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Impact of Last Liquid Point in the Smith-Wilson Interpolation on Risk Profile of an Insurance Company

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Solvency the Second Directive and Smith-Wilson method

Pan-European regulation for insurance business, Solvency II directive (SII) and pan-European supervisor, EIOPA, opted for the Smith-Wilson (SW) method for the construction risk free yield curves, used in discounting insurance liabilities. But, since even the most developed markets lack of liquid, long enough instruments with marketable prices, SW serves also for extrapolation (up to 120 years). SW enjoys numerous advantages:

- Simple to implement (just a set of linear equations),
- Can be used in both interpolation and extrapolation,
- Strongly reduces sensitivity of very long maturities to market changes,

Parameters of Smith-Wilson

- An Ultimate Forward Ratio (UFR). Tantamount to „long term interest rate”. For most currencies it was set 4.2% and is subject to yearly recalibration,

- Alpha, Convergence Point and Convergence Tolerance together drive shape of a yield curve,

- A Last Liquid Point (LLP), upper maturity of a set of liquid market instruments. Extrapolation starts from this point. Contents of the set are very important, ex., shifting the LLP can bring about very unexpected and unpleasant changes (and this is what this presentation is all about).

Some known issues with Smith-Wilson

Liabilities with maturities longer than the LLP, but close to it, are known to be very sensitive to the spread between the LLP yield and the tenor proceeding the LLP (i.e. between 15 and 20 years). Longer maturities become increasingly insensitive to changes in market rates (because the UFR is fixed).

Difficulties with hedging: since in the SW framework every liability can be expressed in terms of linear combination of maturities from the market instruments sets, one could think it would be easy to hedge liabilities: just take position in market instrument in accordance with their weights. However, in practice, weights of neighbourhood tenors have different signs (oscillatory behaviour). Additionally, weights of market instruments with longer maturities have a tendency to be considerably larger in absolute value than the present value of the hedged liability.

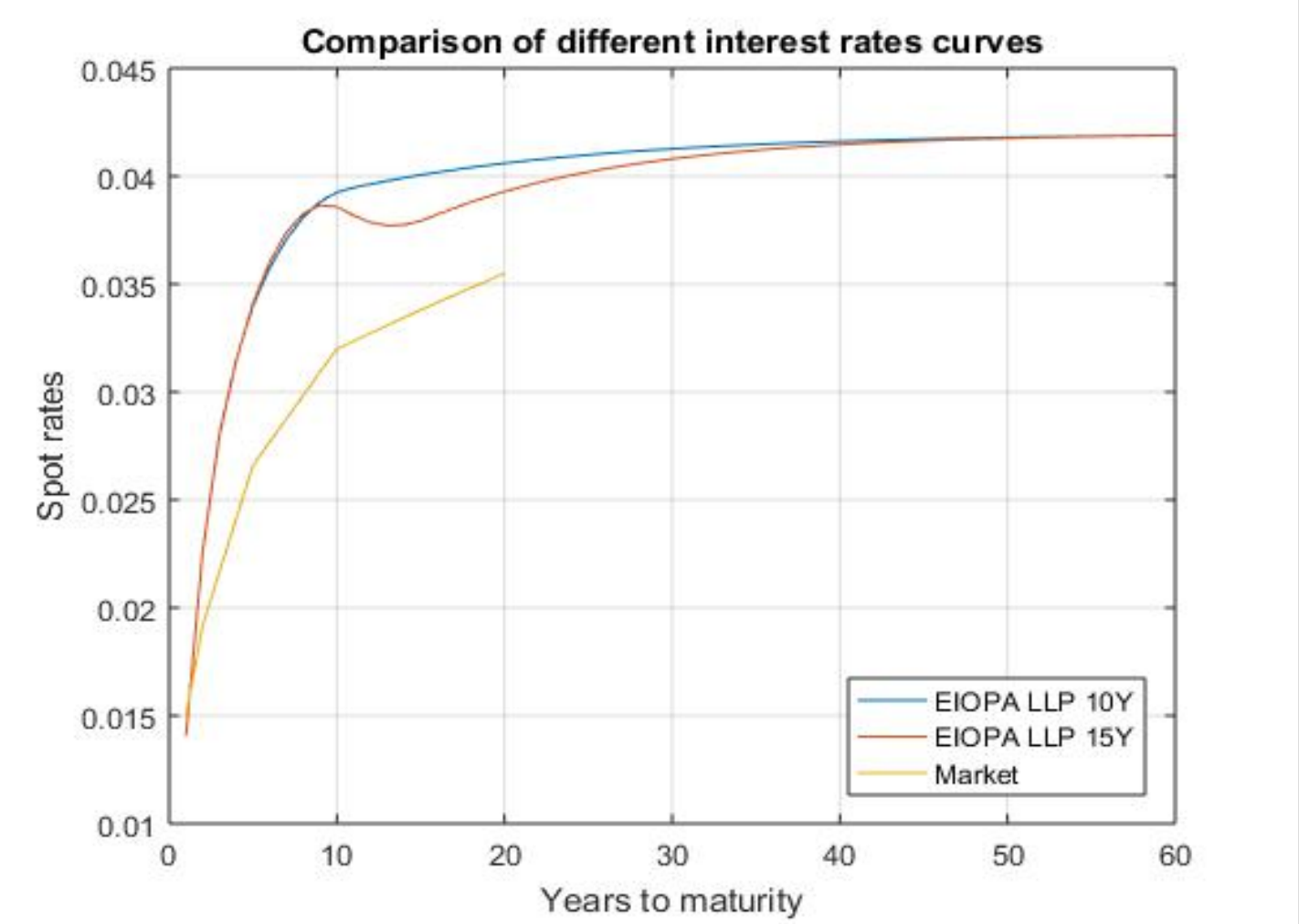
Issues with Smith-Wilson in the ultra-low rates environment

It should be reminded that the SW framework had been designed before the Great Crunch, after which ultra-low rates appeared. The result is that we are immersed in negative rates (short tenors) and very low rates (long tenors, esp. the LLP).

SW curve can resemble two step stairs: from zero at the short tenors to about 1 – 1.5% at the LLP, with steep slope following the first tenor, and from 1 – 1.5% at the LLP to 4.2% at the convergence maturity, with once more steep slope after the LLP tenor.

The curve is clearly divided into real and interpolated part.

Sample SW curves



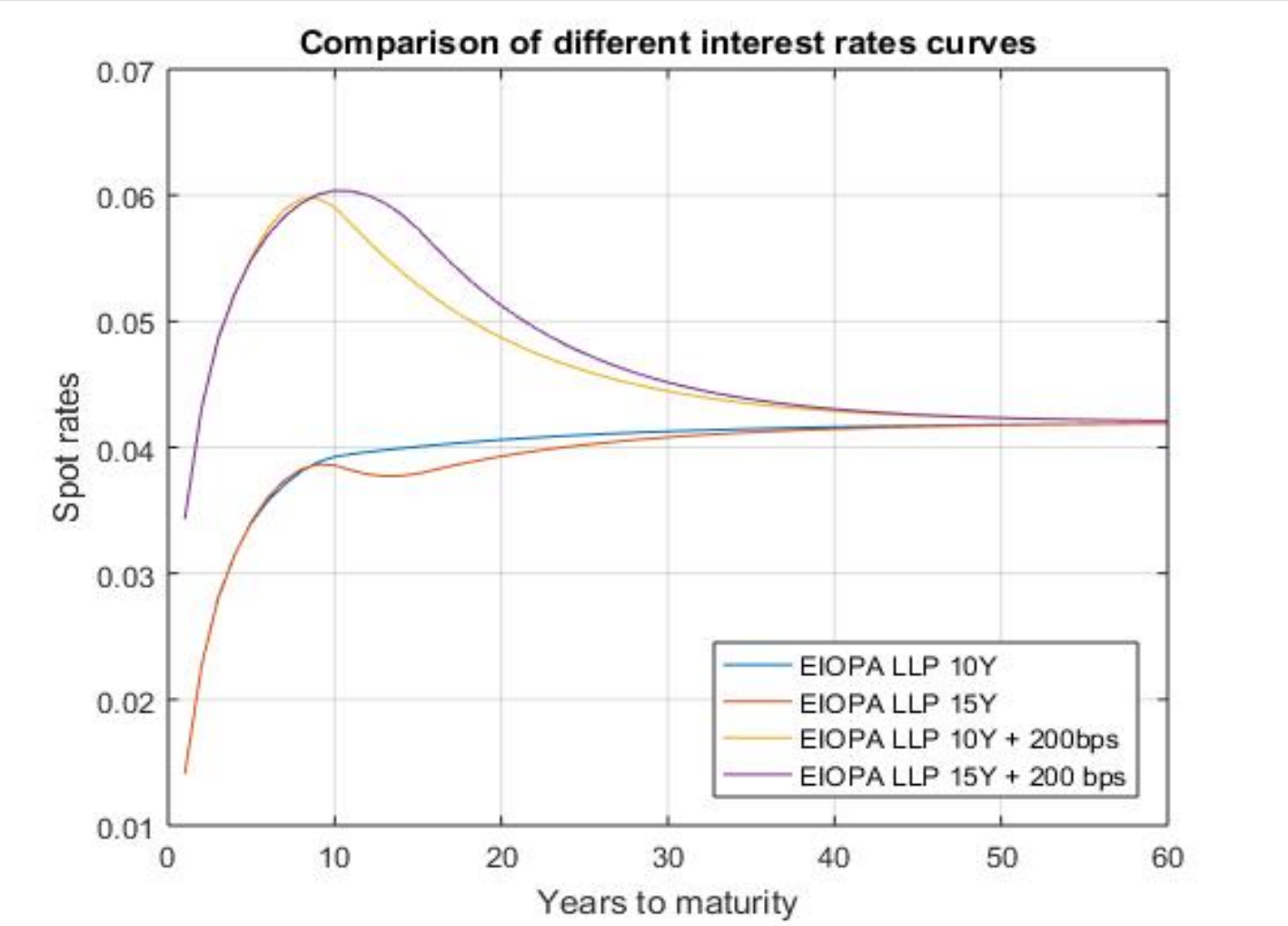
Motivation behind the research

When we had been developing the internal model for market risk in PZU Group, we had experienced an peculiar phenomena:

- By switching the Last Liquid Point, we ended up situation where Value at Risk scenario was determined by raise (when we set LLP at 10Y) or by fall (when we set LLP at 15Y) of the yield curve.
- Essentially, simple modification of one parameter implies change in whole risk profile of the company, so we can not be sure, whether are we exposed to a raise or to a fall in interest rates?

Obviously, we were more than interested why did it happen?

Impact of the LLP shift on SW curves



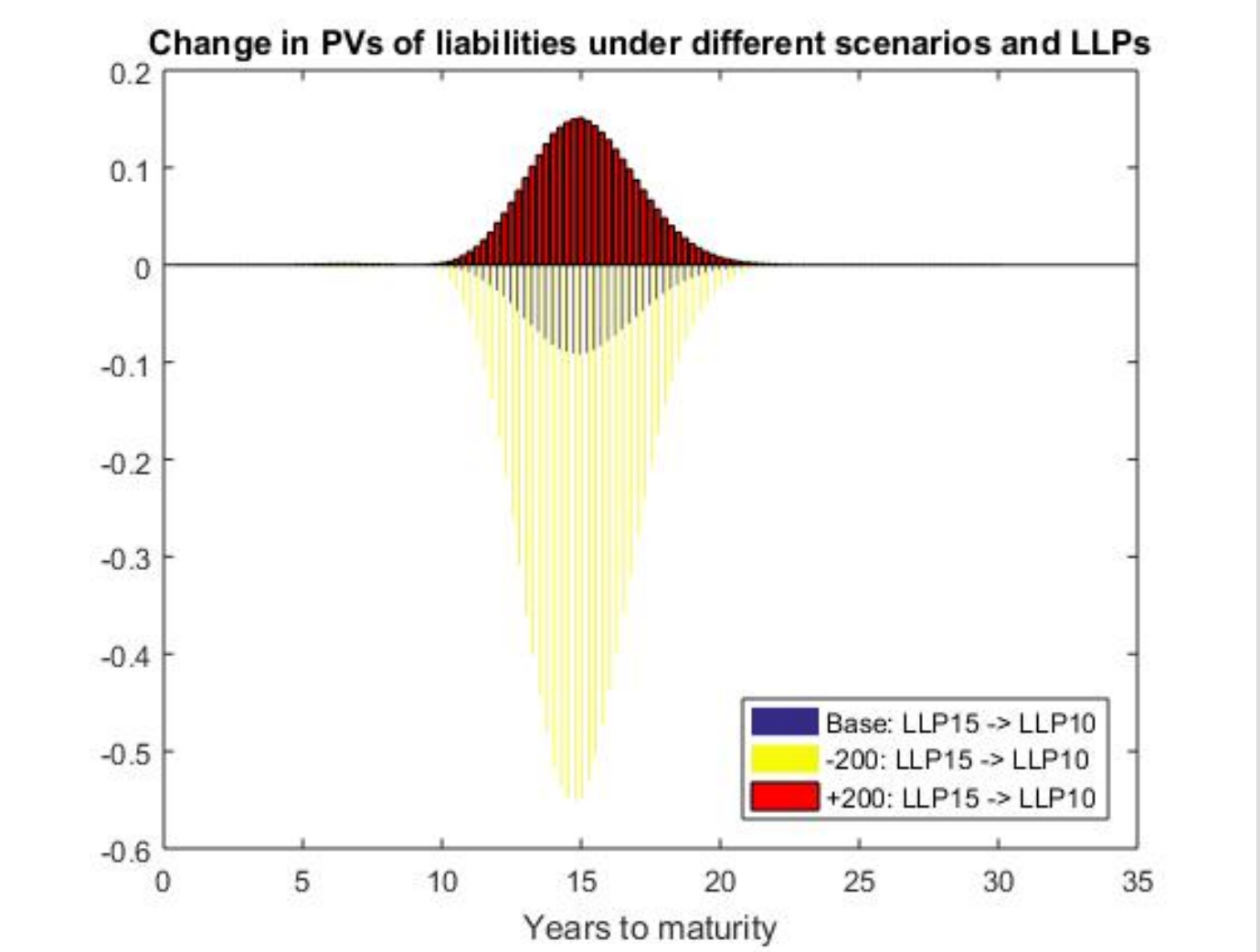
Revelations

If we combine both yield curve move (like stress test scenario or Monte Carlo simulation, here move by +200 bps) with the LLP shift (here from 15Y to 10Y), we can get really extraordinary results:

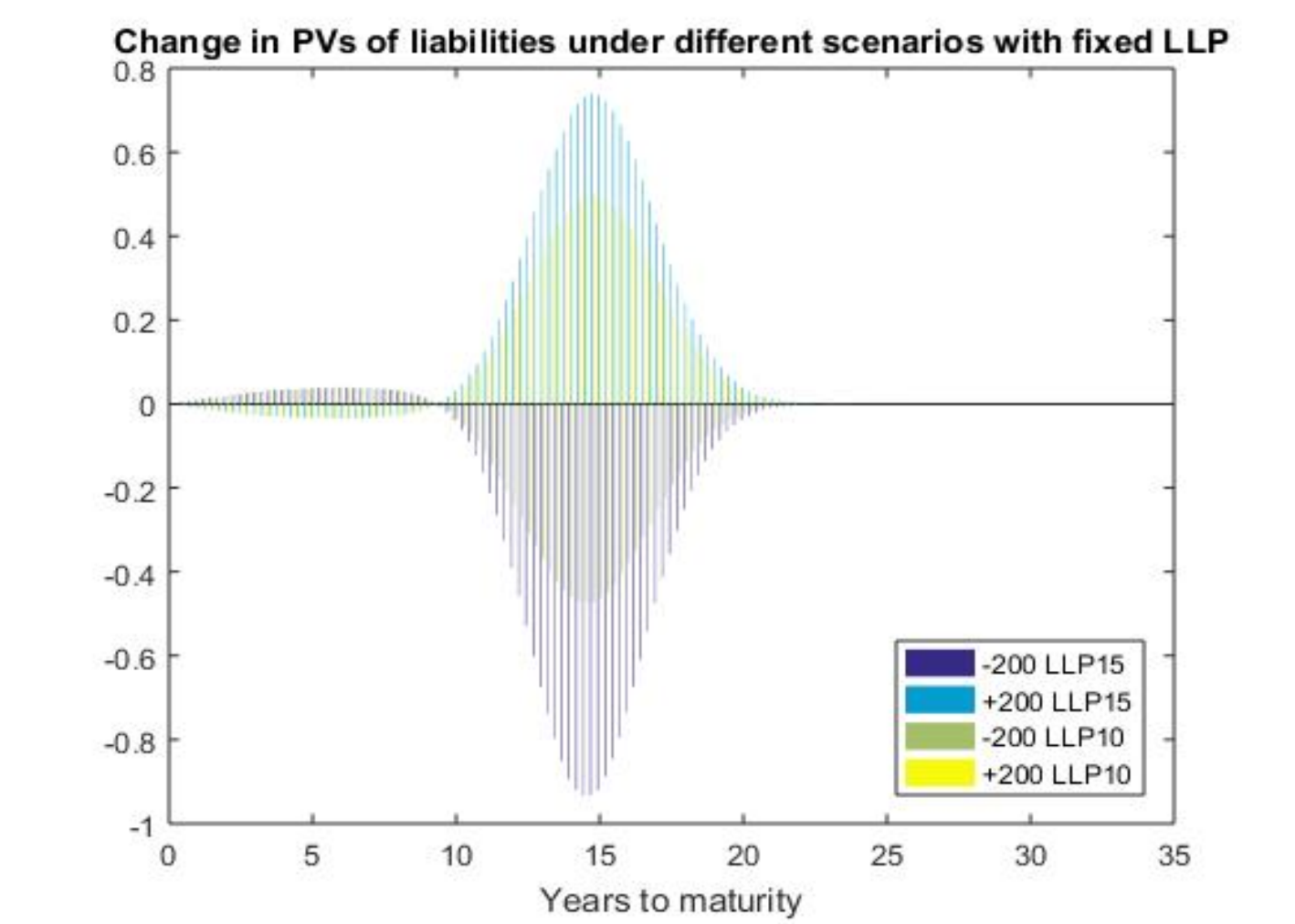
Expected “growth” in PV of liabilities (we raise curve, so they should be less “valuable”, positive effect) was „neutralized” by change in the yield curve (see PnL from shift LLP15 → LLP10).

(*For the purpose of this presentation we approximate full Monte Carlo simulation with two-side stress test scenarios (+/- 200 basis points), as defined by EIOPA. Obviously, we move market rates and the we re-calculate SW curves.*)

Sample PnLs


Change in PVs of liabilities under different scenarios and LLPs
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
0
5
10
15
20
25
30
35
Years to maturity
Base: LLP15 -> LLP10
-200: LLP15 -> LLP10
+200: LLP15 -> LLP10

Sample PnLs, continued



Final remarks

What we can say is that when:

- We are in the environment of ultra-low interest rates,
- We are under SII regime,
- Duration of liabilities is above the current LLP (here 10Y),
- We have a suitably built portfolio of bonds, matching those liabilities (here we have two bonds with maturities below and above the LLP),
- And the Supervisor decided to move the LLP to 15 years (perhaps market has developed somehow)...

...We will end up with a truly Gordian knot, which is able to deprive some sleep even from the just.

Bibliography

Technical documentation of the methodology to derive EIOPA's risk-free interest rate term structures, 2017

https://eiopa.europa.eu/Publications/Standards/Technical%20documentation%20of%20th...

Lageras A., Lindholm M., *Issues with Smith-Wilson method*, Stockholm University, 2016

https://arxiv.org/pdf/1602.02011.pdf

An Excel calculator for the SW method, provided by EIOPA:

https://eiopa.europa.eu/Publications/Standards/Smith-Wilson Risk-Free ...

Smith A., Wilson T., *Fitting Yield Curves with Long Term Constraints*, Research report, Bacon & Woodrow, 2000

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