Improving Participating Life Insurance Product Designs for both, Policyholders and Insurers, under Risk Based Solvency Frameworks

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Contents

Introduction

Considered products

Stochastic modeling

Key questions and results

Conclusion and outlook
Introduction
Motivation

- **Participating life insurance products** play a major role in old-age provision.

- **Key problem**: significant financial risk due to cliquet-style guarantees
  - impact of low interest rates and volatile asset returns
  - market-consistent valuation
  - capital requirements under risk based solvency frameworks (e.g. **Solvency II**)

- Reuss et al. (2014) “Participating Life Insurance Contracts under Risk Based Solvency Frameworks: How to increase **Capital Efficiency** by Product Design”
  - proposed **product modifications** significantly **enhance** “**Capital Efficiency**”
  - reduce the insurer’s risk and increase profitability

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**Focus of this presentation**: optimized designs for insurers and policyholders by

1. **adjustment** of the **strategic asset allocation**, or
2. **additional participation** of policyholders in benefits from **reduced capital requirements**
Contents

Introduction

Considered products

Stochastic modeling

Key questions and results

Conclusion and outlook
Considered products
3 product designs

- **Considered products** with identical **guaranteed benefit** $G$ at maturity:
  - annual premium payments (based on a constant interest rate $i = 1.75\%$)
  - **prospective actuarial reserves** for guaranteed benefit $G$ (also based on $i = 1.75\%$)
  - **yearly surplus** (e.g. 90% of book value returns), credited to a bonus reserve
  - (policyholder’s) **account value** consisting of actuarial reserve and bonus reserve

- Products come with the **same guarantee at maturity**, but **different year-to-year guarantee**:
  - **Traditional product**: $i = 1.75\%$ is also a **year-to-year minimum guaranteed interest rate** (cliquet-style guarantee)
    - at least this rate has to be earned each year on the assets backing the account value
  - **Alternative I product**: **year-to-year minimum guaranteed interest rate** = $0\%$
    - only guarantee that account value cannot decrease
  - **Alternative II product**: no additional guarantee on the account value

- For the **alternative** products: minimum required yield can be **lower than** $i = 1.75\%$ (in case of previously earned surpluses)
- Reuss et al. (2014) show that the **modified products** c.p. result in a **significantly reduced risk** and hence capital requirement from an **insurer’s perspective**
Contents

- Introduction
- Considered products
- Stochastic modeling
- Key questions and results
- Conclusion and outlook
Stochastic modeling and key questions
The financial market model

- Insurer’s assets are invested in a portfolio consisting of **stocks** and **coupon bonds**.
- Short rate process follows a classical Vasicek model, stock market index follows a geometric Brownian motion.
- Risk-neutral (\(\mathbb{Q}\)) valuation framework and real-world (\(\mathbb{P}\)) projections.

<table>
<thead>
<tr>
<th>risk-neutral ((\mathbb{Q}))</th>
<th>real-world ((\mathbb{P}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>short rate process</td>
<td></td>
</tr>
<tr>
<td>(dr_t = \kappa(\theta - r_t)dt + \sigma_r dW_t^{(1)})</td>
<td>(dr_t = \kappa(\theta^* - r_t)dt + \sigma_r dW_t^{<em>,(1)}); (\theta^</em> = \theta + \lambda \frac{\sigma_r}{\kappa})</td>
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<tr>
<td>stock market process</td>
<td></td>
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<tr>
<td>(\frac{dS_t}{S_t} = r_t dt + \rho \sigma_S dW_t^{(1)} + \sqrt{1 - \rho^2} \sigma_S dW_t^{(2)})</td>
<td>(\frac{dS_t}{S_t} = \mu dt + \rho \sigma_S dW_t^{<em>,(1)} + \sqrt{1 - \rho^2} \sigma_S dW_t^{</em>,(2)})</td>
</tr>
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- Bank account given by \(B_t = \exp\left(\int_0^t r_u du\right)\), and used for investment of cash flows during the year.
- Analyses using **Monte Carlo methods**.
- Parameter values:

<table>
<thead>
<tr>
<th></th>
<th>(\tau_0)</th>
<th>(\theta)</th>
<th>(\kappa)</th>
<th>(\sigma_r)</th>
<th>(\sigma_S)</th>
<th>(\rho)</th>
<th>(\lambda)</th>
<th>(\mu)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2.5%</td>
<td>3.0%</td>
<td>30.0%</td>
<td>2.0%</td>
<td>20.0%</td>
<td>15.0%</td>
<td>-23.0%</td>
<td>6.0%</td>
</tr>
</tbody>
</table>

(Source of parameters: **Graf et al. [2011]**; \(\tau_0, \theta, \mu\) modified to take into account interest rate level)
Stochastic modeling and key questions

The asset-liability model

- simplified balance sheet:

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>book value of stocks $BV_t^S$</td>
<td>shareholders’ profit or loss $X_t$</td>
</tr>
<tr>
<td>book value of coupon bonds $BV_t^B$</td>
<td>sum of actuarial and bonus reserves $AV_t$</td>
</tr>
</tbody>
</table>

- **book-value accounting rules** following German GAAP are applied.
- **rebalancing** strategy with a **constant equity ratio** $q$
- **portion of total asset return credited to the policyholders**: participation rate $p$
  - surplus distribution such that total yield is the same for all policyholders
  - but at least the required yield
- further management rules regarding asset allocation (reinvestment, rebalancing) and handling of **unrealized gains or losses** etc.
- projection of sample book of business over **20 years**
Contents

Introduction
Considered products
Stochastic modeling
Key questions and results
Conclusion and outlook
Key questions and results

Key question 1

The **objective** of the present paper is to **share** the **insurer’s benefits** from the alternative product designs **with the policyholders**.

1. In a **first** step, we consider the following question: How can the **alternative products be designed** to achieve the **same profitability** ("iso-profit") as for a traditional portfolio in a base case?

- **Profit measure**: Present Value of Future Profits: 
  \[ PVFP = \frac{1}{N} \sum_{n=1}^{N} \sum_{t=1}^{T} \frac{X_t^{(n)}}{B_t^{(n)}} = \frac{1}{N} \sum_{n=1}^{N} PVFP^{(n)} \] under \( \mathbb{Q} \)

  - \( X_t^{(n)} \), \( B_t^{(n)} \), \( PVFP^{(n)} \) the realizations of \( X_t, B_t, PVFP \) in scenario \( n \)

- **variables**:
  - policyholders’ profit participation rate \( p \)
  - equity ratio \( q \)

- **Starting point** is the profitability of the traditional product in the **base case**, i.e. a \( PVFP \) of **3.62%** with participation rate \( p = 90\% \) and equity ratio \( q = 5\% \)
Key questions and results

Iso-profit curves

For all products, with an increasing stock ratio the participation rate has to be reduced to preserve a constant PVFP of 3.62%.

The alternative products allow for a much higher stock ratio with the same participation rate for policyholders and the same PVFP for the insurer; more pronounced effect for alternative II.
Key questions and results

Key question 2

2. In a **second** step, we only look at product designs that result in the **same PVFP** of 3.62%, and analyze the insurer's risk resulting from these iso-profit products. We focus on market risk and use the insurer's **Solvency** Capital Requirement as a **measure**.

- **Solvency** Capital Requirement for **market risk** ($\text{SCR}_{\text{mkt}}$)
  - based on the Solvency II standard formula
  - interest rate risk: reduction of $r_0$, $\theta$ by 100 bps $\rightarrow \text{PVFP}_{\text{int}}$
    - $\text{SCR}_{\text{int}} = (\text{PVFP} - \text{PVFP}_{\text{int}})$
  - equity risk: reduction of initial market value of stocks by 39% $\rightarrow \text{PVFP}_{\text{eq}}$
    - $\text{SCR}_{\text{eq}} = (\text{PVFP} - \text{PVFP}_{\text{eq}})$
  - correlation $\rho_M = \frac{1}{2}$

$$\text{SCR}_{\text{mkt}} = \sqrt{\text{(SCR}_{\text{int}})^2 + (\text{SCR}_{\text{eq}})^2 + 2\rho_M \cdot \text{SCR}_{\text{int}} \cdot \text{SCR}_{\text{eq}}}$$
Key questions and results

SCR curves

1. same profit and same risk: alternative products allow for a significantly higher equity ratio

2. same profit and same equity ratio: alternative products reduce the insurer’s risk

SCR(mkt)-curves of iso-profit products (under Q)

- Traditional
- Alternative I
- Alternative II
Key questions and results
Key questions 3

3. In a **third** step, we compare the different product designs from a **policyholder’s perspective** using **risk-return-profiles**.

1) ... if comparing products with the **same profitability** and the **same risk** for the insurer
2) ... if comparing products with the **same profitability**, **but** some **risk reduction** for the insurer

* policyholders’ return measured by the **internal rate of return (IRR)**
* policyholders’ risk measured by the **conditional tail expectation** on the **lowest 20% (CTE20)**
  * considering new business of the 1st year
Key questions and results

1) Same PVFP / same SCR

Compare products with same PVFP and same $SCR_{mkt}$:

*equity ratios* of 5% / 10% / 13% for traditional / alternative 1 / alternative 2 product
Key questions and results

1) Same PVFP / same SCR: benefit distribution and risk-return profile

- **Traditional** product has a **lower risk** for the policyholder (CTE20 is larger), but the **alternative** products **exhibit significantly higher expected returns**.

- **Additional expected return** of alternative I/II product: 15 / 26 bps.
Key questions and results

2) Same PVFP / „50/50“ split SCR

Compare products with same PVFP and if $SCR_{mkt}$ reduction (between traditional and alternative product with same $q$) are split 50/50:

- **equity ratio** increase from 5% to 8.25% / 10%, but **SCR** reduced from 3.4% to 2.5%
Key questions and results

2) Same PVFP / „50/50“ split SCR: benefit distribution and risk-return profile

- the alternative products still offer **beneficial risk-return-profiles**
- **additional return** of alternative I/II product: **10 / 16 bps**
Conclusion and outlook
Importance of “risk management by product design” will increase

- **Advantages** of alternative product designs compared to traditional product design:
  - same profit for the insurer and **same participation rate** for policyholders: significantly higher stock ratio
  - same profit and same risk for the insurer: significantly **higher stock ratio**
  - same profit for the insurer and **same stock ratio**: significant **reduction of insurer’s risk**

- **Impact on risk-return profiles** for policyholders:
  - increase of expected return (but also higher tail risk for policyholders)
  - effect depends on amount of risk reduction for the insurer

→ Alternative guarantees allow to **reconcile** the interests of all stakeholders.
  → designs with **significant** increase of expected return and reduction of insurer’s risk possible

- **Areas for additional research**:
  - analysis of a change in new business strategy (traditional product in the past, modified products in new business)
  - product modifications for the annuity payout phase
Thank you for your attention!