Regulatory insight

Minimizing the required capital under Solvency II for credit portfolios

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The Solvency II capital charge has become an important aspect in portfolio construction and asset allocation for insurance companies, next to the traditional trade-off between risk and return. There are various ways to lower the Solvency II capital charge, such as investing in mortgages or government-related private loans.\(^1\) In this article we focus on constructing “Solvency II efficient” credit portfolios.

We discuss how to minimize the solvency capital requirement (SCR) under the standard model of Solvency II for a given target return.\(^2\) The methods developed can be used to construct “Solvency II efficient” credit portfolios. We conclude that the overall SCR of an insurance company can be minimized by applying a barbell-like strategy. This strategy uses high duration high-rated instruments to minimize the SCR and low duration low-rated instruments to reach the target return.

**Standard SCR calculation under Solvency II: an introduction\(^3\)**

We start with an overview of the overall SCR calculation under Solvency II. Readers who are familiar with this topic can continue with the next section, where we focus on the treatment of spread risk under Solvency II.

The SCR is the required capital to withstand a severe stress scenario, occurring once every 200 years. The SCR is equal to a basic solvency capital requirement (BSCR) plus a required capital for operational risk (Op) and an adjustment for the risk-absorbing effect of technical provisions and deferred taxes (Adj).

Figure 1 shows the overall structure of SCR calculation. The BSCR combines the capital requirements for six major risk categories:

- Market risk
- Health underwriting risk
- Counterparty default risk
- Life underwriting risk
- Non-life underwriting risk
- Intangible assets risk

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\(^1\) See Van Bragt (2017a) and Van Bragt (2017b) for more information.

\(^2\) Insurance companies can develop their own internal model to calculate the required capital, but approval of the regulator of an internal model is needed.

\(^3\) See EIOPA (2014) and EU (2015) for a detailed specification of the standard SCR calculation under Solvency II.
Figure 1: Structure of the overall SCR calculation.\(^4\)

Note that these risk categories are typically broken down into more sub categories (e.g. market risk is subdivided in interest rate risk, spread risk, equity risk, property risk, etc.). In this article we specifically focus on the SCR for spread risk, part of the market risk module, which is relevant for credit bonds (i.e., investment grade credits).

**Standard treatment of spread risk under Solvency II**

Article 175 in EU (2015) states that the SCR for spread risk is equal to \(\text{SCR}_{\text{bonds}} + \text{SCR}_{\text{securitization}} + \text{SCR}_{\text{cd}}\) where

- \(\text{SCR}_{\text{bonds}}\) denotes the SCR for spread risk on bonds and loans;
- \(\text{SCR}_{\text{securitization}}\) denotes the SCR for spread risk on securitization positions;
- \(\text{SCR}_{\text{cd}}\) denotes the SCR for spread risk on credit derivatives.

We focus on bonds and loans in our analysis, so we assume \(\text{SCR}_{\text{securitization}}\) and \(\text{SCR}_{\text{cd}}\) to be zero.

In practice, the SCR for spread risk depends on the rating and duration of the bond or loan. The SCR is equal to the decrease of the own funds (i.e., surplus) of the insurance company due to an instantaneous (relative) decrease of stress of the value of each bond or loan \(i\). The risk factor stress depends on the credit rating and modified duration (\(\text{dur}\)) of the bond or loan \(i\), according to Table 1.\(^5,6\)

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\(^5\) EU (2015), Article 176/2.
\(^6\) Duration refers to spread duration in the remainder of the text.
The SCR for spread risk increases for lower ratings and higher durations, which is graphically represented in Figure 2. So, to give an example, for a BBB-rated credit with a duration of 5 the SCR is equal to 12.5%.

**Example portfolio versus benchmark**

As an example, let’s consider an insurer who has invested part of its assets in investment grade credits. The rating weights of this insurer’s credit portfolio, and the corresponding benchmark, are presented in Table 2. Short positions (so negative weights) are not allowed. The duration per rating and spread in basis points (bp) are also presented. The spread refers to credit spread in the remainder of the text.
spread is defined as the spread over the swap rate at the corresponding duration of the credit bond and corrected for expected losses (EL).

<table>
<thead>
<tr>
<th>Rating</th>
<th>Duration</th>
<th>Spread (in bp) corrected for EL</th>
<th>Rating weights example portfolio</th>
<th>Rating weights benchmark</th>
<th>Max. absolute deviation from the benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>-</td>
<td>-</td>
<td>0%</td>
<td>0%</td>
<td>No restrictions</td>
</tr>
<tr>
<td>AA</td>
<td>5.7</td>
<td>44</td>
<td>5%</td>
<td>10%</td>
<td>No restrictions</td>
</tr>
<tr>
<td>A</td>
<td>4.3</td>
<td>78</td>
<td>34%</td>
<td>40%</td>
<td>20%-points</td>
</tr>
<tr>
<td>BBB</td>
<td>4.8</td>
<td>132</td>
<td>60%</td>
<td>50%</td>
<td>10%-points</td>
</tr>
<tr>
<td>BB</td>
<td>3.1</td>
<td>1</td>
<td>1%</td>
<td>0%</td>
<td>N.A.</td>
</tr>
<tr>
<td>Weighted average</td>
<td>4.7</td>
<td>109</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Example portfolio and benchmark.

In our analysis we assume that the insurer only buys credits with an investment grade rating (i.e. not lower than BBB). Due to downgrades, the portfolio however contains a small percentage of bonds with a rating of BB (= 1.0%). These instruments should typically be sold within a certain grace period. We also require that our credit portfolio tracks the benchmark within a certain bandwidth. This means that for A and BBB-rated credits the percentage allocated to these instruments cannot deviate too much from the benchmark. The example portfolio has a duration of 4.7 and a spread of 109 bp.

Solvency II efficient credit portfolios
We investigate in this section which investment grade credit portfolios are most capital-efficient under Solvency II. We observe that efficient solutions can be created applying simple barbell-like strategies. These strategies consist of high duration high-rated instruments to minimize the SCR and low duration low-rated instruments to reach the target return.

Below, we first generate the set of efficient portfolios that minimize SCR and then unravel the underlying strategy. Secondly, we also analyze the effect of maximizing the ratio of the spread and the SCR. This ratio is the additional return obtained for every unit of SCR. To conclude, we optimize for the maximum capital-adjusted return, based on the weighted average funding cost for an insurance company. With these three methods we study how to optimize credit portfolios under Solvency II.

We note that we only consider the standalone SCR for spread risk in our optimization and do not investigate the impact on the overall SCR (i.e., including diversification) as presented in Figure 1. We also aim to minimize the SCR while reaching a certain target return and duration. In our optimization, the duration of the optimized credit portfolio should remain the same as the duration of the example portfolio in Table 2.

We assign all credits in the example portfolio to three different durations (3, 5 and 7) to simplify the analysis. Applying the portfolio information in Table 3 we can now calculate the SCR for spread risk based on the weights per rating and duration. This number is approximately 9.3% for the example portfolio.

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8 The expected losses are 0 bp for AAA and AA, 10 bp for A and BBB and 233 bp for BB.
Stylized example portfolio

<table>
<thead>
<tr>
<th>Rating weights</th>
<th>Spread (in bp) corrected for EL</th>
<th>SCR portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>example portfolio</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Duration</td>
<td>Duration</td>
<td>Duration</td>
</tr>
<tr>
<td>Rating</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>AAA</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>AA</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>A</td>
<td>17%</td>
<td>11%</td>
</tr>
<tr>
<td>BBB</td>
<td>24%</td>
<td>17%</td>
</tr>
<tr>
<td>BB</td>
<td>1%</td>
<td>0%</td>
</tr>
<tr>
<td>Total</td>
<td>42%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Table 3: Stylized example portfolio.

1. **Minimizing the SCR**

Figure 3 shows the efficient solutions that minimize the SCR for a given spread. This figure also shows the worst solutions, which are those solutions that maximize (instead of minimize) the SCR for a given spread.

![Figure 3: Optimization results, also compared with the example portfolio and the worst solutions.](image)

To be expected, we see that optimizing at a higher spread level will result in an increasing SCR. We also observe a significant gap between the efficient frontier and the worst solutions, which means that optimization is a useful exercise, especially for spreads below 110 bp. For higher spreads the possibilities to optimize the SCR become less. We also show that the example portfolio can be improved while keeping the portfolio duration and spread constant.

The composition of the efficient credit portfolios is shown in Figure 4.
Figure 4: Allocation of all efficient credit portfolios to the specific ratings and durations.

**Duration of 3**

- AAA
- AA
- A
- BBB
- BB

**Duration of 7**

- AAA
- AA
- A
- BBB
- BB
We observe that solutions on the efficient frontier mainly consist of an allocation to low duration (3) low-rated instruments (A or BBB) and high duration (7) high-rated instruments (AAA or AA). To obtain portfolios with a spread of more than 90 bp, an allocation to high duration (7) lower-rated instruments (A) is also needed. For example, the solution on the efficient frontier with a spread of 110 bp consists of approximately 60% BBB-rated instruments with a duration of 3 and approximately 40% A-rated instruments with a duration of 7.

In Table 4 we show four examples of Solvency II efficient credit portfolios which are constructed applying the barbell-like strategy while maintaining the portfolio duration at approximately 4.7.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Spread (bp)</th>
<th>Allocation to rating and duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>AAA</td>
</tr>
<tr>
<td>A</td>
<td>64</td>
<td>41% duration 7</td>
</tr>
<tr>
<td>B</td>
<td>83</td>
<td>41% duration 7</td>
</tr>
<tr>
<td>C</td>
<td>99</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>109</td>
<td>42% duration 7</td>
</tr>
</tbody>
</table>

Table 4: Solvency II efficient credit portfolios applying the barbell-like strategy

These ‘handcrafted’ portfolios all lie on the efficient frontier. In practice, the portfolio duration can also be managed applying a separate overlay of interest rate derivatives. This makes a higher allocation to instruments with a duration of 3 possible.

2. Maximizing the ratio of spread and SCR

Next, we analyze the effect of the optimization on the ratio of the spread and the SCR. This is the additional return obtained for every unit of SCR. See Figure 5 for the results.
This figure shows that the example portfolio can be improved with respect to the spread to SCR ratio while maintaining the same return and portfolio duration. This figure also shows that a portfolio with a spread of more than 110 bp leads to a lower (optimal) spread / SCR. This means that obtaining an additional unit of excess return above 110 bp is relatively more expensive in terms of SCR. The results of this analysis also show that barbell-like strategies generate optimized portfolios on the efficient frontier.

### 3. Maximizing the capital adjusted return

Finally, we include the effect of funding costs in our analysis. Insurance companies typically take into account the cost of capital when setting the appropriate target return. As an approximation, we use the weighted average cost of capital (WACC) for this purpose. The WACC is the funding cost for the insurance company which will vary according to the company’s capital structure. We optimize the capital adjusted return which we define as $Yield - WACC \times SCR\%$, where

- $Yield = \text{spread} + \text{swap rate at a certain spread duration}$;
- $WACC$ (weighted average cost of capital) = funding cost for the insurance company.

In our analysis we assume a swap rate of 0.11% for a spread duration of 5 and a WACC of 10%.\(^9\) The results of optimizing the credit portfolios are presented in Figure 6.

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\(^9\) See Grabowski et al. (2015).
Figure 6: Optimizing the credit portfolio when accounting for funding costs.

This figure shows that the example portfolio can be improved with respect to the capital adjusted return. The capital adjusted return is optimized for a spread of 110 bp, also in line with the results in Figure 5. And again, the barbell-like strategies are on the efficient frontier.

Conclusion
In this article we study which credit portfolios are most efficient under Solvency II. We observe that efficient solutions can be created applying simple barbell-like strategies. These strategies consist of high duration high-rated instruments to minimize the SCR and low duration low-rated instruments to reach the target return. These strategies also hold when we allow for the effect of funding costs thus maximizing the capital adjusted return for an insurance company given a certain target spread.
References


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