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# Saving for Retirement in a Low Interest Rate Environment: Are Life Insurance Products Good Investments?

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# 1. Introduction

- **Background**

- EUT can not explain preferences for investment guarantee products

- CPT however can only explain the demand for simple guarantee products

- Hence: Why clique-style interest rate guarantees? (typical guarantee form in participating life insurance contracts for instance in Germany, France, Switzerland)

- Possible reason: Policyholder may care about interim value changes (and not just final payoffs)

- Russ / Schelling (2017, JRI forthcoming) introduce the concept of MCPT – valuation of interim changes and terminal payoff – in an underlying B/S model framework (fair valuation of guarantees / no default risk)

- Result: Under MCPT complex guarantees outperform more simple ones (and products without guarantees)

# 1. Introduction

- **What we do**

- Focusing on the savings part
- Two asset Merton model with stochastic assets and interest rates
- Introducing default risk in respect to embedded investment guarantees
- Average death and surrender probabilities are taken into account
- Comparison of three product forms: 1) direct investment (Merton solution), 2) Merton portfolio with point-to-point guarantee and 3) with cliquet-style option

- **Main finding**

- In general not even MCPT preferences can explain the demand for cliquet-style options

# 2. Model framework

- **Investment portfolio**

- Two asset model: Risky equity index evolves according to a GBM; interest rates evolve according to a one-factor Vasicek model

- Evolution of the investment portfolio for t = 1,…,T and initial condition $A_0$

$$A_t^- = A_{t-1}^+ \cdot \exp\left\{\gamma \int_{t-1}^{t} r_s ds + (1-\gamma)\left(\mu_A \cdot \Delta t - 0.5\sigma_A^2 \cdot \Delta t \cdot (1-\gamma) + \sigma_A\left(\rho \cdot \Delta Z_t^{\mathbb{P}} + \sqrt{1-\rho^2} \cdot \Delta W_t^{\mathbb{P}}\right)\right)\right\}$$

- **Point-to-point guarantee** with initial premium $P_0$

$$^{-}L_t^{ptp} = {}^{+}L_{t-1}^{ptp} \cdot exp\left(g^{ptp} \cdot \Delta t\right) + \alpha^{ptp} \cdot max\left(\pi_T \cdot A_T^+ - {}^{+}L_T^{ptp}, 0\right) \cdot \mathbb{1}_{\{T=t\}}$$

# 2. Model framework

- **Cliquet-style guarantee**

$$^{-}L_t^{cs} = {}^{+}L_{t-1}^{cs} \cdot \left[1 + max\left(g^{cs}, \alpha^{cs}(A_t^{-}/A_{t-1}^{+} - 1)\right)\right]$$

- **Policyholder account** adjustment for regular premium payments as well as death and surrender probabilities

$$^{+}L_t = {}^{-}L_t \cdot (1 - p_t^{d,s}) + P_r \cdot \prod_{i=1}^{t}(1 - p_t^{d,s})$$

- Maintaining the balance between the asset and liability side (adjustment of the investment portfolio)

$$A_t^{+} = A_t^{-} - {}^{-}L_t \cdot p_t^{d,s} + P_r \cdot \prod_{i=1}^{t}(1 - p_t^{d,s})$$

# 2. Model framework

- Development of the policyholder's share in the total assets over time

$$\pi_t = \frac{\pi_{t-1} \cdot A_t^- - p_t^{d,s} \cdot {}^-L_t + P_r \cdot \prod_{i=1}^t (1 - p_t^{d,s})}{A_t^+}$$

- with

$$\pi_0 = \frac{P_0}{P_0 + E_0}$$

- Insolvencies can occure in t = 1,…,T
- Early payouts before T are invested in the money market

• **Policyholder's payoff** in T

$$P_T = L_T \cdot \mathbb{1}_{\{\tau > T\}} + M_T + D_T$$

# 2. Model framework

- Embedded investments guarantees are valued under the risk-neutral measure Q

- Hence, all contract are "fairly priced" (i.e., contracts posses a net present value of zero for both stakeholder groups)

- **Policyholder uses MCPT** for contract valuation (cf. Russ / Schelling (2017))

$$V^{comb}(P) = s \cdot \left( \sum_{t=1}^{T-1} V_t^{int}(P_t) \right) + (1-s) \cdot V^{term}(P_T)$$

- Certainty equivalent concept is used represent the outcomes of the analyses

- Numerical examples are provided via Monte Carlo simulation

- Parameters are motivated in details in the paper

# 3. Model parametrization

| Parameter | Variable | Value |
|---|---|---|
| *Contract* | | |
| Policyholder single up-front premium | $P_0$ | 1.0 (C.U.) |
| Policyholder regular premium | $P_r$ | 1.0 (C.U.) |
| Contract duration | $T$ | 30 (years) |
| Length of a time interval | $[t_i, t_{i+1}]$ | 1 (year) |
| *Interest Rate Process* | | |
| Initial interest rate level | $r_0$ | −0.01% |
| Volatility of the short rate dynamics | $\sigma_r$ | 0.6% |
| Long term average interest rate | $\theta$ | 2.4% |
| Mean reversion speed | $\kappa$ | 0.08 |
| Market price of risk of the short rate dynamics | $\lambda_{MP}$ | −0.18 |
| *Asset Process* | | |
| Drift of the geometric Brownian Motion | $\mu_A$ | 9.0% |
| Volatility of the geometric Brownian Motion | $\sigma_A$ | 19.2% |
| Correlation of asset and interest rate processes | $\rho$ | 7.7% |
| *Solvency regulation* | | |
| Upper bound of the ruin probability for $[0, T]$ | $\epsilon$ | 0.5% |
| *Biometric factors* | | |
| Probability of death or early surrender | $p_{d,s}$ | 4.2% |

# 4. Numerical results

- **Concept:**

- We aim to find contract parameters that maximize policyholder's utility among all admissible parameter combinations

- E.g., for a given guarantee level, we find the participation rate and the asset allocation that maximize utility given the restriction explained before

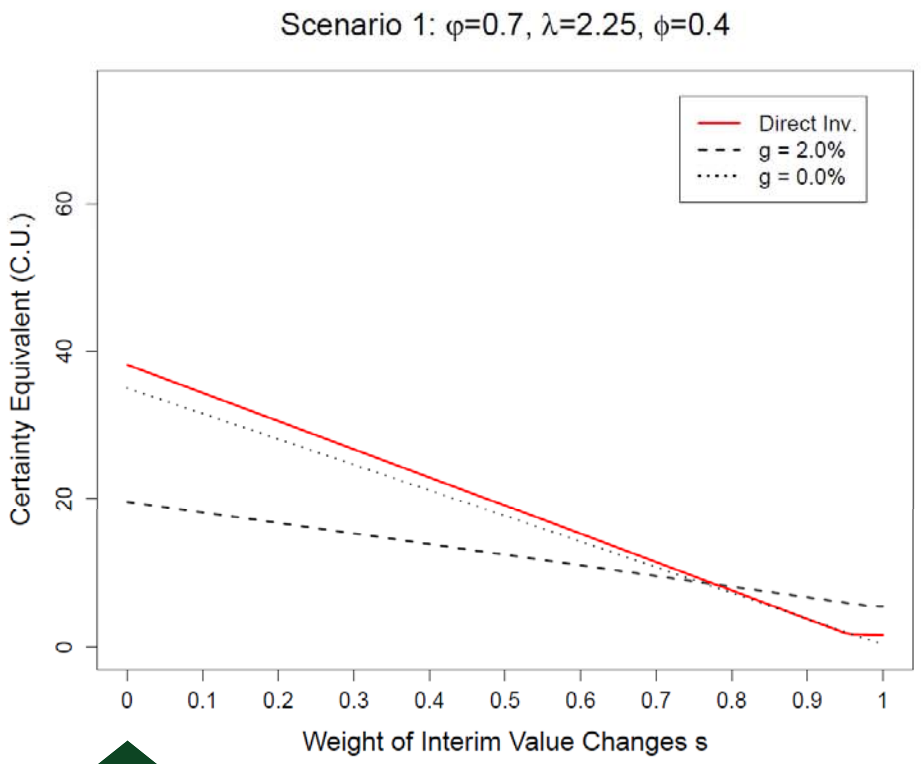
- **Cases**

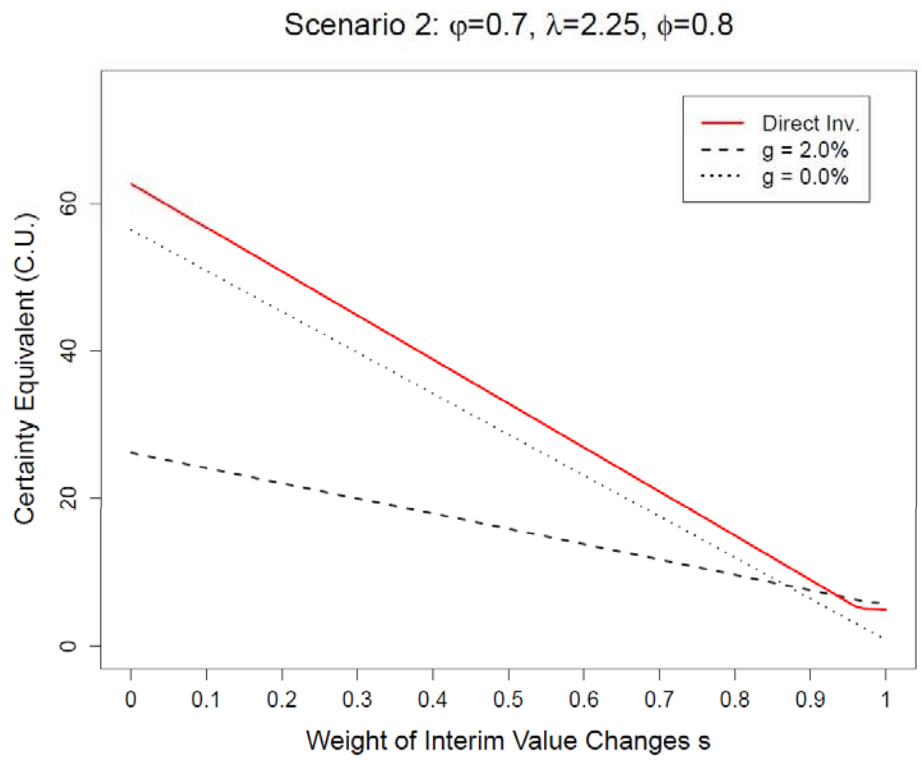
- 1) Maximum CE levels for a product with point-to-point guarantee versus the CE of a direct investment

- 2) Maximum CE levels for a product with cliquet-style guarantee versus the CE of a direct investment

# 4. Numerical results

## Case 1): point-to-point




CPT

# 4. Numerical results

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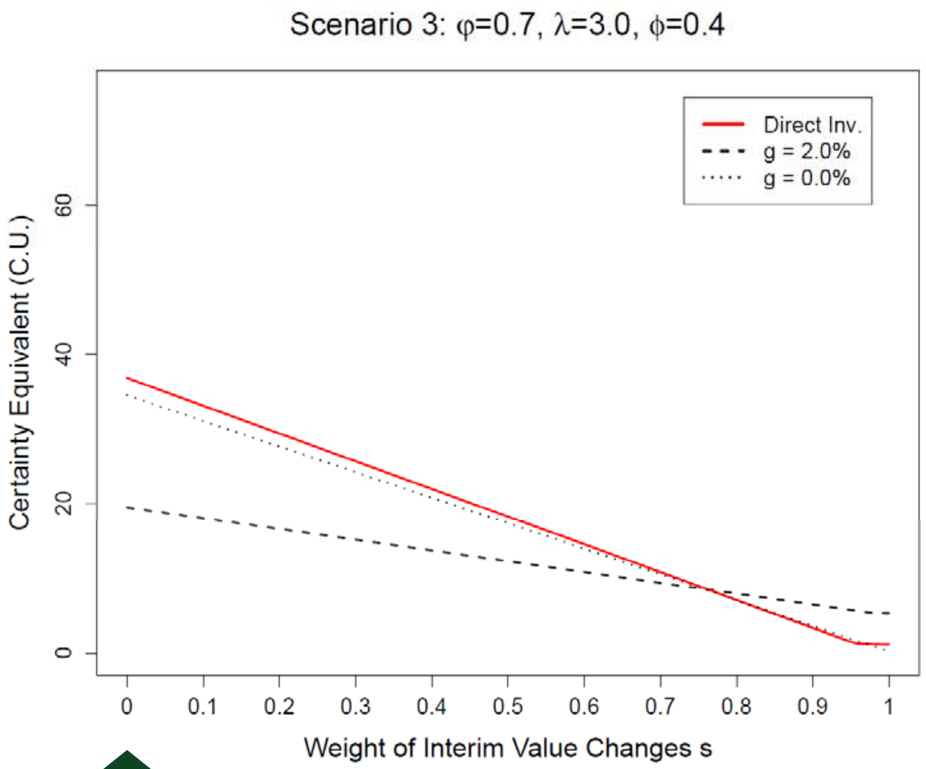
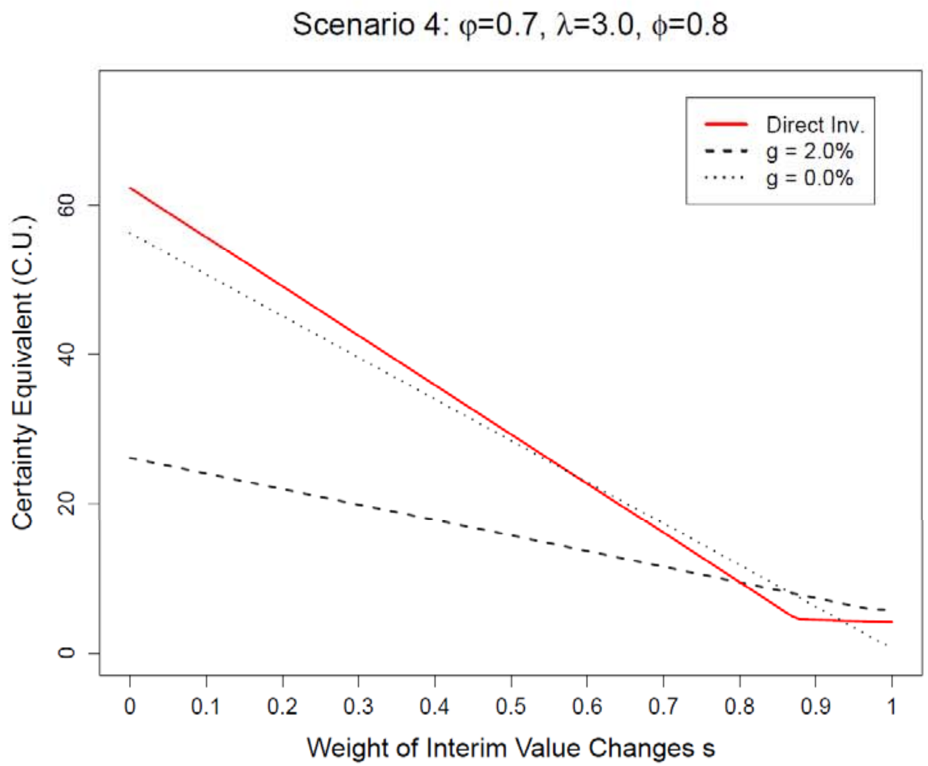
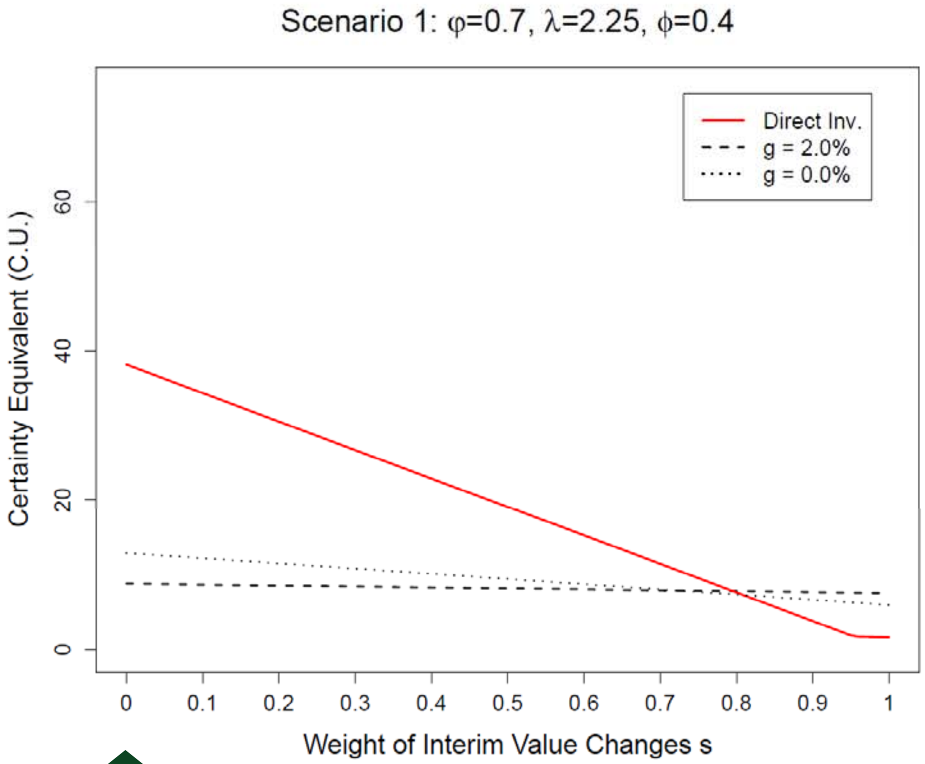


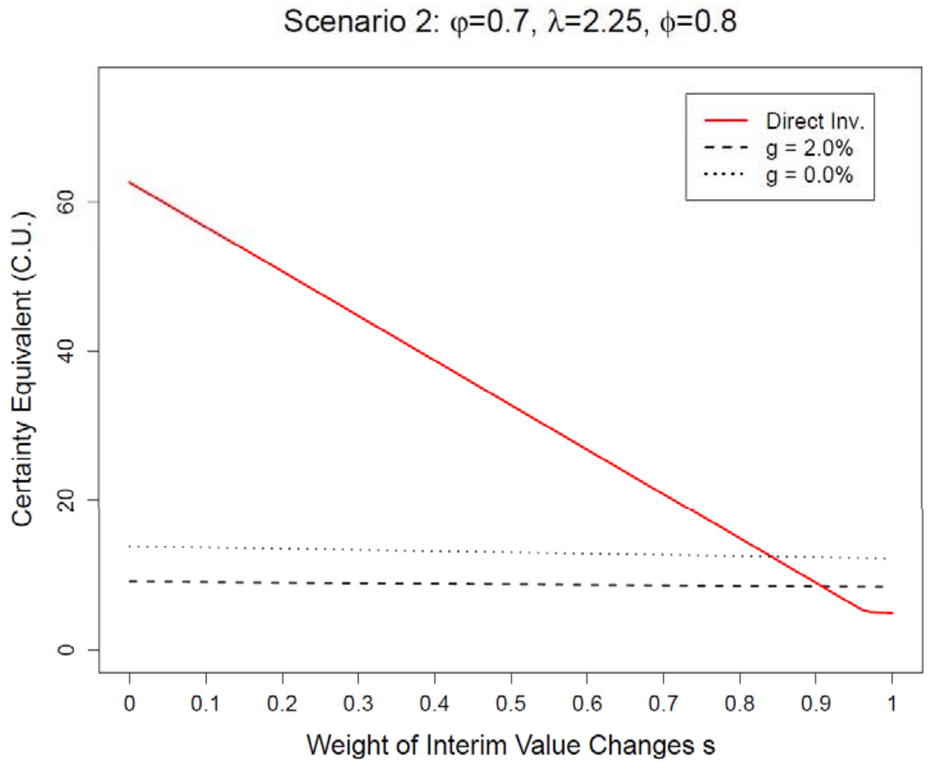




CPT

# 4. Numerical results

## Case 2): cliquet-style




CPT

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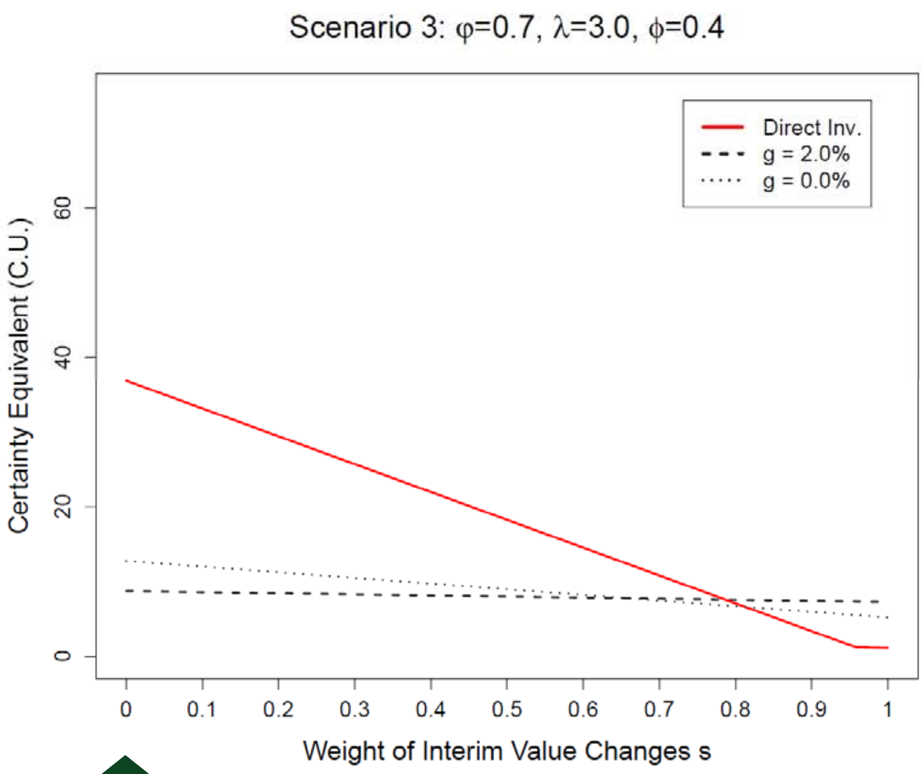


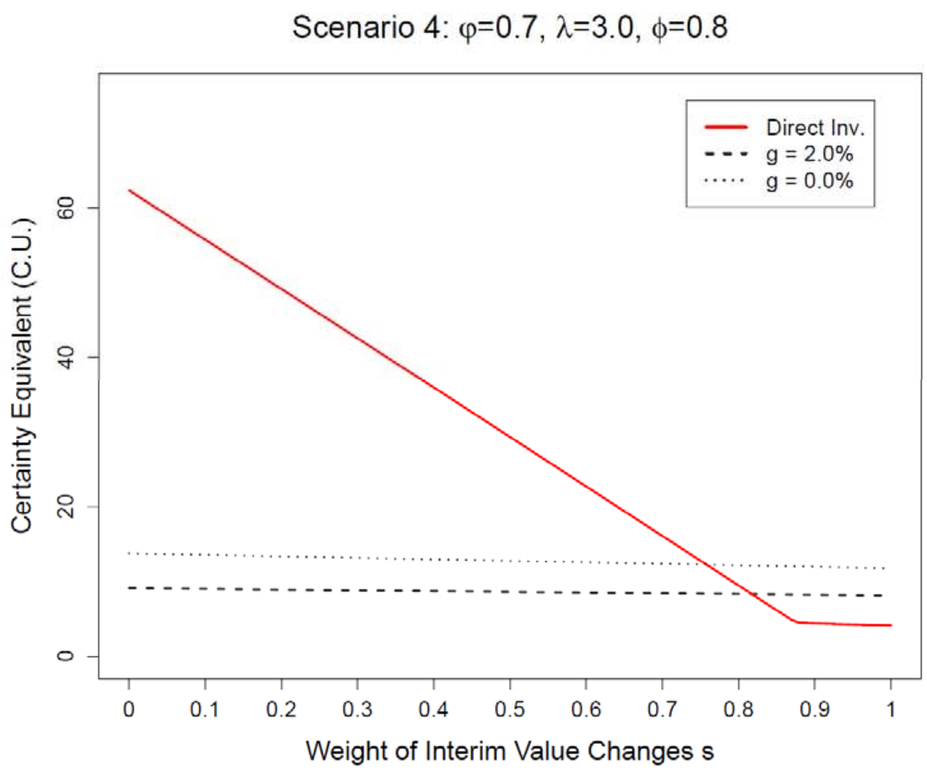


CPT

# 5. Findings and outlook

- **CPT:** Direct investment offers higher utility when taking default risk of the investment guarantee into account

- **MCPT:** Only in rather extreme cases with very large values for the interim weight investment guarantees can posses an additional value for policyholders

- Parameter regulation and product standardization in general reduces policyholder's utility

- Why do our results differ from Russ / Schelling (2017)?

- Even if policyholder's utility is reduces via investment guarantees, there could be other reasons why such options should be part of old-age provisions

- But: Why cliquet-style options?