Measuring Profitability from a Shareholder Perspective

joint work with Stefan Graf, Alexander Kling and Andreas Reuß

Karen Rödel

International Congress on Insurance: Mathematics and Economics (IME)

Munich, July 2019
Agenda

Motivation

Solvency II
  Computation of the SCR
  Balance sheet: Local GAAP vs. Solvency II

Cost of capital

Numerical results
  Model framework
  Simulation under \( \mathbb{Q} \)

Conclusion
Motivation

Main questions

- How can we compare products in terms of their profitability? What are suitable indicators?
- What kind of life insurance products are profitable to shareholders under a Solvency II framework?

<table>
<thead>
<tr>
<th>Product</th>
<th>Payoff at maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>maturity guarantee</td>
<td>[ \text{Premium} e^{rgT} + \delta_m \text{Premium} \left( e^{\sum_{i=1}^{T} \zeta_i} - e^{rgT} \right)^+ ]</td>
</tr>
<tr>
<td>cliquet guarantee</td>
<td>[ \text{Premium} e^{\sum_{i=1}^{T} (rg + \delta_c (\zeta_i - rg))^+} ]</td>
</tr>
<tr>
<td>unit-linked, no guarantee</td>
<td>[ \text{Premium} e^{\delta_u \sum_{i=1}^{T} \zeta_i} ]</td>
</tr>
</tbody>
</table>
Motivation

We can check the **pricing** of the products.

- **Best estimate liability (BEL):** market-consistent valuation of future cash flows (e.g. by risk-neutral valuation)

- **Present value of future profits (PVFP):** value of shareholder cash flows; at time zero: single premium – BEL

Is PVFP the quantity we are looking for?

**It is not sufficient!**

- Under Solvency II, companies have to comply with the solvency capital requirement (**SCR**).
- The SCR is partly covered by shareholder capital.
- However, shareholders do not provide their capital for free. They expect a corresponding return.

In addition to considering **PVFP**, we need to **check how much shareholder capital is bound** and for how long.
**Solvency II**

**Computation of the SCR**

**Definition of the SCR**

“It shall correspond to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99.5% over a one-year period.” (art. 101 framework directive)

- **A** = assets
- **O** = own funds
- **L** = liabilities
- **SCR** = Solvency Capital Requirement

\[
\text{Loss in own funds} = \text{SCR}(t)
\]

99.5% quantile

0.5%
**Solvency II**
Balance sheet: Local GAAP vs. Solvency II

### Local GAAP (HGB)

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>assets</td>
<td>SH capital</td>
</tr>
<tr>
<td></td>
<td>surplus reserve</td>
</tr>
<tr>
<td></td>
<td>mathematical reserve</td>
</tr>
</tbody>
</table>

### Solvency II

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>assets</td>
<td>SH capital</td>
</tr>
<tr>
<td></td>
<td>surplus reserve</td>
</tr>
<tr>
<td></td>
<td>mathematical reserve</td>
</tr>
<tr>
<td></td>
<td>PVFP</td>
</tr>
<tr>
<td></td>
<td>BEL</td>
</tr>
</tbody>
</table>
Cost of capital

We include the **loss from having capital bound** in the company through a cost of capital approach:

\[
coc = \sum_{t=0}^{T-1} e^{-\int_{t}^{t+1} r(s)ds} (e^{coc\_rate} - 1) (\text{SH capital})_t
\]

- we need SH capital and SCR for each point in time → very complex, high computational effort

Then, we compare this figure with **shareholder cash flows**:

\[
\text{profit beyond coc} = \sum_{t=0}^{T} e^{-\int_{t}^{t+1} r(s)ds} \Delta_t - \sum_{t=0}^{T-1} e^{-\int_{t}^{t+1} r(s)ds} (e^{coc\_rate} - 1) (\text{SH capital})_t
\]

- under \(\mathbb{Q}\): we get the market-consistent value by taking the expectation
- under \(\mathbb{P}\): analysis of real-world paths leads to a probability distribution
  - “= 0”: returns are just enough to compensate for having capital bound
  - “>0/<0”: returns are higher/lower than the cost of capital
Numerical results
Model framework

Financial market
- stochastic interest rates: Hull-White model
- stock process: geometric Brownian motion

Product specification
- time to maturity: $T = 20$
- guaranteed interest rate: $r_G = 0\%$
- contract value: $BEL_0 = 100$
- pricing: $Premium = 110 \Rightarrow PVFP_0 = 10$
- cost of capital rate: $coc\_rate = 0.06$

Investment strategy

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>money market</td>
<td>SH capital</td>
</tr>
<tr>
<td></td>
<td>surplus reserve</td>
</tr>
<tr>
<td>$90%$ money</td>
<td>PVFP</td>
</tr>
<tr>
<td>market, $10%$ stocks</td>
<td></td>
</tr>
<tr>
<td>$BEL$</td>
<td></td>
</tr>
</tbody>
</table>
Numerical results
Simulation under $\mathbb{Q}$: 3000 paths

<table>
<thead>
<tr>
<th>participation factor</th>
<th>maturity</th>
<th>cliquet</th>
<th>unit-linked</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.46</td>
<td>0.42</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>$SCR_0$</td>
<td>25.71</td>
<td>30.82</td>
<td>10.60</td>
</tr>
<tr>
<td>initial balance sheet</td>
<td>money market 15.71</td>
<td>SH capital 15.71</td>
<td>surplus reserve 0</td>
</tr>
<tr>
<td>90% MM, 10% stocks 110</td>
<td>PVFP 10</td>
<td>BEL 100</td>
<td>90% MM, 10% stocks 110</td>
</tr>
<tr>
<td>$\mathbb{E}[\text{coc}]$</td>
<td>19.78</td>
<td>22.94</td>
<td>4.25</td>
</tr>
<tr>
<td>$\mathbb{E}[\text{profit beyond coc}]$</td>
<td>$-10.19$</td>
<td>$-13.48$</td>
<td>5.45</td>
</tr>
</tbody>
</table>
Conclusion

How to assess **shareholder profitability**:

- check the **pricing**: How high is the PVFP?
- check the **SCR**: How much capital is bound and for how long? **(cost of capital approach)**
- compare the cost of capital with shareholder cash flows

In our simplified model,

- interest rate guarantees are very expensive due to high capital requirements (SCR)
- the cliquet guarantee is even less profitable than the maturity guarantee

Note that we are still at the beginning of our analysis. We want to further understand how all the different components of our model interact.
Institut für Finanz- und Aktuarwissenschaften

Contact information

Karen Rödel
+49 (731) 20644-237
k.roedel@ifa-ulm.de
What we do
Overview

Life
- product development
- biometric risks
- life settlements/TEPs

Non-Life
- product design
- pricing
- reserving
- DFA
- risk management

Health
- actuarial modeling
- claims management
- portfolio analyses

Actuarial Consulting
- Solvency II
- embedded value
- asset liability management
- ERM
- value- and risk-based management
- data analytics

Actuarial Services
- project management
- market entries
- inforce management
- strategic consulting

Research

Education

... further information is available on our website
www.ifa-ulm.de
Disclaimer

Please consider the following reliances and limitations:

- This document must be considered in its entirety as individual sections, if considered in isolation, may be misleading. No reliance should be placed on any advice not given in writing. Draft versions of this document must not be relied upon by any person for any purpose. All decisions taking into account this document must consider the agreed basis and the specific purposes of this document. If reliance is placed contrary to the guidelines set out above, we disclaim any and all liability which may arise.

- This document is based on our market analyses and views as well as on information which we received from you. We have checked this information for consistency against our market knowledge and experience. But we have not undertaken any independent verification regarding completeness or correctness of this information. Statistical market data as well as information where the source of the information is indicated are in general not checked by us. Please also note that this document was based on data available to us at, or prior to the date it was prepared. It takes no account of developments after that date and we are under no obligation to update or correct inaccuracies which may become apparent in the document. In particular, this holds for possible implications arising from the introduction of new regulatory requirements.

- This document is based on our experience as actuarial advisers. Where, in the course of providing our services, we need to interpret a document, deed, accounts or relevant taxation provision or medical issues in order to advise you, we will do so with the reasonable skill and care to be expected of us in our professional capacity. Should you want definitive advice, for example as to the proper interpretation of a document, deed, accounts, relevant taxation provision or medical issues, you should consult your lawyers, accountants, tax advisers or medical experts for that advice.

- As agreed, this document was made available for internal use only. Except with our written consent, this document must not be reproduced, distributed or communicated in whole or in part to any third party. We disclaim all liability for consequences arising from any third party relying on our reports, advice, opinions, documents or other information.

- Any reference to ifa in context with this document in any report, accounts, other published documents, or oral form is not authorised without our prior written consent. This holds similarly for any oral information or advice provided by us in the context of presenting/discussing this document.