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

Andreas Reuß

Institute for Finance and Actuarial Sciences (ifa)

Jochen Ruß

Institute for Finance and Actuarial Sciences (ifa) and Ulm University

Jochen Wieland

Institute for Finance and Actuarial Sciences (ifa) and Ulm University

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

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

	risk-neutral ($\mathbb{Q}$)	**real-world ($\mathbb{P}$)**
short rate process	$dr_t = \kappa(\theta - r_t)dt + \sigma_r dW_t^{(1)}$	$dr_t = \kappa(\theta^* - r_t)dt + \sigma_r dW_t^{*(1)}$; $\theta^* = \theta + \lambda \frac{\sigma_r}{\kappa}$
stock market process	$\frac{dS_t}{S_t} = r_t dt + \rho\sigma_S dW_t^{(1)} + \sqrt{1-\rho^2}\sigma_S dW_t^{(2)}$	$\frac{dS_t}{S_t} = \mu dt + \rho\sigma_S dW_t^{*(1)} + \sqrt{1-\rho^2}\sigma_S dW_t^{*(2)}$

- 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:

	r_0	θ	κ	σ_r	σ_S	ρ	$\boldsymbol{\lambda}$	$\boldsymbol{\mu}$
	2.5%	3.0%	30.0%	2.0%	20.0%	15.0%	-23.0%	6.0%

  - (Source of parameters: **Graf et al. [2011]**; r_0, θ, μ modified to take into account interest rate level)

Stochastic modeling and key questions

The asset-liability model

- simplified balance sheet:

Assets	Liabilities
book value of stocks BV_t^S	shareholders' profit or loss X_t
book value of coupon bonds BV_t^B	sum of actuarial and bonus reserves AV_t

- **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

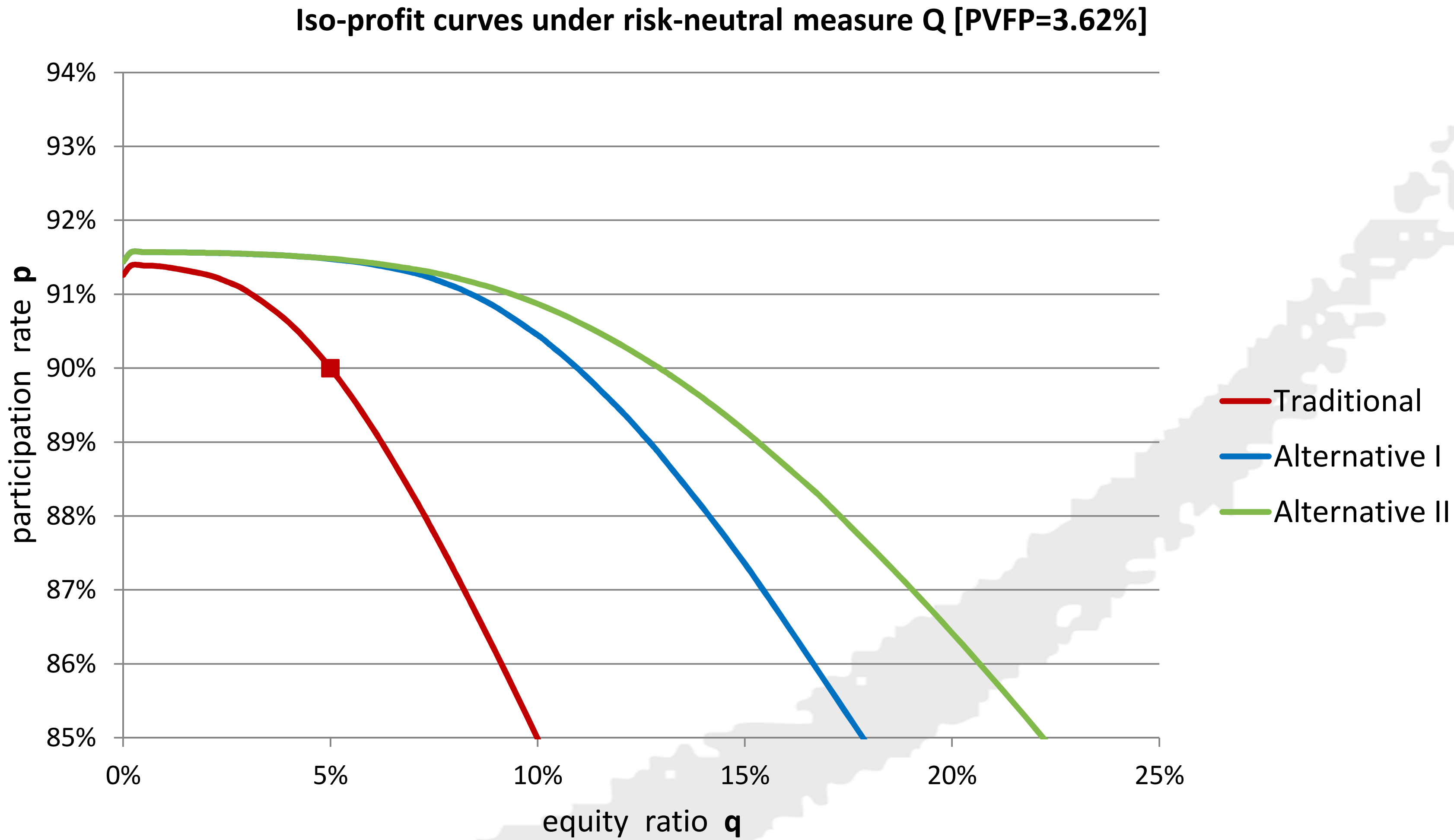
Key question 1

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: $\boldsymbol{PVFP} = \frac{1}{N}\sum_{n=1}^{N}\sum_{t=1}^{\tau}\frac{X_t^{(n)}}{B_t^{(n)}} = \frac{1}{N}\sum_{n=1}^{N} PVFP^{(n)}$ 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 $\boldsymbol{PVFP}$ 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

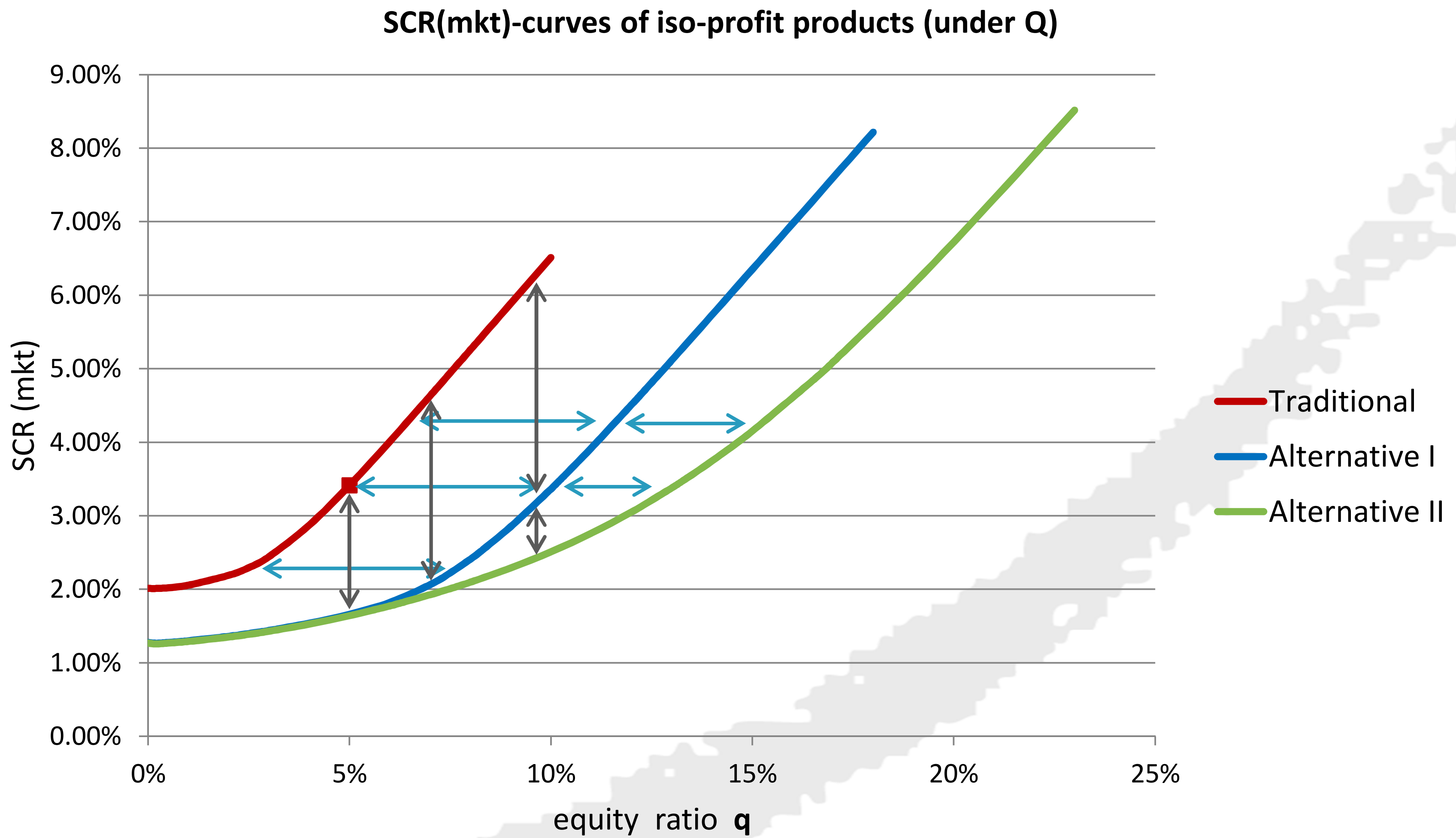
2. In a **second** step, we only look at product designs that result in the **same PVFP** of 3.62%, and analyze the **insurer's risk** resulting from these iso-profit products. We focus on market risk and use the insurer's **Solvency** Capital Requirement as a **measure**.

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

→ $\boldsymbol{SCR_{mkt} = \sqrt{(SCR_{int})^2 + (SCR_{eq})^2 + 2\rho_M \cdot SCR_{int} \cdot SCR_{eq}}}$

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**

Key questions and results

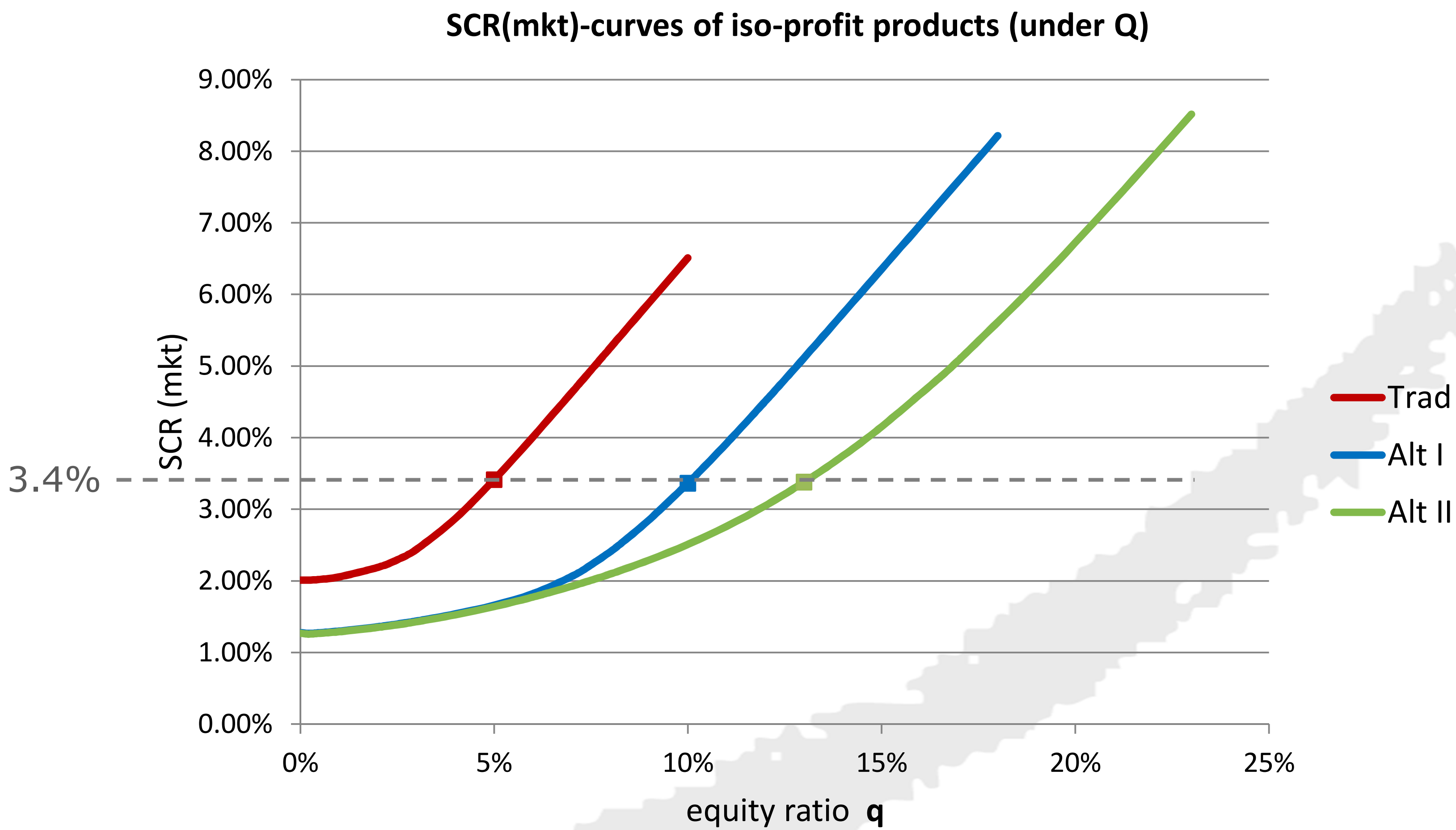
Key questions 3

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

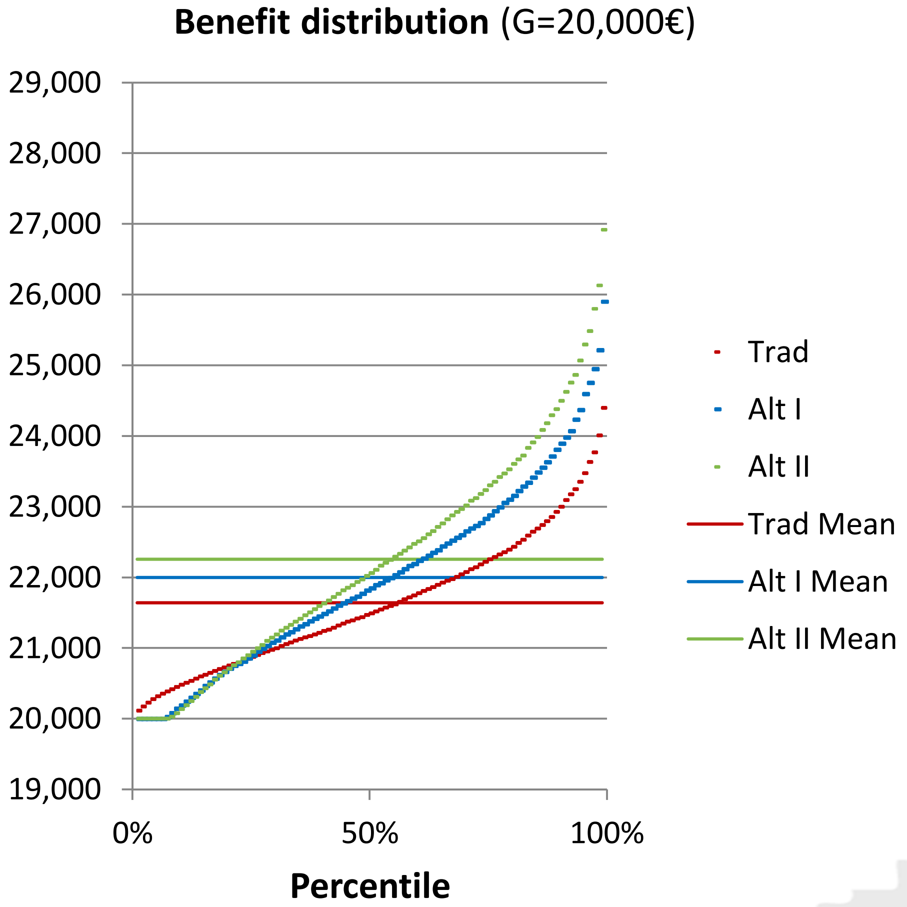


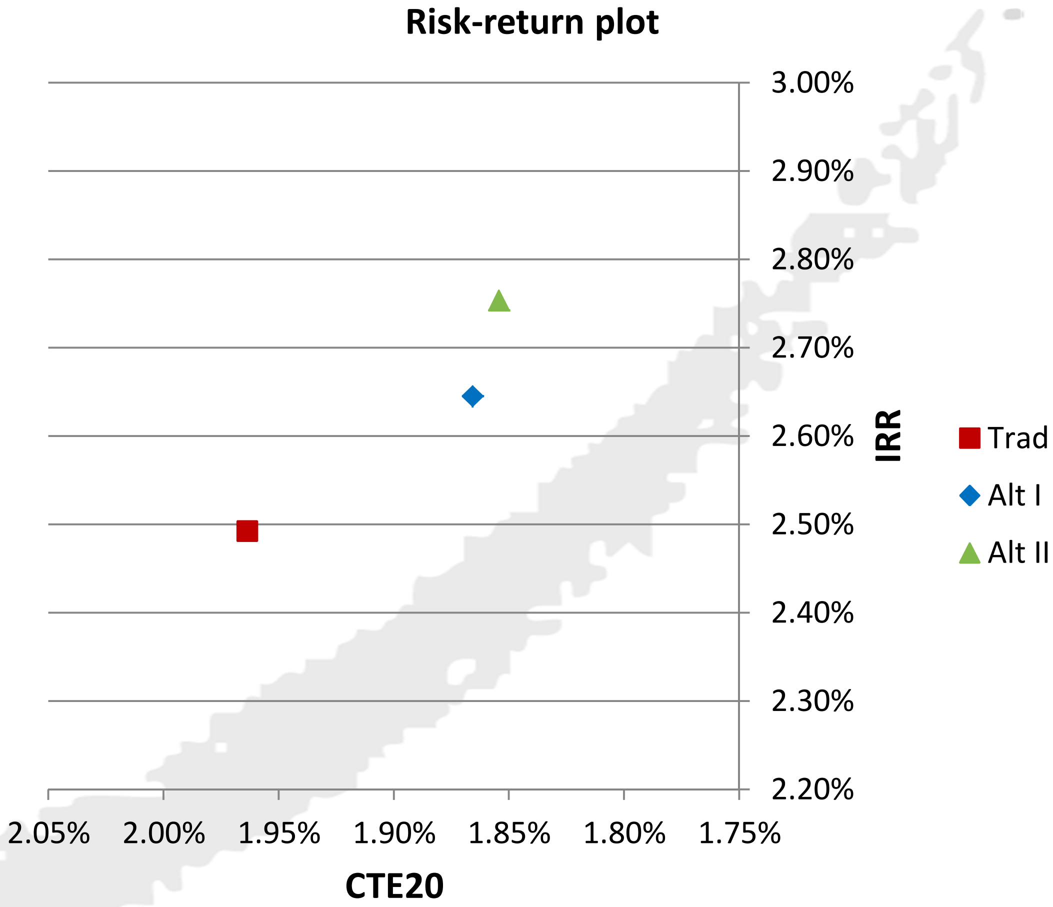
Compare products with same $PVFP$ and same SCR_{mkt}:

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

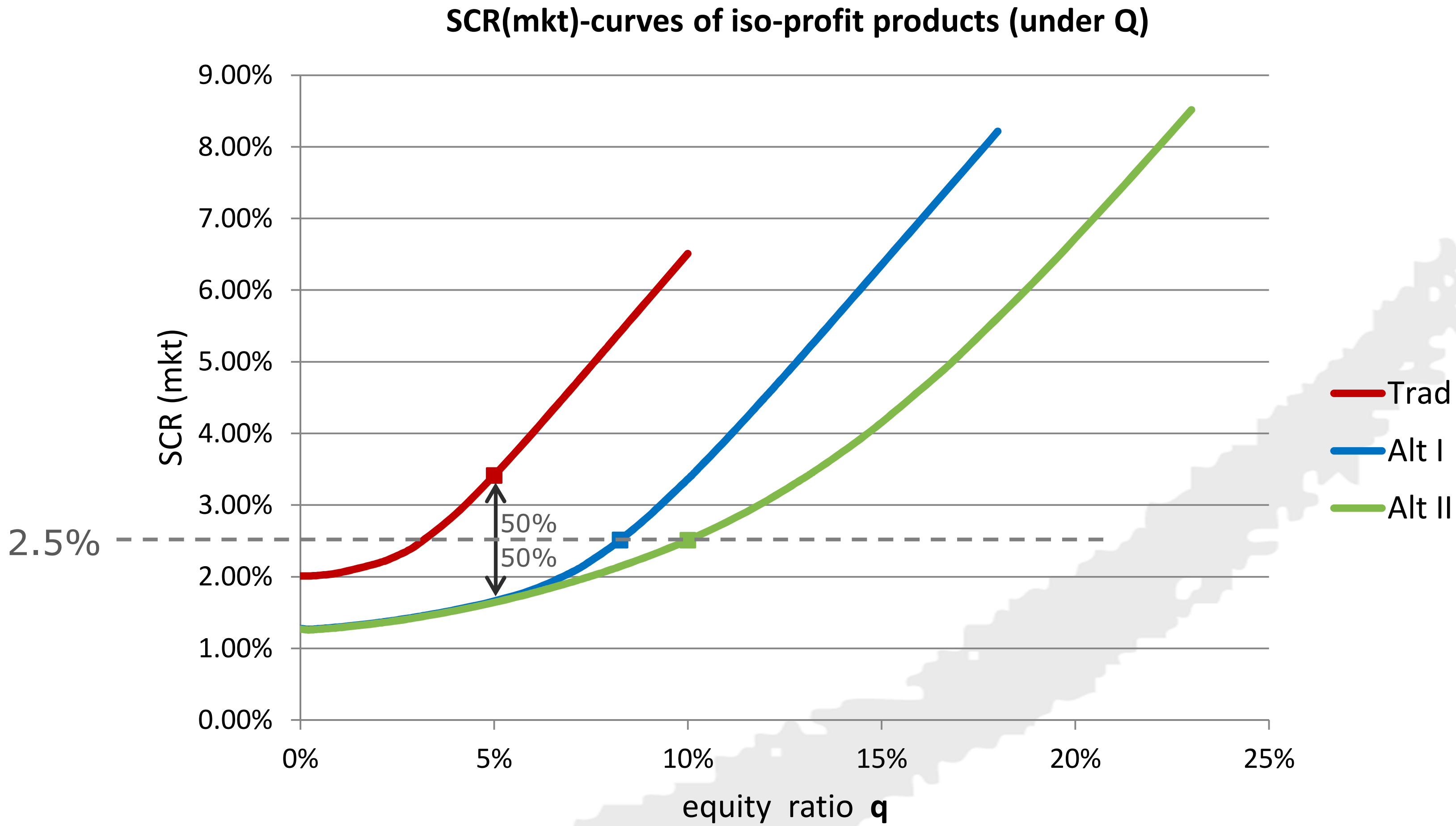




- **traditional** product has a **lower risk** for the policyholder (CTE20 is larger), but the **alternative** products **exhibit significantly higher expected returns**
- **additional expected return** of alternative I/II product: **15 / 26 bps**

Key questions and results

2) Same PVFP / „50/50" split SCR



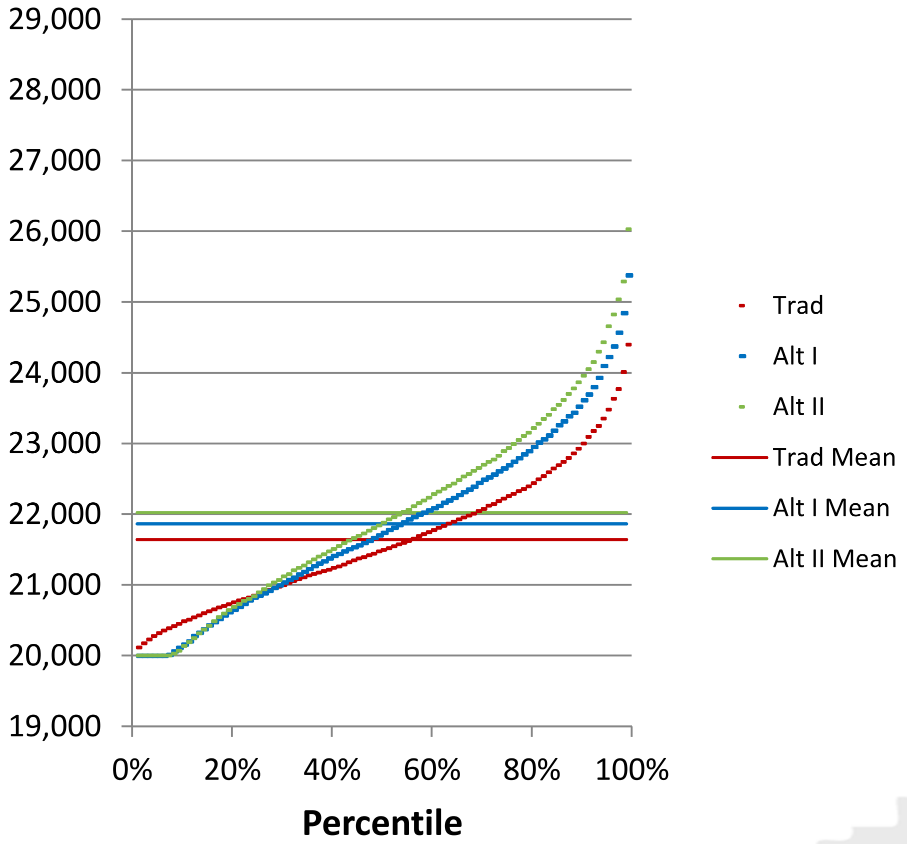
Compare products with same $PVFP$ and if SCR_{mkt} **reduction** (between traditional and alternative product with same q) are **split 50/50:**

equity ratio increase from 5% to 8.25% / 10%, but **SCR** reduced from 3.4% to 2.5%

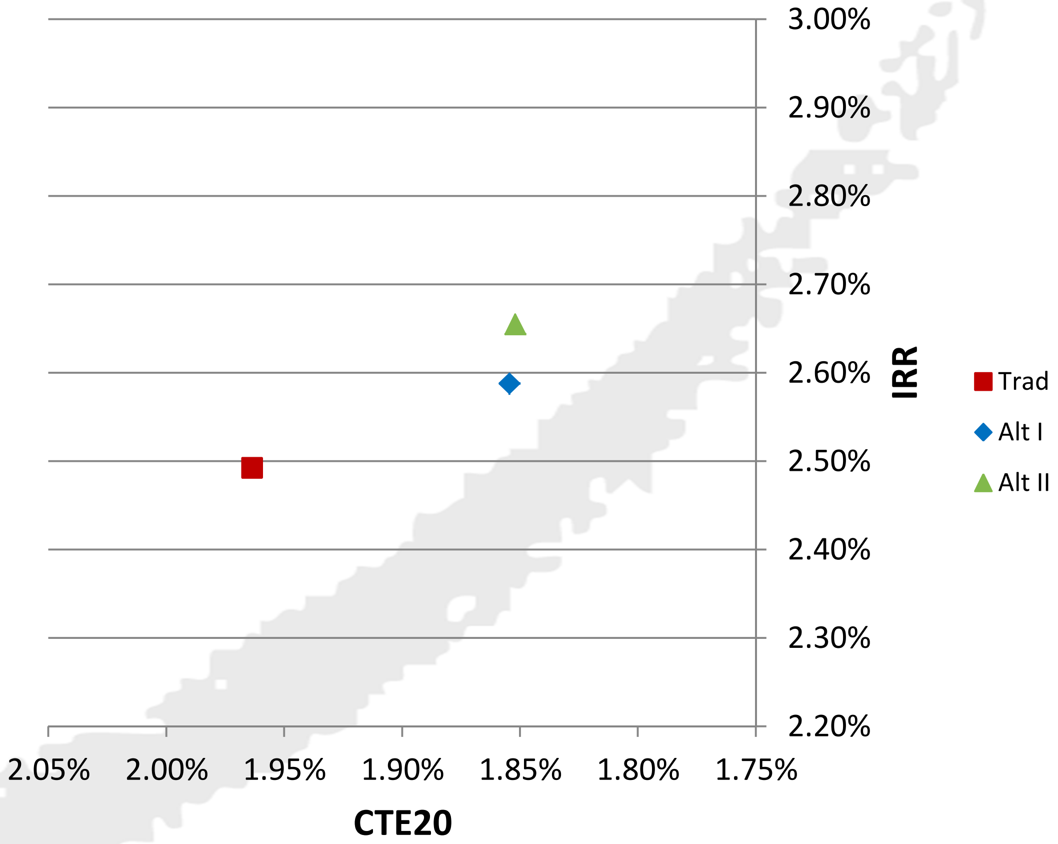
Key questions and results

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

Benefit distribution (G=20,000€)



Risk-return plot



- the alternative products still offer **beneficial risk-return-profiles**
- **additional return** of alternative I/II product: **10 / 16 bps**

Contents

Introduction

Considered products

Stochastic modeling

Key questions and results

Conclusion and outlook

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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!