Institute of Insurance Economics

University of St.Gallen

The Influence of Interest Rate Guarantees and Solvency Requirements on the Asset Allocation of Life Insurance Companies

Working Paper by Hato Schmeiser and Joël Wagner

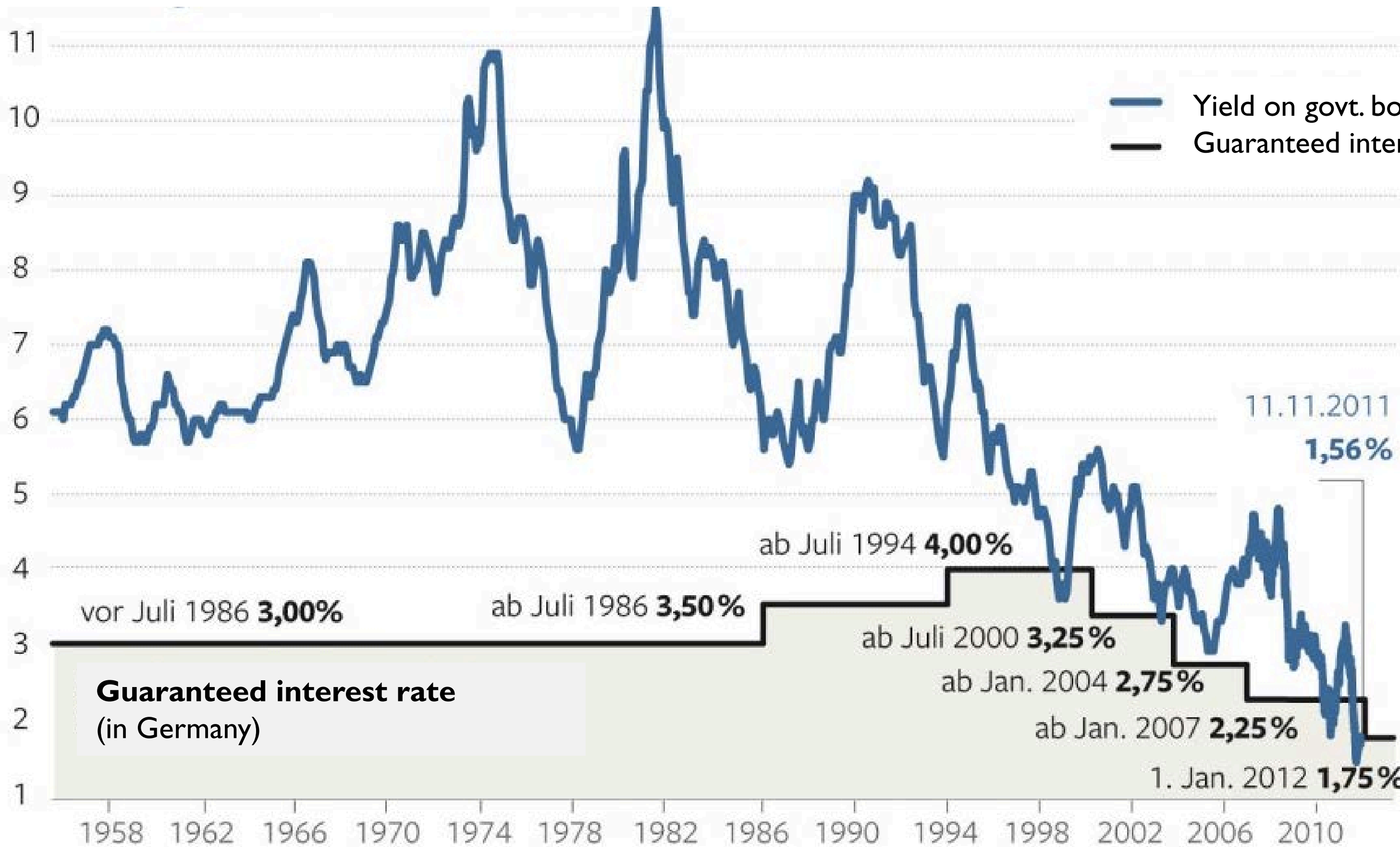
EGRIE 2012

Structure

- **Status quo and current discussions**
- **Model framework**
- **Analyses and results**
- **Conclusion and outlook**

Managing long-term guarantees becomes more and more difficult

Yield / interest (in percent)



Long-term guarantees in life insurance contracts

- **Focus: participating life insurance contracts**
  - Minimum interest rate guarantee based on the savings provided on a year-by-year basis (cliquet-style) for the whole contract duration
  - Participation in the annual return of the insurance company's asset portfolio
  - Both figures are generally regulated by the insurance supervisory authorities

- **Long-term interest rate guarantees are becoming more and more difficult to manage**
  - Long contract durations
  - (Higher) equity capital requirements under new solvency regulations (Solvency II, SST)
  - Current capital market situation with low-return investment opportunities

- **Current discussions in the industry**
  - Introduction of possibilities rendering the guarantees adjustable throughout the contract duration

Current regulation and critical elements

- **E.U. directive**
  - Interest rate guarantees not to exceed 60% of the rate of return on government debt
  - Local maximum rates are adapted over time in line with prevailing rates in the capital market
  - Germany: **from 2.25% (2011) to 1.75% (2012)** / CH: From 1.75% to 1.50% (contracts in CHF)
  - Rate of return of goverment bonds (10 year duration) are currently below these (max) intertes rate guarantees
- **Adjustment applies only to new contracts**
  - Insurers may still have older contracts in their portfolio with guarantees of up to 4% (Germany)
- **Parameters adjusted in response to capital market developments**
  - Time-lag between market changes and regulatory adjustments
- **Only definition of an upper bound for the interest rate**
  - This bound-value is the one offered in practice (due to "intuitive" arguments and "naive" contract assessment, offering of highest possible guarantees: superficial conclusion that contracts with a higher interest rate guarantee have a higher value than contracts with a lower guarantee)

Related literature

Structure

- **Status quo and current discussions**
- **Model framework**
- **Analyses and results**
- **Conclusion and outlook**

Problem

Research question: At what level should the regulator set the maximum value of the interest rate guarantee when taking into account policyholder utility?

Considered characteristics

Insurance company

- **Equity capital** E_0
- **Asset allocation**: share γ invested risk-free
- **Solvency II**: safety level / ruin probability ε

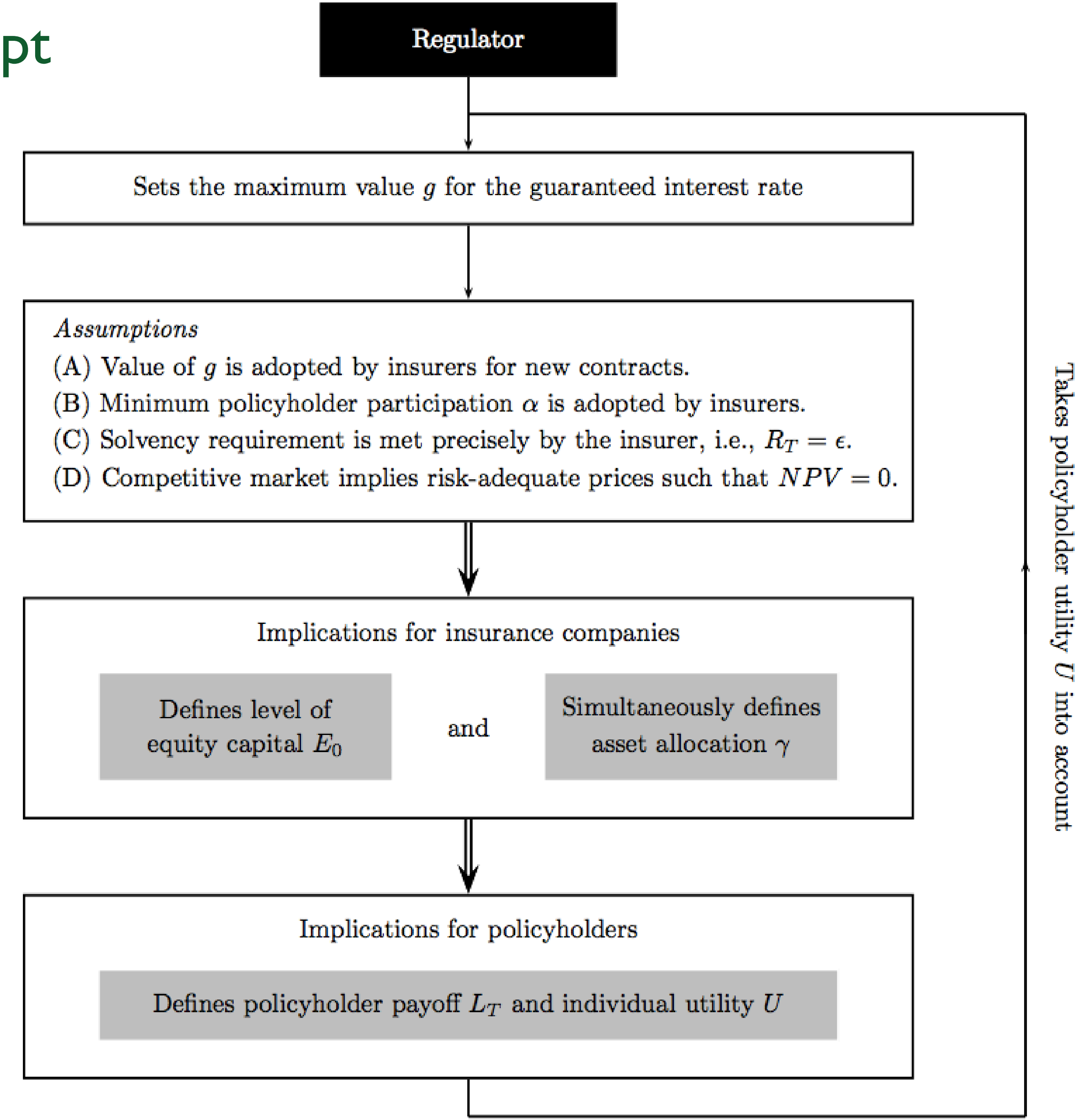
Policyholder

- Iso-elastic **utility function** (CRRA)
- Constant relative **risk-aversion**: parameter ρ

Contract

- **Risik-adequate premium** / price: P_0 (i.e., adequate returns on E_0; market modelles assures financing for the industry)
- **Contact length** T
- Minimum **interest rate guarantee** g
- **Participation** α

Concept


Regulator
Sets the maximum value g for the guaranteed interest rate
Assumptions
(A) Value of g is adopted by insurers for new contracts.
(B) Minimum policyholder participation α is adopted by insurers.
(C) Solvency requirement is met precisely by the insurer, i.e., $R_T = \epsilon$.
(D) Competitive market implies risk-adequate prices such that $NPV = 0$.
Implications for insurance companies
Defines level of equity capital E_0
and
Simultaneously defines asset allocation γ
Implications for policyholders
Defines policyholder payoff L_T and individual utility U
Takes policyholder utility U into account

Positions of policyholders and equity holders

- **Assets process: risk-free and geometric Brownian motion** (t = 1, …, T)

$$A_t = A_{t-1} \cdot \exp[\gamma \cdot r_{\mathrm{f}} + (1-\gamma) \cdot (\mu_{\mathrm{GBM}} - \sigma_{\mathrm{GBM}}^2/2 + \sigma_{\mathrm{GBM}}(W_t^{\mathbb{P}} - W_{t-1}^{\mathbb{P}}))]$$

- **Policyholder account** (t = 1, …, T ; P_0 = 1)

$$P_t = P_{t-1} \cdot (1 + r_t) = P_{t-1} \cdot [1 + \max(g, \alpha(A_t/A_{t-1} - 1))]$$

$t = 0$	
A_0	E_0
	P_0

- **Default Put Option (DPO) and policyholder payoff L_T (in T)**

$$D_T = (P_T - A_T)^+$$

$$L_T = P_T - D_T = P_T - (P_T - A_T)^+$$

- **Equityholder position**

$$E_T = A_T - L_T = (A_T - P_T)^+$$

Safety level, risk-adequate pricing and policyholder utility

- **Solvency restriction** (surrogate)

$$R_T = \mathrm{Prob}(A_T < P_T)$$

$$\boxed{R_T \leq \epsilon}$$

- **Risk-adequate pricing**: premium $\Leftrightarrow$ equity capital („fairness"-condition)

$$\Pi_0^{\mathrm{P}} = E_0^{\mathbb{Q}}[L_T] = E^{\mathbb{Q}}[e^{-r_f \cdot T} \cdot L_T]$$

$$\Pi_0^{\mathrm{E}} = E_0^{\mathbb{Q}}[E_T] = E^{\mathbb{Q}}[e^{-r_f \cdot T} \cdot E_T]$$

$$NPV = \Pi_0^{\mathrm{P}} - P_0$$

$$\boxed{NPV = 0 \Leftrightarrow \quad \Pi_0^{\mathrm{P}} = P_0 \Leftrightarrow \quad \Pi_0^{\mathrm{E}} = E_0}$$

- **Policyholder utility function and definition of certainty equivalent (*CE*)**

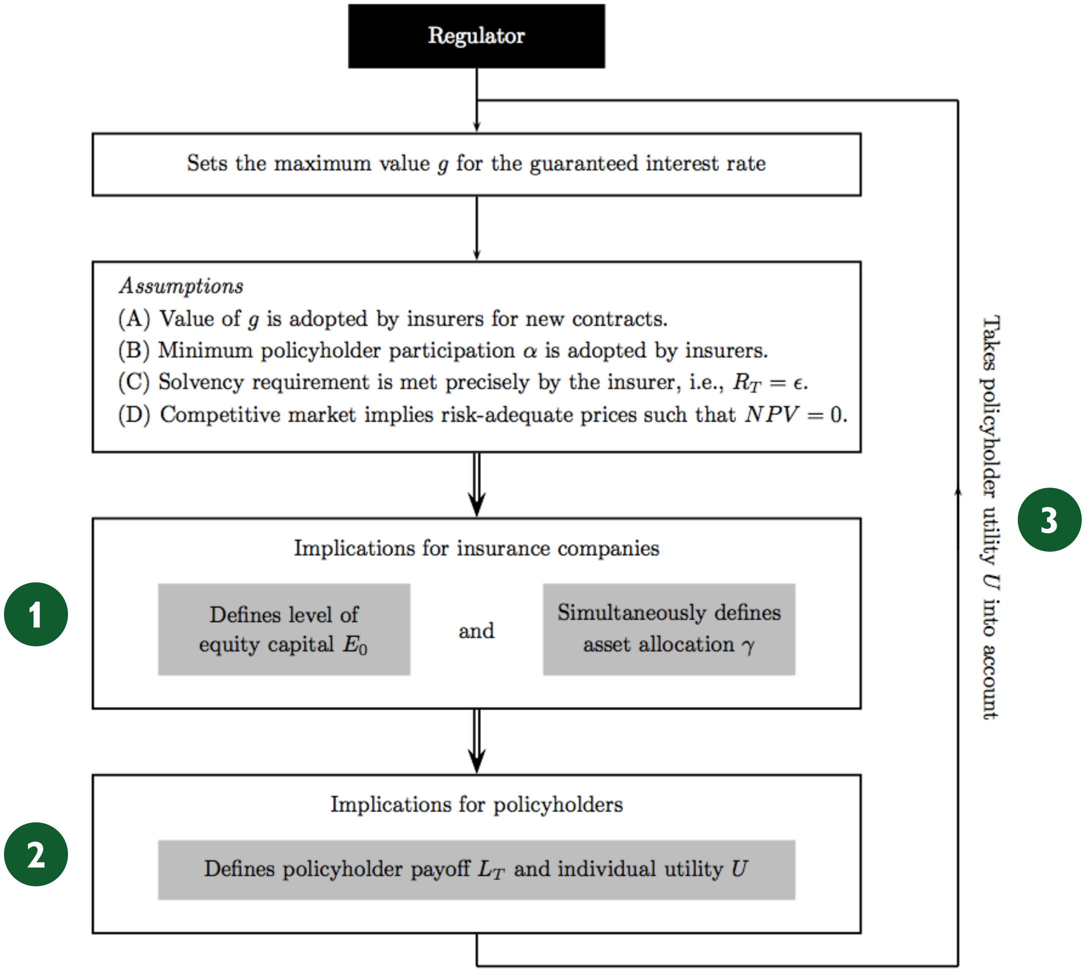
$$U(w) = \frac{w^{1-\rho}}{1-\rho}$$

$$\boxed{U(CE) = E[U(L_T)]}$$

Structure

- **Status quo and current discussions**
- **Model framework**
- **Analyses and results**
- **Conclusion and outlook**

Structure of the analyses



1. **Implications for insurance companies**
2. **Implications for policyholders**
3. **Definition of the optimal interest rate guarantee by the regulator**
4. **Robustness analysis of the results**

Parameterization of the reference case

Parameter	Variable	Value
Contract		
Policyholder single upfront premium	P_0	1.0 (C.U.)
Contract duration	T	10 (years)
Guaranteed interest rate	g	1.75%
Annual surplus participation rate	α	90%
Capital market conditions		
Risk-free rate of return	r_{f}	3.0%
Drift of the geometric Brownian motion process	μ_{GBM}	7.0%
Volatility of the geometric Brownian motion process	σ_{GBM}	20.0%
Solvency regulation		
Safety requirement (upper bound on ruin probability in T)	ϵ	0.5%

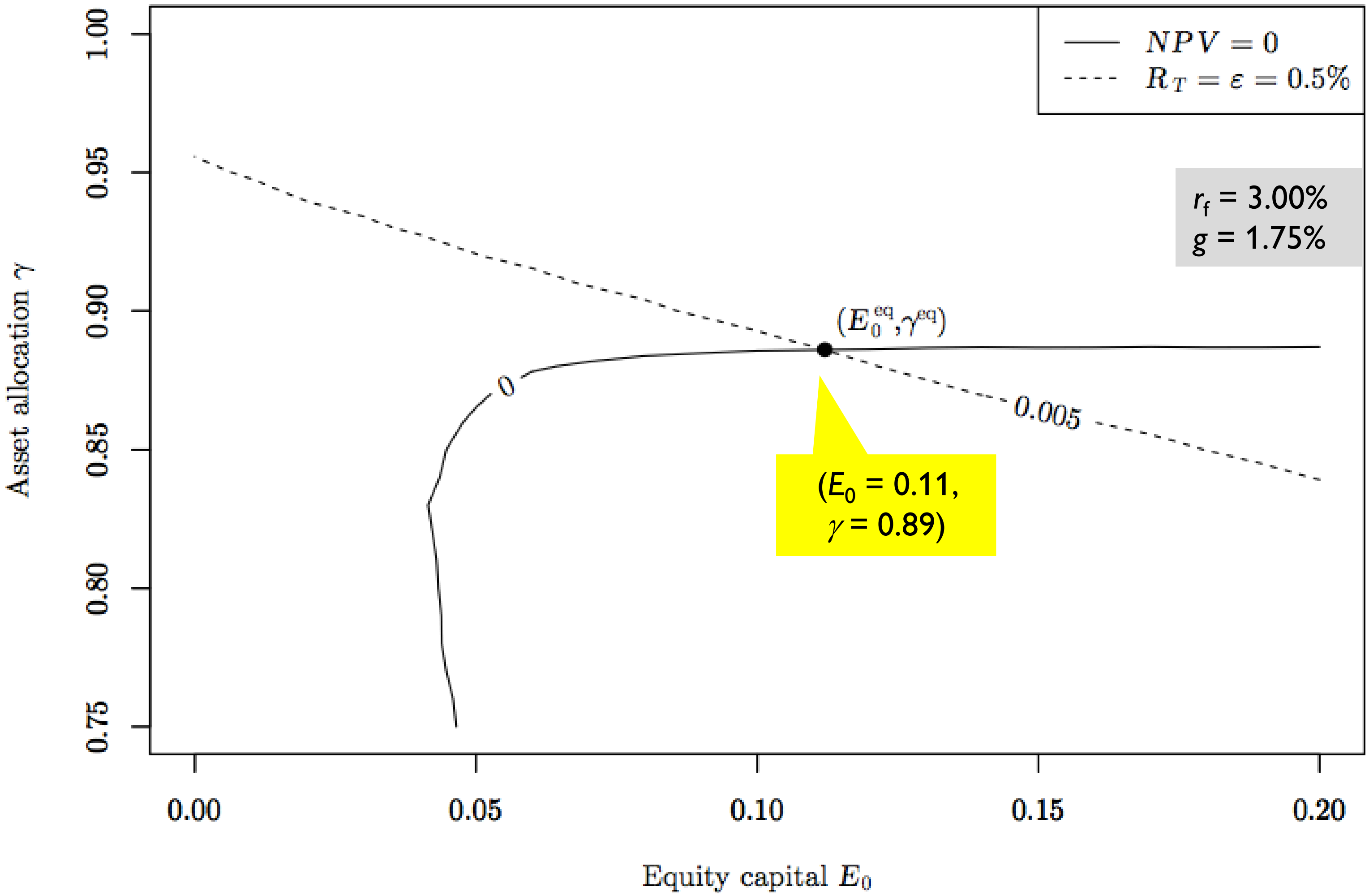
Implications on the asset allocation of insurers

Assumptions (A) – (D)

Level of equity capital (E_0)

and simultaneously

Asset allocation (γ)



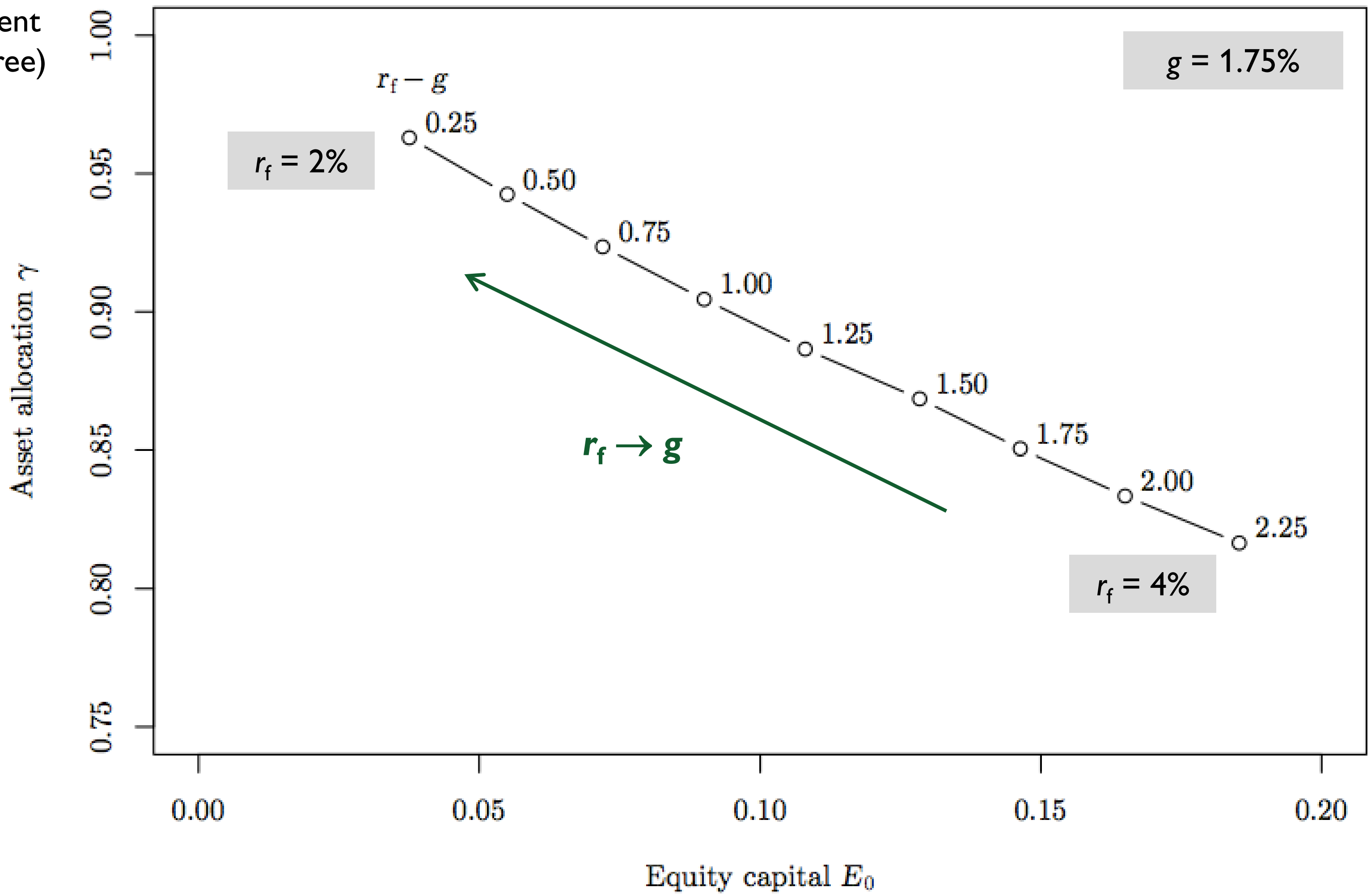
No room for risky investments when $r_f \to g$

Safe investment
(100% risk-free)

$r_f - g \to 0$

Asset allocation
$\gamma \to$ 100%

No room for risky but also promising investments
⇒ In practice, enforced asset allocation only superficially safe, since not diversified (Euro crisis!)



- **Minimum interest rate guarantee virtually worthless**
- **Investment possibly unfavorable compared to direct investment (transaction costs)**
- **Asset portfolio without opportunities for participation in insurer's surplus**

Policyholder utility depends on the difference of the rates r_f and g

Insurer's position (E_0,γ)

Policyholder payoff (L_T)

and

Utility / certainty equivalent *CE*

Interest (in %)		Insurer		Characteristics of L_T			CE of payoff L_T		
r_f	g	E_0^{eq}	γ^{eq}	$E[L_T]$	$\sigma[L_T]$	$Sk[L_T]$	$\rho=2$	$\rho=5$	$\rho=8$
3.0	**1.5**	0.12	0.87	1.39	0.08	0.44	1.389	1.383	1.376
3.0	**1.0**	0.14	0.84	1.41	0.10	0.46	1.401	1.390	**1.380**
3.0	**0.5**	0.16	0.82	1.42	0.12	0.49	1.408	1.393	1.379
3.0	**-0.5**	0.21	0.76	1.44	0.17	0.55	1.426	1.400	1.375
3.0	**-1.0**	0.23	0.74	1.46	0.19	0.59	1.433	**1.400**	1.370
3.0	**-1.5**	0.25	0.71	1.47	0.21	0.61	1.439	1.400	1.362
3.0	**-10.0**	0.47	0.36	1.66	0.59	1.27	**1.487**	1.273	1.105

Maximum utility depends on actual risk-aversion –
overall, lower interest rate guarantees (compared to r_f) offer the higher utility

Implications for the definition of the interest rate guarantee

- Hypotheses (A) and (B) – Regulator's values of the **interest rate guarantee** and minimum **participation** adopted by insurers, – meeting **solvency requirements** (C) and assumption of competitive market / offering of **fair premiums** (D)

- **Generally customer utility is high if the guaranteed interest rate is way below the risk-free interest rate (by around two percent in the considered examples)**
  - Given the current market situation, a nominal investment guarantee (0%-interest) is reasonable

- Under current regulations only **lower interest rate guarantee** allow for more **risky investments** and portfolio diversification (cf. current high demand for government bonds with good credit-standing)
  - Opportunities for customers through policyholder participation
  - Limitation of customers' risks due to minimum interest rate guarantee

Robustness analysis (1)

Safety level

(a) Variation of the safety requirement ϵ

ϵ	E_0^{eq}	γ^{eq}	CE $\rho = 2$	CE $\rho = 8$
10.0%	0.059	0.876	1.392	1.379
5.0%	0.069	0.882	1.389	1.378
1.0%	0.096	0.886	1.386	1.376
0.5%	0.108	0.887	1.386	1.375
0.1%	0.120	0.887	1.385	1.375

1 2 2

Contract length

(b) Variation of contract length T

T (years)	E_0^{eq}	γ^{eq}
1	0.039	0.885
2	0.056	0.886
5	0.071	0.886
10	0.108	0.887
20	0.152	0.887
30	0.186	0.887

1

(1) Asset allocation independent of safety level and contract length;
(2) Safety level with limited influence on policyholder utility

Robustness analysis (2)

Interest (in %) r_f	g	CE of payoff L_T $\rho = 5$ $T = 5$	$T = 10$	$T = 20$	$\rho = 8$ $T = 5$	$T = 10$	$T = 20$
3.0	**1.5**	1.176	1.383	1.912	1.173	1.376	1.894
3.0	**1.0**	1.179	1.390	1.933	**1.175**	**1.380**	**1.905**
3.0	**0.5**	1.182	1.393	1.940	1.175	1.379	1.901
3.0	**-0.5**	1.183	1.400	1.958	1.172	1.375	1.890
3.0	**-1.0**	**1.183**	**1.400**	**1.959**	1.170	1.370	1.874
3.0	**-1.5**	1.183	1.400	1.959	1.167	1.362	1.857

Guaranteed interest rate stable for different contract lengths (within a given risk-aversion)

Structure

- **Status quo and current discussions**
- **Model framework**
- **Analyses and results**
- **Conclusion and outlook**

Summary and conclusion

- **Current market scenario: risk-free interest rate closes up to guaranteed interest rate**
  - Insurer invests risk-free, policyholder guarantees become virtually worthless

- **Generally, policyholder utility is higher when the guaranteed interest rate is (min.) two percent lower compared to the risk-free interest rate**
  - **Opportunities** for customers through policyholder participation
  - **Limitation of customers' risks** due to minimum interest rate guarantee (minimum interest rate guarantee maintains value)

- Strategy leads to higher policyholder utility, however requires a **challenging communication strategy in the distribution**, to make the (rather complex) relationships understandable for customers

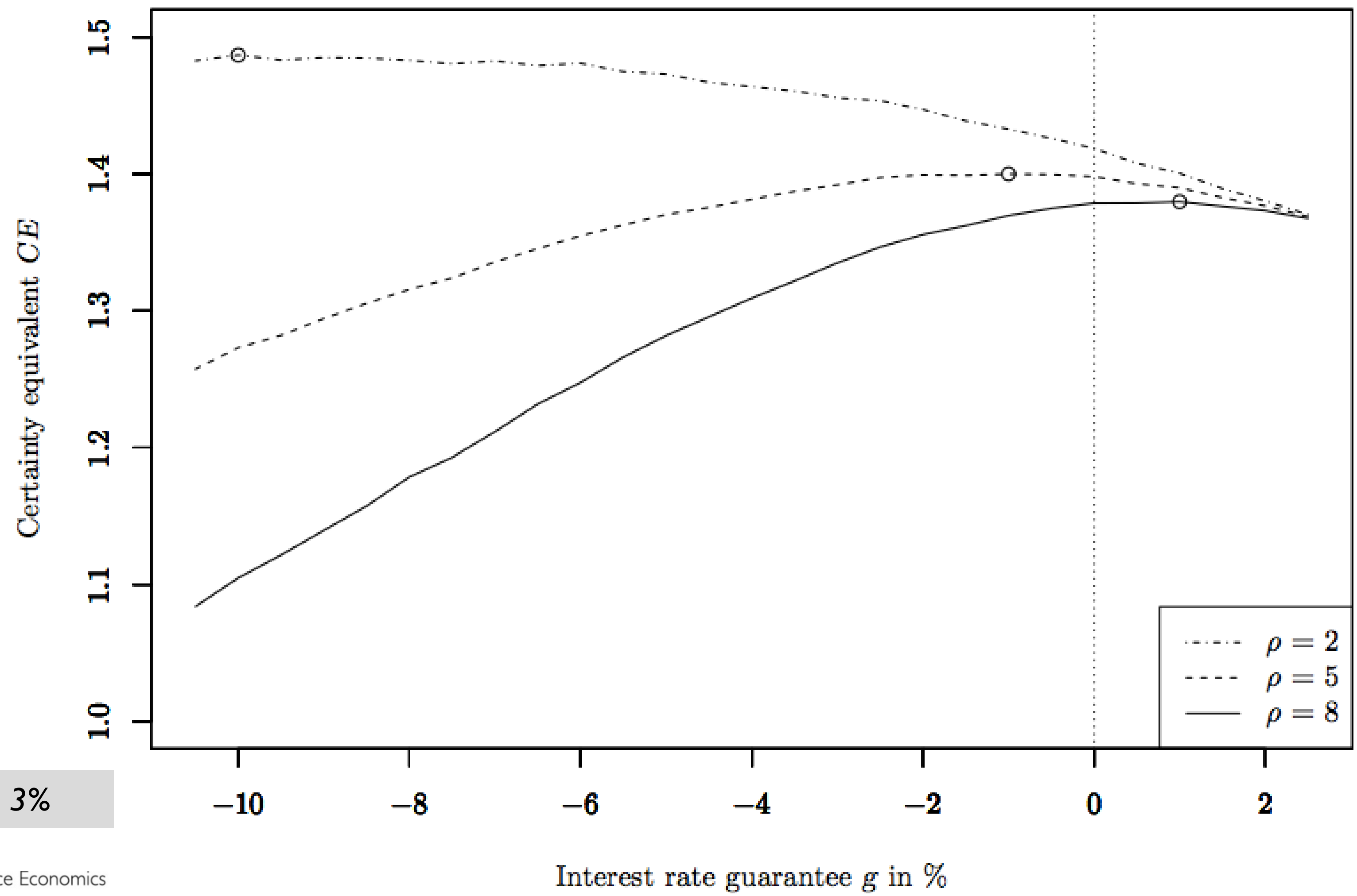
Backup

Backup: Fair calibration

Interest rates (in %)			Insurer position	
r_f	g	$r_f - g$	E_0^{eq}	γ^{eq}
4.00	1.75	2.25	0.185	0.817
3.75	1.75	2.00	0.165	0.834
3.50	1.75	1.75	0.146	0.851
3.25	1.75	1.50	0.128	0.869
3.00	1.75	1.25	0.108	0.887
2.75	1.75	1.00	0.090	0.905
2.50	1.75	0.75	0.072	0.924
2.25	1.75	0.50	0.055	0.943
2.00	1.75	0.25	0.038	0.963

Backup: Graphical illustration of the certainty equivalent

2



S.t. r_f = 3%