Hedging Pension Liabilities

when there are incomplete markets and regulatory uncertainty

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Outline

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Sampension

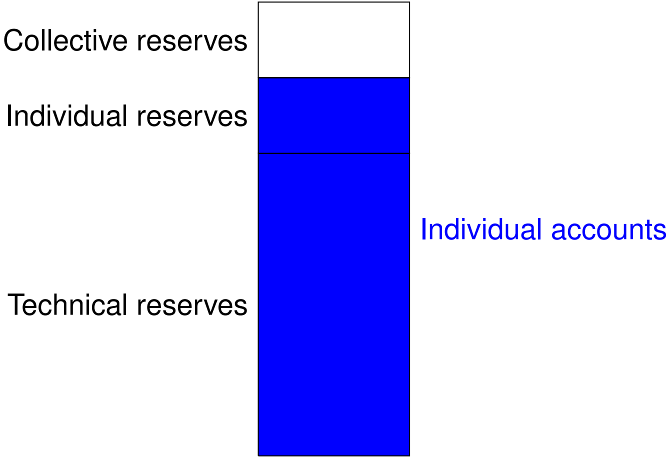
- Sampension is a Danish Life Insurance Company
- Even though organised as a limited company it is a non-profit organisation, and it's shareholders are employer organisations and labour unions
- At mid 2012 roughly 45 bn DKK in un-guaranteed variable annuity products, and 90 bn DKK in guaranteed or guarantee-like life annuity products
- They are all with-bonus policies

Outline

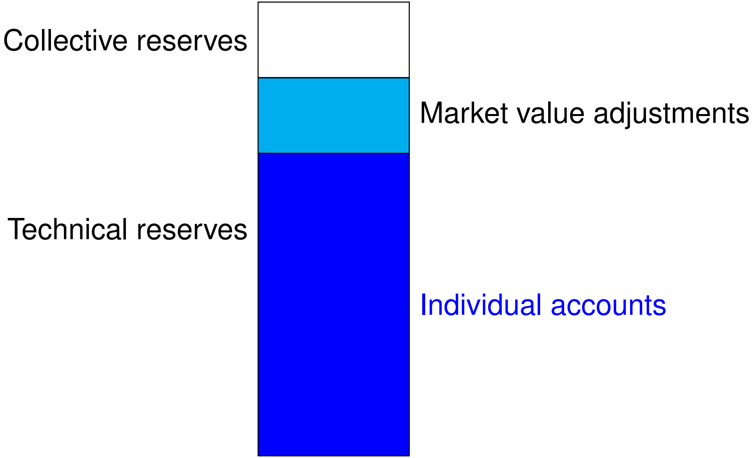
The pension liabilities

- Life long annuity payments
- Most of these based on already paid-in premia (corresponding to so-called free policies)
- Part of pension promises are conditional on future premia with promises less premia creating a net liability and a cash flow with a change of sign
- In total these are the so-called guaranteed payments (even if uncertain, conditional and in our case to a large extent not formally guaranteed)

Pension reserves: Case Low



Pension reserves: Case High



Contribution groups

- The pension annuity payments are calculated using a certain calculation rate - fixed at the origination of the policy
- Liabilities and reserves corresponding to different calculation rates (in practise also periods of origination) are segregated into contribution groups
- In the case of Sampension groups A to D, corresponding to average policy calculation rates of $(3.5, 4.5]$, $(2.5, 3.5]$, $(1.5, 2.5]$ and $(0, 1.5]$ respectively
- Equity has a portfolio of short puts, i.e. negative gamma/convexity

Risk characteristics of liabilities

- The cashflows have a very long duration, especially net liabilities from future premia
- The modified duration of the cashflows to A is e.g. 13, to C it is 17
- The also have a very large convexity
- In practice longer and larger that what can be found in liquid bond markets

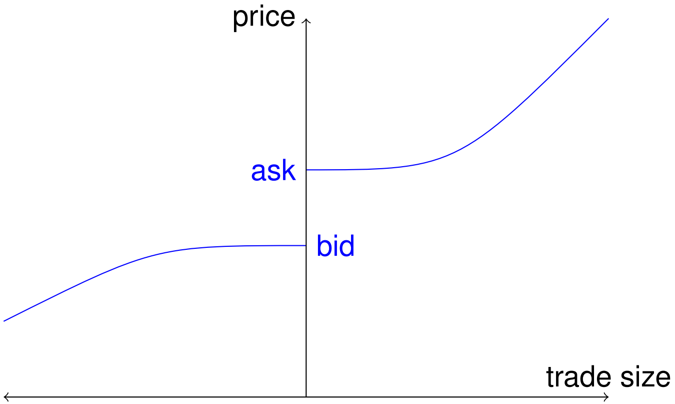
Market valuation of liabilities

- The market value of liabilities is the minimal purchase price of a basket of securities that would generate a cash flow sufficiently high to cover liabilities in all states of the world
- In practice expected cash flows of known liabilities are discounted using a proxy for risk free interest rates
- In Denmark life insurance technical reserves has been calculated as market values since the accounting year 1999

Why market values?

- Many think that market values are to conservative, especially since we also put aside capital for negative market value adjustment to asset prices, so that there may be a double risk reserve
- One advantage of market valuation is that is it not easy to manipulate
- However here "not easy" also implies that it can be done - a known example is to increase the market valuation of a holding of a less liquid asset by buying more of it

Which market price?



- Non-existence of markets can be seen as the limit of increasing bid-ask spreads
- In practice there are plain vanilla interest rate swaps in DKK up to a maturity of 30 years, but only for small amounts
- Danish life and pension companies have therefore used the EUR swap market to hedge
- Even the EUR market has limited depth especially after the 30 year maturity point
- Not at all enough liquidity to hedge all EUR liabilities

Outline

A short history of curves

- With effect for the 1999 annual accounts technical reserves are calculated with a maximal rate of 4%
- This (maturity independent) rate is changed several times the following years
- The reference is first a 30 year government bond, later a basket of 3 bonds with a weighted duration of 10
- In December 2004 a curve with maturity dependent discount rates is introduced based on swap rates
- In October 2008 a new curve was introduced (to achieve "‘financial stability"’) with a number of positive additions to the curve, particularly a mortgage bond derived OAS
- In June 2012 a new curve was introduced modeled on a drafted Solvency II-curve

So what is Solvency II?

- The EU Solvency II Directive was adopted in 2009
- It is to govern the capital requirement of EU insurance companies
- It is currently scheduled to take effect on 1 January 2014
- As a part of this a principle of market valuation of liabilities (technical provisions) is applied where liabilities are hedgeable, where not liabilities are valued at a best estimate plus a risk margin

Construction of the market curve under Solvency II

- The principle is implemented by discounting expected cash flows from pension liabilities
- There was a long debate on whether a discount curve should be based on AAA government bonds or on interest rate swaps
- After advise from the industry the likely discount curve will be derived from plain vanilla (Xibor-) quoted swap rates using a spline regression
- Does swap rates indicate a risk free rate?

Interpolation and extrapolation

- Utilizing observed market data discount rates for intermediate tenors can be interpolated or for later tenors extrapolated
- Many methods have been discussed

UFR

- The discount curve is build up by splicing a market based curve with a long term equilibrium rate given by an Ultimate Forward Rate, UFR
- The UFR has been derived as a historical estimated real bond yield of 2.2% plus a target inflation of 2%
- A purpose of the UFR is to reduce the volatility of pension liabilities derived from distortions in the less liquid long end of the market

Extrapolation to the UFR

- The market curve is used until a defined Last Liquid Point, LLP
- From that point (the entry point T_1) and until a convergence point T_2 there is an extrapolation of forward rates to the UFR
- EIOPA has pointed to an extrapolation method suggested by [Smith and Wilson(2001)]

- [Smith and Wilson(2001)] proposed a class of models where the long forward rate is a fixed input parameter
- It gives a method for extrapolating the yield curve
- It is capable of exactly fitting the initial term structure
- Zero Coupon Bond prices takes the form

$$P_t(h) = \mathrm{e}^{-UFR\cdot h} + \Sigma_{i=1}^{I}\zeta(t,h)K_i(h)$$

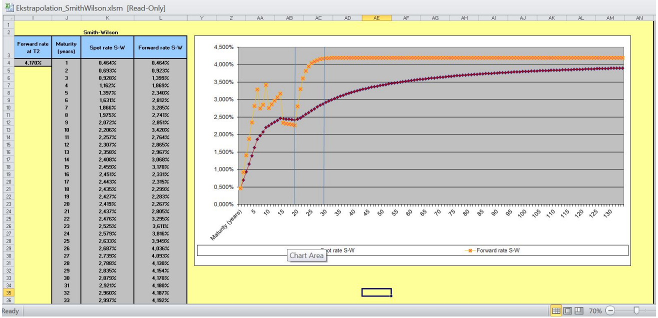
where I is the number of instruments used for calibration, and $\zeta(t,h)$ are (time-varying) parameters chosen to fit the initial curve, whereas K_i are specific kernel functions (one for each instrument)

Figure: 30 year EUR swap rate

Dynamic relationship between regulation and markets

- 7 June 2012 Sweden: A temporary floor for the existing discount rate, no Solvency II-style discount curve
- 12 June - Denmark: New discount curve with $UFR = 4.2\%$ and $LLP = 20y$
- 2 July - Holland: DNB adjusted the method for extrapolating the interest rate curve for insurers $UFR = 4.2\%$, to be reached in 40 years from the $LLP = 20y$.
- 24 September - Holland: DNB adjusted the method for extrapolating the interest rate curve for pensions $UFR = 4.2\%$, to be reached in 40 years from the $LLP = 20y$
- 3 October - Holland: DNB made technical clarifications to the Sep 24th-curve leaving SW. The new curve will reduce pension fund sensitivities beyond for longer maturities

The SW-curve



Forward rate at T2	Maturity (years)	Spot rate S-W	Forward rate S-W
4,170%	1	0,464%	0,464%
	2	0,693%	0,923%
	3	0,928%	1,399%
	4	1,162%	1,869%
	5	1,397%	2,340%
	6	1,631%	2,812%
	7	1,866%	3,285%
	8	1,975%	2,741%
	9	2,072%	2,851%
	10	2,206%	3,420%
	11	2,257%	2,764%
	12	2,307%	2,865%
	13	2,358%	2,967%
	14	2,408%	3,068%
	15	2,459%	3,170%
	16	2,451%	2,331%
	17	2,443%	2,315%
	18	2,435%	2,299%
	19	2,427%	2,283%
	20	2,419%	2,267%
	21	2,437%	2,805%
	22	2,476%	3,295%
	23	2,525%	3,611%
	24	2,579%	3,816%
	25	2,633%	3,949%
	26	2,687%	4,036%
	27	2,739%	4,093%
	28	2,788%	4,130%
	29	2,835%	4,154%
	30	2,879%	4,170%
	31	2,921%	4,180%
	32	2,960%	4,187%
	33	2,997%	4,192%

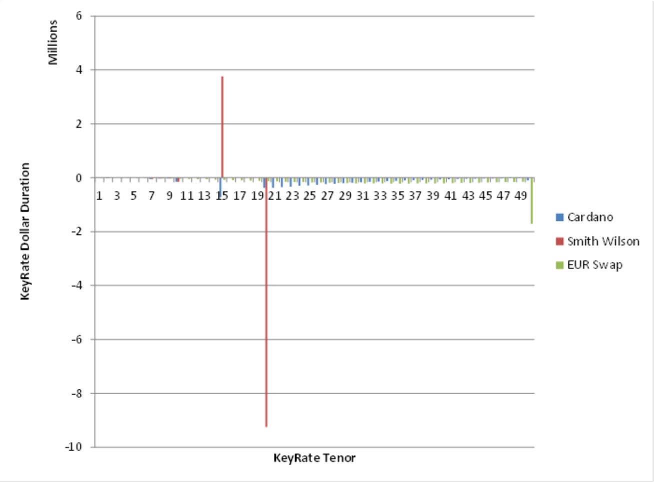
Figure: A tool on the Danish FSA home page

Technical weaknesses of the method

- Hedging based on the SW-curve is very sensitive to the level of the $1y$ forward in $19y$-point: in practice determined by the $15y$ and the $20y$ rates
- Due just to spreads and non-synchronized pricing forward rates are imperfectly determined
- The form of the curve can drastically change around a flat forward rate
- The numerical iteration stop generates jumps in sensitivities

Economic weaknesses of the method

- There is no impact of any market rates beyond the LLP
- Hedging of regulatory capital against interest rate changes will place little weight on long term liabilities - and whatever weight will be moved to hedging solely at the LLP
- Hedging the peculiarities of the SW-curve will lead no large convexity positions
- A precise hedge would be very unstable, leading to large transaction costs



Source: Nordea

Regulatory risks

- The regulatory framework for Solvency II is not yet finalized
- ...and even when it is, rules may and will be changed
- The Danish and Dutch experiences has been that the calculation of market values is subject to changes - not only based on new academic insights
- Technical issues may also lead to change
- Changes to the UFR could be a result of a revised view on nominal rates or a political tool
- In any case such risks are difficult to hedge

Outline

On risk buffers

- Reserves for pensions with a right to bonus are divided into technical reserves (market values of liabilities), individual bonus potential and collective bonus potential
- The individual bonus potentials stems form pensions promises written on a calculation rate lower than current market rates, and are bonus potentials on free policies (paid in) and bonus potential on future premiums (not paid in) Currently bonus potential on future premiums are not a part of reserves, but can - subject to certain conditions - be so under Solvency II

What to risk manage?

- Total buffer capital
- Excess buffer capital - solvency capital requirement is also interest rate dependent
- Long term default risk

Dilemmas of risk managing 1

- Hedging the regulatory buffer capital is not the same as hedging buffer capital
- E.g. the interest rate risk of a very long liability will be very large from an economic viewpoint, but nearly nothing from the regulatory viewpoint
- This also means that the implicit discounting of the long liability of the UFR has the best regulatory hedge with a low duration bond currently with a yield near zero
- Thus hedging short term solvency can drive you into insolvency in the longer term

Dilemmas of risk managing 2

- The hedge of the regulatory buffer capital is not the same as the portfolio that minimizes solvency requirements
- The hedge of the regulatory buffer is not the same as a hedge of the free regulatory reserves because solvency requirements are also interest rate dependent

Hedging with tax

- Danish pension funds pays a tax (called PAL) on net investment returns, currently 15.3%
- This is an income tax, not a tax on cash flows
- So a liability on a future date e.g. 1 krone on a future date T can not be hedged by buying zero coupon bonds maturing on that date, as these will give rise to tax, and thus cash flows, on all dates prior to and including T
- With known rates you can solve for this iteratively
- But also here it is difficult to hedge a change in tax (note that we take the present value effect of a tax change immediately...)

In summary

- Pension accounting, return attribution and risk management has become more complex
- And this delightful development seems just to go on

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