Multi-Year Analysis of Solvency Capital in Life Insurance

by Stefan Graf, Alexander Kling and Karen Rödel

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About the speaker

Karen Rödel

Institut für Finanz- und Aktuarwissenschaften (ifa)

- ifa is an independent actuarial consulting firm.
- Our consulting services in all lines of insurance business include:
  - typical actuarial tasks and actuarial modelling
  - insurance product development
  - risk management, Solvency II, asset liability management
  - data analytics
  - market entries (cross-border business, setup of new insurance companies, Fintechs)
  - professional education
  - academic research on actuarial topics of practical relevance
- located in Ulm, Germany
- currently about 30 consultants
- academic cooperation with the University of Ulm (offering the largest actuarial program in Germany)

- joined ifa in 2017
- Ph.D. student (University of Ulm)
- Master of Science (Mathematics and Management, University of Ulm, 2017)
- Master of Mathematics (Actuarial Science, University of Waterloo, 2016)

Multi-Year Analysis of Solvency Capital in Life Insurance

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Motivation

3-Pillar-Concept of Solvency II

SCR (Pillar 1)

ORSA (Pillar 2)

Overview of related literature

The Model

Results

Conclusion

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Motivation

3-Pillar-Concept of Solvency II

Solvency II

Pillar 1	Pillar 2	Pillar 3
Quantitative Requirements	**Qualitative Requirements and Supervision**	**Market Discipline**
▪ Valuation of assets and liabilities ▪ Solvency Capital Requirement (SCR) and Minimum Capital Requirement (MCR) ▪ Own funds ▪ Standard formula vs. internal model	▪ Governance system and risk management ▪ Own Risk and Solvency Assessment (ORSA) ▪ Supervisory review process ▪ Capital add-on	▪ Supervisory reporting (QRTs, RSR) ▪ Public disclosure (SFCR)

Motivation

SCR (Pillar 1)

Definition of the Solvency Capital Requirement (SCR)

source: art. 101 framework directive

The Solvency Capital Requirement shall be calibrated so as to ensure that all quantifiable risks to which an insurance or reinsurance undertaking is exposed are taken into account. It shall cover existing business, as well as the new business expected to be written over the following 12 months. With respect to existing business, it shall cover only unexpected losses.

It shall correspond to the Value-at-Risk of the basic own funds of an insurance or reinsurance undertaking subject to a confidence level of 99,5 % over a one-year period.

Insurers need to hold sufficient own funds to overcome negative events that statistically only occur **once in 200 years**.

Motivation

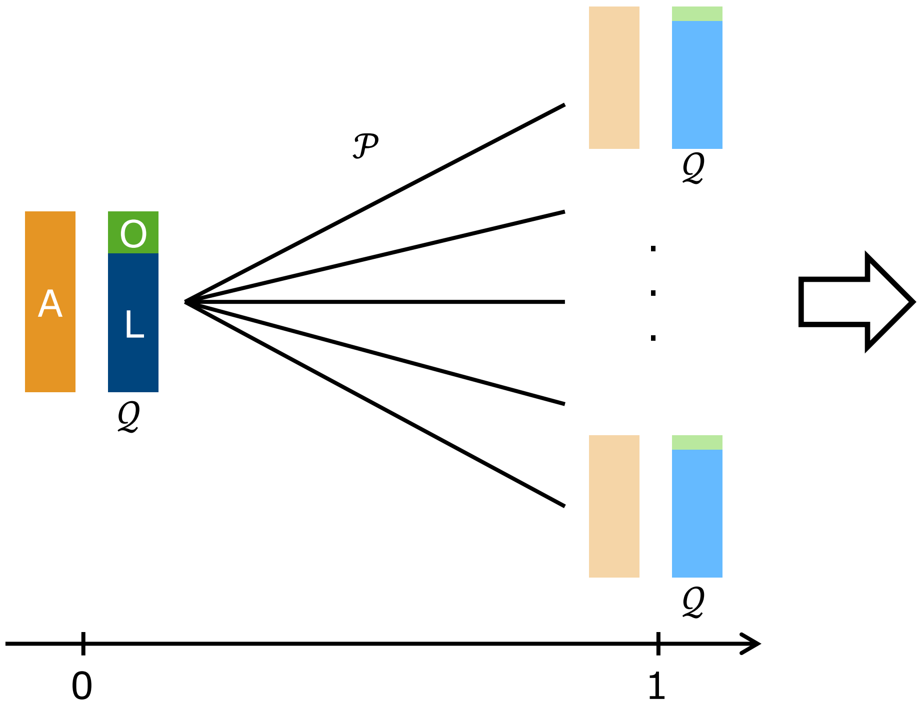
SCR (Pillar 1)

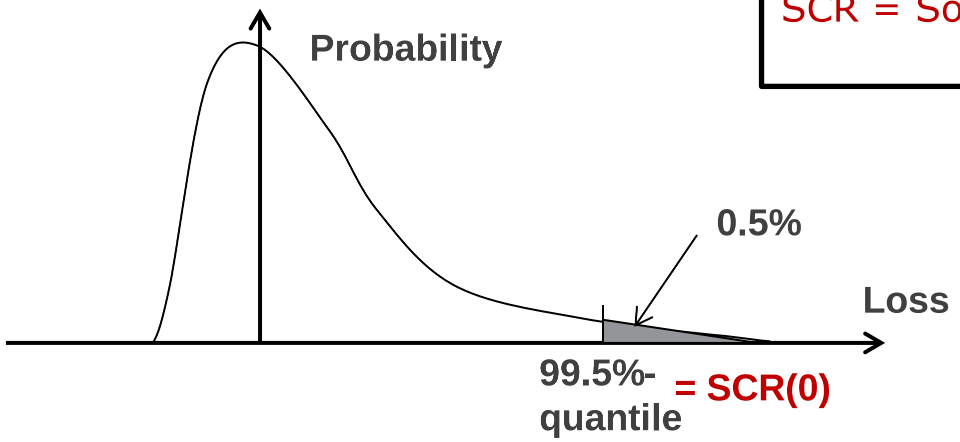
Derivation of the SCR at time zero

- We consider the loss in own funds over one year.
- high complexity due to nested simulations: valuation of liabilities, one-year projection

A = assets
O = own funds
L = liabilities

SCR = Solvency Capital Requirement



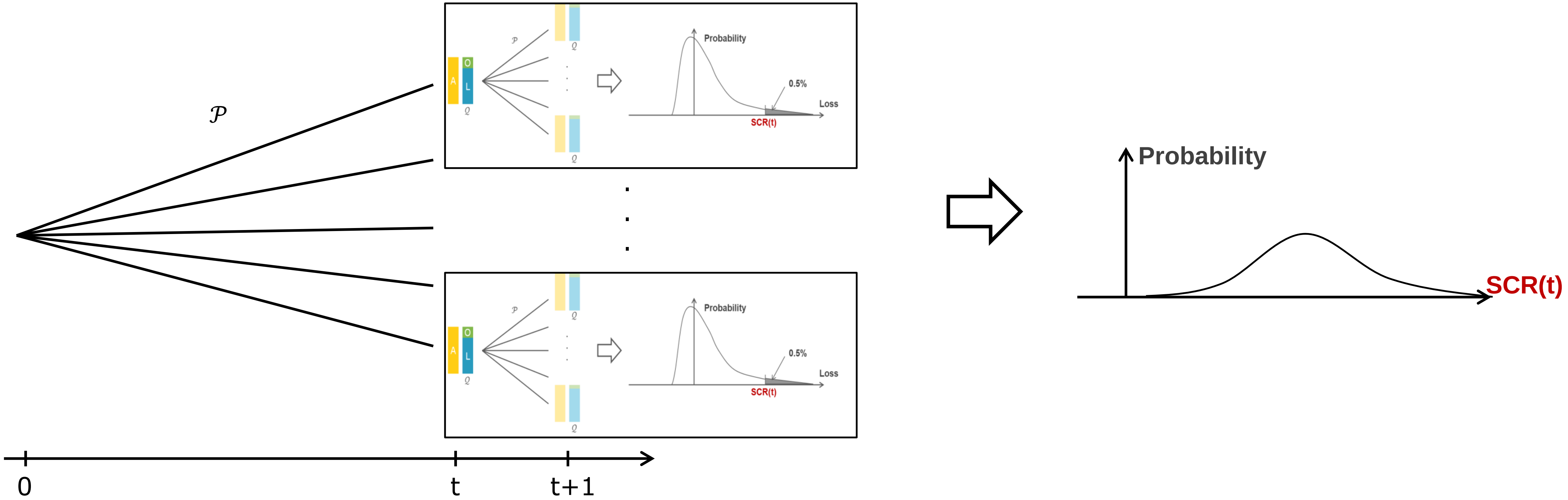


Motivation

ORSA (Pillar 2)

Own Risk and Solvency Assessment (ORSA)

- assessment of whether capital requirements can be met in the short and long term
  - projection of the SCR → additional level of nesting



Motivation

ORSA (Pillar 2)

Due to the high complexity, companies are forced to limit their assessment to **only few scenarios**.

BaFin Feedback

„Als Ergebnis der Beurteilung der jederzeitigen Einhaltung der aufsichtsrechtlichen Kapitalanforderungen wird in vielen ORSA-Berichten nur der zu erwartende Betrag der Solvabilitätskapitalanforderung, der Mindestkapitalanforderung (Minimum Capital Requirement – MCR) sowie der Eigenmittel mehrere Jahre in die Zukunft projiziert und eine Aussage dazu getroffen, ob sich aus diesen Projektionen ein Kapitalengpass ergibt. Diese Angaben reichen nicht aus." (BaFin Journal, September 2017)

- In many ORSA reports, only the expected values of SCR and own funds are projected into the future.
- This is **not sufficient** according to the German regulator.

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- **Overview of related literature**
- The Model
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Overview of related literature

fair valuation through closed formulas for a French participating contract

- Bonnin et al. (2014)

techniques to lower the computational effort: curve fitting, least squares Monte Carlo

- Vedani and Devineau (2012)

effects of prolonged low interest rate periods, company's asset allocation rules, leverage ratios, …

- Berdin and Gründl (2015)
- Berdin (2016)
- Berdin, Pancaro and Kok (2016)

In contrast, our work focuses on the **characteristic influence of different types of guarantees** on the development of the solvency ratio.

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The Model

Two model companies

Maturity guarantee

Assets	Liabilities
A_0	$E_0 = (1-\alpha)A_0$ $L_0 = \alpha A_0$
A_0	A_0

- Briys and De Varenne (1997)
- Grosen and Jørgensen (2002)

Cliquet guarantee

Assets	Liabilities
A_0	$E_0 = (1-\alpha)A_0$ $L_0 = \alpha A_0$
A_0	A_0

- Miltersen and Persson (2003)

We aim for a model that is **transparent and efficient**, but nevertheless displays the **key features** of these two main types of guarantees.

The Model
Assets

combination of stocks and money market, constant allocation

Short rates follow the Hull-White model as in Hull and White (1990).

$$dr(t) = \big(\theta(t) - ar(t)\big)dt + \sigma_r dW_1(t) \qquad \mathcal{Q}$$

$$dr(t) = \big(\theta(t) + \lambda_r - ar(t)\big)dt + \sigma_r d\widetilde{W}_1(t) \qquad \mathcal{P}$$

- consistent with the term structure observed in the market, mean reversion
- normally distributed, negative values possible

Stocks are modeled through a geometric Brownian motion as in Black and Scholes (1973).

$$dS(t) = r(t)S(t)dt + \sigma_s S(t)\left(\rho dW_1(t) + \sqrt{1-\rho^2}dW_2(t)\right) \qquad \mathcal{Q}$$

$$dS(t) = (r(t) + \lambda_A)S(t)dt + \sigma_s S(t)\left(\rho d\widetilde{W}_1(t) + \sqrt{1-\rho^2}d\widetilde{W}_2(t)\right) \qquad \mathcal{P}$$

- correlation between the two Wiener processes

Log returns of the assets are normally distributed.

The Model

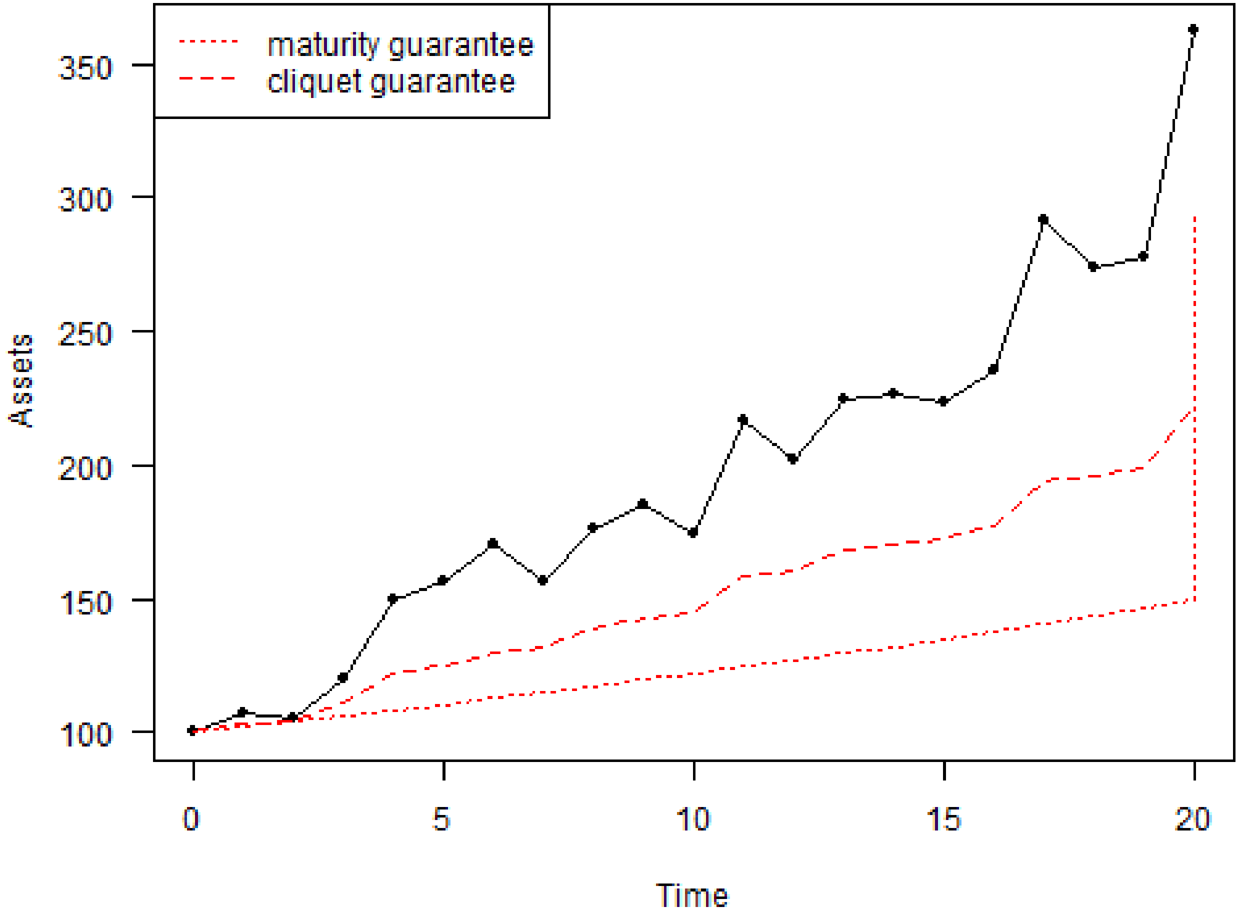
Liabilities

Maturity guarantee

- guaranteed sum: $L_T^G = L_0 \, e^{r_G T}$
- payoff at maturity: $L_T^G + \delta \left(\alpha A_T - L_T^G\right)^+$
- valuation: in closed form

Cliquet guarantee

- yearly accumulation: $e^{g+\beta(\zeta_t - g)^+}$
- payoff at maturity: $L_0 \, e^{\sum_{i=1}^{T}(g+\beta(\zeta_i - g)^+)}$
- valuation: simulation of a multivariate normal distribution as in Kijima and Wong (2007)



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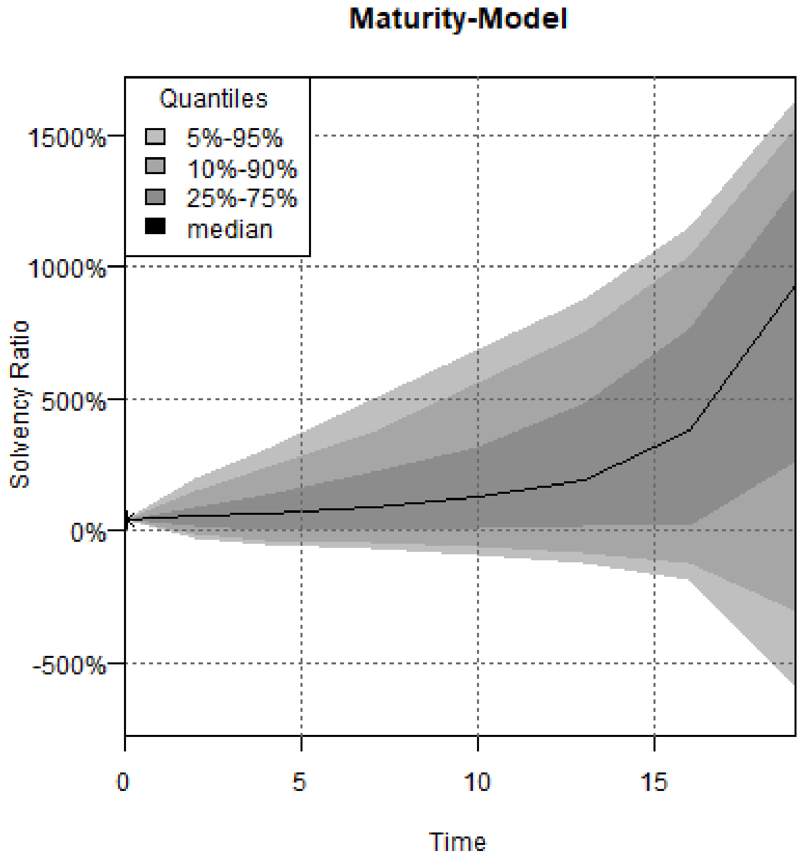
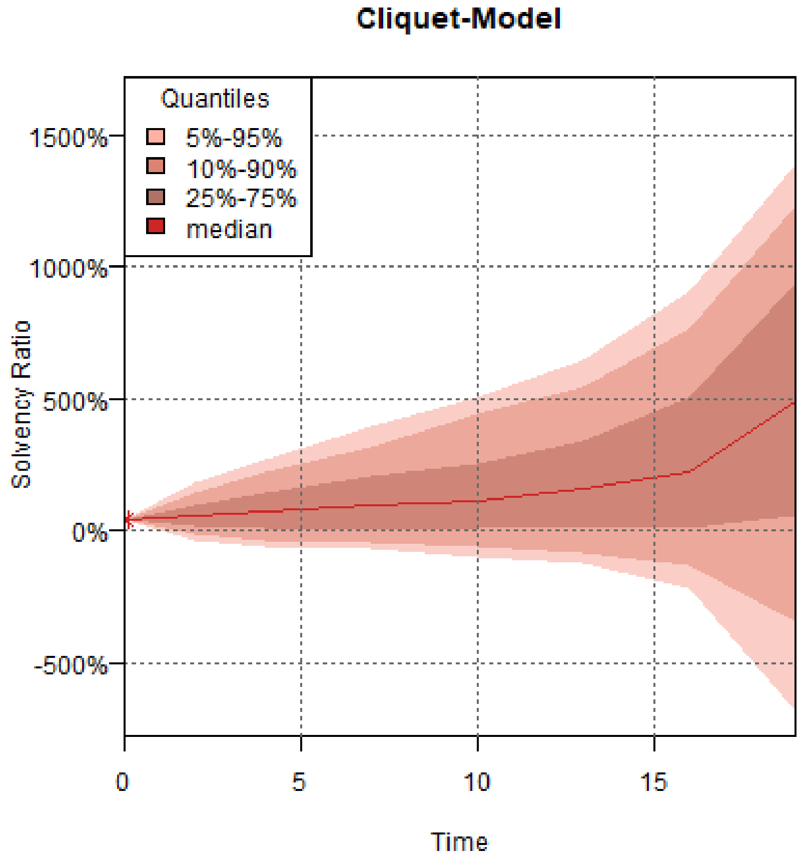
Results

Time period analysis

Quantile plots of the solvency ratio





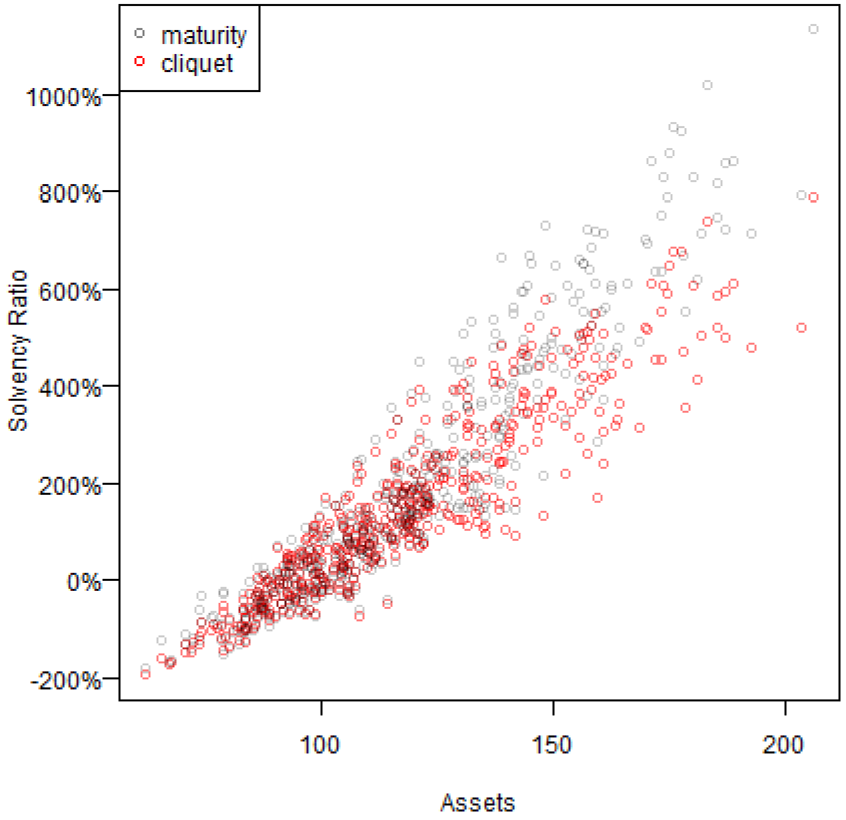
The maturity-company has an advantage over the cliquet-company.

- guaranteed interest rate: 0.5% vs. 0%
- initial solvency ratio: 43.8% vs. 41.3%
- higher upside potential for the maturity-company
- similar downside

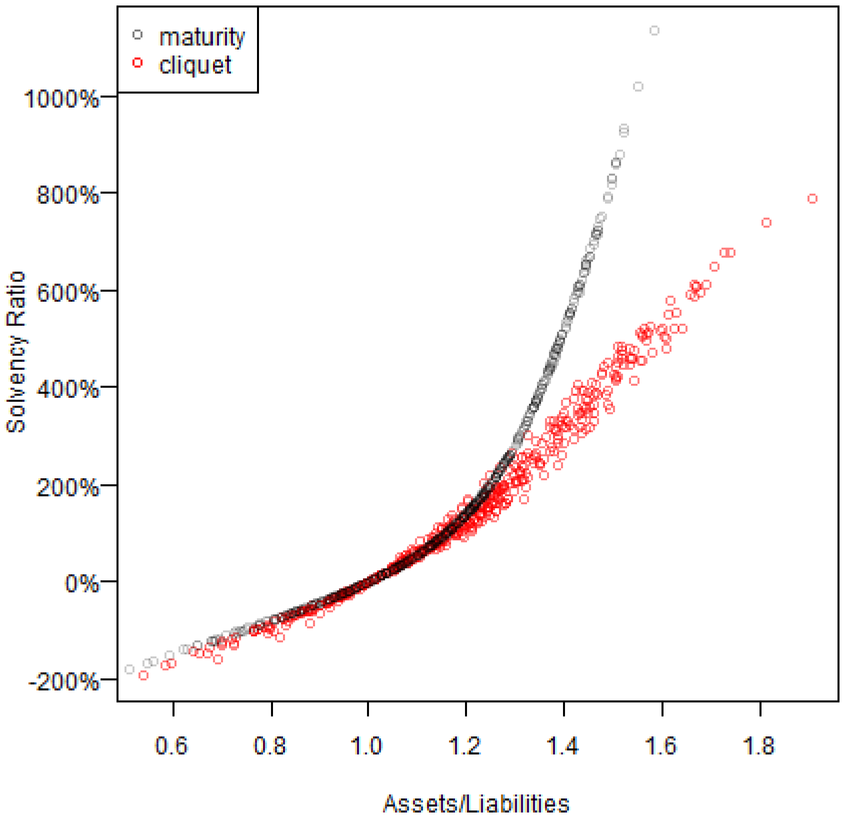
Results

Time point analysis

Scatter plots of the solvency ratio at time ten



- correlation between assets and solvency ratio, but no unique mapping
- value of the liabilities is unknown due to
  - dependence on stochastic interest rates
  - path dependence for the cliquet guarantee
- less dispersion
  - unique mapping for the maturity guarantee



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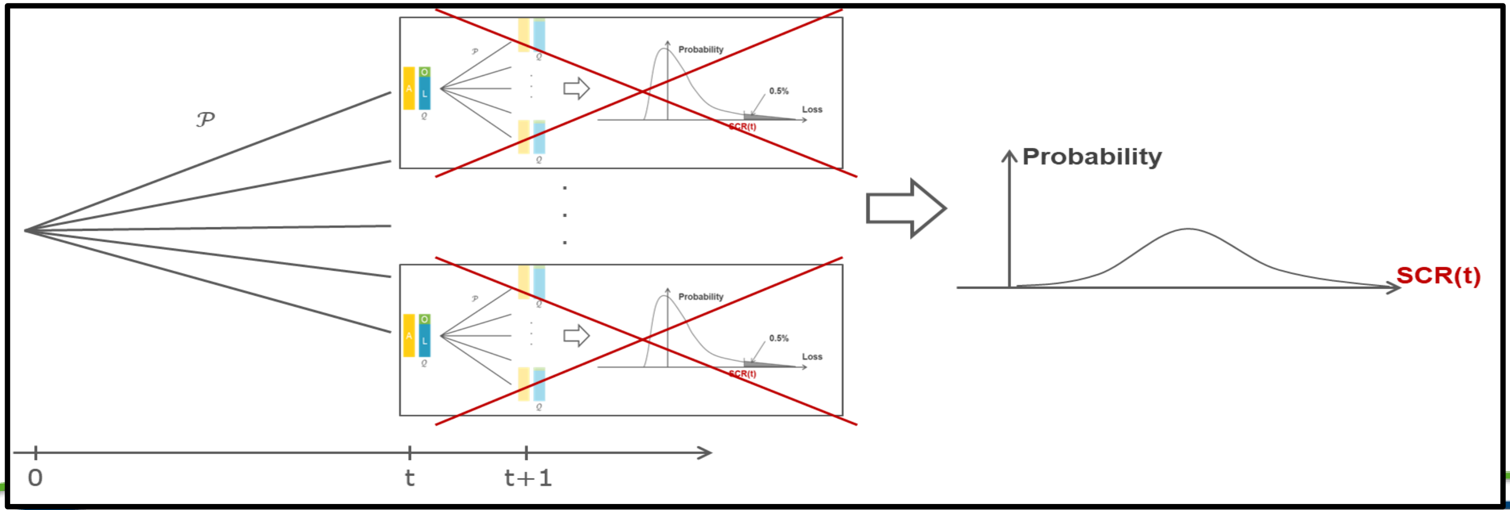
Conclusion

Solvency II is a huge challenge for insurance companies.

- In the context of **ORSA**, companies are required to project their solvency figures into the future.
  - Nested simulations lead to high computational effort.
  - Many companies are forced to limit their assessment to only few scenarios.
- analysis of a **simple model** with two common types of guarantees
  - entire distributions of future solvency ratios and their development over time
  - goal: identify the quantities that determine the solvency ratio and reduce complexity



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Conclusion

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- First results confirm that **key features of different interest rate guarantees** can be analyzed.
  - **better understanding** of the projection required for ORSA
- Solvency II is a very young regulatory regime.
  - plenty of questions to be answered in future research

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