Replicating Portfolios in life insurance business: Use and limitations
Today’s investigation:

• The robustness of Replicating Portfolios
  – How should Replicating Portfolios (RPs) be designed to be adequate for future application, i.e. to give reasonable results under changed capital market conditions?
  – Is the correlation coefficient a reliable indicator for the goodness of a Replicating Portfolio?
RPs and where they come from:

Re-fit the replicating portfolio – Regular process (e.g. monthly)

Economic scenarios

Liability cashflows per scenario
Benefits: t=1: ... t=10:...

Candidate assets cashflows

Optimiser: weights

Replicating portfolio

Use the replicating portfolio to produce daily financial information

Current economic data

MCEV
Hedge sensitivities
Economic Capital
You never know what you’re gonna get:

• Replicating Portfolio shall help you to calculate “business values” (e.g. MCEV)
  – in the future
  – under unknown future capital market conditions
  – instead of running the whole business model

• Therefore: The Replicating Portfolio does not need to be “optimal” today – but robust enough for tomorrow!
Try to “span the space”:

• Take several scenario sets as basis for the calibration of a Replicating Portfolio
  – real world, risk neutral
  – shifts in interest, equities, volatilities

• Nevertheless: You have to do more!
  – The trouble can be named: It’s the randomness of the shape of the interest rate curve
A simple example:

- The “value of business” is a concave function of interest rates at $t = 1$: 

![Graph showing the concave function of value of business against interest rate]
A simple example:

- Candidate assets are
  - Cash
  - 2- and 6-year zero coupon bond
  - Receiver and Payer Swaptions with
    - term = 1 year
    - tenor = 5 years
    - strike = 4%
- Optimisation is done by “least squares”
A simple example:

- As an example – a flattened shape at $t = 0 + x$ with $x = 1$ month (e.g.)
- with minor changes of volatility at $t = 0 + x$
Results:

The “value of business” is:

<table>
<thead>
<tr>
<th></th>
<th>Shift</th>
<th>Shift + Vola</th>
<th>Shift + Vola + Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>t = 0</td>
<td></td>
<td></td>
<td>86,1</td>
</tr>
<tr>
<td>t = 0 + x</td>
<td>– 20,3</td>
<td>– 3,2</td>
<td>34,3</td>
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</tbody>
</table>

Three different Replicating Portfolios have been calculated for Monte-Carlo simulations at t = 0 + x:
Resumee:

• Span the whole space!
  – Include many different scenario sets
  – “Generate” scenario sets with significantly different shapes of interest rate curve
  – Include also deterministic scenario sets

• Don’t trust the correlation coefficient!
  – In our example, the best replicating portfolio was always worst in the sense of the correlation coefficient…. 
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