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University of St.Gallen

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

by Alexander Braun / Marius Fischer / Hato Schmeiser

Hato Schmeiser, University of St. Gallen

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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 $t = 1, \dots, T$ 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

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

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

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

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

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

2. Model framework

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

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

- with

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

- Insolvencies can occur in $t = 1, \dots, T$
- 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

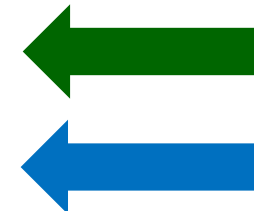
- Embedded investments guarantees are valued under the risk-neutral measure Q
- Hence, all contract are “fairly priced” (i.e., contracts possess a net present value of zero for both stakeholder groups)
- **Policyholder uses MCPT** for contract valuation (cf. Russ / Schelling (2017))

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

- Certainty equivalent concept is used to 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
<i>Contract</i>		
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)
<i>Interest Rate Process</i>		
Initial interest rate level	r_0	-0.01%
Volatility of the short rate dynamics	σ_r	0.6%
Long term average interest rate	θ	2.4%
Mean reversion speed	κ	0.08
Market price of risk of the short rate dynamics	λ_{MP}	-0.18
<i>Asset Process</i>		
Drift of the geometric Brownian Motion	μ_A	9.0%
Volatility of the geometric Brownian Motion	σ_A	19.2%
Correlation of asset and interest rate processes	ρ	7.7%
<i>Solvency regulation</i>		
Upper bound of the ruin probability for $[0, T]$	ϵ	0.5%
<i>Biometric factors</i>		
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

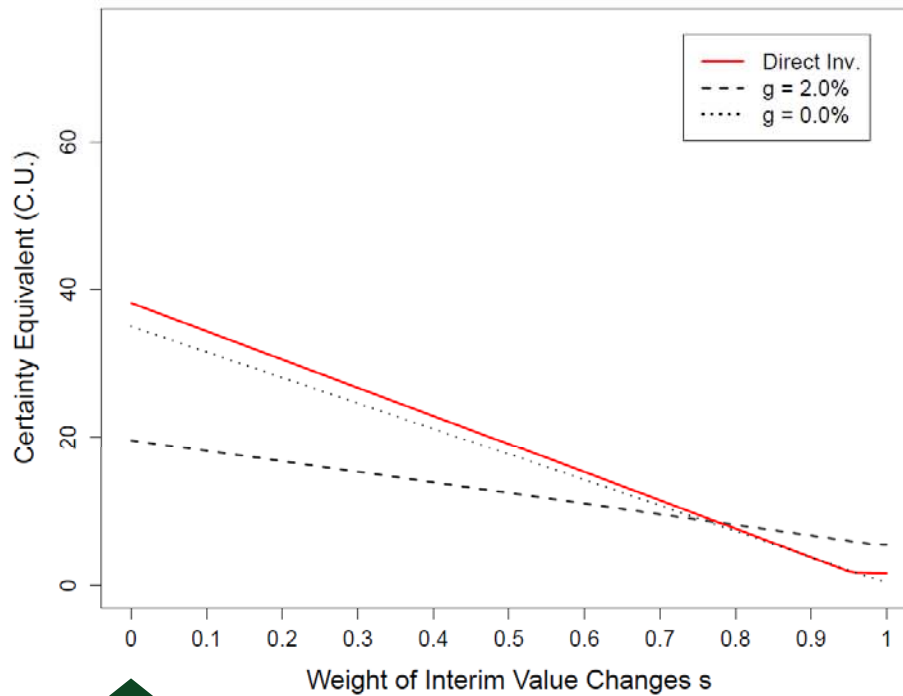
- **Cases**

- 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

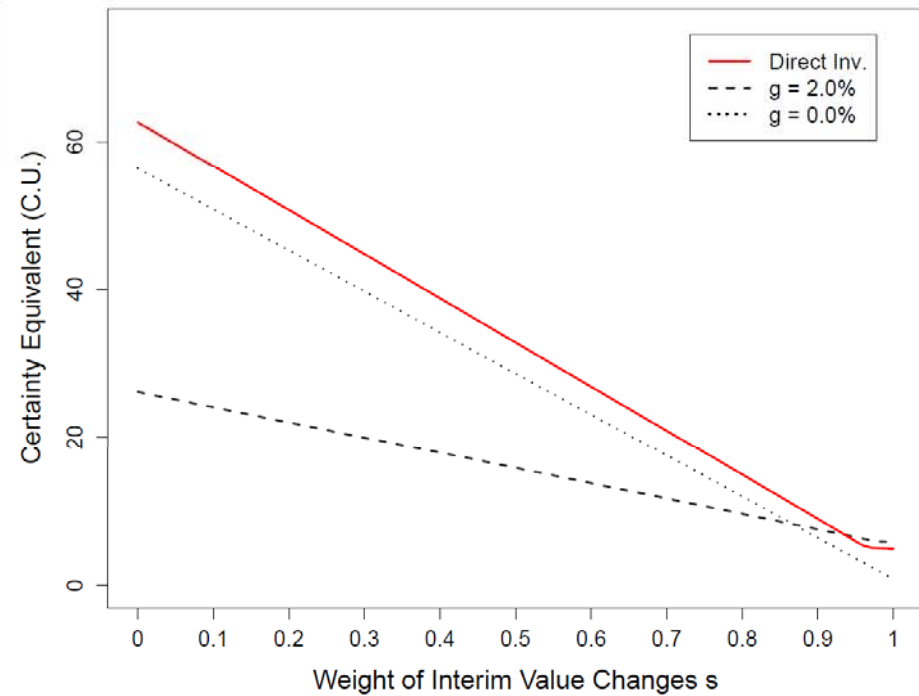
4. Numerical results

Case 1): point-to-point

Scenario 1: $\varphi=0.7$, $\lambda=2.25$, $\phi=0.4$



Scenario 2: $\varphi=0.7$, $\lambda=2.25$, $\phi=0.8$



CPT

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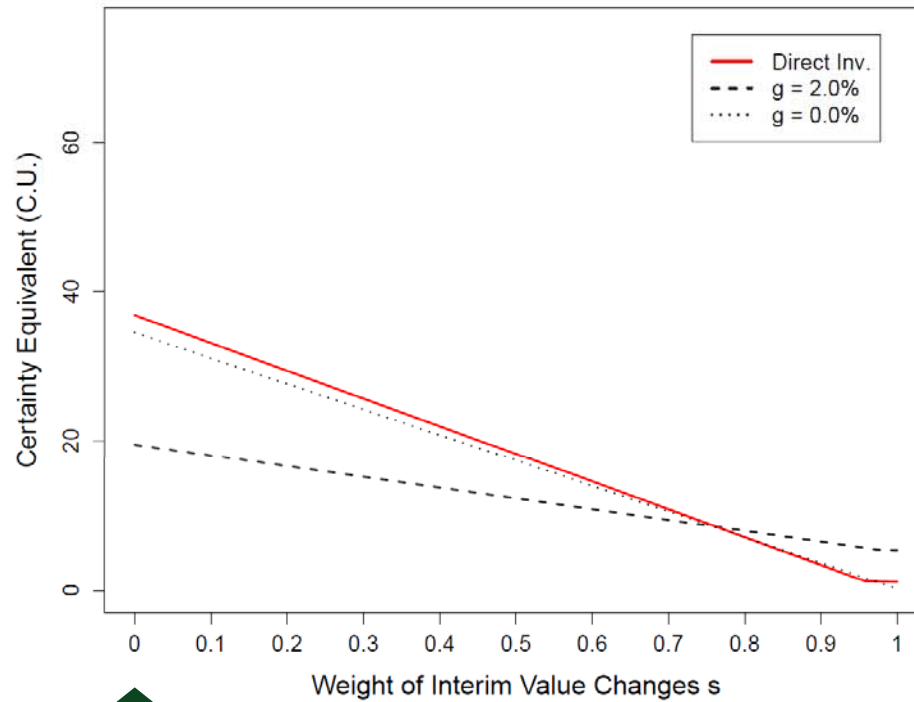


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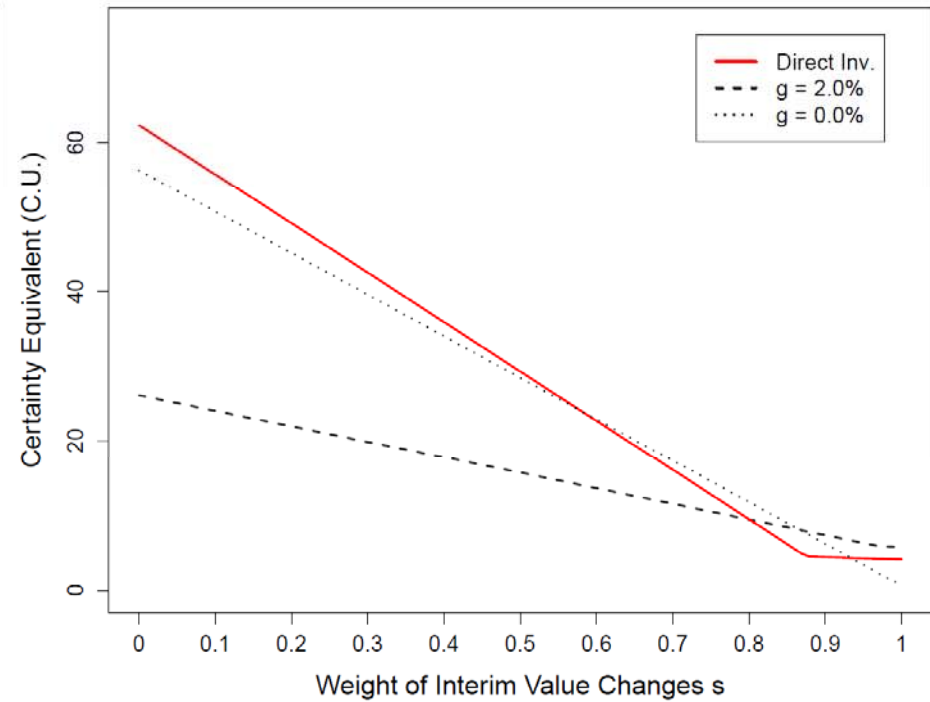
4. Numerical results

Case 1): point-to-point

Scenario 3: $\phi=0.7$, $\lambda=3.0$, $\phi=0.4$



Scenario 4: $\phi=0.7$, $\lambda=3.0$, $\phi=0.8$



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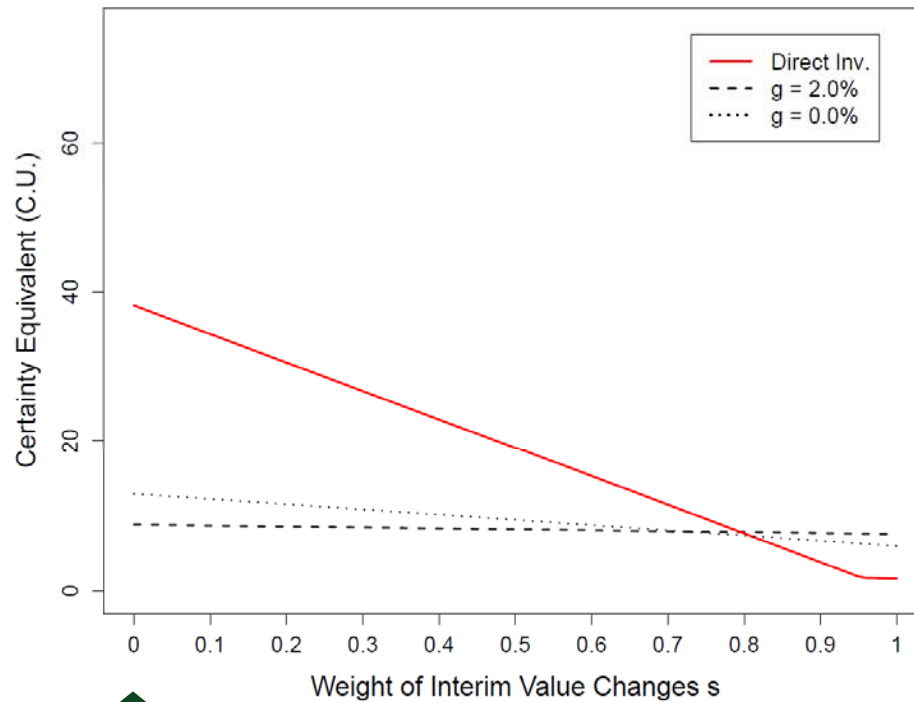


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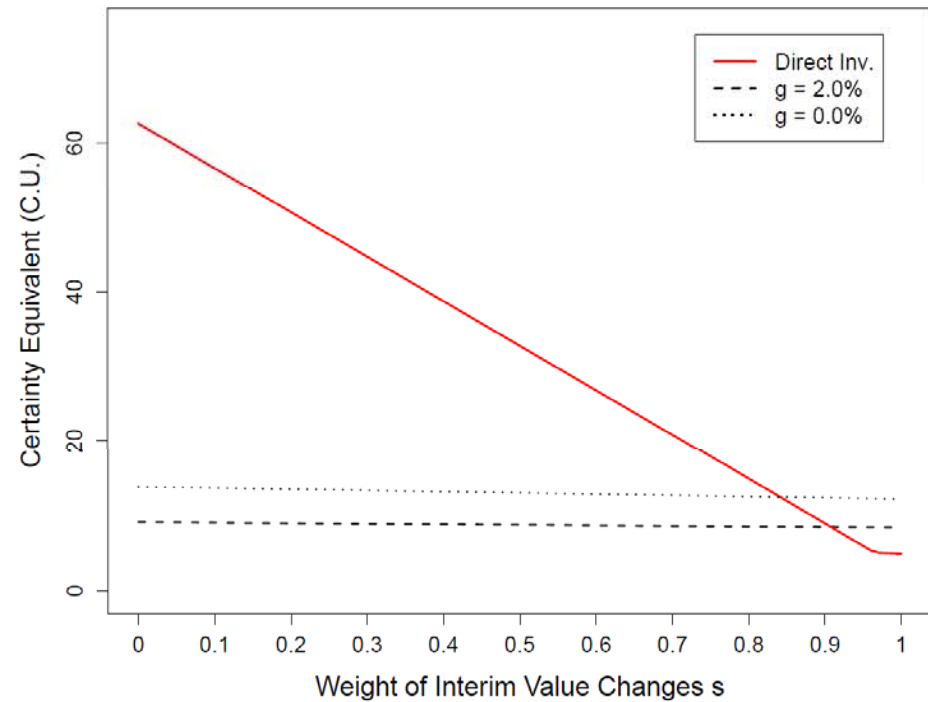
4. Numerical results

Case 2): cliquet-style

Scenario 1: $\varphi=0.7$, $\lambda=2.25$, $\phi=0.4$



Scenario 2: $\varphi=0.7$, $\lambda=2.25$, $\phi=0.8$



CPT

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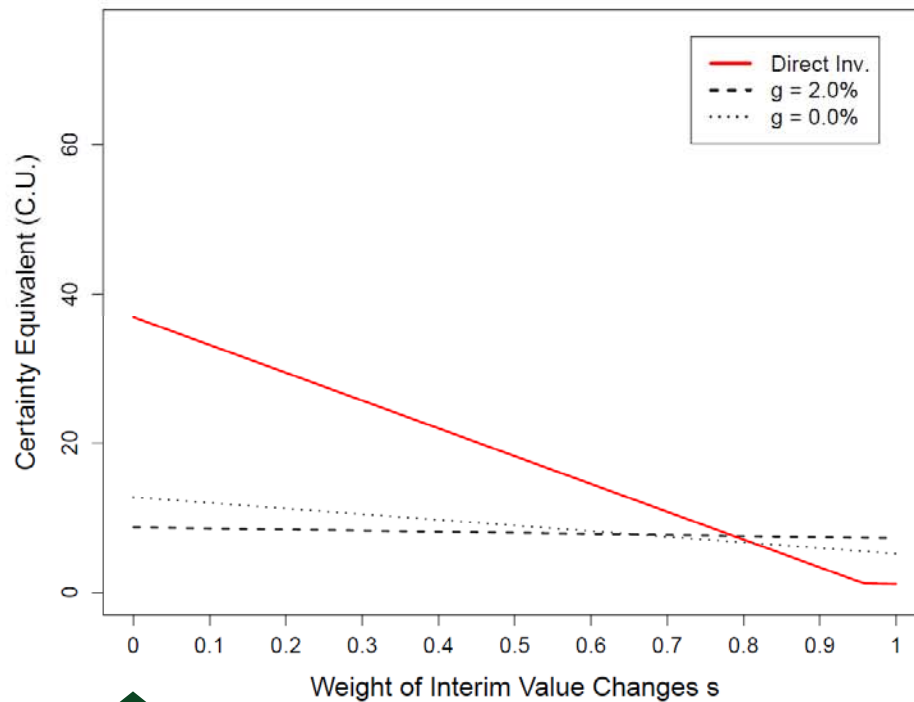


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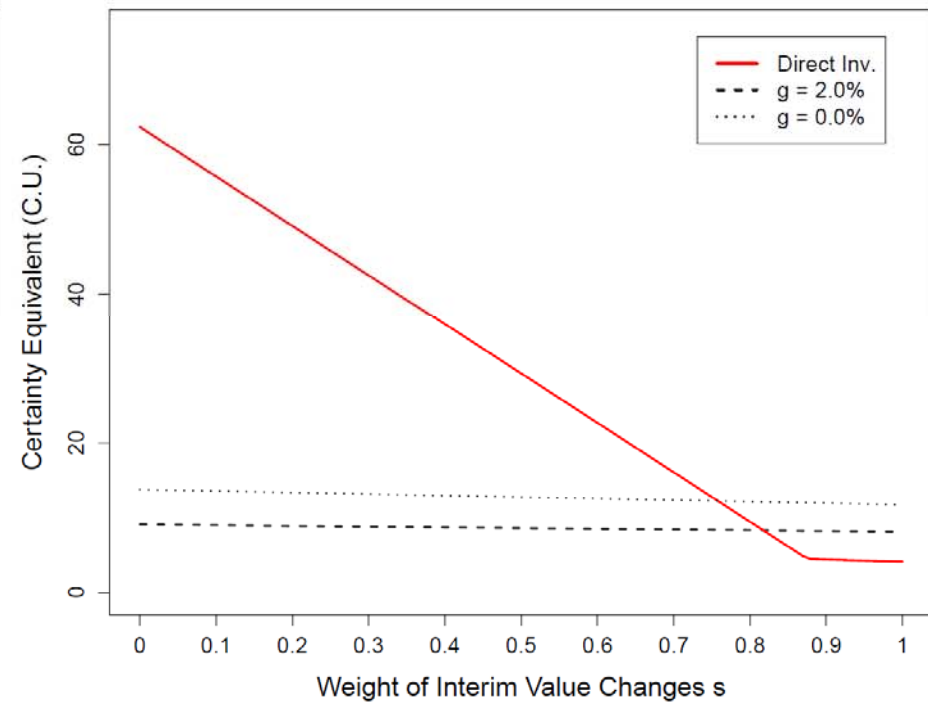
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5. Findings and outlook

- **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 possess 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 reduced via investment guarantees, there could be other reasons why such options should be part of old-age provisions
 - But: Why cliquet-style options?