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Duration Extension: Analysis and Considerations

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THE PURPOSE OF THIS PAPER IS TO INTRODUCE STRATEGIES insurance companies could consider to reduce interest rate duration mismatch between Assets and Liabilities. All the analysis is based on a sample Asset and Liability portfolio of Life Insurance Company XYZ. In the first part, we analyse the residual Surplus (Assets - Liabilities) interest rate exposure and we derive its corresponding benchmark. In the second part, we compare (in terms of risks and rewards) the “swaps-only” vs “swaps + swaptions” duration extension strategies and we find that companies could benefit from the additional convexity introduced by swaptions. In the third part, we introduce the traditional short convexity exposure of with-profit insurance and the benefits of non-linear instruments in this framework.

I. SAMPLE COMPANY'S INTEREST RATES EXPOSURE

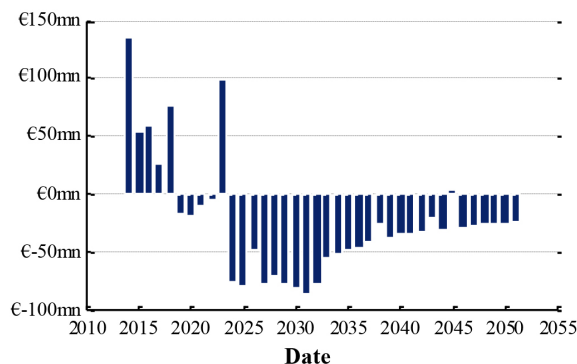
Based on the Asset & Liability profile (related to a particular pool of policies), we derived the net Surplus (Assets – Liabilities) inflows/outflows. We calculated then the interest rate sensitivity of the net Surplus with respect to all tenors of the swap curve and we summa-

rized this sensitivity over different swap buckets (2y, 5y, 10y, 15y, 20y, 25y, 30y and 40y). Based on this analysis, we found that Company XYZ is overall short €1.5mn DV01 between Assets and Liabilities: €600k Asset DV01 vs. €2.1mn Liability DV01. In other words, the net Surplus appreciates/ depreciates by €1.5mn for a +/-1bp parallel shift of the interest rates swap curve. The company is over-hedged on the short-end (0y-5y) and under-hedged on the long-end (10y-40y) of the curve. This means that Company XYZ would need to increase overall duration on the Asset side while entering payer swaps on the short-end to be properly hedged (by buckets) with respect to interest rates. A hedge by buckets would be relevant as the interest rate curve does not move in parallel shifts.

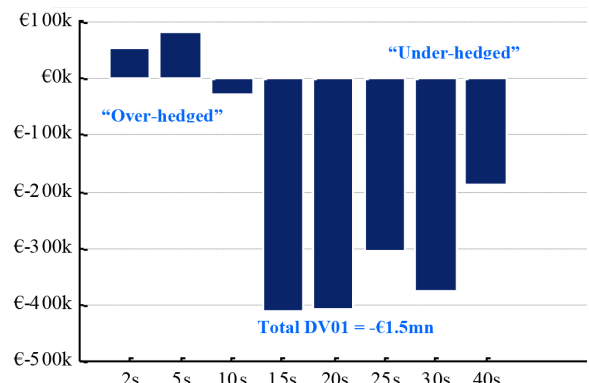
Moreover, the mark-to-market profile of the surplus is negatively convex. This means that for large negative shifts of the interest rates swap curve, the Surplus interest rate sensitivity increases leading to further depreciation. For large positive shifts of the curve, the Surplus interest rates sensitivity decreases which reduce its appreciation.

Creating the Interest Rates Surplus Benchmark

Surplus cash inflows/outflows



Surplus benchmark



“ This means that for large negative shifts of the interest rates swap curve, the Surplus interest rate sensitivity increases leading to further depreciation ”

II. DURATION EXTENSION STRATEGIES

We compare two duration extension strategies to deal with the matter

1. “Swaps only strategy”

The company could increase overall duration exposure while remaining consistent with its partial interest rates curve exposure by deriving the required swap notional to be hedged at 100 percent on each bucket considered. Alternatively, the company could still derive the required notional to reach a target hedge ratio by buckets. In both cases, the company would need to enter 2y and 5y payer swaps while receiving fixed on the remaining tenors.

2. “Swaps + swaptions strategy”

The company could also increase overall duration while remaining consistent with key rate sensitivities by entering receiver swaptions (5y10y, 5y15y, 5y20y, 10y20y) to match its DV01 needs on the long-end segment (15y, 20y, 25y and 30y buckets) of the curve and consider swap overlays in order to reduce the residual DV01 exposure. This strategy could also be executed to reach a target hedge ratio by buckets.

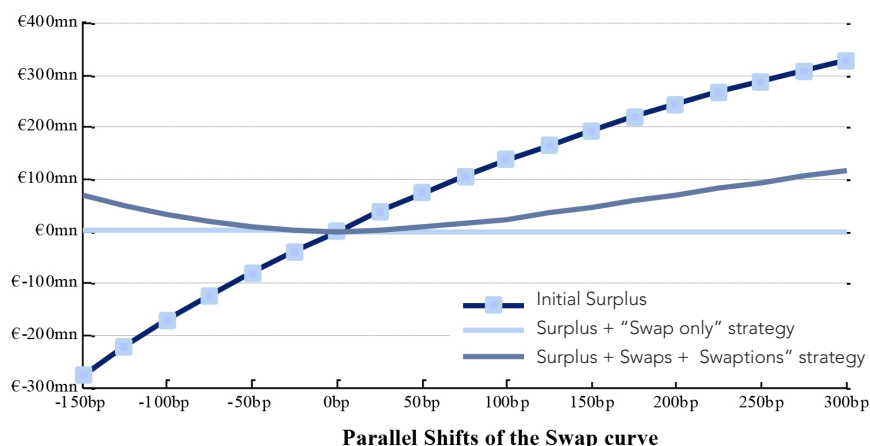
We compare the mark-to-market of the surplus (over different parallel shifts of the curve) for three different alternatives:

Mark-to-Market of the Surplus



- Keeping the same balance sheet position.
- “Swap only duration strategy”: Hedging 100 percent of residual surplus risk with a portfolio of swaps that match key rate sensitivities (by buckets).
- “Swaptions + swaps duration strategy”: Hedging 100 percent of residual surplus risk with a combination of swaps and swaptions.

While the portfolio of swaps considerably removes the risks related to parallel shifts of the curve, the swaption based strategy provides upside (compared to the “swap only” strategy) in both a decreasing and increasing rates scenario thanks to the convexity introduced in the balance sheet.



KEY CONSIDERATIONS

- All the options considered in this analysis are struck at the money forward
- A relative value analysis could potentially be performed to optimise the swaption pair and the strike depending on the company’s objectives and constraints

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Macro & tail risk hedging considerations

Extending duration with swaptions introduces positive interest rates volatility sensitivity (positive “vega” exposure). This could help the insurance company in periods of stresses (when spreads widen and/or equity fall) as rates volatility tends to increase and monetize macro-economic and financial shocks. Swaptions provide offer thus diversification benefits for life insurers who hold traditionally invest in credit and equity markets.

“Swaps-only” strategy

bucket	DV01	start	end	Swap rate	Required notional
2	€ 43,796	18/04/2013	20/04/2015	0.43	-€ 219,572,992
5	€ 67,020	18/04/2013	18/04/2018	0.83	-€ 136,591,770
10	-€ 12,017	18/04/2013	18/04/2023	1.58	€ 12,789,300
15	-€ 382,739	18/04/2013	18/04/2028	2.03	€ 288,121,906
20	-€ 401,669	18/04/2013	18/04/2033	2.19	€ 241,374,814
25	-€ 292,322	18/04/2013	19/04/2038	2.24	€ 149,223,987
30	-€ 360,831	18/04/2013	20/04/2043	2.26	€ 162,496,671
40	-€ 191,716	18/04/2013	18/04/2053	2.31	€ 72,181,223

“Swaps + swaptions” strategy

swaption	expiry	expiry date	starts	tenor	fwd	Strike	DV01	Notional
5y10y	5y	16/04/2018	18/04/2018	10y	2.74	2.74	-€ 267,434	€ 499,983,342
5y15y	5y	16/04/2018	18/04/2018	15y	2.76	2.76	-€ 314,140	€ 411,022,033
5y20y	5y	16/04/2018	18/04/2018	20y	2.71	2.71	-€ 242,907	€ 248,125,625
10y20y	10y	17/04/2023	19/04/2023	20y	2.75	2.75	-€ 249,569	€ 253,773,289

bucket	DV01	start	end	Swap rate	Required notional
2	€ 36,337	18/04/2013	20/04/2015	0.43	-€ 182,176,002
5	-€ 232,070	18/04/2013	18/04/2018	0.83	€ 472,979,177
10	-€ 123,187	18/04/2013	18/04/2023	1.58	€ 131,107,863
15	€ 21,927	18/04/2013	18/04/2028	2.03	-€ 16,506,313
20	€ 16,352	18/04/2013	18/04/2033	2.19	-€ 9,826,357
25	€ 10,750	18/04/2013	19/04/2038	2.24	-€ 5,487,407
30	€ 5,180	18/04/2013	20/04/2043	2.26	-€ 2,332,944
40	-€ 191,716	18/04/2013	18/04/2053	2.31	€ 72,181,223

III. FURTHER CONSIDERATIONS – LIFE INSURANCE CONVEXITY**Life insurers are exposed to both low and high interest rates**

Lower interest rates would adversely impact insurance companies:

- **Cash flow impact:** lower interest rates would expose life insurers to reinvestment risk, as maturing fixed income securities would have to be reinvested at a low yield (potentially lower than minimum guarantees).
- **Business impact:** insurers’ margin could decrease if rates remain low and (potentially) insurers’ ability to maintain market share by paying high bonus rate may be impaired.

A sharp increase in rates could have a material negative impact as well:

“ Life insurers are exposed to both low and high interest rates ”

- **Accounting impact:** available for sale assets would depreciate while liabilities could depreciate less (surrender of policyholders), thereby reducing shareholders' equity.
- **Business impact:** A sharp increase in interest rates would make life insurance less attractive relative to alternative savings products and lead to market share erosion and lapse of policyholders.
- **Regulatory capital considerations:** fast rising rates could translate into a significant solvency risk when surrender is taken implicitly or explicitly into account for regulatory purposes.

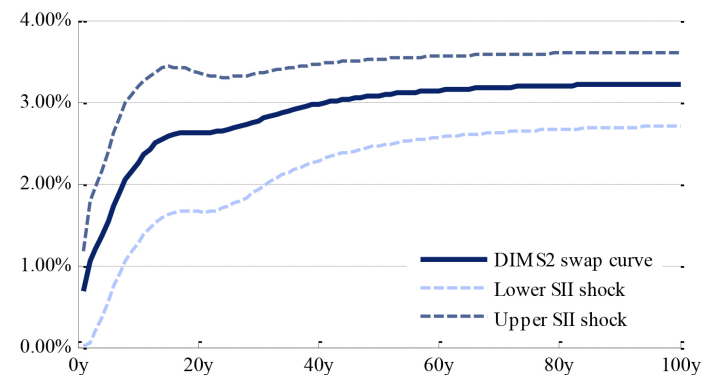
Assuming a market consistent valuation of Assets and Liabilities, the life convexity risk is translated into interest rates volatility squared exposure of shareholders' equity

This could be illustrated using a Solvency II framework where the interest rates capital charge is derived as the highest (in absolute terms) negative mark-to-market change of the Surplus (Assets – Liabilities) after applying both a standard upward and downward stress to the interest rate curve. The graphic below illustrates the altered SII term structures derived from the interest rates swap curve.

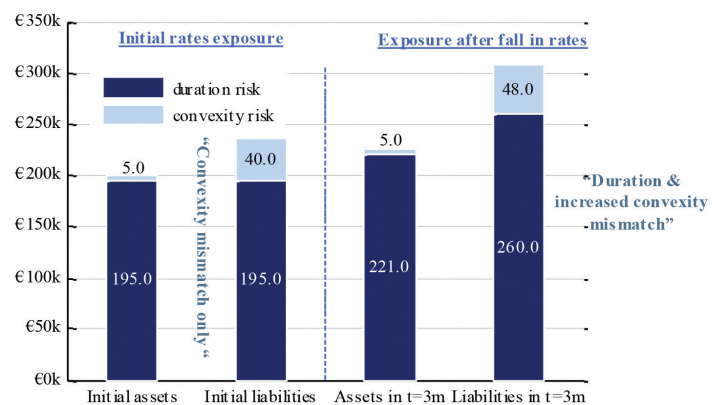
Assuming Assets and Liabilities are DV01 matched, the interest rate capital charge under SII should be either low or limited to the convexity mismatch between Assets and Liabilities. Indeed and for the reasons mentioned above, life insurance Assets tend to display less convexity than Liabilities: when rates fall, insurers need to increase Asset duration as minimum guarantees are in the money and increasing the Liability duration. On the other hand, when rates spike, insurers need to reduce Asset duration as early surrenders reduce the Liability duration.

In order to emphasize the volatility squared exposure, we consider an Asset portfolio which consists of €130mn bonds (15y duration) backing €100mn technical reserves (19.5y duration).

Interest Rate Stress Under Solvency II



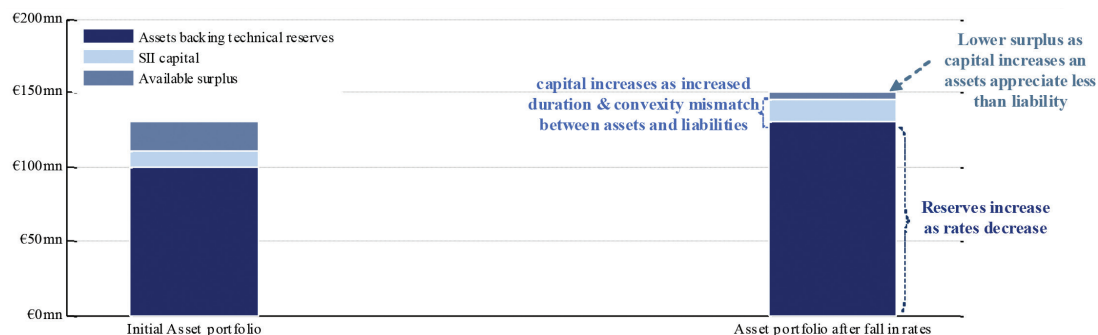
Interest rates exposure



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Interest rates volatility squared Illustrated



The initial asset DV01 (€195k) is matching liabilities DV01 (€195k). However, we assume Liabilities to display a significantly higher convexity profile when compared to the Asset portfolio. The initial interest rates SII capital is assumed to be €10mn. Available Surplus is also assumed to be €20mn.

Following decreased rates over 3 months, Asset portfolio is assumed to have increased to €150mn in market value while reserves increased more quickly to €130mn.

Because Assets and Liabilities are no-longer matched in terms of DV01 (€221k vs. €260k DV01) and because of the convexity mismatch exposure, the SII capital requirement increased to €15mn.

This resulted in available surplus decreasing from €20mn to €5mn because of Liabilities increasing faster than Assets as well as an increased capital requirement. This illustrates the concept of interest rates volatility squared exposure of shareholders' equity.

In this situation, the company clearly need to use non linear interest rates instruments (swaptions for instance) to stabilize Surplus volatility. Swaptions can not only close the gap between Assets and Liabilities when rates move, provide diversification benefits at balance sheet level, reduce capital requirements but also reduce the volatility of Solvency ratios. So this case study provides another reason that swaptions need to be considered when companies think of duration extension. ■