Overview – Research Question and Procedure

Research Question

- What are the influences of the market risk module of the Solvency II Standard Formula on the asset allocation of an insurer?
- Can the detected influences be economically justified?

Procedure

1. Starting point: Portfolio Selection in a mean-variance setting by using empirical data

2. Effects of a) the Solvency II Standard Formula and b) a proposed partial internal model for market risk on efficient and inefficient portfolios are derived

3. Results of a) and b) are compared

Policy implications
Exemplary Balance Sheet of an Insurance Company

Portfolio Optimization

Investment Regulation

Free Assets

Restricted Assets

Equity Capital

Debt Capital

Regulated by Solvency II* (Start in 2016/2017)

*Capital Requirements of Solvency II

- Standard Formula
- Internal Model

Braun, Schmeiser, Schreiber | Portfolio Optimization under Solvency II
Empirical Data

**Six asset classes**

- Discrete returns for 20-year period from 01/1993 until 12/2012

<table>
<thead>
<tr>
<th>Stocks</th>
<th>EURO STOXX 50 Total Return Index</th>
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<tbody>
<tr>
<td>Government Bonds</td>
<td>German Stock Exchange REX Performance Index (REXP)</td>
</tr>
<tr>
<td>Corporate Bonds</td>
<td>Barclays U.S. Corporate Bond Total Return Index</td>
</tr>
<tr>
<td>Real Estate</td>
<td>Real Estate “Grundbesitz” Europa Fund (adjusted for dividends)</td>
</tr>
<tr>
<td>Hedge Funds</td>
<td>HFRI Fund Weighted Composite Index</td>
</tr>
<tr>
<td>Money Market</td>
<td>1 Month FIBOR/ EURIBOR</td>
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</tbody>
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Results (1/5) – Efficient Frontiers in a mu-sigma-Space
Results (2/5) – Portfolio Compositions

[Graph showing portfolio compositions over different portfolio numbers with shaded areas representing different asset classes: Money Market, Hedge Funds, Real Estate, Corporate Bonds, Government Bonds, and Stocks.]
Solvency II Standard Formula

- Simple $\Delta$-NAV approach based on capital market shocks
- Preset stress factors and correlation values
  - The Standard Formula does not capture the typical performance characteristics of different investments
  - Stress factors are mainly driven by the asset volatilities

Concern: Inappropriate capital charges may cause an underrepresentation of asset classes that could be well-suited for portfolio optimization / diversification!

Internal Model for Market Risk

- Assets and liabilities are stochastically determined (Asset-Liability-Approach)
- Structural model, mean-variance-approach, flexible calibration with return time series
- Easy to implement due to normally distributed asset returns and liability growth rate
Partial Internal Model (1/2)

Why normal distribution?

- Simply to have a benchmark that is consistent with what the Solvency II Standard Formula claims to use

Equations

- Basic own funds $BOF$ at the end of the year / change within one year respectively:

\[
BOF_1 = \tilde{A}_1 - \tilde{L}_1,
\]

\[
\Delta BOF = BOF_1 - BOF_0 = (\tilde{A}_1 - \tilde{L}_1) - (A_0 - L_0).
\]

- Expected value of the change of $BOF$ within one year

\[
\mu_{\Delta BOF} = E[\Delta BOF] = E[BOF_1 - BOF_0]
\]

\[
= E[\tilde{A}_1] - E[\tilde{L}_1] - (A_0 - L_0)
\]

\[
= E[A_0(1 + \bar{r}_A)] - E[L_0(1 + g_L)] - (A_0 - L_0)
\]

\[
= A_0 \mu_A - L_0 \mu_L
\]

\[
= A_0 w'M - L_0 \mu_L,
\]
Partial Internal Model (2/2)

Equations

- Standard deviation of the change of BOF within one year

\[
\sigma^2_{\Delta \text{BOF}} = \text{Var}[\Delta \text{BOF}] = \text{Var}[\text{BOF}_1 - \text{BOF}_0] \\
= \text{Var}[\tilde{A}_1] + \text{Var}[\tilde{L}_1] - 2\text{cov}[\tilde{A}_1, \tilde{L}_1] \\
= \text{Var}[A_0(1 + \tilde{r}_A)] + \text{Var}[L_0(1 + \tilde{g}_L)] - 2\text{cov}[A_0(1 + \tilde{r}_A), L_0(1 + \tilde{g}_L)] \\
= A_0^2\sigma_A^2 + L_0^2\sigma_L^2 - 2A_0L_0\sigma_{A,L} = A_0^2\sigma_A^2 + L_0^2\sigma_L^2 - 2A_0L_0\rho_{A,L}\sigma_A\sigma_L \\
= A_0^2\mathbf{w}'\Sigma\mathbf{w} + L_0^2\sigma_L^2 - 2A_0L_0\mathbf{w}'\text{cov}[\mathbf{R}, \tilde{g}_L].
\]

- Solvency Capital Requirement SCR based on the 0,5% confidence level

\[
\text{SCR}_{Mkt} = \left| (\mu_{\Delta \text{BOF}} + z_{0.5\%}\sigma_{\Delta \text{BOF}}) \right|
\]

- Equity capital of the insurer should exceed SCR
Results (3/5) – Capital Requirements for Individual Portfolios

![Graph showing capital requirements for individual portfolios](graph.png)
Results (2/5) – Portfolio Compositions

[Graph showing cumulative portfolio weights across different asset classes for various portfolio numbers.]
Results (4/5) – Admissibility of Inefficient Portfolios

Solvency II Standard Formula

- Short Sale Constraints
- Allowed Portfolios
- Disallowed Portfolios

\[ \mu_A \text{ (in percent)} \]
\[ \sigma_A \text{ (in percent)} \]
Results (5/5) – Admissibility of Inefficient Portfolios

Internal Model

- Short Sale Constraints
- Allowed Portfolios
- Disallowed Portfolios

\[ \mu_A \text{ (in percent)} \]
\[ \sigma_A \text{ (in percent)} \]
Implications

Initial Research Question

- What are the influences of the market risk module of the Solvency II Standard Formula on the asset allocation of an insurer?
  - Low risk portfolios are chosen, even though they lead to a high ruin probability for the insurance companies
  - The Standard Formula and the used stress factors are not at all consistent with the “m"u-sigma-world” (even though this is claimed)
  - The ruin probability of the insurer in a m"u-sigma-setting is not at all consistent with the ruin probability of 0.5% proposed by the Standard Formula (cf. back-up)
- Can the detected influences be economically justified?
  - Market risk module of the Solvency II Standard Formula is economically inconsistent
  - Since a majority of European insurers may apply the Standard Formula, substantial impacts (demand and pricing of asset classes on the financial market) can be expected
Summary

- The analysis reveals that many portfolios are not admissible under the Solvency II standard formula.

- In a nutshell: The standard approach is unable to distinguish portfolios according to their risk-return profiles and does hence not produce economically sensible results.

  - Major concerns:

  - The standard formula of Solvency II gives strong incentives to invest in widely undiversified portfolios with low returns and volatilities – insurance practice: Strong investments in government bonds.

  - Negative effects for main stakeholders: Low asset returns, risk situation within the industry may be much higher than expected.

Thank you very much for your attention!
Back-up: “True” ruin probability