# Volatility Adjustment and Life (Insurance)

## Why and how (not) to correct illiquidity artifacts

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risk.free.style

## Objectives *high level coverage*

- Adjusting for illiquidity
  - Why the idea?
  - What actually is illiquidity?
- All those methods along the Solvency II path
  - Why so many?
- Volatility Adjustment
  - Fall in love with it or just live with it?
  - ... vs. previous methods
  - ... vs. a 'very actuarial' alternative
  - Consequences, caveats, criticisms
- Risk management incentives
- Quantitative illustration using CEE government spreads

## Objectives *background coverage*

- What is the valuation discount rate?
- How does government spread emerge?
- What are the consequences?
- How can we address these (esp. in Solvency II)?
- What can go wrong?

3

## Objectives *of CEE focus*

- Spread that is
  - clearly present
  - material (in times of financial distress)
  - attributable to a single issuer – easier to analyse than countries with diverse fixed income securities markets
- All in all: cleanest examples for not-so-straight concepts
  - particular phrasing is straighter
  - concepts and high level conclusions could be carried over to more subtle setups once we have built them

## Objectives *of prudent regulation*

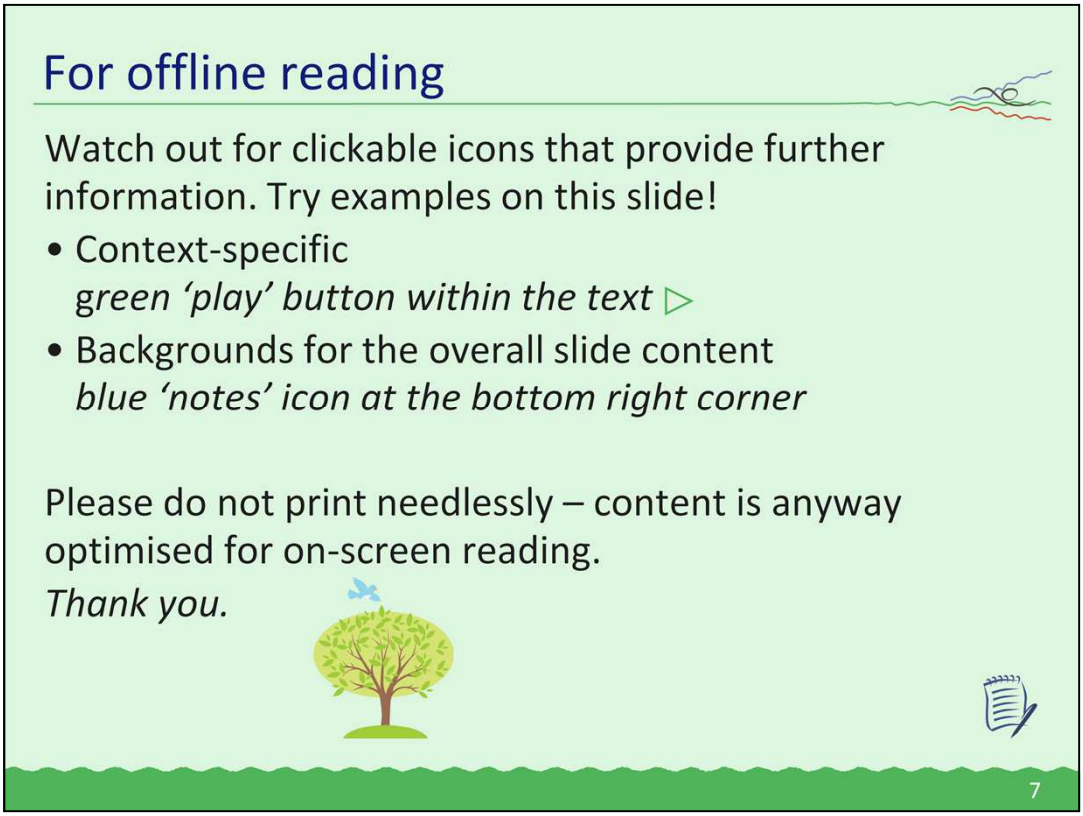
- Client protection
  - capital adequacy
  - market stability
- Shareholder information
  - value recognition
  - risk quantification
  - comparison of companies
- Incentives for risk management
  - value recognition
  - risk quantification
  - comparison of alternatives

In SII context, we should assess valuation techniques for how they serve these regulatory goals.

5

## Out of direct scope

- Is it valid at all to adjust against illiquidity?
- Matching adjustment in detail
- EUR region
  - corporate bonds
  - country differentiation vs. single currency
- SII transitional measures: gradual phase-in
  - from TIR to market rate, or
  - from TIR-based technical provision to BEL+RM
  - “gradual” means up to 2032...




**Context specific comments**

Though sometimes breached in this presentation, common sense sets limits on how detailed a slide can be. A bit unfair but useful trick is to hide extra information in pop-up boxes like this one.

- When this extra is linked to a particular item or phrase, you can access it via a green button right in place.
- The pop-up disappears on click.

Well, full comprehension of certain comments or slide notes may take an effort. I hope this effort will deepen your understanding of the main text and may help in remembering the concepts later.

**Notes**

Some slides contain additional notes.

These are either less important (or assumed to be better known) or too technical – so mostly skipped for live presentation.

However for offline reading you may consider them

useful – some acronyms and terms are only explained

in the notes, actually.

# Agenda

Interest rate markets
The valuation gap
Spreads in ALM modelling
Wrap-up

In concept
Illustration, relevance

## Interest rate markets – in concept

Inventory and comparison

- central bank deposit rates
- interbank rates
- government rates / curves
- swap rates / curves
- repo, overnight

Aim

- find candidate risk free term structure of interest rates
- identify differences in how these rates / markets function

9

**Note the absence of corporate bonds**

- They obviously don't qualify as "risk free" in any market.
- For the region considered in the presentation, corporate bonds – especially if we exclude companies with substantial governmental share – contribute small to the typical investment mix.

## IR market concepts – interbank rates

- short term
- market driven
  - thus considered 'correct' ▷
- liquidity management and strict rules on deposit ratio may produce noise for very short rates

A good starting point for "risk free" rate but not a full curve.

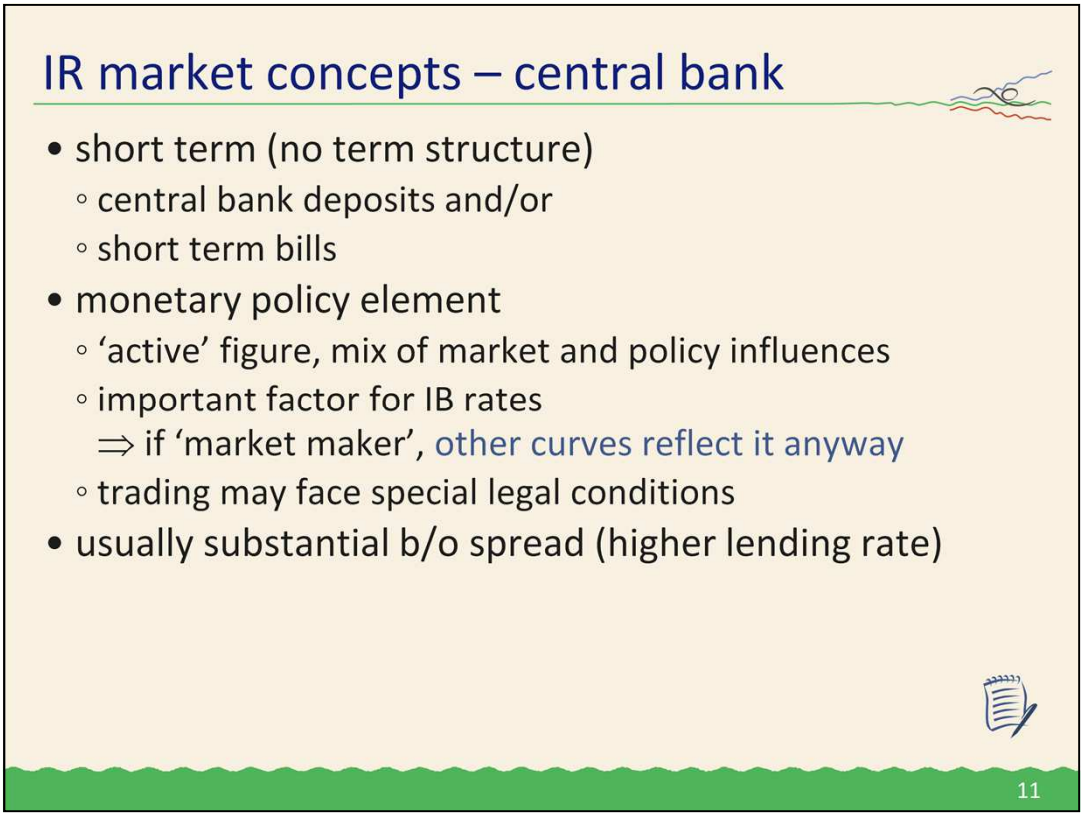
10

**On the appropriateness of interbank rates**

We can't avoid mentioning
http://en.wikipedia.org/wiki/Libor_scandal

We may see that distortion actually came from unbalanced swap positions where the gross total notional was beyond $100 trillion ($10^{14}$), i.e. six times the total combined public debt of the US. In some sense, the market was too deep.

Still it is the closest in concept to 'market' rate.

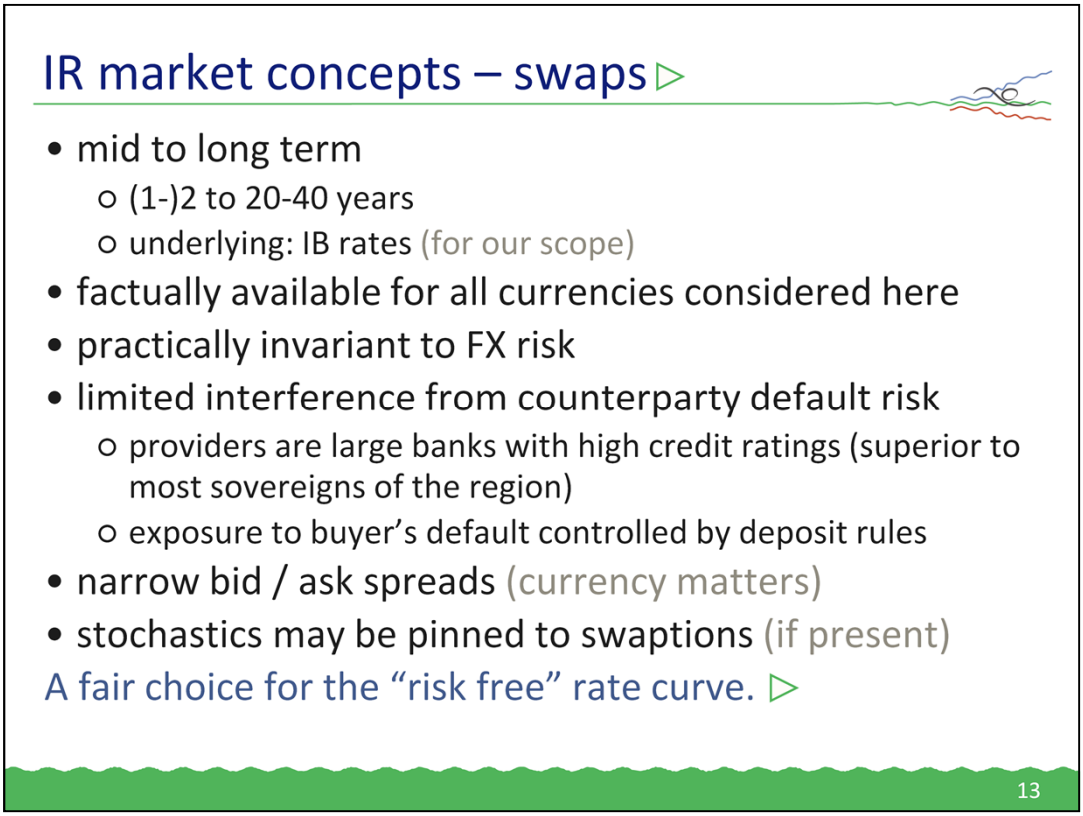



**Central bank rates**

- Many names, content may show minor alterations: central bank deposit rate, overnight (policy) rate, key (policy) rate, base rate.
- Some central banks also declare(d in the past) a benchmark interest rate – not even tied to actual assets.
- Risk free (or very close to that) within the available investment horizon – but that is very short for an insurance savings investment pool.
- Direct derivatives trading, if any, is minimal.

## IR market concepts – government debt

- mid to long term
  - 1 to 20-40 years (US, Western Europe)
  - 1 to 5-10-20 years (CEE)
- subject to monetary policy (esp. CEE)
- involves credit risk
  - may be limited (ruled out) by FX risk if the country has its domestic currency (we will discuss this later)
  - creates a spread over whatever "risk free rate"
- primary investment vehicle for trad ALM business (CEE)
- government curve – both primary issues (auctions) and secondary markets




**Interest rate swap as a product**

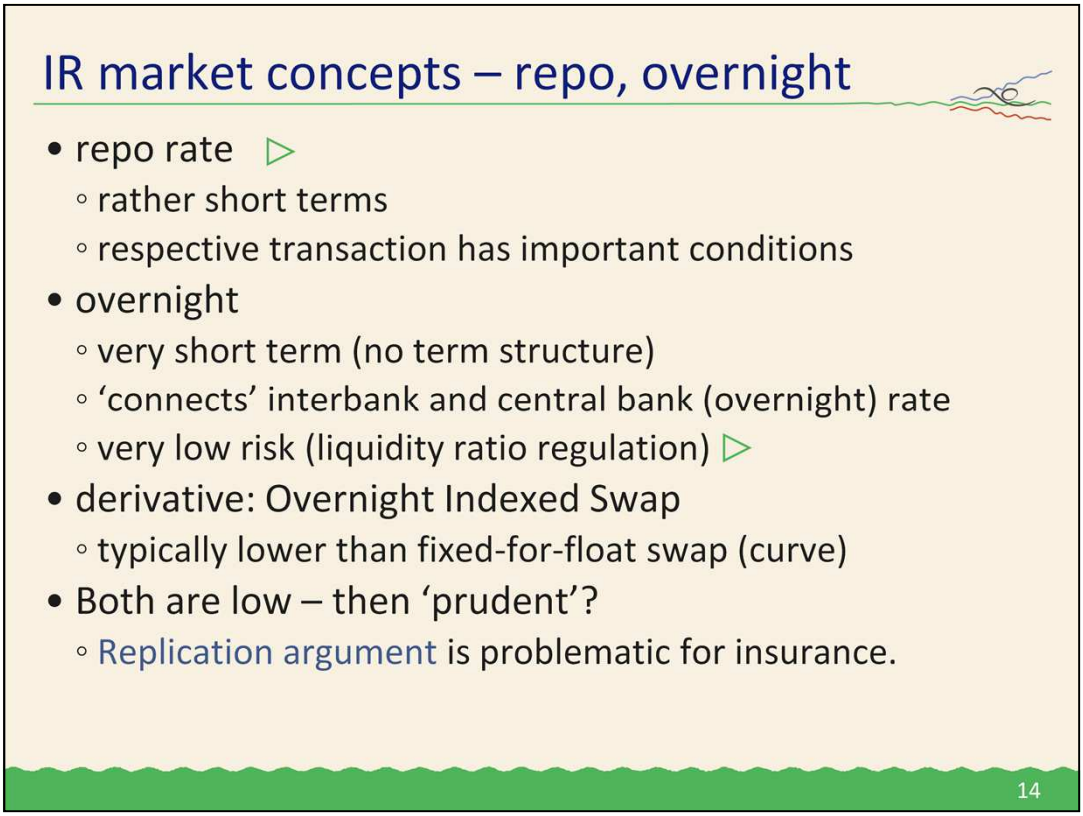
- For our scope: fixed-for-floating IRS, same currency.
- Construct: predefined, fixed regular payment is traded for regular payment of a varying amount. Floating leg is linked to a traded, liquid, observable measure, e.g. 3-months LIBOR rate.
- Swaps trade 'in par', i.e. with no up front payment – implies a market consensus on 'expected average' of the floating payment.
- Swaps are often liquid enough (both sides) to allow for low tolerance hedging of exposure to the floating instrument, thus allowing for a no-arbitrage calibration argument. For currencies where multiple interest rate swap instruments are available, the one to use is the one with the most relevant underlier for investment (and hedging) of the core business.

Naming

- Payer / receiver is named by who pays / gets fixed amount.
- 'Long swap' position is (rather) that of the receiver. This convention is not uniform, for disambiguation one can say 'long LIBOR-3M'.

**Risk free rate curve construction**

For the sake of precision: swaps are not really meaningful for short terms. So the short end of the yield curve is rather taken from direct IB data, not swap transactions. In general this barely matters, but for the CRA (credit rating adjustment, see more at the end of the appendix) some care might need to be taken.




**Repo transaction**

- A has an asset and needs cash, C has cash
- A sells the asset to C for price P...
- and they agree to revert it in the future at the preset price P+i
  ('same or similar' – C may even sell it in between)
- i is actually the interest on P
- C has more legal protection against the default of A than in a collateralized loan
  *owns the asset*
- risk to C: A defaults and the asset value drops
  *loses P+i, has only the asset*
- risk to A: C defaults and the asset value increases
  *loses asset earning, has only P+i*
- fairly symmetric exposure so no material risk charge on either side
- some liquidity charge credited to C

**Repo rate as risk free for insurers?**

- implies insurer's role is 'C'
- some other asset needs to be involved to earn this – constrains market liquidity
- C has to have large liquid position – exactly not what traditional reserves have
- not a good replication instrument

**OIS swap as a product**

- Practically no default risk in underlier (fixed-for-float swap has some).
- Swap: daily margining is common, so no default risk for the construct either.
- Note: LIBOR – OIS spread is widely understood as a banking system health indicator (captures expectations on short term bank defaults, plus liquidity charge).

**Repo rate as risk free for insurers?**

- Actually used as valuation curve for EQ derivatives on markets where the margin account balance accrues overnight rate.
- Yet to us, replication argument would mean:
  - Insurers (all) hold reserves on cash account (or central bank deposit) and add OIS swaps to secure long term returns.
  - Beyond accounting artifacts, this would impose major liquidity (capital) strain on the banking system and could even shift the market from the state we experience now.
  - OK, not a perfect no-go per our argumentation, but not a straight story for sure. We don't research this deeper.

See also: http://research.stlouisfed.org/publications/es/08/ES0825.pdf

## INTEREST RATES - SWAPS

| | Euro-€ | | £ Stig. | | SwFr | | US $ | | Yen | |
|---|---|---|---|---|---|---|---|---|---|---|
| Jan 29 | Bid | Ask | Bid | Ask | Bid | Ask | Bid | Ask | Bid | Ask |
| 1 year | 0.39 | 0.43 | 0.59 | 0.62 | 0.04 | 0.10 | 0.28 | 0.31 | 0.18 | 0.24 |
| 2 year | 0.47 | 0.51 | 0.96 | 1.00 | 0.05 | 0.13 | 0.46 | 0.49 | 0.18 | 0.24 |
| 3 year | 0.62 | 0.66 | 1.33 | 1.37 | 0.15 | 0.23 | 0.82 | 0.85 | 0.20 | 0.26 |
| 4 year | 0.84 | 0.88 | 1.66 | 1.71 | 0.32 | 0.40 | 1.23 | 1.26 | 0.25 | 0.31 |
| 5 year | 1.06 | 1.10 | 1.95 | 2.00 | 0.51 | 0.59 | 1.63 | 1.66 | 0.31 | 0.37 |
| 6 year | 1.28 | 1.32 | 2.18 | 2.23 | 0.72 | 0.80 | 1.97 | 2.00 | 0.40 | 0.46 |
| 7 year | 1.47 | 1.51 | 2.37 | 2.42 | 0.92 | 1.00 | 2.24 | 2.27 | 0.49 | 0.55 |
| 8 year | 1.65 | 1.69 | 2.53 | 2.58 | 1.09 | 1.17 | 2.47 | 2.50 | 0.60 | 0.66 |
| 9 year | 1.80 | 1.84 | 2.67 | 2.72 | 1.24 | 1.32 | 2.66 | 2.69 | 0.70 | 0.76 |
| 10 year | 1.94 | 1.98 | 2.78 | 2.83 | 1.37 | 1.45 | 2.82 | 2.85 | 0.80 | 0.86 |
| 12 year | 2.16 | 2.20 | 2.95 | 3.02 | 1.55 | 1.65 | 3.07 | 3.10 | 0.98 | 1.06 |
| 15 year | 2.38 | 2.42 | 3.10 | 3.19 | 1.74 | 1.84 | 3.30 | 3.33 | 1.24 | 1.32 |
| 20 year | 2.52 | 2.56 | 3.20 | 3.33 | 1.87 | 1.97 | 3.50 | 3.53 | 1.54 | 1.62 |
| 25 year | 2.56 | 2.60 | 3.24 | 3.37 | 1.89 | 1.99 | 3.58 | 3.61 | 1.69 | 1.77 |
| 30 year | 2.56 | 2.60 | 3.25 | 3.38 | 1.90 | 2.00 | 3.62 | 3.65 | 1.76 | 1.84 |

Bid and Ask rates as of close of London business. £ and Yen quoted on a semi-annual actual/365 basis against 6 month Libor with the exception of the 1Year GBP rate which is quoted annual actual against 3M Libor. Euro/Swiss Franc quoted on an annual bond 30/360 basis against 6 month Euribor/Libor.
Source: ICAP plc.

*Source: www.ft.com*

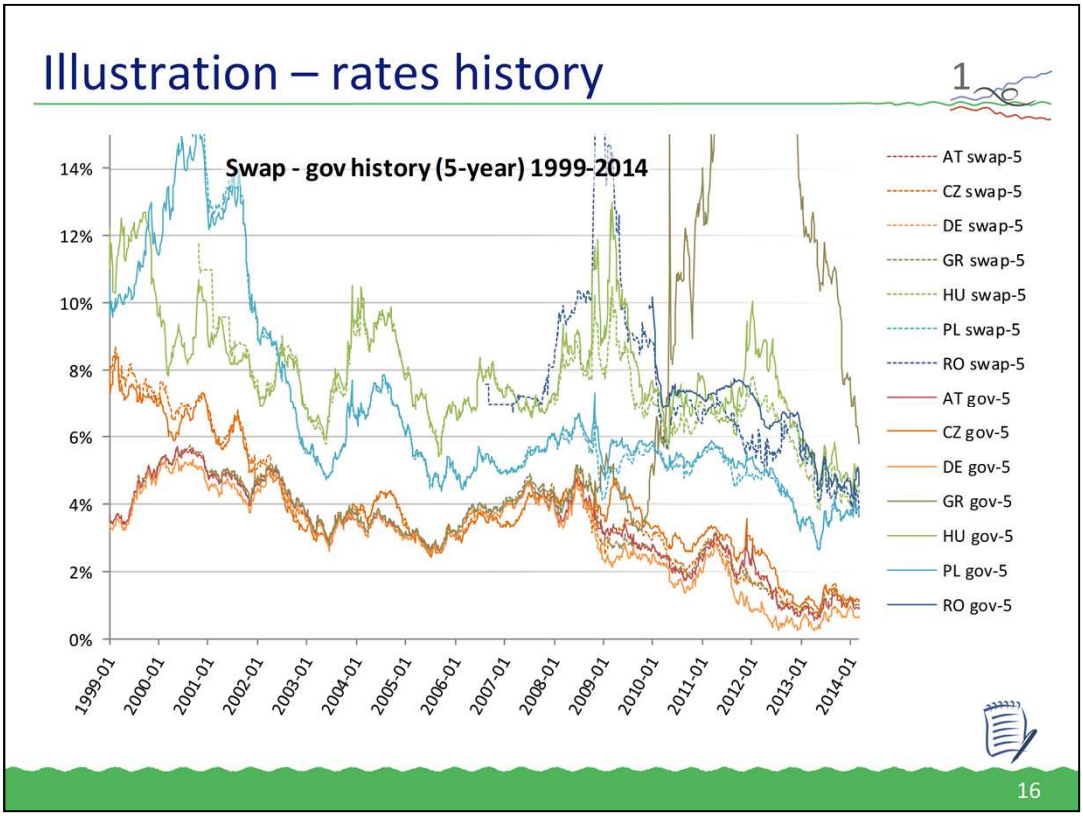
**Actual swap prices**

The point here is the narrow spreads.

- These still seem to be 'shop window' prices – liquid points (short term), wholesale clients can rather get 1-2 bps (esp. in liquid times).
- Bid/ask difference might be about 5 times larger for CEE currencies.
- This particular source exposes historical quotes back to some 4 years and the gaps are fairly the same – i.e. already in the beginning of 2010. Partly because this is an 'upper bound' gap, partly because such a list is still not a trading record that fully reflects the underlying availability.

*I did not seek up the exact content behind these rates. You may research further at the address below if you wish:*

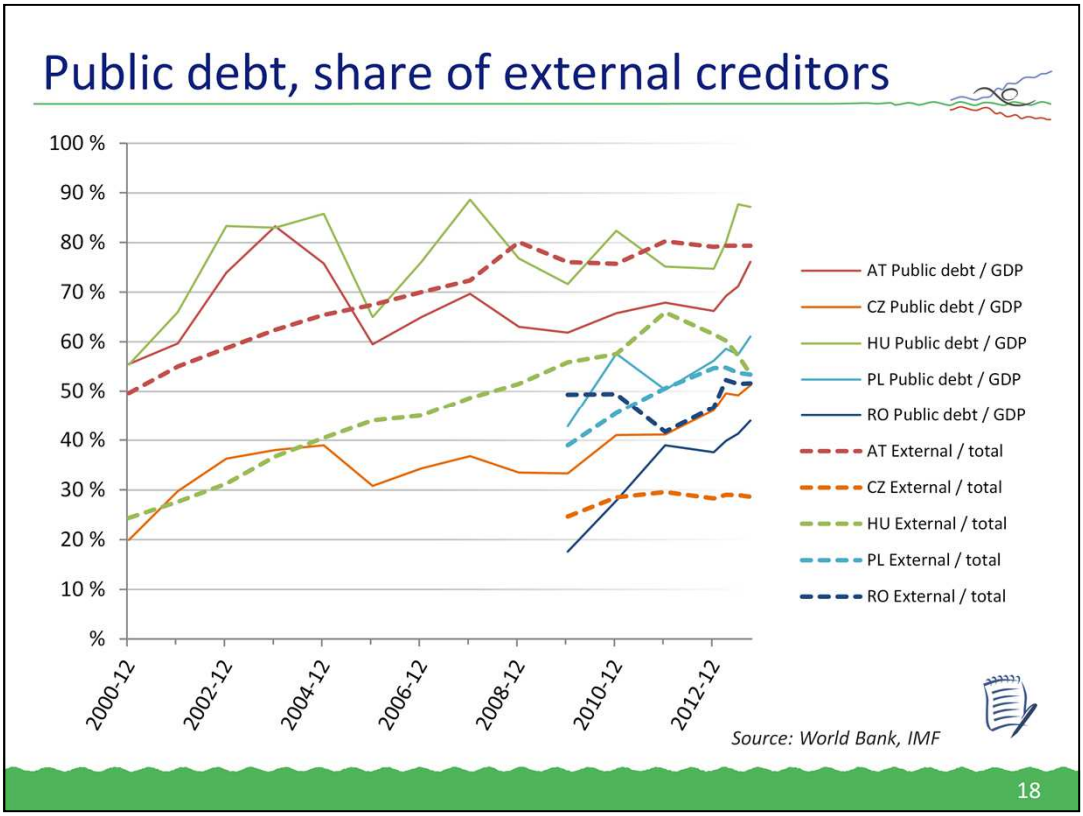
*http://markets.ft.com/RESEARCH/markets/DataArchiveFetchReport?Category=BR&Type=ICAP&Date=01/29/2014*




**Rates history**

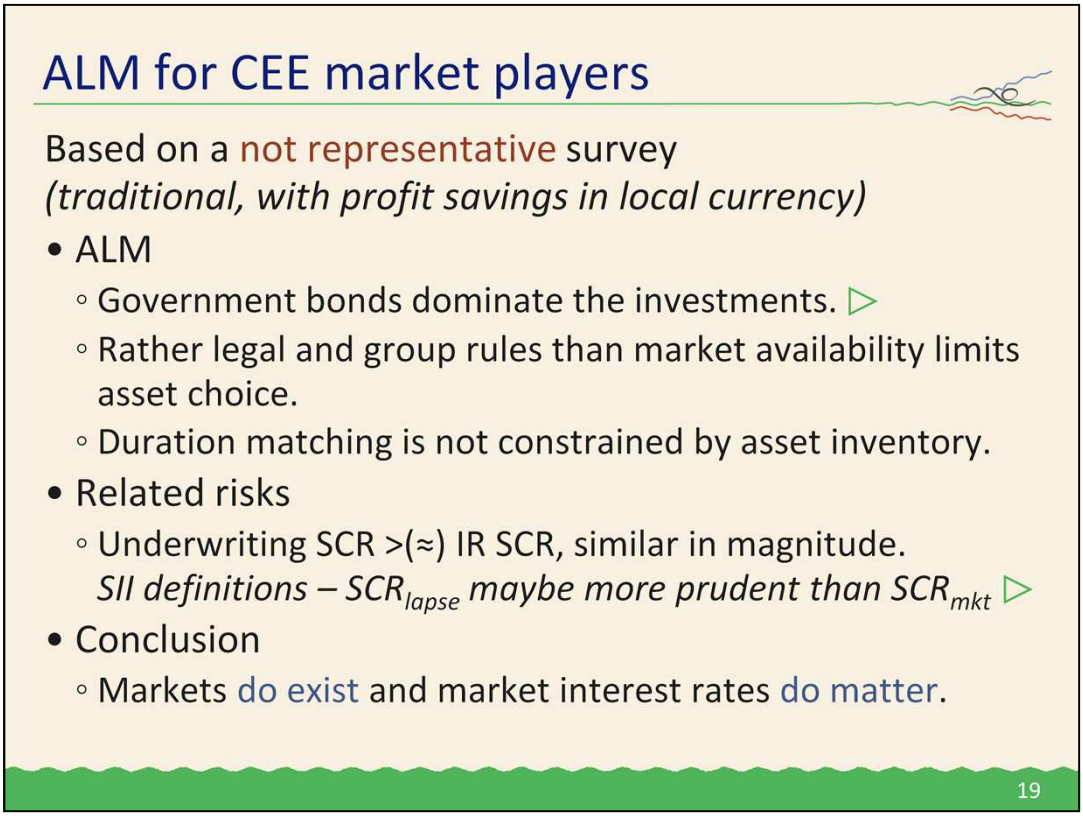
This chart aims to build an impression (and not an understanding) of the interest rate and government spread history of some CEE countries. For comparison, AT, DE and GR were added.

# Illustration – rates' history




**Public debt chart**

- More than 50% share of external creditors for HU, PL and RO indicates possible exposure to global liquidity trends and chance for FX risk premium.
- Yet neither of the two indicators gives a perfect cause for volume and risk in the interest rate and the spread (of course). E.g.:
    - AT also has high debt/GDP and high share of external creditors in that debt. (External has the same currency as internal.)
    - For RO note the IMF deals as of 2009 which also imply less risk than typical market financing.




**Investment mix summary (PL)**

- 60%+ in sovereign debt
  Issued or guaranteed; also includes international organizations where Poland is member.
- 6% other bonds (listed, unlisted)
- 20% deposits with credit institutions
- 10% open end investment funds

*Source: summary from Polish regulator (life insurance total, value covering technical provisions).*

See also the reference portfolio compositions in LTGA TS Appendix 1 – CCP adaptation calibration.

**Solvency II risk measures**

- IR shock is a simple multiplier
  - varies per tenor but not by country and not over time
  - has small impact if rates are already low
- persistency capital includes mass lapse shock

## Note: a subtle change

SII Directive, Article 77a (O2 update)

**Extrapolation of the relevant risk-free interest rate term structure**

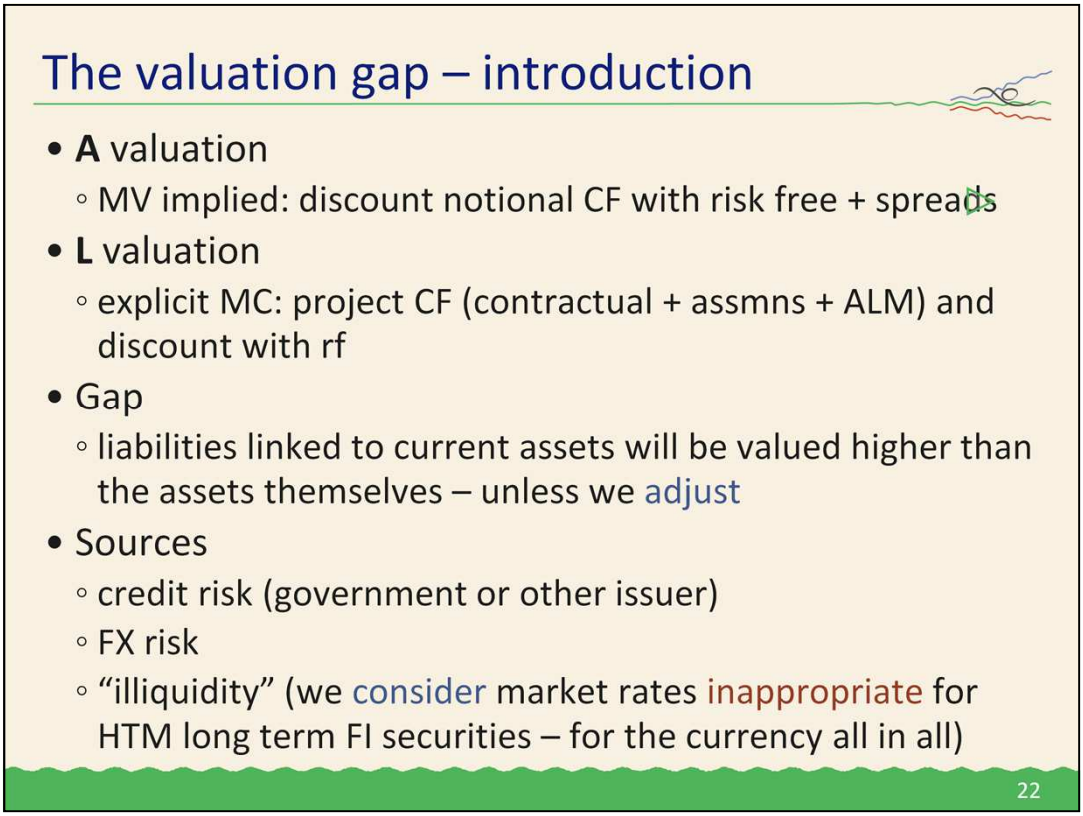
... The determination of the relevant risk-free interest rate term structure referred to in Article 77(2) shall make use of, and be consistent with, information derived from relevant financial instruments. That determination shall take into account relevant financial instruments of those maturities where the markets for those financial instruments as well as for bonds are deep, liquid and transparent. For maturities where the markets for the relevant financial instruments or for bonds are no longer deep, liquid and transparent, the relevant risk-free interest rate term structure shall be extrapolated.

Consequence: whatever rates we take, we need bonds.

# Agenda

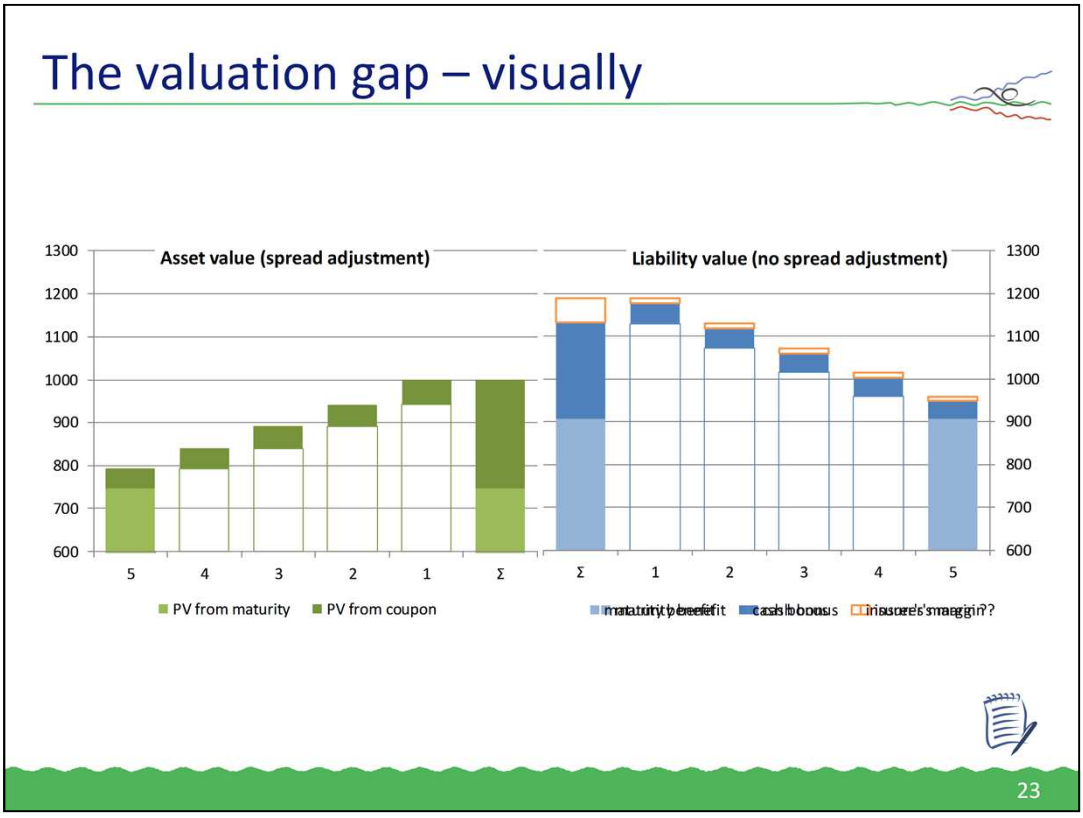
Interest rate markets
The valuation gap
Spreads in ALM modelling
Wrap-up

The basic problem
Sources
Resolution approaches




**Asset valuation**

- *short description*
  Market value of assets is obtained by discounting notional cash flows with risk free + spread.
- *more precisely*
  Recognition of spread is based on how MVA can only be reconciled if, when discounting notional cash flows, we augment the discount rates. So observed MVA is the cause and not the consequence of the spread.




**Explanation**

- We take a very simple insurance portfolio with profit sharing:
  - no future premium inflow, no decrements;
  - no expenses, commission, capital costs, taxes
    (or these are evaluated in a later step, against the margin).
- The investment portfolio is 'perfectly matched'.
  - It comprises of (copies of) a single coupon bond with 5 years outstanding term (6% coupon rate), book value = notional (= 1 000 to keep it simple).
  - After each year the investment return is used to finance the guaranteed TIR (3%) and the profit sharing, the latter being 60% of the excess yield.
  - The liability maturity is paid out from the asset maturity.
- The current risk free rate is 2% for all tenors and the bond trades at its notional value. (If it was risk free, it's value should be 1 189!).
- In a traditional FDE (free distributable earnings) view:
  - The insurer's margin is 12 of the notional each year.
  - In present value, this is 57, equals $PV_{@rf}$(asset CF) less $PV_{@rf}$(liability CF).
- In a market consistent balance sheet view (and no liability adjustment):
  - The market value of assets is 1000 for notional of 1000.
  - Thus the spread must be ≈4%
  - The liabilities are still worth 1 132 in PV so the net position is
    –132 = $PV_{@rf+spread}$(asset CF) less $PV_{@rf}$(liability CF).

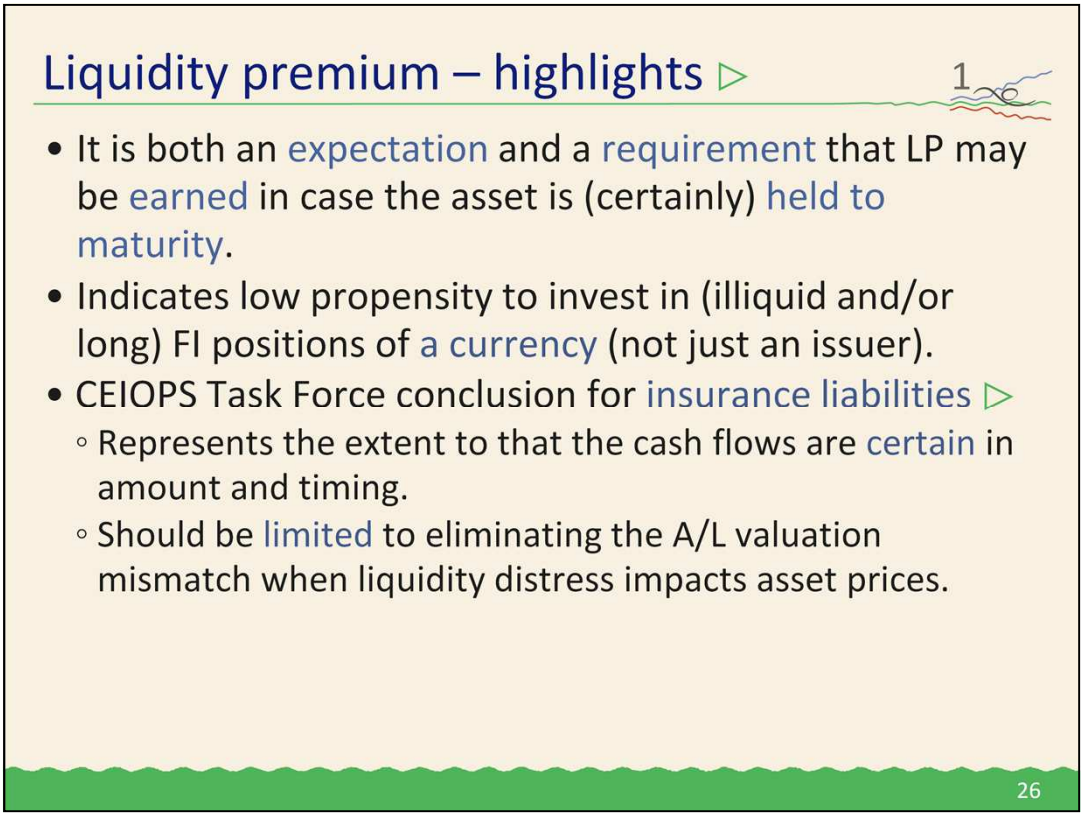

**Granularity of discount rate (adjustment)**

- As the discount rate is the cornerstone of risk neutral valuation, any adjustment to the discount rate can only apply to a full calculation run and to all cash flows of the affected run.
  - Things that are discounted differently – e.g. products qualifying for different amount of adjustment – can only be combined on t=0 present value terms. Future figures on different calibration are not interchangeable by any means.
  - If different asset mix implies different adjustment, the respective portfolios need to be split for any calculations. 'Split' in any other way than feeding different inputs (different scenario sets) is cumbersome and intransparent.
  - All in all: a lot of extra effort is needed to operate the models and runs.
  - Future, dynamic changes in asset mix can not be handled at all – calibration of discounting can not depend on the projection itself.
- When discounting is adjusted in the (base) valuation, the load multiplies for risk capital assessment – all shocked runs need the same splits.
- The operational complexity extends to interpretation difficulties and – as pointed out for some cases in EIOPA findings – unclear or ill risk management incentives.
- When discounting is adjusted only in analysis runs and certain shocks, the same complications apply to a lesser degree and operation is cleaner.

## The valuation gap – resolution approaches 2

- Cash flow adjustments
  - possibly more flexible and generic in aim and granularity
  - possibly complex – stresses calibration, regulation, supervision

  *See the examples later.*
- Common underlying assumption: not all of the spread, or at least not at any time, should be attributed to direct and clear loss expectations and cost of loss uncertainty.




**Liquidity premium**

- *Importance*
  The 'code name' for accessing the literature and discussions on spread related adjustments.
- *Constitution*
  A spread in asset prices (bonds) that is:
  - beyond the part for expected and unexpected credit risk;
  - additional premium demanded (and recognized in the prices!) for the investor's risk additional losses and transaction costs in cases of (premature) sale.
    Note: in risk neutral valuation, usually the expected value impact of a risk is zero, for the risk neutral calibration creates the balance between the upside and the downside. But here we denote as risk the potential loss when compared to the (imaginary) risk free investment – the net value of this expectation is negative.
    (It is exactly the necessary premium that creates the balance in the end.)
- *Naming*
  Consider bonds promising the very same notional cash flows.
  - Liquidity premium: spot prices of more liquid bonds include a premium. This is factually observed for assets that only differ in market accessibility, not even in issuer credit risk.
  - Illiquidity premium: as less liquid bonds have lower current price, their rate of return is higher (same payouts on lower investment). For insurance we rather care for this view
  - Finally these opposing names denote the same thing, from different angles.

**Consensus on liquidity premium (?)**

- Quoted from the CEOIPS Task Force Report on Liquidity Premium (2010):
  'Doubts have been expressed as to the compatibility of the inclusion of a liquidity premium in the calculation of liabilities with the Level 1 text.
  Esp. 77.2 of the Directive 2009/138/EC: "the best estimate shall correspond to the probability-weighted average of future cash-flows, taking account of the time value of money, using the relevant risk-free interest rate term structure."
  The EC representative confirms however that the notion of relevant risk free rate allows for the addition of a liquidity premium insofar this premium may be earned by insurance undertakings without incurring credit risk.'
- Even this very report presents applicability of liquidity premium to insurance liabilities as a majority opinion, not a common position.
- In literature:
  - Several authors and analysis methods confirm existence and it being a spread constituent on its own right (significant explanatory power).
  - Applicability to liabilities is often disputed.
  - Attribution / quantification within the total spread is a hard nut.

## Liquidity premium – highlights


- Application – SII related drafts and final text
  - Part of risk free interest rate used for discounting.
  - The level is declared, applicability factor varies.
  - LP is based on analysis of a representative asset mix.
  - LTGA+ suggests predictable (...) and smooth direct link to market prices.
- Calculation for LTGA takes a residual approach
  - All except the 'fundamental spread' (roughly associated with risks assessed – calculated just as long term average spread).
  - This remains, just subjected to application factor.

## Liquidity premium concerns

1

- Recognition
  - Asset side liquidity premium is identified in market prices.
  - Bond sellers/issuers, in accepting the stressed price, do provide for the possibility of earning the LP. ▷
  - For the liability side application, the insurer's demand for premium is deemed implicitly justified on the basis of fixed cash flows to back up.
    It might be more plausible and transparent to acknowledge liquidity premium only through explicit projection of assets delivering LP earning.

28

**Illiquidity earning 'is possible'**

Reverse view of recognition in asset prices: buyers of liquid assets, in accepting higher current price, provide for the possibility of earning the LP on the illiquid assets.

## Liquidity premium concerns


- Lack of uniform discount rate
  - aggregation?
  - CF model integrity and validation?
  - option prices, RNS generation?
- Tail risk correlation
  - Exactly in times of market distress will liquidity risk manifest.

*See also the references for further critics.*

# Agenda

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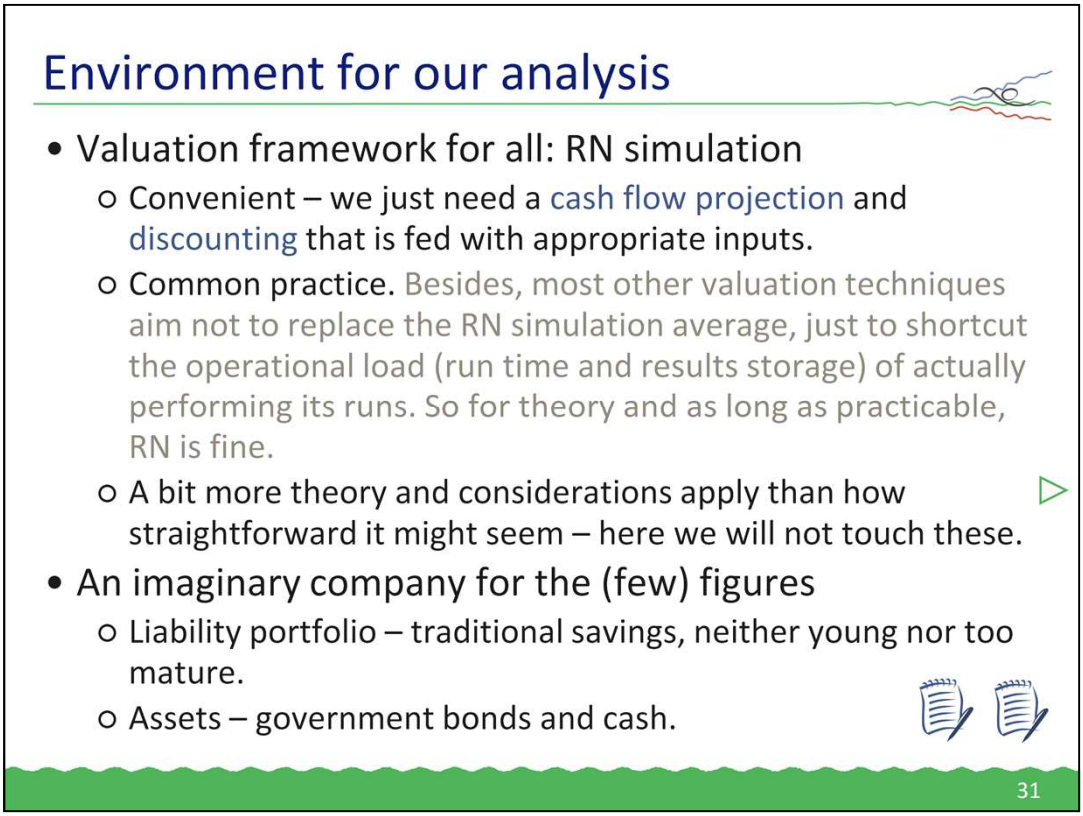
Spreads in ALM modelling
Wrap-up

Analysis context
Results without adjustment
Full CF adjustment
QIS5 liquidity premium
L2IM* counter-cyclical premium
LTGA MA
LTGA+ volatility balancer
Spread decomposition
Omnibus II vol adjustment




**Technical notations, abbreviations**

- rfr: relevant basic risk free interest rate as used for discounting
- $rfr_{scen}$: per scenario discount rate in the RN valuation
- FCL (financial component of liabilities):
  BE value of liabilities + margin for replicable risks
  - calculated as $\mathbf{E}_{\mathbf{Q}}(PV_0(\mathbf{E}(CF|eco)))$
  - (+) denotes net outgo position
- CF: for simplicity we will denote as CF the modelled part where this causes no ambiguity – formally it would be $\mathbf{E}(CF|eco)$ but the non-modelled part has to be addressed separately anyway.
- MVA: market value of assets as observed
- MVA': market value of assets as implied by the liability side valuation approach
  - technically: $\mathbf{E}_{\mathbf{Q}}(PV_0(\mathbf{E}(\text{asset CF}|eco)))$
  - A very humble comment (hold up thinking on it for later): in the notation above, we start off with *not* assuming any non-replicated risk in the asset payouts. Less precisely and more clearly: for the asset CF we blindly believe the notional CF, the payouts promised by the issuer. Thus $\mathbf{E}(\text{asset CF}|eco)$ is – at start, and for some methods all the way through – just $(\text{asset CF})_{scen}$.

**Concepts and high level notations for RN (risk neutral) valuation**

- We sample the eco scenarios from RN distribution Q.
- We project the CF along each scenario and take $\mathbf{E}_{\mathbf{Q}}(PV_0(\ldots))$
  This inherently means that we actually project the conditional expected value
  $\mathbf{E}(CF|eco)$. For understanding the concept and the notation:
  - $\mathbf{E}(\ldots)$: we multiply death benefit amount with death probability, do not individually project and evaluate the individual outcomes – (…) must be measurable by **Q**, can not present risk that is not captured in **Q**.
  - $(\ldots|eco)$: death benefit amount reflects the evolution of the investment returns along the scenario and the consequent accumulation of credited bonus.
  - Risks calibrated into **Q** based on market prices will be ascribed market consistent value within $\mathbf{E}_{\mathbf{Q}}(PV_0(\mathbf{E}(CF|eco))$ – here we calculate "as a whole".
  - The residual { CF – $\mathbf{E}(CF|eco)$ } represents the non replicable risks, the value needs to be recognized separately through risk margin. E.g. actual death count on a policy will be either 0 or 1, never 0.0017 – the death risk resides in this residual cash flow.

**Applicability of RN valuation and its processes and parameters**

We take as granted the RN valuation as such, and in particular the calibration of the scenario generation process and the sample size, to be relevant, appropriate and sufficiently accurate for the business considered. This, of course, happens simply by not discussing it in detail.

This would very much be a relevant topic in reality, esp. that calibration methods and the variety of risks remaining residual to the RN measure highly interact with how the scenario data is used in the model and how adjustments are performed. For all RN models employ simplifications to the structure of prices, discretion is present in which market segment we best capture with parameterization, with the prices we select to calibrate and validate the scenario generation and use. But we must put it out of the current scope and, not in charge of actual reporting or audit, we can afford the luxury here.

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- MVA': market value of assets as implied by the liability side valuation approach
  - technically: $\mathbf{E_Q}(PV_0(\mathbf{E}(\text{asset CF}|eco)))$
  - A very humble comment (hold up thinking on it for later): in the notation above, we start off with *not* assuming any non-replicated risk in the asset payouts. Less precisely and more clearly: for the asset CF we blindly believe the notional CF, the payouts promised by the issuer. Thus **E**(asset CF|eco) is – at start, and for some methods all the way through – just $(\text{asset CF})_{scen}$.

**Concepts and high level notations for RN (risk neutral) valuation**

- We sample the eco scenarios from RN distribution Q.
- We project the CF along each scenario and take $\mathbf{E_Q}(PV_0(\ldots))$
  This inherently means that we actually project the conditional expected value **E**(CF|eco). For understanding the concept and the notation:
  - **E**(…): we multiply death benefit amount with death probability, do not individually project and evaluate the individual outcomes – (…) must be measurable by **Q**, can not present risk that is not captured in **Q**.
  - (…|eco): death benefit amount reflects the evolution of the investment returns along the scenario and the consequent accumulation of credited bonus.
  - Risks calibrated into **Q** based on market prices will be ascribed market consistent value within $\mathbf{E_Q}(PV_0(\mathbf{E}(CF|eco))$ – here we calculate "as a whole".
  - The residual { CF – **E**(CF|eco) } represents the non replicable risks, the value needs to be recognized separately through risk margin. E.g. actual death count on a policy will be either 0 or 1, never 0.0017 – the death risk resides in this residual cash flow.

**Applicability of RN valuation and its processes and parameters**

We take as granted the RN valuation as such, and in particular the calibration of the scenario generation process and the sample size, to be relevant, appropriate and sufficiently accurate for the business considered. This, of course, happens simply by not discussing it in detail.

This would very much be a relevant topic in reality, esp. that calibration methods and the variety of risks remaining residual to the RN measure highly interact with how the scenario data is used in the model and how adjustments are performed. For all RN models employ simplifications to the structure of prices, discretion is present in which market segment we best capture with parameterization, with the prices we select to calibrate and validate the scenario generation and use. But we must put it out of the current scope and, not in charge of actual reporting or audit, we can afford the luxury here.

## Starting point and problem statement

1

- MVA is $PV_0$(notional bond CF)@(rfr + spread)
  - Or rather: spread is identified by MVA < $PV_0$(bond CF)@rfr
- FCL is $\mathbf{E_Q}(PV_0(\text{liability CF})@rfr_{scen})$
  - Imagine a portfolio with perfect CF matching with respect to replicable risks (e.g. benefits equal asset maturities and expenses equal coupon payments).
  - Then FCL is equally MVA' = $\mathbf{E_Q}(PV_0(\text{asset CF}))@rfr_{scen})$
  - As **Q** is calibrated to bond prices FCL = $PV_0$(asset CF)@rfr
  - Despite the perfect match MVA – FCL < 0.

*Note: we soon elaborate on "perfect match".*

32

**Grabbing the valuation gap in notation**

This slide does nothing else than putting the known issue into formulae.

We could spot the issue even more precisely via the effort of introducing a notion of leakage. Shortly, it is when our modelling framework gives different answers about the portfolio value in terms of market value balance sheet vs. present value of future earnings (profits). Value leaks in or out through unclear holes as we pass between the two views. Whilst leakage may arise for many modelling subtleties and plain errors, the far most important suspect is always the asset valuation.

Important is: in theory a model (under quite reasonable criteria) leaks if and only if the asset value is accurately recognized in the liability projection and discounting.

For any individual asset and any definition of book value

$$\Sigma_{periods}\,(PV_0(\text{book value return in amount} - \Delta BV)\ @\ rfr_{scen})$$

is easily seen to be equivalent to $PV_0$(asset CF)@$rfr_{scen}$

In an ALM projection, we can sum up and take aggregate the rule, then take the RN average:

$$\Sigma_{periods}\,(PV_0(\text{int on res} - \Delta\text{res})) = PV_0(\text{CF assets behind res})$$

$$\mathbf{E_Q}(\,PV_0(\text{int on res} - \Delta\text{res})\,) = MVA'_{\text{IF at t=0}}\,[+\,MV'_{\text{future inv.}}@t=0]$$

The model "leaks" value (benefits give away more projected asset earning than asset is valued for in BS) if:

MVA' > MVA on the opening asset stock (or < but that's rare), or

$MV'_0$ of future investment > 0 (maybe <).

Beyond pure satisfaction, a leakage-free model allows for human digestible profit by source analysis, movement analysis without giving up market consistency, and the criterion itself supports technical quality check of models.

## Starting point and problem statement


The part of liability CF that is directly covered by the run-off CF of the initial assets will be valued higher than the assets themselves, depressing the net position.

## How to compress the gap?


- Ingredients of it are
  - discount rate curve that, for RN valuation, must equal the risk free term structure of interest rates
  - asset value that, for market consistency, should not capitalize more future return (on MV) than the same rfr
  - projected investment return for liability valuation that exceeds the rfr by the government spread curve
- The valuation gap emerges as the latter two differ.
  - Returns to policyholders can be higher because they do not bear (most of the) investment risk – we will see examples.

## How to compress the gap?


- Possible ‘building blocks’ to narrow or close the gap:
  - chop the investment return projection for valuing liabilities
  - augment rfr and discounting against the spread (gov stays!)
  - admit to capitalize some excess return assumption into the asset value – unclear at first sight, but see example later
- We will digest how various methods select from these.

## Technical alternatives – overview

- No adjustment – creates a gap in the BS
  - *CF based or FDE based valuation yields different results.*
- Direct and full CF adjustment (MCEV Principles)
  - No gap – will pull the CF valuation to the FDE version, chops the projected returns in liabilities.
- Spread decomposition, split to transferable / own risk
  - Nice on paper (?) but hard to calibrate (!). ▷
  - May be useful for assessment and benchmarking.
  - Touches both types of return but not the discounting.
- High level adjustments and corrections
  - Global shifts in discount curve / investment returns
  - BS, SCR post-adjustments (standalone or related to shifts)

36

**Calibration concerns for decomposition**

*The problem should be mentioned in this overview, but you may prefer to read these details after getting to know the approach itself later on.*

- Nature of phenomenon / modelling approach would suggest many attributes to go stochastic with interest rates (the spread itself, and to some extent also its split-up). At least credit spreads and market implied default probabilities (or FX risk parameters) should respond to movements in the risk free curve.
- But: that would involve many standalone parameters for stochastic processes...
- plus a vast amount of correlations. (Not to mention that correlations of core stochastic process variables are hard to relate, whilst correlations in output are hard to represent.)
- Assessment of the calibration input involves substantial discretion, plus an infinite number of scenarios is needed for only an accurate representation of these inputs.

## Simplest option – no adjustment

- Cons we covered already.
- Pros
  - Clear and easy – both the execution and the risk management incentive.
  - No risk of imprudence.
  - Existence of a gap does not mean we are on the wrong side.
  - If the overall impact is small, a fair choice.
- Similar – risk free we declare as government rate
  - This 'happened' to Poland in LTGA
  - Proliferates in SII preparatory TS (Appendix DC1).
  - Basis: SII Delegated Acts (draft), Art 44 ▷

*We will discuss this option later.*

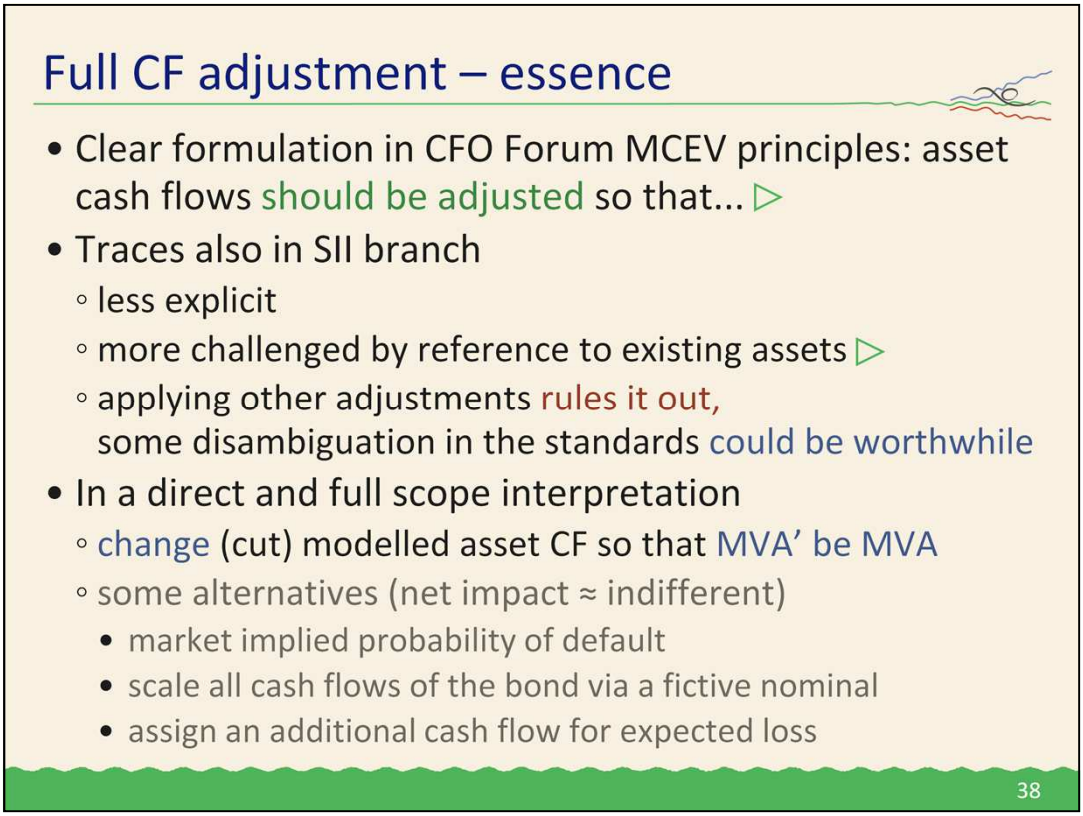
37

*Article 44 Relevant financial instruments to derive the basic risk-free interest rates*

1. For each currency and maturity, the basic risk-free interest rates shall be derived on the basis of interest rate swap rates for interest rates of that currency, adjusted to take account of credit risk.

2. For each currency, for maturities where interest rate swap rates are not available from deep, liquid and transparent financial markets the rates of government bonds issued in that currency, adjusted to take account of the credit risk of the government bonds, shall be used to derive the basic risk free-interest rates, provided that, such government bond rates are available from deep, liquid and transparent financial markets.

*By the way: what if neither swaps not government bonds trade deep, liquid and transparent enough? Whatever the case, basic risk free rate curve is up to EIOPA...*




**MCEV Principles G14.4**
'Where a company invests in fixed-income assets which have a yield different to the reference rates, the company should make appropriate adjustments to the projected asset cash flows to ensure that the asset cash flows, discounted at the reference rates, equal the market value of the assets.'

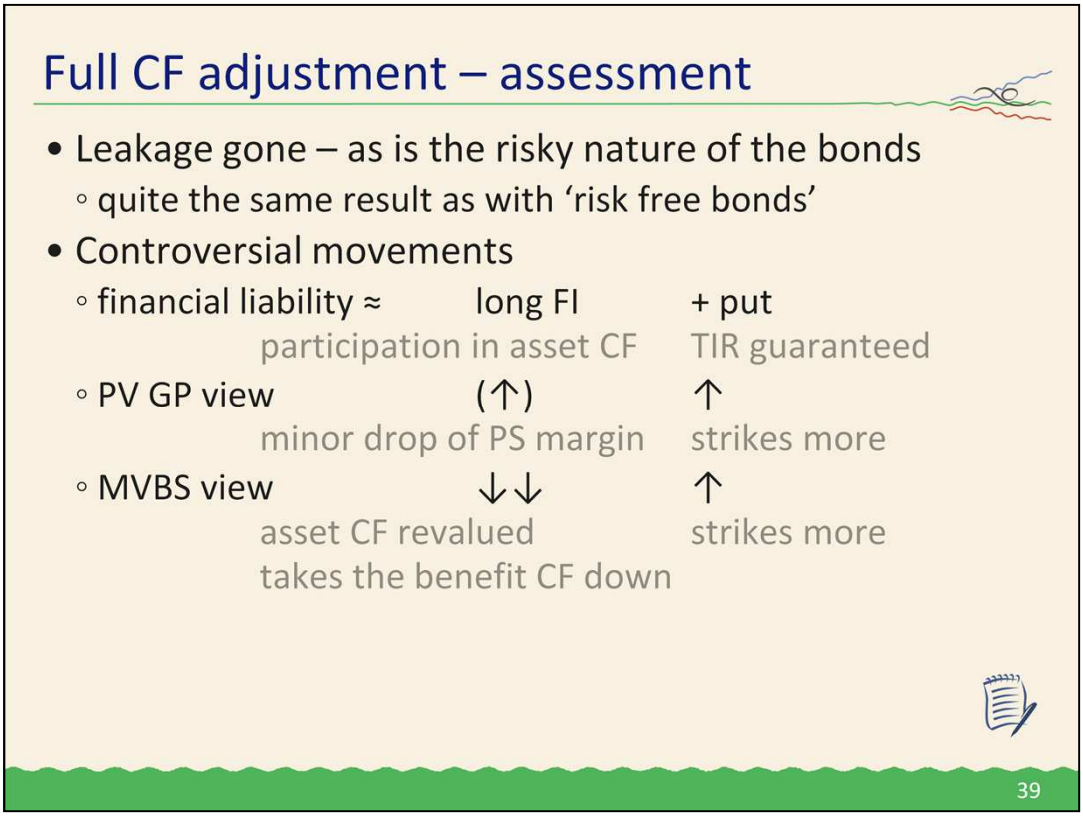
**SII technical specifications for the preparatory phase**
**Valuation of options and guarantees embedded in insurance contracts**

**(pro) TP.2.105.** For the purposes of valuing the best estimate of contractual options and financial guarantees, a stochastic simulation approach would consist of an appropriate market-consistent asset model for projections of asset prices and returns (such as equity prices, fixed interest rate and property returns), together with a dynamic model incorporating the corresponding value of liabilities (incorporating the stochastic nature of any relevant non-financial risk drivers) and the impact of any foreseeable actions to be taken by management.

**(con) TP.2.116.** Where the future discretionary benefits depend on the assets held by the undertaking, the calculation of the best estimate [investment return] should be based on the current assets held by the undertaking. [...]

**(pro) TP.2.117.** The assumptions on the future returns of these assets, valued according to the subsection V.1 [ie. on market basis], should be consistent with the relevant risk-free interest term structure, including where applicable a matching adjustment or a volatility adjustment. Where a risk neutral approach for the valuation is used, the set of assumptions on returns of future investments underlying the valuation of discretionary benefits should be consistent with the principle that they should not exceed the level given by the forward rates derived from the risk-free interest rates.

However, if other adjustments (CCP, MA, OFA, VA) are used, CF adjustment is invalid on general principle – there should be no double counting.




**'Risk free bonds'**

- In the interest rate markets overview, we concluded not to link the risk free rates to any bonds – risk free bond is an abstraction whatsoever. (Esp. in CEE.)
- Some derivatives may be used for partial de-risking, then the combination (risky bond + derivative) could be closer to a risky bond. Just 'could', though.
  - This involves other risk sources appearing in our balance sheet.
  - Hedge asset outside of the fund has no effect on the liability, plus the deposit requirements are hard to meet without access to the underlying bonds.
  - Hedge instruments can only be accounted on MV, so the BV accounting of the 'risk free bond' could not be replicated even if the value could. Thus hedge asset within the fund rather adds noise than protection to the BV return, augmenting the guarantee price instead of decreasing it.
- Anyway, hypothetic calculation with hypothetic risk free bonds is still a benchmark for other methods. Just don't think it's real.

**Controversial movements**

Not unexpected as we aligned two things that were different, but hard to explain the true nature of the adjustment.

# Full CF adjustment – problem

Example

| | | | |
|---|---|---|---|
| 4% coupon 2% risk free | | 3% TIR | ▷ 2% implied PD |
| average before PS calculation | | | |
| 2% net return | = risk free ✔ | 3% TIR | 0% profit share |
| average after PS calculation ▷ | | | |
| 4% net return (**P**≈96%) | | 3% TIR | PS 1 % |
| –50% net loss (**P**≈4%) | | 3% TIR | PS 0 % |
| 2% avg return | ✔ | | PS 0.96% |

$\mathbf{E}_Q$(implied loss|scenario) added against asset leakage

- appears in investment return = profit sharing basis
- TIR guarantee is a put option, payout is convex
- hides FOG on non-replicated risk: (implied loss – **E**(i.loss|eco))
  *Remember "perfect match" a few slides before ☺?* ▷

**Explanation of full CF adjustment**

- The numerical example is for a bond with market value equal to the nominal.
- We calculate the implied probability of default so that the (expected, market value based) return of the fund becomes 2%
- This – either as a decrement on the number of bonds or as a generic asset loss cash flow – is achieved by attributing an annual 2% loss to the credit default risk.

**Simplification warning**

- Of course, you can have a coupon rate higher than the risk free rate without an implied loss.
- E.g. a German coupon bond from 2011H1 nowadays has higher value than nominal (for rates have dropped) – and no spread for potential losses.

**A smarter – and more realistic – risk representation**

- We assume the default risk comprise of two possible outcomes: no loss or 50% net loss.
- The implied probability distribution is as indicated to get the average return to the MC level.
- Finally and most importantly: we first calculate the PS for each case and average only afterwards.

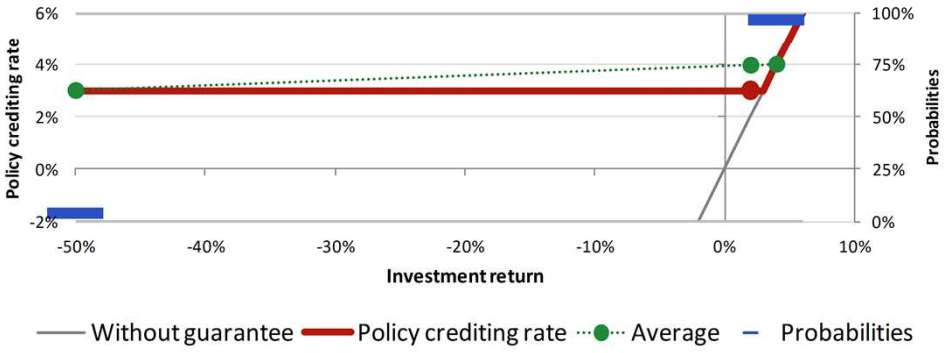
**'Scientific' explanation**

- We thought to have a close to perfect match to the liability before the guarantee: the bond payout is very close to the liability in each scenario. (Moreover the hidden assumption of RN valuation is that the liability can be replicated with a dynamic strategy of fixed income instruments that are properly priced by the scenario set.)
- However, the exposure is barely exposed to default risk – protected by the TIR guarantee – while the asset we have is. This risk is not represented by the scenarios and can not be priced (our interest rate, be it stochastic or just a base curve, was calibrated for risk free instruments). This is why we could only use a 'flat' loss cash flow in the scenario based projection to offset the excess return. The conditional expected value of the implied loss on default, with respect to the scenario data, is flat 2%.
- As soon as we consider the residual risk – the default risk of our net balance sheet – we find that a liability option on this was left out of the valuated. It was 'sheltered' by the flat payout on the excess return, but only a bit smaller than that in value. The flat 2% is in each case an average from a very skew distribution and (implied loss – $\mathbf{E}$(implied loss|eco)) ≡ (implied loss – 2%) is not any less skew. An important option is written on this residual risk that our scenarios can not capture.
- Very briefly: we were far from a perfect match and most of what appeared a valuation gap was rather the option price of a non-replicated asset risk.
- Perfect match within the asset universe we can price with the risk neutral pricing is a relative thing, and can only be measured from outside. The more relevant risks you find outside it's reach (it's linear space) the more a perfect internal match becomes insufficient. Here default risk was 'outside' and very relevant.

# Full CF adjustment – visually

*When the return without default exceeds the strike point and the loss given default falls far short of it, then…*

It's all just Jensen's inequality.



## Full CF adjustment – lesson learnt

- Skew risks on the investment return mostly constitute an option through the TIR guarantee.
- Thus only a fraction of expected losses and uncertainty costs can be transferred to the PS scheme.
- This does not change just because such risk is not modelled stochastically.

## QIS5 liquidity premium – concept

- Part of the market spread can be earned.
  - liquidity premium declared officially (part of the specification), based on reference asset mix
  - for sufficiently stable liabilities – level approach per line of business
  - general unit linked excluded (obviously)
- Recognized in the discounting of liabilities.
  - Two rules set on asset earning expectations: market consistency and reference to actual portfolio.
  - earnings of existing assets: (rather) relevance
  - future purchases: (rather) MC – practically ≡ risk free assets

  *At least the most plausible way to factually use both rules.*
- SCR for illiquidity risk (-50% correlation with spreads)

## Counter-cyclical premium – concept

- Argument and impact: as liquidity (discounting)
  - declared officially in times of financial distress – otherwise 0
  - all eligible (except where matching adjustment is used) to uniform level
- SCR for CCP risk (no correlations)
- Additional disclosure on impacts
- Recovery plan if only CCP saves from insolvency
  - double workload (two SII balance sheets)
  - no true relief (regulatory action on the 'worse' variant)
- Note: LTGA report recalls fuzzy net impact
  - e.g. CCP$\Rightarrow$L$\downarrow$, $SCR_{CCP}$ offsets, net gain is in CCP$\Rightarrow$$SCR_{Lapse}\downarrow$

## Matching premium – concept

- Aimed for „perfectly matched" assets and liabilities
  - cost of the liability can be determined via discounting along the investment return (as implied by market value)
  - shifts the basic risk free rate to the level that only "fundamental" spread (default + downgrade risk) remains
  - the shift is portfolio specific and parallel
- Strict applicability rules
  - liability locked in – no new premium, surrenders on asset value, limited mortality risk
  - assets matching cash-flows and (could be) ring-fenced
  - asset quality
  - some numerical limits on the extent

## Matching premium – notes

- Final version
  - Quite as in LTGA (extended variants were dropped).
  - There were some, seemingly technical but probably important, changes in the conditions before.
  - Shift is flat and applies after extrapolation.
  - Definition practically based on MVA = MVA'. ▷
- Close to a special case of decomposition
  - asset cash flows need to match liabilities after de-risking for credit – whatever this means should imply that credit risk is not transferred to clients
  - all non-credit spread fully earned – no other losses so no concern on transferability

46

**Article 77c**
**Calculation of the matching adjustment**

(a) The matching adjustment must be equal to the difference of the following:

(i) the annual effective rate, calculated as the single discount rate that, where applied to the cash flows of the portfolio of insurance or reinsurance obligations, results in a value that is equal to the [market] value ... of assigned assets;

(ii) the annual effective rate, calculated as the single discount rate that, where applied to the cash flows of the portfolio of insurance or reinsurance obligations, results in a value that is equal to the value of the best estimate of the portfolio of insurance or reinsurance obligations where the time value of money is taken into account using the basic risk-free interest rate term structure;

(b) The matching adjustment must not include the fundamental spread reflecting the risks retained by the insurance or reinsurance undertaking.

*The draft Delegated Act specifies that (b) means substraction, so*
*MA = $IRR_A$ – $IRR_L$ – FSpr.*

## LTGA+ volatility balancer – concept

- Assessment and declaration: aimed smooth and predictable
  - declared reference asset mix and calculation method
  - automatic: applies regardless of level, sign of results or presence of financial distress
- Application: simplified
  - full Solvency II balance sheet and capitals calculated 'clean'
  - base case recalculated with augmented discount rate
    - 20% of the 'available' spread
    - special bucket for country adjustment in exceptional cases
  - discounting difference placed as special own fund element

## LTGA+ volatility balancer – notes

- Intransferable losses
  - Credit – supposed to be covered by fundamental spread, but that is remote to the actual company assets.
  - Other – 80% buffer is a lot.
- Level
  - 20% provides minimal relief
  - SCR evaluated at basic rfr – remains high
- Own funds adjustment

  *Personal opinion*

  Presentation faithful to illiquidity core concept:
  not liabilities that get cheaper,
  assets that provide a margin on HTM strategy.

## SII final volatility adjustment – concept

- Assessment and declaration as LTGA+ VB
- Application: BEL and SCR discounting
  - not risk margin (common for all SII versions)
  - no dedicated SCR component
- Level
  - 65% of 'available' spread on reference portfolio
  - flat, shift applies before extrapolation
  - invariant to IR and spread shocks
- Liability scope: all – except
  - MA, transitional measures
  - 'valued as a whole' (draft TS TP.4.6), mostly basic UL

## Spread decomposition – idea

- It is not a viable option to include the underlying risks (e.g. credit) in the RNS generation process
  - skew risk – slooow convergence
  - correlations – parameter set explodes, market calibration not possible
  - relevance of calibration also in doubt – observed prices may be set by buyers of different risk composition
  - though it could model future investment in risky assets
- We may (and for illustration, will) attempt to
  - decompose the spread
  - attribute relevance (…)
  - attribute transferability (the extent to that the PS basis can be affected)

# Spread decomposition – disclaimer


*The following section is for and only for the illustration of the concept. Not just the values but even the choice of possible decomposition parameters were created out of thin air – though with the intention of deriving results that look like meaningful.*

## Spread decomposition – assumptions

- Decompose spread to (many) components
  - spread varies by tenor – we split curve to curves
  - stochastic rates modelling
    - » stochastic spread (?)
    - » stochastic decomposition (??)
- Find for each component
  - source – expectation or risk that triggers a premium
  - nature – how the cause affects insurer's asset portfolio
  - scale – more / less exposed than 'reference buyer'
  - allocation – split impact between own funds and liabilities
- Bottom line
  - an awful lot of parameters

## Spread decomposition – case specifics

In setting the (fictive) assumption parameters ahead, we rely on the following aspects of the (fictive) case:

- Business and investments are exclusively in local currency.
- The country has substantial external debt and it is necessary for the financing, domestic saving can not take up all sovereign issues.

Assume the total government spread in local currency to be 100 bps.

# Spread decomposition – original input

| market observed | risk source | cost type | principle behind market price | attributed share in spread | principle for insurance pricing | modelled value |
|---|---|---|---|---|---|---|
| Total spread = 100 | early sale | exp. | N/A | - | – | 0 |
| | (external non-mkt) | MVM | N/A | - | non-market MVM | 0 |
| | early sale | exp. | illiquidity | 3 | SA CF adjustment [implied PD] | 2 |
| | (ext-mkt, mandated) | MVM | illiquidity | 5 | GA CF adjustment | 2 |
| | MVA gain/loss | exp. | = 0 | - | – | - |
| | for investor (IR, | MVM | **illiquidity** | 16 | GA CF adjustment | 4 |
| | capital need after | exp. | N/A | - | – | 0 |
| | unrealized loss (gain) | MVM | N/A | - | GA CF adjustment | 8 |
| | MVA gain/loss | exp. | present in swap rates | - | – | - |
| | for investor (FX) | MVM | FX spread | 35 | practically void | 0 |
| | credit default | exp. | credit spread | 17 | implied PD [SA CF adjustment] | 17 |
| | | MVM | credit spread | 24 | GA CF adjustment | 24 |
| | | | | | | |
| | | | illiquidity | 24 | implied PD | 17 |
| | | | FX spread | 35 | SA CF adjustment | 2 |
| | | | credit spread | 41 | GA CF adjustment | 38 |
| | | | | | | |
| | | | **MC : total = 100** | **100** | **total impact for local insurer** | **57** |
| | | | | *no gain over rfr* | *43% of spread earned on investment* | |

**Legend – for what could be a structure to derive parameters**

*Don't forget it's just a game. For simplicity, description is written as if it was real.*

The left column of green cells represents our assessment of how the total spread in the market prices can be attributed to risk factors affecting the reference buyer. For each risk there is an expectation (e.g. FX devaluation in line with current FX forward rates) and an unpredictability. The latter we denote as MVM, though the particular methodology of calculating the insurance MVM may not apply directly to other market players. However the concept of opportunity cost on capital at risk is quite generic and can be treated as general, regardless of how it does or does not appear in books.

The second column presents how we assess these risk to relate to insurance business through the investments.

Market consistency primarily applies in the left column adding up to the observed spread. Usually we set up models where the second column also does add up to the same (rather, there is no distinction between insurance aspects and common aspects of the underlying risks and there is not even a second column thought of) – this, however, can be waivered if we can firmly present a difference in nature. We do calibrate on the true prices where considering marketed instruments (left column), but the specifics of insurance and those of the company deviate from the marketed set of instruments and require a marked to model assessment of these factors (second column). Once we entered these cash flow and risk elements to the set of reference prices, we can use them as building blocks to model and price our insurance company.

**Notations**

- cost type: **exp**ected loss vs. **MVM** type of loss (cost of capital for unexpected loss)
- principle for insurance pricing
  - **S**pecial **A**ccount cash flow adjustment: loss that emerges directly on the invested assets, so is included in the fund return and the profit sharing basis
  - **G**eneral **A**ccount cash flow adjustment: loss that emerges as capital cost or hedge cost (it is very unlikely that any material part of it can be transferred into the fund return, we argued for this in a note to the full CF adjustment method)
  - implied **P**robability of **D**efault: in effect, quite the same as SA CF adjustment but a decrement seems more natural (there is some minuscule difference in reinvestment patterns of the ALM if we model via decrements)

## Spread decomposition – model input


Bottom line – for the 100 bps market observed spread we made up parameters where:

- Reference buyers of the asset do not have arbitrage.
  *RN expected excess is offset by capital cost – MC principle is OK.*
- Local insurance company earns 43 bps net due to different risk profile.
  *Primary source: spread for unexpected FX risk does not apply for local entities, yet domestic liquidity is insufficient to wipe off this extra earning opportunity.*
- The remaining 57 bps spread hits the company.

## Spread decomposition – model input

| risk source | insurance pricing | modelled value (bps) | E(payoff \| loss event) % of nominal ≈ % of BV | PS threshold | r(BV) before adj | P( loss event ) P×[ (1+r) - V(loss) ] = spr | PS basis impact | transferability ratio |
|---|---|---|---|---|---|---|---|---|
| early sale (mkt) | SA CF | 17 | 80.00% | 2.50% | 4.85% | 0.684% | 0.01608% | 9.46% |
| credit default | implied PD | 2 | 50.00% | 2.50% | 4.85% | 0.036% | 0.00086% | 4.28% |

Of 57 bps total loss

- 38 bps does not pass through investment returns at all
  - mostly CoC
  - could be less if hedge instruments were included in the asset pool and PS basis – barely possible
- 19 bps impacts expected returns, but only a fraction can be transferred to PS scheme
  - e.g. for return before adjustment ≈5%, ≈1 bp goes through

56

**Transferability calculation example**

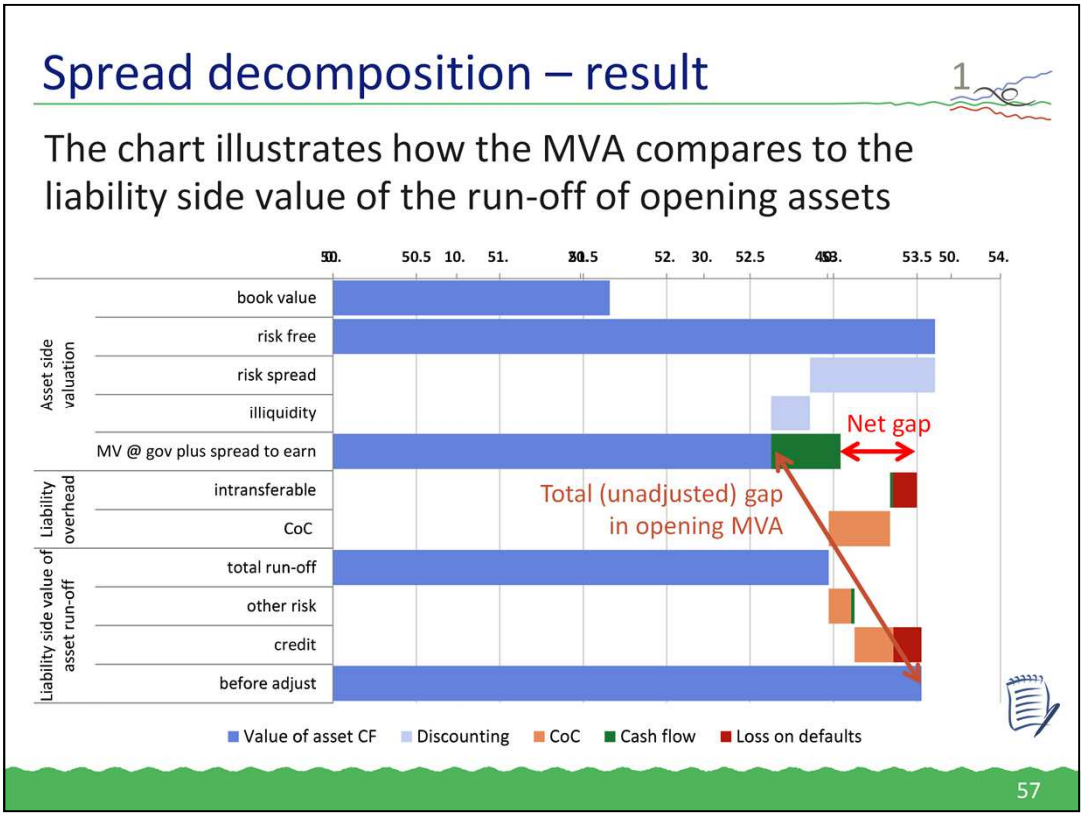
For the cash flow losses – and the quite similar default probabilities – per cause, we can estimate a loss given default distribution and a loss event probability, which yields figures on how much of the loss can be transferred to the profit participation scheme. As the losses tend to exhibit sparse and skew tails, this transferability rate will be low in general.

**Conclusion – inputs to cash flow model**

Attributing the total spread to individual factors allows us to place the consequent cash and CoC flows accurately in our projection.

CoC can barely pass through to the investment fund – the investment risks are not borne by the policyholder, so the risk and the capital charge is at the insurer. This can be translated to a hedge programme where risk is translated to a less volatile consolidated loss – but that's still the insurer's book (see argument in the notes for full CF adjustment).

Some CF losses do arise within the investment fund



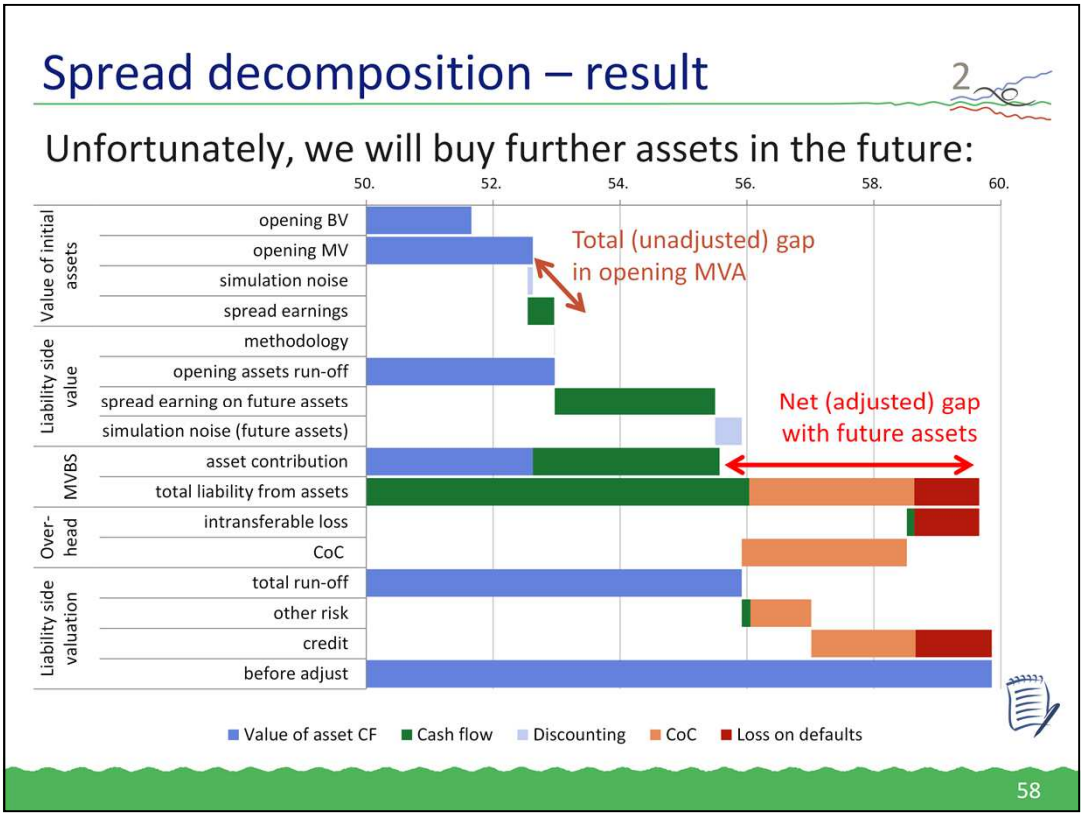

**Asset side buildup**

- book value: amortized aquisition cost, fairly close to the nominal (we model with coupon bonds)
- risk free: notional asset cash flows discounted at initial risk free curve
- risk spread: discount rate includes all of spread except illiquidity
- Illiquidity effect: we finally add the illiquidity to the discount curve to get the actual MV of opening bonds.
- MV @ gov + spread to earn: we add the expected present value of future spread earnings to the MVA (these two will be used to finance our liability)

**Liability side buildup**

- before adjust: the risk neutral discounted value of the notional asset cash flows of the opening assets (the high end of the unadjusted gap)
- credit: we deduct CoC and loss on default (as decrement) for unexpected and expected credit risk
- other risk: we attribute cash flow loss and CoC to further risk components that are relevant for us
- total run-off: we have obtained the value that we will project in the investment earning and will thus surely feed the profit sharing scheme
- CoC: cost of risk capital directly impacts the value (does not pass through PS)
- intransferable: finally, we will (in expectation) distribute more to the profit sharing scheme than what we earn, given the aforementioned convexity

The **net gap** (which we believe is right to load on our portfolio value) is the difference between the last items of the two sides.




**Impact of future assets (reinvestment)**

- If we continue in the future to invest in similar assets, thus traded with spreads implied from the same current prices, the situation gets worse.
- Our future earnings from the spread will increase – but these feed the profit sharing scheme –, and so will the CoC and intransferable losses from these assets. (Of course, we are still far better off than projecting future investments in risky assets and not adjusting at all.)
- Summary: in this example, the adjusted gap is still far higher than the opening total difference in MVA for the spread, and in total a very material figure.
  Settings we used:
  - 2009Q4 HUF curves (moderate spread, yield curve far above TIR of 2.25%),
  - portfolio started in 2005, so not very small and still increasing, gradually running out by 2020
  - parameters all in all close to the '65% of spread other than credit can be earned' rule adopted by the EU in 2014 – and for that I felt struggling to put the necessary amounts into all the relevant places, heavily relying on the FX argument that did the most of it
  - The value of the company – using this adjustment method, and before all other MVM and EC – came out around 2% of the current asset value. With the inclusion of future investments, the gross gaps approaches 15% and the net is around 8%.

## Spread decomposition – assessment


- Overcomes convergence issue of exploded stochastics.
  - risks in spread simplified to fair deterministic scheme
- Supports future investments in risky assets.
- No leakage – we can track every cent
  - new CF elements (+ earned spread, – intransferable loss)
- Assumption setting ▷
  - escaped correlations (if scheme is fixed or a simple rule)
  - substantial discretion – not market calibrated
    *Well, we could borrow FSpread and 65% from SII VolAdj.*
- Not for production use
  - conceptual reference
  - model cross-validation, model selection

59

**Problems of assumption setting for CF decomposition**

- In the example we have selected a flat split-up scheme and still there are a lot of items in it with no traded assets for reference (it's exactly the point that there are no better reference prices).
- Disproportionate split (e.g. illiquidity being zero if the overall spread is below a threshold) could be argued for, augmenting parameter ambiguity.
- The more this split-up matters for our final outcome the more we should consider modelling spreads correlated with the stochastic interest rates. Correlations are (nearly?) always established on the basis of historical observations and not market implied, so more correlated stochastic factors expose our overall model to higher parameter risk. Even worse, spread distribution tends to be skew and to represent even skewer underlying risks, which makes modelling and calibration a greater effort and slows down simulation convergence.

**Some relief**

- However the end results hardly depends on anything else than the proportion of the spread that can be earned. Losses are either immediately out of PS scope or qualifying for PS but practically intransferable, let alone very special situations.
- If we focus on just this factor, we have chances for a (more) simple model.

## Spread decomposition – assessment


- Note for groups
  - If FX risk is the major source of earning, part of it leaps back on consolidated profits – but that's far less a problem than A–L balance.
  - Some relief in CoC diversification – but that does not help PS balance, on average clients do receive more than what we earn.

## Spread decomposition vs SII VA – numeric

- Portfolio value, sub module risk capitals
  - The two ended up really close on aligned parameters.
- Risk management incentive
  - Don't suggest cash instead of bonds!
    *Escape spreads but enter higher volatility – no good.*
  - Fortunately both models presented a clear punishment for that alternative – net value decreased by about 6% of the opening asset value, a clear no-go – and even in this case very close results. ▷

61

**Scenario generation and risk management**
Would be interesting to test this on other interest rate models (1-factor Hull-White is a short rate model and may overestimate the volatility saving on longer durations).

## SDC vs SII VA – concept


- SDC adjusts the asset side, VA the liabilities
  - The underlying concept really is the excess asset gain open to the insurer for 'safely HTM' assets and constrained exposure to some underlying risks.
  - SDC calculates the asset value add-on directly, VA transposes it to a drop in liability value (and no OFA moves it back to assets).
- ALM connection
  - SDC requires tight ALM projection, in turn it can deal with investment mix changes.
  - VA has no idea of investment mix.
    However it is applicable even in absence of a proper ALM projection (to the extent that the model can still calculate fair liability values – which is questionable in this case).

## SDC vs SII VA – concept


- Scope
  - SDC sticks to adjusting asset based cash flows.
  - VA adjusts all and may upscale the net value of:
    - level term, riders, non-life products
    - late claim reserves, non-life rare event reserves
      *if payout does not accumulate along risk free rate and latency is modelled explicitly*
- Modelling consistency
  - SDC can provide the same portfolio value as MVA–MVL or MV(profits) – supports profit by source and error trapping.

# Agenda

Interest rate markets
The valuation gap
Spreads in ALM modelling
Wrap-up
Conclusion
How to use VA
Exit path
Readings
Credits

## Conclusions

*generic*

- We do have a situation
  - Valuation of assets and liabilities, valuation of FDE and CF don't line up.
  - The amount of unclarity can be material in times of stress.
  - Assumptions on future reinvestment are vital.
- There are too many solutions.
  - Clear, accurate, practiceable, comparable, manageable, objective, market driven? – *Make your choice…*
  - It could also be valid to abandon knowingly and deliberately.
- Cash flow decomposition I'd love to propose
  - for benchmarking and analysis
  - not for marked-to-market reporting

## Conclusions

*SII VA*

- Parameterization
  - increased emphasis on smoothness, counter-cyclicality
  - level high enough not to leave buffer for errors
  - flat, though spreads themselves are not
- Releases excess dependence on ALM projection
  - drawback: insensitive to asset composition
  - would anyway be necessary for consistent BEL...
- Results
  - on comparable inputs close to SDC
  - provide cross-company comparison
  - limited decision support

## How to use the volatility adjustment


- Return on cash asset includes VA
  - MVA'(cash) = MVA(cash) must hold, obviously
  - same for equity returns
- Include spread in reinvestment projection
  - If reinvestment rates just calibrated to augmented risk free rate: VA offsets all gap on future assets, not just 65% after credit.
  - If reinvestment rates calibrated to basic risk free rates, VA will even offset a non-existent gap on future assets.
- Exclude reserves that are not in HTM bonds?
  - Well, not how SII sets the rules.

67

**Return on cash asset**

- If projected investment return on cash is less than discount rate, MVA'(cash) < MVA(cash).
- Also any equity returns must be shifted up accordingly.

## How to use the own funds adjustment


- Spread risk shock scenario
  - SII says no scaling of VA
  - EU sovereign debt exempt anyway
  - Spread risk definition sticks to existing assets in specifying an MVA shock. Similarly to how VA enforces spreads there, we can argue to shock projected spreads in reinvestment rates.
- Interest rate shock
  - amount of VA unaffected
  - same to spreads, reinvestment rate shifts parallel to IR
- Shocks in general
  - SII is not a framework that easily addresses tail correlations. Pity, for any illiquidity adjustment.

68

**Return on cash asset**

- If projected investment return on cash is less than discount rate, MVA'(cash) < MVA(cash).
- Also any equity returns must be shifted up accordingly.

## Exit path – swap risk free to gov

1

- Risk ownership and presentation (personal opinion!)
  - Eventually indicates that the risk of sovereign default is not pushed onto the insurance system. ▷
  - Hopefully prices this risk out of (savings) tariffs.
  - A preference for local figures of local companies over a subsidiary's share in the group capital.
  - Unlikely that these appear as a stated objectives, though.
- FX risk in spread also phased out (if any) – that's OK.
  *In CEE, ultimate form of credit risk is still rather FX.*
- Similar to "no spread risk on EU sovereign".
- UFR still 4.2% – likely immaterial in practice.

69

**Risk charge waiver on sovereign default risk**

For the (low) risk of the government defaulting in the local currency, there are costs for the country far beyond whether and how insurer's can fund the policy payouts. It might be pragmatic not to put too much of this risk onto the insurance product prices.

# Exit path – swap risk free to gov

| Country | Currency | LLP | Conv | UFR | Instrument |
|---|---|---|---|---|---|
| Eurozone | EUR | 20 | 40 | 4.2% | Swap |
| Croatia | HRK | 7 | 40 | 4.2% | Gov |
| Czech Republic | CZK | 15 | 40 | 4.2% | Swap |
| Hungary | HUF | 15 | 40 | 4.2% | Gov |
| Iceland | ISK | 20 | 40 | 4.2% | Gov |
| Japan | JPY | 20 | 40 | 3.2% | Swap |
| Poland | PLN | 15 | 40 | 4.2% | Gov |
| Romania | RON | 10 | 40 | 4.2% | Swap |
| Russia | RUB | 10 | 40 | 4.2% | Swap |
| Switzerland | CHF | 25 | 35 | 3.2% | Swap |
| Turkey | TRY | 20 | 40 | 4.2% | Gov |
| United Kingdom | GBP | 50 | 40 | 4.2% | Swap |
| USA | USD | 50 | 40 | 4.2% | Swap |

*Technical Specification for the Preparatory Phase (Part II), 30 April 2014 – Appendix DC1*

## Bonus page – spot the inefficient market?

Typical legitimacy concerns on illiq. adj. (SII or any)

- deficient risk representation (tail correlations) – I admit
- painful and unreliable market calibration – no doubt
- no arbitrage, "no free lunch"

For the last, we present the "cheap dinner" case study.

- Take a mall that offers two croissants for the price of one from $19^h$, one hour before closing.
- Assume I'm there at 18:40, I really like croissant and there are still some.
- What strategies can I choose from?
- At a first glance, do I have an arbitrage opportunity?
- If we can identify one or something very similar – why has this not disappeared months before?

# Readings, references


Legislation, methodology principles

- Directives (SII, O2), Delegated Acts (draft) overview and links
  http://ec.europa.eu/internal_market/insurance/solvency/solvency2/
- Directive 2009/138/EC including Omnibus II modifications
  http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0138
  See 'All consolidated versions' close to the bottom of the page
- EIOPA SII Technical Specifications (Preparatory Phase)
  https://eiopa.europa.eu/en/publications/technical-specifications/index.html
- SII Level 2 IM (draft Nov/2012 and Jan/2014 – neither are publicly available)
- Technical specifications for Quantitative Impact Studies including LTGA
- https://eiopa.europa.eu/en/consultations/qis/insurance/index.html
- CFO Forum MCEV Principles
  http://www.cfoforum.eu/embedded_value.html

# Readings, references

Liquidity premium articles and SII commentary

- Towers Watson (Aug/2012) : Solvency II – The matching adjustment and implications for long term savings
  *The valuation gap phenomenon with examples, detailed yet readable*
  http://www.towerswatson.com/en/Insights/IC-Types/Survey-Research-Results/2012/08/Solvency-II-The-matching-adjustment-and-implications-for-long-term-savings
- CEIOPS Task Force Report on the Liquidity Premium (2010)
  *An analysis and assessment of applying liquidity premium for insurance liabilities*
- Solvency II: Three principles to respect (2013)
  *A critical view on the particular proposal of and processes around LTGA+ vol. adj.*
  http://www.voxeu.org/article/solvency-ii-three-principles-respect
- Liquidity and credit risk premia in government bond yields
  *identifies and estimates distinct credit and liquidity in DE and FR govt. spreads*
  http://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1440.pdf
- Decomposing euro-area sovereign spreads: credit and liquidity risks
  *Concludes explanatory power of a common liquidity factor in EUR spreads*
  http://jeanpaul.renne.pagesperso-orange.fr/papers.html

## Credits

- ING Insurance Europe
  - Input for assessment of materiality and relevance
  - Scenario generation
- Bloomberg via EIOPA and Budapest Corvinus University
  - Market data
- Towers Watson
  - Leakage concept
- Jonas.tesch (Wikimedia user)
  - cover photo

Feedback, questions

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