$\frac{BE_1}{\pi_x}$	-8.56	-4.37	-1.19
SCR	$2,861.26$	$2,512.89$	$1,227.92$

Table 3.5: Option 2 - Scenarios with $\rho = 0$

Scenario 1			
x (years)	30	50	70
BE_0	$2,643.42$	$1,163.25$	351.69
BE_1	$2,708.67$	$1,260.33$	389.66
$\frac{BE_1}{\pi_x}$	19, 88	7.15	1.76
SCR	626.36	599.41	361.51

Scenario 2			
x (years)	30	50	70
BE_0	$3,092.62$	$1,386.89$	429.60
BE_1	$3,191.99$	$1,509.27$	477.36
$\frac{BE_1}{\pi_x}$	23.43	8.56	2.15
SCR	$1,038.81$	952.53	501.03

Scenario 3			
x (years)	30	50	70
BE_0	$4,466.84$	$2,096.99$	669.57
BE_1	$-218,534.11$	2310.09	735.92
$\frac{BE_1}{\pi_x}$	$-1,604.09$	13.11	3.32
SCR	$69,804.72$	$7,222.96$	925.95

Scenario 4			
x (years)	30	50	70
BE_0	-808.92	-624.67	-219.58
BE_1	-732.05	-524.68	-189.63
$\frac{BE_1}{\pi_x}$	-5.37	-2.98	-0.86
SCR	663.00	589.86	351.61

Scenario 5			
x (years)	30	50	70
BE_0	-146.28	-290.55	-105.49
BE_1	-34.42	-162.32	-65.48
$\frac{BE_1}{\pi_x}$	-0.25	-0.92	-0.3
SCR	$1,154.86$	993.39	501.87

Scenario 6			
x (years)	30	50	70
BE_0	$1,709.51$	617.57	185.31
BE_1	$-6,965.68$	813.39	244.27
$\frac{BE_1}{\pi_x}$	-51.13	4.61	1.1
SCR	$2,570.05$	$2,005.52$	952.98

Scenario 7			
x (years)	30	50	70
BE_0	$-4,550.45$	-2515.45	-804.14
BE_1	$-4,465.71$	$-2,412.55$	-782.81
$\frac{BE_1}{\pi_x}$	-32.78	-13.69	-3.53
SCR	674.75	595.4	338.36

Scenario 8			
x (years)	30	50	70
BE_0	$-3,653.57$	$-2,061,45$	-652.57
BE_1	$-3,530.14$	$-1,927.41$	-621.1
$\frac{BE_1}{\pi_x}$	-25.91	-10.93	-2.8
SCR	$1,240.52$	$1,024.38$	495.73

Scenario 9			
x (years)	30	50	70
BE_0	-1355.84	-961.95	-315.97
BE_1	$-1,162.64$	-778.44	-264.19
$\frac{BE_1}{\pi_x}$	-8.53	-4.42	-1.19
SCR	$2,817.26$	$2,102.25$	979.41

Table 3.6: Option 2 - Scenarios with $\rho = 0.5$

Scenario 1			
x (years)	30	50	70
BE_0	$2,643.42$	$1,163.25$	351.69
BE_1	$2,702.25$	$1,261.55$	388.60
$\frac{BE_1}{\pi_x}$	19.84	7.16	1.75
SCR	310.09	234.83	128.52

Scenario 2			
x (years)	30	50	70
BE_0	$3,092.62$	$1,386.89$	429.60
BE_1	$3,181.25$	$1,511.23$	473.7
$\frac{BE_1}{\pi_x}$	23.35	8.57	2.14
SCR	569.99	390.08	205.84

Scenario 3			
x (years)	30	50	70
BE_0	$4,466.84$	$2,096.99$	669.57
BE_1	$20,770.3$	$2,331.26$	730.37
$\frac{BE_1}{\pi_x}$	152.46	13.23	3.3
SCR	$952,992.54$	$3,621.8$	745.73

Scenario 4			
x (years)	30	50	70
BE_0	-808.92	-624.67	-219.58
BE_1	-737.97	-523.83	-191.52
$\frac{BE_1}{\pi_x}$	-5.42	-2.97	-0.86
SCR	336.56	251.63	130.92

Scenario 5			
x (years)	30	50	70
BE_0	-146.28	-290.55	-105.49
BE_1	-44.18	-160.94	-69.75
$\frac{BE_1}{\pi_x}$	-0.32	-0.91	-0.31
SCR	724.99	446.71	216.75

Scenario 6			
x (years)	30	50	70
BE_0	$1,709.51$	617.57	185.31
BE_1	$1,893.55$	793.66	235.87
$\frac{BE_1}{\pi_x}$	13.9	4.50	1.06
SCR	$2,931.04$	$1,485.21$	770.04

Scenario 7			
x (years)	30	50	70
BE_0	$-4,550.45$	-2515.45	-804.14
BE_1	$-4,469.99$	$-2,412.02$	-785.19
$\frac{BE_1}{\pi_x}$	-32.81	-13.68	-3.54
SCR	380.09	275.04	133.33

Scenario 8			
x (years)	30	50	70
BE_0	$-3,653.57$	$-2,061,45$	-652.57
BE_1	$-3,539.37$	$-1,926.72$	-625.73
$\frac{BE_1}{\pi_x}$	-25.98	-10.93	-2.82
SCR	858.26	500.14	222.93

Scenario 9			
x (years)	30	50	70
BE_0	-1355.84	-961.95	-315.97
BE_1	$-1,184.13$	-776.34	-272.65
$\frac{BE_1}{\pi_x}$	-8.69	-4.40	-1.23
SCR	$2,629.47$	$1,648.52$	803.9

Table 3.7: Option 2 - Scenarios with $\rho = 1$

3.2.3 Analysis

In option 1, the best estimate at time 0 remains unchanged, whatever the scenario and the correlation coefficient between market and company-specific medical indices. This is not surprising given that its expression does not take account for the medical inflation. In the second option, the best estimate at time 0 varies depending on the scenario and becomes negative in the scenarios where the average deviation of the company index is smaller than the one of the market.

Regardless of the method used, we notice that:

- The best estimate at time 1 is the lowest (negative in option 2) in scenarios 7, 8 and 9, i.e. when δ_M is larger than δ_C. This is because the premiums are too inflated compared to the expenses. However, the best estimate at time 1 is positive when the average deviation of the company index is higher than the one of the market, which is the case in scenarios 1, 2 and 3.

- The higher the correlation between the market and the company medical indexes, the lower the SCR. Since the company evolves in the same way as the market, less capital must be put aside.

- Whatever the correlation between the market and the company medical indexes, the SCR is very high (thousands of euros) in scenarios 3, 6 and 9. This is not surprising given that these are the scenarios where market volatility is twice the one of the company.

- Concerning the ratio $\frac{BE_1}{\pi_x}$, we observe that it decreases with policyholder's age, seeing that the provision at time 1 becomes lower. However, this ratio is larger in option 2 where the best estimates at time 1 are much higher (thousands of euros) than those of option 1.

Chapter 4

About the serie and the authors...

4.1 The FAQctuary's

The FAQctuary's are a series of educational papers dedicated to the insurance sector. Each issue addresses a specific actuarial topic, expressed as a question asked by market players. FAQctuary's are published by members of the Detralytics team and written in a clear and accessible language. The team combines academic expertise and business knowledge. Detralytics was founded to support companies in the advancement of actuarial science and the solving of the profession's future challenges. It is within the scope of this mission that we make our work available through our Detra Notes and FAQctuary's series.

4.2 Authors' biographies

Candy Mahirwe

Candy is part of the Talent Consolidation Program (TCP) at Detralytics. During her various missions, Candy has worked on IAS19 valuation of pension plans in a consultancy firm; on the creation of an internal note about the analysis of spreads on loans of an insurance company; and as a life product manager in the actuarial department of an insurance company. Prior to joining Detralytics, Candy worked as an intern at AG Insurance. Candy holds a Master's degree in Actuarial Sciences from ULB University.

Audrey Meganck

Audrey is CEO at Detralytics and oversees all operations of Detralytics' four key components (Interim, Consulting, Training & R&D). Prior to joining Detralytics, Audrey was Head of the Actuarial & Reporting Department at Belfius Insurance, where she was in charge of pricing & competitivity analyses for all Non-Life Retail products as well as claims & financial actuarial tasks such as the valuation of non-life technical components in the different frameworks (SII, IFRS 4/17, BeGAAP, among other things).

Michel Denuit

Michel is Scientific Director at Detralytics, as well as a Professor in Actuarial Science at the Université Catholique de Louvain. Michel has established an international career for some two decades and has promoted many technical projects in collaboration with different actuarial market participants. He has written and co-written various books and publications. A full list of his publications is available at : https://uclouvain.be/en/directories/michel.denuit .

Julien Trufin

Julien is Scientific Director at Detralytics, as well as a Professor in Actuarial Science at the department of mathematics of the Université Libre de Bruxelles. Julien is a qualified actuary ofthe Instute of Actuaries in Belgium (IA|BE) and has experience as a consultant, as well as a compelling academic background developed in prominent universities such as Université Laval (Canada), UCL and ULB (Belgium).He has written and co-written various books and publications. A full list of his publications is available at : http://homepages.ulb.ac.be/~jtrufin/.

Detralytics

Expertise and innovation at the service of your future

www.detralytics.com - info@detralytics.eu