A series of practical papers on Interest Rate Risk Management under Solvency II

Part 1: Managing the Standard Formula SCR

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Introduction

EIOPA, the European Insurance and Occupational Pensions Authority, as part of its Solvency II review, proposed updates to the approach used to derive yield curves. This update attempts to balance several competing concerns, including liquidity considerations, market consistency, and counter-cyclicality. As one would expect, such considerations are often in conflict. Successfully threading the appropriate regulatory needle therefore involves some finesse.

In our prior paper, “Introduction to the Changes in the Solvency II Yield Curve and the Implications for Hedging,” we explored the nature of the proposed changes by the EIOPA as they relate to discount curve construction. In particular, we examined how the new ‘Alternative Methodology” modified the current approach to constructing discount curves under Solvency II, and the implications for hedgers of insurance liabilities. In that paper, we kept the analysis generalized, and did not explore the intricacies of any particular subject. However, we did identify three key areas that warranted further attention: managing Solvency Capital Requirements; assessing the impact of changing swap market liquidity on key interest rate modelling assumptions; , and exploring how to manage Solvency ratios through time, with particular focus on implicit hedging of UFR, LLP, and SoC changes, all while keeping a view on the underlying economics.

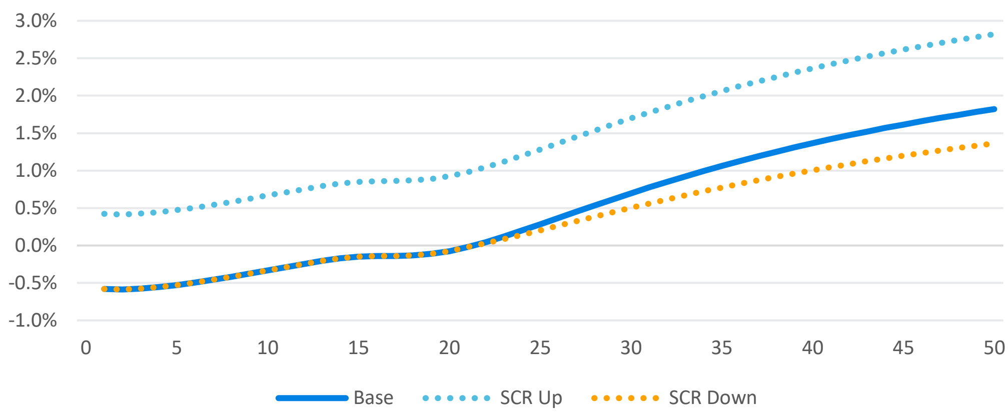
This current paper addresses the first issue, namely how hedgers can manage Solvency Capital Requirements, given the details of the proposed changes communicated by EIOPA in its consultation document. Subsequent papers will explore each of the other two items.

Current methodology to calculate the SCR

In order to determine the Solvency Capital Requirements (SCR) for interest rate risk, assets and liabilities are revalued using the yield curves from two scenarios: an interest rate up shock, and an interest rate down shock. The magnitudes of these stressed scenarios are prescribed. The stresses are applied relative to the Solvency II risk-free interest rate term structure. The capital required is set equal to the more severe net impact of the two shocks.

For the down interest rate sensitivity, a floor is applied, which restricts the shock to the non-negative portion of the yield curve. That is, if the base interest rate is negative, the calculation of the SCR will not apply an additional downward shock to that rate. The application of this floor for yield curves that contain both positive and negative rates results in a flattening of the yield curve under the down shock. There is no analogous cap on the up shock scenario. However, the regulations mandate that the difference between the base curve and the shocked curve be no less than 100 bps at all points. Figure 1 illustrates these features.

FIGURE 1: IMPACT OF STANDARD FORMULA INTEREST RATE RISK SCR SHOCKS ON THE SOLVENCY II RISK-FREE INTEREST RATE CURVE, IN EUR AS OF THE END OF SEPTEMBER 2020



It is important to note that the standard formula prescribes that in SCR calculations, the Risk Margin remains fixed. For this reason, the SCR calculations for interest rate risk only covers the assets and the best estimate liabilities (BEL).

Shortcomings of current SCR methodology

It is one of the abiding ironies in risk-neutral pricing theory that there was a strong push away from Gaussian models to lognormal models in the 2000s because the former could produce negative rates, which many viewed as unrealistic. In this vein, when regulators initially calibrated the standard formula shocks, they did so with that same view in mind. Subsequently, EIOPA concluded in their 2018 review[1] of the standard formula that negative rates are not only possible but can persist indefinitely. As such, the current calibration severely underestimates this risk.

The above is not the sole limitation of the current framework. In addition, the method used to measure interest rate risk deviates significantly from most internal models. Third, the alternative proposals impact assessments reveal material risk not captured in the current framework. As all these limitations suggest, there is general stakeholder agreement that the current approach needs a refresh.

[1] source: https://www.eiopa.europa.eu/sites/default/files/publications/pdfs/eiopa-18-075-eiopa_second_set_of_advice_on_sii_dr_review_0.pdf

Proposed SCR methodology

EIOPA RECOMMENDATION FOR THE 2018 REVIEW OF THE STANDARD FORMULA

As part of the 2018 review, EIOPA provided an alternative methodology, referred to as the Relative Shift approach. EIOPA analysed several approaches to better align the calibration of the interest rate capital charge. EIOPA recommended this Relative Shift approach for calibration for the following reasons:

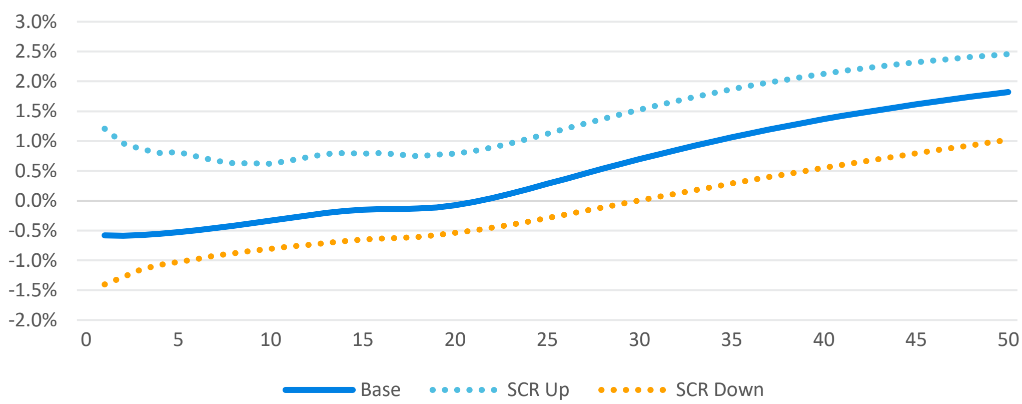
- The methodology is simple and transparent
- It is a purely data driven approach
- It is a risk-sensitivity approach that remains applicable in any interest rate environment
- It can well cope with low and negative interest rates

EIOPA's 2018 proposal recommended replacing the existing shocks with the following:

- In the upward scenario, a declining relative shock for each maturity, in the range of +61% for one-year maturities to +20% for the longest maturities. In addition, for maturities up to 60Y an absolute shock is applied that decreases in magnitude starting from 2.14% for one-year maturities to 0% in 60-year maturities.
- In the downward scenario, a declining relative shock by maturity, in the range of -58% for one-year maturities to -20% for the longest maturities. In addition, for maturities up to 60Y an absolute shock is applied that decreases in magnitude starting from -1.16% for one-year maturities to 0% in 60-year maturities.

Figure 2 illustrates the shocks applied to the Solvency II risk-free curve as per September 2020.

FIGURE 2: IMPACT INTEREST RATE RISK SCR SHOCKS UNDER THE RELATIVE SHOCK APPROACH ON THE SOLVENCY II RISK-FREE INTEREST RATE CURVE, IN EUR AS OF THE END OF SEPTEMBER 2020



The European Commission chose not to adopt this proposal, however, and recommended revisiting the subject as part of the 2020 review.

EIOPA RECOMMENDATION FOR THE 2020 REVIEW OF THE STANDARD FORMULA

EIOPA re-affirmed its recommendation for a Relative Shift approach in its 2020 review. As the discussion above makes clear, the current shocks no longer correspond to a 99.5% Value-at-Risk level for basic Own Funds. In order to achieve this risk-level, modification is necessary, and only an approach that allows for shocked rates to become more negative will succeed in accomplishing that.

STAKEHOLDER PROPOSAL

Though many stakeholders agree that a move to a Relative Shift approach makes sense, that view is far from universal. EIOPA's own Insurance and Reinsurance Stakeholder Group (IRSG) opposed[2] to the proposed alternative interest rate risk

[2] Source: https://www.eiopa.europa.eu/content/advice-interest-rate-risk-proposal-solvency-ii-review-2020_en

methodology advance several arguments against its adoption. The Relative Shift approach in its current form would severely impact the Solvency II ratio, since in the downward shock interest rates would largely become negative. Furthermore, some believe that the new downward shock lacks economic justification. For example, Insurance Europe[3] commented that the revised floor in the downward shock scenario results in negative interest rates that are perceived as "too low" and "unrealistic." As the current low interest environment is partly caused by the quantitative easing policy of the European Central Bank (ECB), Insurance Europe argues that under current legislation rates would not and perhaps could not get much lower than currently observed. That is, while the formerly prevailing economic view that interest rates could not go negative was wrong, defining a new shock using distributional arguments divorced from economic reasoning is not the proper response. Indeed, it may result in a material overcorrection.

In this paper we do not investigate the counterproposal by the IRSG, since not all details are available to do a full analysis. Consequently, we focus on the current SCR methodology and the proposal with the Relative Shift approach.

Impact of alternative extrapolation

According to the EIOPA consultation the proposed interest rate calibration for the Smith-Wilson method with a last-liquid point (LLP) of 20 years and the alternative extrapolation method with first-smoothing point (FSP) of 20 years coincide. Theoretically, differences could arise from interpolated rates before the LLP/FSP. In practice the Smith-Wilson interpolation and the interpolation of the alternative extrapolation method yield very similar results. In view of these small differences no recalibration of the interest rate risk shocks for the alternative extrapolation method was carried out.

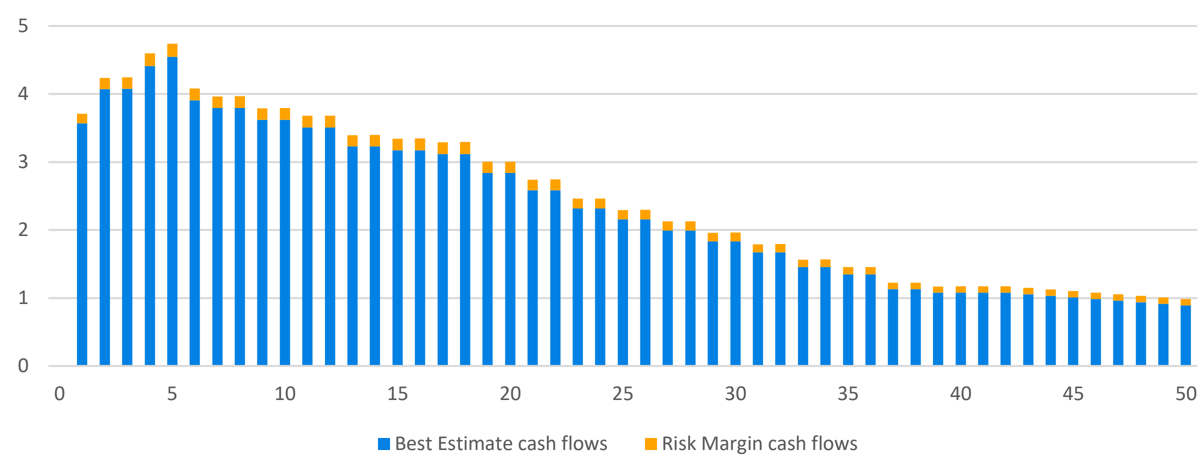
As a second order effect, the level of the extrapolated curve does have an impact on the SCR outcomes, as the lower discount curve leads to a higher sensitivity of the liabilities. For simplicity reasons we ignore the alternative extrapolation method in this paper and focus on the difference arising from the SCR methodologies.

Impact analysis and implications for hedging

GENERAL APPROACH

The proposed alternative interest risk calibration will have implications on insurers hedging strategies. In particular, the removal of the floor on negative interest rates will change interest rate dynamics for companies that use the standard formula. To assess its implications, we have analysed several hedge strategies on a set of proxy liabilities. For the proxy liability we use cash flows[4] that represent an average Dutch life insurer. The cash flows have the following pattern:

FIGURE 3: INSURANCE LIABILITY (BEL AND RISK MARGIN) CASH FLOWS OF A TYPICAL DUTCH LIFE INSURER



[3] Source: https://www.insuranceeurope.eu/insurance-industry-views-solvency-ii-review

[4] A proxy cash flow, internally constructed, representing an average Dutch Life insurance company is used for the calculations. The cash flow is calibrated to have a duration of 16 when applying the Solvency II curve including the VA at the end of 2019.

In setting up the hedge portfolio it is important to make a distinction between BEL and Risk Margin cash flows. Hedging the interest rate risk SCR implies interest rate shocks are only applied to the BEL. When hedging the Own Funds the interest rates sensitivity of both the BEL and Risk Margin are taken into account.

As in all hedging strategies, setting the hedge objective is key, particularly when using multiple metrics in setting the objective. In our situation we have to deal with a metric which measures the level of the Own Funds and a metric which measures the SCR. The key difference between the two is in the effect of calculating a shock. To determine the Own Funds, a shock is applied to the liquid part of the interest rate curve (e.g., up to the LLP of 20Y in the Eurozone) and subsequently extrapolated towards the Ultimate Forward Rate (UFR). When calculating the SCR, an absolute shock is applied to the full Solvency II discount curve and hence there is also an impact to the extrapolated (non-liquid) part of the curve..

We analyse the impact of two different hedge objectives in this paper, (1) to minimise the SCR and (2) to minimise the Own Funds sensitivity. In addition, we study the impact of the adjusted SCR methodology by comparing the results between the current and proposed alternative interest rate risk SCR shocks.

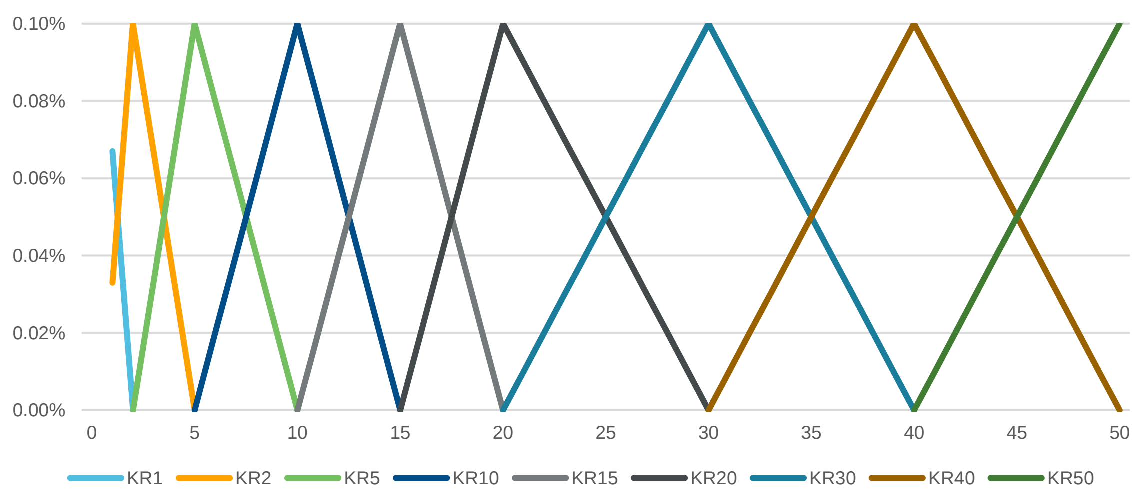
In order to do so, for each scenario, we construct a hedge portfolio for both objectives. Scenarios are defined as different historical curves, which additionally enables us to assess the hedging implications in different interest rate environments.

The process for setting the hedge portfolio is explained in more detail in the next section.

INTRODUCING DIFFERENT HEDGING STRATEGIES

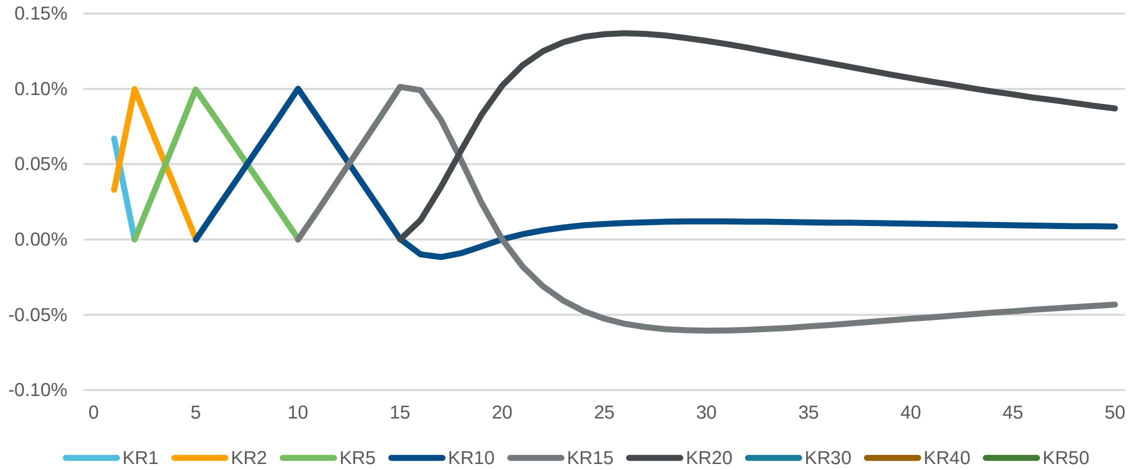
In our prior paper, we quantified interest rate sensitivity using DV01, the currency value change in an asset or liability given a 1 basis point change in the yield curve. Analogously, we calculate key rate DV01 using 1 bp triangle shocks centered at the relevant key rate, with the triangle's vertices extending to the adjacent key rates. Figure 4 illustrates this approach.

FIGURE 4: TRIANGLE SHOCKS APPLIED TO KEY RATES



When applying the Smith-Wilson extrapolation methodology after shocking the liquid part of the curve, the implicit triangle shocks have the shape shown in Figure 5 on page 6.

FIGURE 5: EFFECT OF SMITH-WILSON EXTRAPOLATION METHODOLOGY AFTER SHOCKING THE LIQUID PART OF THE CURVE



As explained in our previous paper, this sensitivity would imply a large short position at 15Y and a strong overcompensation of the sensitivity at 20Y. Consequently, a hedging strategy which neutralizes the modeled rate exposure necessitates large, opposing hedge rebalances as time passes.

In this paper we have decided to ignore this technicality and aim for practical hedge portfolios. We constructed the hedge portfolios to match with their hedge objective with the following considerations in mind:

1. **Hedging the SCR for interest rate risk (SCR hedge)**

   Hedge portfolio: We construct an asset portfolio that minimizes the SCR for interest rate risk. The asset portfolio consists of 5Y, 10Y, 15Y, 20Y, 30Y, 40Y and 50Y interest rate swaps.

   Valuation of the liabilities: The liabilities' cash flows are discounted using the Solvency II curve adjusted for the respective up or down shock. We consider the up and down shock in both the Standard Formula approach and the Relative Shock approach. An illustration of the shock sizes is given in the next section.

   Valuation of the assets: The asset cash flows are discounted using the 6M EURIBOR swap curve adjusted for the absolute change of the Solvency II curve in the up and down scenario.

2. **Hedging the Own Funds impact of interest rate movements (OF hedge)**

   Hedge portfolio: We construct an asset portfolio that minimizes the Own Funds impact to changes in the interest rate curve following the SCR interest rate shock.

   Valuation of the liabilities: The liquid terms on the interest rate curve are shocked in accordance with the relevant interest rate risk shocks. Then, the interest rate curve is extrapolated using the applicable extrapolation methodology. To reflect the effects of negative interest rates becoming more negative, the floor (applicable under current SCR risk downward shock) on negative interest rates is not taken into account.

   Valuation of the assets: We discount the assets using the 6M EURIBOR swap curve corrected for the absolute change of the Solvency II curve in the up and down scenario.

As introduced before, with an SCR hedge the Solvency II curve including the UFR is shocked upwards and downwards, implicitly shifting the UFR. An Own Funds hedge requires shocking only the liquid interest rates, with extrapolation occurring subsequently. Re-extrapolating the curve dampens the effects of shocks to the interest rate curve, which results in different interest sensitivities across the curve. Consequently, while measuring the SCR, the more extensive shocks effectively cause liabilities to have higher duration and convexity measurements.

In the process of setting up the hedge portfolios we also made the following assumptions:

1. Given that short-term interest rate swaps are more liquid than longer dated interest rate swaps, we assumed that most of the liability cash flows are hedged using short-term interest rate swaps. We further assumed that at least 80% of the liability cash flows up to 15Y are perfectly hedged using interest rate swaps at 5Y, 10Y, and 15Y.
2. Portfolio optimization is such that it requires a minimum amount of assets to hedge the liabilities.
3. When setting up an Own Funds hedge: We did not use interest swaps with a maturity beyond the LLP of 20Y (following the analysis in Figure 5).
4. When setting up an SCR hedge: Interest rate swaps beyond the LLP 20Y cannot have a larger notional than its prior maturity, e.g., notional 20Y > notional 30Y > notional 40Y > notional 50Y.

For the main body of our analysis, we have used data representing the end of the third quarter of 2020. To illustrate the effect of different interest levels, we also provide a historical overview at the end of this paper.

SETTING UP HEDGE PORTFOLIOS TO MINIMISE THE SCR

This section presents the interest rate risk SCR-minimisation hedge portfolio. The interest rate risk SCR is calculated based on the Standard Formula approach and the Relative Shock approach, with the latter being consistent with the EIOPA Consultation's proposed approach. Using the interest rate curves illustrated in Figure 3 above, we constructed hedge portfolios using the rubric described in the prior section, the results of which are illustrated in Figure 6 below.

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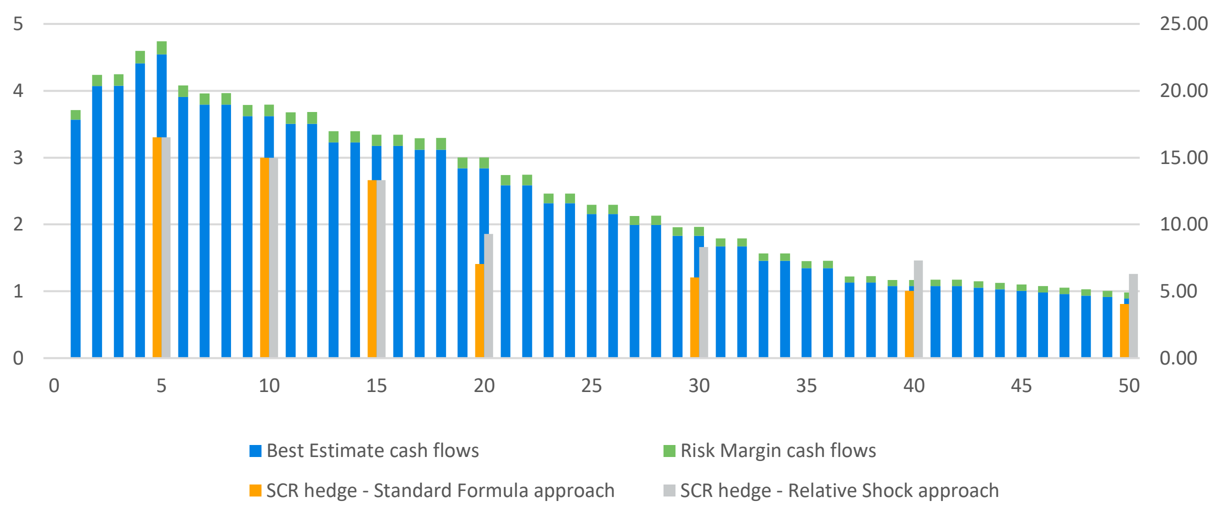
FIGURE 6: HEDGE PORTFOLIOS FOR EACH MATURITY BUCKET WITH ON THE LEFT AXIS THE VALUE OF THE LIABILITY CASH FLOWS AND ON THE RIGHT AXIS THE VALUE OF THE ASSET PORTFOLIOS UNDER BOTH SCR HEDGE METHODOLOGIES



We note here that under both approaches, the SCR minimising hedge, the down shocks result in higher capital requirements than the up shocks.

Analysis of the hedge portfolio for the SCR Standard Formula approach

As a consequence of the combined effect of the methodology and the current low interest rate environment, a substantial part of the Solvency II curve is not shocked downwards. Therefore, the asset portfolio has to hedge asymmetric shocks across the curve. The first constraint prescribes that the 5Y, 10Y, and 15Y interest rate swaps hedge 80% of the liability cash flows. The combination of the second and fourth constraint results in a hedge portfolio with a slowly decreasing notional pattern across the longer maturities.

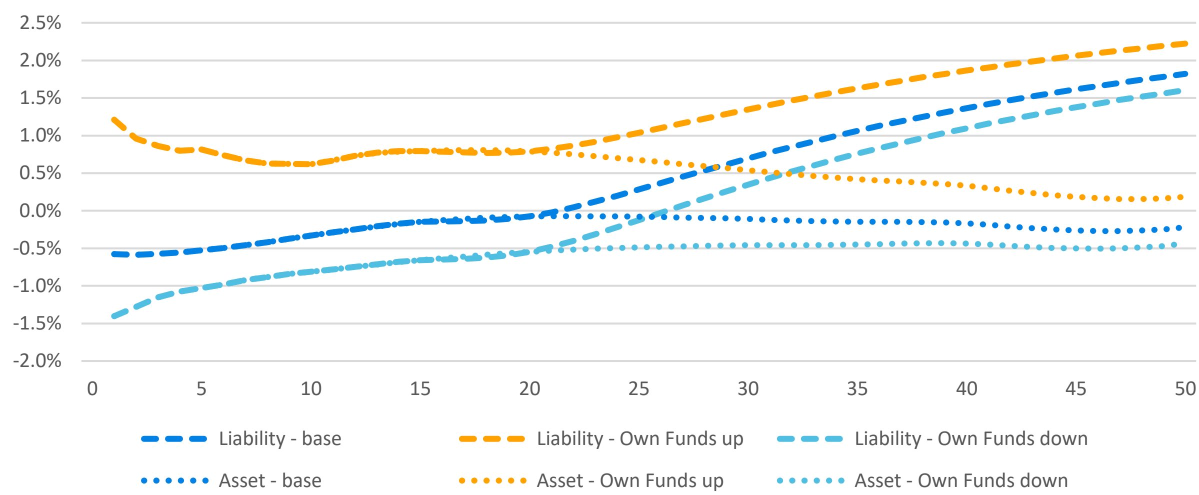
Analysis of the hedge portfolio for the relative shock approach

Compared to the current interest rate risk SCR shocks, the alternative approach leads to more parallel up and down shocks. In particular, for short to medium interest rates (up to 20 years), the removal of the floor impacts hedging on the shorter end of the curve. As a result, hedging the interest rate exposure requires more hedge volume in the asset portfolio.

SETTING UP HEDGE PORTFOLIOS TO MINIMISE THE OWN FUNDS SENSITIVITY

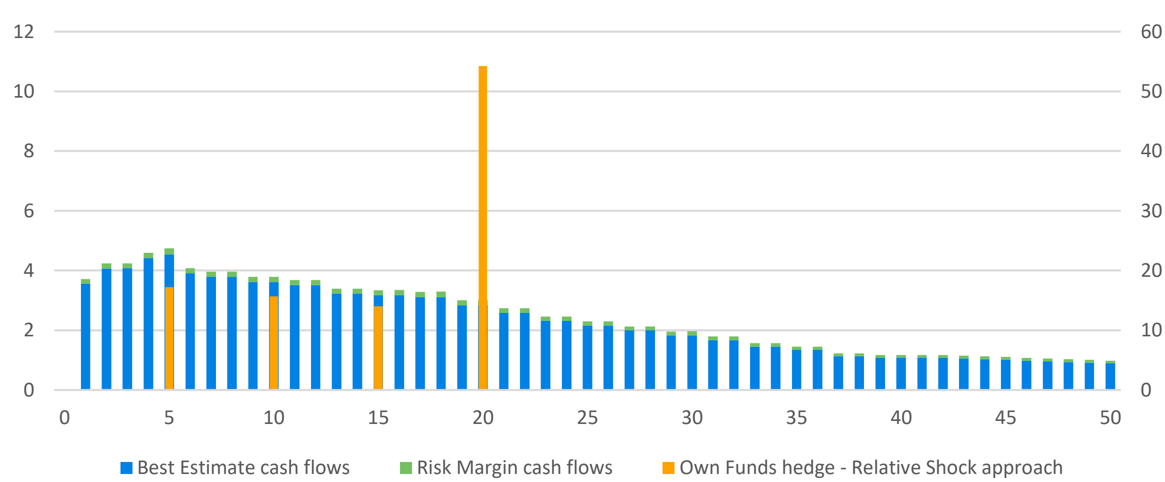
This section presents the hedge portfolio when the objective is to minimise Own Funds sensitivity. Under this hedge, we construct an asset portfolio that minimises the changes in the level of the Own Funds in an up- and down-shock similar to the SCR scenarios. In this scenario the UFR in the interest rate curve is not shocked, since we shock only the liquid terms on the curve. An illustration of the curves used in the hedge is shown in Figure 7.

FIGURE 7: (SHOCKED) ASSET AND LIABILITY CURVES USED IN THE OWN FUNDS HEDGE



The magnitude of the interest rate shocks applied are in line with the relative shock approach. We illustrate the Own Funds sensitivity reducing hedge portfolioin Figure 8.

FIGURE 8: HEDGE PORTFOLIOS FOR EACH MATURITY BUCKET WITH ON THE LEFT AXIS THE VALUE OF THE LIABILITY CASH FLOWS AND ON THE RIGHT AXIS THE VALUE OF THE ASSET PORTFOLIOS UNDER OWN FUNDS HEDGE METHODOLOGY



With the Own Funds hedge, the interest rate sensitivity of both the BEL and Risk Margin is taken into account in setting up a hedge portfolio. With an SCR hedge, we shock only the BEL cash flows, and we do not revalue the Risk Margin. As a result, the Own Funds hedge portfolio has more volume compared to the SCR hedge.

Due to constraints 1 and 3, the bulk of the asset cash flows are at the 20Y maturity. This is in line with the market practice for insurance companies who aim to minimise Own Funds or Solvency II ratio sensitivities. In the third paper of this sequence, we will analyse how to manage the potential conflicts this view has with a more economic view.

IMPACT OF INTEREST RATE LEVELS

To assess the stability of the hedging portfolios over time, we have repeated our analysis of setting up a hedge portfolio using historical interest rate curves. We analysed the past 21 months, back to the end of 2018. In this period interest rates decreased significantly. For example, the 20Y rate decreased from 1.30% to negative territory in 2020 (-0.08% at the end of the third quarter).

FIGURES 9 AND 10: EVOLUTION OF HEDGE PORTFOLIOS OVER TIME UNDER EACH HEDGE METHODOLOGY—ON THE LEFT AXIS THE AVERAGE PORTFOLIO (LEFT GRAPH) / 20Y ASSET PORTFOLIO (RIGHT GRAPH OVER TIME IS GIVEN, WITH ON THE RIGHT AXIS THE 20Y INTEREST RATE

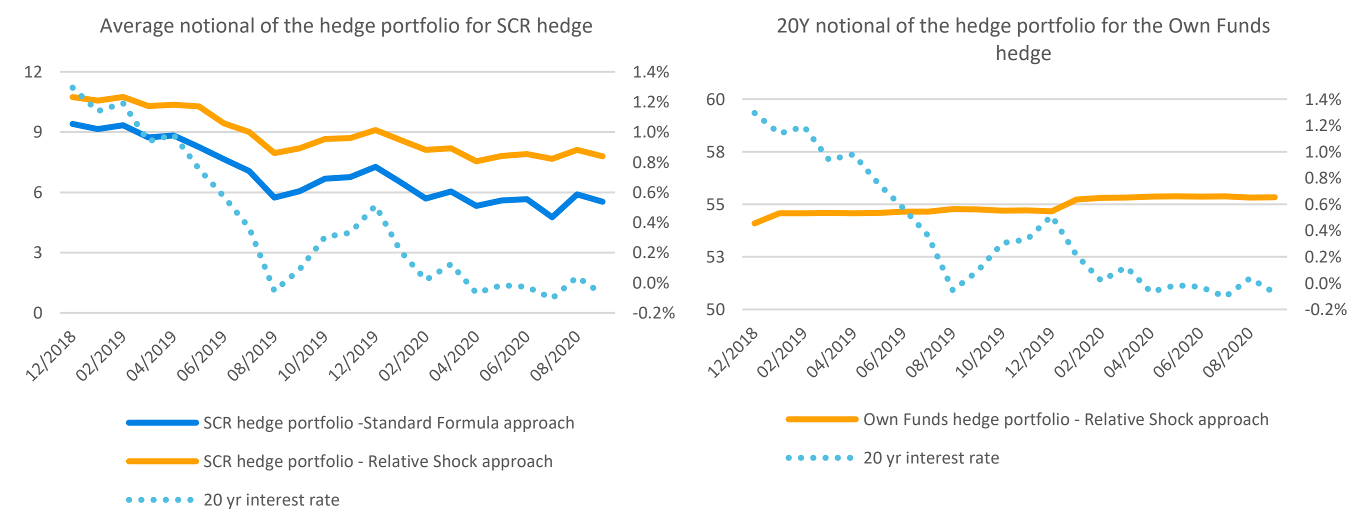


Figure 9 shows the average notional of the asset portfolio across all maturities for the two interest rate risk SCR methodologies. First of all, we can confirm that the average notional required for hedging the SCR is structurally higher under the relative shift approach. As noted previously, this is due to the absence of caps and floors compared to the Standard Formula approach, which therefore requires more interest rate hedging across all terms. Over time the average notional of the portfolio decreases in line with the decreasing interest rates. This is driven by the increased interest rate sensitivity of long-term assets as the level of rates decline. When the UFR is simply extrapolated, however, there is a more muted change to the curve, and thus the liability sensitivity is also lower. In other words, the Smith-Wilson extrapolation causes more asset convexity.

Contrary to the decreasing notionals required for SCR hedging, the average notional in managing the Own Funds sensitivity is stable over time (Figure 10). Again, theoretically, hedging liabilities with assets that have a shorter duration than the liabilities would mean that changing interest rates require continuous asset rebalancing. Over the last observed years interest rates have declined, increasing the convexity on both the asset and liability curves. However, as a result of extrapolation to the UFR, interest rates on the liability curve with a long duration (20Y+) decrease less rapidly compared to the 20Y interest rate on the asset curve. Consequently, the 20Y assets have a higher convexity than the 20Y+ liabilities, such that impact on the liabilities from changing interest rates are offset by changes to the asset portfolio. The “UFR effect” causes the Own Funds hedge portfolio to remain relatively stable over time.

Concluding remarks

In this paper, we explored the implications of EIOPA's alternative methodology for standard formula calculations on hedging strategies. Notable among our results was the declining average notional required to hedge SCR in the scenarios where interest rates decreased, a feature not shared by a Own Fund's hedge target. The primary driver of this behaviour is the increased convexity of the hedging assets as rates decline, with no comparable increase on the liability side. The UFR's effect on the level of rates for the extrapolated part of the yield curve is, in turn, the driver for this more muted liability convexity. The dynamics for Own Funds hedging does not show analogous behaviour because the duration mismatch between assets and liabilities compensates for the convexity mismatch.

In our next paper, we turn to exploring the Deep, Liquid and Transparent (DLT) assessment EIOPA conducted in 2016-2018, with the goal of replicating and updating that work to include the last couple years. We will then discuss the implications for setting the LLP and alternative extrapolation weights. Finally, we will combine that study with the work in this paper to assess the hedging impacts.

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