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

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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

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**

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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**

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Key questions and results

Key question 1

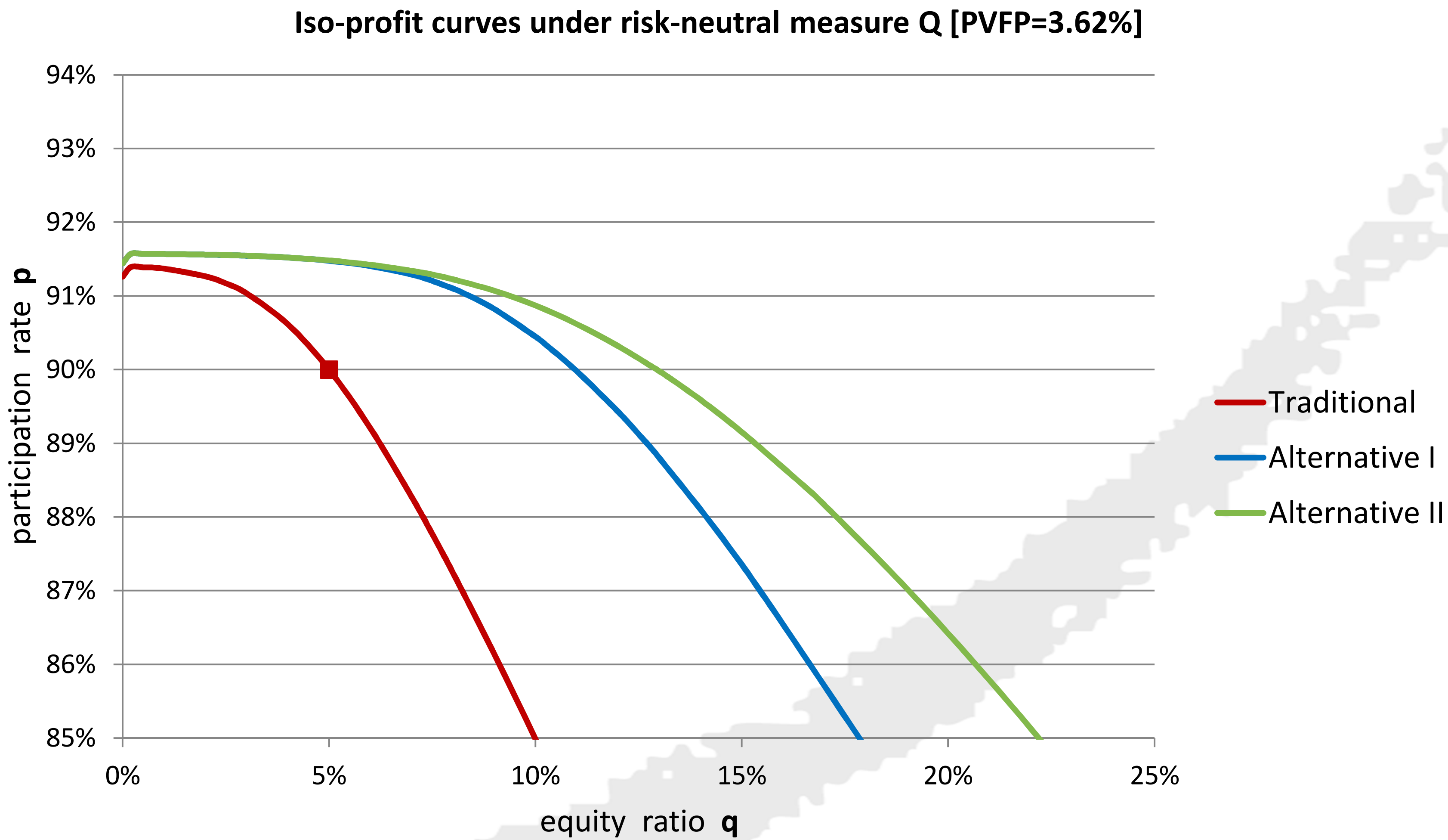
The **objective** of the present paper is to **share** the **insurer‘s benefits** from the alternative product designs **with the policyholders**.

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

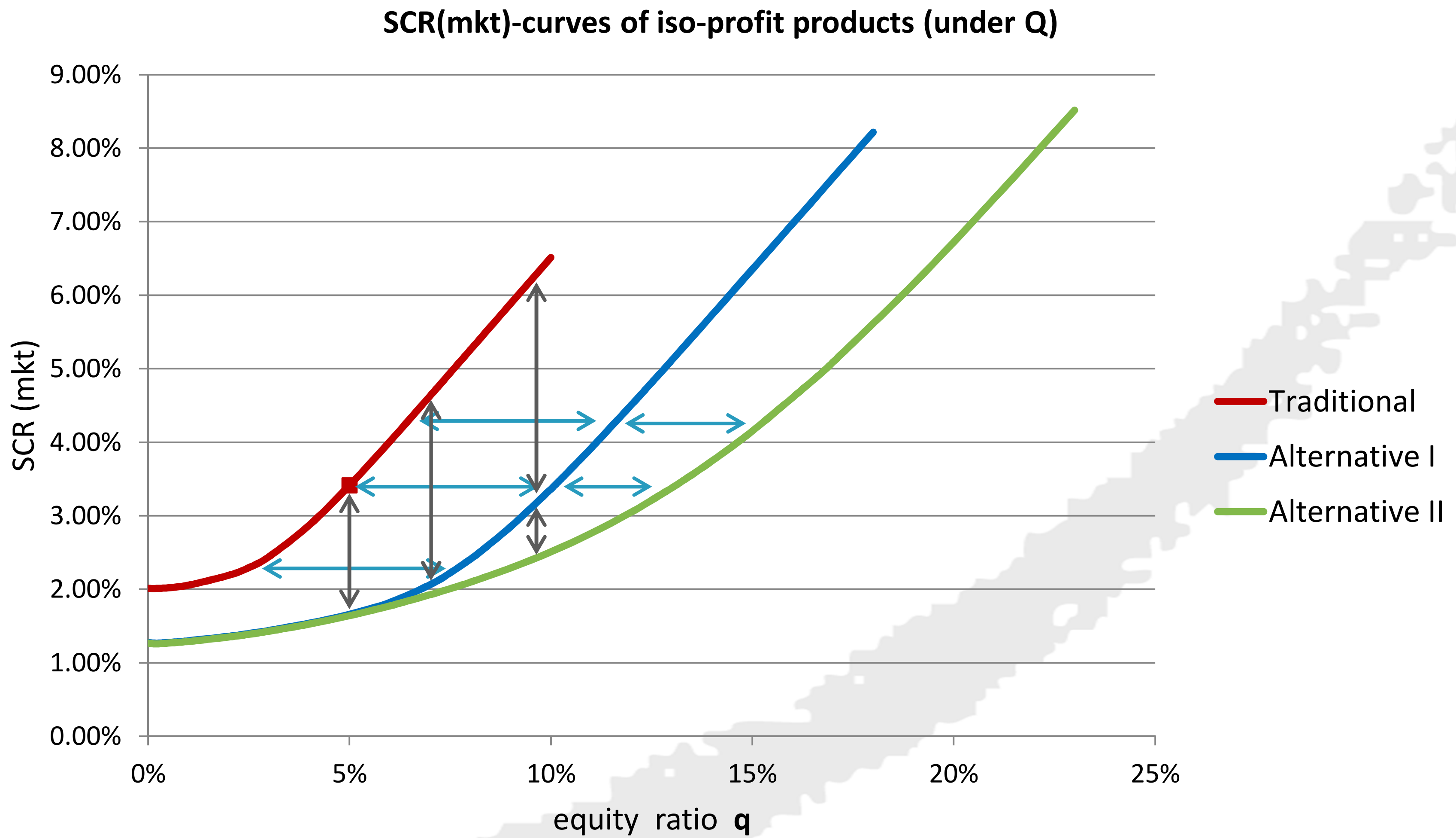
2. In a **second** step, we only look at product designs that result in the **same PVFP** of 3.62%, and analyze the **insurer's risk** resulting from these iso-profit products. We focus on market risk and use the insurer's **Solvency** Capital Requirement as a **measure**.

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

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

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**.

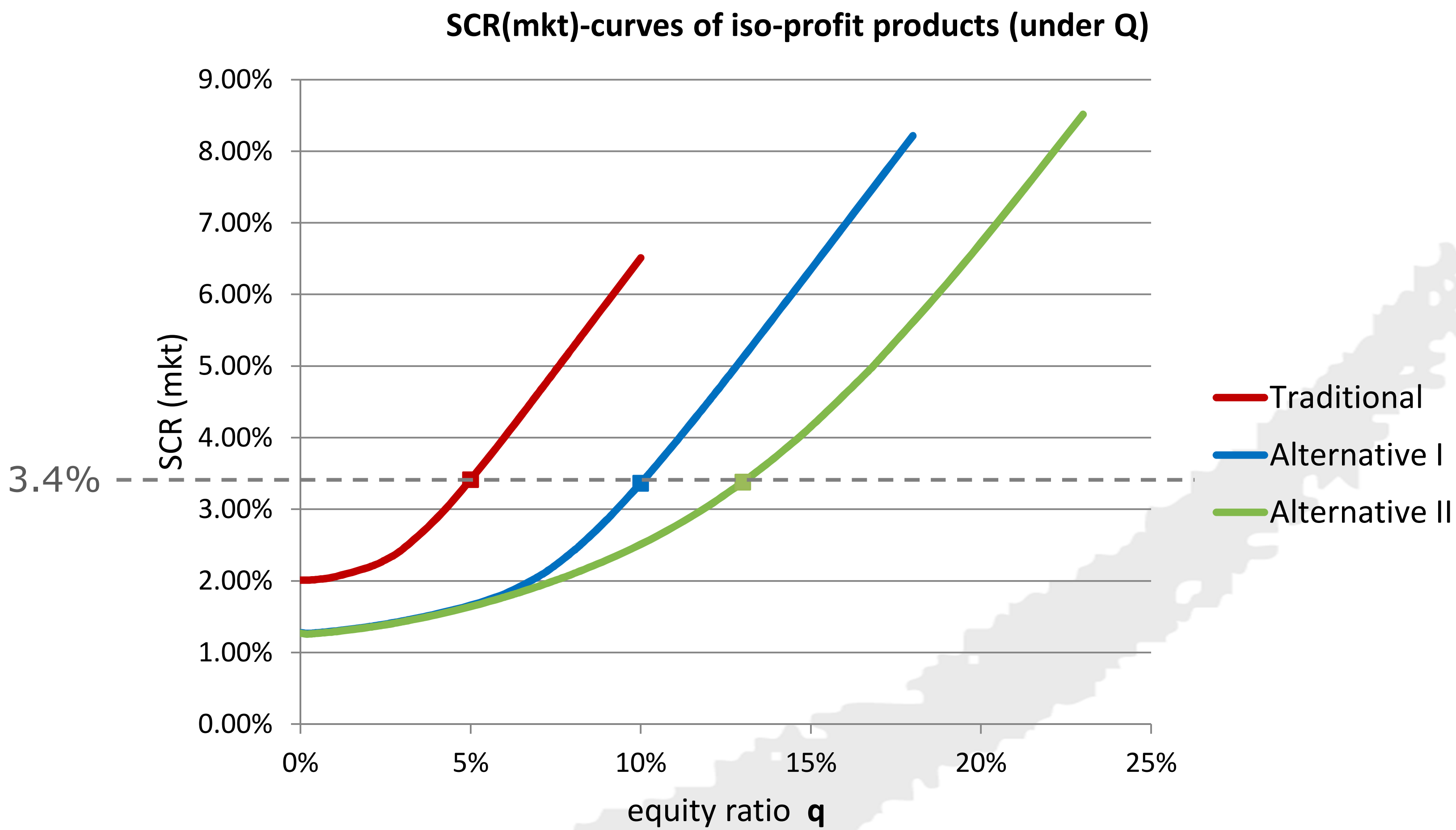
   1) … if comparing products with the **same profitability** and the **same risk** for the insurer

   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

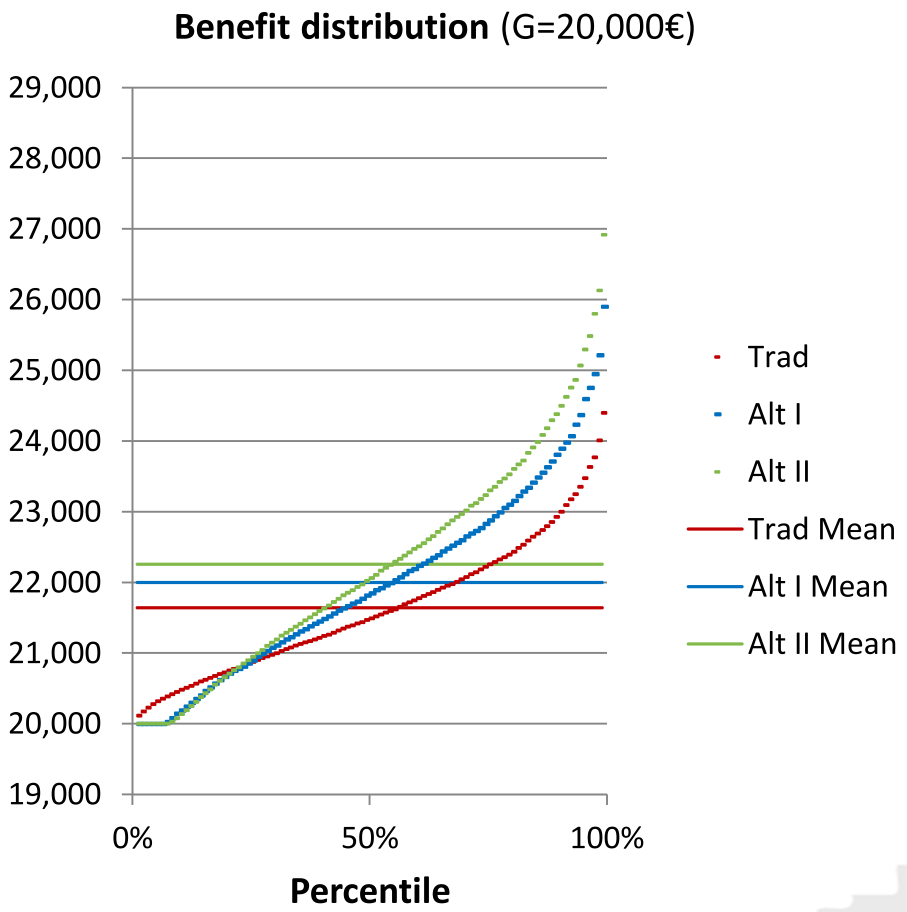


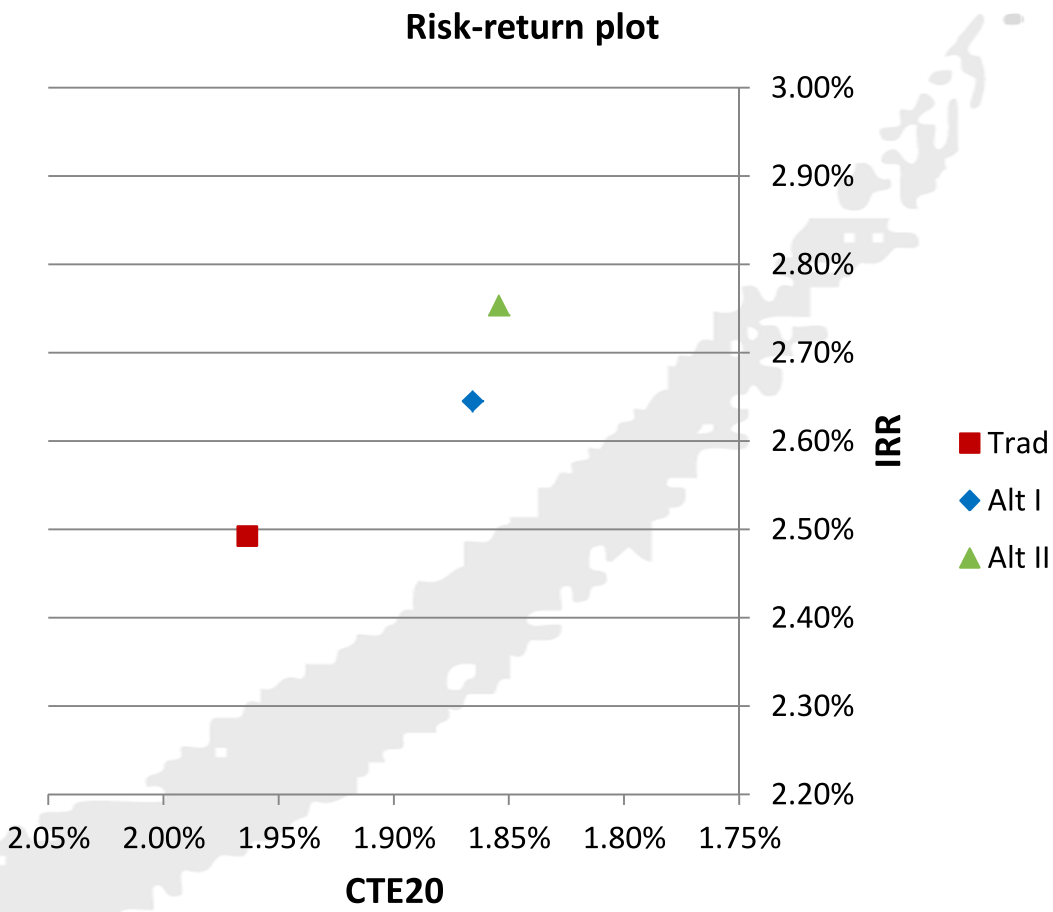
Compare products with same $PVFP$ and same SCR_{mkt}:

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**

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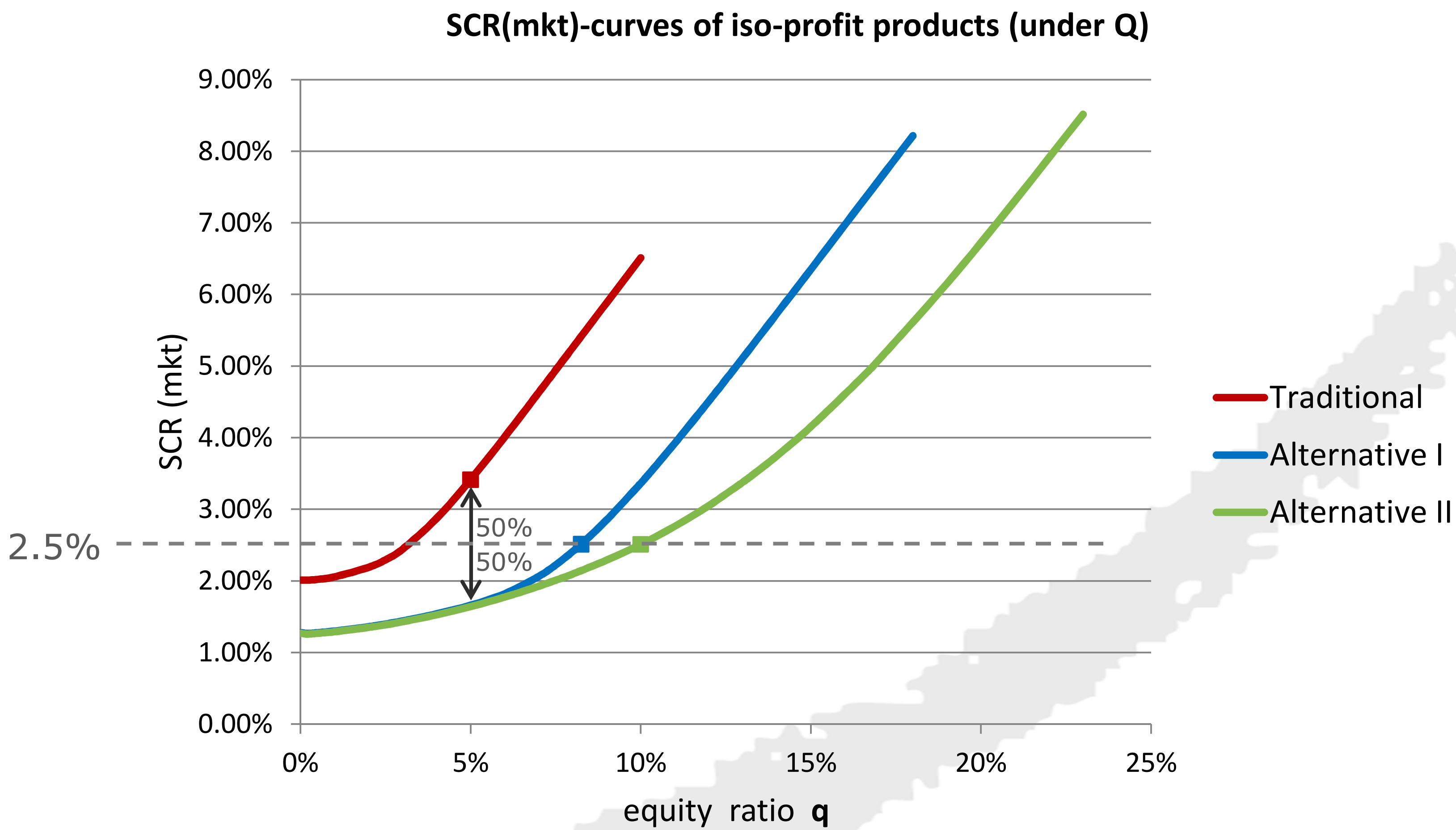
Key questions and results

2) Same PVFP / „50/50" split SCR



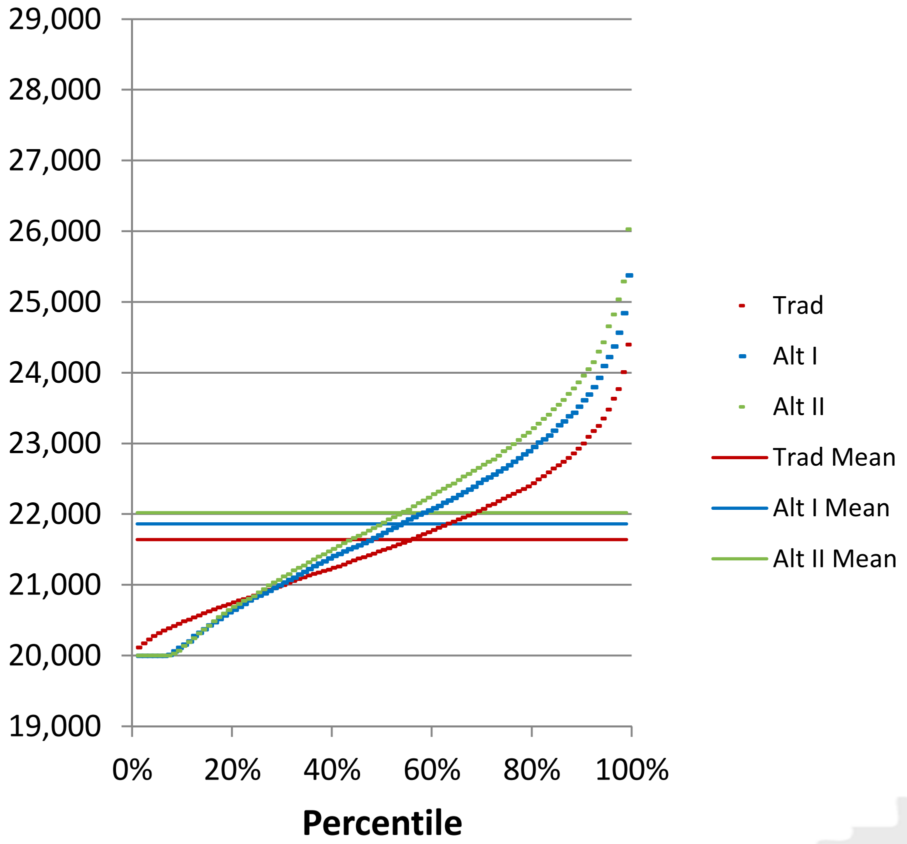
Compare products with same $PVFP$ and if SCR_{mkt} **reduction** (between traditional and alternative product with same q) are **split 50/50:**

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

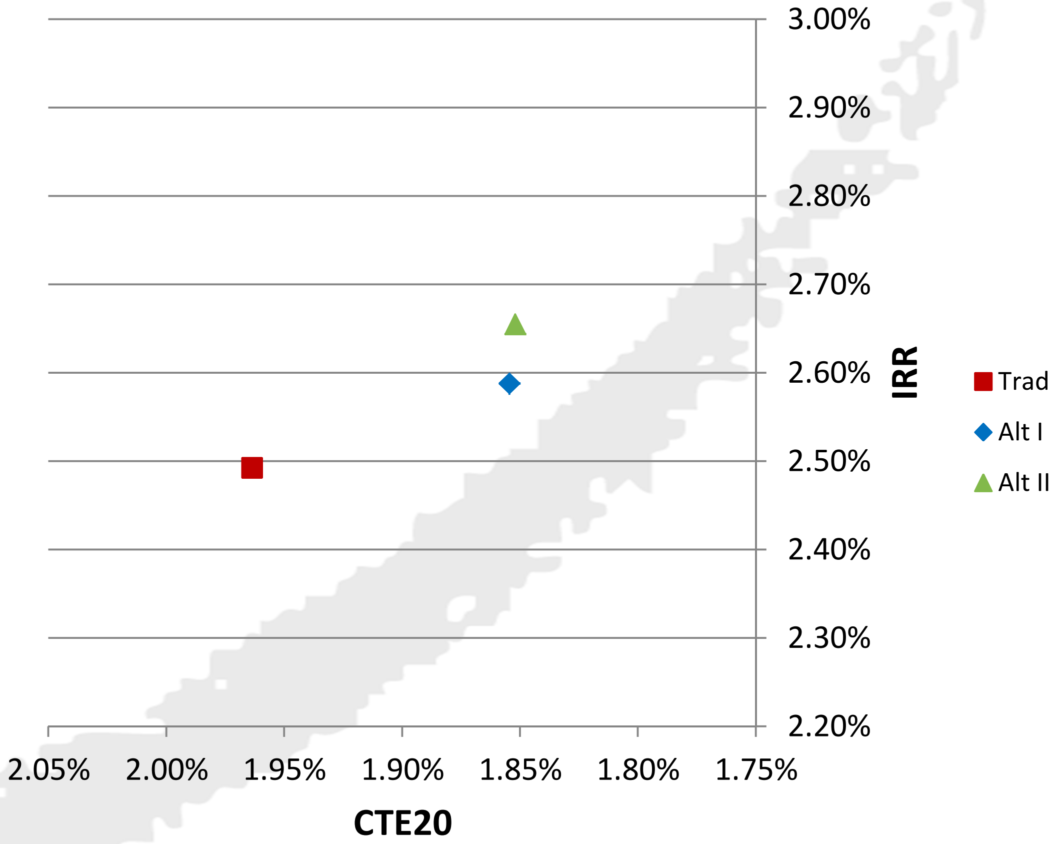
Key questions and results

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**

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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 are 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

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Thank you for your attention!