



Intertemporal vs. Intergenerational Risk Sharing: Effects on Guarantees of Life Insurance Products

Timon Kramer, Institut für Finanz- und Aktuarwissenschaften (ifa) and University Ulm

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About the Speaker

- **Timon Kramer**

Actuarial Consultant at ifa

PhD Student at Ulm University

Master of Science (Mathematics and Management, Ulm University)

Master of Science (Mathematics, University of Wisconsin)



- **Ulm University**

Institute of Insurance Science

- **Institut für Finanz- und Aktuarwissenschaften (ifa)**

ifa is an independent actuarial consulting firm located in Ulm, Germany.



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Introduction

Motivation and Research Objective

▪ Starting point:

- In traditional life insurance, policyholders participate in the same pool of assets.
- Enables the implementation of various **return smoothing mechanisms**.
 - Goal: Reduction of the volatility of the policyholders' return.
- Concrete type of smoothing mechanism can have a significant effect on **risk-return-characteristics** cf. Kling et al. (2025).
 - Intertemporal mainly smoothing reduces pathwise volatility.
 - Intergenerational risk sharing mainly reduces uncertainty of terminal value.
- Alongside smoothing mechanisms, products often include a guarantee, e.g., terminal guarantee.
- Guarantees are well researched, however, not in combination with different types of return smoothing mechanisms.

Introduction

Motivation, Research Objective and Main Results

■ In this Paper:

- We argue that the concrete design of smoothing mechanism can have a significant impact on the value of a guarantee.
- Therefore, return smoothing mechanisms based on intergenerational risk sharing and intertemporal smoothing combined with a terminal guarantee and different underlying funds are analyzed.
- We find that smoothing mechanisms can lead to higher return potential while maintaining a similar risk profile.
- Additionally, two fairness conditions are applied to the products illustrating that policyholders benefit from products that can only be provided by insurance companies.

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Capital Market and Products

The Capital Market Model and the Book Of Business (Kling et al. 2025)

Capital Market Model:

- On a finite time horizon $\mathbb{T} = [-T, T]$ and under the real-world measure $\mathbb{P}$, our model consists of

- a **risky asset** $(S_t)_{t \in \mathbb{T}}$ following a geometric Brownian motion

$$dS_t = S_t(\mu dt + \sigma dW_t)$$

- a **risk-free asset** given by

$$\beta_t = e^{r(t-(-T))}$$

- From these we derive a fund process F^δ

$$dF_t^\delta = F_t^\delta \left(\delta \frac{dS_t}{S_t} + (1 - \delta) \frac{d\beta_t}{\beta_t} \right), \text{ with } \delta \in [0, 1].$$

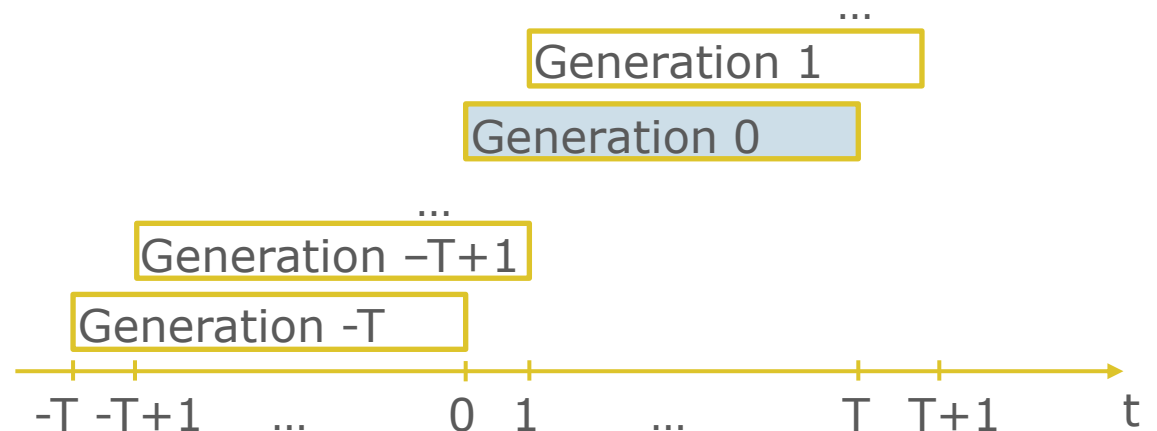
- Under the risk-neutral measure $\mathbb{Q}$, we receive

$$dS_t = S_t \left(r dt + \sigma dW_t^\mathbb{Q} \right)$$

$$dF_t^\delta = F_t^\delta \left(r dt + \delta \sigma dW_t^\mathbb{Q} \right), \forall t \in \mathbb{T}$$

Book Of Business:

- Policyholder pays a single premium at the start of the contract.
- After T years policyholder's account is paid out.
- Based on different generations buying the same contract at different points in time.
- The set of all generations is $\mathcal{H} = \{-T, \dots, T\}$.
- Analysis focuses on the generation entering at time $t = 0$ while the company is in a going-concern state.



Capital Market and Products

Smoothing Mechanisms (Kling et al. 2024, 2025)

- Intertemporal Smoothing: **Return Averaging (RA)**
 - Return = average return of the past 3 years
- Intergenerational Risk Sharing: **Collective Buffer Smoothing (CBS)**
 - Policyholders pay a share $(1 - \alpha)$ of their premium into a buffer account.
 - The buffer account B is used to keep the annualized return of the policyholders' account within some target range.
 - Payment of a terminal bonus depending on parameter ϑ .
- Combination of the approaches: **Collective Buffer Smoothing and Return Averaging (CBS RA)**
- Additionally: **Product with no smoothing (nS)**

Capital Market and Products

Fairness conditions and Guarantee

Fairness of the Products:

- The products with smoothing mechanisms are parametrized consistently to allow for comparisons.
- For the CBS and CBSRA products, the terminal bonus parameter ϑ has been chosen such that

$$\mathbb{E}_{\mathbb{P}}(B_0^+) = \mathbb{E}_{\mathbb{P}}(B_{20}^+).$$

- For the RA product, annual expected return is equal to that of the underlying fund.

Pricing of the Guarantee:

- A terminal money back guarantee for the contract of generation $h = 0$ is added.
- The value of the guarantee P_g is paid upfront and included in the total premium TP_0 of generation $h = 0$, i.e., $TP_0 = P_g + P_0$.
- The value of the guarantee is given by the risk-neutral expected value of the discounted payoff, i.e.,

$$P_g = \mathbb{E}_{\mathbb{Q}} \left(e^{-Tr} \max(TP_0 - I_t^h, 0) \right)$$

Capital Market and Products

Choice of Parameters

- For the model we use the following parameters: $T = 20$, $TP = 10,000$, $r = 2\%$, $\mu = 6\%$, and $\sigma = 20\%$.
- For the fund process, we consider different levels of $\delta \in \{0.25, 0.3, \dots, 0.95, 1.0\}$.
- Leading to 16 products for each smoothing mechanism and fairness condition.

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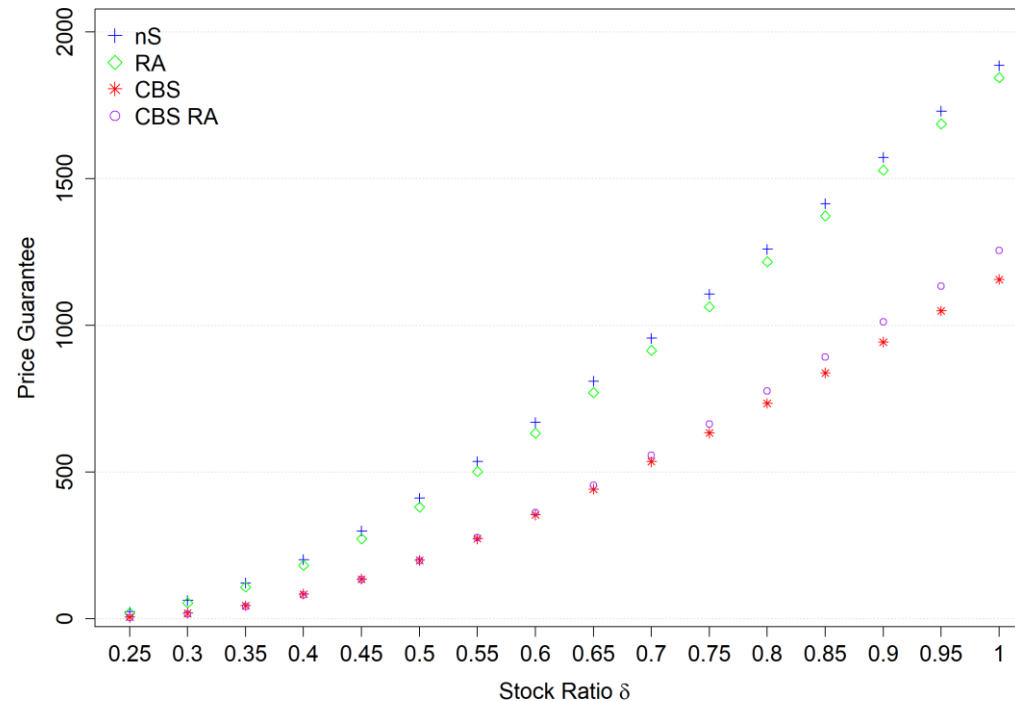
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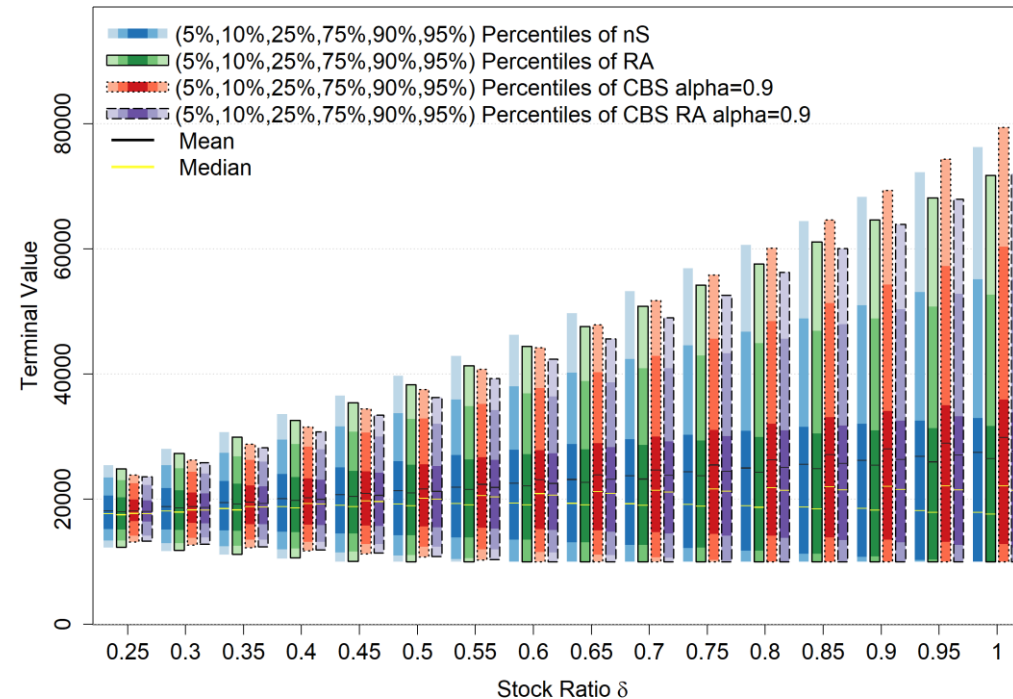
Guarantee Value



- Return smoothing mechanisms lead to lower guarantee values for the same stock ratio.
- Intergenerational risk sharing has a greater effect than intertemporal smoothing.
- For the same value, a higher stock ratio can be chosen with smoothing mechanisms.

Effects of Return Smoothing on Guarantees

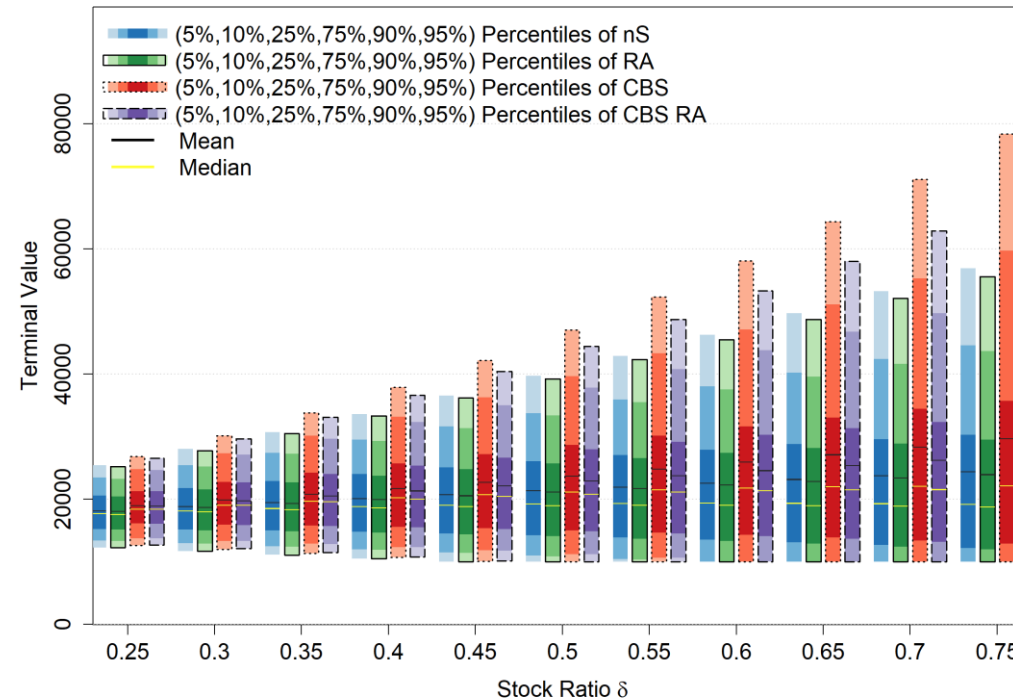
Payoff of the Products – Fixed Stock Ratio



- Intergenerational risk sharing leads to lower risk and higher chances for higher stock ratios.
- Intertemporal smoothing has almost no effect on the payoff structure.

Effects of Return Smoothing on Guarantees

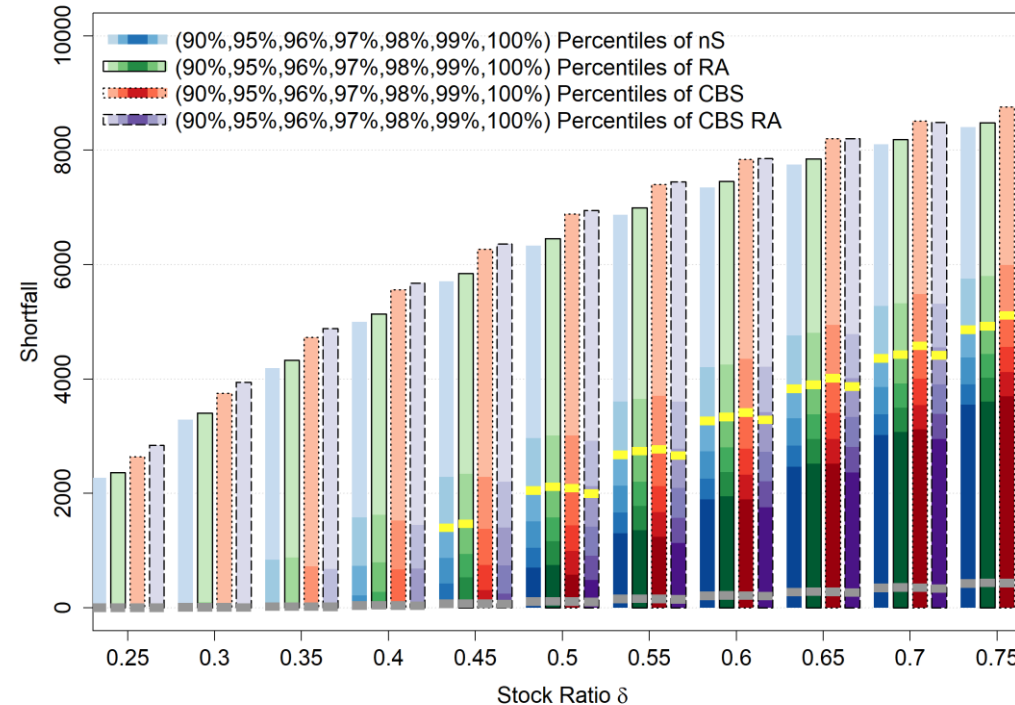
Payoff of the Products – Fixed Guarantee Value



- Intergenerational risk sharing can lead to considerably higher chances and a similar level of risk.
- Intertemporal smoothing has almost no effect on the payoff.

Effects of Return Smoothing on Guarantees

Payoff from the Guarantee – Fixed Guarantee Value



- The payout structure is very similar for the different products.
- The risk of providing a guarantee is mainly driven by the value of the guarantee.

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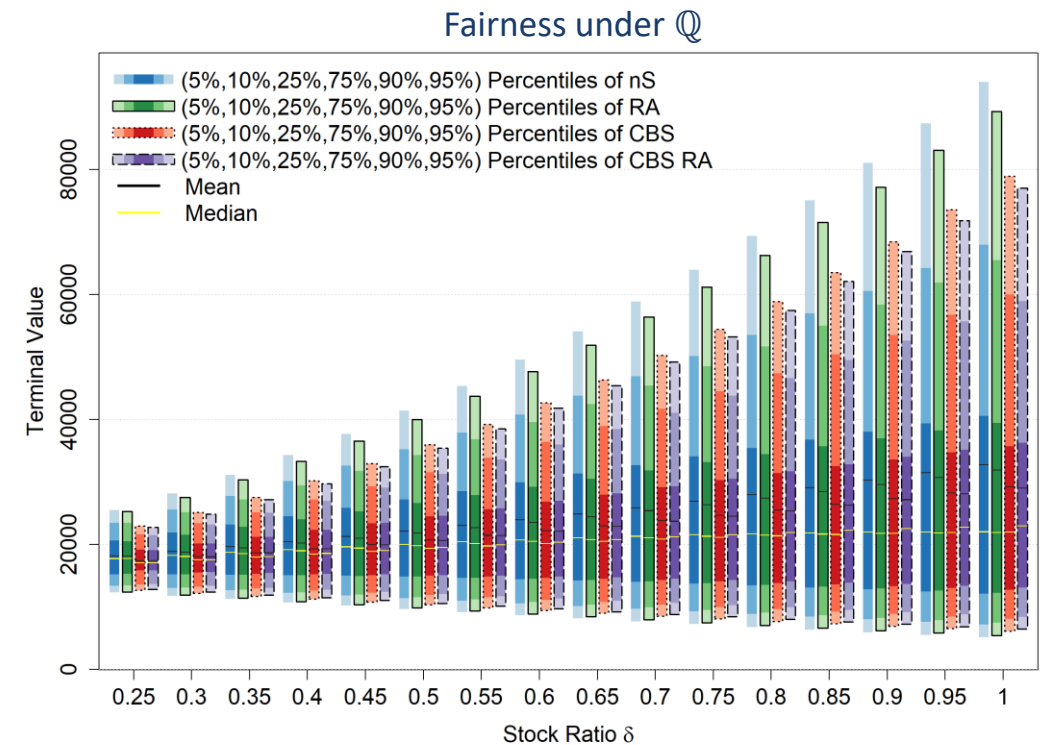
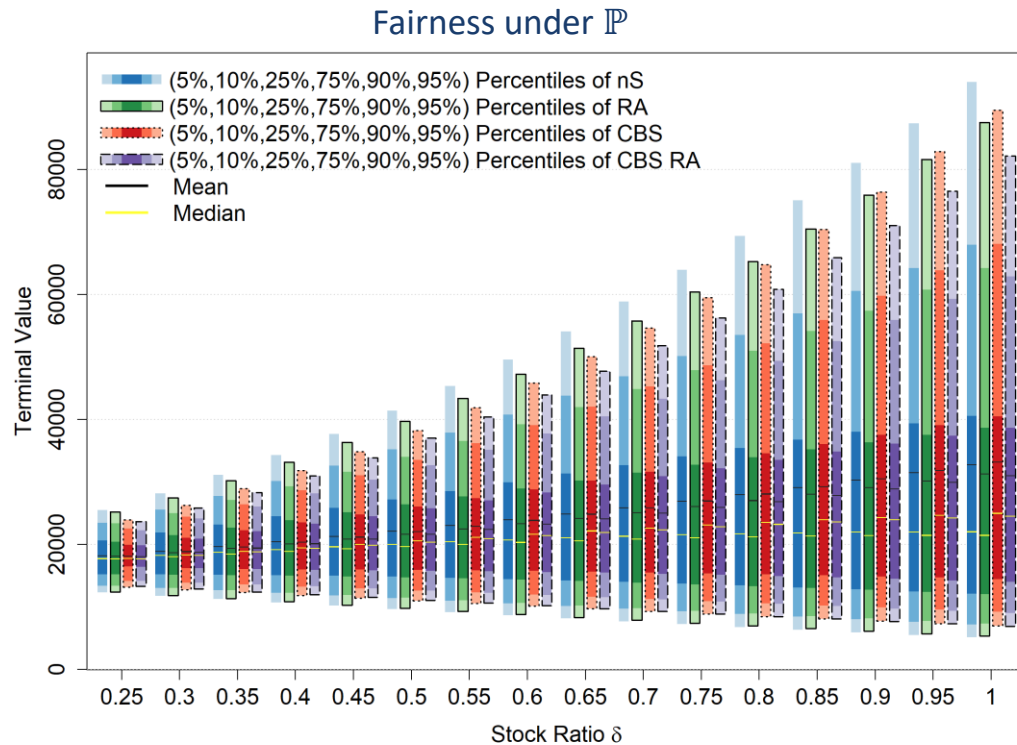
Effects of Different Fairness Conditions

Discussion of Fairness Conditions

- The considered products hold specific fairness conditions under the real-world measure $\mathbb{P}$.
- These products can only be offered by an insurance company with a pool of generations.
- For a comparison with products replicable on the capital market, we consider fairness conditions under the risk neutral measure $\mathbb{Q}$.
- For this, the products with smoothing mechanisms are priced under $\mathbb{Q}$.

Effects of Different Fairness Conditions

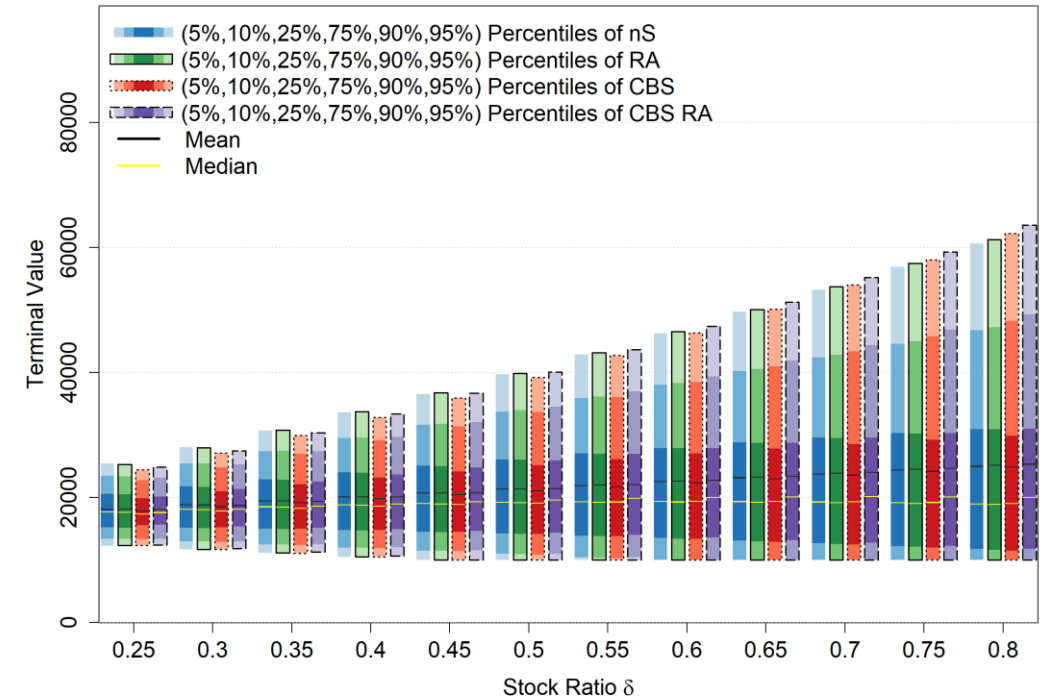
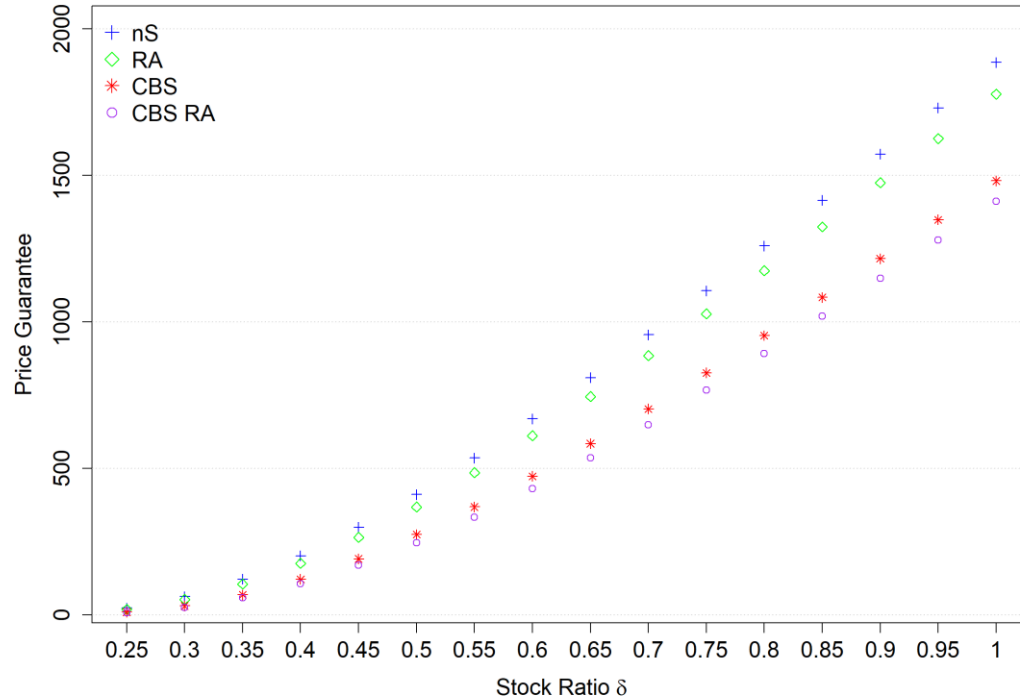
Payoff of the Products without Guarantees



- With fairness under $\mathbb{P}$, intergenerational risk sharing leads to a higher payoff.
- Almost no difference for intertemporal smoothing.

Effects of Different Fairness Conditions

Payoff of the Products with Guarantees and Fairness under $\mathbb{Q}$



- The guarantee value decrease due to smoothing mechanisms are smaller with fairness under $\mathbb{Q}$.
- Only slightly higher chances for products with smoothing mechanisms.
- The effects are the strongest for the CBSRA product and higher stock ratios.

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Concluding Notes

Our main results:

- Smoothing mechanisms lead to lower guarantee values.
- Intergenerational risk sharing has a greater effect than intertemporal smoothing.
- For the same value, a higher stock ratio can be chosen for products with smoothing mechanisms which can lead to higher chances for the policyholder.
- These effects are especially strong for intergenerational risk sharing with fairness conditions under $\mathbb{P}$.
- The risk for providing a guarantee is mainly driven by the value of the guarantee.

Consequences:

- Smoothing mechanisms are a useful tool on products with guarantees to decrease the guarantee value or to increase the chances for the policyholder.
- Intergenerational risk sharing can release its full potential when offered with a collective of policyholders from different generations.
- Insurance companies can mitigate capital market risk over different generations which provides their products with an advantage over hedgeable investments on the capital market.

Thank you

Timon Kramer
t.kramer@ifa-ulm.de



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If you want to see more details on my research on smoothing mechanisms

- Kling, A., Kramer, T. & Ruß, J. From intertemporal smoothing to intergenerational risk sharing: The effects of different return smoothing mechanisms in life insurance. Eur. Actuar. J. (2025). <https://doi.org/10.1007/s13385-025-00430-x>
- Kling, A., Kramer, T., Ruß, J., & Schelling, S. (2024). Intertemporal smoothing and intergenerational risk sharing: The impact on objective utility and subjective attractiveness of retirement savings products. <https://dx.doi.org/10.2139/ssrn.5005853>.