Dangerous design flaws in the Ultimate Forward Rate:
The impact on risk, stakeholders and hedging costs

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Introduction and summary

In today's world, managing a financial institution such as an insurance company or pension plan requires great skills in dealing with uncertainty. By now, Management Boards have become used to huge levels of uncertainty that have been reigning financial markets for the last few years. In addition, they are faced with regulatory bodies continuously adopting regulation to deal with the changing world around us. It is this kind of uncertainty – around future regulation – which is increasingly more difficult to handle for investors.

Recently, both insurance and pension regulators in Europe have been moving away from market-consistent valuation of long-dated liabilities. Market-consistent valuation was intended to bring transparency to the balance sheet, but it also brought along low interest rates and high balance sheet volatility. Given the lack of liquidity of ultra long-dated interest rate swaps, it has been suggested that the illiquid part of the curve, beyond the so-called "Last Liquid Point" (LLP), should be replaced by a more theoretical curve which gradually converges to a long-term "Ultimate Forward Rate" (UFR).

The choice for a UFR curve can be justified based on the substantially lower swap transaction volumes for maturities beyond 30 years. However, implementation of the suggested method will have some very serious consequences. The risk profile of insurance companies will change drastically and we will see a strong concentration of interest rate risk in the LLP. As a result, the swap market as well as the newly created UFR curve will be distorted due to enormous hedge trade volumes. Moreover, managing risks will become more complex and less effective due to substantial differences between economic and regulatory risks.

Although different regulators have opted for a UFR discounting curve, the details of the method still have to be finalized. We propose a minor but crucial adjustment of the existing UFR method which removes the risk of market distortion and minimizes the wedge between economic and regulatory risk, while at the same time solving some of the issues surrounding pure market-based valuation methods.

What is the Ultimate Forward Rate?

The UFR was initiated within the insurance sector to deal with swap price distortions resulting from a lack of liquidity on the ultra long end of the curve.[3] As a first step in the suggested Smith-Wilson (SW) method, we need to determine the longest maturity on the curve which is still deemed sufficiently liquid – the LLP.

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[3] The volumes and liquidity of government bonds and swaps are discussed in more detail in the appendix.

Under the Solvency II proposal which will be negotiated between the European Parliament, Commission and Council, the LLP is set at 20 years for the euro zone. That point comes relatively soon, given that the swap trade volumes in the 20-30 year segment are not much lower than in the 10-20 year segment, and lower volumes are only seen after thirty years.

As a next step, the *forward curve* is used to construct the discount curve beyond the LLP through interpolating between the forward rate within the LLP and the predetermined UFR. The current proposals contain a UFR of 4,2%, simply the sum of a long-term real yield of 2% and a long-term inflation rate of 2,2%.

A final mechanism in the method relates to the speed of convergence from the LLP to the UFR. For Solvency II, convergence periods from 10 years (European Parliament) up to 40 years (European Commission and Council) have been proposed. The Dutch Central Bank (DNB) has recently chosen a 20 year LLP for the Dutch insurance industry. Figure 1 provides an example of a UFR based *forward curve* construction, based on market data of end June 2012, where the market forward rate in the LLP is 2,37% and the UFR is 4,2%. The *spot* discount curve can be constructed using this forward curve in a straightforward manner.

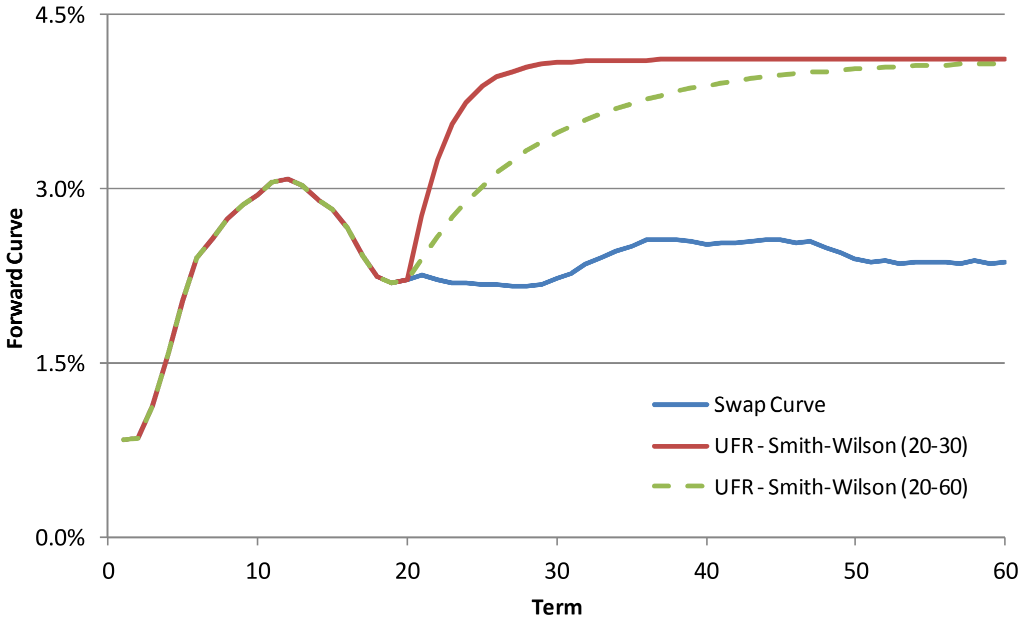

Figure 1: The one year forward curve according to the market and the Smith-Wilson model. Beyond the LLP, the SW forward curves start to deviate from the market forward curve. The two UFR curves have a convergence period of 10 years (UFR 20-30) and 40 years (UFR 20-60) respectively

The impact of the UFR for insurance companies

In the following, we will consider the impact of a potential UFR introduction on a set of insurance liability cash flows. The results can easily be generalized to other insurance companies or other financial institutions, like pension funds. We see two types of impact.
First of all, introducing UFR based liability valuation has a direct **valuation impact**. This impact has already been widely discussed. As the resulting UFR discount curve exceeds the current swap curve, the value of liabilities is substantially reduced.

The reduction ranges from 1% to 15%, depending on the duration of the liabilities and the chosen convergence period. The valuation impact is particularly strong for life insurers which have very long-dated liabilities.

A second type, the **risk impact**, is essentially based on the considerable change in interest rate sensitivity of the liabilities. Beyond the LLP, the current UFR proposal does not employ any new market information, so all discount rates with maturities beyond the LLP are simply based on the LLP and UFR. Investors who consider to change their interest rate risk management based on the new regulatory curve now face a substantial shift in hedging needs. In the remainder of this article, we will analyze the risk impact and how it translates to an impact on a macro, sector-wide level. We will therefore assume that insurance companies will decide to adjust their hedging policies in order to embrace the UFR framework as much as possible.

Hedging and the UFR method

We demonstrate the hedging needs for a stylized set of insurance cash flows. The (swap) present value of the liabilities is ten billion Euro and the duration of liabilities amounts to eighteen. Figure 2 provides the interest rate risk of the liabilities broken down into maturity segments and expressed in terms of *basis point value* (BPV) per segment.

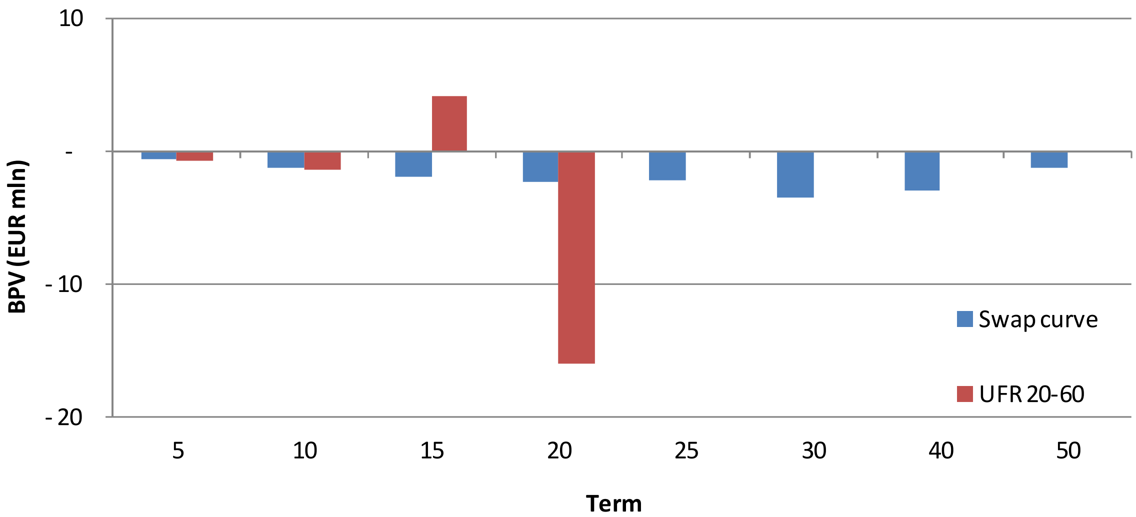

Figure 2: Interest rate sensitivity to each curve segment, swap curve versus UFR 20-60 curve

Figure 2 clearly shows that once the UFR has been introduced, the regulatory interest rate exposure changes dramatically.

To be more precise, the sensitivity profiles in figure 2 show us that:

1. The aggregated net interest rate sensitivity decreases with around 20% for this set of liabilities. This regulatory risk reduction is clearly based on the assumption that the long end of the curve remains fixed. Under new regulation, the insurer finds itself exposed to discretionary changes in the UFR rate. In the future, the UFR level could be lowered to e.g. 3.2%, the level which is currently proposed in Japan and Switzerland. Depending on the liability profile, such an adjustment would trigger a negative liability impact of up to 7%, with long-dated liability portfolios exposed the most.

2. The insurer is now exposed to only a few segments of the curve, up to the LLP, rather than to all segments of the curve. This is intuitively clear, as market changes beyond the LLP are not being 'picked up' by the UFR curve.

3. Relative to the interest rate sensitivity under market-based valuation, there is a huge concentration of exposure in the 20-year rate (LLP). In the example, the sensitivity towards the 20-year rate increases more than six fold. In fact, under the UFR regime, the sensitivity towards the 20-year rate exceeds the *total* interest rate sensitivity over the entire curve under market-based valuation.

4. Finally, there is a remarkable reversed sensitivity towards the 15-year interest rate, which is typical for Smith-Wilson. The shape of the UFR curve after the LLP depends on the slope in the LLP and that slope itself is mainly determined by the last *two* market rates (i.e. the 15y and 20y swap rates in our example). If the 15-year rate increases, while the 20-year rate remains unchanged, this pushes down the slope and the entire UFR curve, as illustrated in Figure 3. The phenomenon is stronger, when a longer convergence period is chosen.

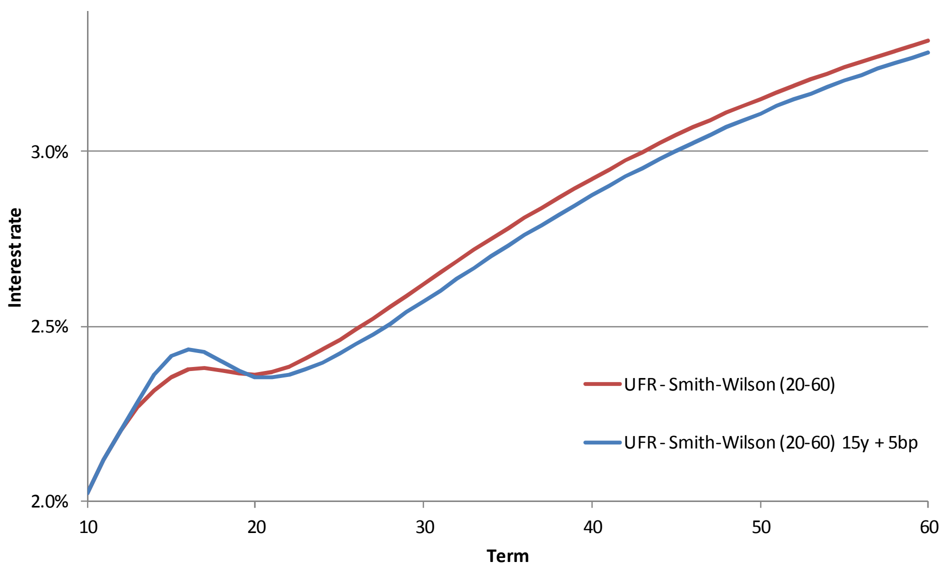

Figure 3 When the 15-year market rate is pushed up while the 20-year rate remains unchanged, this pushes down the slope of the curve and the entire UFR curve after the LLP.

The insurance company that was used to hedging against falling interest rates, suddenly has to protect itself against a falling 20-year rate as well as a rising 15-year rate under the new regulatory framework. The sensitivities towards the 15 and 20-year points imply a 4 million Euro (0,04%) and a -16 million Euro (-0,16%) change in liabilities value as a result of a one basis point rate increase;

The last two effects would give rise to a landslide change in hedging needs of financial institutions. If all insurers and designated pension funds were to tailor their hedging needs towards the proposed UFR regime and seek the suggested exposure in the 15 and 20-year rates, the Last Liquid Point would effectively become the 'Most Illiquid Point'.

In addition, investors would incur substantial trading costs. For the liability cash flows in our example, the one off trading costs to unwind a full economic hedge and simultaneously set up a regulatory hedge are estimated to be around 10 million Euro. To make things worse, that hedge position would require a substantial annual rollover trade. This is due to the reversed sensitivity in the 15-year point: when a hedge is set up, long-dated liabilities will all be sensitive to a drop in the last liquid rate, and will be hedged accordingly with a 20-year swap. Five years later, the long-dated cash flows will still be mostly exposed to the 20-year rate, but the remaining swap maturity will be only 15 years. By then, the swap is not just ineffective, it actually works the wrong way around and should be replaced by a new 20-year swap.

The total transaction volume for the European insurance sector implied by this regime change would significantly exceed the usual volume in trading of swaps and would further magnify the concentration risk in trading in a single or just a few points of the curve. Although it is impossible to quantify the impact of this concentration of exposure, it takes only a little imagination to grasp the pressure mounting on the 15 and 20-year swap rates. This is all the more worrying, as the 15-20 year spread largely determines the shape of the UFR curve – systemic risk at work.

One could easily argue that not all financial institutions will switch from their current market based hedging towards UFR regulatory hedging. They may as well decide to stick to their current economic hedges instead. The differences in rate sensitivity profiles in figure 2 do point out, however, that under an economic hedge, insurers should be prepared to face considerable regulatory and political risk. Under an economic hedge, the example insurance company stands to risk 16 basis points for each basis point *decrease* in the 20-year rate. The sensitivity to the 15-year rate is even reversed: insurance liabilities will *increase* by 5 basis points for each basis point *increase* in the 15-year rate.

Towards a robust version of the UFR

The proposed UFR method suffers from two severe weaknesses. First of all, the UFR itself is set arbitrarily and implies a substantial potential economic exposure to unanticipated changes in the UFR. Secondly, the convergence algorithm relies too heavily on a single point on the forward curve, leading to market distortion and hedges which are too far removed from their underlying economic counterparts. In the remainder of the article, we focus on fixing the second issue concerning the convergence algorithm.

In developing an alternative to the method that is currently being proposed, we have attempted to remain as close as possible to the proposed method, while introducing smarter ways to deal with market information beyond the LLP. Before focusing on how we suggest to fix the UFR method, we first explain the current convergence algorithm in a bit more detail.

The Smith-Wilson technique uses the one year forward rates to construct the spot curve. Up to the LLP, the constructed curve is an exact copy of the market curve, only beyond the LLP the constructed forward curve and market forward curve start to deviate from each other. Beyond the LLP, every new forward rate in the SW model is a weighted average of the 19 into 20-year forward, and the predefined UFR, therefore:

$$\mathrm{fwd}^{\mathrm{SW}}_{\mathrm{t-1,t}} = (1 - \mathrm{w(t)})\ \mathrm{fwd}_{\mathrm{LLP-1,LLP}} + \mathrm{w(t)\ UFR}$$

The weights *w*(t) and 1-*w*(t) determine how much importance is attached to the market information in the LLP. These weights are maturity dependent: w(t) gradually increases from zero in the LLP to one as the end of the convergence period (say, 40 years) is approached. The concentration of exposure to the LLP increases, when a longer convergence period is chosen.

In order to repair the issue of the concentration of exposure in a single point in the SW method, we propose a minor but crucial revision of the original algorithm. The idea is that rather than abruptly switching from fully relying on market data to fully discarding all market data beyond the LLP, we continue to rely on market data beyond the LLP. The curve construction is again separated into two parts – before and after the LLP[4]. Before, the constructed curve again coincides with the market swap curve. After the LLP, curve construction is based on the forward curve which again converges to the UFR, using the weighting scheme in an identical manner.

[4] Technically, 'Last Liquid Point' is not an appropriate name anymore, but we stick to it for the sake of explanation.

The difference between the alternative and the original method relates to the model which determines the one year forward rates beyond the LLP:

$$\mathrm{fwd}^{\mathrm{ALT}}_{t-1,t} = (1 - w(t))\ \mathrm{fwd}_{t-1,t} + w(t)\ \mathrm{UFR}$$

This model continues to use new market forward rates beyond the LLP, rather than focusing on the 19 into 20-year forward rate only. Because we basically choose the same recipe, both the constructed curve itself and the valuation effect on the liabilities are highly similar to the original SW method. Yet, there is a pronounced difference in terms of sensitivity to various segments of the interest rate curve, as shown in Figure 4.

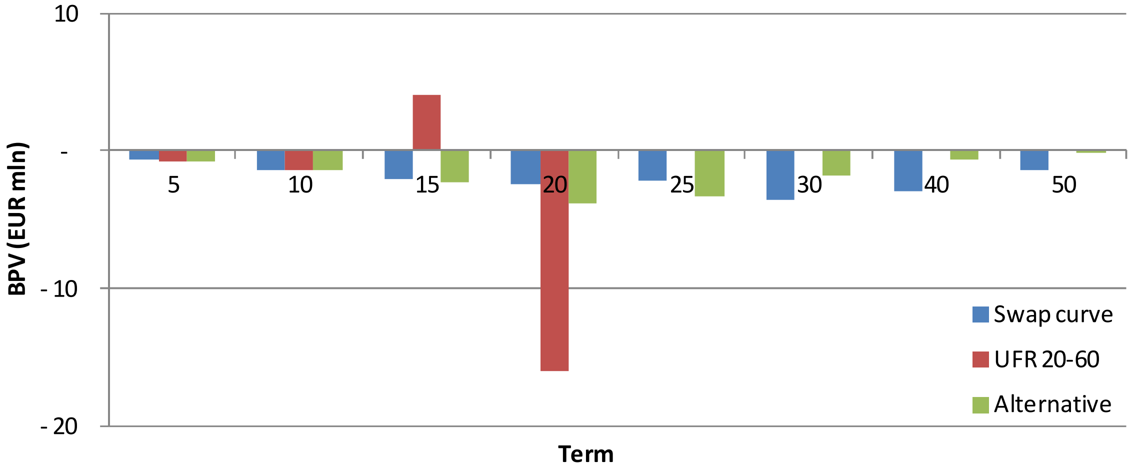

Figure 4: Interest rate sensitivity to each curve segment; market-based, SW and alternative methods

As expected, the proposed alternative removes the huge concentration of exposure in the LLP, as well as the reverse exposure in the 15-year rate. In fact, the sensitivity profile in Figure 4 is much closer to the market-based sensitivity profile. Market information after the LLP is not simply discarded, but receives a weight which is much more in line with the existing market liquidity. Compared to the original UFR method, this introduces a whole range of improvements to stakeholders of the insurance company. The economic and regulatory hedge are now much more alike, with less one off and recurring transactions costs. And chances are that swap markets will continue to trade in a much more orderly fashion, without systemic feedback loop mechanisms from rates to UFR curve construction and back.

Appendix

Liquidity in the bond and swap market

Defining a Last Liquid Point after twenty years for the Euro swap market (compared to e.g. 50 years for GBP) conflicts with evidence in the financial markets. The liquidity in the bond and swap market remains high up to 30 years point. After the 30 years point, liquidity diminishes to less than 10% of the liquidity in the 10-30 years range. This holds both for the AAA-government bond market and the interest rate swap market.

Government bond market

The largest issuers of bonds with a high credit quality in the Eurozone government bond market are Germany, the Netherlands and France. These countries are hence considered representative for the liquidity and availability of government bonds.

Segment	Germany	Netherlands	France	Total	Percentage
10y-20y	88	41	119	249	51%
20y-25y	43	19	42	104	21%
25y-30y	30	12	46	89	18%
>30y	18	0	24	42	9%

Table 1 Government bonds: outstanding notional amounts (billion Euro)

Table 1 summarizes the outstanding notionals of government bonds with maturities longer than ten years, split per maturity segment. The notional amounts add up to around 500 billion euro. The table shows that of all government bonds with maturities beyond ten years, approximately half (i.e. 249 billion euro) are in the 10-20 segment, while the other half is longer than 20 years. The numbers should be related to the estimated 1,000 to 2,000 billion Euro of insurance and pension liabilities in the >10 years segment.

OTC swap market

The OTC interest rate derivatives market even exceeds the government bond market in volume. Compared to the government bond market, the interest rate swap market shows slightly lower volumes in the 20-30 years segment and slightly higher volumes in the 10-20 years market. Yet, data from London Clearing House[5] (LCH) shows that liquidity in the 20-30 years segment is still considerable (Table 2).

Segment	10-20	20-30	>30
Relative Volume	62%	32%	5%

Table 2 Relative volumes of interest rate swaps cleared by LCH (H1, 2012). LCH clears approximately half of all traded interest rate swaps. The total notional traded in the first six months of 2012 was 1785 billion Euro.

In addition to the information in Table 2, the publicly available OTC Trade Repository Database report of TriOptima[6] shows there is a voluminous and liquid market beyond twenty years, especially up to the 30 years point. The TriOptima report shows aggregated data for derivatives contracts in all major currencies and the Euro denominated contracts account for approximately 35% of the total. In this report, the 10-30 years Euro swap market is estimated to be approximately 10 thousand billion Euro (split 60-40 over the 10-20 and the 20-30 years segment). The number of trades is equally high in both segments, which indicates that there is ample liquidity in both segments. Although Euro data cannot be derived exactly from this source of information, the data of LCH reveals roughly similar profiles. More specific figures may be provided by the DTCC (the successor of TriOptima in maintaining the OTC Trade Repository Database, per April 2012).

After the 30 years point, the traded and outstanding volumes are again less than 10% of the volumes in the 10-30 years segment, indicating reduced liquidity that gave rise to the UFR discussion.

Summary

The outstanding interest rate swap volumes in the 10-30 years segment are great compared to the estimated 1,000 to 2,000 thousand billion Euro of insurance and pension liabilities in the segment after ten years. These liabilities are (potentially) hedged with interest rate swaps (a substantial part of the interest rate risk of insurance companies is hedged with government bonds in the investment portfolio). The volumes in the 20-30 years Euro government bond and interest rate swap market are lower than in the 10-20 year segment, but there is no reason to assume insufficient liquidity. In order to avoid the damaging effects of the Smith-Wilson approach and the creation of a Most Illiquid Point, the Still Relevant Liquid Point should at least be extended to 30 years.

5 http://www.swapclear.com/what/clearing-volumes.html

6 http://www.trioptima.com/uploading_images/pdf/Rates_Repository_Industry_Report_20120420.pdf