Institut für Finanz- und Aktuarwissenschaften

Multi-Year Analysis of Solvency Capital in Life Insurance

- Karen Rödel

- Frankfurt Insurance Research Workshop
- International Center for Insurance Regulation
- Goethe Universität Frankfurt am Main
- December 2017

Multi-Year Analysis of Solvency Capital in Life Insurance

Agenda

What is Solvency II?

3-Pillar-Concept

SCR (Pillar 1)

ORSA (Pillar 2)

Overview of related literature

The Model

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What is Solvency II?

3-Pillar-Concept

Pillar 1

Quantitative Requirements

- Valuation of assets and liabilities
- Solvency Capital Requirement (SCR) and Minimum Capital Requirement (MCR)
- Own funds
- Standard formula vs. internal model

Pillar 2

Qualitative Requirements and Supervision

- Governance system and risk management
- Own Risk and Solvency Assessment (ORSA)
- Supervisory review process
- Capital add-on

Pillar 3

Market Discipline

- Supervisory reporting (QRTs, RSR)
- Public disclosure (SFCR)

Bicentenary Event

- Definition of the Solvency Capital Requirement (SCR), source: art. 101 framework directive

3. 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.

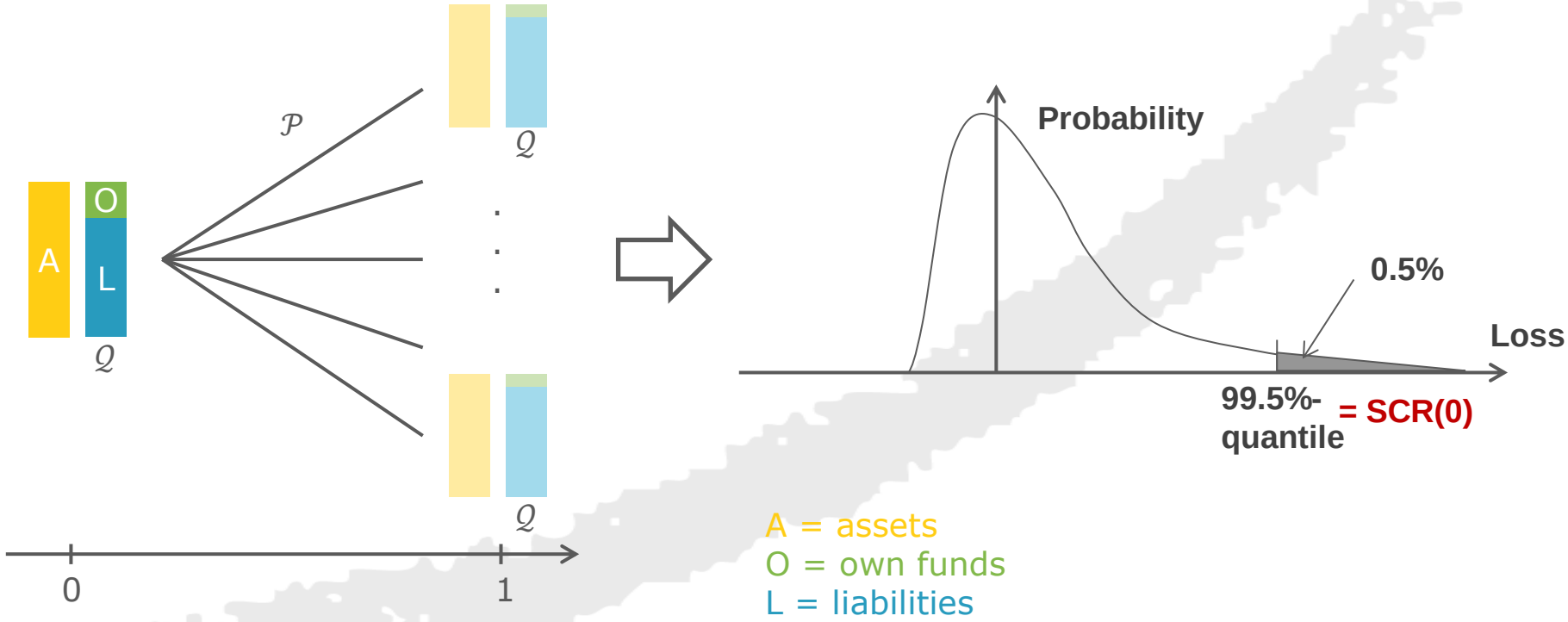
Insurers need to hold sufficient own funds to overcome negative events that statistically only occur **once in 200 years**.

What is Solvency II?

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

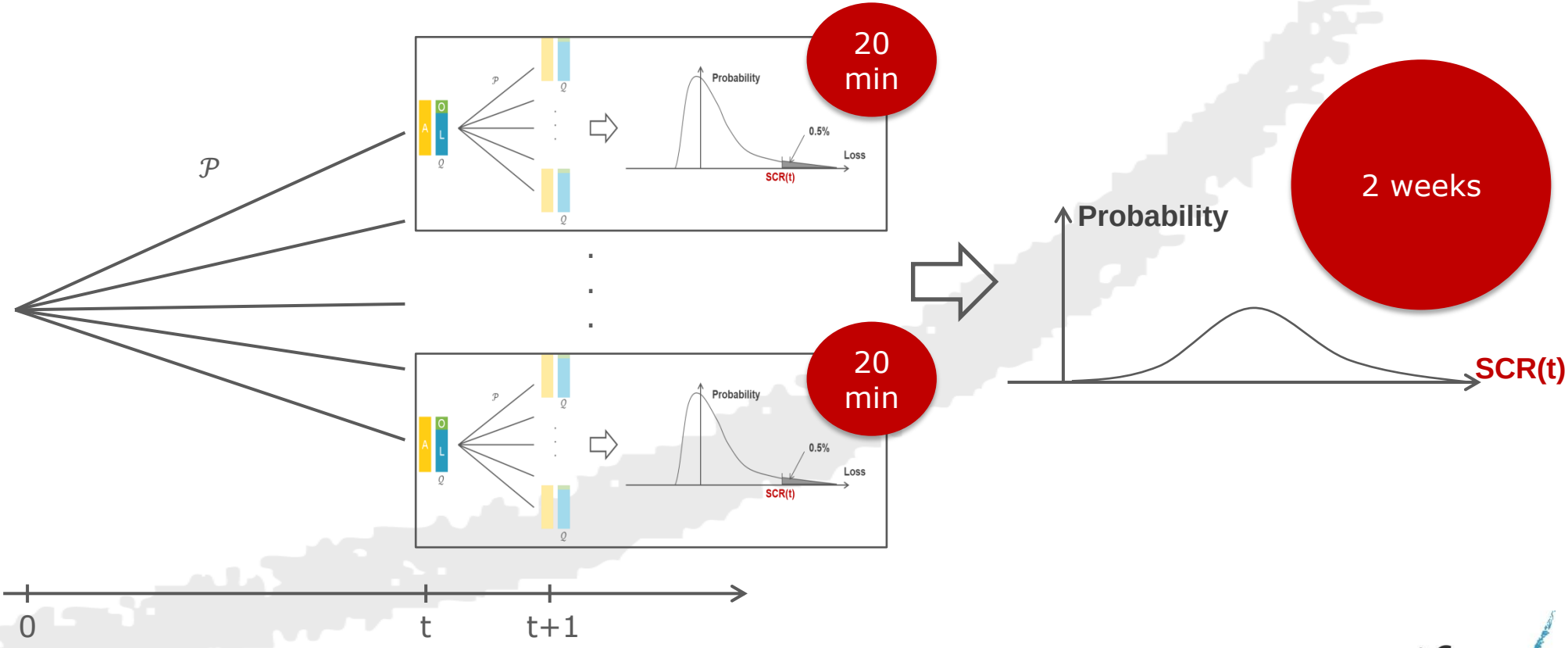
SCR = Solvency Capital Requirement

What is Solvency II?

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



What is Solvency II?

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**.

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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, this work focuses on the characteristic influence of different types of guarantees on the development of the solvency ratio.

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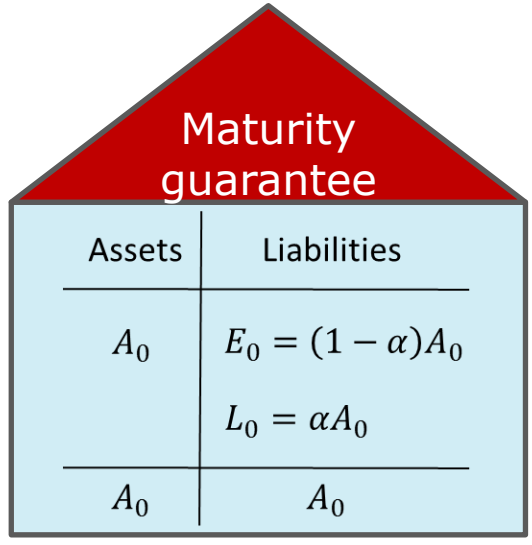
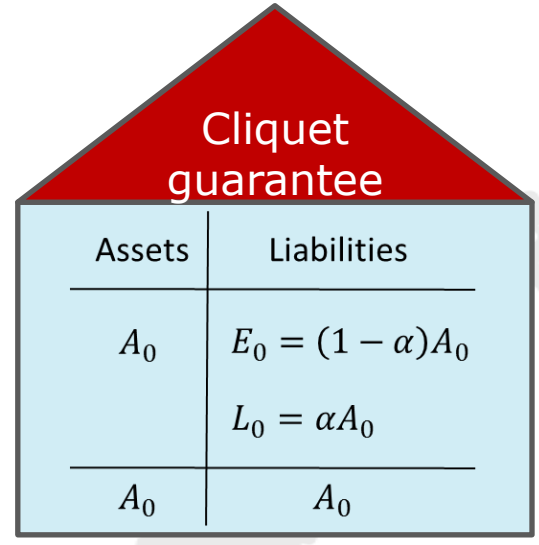
The Model

Two model companies





- Briys and De Varenne (1997)
- Grosen and Jørgensen (2002)
- Miltersen and Persson (2003)

We aim for a model that is **transparent and efficient**, but nevertheless displays the **key features** of the 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 assets are normally distributed.

The Model

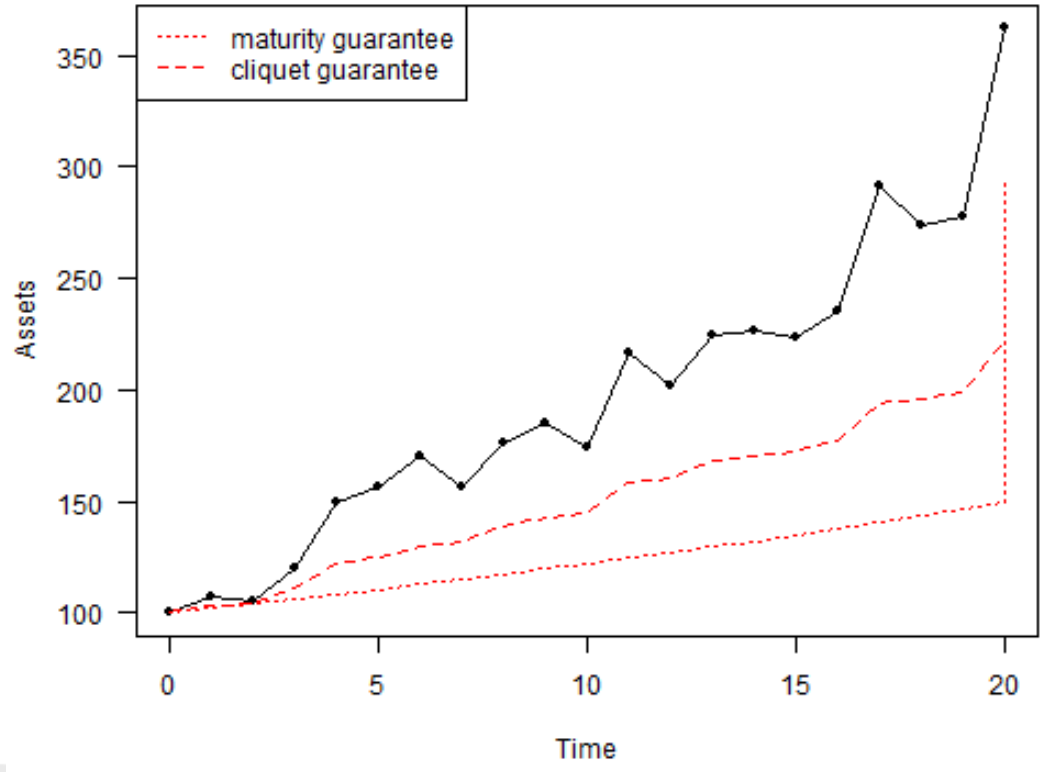
Liabilities

Maturity guarantee

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

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 of the liabilities:

- maturity: in closed form
- cliquet: simulation of a multivariate normal distribution as in Kijima and Wong (2007)

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Time point analysis

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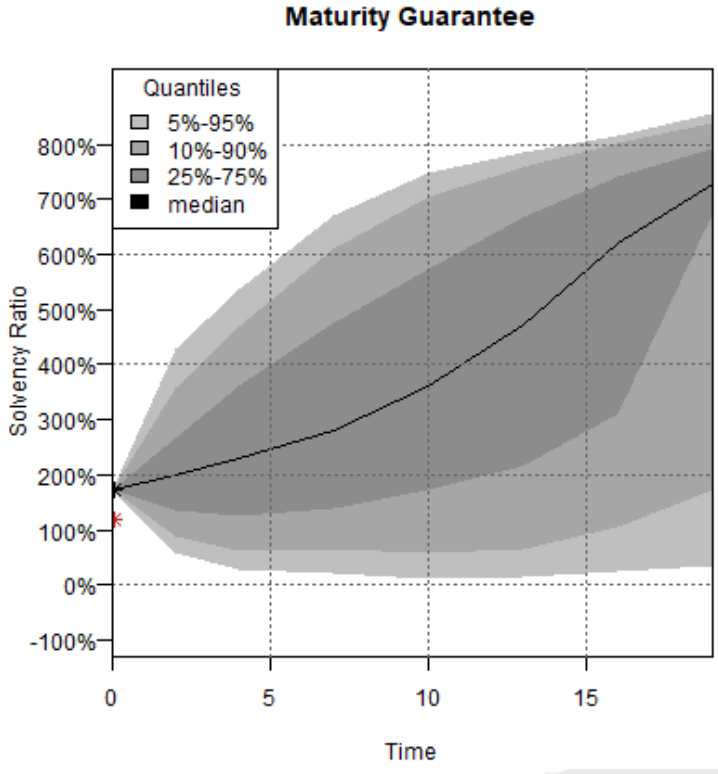
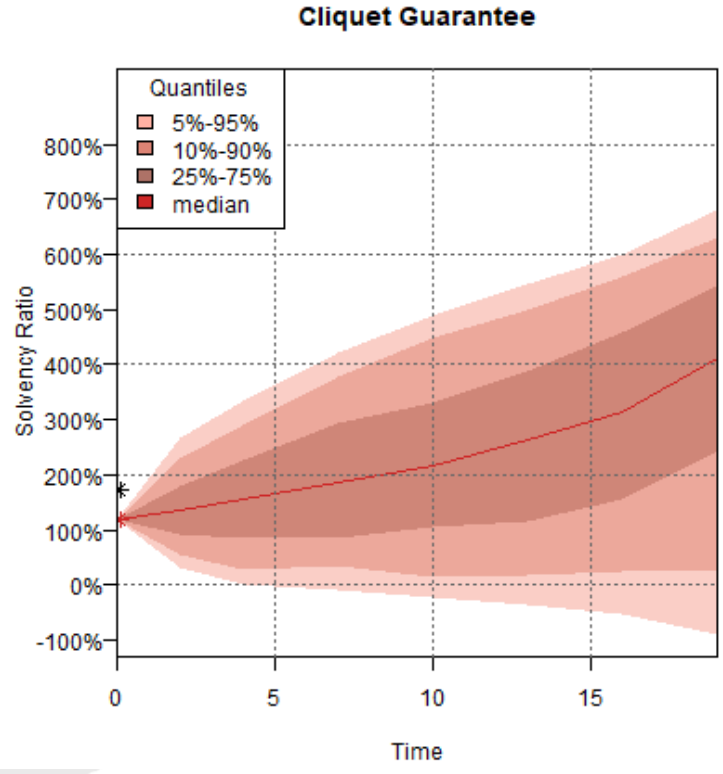
Results

Time period analysis

Quantile plots of the solvency ratio





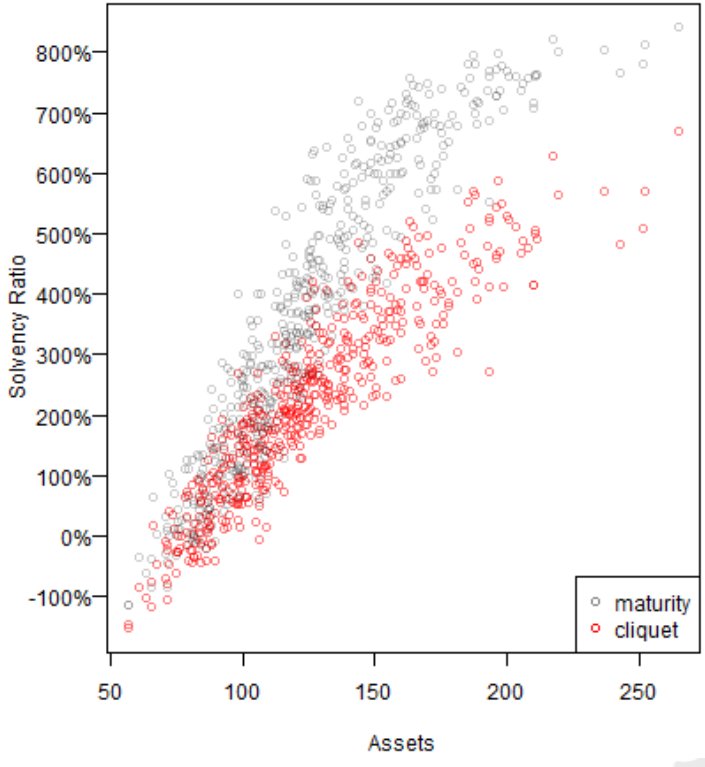
The maturity-company has an advantage over the cliquet-company.

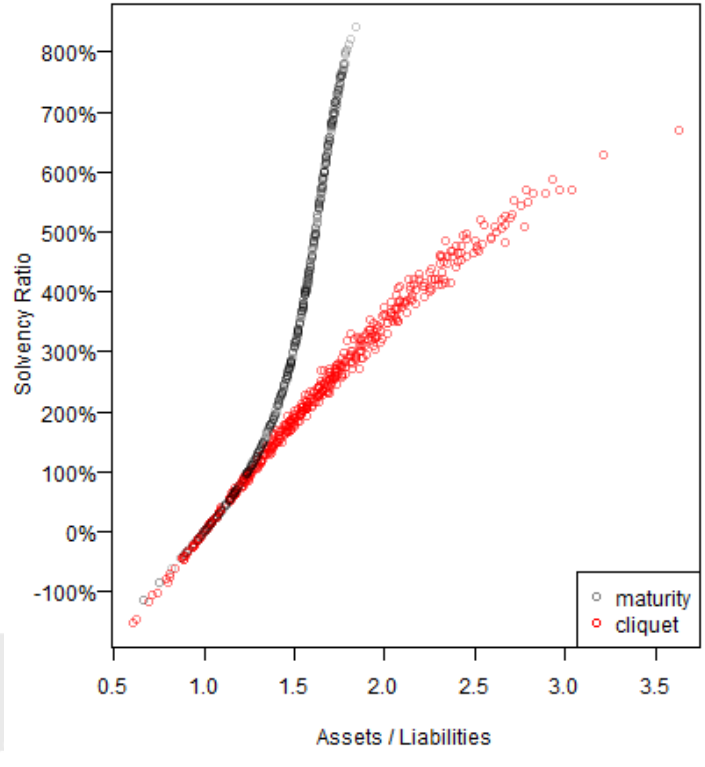
- initial solvency ratios: 173% vs. 119%
- Quantiles are constantly above those of the cliquet-company.

Results

Time point analysis

Scatter plots of the solvency ratio at time ten





- correlation between assets and solvency ratio, but no unique relation
  - dependence on stochastic interest rates
  - path dependence of the cliquet guarantee
- less dispersion
  - unique relation of the maturity guarantee

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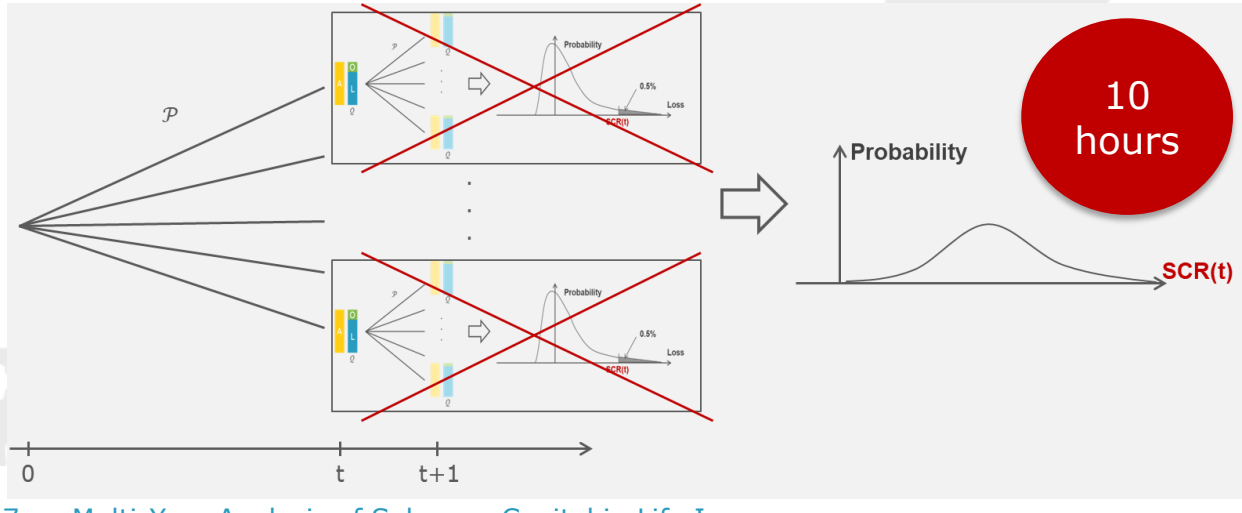
Solvency II is a huge challenge for insurance companies.

- 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**
  - 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

- First results confirm that **key features of different interest rate guarantees** can be analyzed by the use of a simple model.
- **better understanding** of the projection required for ORSA and of the behavior of the solvency ratio

- Solvency II is a very young regulatory regime.
  - plenty of questions to be answered in future research

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References

Fisher Black and Myron Scholes. The Pricing of Options and Corporate Liabilities. Journal of Political Economy, 81(3): 637-654, 1973.

Eric Briys and François De Varenne. On the risk of insurance liabilities: Debunking some common pitfalls. The Journal of Risk and Insurance, 64(4):673–694, 1997.

Elia Berdin. Interest rate risk, longevity risk and the solvency of life insurers. ICIR Working Paper Series, (23/2016), 2016.

Elia Berdin and Helmut Gründl. The effects of a low interest rate environment on life insurers. The Geneva Papers on Risk and Insurance Issues and Practice, 40:385–415, 2015.

François Bonnin, Frédéric Planchet and Marc Juillard. Best estimate calculations of savings contracts by closed formulas: application to the ORSA. European Actuarial Journal, 4:181–196, 2014.

Elia Berdin, Cosimo Pancaro and Christoffer Kok. A stochastic forward-looking model to assess the profitability and solvency of European insurers. SAFE Working Paper, (137), 2016.

Anders Grosen and Peter Løchte Jørgensen. Life insurance liabilities at market value: An analysis of insolvency risk, bonus policy, and regulatory intervention rules in a barrier option framework. The Journal of Risk and Insurance, 69(1):63–91, 2002.

References

John Hull and Alan White. Pricing Interest-Rate-Derivative Securities. The Review of Financial Studies, 3(4): 573-392, 1990.

Masaaki Kijima and Tony Wong. Pricing of Ratchet equity-indexed annuities under stochastic interest rates. Insurance: Mathematics and Economics, 41:317-338, 2007.

Kristian R. Miltersen and Svein-Arne Persson. Guaranteed investment contracts: Distributed and undistributed excess return. Scandinavian Actuarial Journal, 2003(4):257–279, 2003.

Julien Vedani and Laurent Devineau. Solvency assessment within the ORSA framework: issues and quantitative methodologies. arXiv, 1210.6000, 2012.

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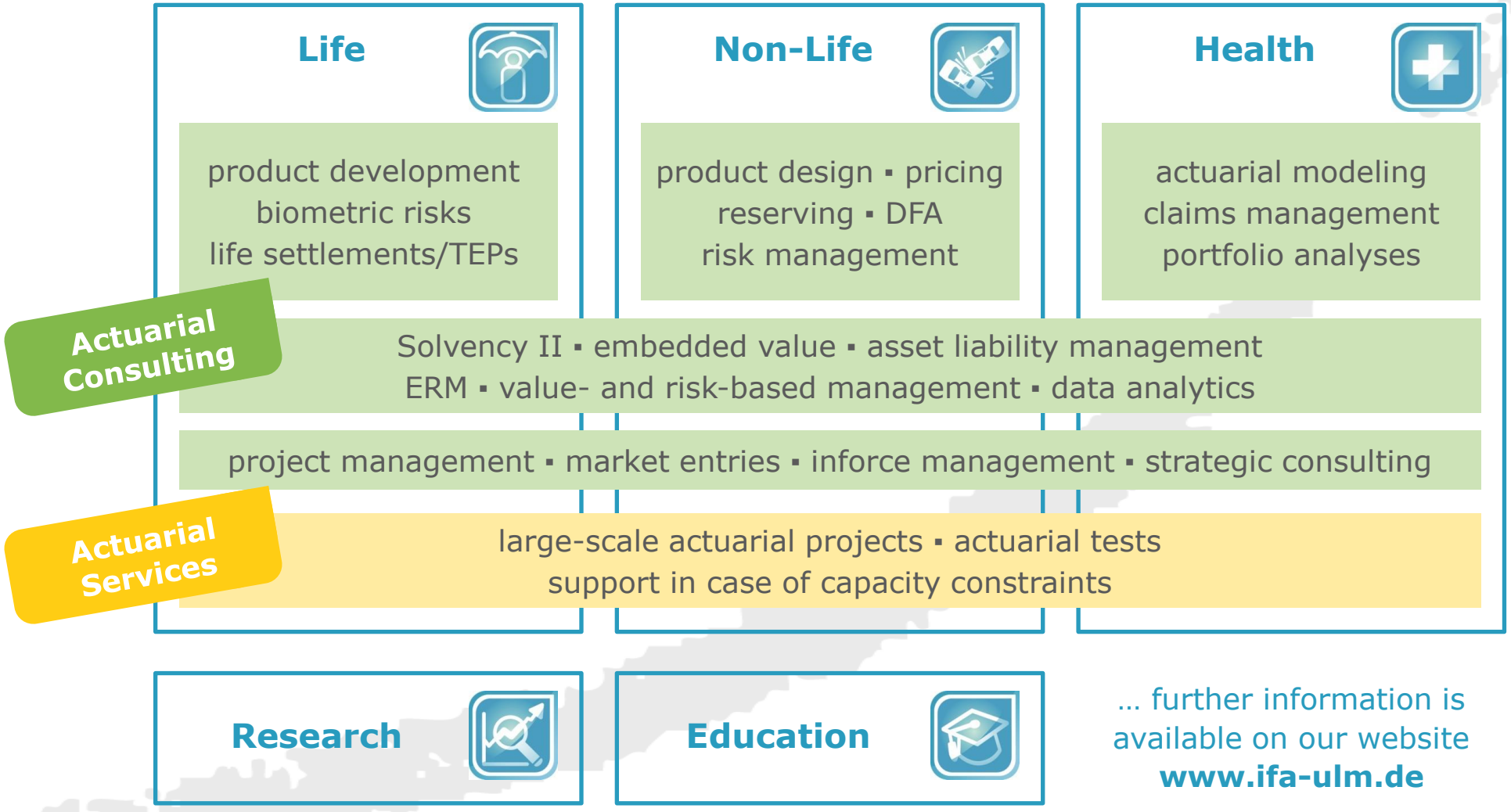

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