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Comments on the Solvency II Risk Margin and proposed amendments

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Abstract

The Risk Margin under Solvency II is determined as the cost of holding capital over the lifetime of liabilities, whereby future costs are discounted to the valuation date at risk-free rates. An implicit assumption of the current method is that the Risk Margin should allow for new capital to be raised after the occurrence of losses no larger than required capital. Using "Cost of Capital" as general valuation method, various approaches are discussed, giving rise to several alternative calculation methods of the Risk Margin. A comparison is made with the adjustment proposed by EIOPA in 2020 and also an approach is explored where future capital raisings are treated as contingent commitments. Each of the approaches discussed can be justified on its own merits in the context of Solvency II legislation, and leads to substantially different results for liabilities with long durations. Therefore, a more precise specification of the function of the Risk Margin and underlying assumptions is desirable.

Keywords: Risk Margin; Solvency II Cost of Capital; Discount Rate; Contingent Capital

Introduction

In EIOPA (2020), "Opinion on the review of Solvency II," EIOPA has proposed to amend the formula for the Risk Margin (RM). The proposed formula reduces future amounts of the Solvency Capital Requirement (SCR) in the "Cost of Capital" formula by a factor of 0.975^t for each future year *t*, with a minimum factor of 0.5.

In Council (2024), the European Council published a provisional agreement with the European Parliament outlining a similar amendment comprising a, yet unspecified, exponential and time dependent element and a Cost of Capital rate of 4.75%. The latter is to be periodically reviewed, with a maximum of 5%. The minimum factor of 0.5 in EIOPA's proposal does not form part of the Council's proposed amendment. Imposing this factor has a minor impact for liabilities with very long durations, but becomes negligible for shorter durations.

The stated argument for the adaptation of the formula is "to recognize diversification over time." Such diversification may occur as follows[1]: the current approach enables the Reference Undertaking (RU) to raise an amount of capital equal to the projected amount of SCR, at each time that unexpected losses erase available capital. After suffering from one such loss, however, the SCR in subsequent years is expected to be generally lower than it otherwise would have been because a part of the risk has already manifested itself.

For example, after an occurrence of severely increased lapse, higher lapse in successive years would only affect the portfolio that has not yet lapsed, and hence would therefore have a lower impact. Hence the current approach, but also the amendment proposed by EIOPA, are based on

[1] Also see AAE (2019) Chapter 8 for further elaboration on this topic

the premise that the Risk Margin serves to enable the RU to raise fresh capital in each future year following the occurrence of losses no larger than the SCR.

The interpretation that the RM serves not only to fund the Cost of Capital already provided but also to raise additional capital in future years, is not unambiguously clear from Solvency II legislative texts. The well-known Article 101 of the Level 1 legislative text merely states that the SCR is *determined* as the 99.5% confidence level over a one-year time horizon. However, the same text also states that SCR of the RU is the capital required to support the liabilities over the lifetime thereof (Article 77.5).

Moreover, Article 122 of the level I text states that the SCR may also be determined over a different confidence level and time horizon, as long as it gives rise to an equivalent level of protection for policyholders. One could argue, for example, that a 99% confidence level over a two-year period is roughly equivalent to a 99.5% confidence level over a one-year period, as both imply an expected failure rate of 0.5% per annum.

In Waszink (2013), it was argued that although it is indeed possible that additional capital is required at some point during run-off, this in itself does not justify the use of risk-free rates for discounting. Also, in EIOPA (2014), EIOPA provided further specification of the "capital scenario," underlying the provision of capital to the RU in the Cost of Capital (CoC) formula. In this specification, it is stated that the RM is determined "*under the assumption that obligations run off according to the best estimate assumption.*" Hence, the Cost of Capital is the cost of providing an amount equal to the SCR at the valuation date, which is expected to be fully released over time as liabilities run-off.

Furthermore, the 99.5% confidence level specified in Solvency II legislation was originally set to correspond to a BBB financial strength rating of the insurance undertaking, see CEIOPS (2007). Next to a probability of default, a BBB-rated entity also has a substantial probability of migrating to a lower credit rating without defaulting in subsequent years, see e.g. Xiong and Idzorek (2012). Hence, requiring that an entity maintain a 0.5% probability of default unless it defaults, will generally lead to substantially better credit quality than that of a regular BBB-rated entity without this requirement.

In more recent years, however, the notion that the RM does serve to raise additional capital in future years has gained wider acceptance[2]. It was argued in EIOPA (2018) that there is no conceptual reason why the RM should not exceed the SCR. Also, the adjustment proposed in EIOPA (2020) implies that lost capital should be replenished each year. In Pelkiewicz *et al.* (2020), the Risk Margin Working Party in the UK also stated that in its opinion, the discount rate should be the risk-free rate, to enable additional capital to be raised each year.

In this article, we will further explore the implications of different interpretations of the function of the RM, using the following three perspectives:

1. The investors' perspective: the RM as the present value of the expected reward to investor(s) that provide capital at the valuation date without assuming further liability.
2. The regulatory perspective: the RM as an instrument to ensure that the RU has sufficient assets to replenish Own Funds after a loss no greater than the SCR, or to transfer the liabilities to another market participant.
3. The RM as a contingent capital arrangement: the RM as the cost of raising capital at the valuation date, plus the present value of the potential extra cost of raising additional capital when and if required at a later date.

Each of these perspectives is discussed respectively in the following three sections.

Note that we will not discuss the appropriateness of the Cost of Capital rate of 6% in excess of the risk-free rate, as is currently prescribed by Solvency II. Only the framework and the underlying assumptions to derive the RM, given the required rate of return, are discussed.

[2]Examples can be found in Risk Margin Working Party (2020) paragraph 6.6 and ABI (2017) page 55 and AAE (2019) Chapter 8.

1. The Investors' Perspective

Under this perspective, investor(s) provide an amount of capital equal to the SCR at the valuation date and cannot be compelled to provide additional capital at a later stage. Investors expect a reward, in cash or equivalent, that matches their Cost of Capital based on their exposure to unhedgeable risk. The Cost of Capital is determined as a fixed rate, in excess of the risk-free rate, over required capital. The latter is set at the start of each year.

From the investors' perspective, the present value of future rewards is the total cash flow they expect to receive, discounted at the required rate of return reflecting the riskiness of these cash flows.

Assuming risk-free rates are all equal to zero[3], the Risk Margin at the end of each year t should then be as follows:

$$RM_t = CoCr \sum\nolimits_{t'=t}^{n} 1/(1 + CoCr)^{t'-t+1} \times SCR_{t'}, \quad t = 0, 1, 2, \ldots n, \tag{1}$$

with:

RM_t: expected RM t years after the valuation date.
SCR_t: expected SCR t years after the valuation date.
$CoCr$: required return on capital in excess of the risk-free rate.
t: number of years after the valuation date.
n: number of years until full run-off.

Although the value to investors is thus the discounted value of future returns, the RU needs to hold an undiscounted reserve to supply the same returns at the end of each future year. After all, risk-free rates are assumed zero, and there is no other source of income for the RU. Especially for liabilities with long durations, there are very large differences between the total of undiscounted and discounted future returns.

So it appears that there is a difference in valuation from the perspective of the investors and the RU, where the cost to the RU is higher than the gain to investors. However, the investors' required return was based on the notion that their entire capital is fully exposed to the unhedgeable risk in the RU. However, adding the RM to the balance sheet of the RU substantially mitigates the risk to the investors, as it provides an extra buffer available to cushion unexpected losses.

How investors will value the risk mitigation that arises from adding the RM to the balance sheet of the RU may depend on many factors. These include the required reward for risks beyond the 99.5% annual confidence interval as well as the (perceived) diversification of risk over time. On the other hand, assuming that the risk exposure for investors is not changed by the addition of the RM to the balance sheet of the RU can lead to excessive prudence that is not reflective of Market Value.

One way to approach the valuation of the risk to investors, after adding the RM to the balance sheet of the RU, is as follows: assume that losses over the lifetime of the liabilities in excess of the SCR at the valuation date have a negligible impact on the RM at the same date. This assumption appears to be in line with Article 77.5 of the Solvency II level I legislative text, which states that:

> *[...]the risk margin shall be calculated by determining the cost of providing an amount of eligible own funds equal to the Solvency Capital Requirement necessary to support the insurance and reinsurance obligations over the lifetime thereof.*

Obviously, larger aggregate losses than the SCR may occur in reality, in the same way as many other assumptions in the RM model hold only by approximation. For example, the

[3]As discussed in Waszink (2013), assuming zero risk-free rates is not only a simplification, but also ensures that the Risk Margin does not depend on the choice of time unit. Moreover, risk-free rates equal to zero give rise to a higher Risk Margin then positive risk-free rates, see Equation (5) in Chapter 2.

assumption that liabilities will be held in an RU that is closed to new business reduces diversification benefits that exist in real companies. Additional prudence may be incorporated into Equation (1) by increasing the required rate of return *CoCr*.

As the maximum loss over the lifetime of liabilities that the RU may suffer is now deemed to equal SCR_0, an amount equal to RM_0 of the capital SCR_0 provided by investors is not exposed to risk. Therefore, only an amount (SCR_0 – RM_0) of the capital requires a return above the risk-free rate.

We will now show that when the RU holds an RM according to Equation (1), investors will receive a sufficient return assuming the SCR is the maximum loss over the lifetime of the liabilities.

Figure 1 below shows expected cash flows and Own Funds, with incoming cash flows for the investor denoted as positive:

	CF_R_t	CF_RF_t	OF_R_t	OF_t
t=0:	$-SCR_0 + RM_0$	$-RM_0$	$SCR_0 - RM_0$	SCR_0
t=1,2,…,n:	$SCR_{t-1} - SCR_t$	$RM_{t-1} - RM_t$	$SCR_t - RM_t$	SCR_t

Figure 1. Expected cash flow and own funds -Investor's perspective
CF_R_t : expected Net Cash Flow from/to Investor exposed to Risk,
CF_RF_t : expected Risk-Free Net Cash Flow from/to Investor,
OF_R_t : expected Own Funds at the end of year t, exposed to risk,
OF_t : total Expected Own Funds at the end of year,
RM_t : expected Risk Margin at the end of year t,
SCR_t : expected *SCR* at the end of year t,
t : number of years after the valuation date,
n : number of years until full run-off.

At the end of each year t, total assets of the RU exposed to risk equal SCR_t. These assets comprise Own Funds OF_R_t in the amount of (SCR_t – RM_t), and the Risk Margin RM_t. In addition, Own Funds that are not exposed to risk equal $OF_t - OF\_R_t = RM_t$.

At the valuation date, investors put up an amount SCR_0 of which only $SCR_0 - RM_0$ requires a return above the risk-free rate. In later years, total cash flows to investors equal the release of SCR and RM.

We can derive CF_R_t from the requirement that OF_R_t must equal OF_R_{t-1} plus the release of RM during year t, minus the cash flow to the investor:

$$\begin{aligned} OF\_R_t &= OF\_R_{t-1} + RM_{t-1} - RM_t - CF\_R_t \\ &= SCR_{t-1} - RM_{t-1} + RM_{t-1} - RM_t - CF\_R_t \\ &= SCR_{t-1} - RM_t - CF\_R_t, \end{aligned}$$

hence:

$$\begin{aligned} CF\_R_t &= SCR_{t-1} - RM_t - OF\_R_t \\ &= SCR_{t-1} - RM_t - SCR_t + RM_t \\ &= SCR_{t-1} - SCR_t. \end{aligned}$$

We can now verify that the return on OF_R_t equals *CoCr* in each period when involving only the risk-exposed cash flows. Total Return on risk-exposed Own Funds in year t to investors equals the change in Own Funds plus the net incoming cash flow:

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$$
\begin{aligned}
& OF\_R_t - OF\_R_{t-1} + CF\_R_t \\
& \quad = OF\_R_t - OF\_R_{t-1} + SCR_{t-1} - SCR_t \\
& \quad = (SCR_t - RM_t) - (SCR_{t-1} - RM_{t-1}) + SCR_{t-1} - SCR_t \\
& \quad = RM_{t-1} - RM_t \\
& \quad = RM_{t-1} - (RM_{t-1}[1 + CoCr] - SCR_{t-1} \times CoCr), \text{ which follows directly from Equation (1)} \\
& \quad = -RM_{t-1} \times CoCr + SCR_{t-1} \times CoCr \\
& \quad = (SCR_{t-1} - RM_{t-1}) \times CoCr \\
& \quad = OF\_R_{t-1} \times CoCr.
\end{aligned}
$$

This shows that Equation (1) provides investors with an expected return equal to the required return *CoCr* over invested capital exposed to risk, where no additional capital is raised after the valuation date. As stated in the beginning Section 1, risk-free rates are assumed to be equal to zero.

The next two sections discuss approaches where additional capital will be raised in future years, to replenish Own Funds to the level of the SCR after the occurrence of large losses.

2. The Regulatory Perspective

For the RU to be compliant with Solvency II regulations going forward, it should at all times have sufficient assets to cover Best Estimate Liabilities, Risk Margin and SCR. The SCR is recalculated once a year at the 99.5% confidence level of unexpected losses over a single year. One can argue, therefore, that following a loss in Own Funds up to the SCR in any year, the RU should be able to replenish Own Funds to the level of the SCR by the end of the year.

As an alternative to raising capital itself, the RU should be in a position to transfer the liabilities to another market participant who will contribute Own Funds to the level of the SCR. In either case, the RM should be available to provide an adequate return on the additionally provided capital over the remaining lifetime of the liabilities.

Under this perspective, the only scenario where the RU may no longer be compliant with regulatory capital requirements occurs when losses in the RU exceed the SCR in any year. Hence, in the following, we will assume that losses of the RU in any year cannot exceed the SCR.

We can now no longer assume up front that any part of Own Funds of the RU at the valuation date is not exposed to risk. Depending on the size of losses occurring, investors may lose part or the entire amount of capital invested. The Risk Margin will then be used to raise fresh capital and the providers of that capital will be entitled to the future returns that will emerge from the release of the RM as liabilities run-off.

Hence there is no longer a distinction between "risk exposed" and "risk-free" cash flows. Cash flows to and from investors and Own Funds of the RU are now as in Figure 2:

	CF_t	OF_t
t=0:	$-SCR_0$	SCR_0
t=1,2,…,n:	$(SCR_{t-1} + RM_{t-1}) \times (1+rf_t) - SCR_t - RM_t$	SCR_t

Figure 2. Expected cash flow and own funds – Regulatory perspective
CF_t: expected net cash flow from/to investors,
OF_t: expected Own Funds at the end of year,
RM_t: expected Risk Margin at the end of year t,
SCR_t: expected *SCR* at the end of year t,
rf_t: the applicable annual risk-free rate in year t,
t: number of years after the valuation date,
n: number of years until full run-off.

Cash flows in year 1 and later equal the release of SCR and Risk Margin at the end of the year. Note that one can also assume that at the end of each year, the incumbent capital provider receives an amount $(SCR_{t-1} + RM_{t-1}) \times (1+rf_t) - RM_t$ and withdraws. A new capital provider then enters and provides an amount SCR_t. Such a change of capital provider does not change the position of the RU and therefore does not affect the valuation.

The Expected Risk Margin at the end of year t is now determined as follows:

$$RM_t = CoCr \sum\nolimits_{t'=t}^{n-1} \frac{SCR_{t'}}{(1 + r_{t'-t+1,t})^{t'-t+1}}. \tag{2}$$

with $r_{s,t}$: risk-free rate with maturity s years at the end of year t,
$CoCr$: required return on capital in excess of the risk-free rate.

Equation (2) is currently used in Solvency II. From (2) it follows that:

$$RM_{t-1} \times \left(1 + rf_t\right) - RM_t = SCR_{t-1} \times CoCr.$$

The release of the Risk Margin after adding risk-free interest over year t equals the required return over the SCR in excess of the risk-free return over the SCR itself. The total expected return over the entire SCR is now as follows:

$$\begin{aligned}
&\textit{Total Expected Return on Own Funds in Year t} \\
&= OF_t - OF_{t-1} + CF_t \\
&= SCR_t - SCR_{t-1} + (SCR_{t-1} + RM_{t-1}) \times \left(1 + rf_t\right) - SCR_t - RM_t \\
&= SCR_{t-1} \times rf_t + RM_{t-1} \times \left(1 + rf_t\right) - RM_t \\
&= SCR_{t-1} \times rf_t + SCR_{t-1} \times CoCr \\
&= SCR_{t-1} \times (rf_t + CoCr).
\end{aligned}$$

If a loss in the amount of SCR_{t-1} occurs in year t, the total return to investors becomes:

$$\begin{aligned}
&\textit{Total Return in year t if loss equal to } SCR_{t-1} \textit{ occurs} \\
&= SCR_{t-1} \times (rf_t + CoCr) - SCR_{t-1} \\
&= -SCR_{t-1} \times (1 - CoCr - rf_t).
\end{aligned}$$

Hence, if one assumes that SCR_{t-1} is the largest loss that can occur in year t, a fraction $CoCr + rf_t$ of the SCR_{t-1} is still not exposed to risk. This fraction equals the release of the RM plus risk-free interest over the SCR.

Therefore, under the assumption that SCR_{t-1} is the maximum loss that the RU can incur in year t, some part of the SCR would not need to earn a return in excess of the risk-free rate. This justifies a slight reduction in the RM, which can be derived as follows:

Firstly, RM_{t-1} can be written recursively as:

$$RM_{t-1} \times \left(1 + rf_t\right) = (SCR_{t-1} - RM_{t-1} + RM_t) \times CoCr + RM_t[4].$$

On the left-hand side is the RM at time t-1, increased with one year of risk-free interest.
On the right-hand side, $SCR_{t-1} - RM_{t-1} + RM_t$ is the capital over which a required return of $CoCr$ in excess of the risk-free rate is to be expected in year t. In addition, the Cost of Capital over years t+1 and later is represented by RM_t.

[4]Formula provided by Brian Woods.

We can rewrite the above equation as:

$$RM_{t-1} = [SCR_{t-1} \times CoCr + RM_t \times (1 + CoCr)]/\left(1 + CoCr + rf_t\right).$$

Starting from $t = n$ for which $RM_t = 0$, we can derive RM_{n-1}, RM_{n-2} etc. by recursion which leads to the following formula for RM_0:

$$RM_0 = CoCr \times \sum\nolimits_{t=0}^{n-1} SCR_t \times \frac{(1 + CoCr)^t}{\left(1 + CoCr + r_{t+1,0}\right)^{t+1}}. \tag{3}$$

For long durations, this equation generally leads to a marginally lower RM than Equation (2).

2.1. The Amendment Proposed by EIOPA

As discussed in the introduction, an amendment to the Risk Margin has now been proposed by EIOPA, to take into account that following a large loss, future SCRs are expected to be lower. The adjusted formula for the Risk Margin is as follows:

$$RM_t = CoCr \sum\nolimits_{t'=t}^{n} \frac{SCR_{t'}}{\left(1 + r_{t'-t+1,t}\right)^{t'-t+1}} \times \max\left(0.5,\ 0.975^{t'}\right) \tag{4}$$

In the original Solvency II formula for the Risk Margin, an implicit assumption was that the Risk Margin is unaffected by the amount of actual losses occurring. In the adjusted formula, the SCR and therefore the Risk Margin are assumed to be lower following the occurrence of a severe loss. Hence the release of the Risk Margin following a large loss is larger than $SCR_{t-1} \times CoCr$, thus providing an additional buffer mitigating the impact on Own Funds.

Although the assumptions underlying this formula are not specified, we can analyse the impact of a lower RM following a loss in the amount of SCR, as follows. Recall the recursive formula above that takes into account a release of the RM that is unaffected by the level of the actual loss:

$$RM_{t-1} \times \left(1 + rf_t\right) = (SCR_{t-1} - RM_{t-1} + RM_t) \times CoCr + RM_t.$$

A release of Expected Risk Margin of $(RM_{t-1} - RM_t)$ is taken into account at the end of each year which reduces the risk exposure for the investors, assuming RM_t does not depend on the loss or gain in year t.

Instead, we can assume that the Risk Margin at the end of year t after a loss in the amount of SCR_{t-1}, equals αRM_t, with α a fixed parameter, $0 \leq \alpha \leq 1$. This means that after a loss in the amount of SCR_{t-1}, the RM at the end of year t is reduced by a factor α compared to the expected Risk Margin RM_t.

RM_t is the expected RM, which is assumed to emerge in case there is no loss or gain before the end of year t.

The recursive formula above now becomes as follows:

$$RM_{t-1} \times \left(1 + rf_t\right) = (SCR_{t-1} - RM_{t-1} + \alpha RM_t) \times CoCr + RM_t,$$

hence:

$$RM_{t-1} = [SCR_{t-1} \times CoCr + RM_t \times (1 + \alpha\ CoCr)]/\left(1 + CoCr + rf_t\right)$$

and

$$RM_0 = CoCr \times \sum\nolimits_{t=0}^{n-1} SCR_t \times \frac{(1 + \alpha CoC)^t}{\left(1 + CoC + r_{t+1,0}\right)^{t+1}}. \tag{5}$$

It is not straightforward to determine α based on an actual portfolio, as it depends on the particular combination of unhedgeable risks that may lead to an aggregate loss in the amount of the SCR. For example, a large increase in lapse rates gives rise to a different RM after occurrence of the loss than a large increase in longevity.

To make a comparison with Equation (4), the adjusted formula proposed by EIOPA, we can however set the parameter α in such a way that RM_0 according to (5) equals RM_0 according to (4). Note that when setting $\alpha = 0$ and $rf = 0$, Equation (1) from Section 1 arises.

The table below shows a comparison of the RM determined based on Equations (1)–(5) for RM_0, which are:

(1) Equation (1) proposed in Section 1, discounting future Cost of Capital at the 6% required rate of return,
(2) the current Solvency II formula,
(3) the adjustment taking into account the release of Risk margin unaffected by losses,
(4) the adjustment proposed by EIOPA,
(5) the adjustment taking into account a proportional release of the RM following a loss in the amount of the SCR with the proportion α such that RM_0 is the same as under (4).

These results are shown under a pattern of future SCRs[5] for a sample life insurer with very long liabilities, such as one carrying mainly annuities or funeral insurance. Also, the results are shown for various discount rate levels, i.e. fixed discount rates of 0%, 2% or 4% and the EIOPA Risk-Free curve for December 2023 without VA (see EIOPA (2023)).

Table 1. RM under Various Alternatives for Sample Life Insurer with Very Long Liabilities

		RM_0 according to Equation				
SCR Duration*	Risk-free Rates	(1)	(2)	(3)	(4)	α such that (4) = (5)
27.0	$rf_t = 0\%$, all t.	0.83	2.58	2.44	1.64	$\alpha = 0.71$
20.9	$rf_t = 2\%$, all t.	0.83	1.59	1.54	1.09	$\alpha = 0.67$
16.4	$rf_t = 4\%$, all t.	0.83	1.10	1.08	0.81	$\alpha = 0.65$
18.8	EIOPA RFR 12-23 no VA	0.83	1.41	1.37	0.99	$\alpha = 0.66$

*SCR Duration is determined as: SCR Duration $= \sum_{t=0}^{n-1} \frac{SCR_t \times (t+1/2)}{(1+r_{t+1,0})^{t+1/2}} / \sum_{t=0}^{n-1} \frac{SCR_t}{(1+r_{t+1},0)^{t+1/2}}$.

The derivation of the results in Tables 1 and 2 can be viewed in the Supplementary material.

It is important to note that the results in Table 1 only show the direct sensitivity of the RM on discount rates, as the amount and run-off pattern used are identical under each alternative. However, there will also be a substantial reduction in current and future SCRs when interest rates rise, as future losses in SCR scenarios are discounted at higher rates. Hence the total impact of interest rates on the RM can be expected to be considerably larger than shown in this table.

As expected, Equation (1) leads to the lowest result in almost all cases. Comparing Equations (2) and (4), it is apparent that the adjustment proposed by EIOPA in Equation 4 has a profound impact on the RM, which is more pronounced when discount rates are lower. Only in the case that the risk-free rate equals 4% (or higher) for all durations, does the adjusted formula proposed by EIOPA (Equation (4)) yield a lower result than Equation (1).

[5] $SCR_0 = 1$, see Appendix A for the full SCR projection.

Equation (1) is generally less conservative than Equations (2)–(4), as it assumes no RM needs to be held after a loss in the amount of the SCR. On the other hand, there is implicit prudence in Equation (1) as it uses risk-free rates equal to zero for all durations, whereas the other equations use actual risk-free rates. Equation (1) has the added advantage that, given SCR projections, it is not sensitive to changes in risk-free rates.

The correction applied in Equation (3) leads to a minor reduction of the RM compared to Equation (2), the current Solvency II Risk Margin formula. Equation (4), suggested by EIOPA, is equivalent to Equation (5) with a parameter α ranging between 0.65 and 0.71 This means that for this portfolio, Equation (4) is equivalent to assuming a reduction of the RM after a loss in the amount of the SCR, by approximately one third.

Table 2 below shows the results for an SCR pattern[6] relating to a portfolio with moderate duration, which could represent an insurer with a more mixed portfolio of products.

Table 2. RM under Various Alternatives for Sample Life Insurer with Moderate Duration Liabilities

		RM_0 According to Equation				
SCR Duration	Risk-free Rates	(1)	(2)	(3)	(4)	α such that (4) = (5)
10.1	$rf_t = 0\%$, all t	0.41	0.68	0.64	0.55	$\alpha = 0.70$
8.6	$rf_t = 2\%$, all t.	0.41	0.56	0.53	0.46	$\alpha = 0.69$
7.5	$rf_t = 4\%$, all t.	0.41	0.47	0.45	0.40	$\alpha = 0.69$
8.3	EIOPA RFR 012-23 no VA	0.41	0.53	0.51	0.45	$\alpha = 0.69$

Given this pattern of SCRs, results of the different methods are closer together than for the sample insurer with very long liabilities, as could be expected. Equation (4) yields a lower result than Equations (2) and (3) but greater than Equation (1), again with the exception of the cases when a discount rate of 4% or higher is used.

The values of α used in Equation (5) to arrive at identical results in Equation (4) are now all much closer to 0.70. An advantage of Equation (5) over Equation (4) is that the underlying assumption can be made explicit by setting the parameter α.

3. The Perspective of the RM as Contingent Capital Arrangement

In the Cost of Capital method, the RM represents the present value of future costs of capital, i.e. expected future cash flows from the RU to investors, discounted to the valuation date. Hence the model for the RM is a discounted cash flow model.

In conventional discounted cash flow models, the discount rate equals the required rate of return, which in this case would be the risk-free rate plus 6% per annum. In the Solvency II RM model, however, future cash flows are discounted at risk-free rates.

As argued by Waszink (2013), it is generally inconsistent to discount risky incoming cash flows at risk-free rates, which also leads to the Cost of Capital possibly being higher than the capital requirement itself. The incongruity between traditional discounted cash flow models and the Solvency II RM model was also noted in Meyers (2017).

A main difference between more conventional discounted cash flow models and the model under consideration here is that, in the former, capital is generally provided only once. However,

[6]See Appendix A for the full SCR projection.

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we will now determine the RM under the premise that it should allow for additional capital to be raised at future points in time as well, when and if required. This was also the starting point for the approach outlined in Section 2 above, but not in Section 1.

The approach under this perspective is however different from the approach of Section 2 in the way that possible future capital raisings are valued up front. In Section 2, it was shown that using risk-free discounting allows new capital to be raised each year in the amount of the SCR after a loss in the same amount. In fact, the number of times that additional capital could be raised following losses in the amount of the SCR was not limited to once a year when using the approach of Section 2.

At any time after the occurrence of losses no greater than the SCR, new capital could be raised to replenish Own Funds of the RU. Hence, at least in theory, when using the approach of Section 2, new capital could not only be raised once a year but an unlimited number of times.

Thus, the level of the RM determined in this way provides a level of assurance to policyholders that exceeds Solvency II requirements. Aggregate unexpected losses in any year that can be absorbed by the RU are not limited to the amount of SCR, as there is no (theoretical) limit to the number of times additional capital can be raised within a single year.

Furthermore, using the approach of Section 2, it was assumed that additional capital could be raised with certainty from new, yet uncommitted, investors after the occurrence of any loss not exceeding the SCR. This implies that the probability that fresh capital indeed needs to be raised after the RU is initially funded, does not factor into the derivation of the RM.

The probability of having to raise capital in the full amount of the SCR once is however already small. The probability of having to raise capital equal to the SCR more than once is still much smaller, let alone the probability of having to raise capital in the amount of SCR every year to full run-off.

The market value of possible future capital raisings, if they should indeed form part of the RM, should therefore reflect the probability that such capital raisings will indeed occur. Especially when future capital raisings will occur with extremely low probability, their contribution to the market value of unhedgeable risk, as perceived by investors at the valuation date, may be small.

Put differently, the RM represents the Market Value of unhedgeable risk in the liabilities of the RU at the time of valuation. If the costs of potential future capital raisings are deemed to form part of the liabilities at the valuation date, then these costs should be valued at the same date.

They should then reflect the (low) up front probability that such capital raisings will take place. The amount and timing of such funding will be uncertain and contingent upon the occurrence of losses in the RU over time.

In the next paragraph, we will aim to develop a model for the valuation of the unhedgeable risk in the RU, including contingent future capital raisings, using Cost of Capital as the general approach.

3.1. Valuation Model

We use the following (simplifying) assumptions:

- In each year t, unhedgeable risk occurs which affects Own Funds at the end of year t by an amount UR_t.
- The UR_t are random variables that fully reflect all uncertainties that impact Own Funds over the run-off period of the liabilities. Hence the RU is not exposed to any other risks. $UR_t > 0$ means there is an unexpected increase in Own Funds over year t, $UR_t < 0$ means there is an unexpected decrease in Own Funds.
- The distributions of UR_t are fully known at the valuation date ($t = 0$), and $\mathrm{E}[UR_t] = 0$ for each t. Hence the SCR_t, the Solvency Capital Requirements at the end of each year t, are also known at the valuation date for all future years t.

- The loss that can occur in any year t is no larger than SCR_{t-1}, hence $P[-SCR_{t-1} \leq UR_t] = 1$.
- The UR_t for different years t is independent. If the occurrence of a large loss in any year reduces the RM in later years, as discussed in Section 2, then the assumption of mutual independence of the UR_t is a prudent assumption.
- SCR_t is determined annually and capital raisings, if they occur, will take place no more often than once a year.
- In any year in which UR_t <0, capital providers provide risk-free assets to the RU in the amount – UR_t.
- In any year in which UR_t >0, capital providers receive risk-free assets from the RU in the amount UR_t.
- The risk-free rate equals zero for all durations.

Cash flows to and from investors (CF_R_t), Own Funds exposed to risk (OF_R_t) and Own Funds in total (OF_t) are now as in Figure 3:

	CF_R_t	CF_RF_t	OF_R_t	OF_t
t=0:	$-SCR_0 + RM_0$	$-RM_0$	$SCR_0 - RM_0$	SCR_0
t=1,2,…,n:	$SCR_{t-1} - SCR_t + UR_t$	$RM_{t-1} - RM_t$	$SCR_t - RM_t$	SCR_t

Figure 3. Cash flows and own funds – Contingent capital perspective

CF_R_t : net cash flow from/to investors exposed to Risk,
CF_RF_t : risk-free net cash flow from/to Investors,
OF_R_r : Own Funds at the end of year t, exposed to risk,
OF_t : total Own Funds at the end of year t,
RM_t : Risk Margin at the end of year t,
SCR_t : SCR at the end of year t,
t : number of years after the valuation date,
n : number of years to full run-off.

The only difference with the overview in Figure 1 of Section 1 is that UR_t is added to risk-bearing cash flows CF_R_t. As a result, CF_R_t are not the expected but rather the actual cash flows.

In addition to the release of the SCR, investors now receive or supply an additional amount of UR_t each year, which has a minimum of minus SCR_t. As a result, total assets in the RU are still equal to SCR_t at the end of each year.

One can also assume that at the end of each year, the incumbent investors receive an amount ($SCR_{t-1} + UR_t$) and withdraw, after which new investors enter and provide SCR_t. Such a change of investors does not change the position of the RU and therefore does not affect the valuation.

Investors do not only supply an amount (SCR_0 – RM_0) to the RU at time $t = 0$. They also commit, at time $t = 0$, to providing amounts equal to minus UR_t in any year t where UR_t has a negative value, next to receiving an amount (SCR_{t-1} – SCR_t). In any year in which UR_t is positive, investors will receive a total amount (SCR_{t-1} – SCR_t +UR_t). As UR_t in different years is independent, there is diversification between different years.

The next question is how RM_0 should be determined such that investors are adequately compensated for the risk they are exposed to. We can once again require that the Net Present Value of the expected cash flows to and from investors equals 0 when applying a discount rate of *CoCr*. Doing so ensures that the expected rate of return to the capital provider(s) over the entire period equals *CoCr*.

But as $E[UR_t] = 0$ in all years, it is immediately clear that expected cash flows are not affected by the addition of UR_t to the annual cash flows. Hence, setting RM_0 as in Equation (1) in Section 1 would still lead to an expected return of *CoCr* on the risk-exposed capital provided at the valuation date[7]. Nonetheless, the commitment to provide capital in future years in case of losses clearly increases risk for investors. This extra risk should therefore be reflected in the required rate of return.

A disadvantage of this approach is therefore that the expected return to investors is expressed relative to the original capital requirement, and not to the amounts that may have to be provided at later stages. As a result, discounted cash flow methodology may be considered less suitable, and alternative valuation methods may be more appropriate.

Finally, as mentioned above, we have assumed that the UR_t are mutually independent. If the occurrence of a large negative value of UR_t reduces the risk of further large negative values in later years, the overall risk to investors over the lifetime of the liabilities is reduced. As a result, a lower overall rate of return would be required than if the UR_t were independent.

Note however, that to satisfy the condition that UR_t represents the total impact of unhedgeable risk in year t, the UR_t must be uncorrelated although not necessarily independent. See Appendix B for a proof of this result.

4. Summary and Comparison of Approaches

In this paper, three methods have been discussed to determine the RM using Cost of Capital as the general approach. Each of these methods is based on a different interpretation of Solvency II legislation.

The first approach, discussed in Section 1, takes the perspective of the initial provider of capital to the Reference Undertaking (RU) at the valuation date. As there is no obligation to provide additional funding at a later stage, the capital provided at the valuation date is deemed to be sufficient to fully support the liabilities over their lifetime. This perspective is based on wording in the Level 1 legislative text of Solvency II, as well as the original intention to achieve a BBB financial strength rating.

Under this approach (Equation (1) in Section 1), the present value of future expected returns to investors is discounted at the required rate of return, assuming risk-free rates equal to zero. The main advantage of this approach is that this is a simple approach that is in line with conventional discounted cash flow valuation methodology. As risk-free rates are not used in the RM formula, there is only an indirect sensitivity of the RM to these, through projected SCRs for future years.

As this approach does not allow for additional capital to be raised after the valuation date, it is generally less conservative than the approaches discussed in Sections 2 and 3. However, the assumption that risk-free rates equal zero, given future SCR projections, leads to a degree of implicit prudence in case actual risk-free rates are positive.

In the second approach, discussed in Section 2, risk-free rates are used for discounting. It is assumed that following a loss in the amount of SCR, further capital requirements are reduced by a fixed factor compared to the originally projected SCR (Equation (5) in Section 2).

An advantage of this approach is that capital of the RU can be replenished after large losses, leading to increased security for policyholders.

Disadvantages are, firstly, that the RM may prove to be excessive as there are no limits- at least in theory- to the number of times additional capital can be raised by the RU. Secondly, the (extremely) low probabilities of having to raise additional capital repeatedly are not factored into the valuation. Finally, using risk-free rates for discounting leads to high sensitivity of the RM to changes in risk-free rates, especially for liabilities with long durations.

In the third approach, discussed in Section 3, the Risk Margin is viewed as a contingent capital arrangement. Investors not only provide capital at the valuation date but also commit to providing additional capital when and if Own Funds of the Reference Undertaking fall below the SCR. Under this approach, Equation (1) in Section 1 still applies, where the additional risk of having to raise further capital must be reflected in the required rate of return.

[7]A similar model specification is followed in Meyers (2017).

An advantage of this approach is that the (extremely) low probabilities of having to raise additional capital repeatedly are reflected in the RM at the valuation date, albeit implicitly. Investors assess up front what additional return they require for their commitment to provide additional capital in the future when and if required. The other properties of the approach discussed in Section 1 also apply here as the same formula is used.

A disadvantage of this approach is that discounted cash flow methodology may be less suitable to value the contingent commitment to raise additional capital in the future in case of shortfalls. The required rate of return is applied only to the original capital requirement, and not to the amounts that may have to be provided at a later stage.

5. Conclusions

The Risk Margin serves as an approximation to the market value of unhedgeable risks, for which actual market prices are not readily available. In essence, the Cost of Capital method used in Solvency II is a discounted cash flow method aimed at determining the present value of future cash flows to investors.

In commonly used discounted cash flow models, expected cash flows are discounted at the required rate of return. In the Solvency II formula for the Risk Margin, on the other hand, cash flows are discounted at risk-free rates.

Other than the required rate of return, there are several implicit assumptions in the Cost of Capital approach of Solvency II that have a profound impact on the Risk Margin, especially for liabilities with long durations. Main assumptions relate to how the Risk Margin will be impacted by the occurrence of severe losses. It is generally expected that the Risk Margin will be lower after the occurrence of large losses than otherwise.

Furthermore, it is not clear from Solvency II legislation to what extent the Reference Undertaking should be able to refinance itself in case large losses occur repeatedly. If so, another matter is how the cost of raising capital in the future should be valued at present, where such capital raisings are (extremely) unlikely to occur.

To conclude, different interpretations of the purpose and conditions that should apply when using Cost of Capital methodology for the Risk Margin can lead to major differences in its value. Therefore, a more precise specification of the function of the Risk Margin and underlying assumptions is desirable.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1357321724000047.

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References

AAE. (2019). A review of the design of the Solvency II risk margin. Discussion paper, Actuarial Association of Europe, available at https://actuary.eu/wp-content/uploads/2019/12/Solvency-II-Risk-Margin-FINAL.pdf

ABI (Association of British Insurers). (2017). Comments Template on Discussion Paper on the review of specific items in the Solvency II Delegated Regulation, European Insurance and Occupational Pensions Authority, Page 55, available at https://register.eiopa.europa.eu/Publications/Comments/Comments%20received%20by%20Association%20of%20British%20Insurers_02-05-2017.pdf.

CEIOPS. (2007). Advice to the European commission in the framework of the Solvency II project on Pillar I issues – Further advice. Publication, Committee of European Insurance and Occupational Pensions Supervisors. Page 18, available at https://waszinkadvies.nl/CEIOPS_Paper.pdf

Council of the European Union. (2024, January). Interinstitutional File: 2021/0295 (COD) https://data.consilium.europa.eu/doc/document/ST-5481-2024-INIT/en/pdf

EIOPA. (2014). Annexes to the technical specification for preparatory phase (Part I). Technical report, European Insurance and Occupational Pensions Authority. Point 8, page 18, available at https://waszinkadvies.nl/Annexes_EIOPA_2014.pdf

EIOPA. (2018). EIOPA's second set of advice to the European Commission on specific items in the Solvency II delegated regulation. Consultation Paper, European Insurance and Occupational Pensions Authority. Page 350, available at https://register.eiopa.europa.eu/Publications/Consultations/EIOPA-18-075-EIOPA_Second_set_of_Advice_on_SII_DR_Review.pdf

EIOPA. (2020). Opinion on the 2020 review of Solvency II. Publication, European Insurance and Occupational Pensions Authority. Page 30, available at https://www.eiopa.europa.eu/system/files/2020-12/eiopa-bos-20-749-opinion-2020-review-solvency-ii.pdf

EIOPA (2023). Risk-free Term Structures. Solvency II Technical Information, European Insurance and Occupational Pensions Authority, available at https://www.eiopa.europa.eu/tools-and-data/risk-free-interest-rate-term-structures_en

Meyers, G. (2017). A cost of capital risk margin formula for non-life insurance liabilities. In *Casualty Actuarial Society e-forum*, available at https://www.casact.org/sites/default/files/2021-02/2018-Glenn%20Myers.pdf

Pelkiewicz, A.J., Ahmed, S.W., Fulcher, P., Johnson, K.L., Reynolds, S.M., Schneider, R.J., & Scott, A.J. (2020). A review of the risk margin–Solvency II and beyond. *British Actuarial Journal*, **25**, available at https://www.cambridge.org/core/journals/british-actuarial-journal/article/review-of-the-risk-margin-solvency-ii-and-beyond/4B2AAD320E4388A7EE6F1FA3ED69C4C3

Waszink, H. (2013). Considerations on the Discount Rate in the Cost-of-capital Method for the Risk Margin. Preprint, available at https://www.actuaries.org/ASTIN/Colloquia/Hague/Papers/Waszink.pdf

Xiong, J.X., & Idzorek, T.M. (2012). Estimating credit risk and illiquidity risk in guaranteed investment Products. *Journal of Financial Planning*, **25**(7), 38–47. Table 4 page 44, available at https://www.researchgate.net/publication/337840344

Appendix A. SCR Run-off Patterns Section 2

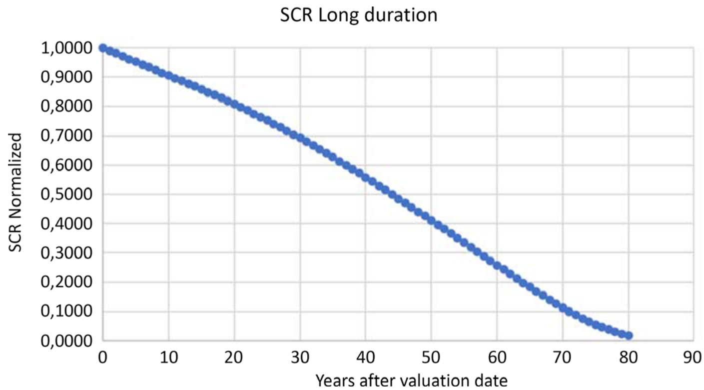

Figure A1. SCR pattern sample insurer long duration, used in Table 1.

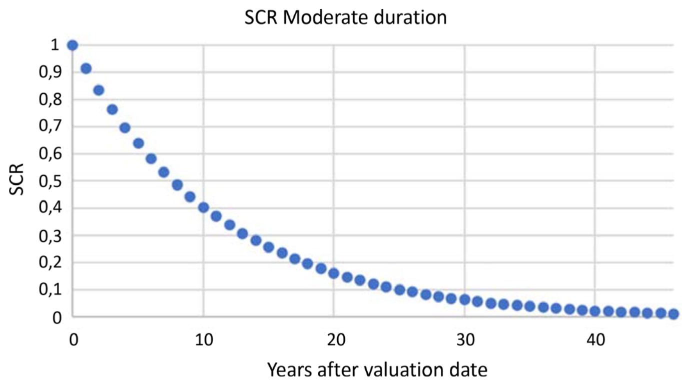

Figure A2. SCR pattern sample insurer moderate duration used in Table 2.

Appendix B. Proof that UR_t in Section 3 must be Uncorrelated

Let $\rho(X, Y)$ be the linear correlation between random variables X and Y.

Recall that: $E[UR_t] = E\left[UR_{t+1}\right] = 0$.

Generally, we have that:

$$E[UR_{t+1}|UR_t] = f(UR_t),$$

with f a function that depends on $\rho\left(UR_t, UR_{t+1}\right)$ and the variances of UR_{t+1} and UR_t.

Hence the total impact on Own Funds at the end of year t of unhedgeable risk that manifests itself in year t equals:

$$UR_t + f(UR_t).$$

But as UR_t represents the full impact of unhedgeable risk in year t we also have:

$$UR_t + f(UR_t) = UR_t, \text{ so that :}$$

$$f(UR_t) = 0 \text{ for all outcomes of } UR_t.$$

Therefore,

$$0 = E[UR_{t+1}|UR_t] = E\left[UR_{t+1}\right].$$

The conditional expectation of UR_{t+1} given UR_t is the unconditional expectation of UR_{t+1}. This is only the case if $\rho\left(UR_t, UR_{t+1}\right) = 0$.

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