SUSTAINABILITY RISK UNDER SOLVENCY II

A practical approach for quantitative assessments under Pillar II requirements

Mario Hoerig | Giammaria Famiglietti | Florian Ketterer | Mario Zacharias | Daniel Teetz | Robin Degezelle
Executive summary

Climate change related risks are **material** within the exposure of insurers. Regulators are expecting insurers to **actively address** these risks within their risk management. The integration of such risks into traditional risk management frameworks poses **significant challenges**.

In this publication, we discuss a **practical approach** for the quantification of climate change related risks insurers are facing under a Solvency II framework for their investments. In this approach, we are integrating guidelines set out by the regulator, other practitioners as well as current academic research.

Our particular focus for this approach lies on **effective implementation** into existing processes and calculations for Solvency II. This includes leveraging readily available data sources as well as an effective pathway to scenario design based on existing research.

We demonstrate the viability of this approach by conducting a **case study** on a sample European life insurer assessing the impacts of different climate policy scenarios on its Solvency II position.

The case study shows, that climate change related risks can have a **substantial impact** on the Solvency II figures of typical insurers. A proper inclusion of such climate risk related quantifications can lead to **valuable guidance and incentives** for wider risk and investment management.

The approach laid out here provides an effective way to assess climate change related risks in a **robust** and **transparent** manner. We believe that it may serve as an **industry best practice approach** that meets the changing economic landscape as well as regulatory requirements.
OLIVER WYMAN HAS SIGNIFICANT EXPERIENCE IN THE ASSESSMENT OF CLIMATE RISK AT ALL LEVELS OF GRANULARITY FOR A WIDE RANGE OF PURPOSES

Selected Oliver Wyman Publications

Climate Financial Risk Management
Together with the IACPM, Oliver Wyman has laid out governance and risk management frameworks that adequately address the financial risks associated with climate change.

Climate Scenario Analysis
Following the publication of TCFD recommendation, Oliver Wyman and the UN Environment Program – Finance Initiative convened a consortium of 16 international banks to pilot climate scenario analysis.

Regulatory Compliance
In this publication, we propose a methodology for effective implementation of climate risks within the Solvency II framework for European Insurers.

Climate Credit Analytics
Together with S&P Global, Oliver Wyman developed a climate credit analytics model for use by banks and investors for counterparty- and portfolio level analysis of climate-related financial and credit risks.

As a thought leader in climate risk management with deep expertise in climate scenario analysis, we are looking to establish a blueprint approach for Pillar II integration of climate risks.
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01 Introduction and Regulatory Environment

02 Basic Concepts and Challenges

03 Practical Modelling Approach

04 Case Study – Coverage Ratio Impact on a Sample Insurer

05 Conclusion and Outlook
REGULATORY ATTENTION REGARDING SUSTAINABILITY AND CLIMATE RISK HAS SUBSTANTIALLY INCREASED IN THE RECENT PAST

Regulatory developments

<table>
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<td>2015</td>
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<td></td>
<td>Since then environmental aspects moved into focus of regulatory and societal responsibility</td>
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<td>2017</td>
<td>Central banks and supervisors network for greening the Financial system</td>
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<td>Development of best practices for climate risk management within the financial sector</td>
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<td>Sustainable finance – advisory board of the German government</td>
</tr>
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<td>National strategy regarding (amongst others) stability of financial markets and risk management</td>
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<td>2019</td>
<td>EU Technical Expert Group on sustainable finance</td>
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<td>Developed EU sustainability taxonomy (Delegated Act awaited end of 2020)</td>
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<tr>
<td>2021</td>
<td>SFDR (EU 2019/2088) Sustainability-related disclosures in the financial services sector</td>
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</table>
EIOPA HAS MADE CLEAR THAT CLIMATE RISKS ARE TO BE ADDRESSED WITHIN THE SOLVENCY II FRAMEWORK

Competent authorities should require undertakings to integrate climate change risks in their system of governance, risk-management system and ORSA, in line with Solvency II regulation, guidelines, and the Opinion of Sustainability within Solvency II.\(^1\)

EIOPA acknowledges that undertakings may use qualitative scenarios as a first step to help management explore the potential range of climate change related risks implications. Where appropriate, especially if the risk exposure is material, this qualitative approach should be complemented with quantitative scenarios.\(^2\)

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1. EIOPA. (2020). Consultation paper on the draft opinion on climate scenarios in ORSA (EIOPA-BoS-20/256).
UNDER SOLVENCY II, SUSTAINABILITY RISK IS RELEVANT FOR BOTH PILLAR I AND PILLAR II REQUIREMENTS

The current regulatory risk management framework for insurers - Solvency II – does not explicitly require sustainability risks to be incorporated. However, according to the interpretation of various regulators\(^1\), sustainability risks are captured implicitly within the Solvency II framework.

![Solvency II Framework Table]

While Pillar II integration is inevitable, internal model users are encouraged to also consider the integration of sustainability risk into Pillar I requirements.

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1. See e.g. EIOPA, in Opinion on Sustainability within Solvency II (EIOPA-BoS-19/241, 2019); PRA in The impact of climate change on the UK insurance sector (2015) or BaFin in Sustainability: a duty and a challenge for the insurance industry (Issues 2/2019)
THE REGULATOR HAS ALREADY SET OUT DETAILED GUIDELINES ON THE TREATMENT OF CLIMATE CHANGE RELATED RISKS

EIOPA-BoS-19/241: Opinion on sustainability within Solvency II

At the request of the European commission, EIOPA published an opinion on sustainability risk within Solvency II. This opinion provides important guidelines for the treatment of climate risks for insurers, in particular

- Sustainability risk may also arise on shorter time horizons relevant for Pillar I and II requirements. In particular, climate policy related risks ("transition risks") could trigger sudden asset revaluations.
- The calibration to historical data is not appropriate to the problem at hand. Climate risks must be considered on a forward-looking basis.
- For material risks, a quantitative consideration is required. In the medium term, integration into risk capital requirements is also suggested.

EIOPA-BoS-20/341: Discussion paper on methodological principles of stress testing

The EIOPA discussion paper on Methodological Principles of Stress Testing, published in June 2020, sets out a detailed framework for climate risk scenarios

- The focus lies on transition risks and physical risks.
- Various transmission channels are identified through which climate risks can materialize.
- The use of IPCC scenarios from integrated assessment models ("IAMs") is recommended for a forward-looking approach.
- Scenarios can be constructed at various levels of granularity. The aggregation level should strike a balance between comparability, complexity and appropriate asset valuation.
- For the quantification of impacts, various approaches are discussed for different asset classes.

The regulator has strongly indicated the necessity to include climate risks into Pillar II requirements. The exact design is still subject of ongoing discussions¹.

¹. In particular, there is an recent consultation on a draft opinion on the use of climate change risk scenarios in ORSA, see EIOPA-BoS-20/561.
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SCIENTIFIC AND REGULATORY LITERATURE GENERALLY DIFFERENTIATE BETWEEN TWO MAJOR SOURCES OF CLIMATE FINANCIAL RISK

**CLIMATE FINANCIAL RISKS**

### Physical/Liability risks
- Destruction of productive capital as a result of climate-induced weather events
- Changes in real-estate values can also induce further liability risks via securitized assets
- Compensation for losses suffered from physical/transition risk (Professional Indemnity)

### Transition risks
- Shift of investment conditions due to regulatory interference or investor sentiment
- Changes in asset values due to implementation of climate policies ("stranded assets")
- Transition of the energy market will affect value chain of energy-intensive companies

Especially relevant for P&C business, already partially factored into existing models

No existing standard for risk capital calculations

Both types of risks have a material impact on the risk profile of significant asset classes, and should therefore be included into a holistic risk assessment.

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1. See e.g. Chenet, Climate Change and Financial Risk (April 2019)
2. See e.g. International Association of Insurance Supervisors (IAIS), Issues Paper on Climate Change Risks to the Insurance Sector (July 2018) or Battiston et al, Climate Risk Assessment of the Sovereign Bond Portfolio of European Insurers, EIOPA Financial Stability Report (2019)
There are several transmission channels through which insurers may be affected by climate-related financial risks

Transmission channels for climate risk

- Typical asset portfolios carry significant climate risks:
  - Transitional risks can have material effects on fixed income and equity in particular.
  - Physical risks may impact real estate holdings or exposed equities.
- Underwriting Risk may stem from both physical and transition risk via e.g. higher than expected claims or change in underwriting business or policyholder behaviour.
- For life insurers, the risk exposure on a short-to medium-term perspective is typically strongly dominated by market and credit risk.
- Consequently, we see the main risk exposure in the SII-context for most insurers in transition-related market and credit risks, although other risks may also become relevant on longer time horizons.

On a short- to medium-term perspective, we expect transition risks and their effects on equities and fixed income in particular to be the main contributors to increased risk for insurers.

Climate change related risks are present with or without policy action in the form of physical or transition risks. For a near-term assessment, transition risk is particularly relevant.
Transition risks are considerable sources of risk which are currently not yet reflected in typical risk assessments.

Transition risks are currently not reflected, but may materialize on relatively short time horizons.

The primary exposure for insurance companies to transition risk lies within equity and bonds:

- Equity prices will be subject to immediate major adjustments if region or sector is affected by policy change.
- Corporate bonds may be up- or downgraded depending on issuers asset base and value chain.
- Sovereign bonds may receive adjustments depending on industry composition.

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Transition risks are considerable sources of risk which are currently not yet reflected in typical risk assessments. In particular, they may arise on short- to medium term horizons.

Possibility 1

Real implementation of stronger climate protection policies leads to major shifts in the global economic landscape.

Possibility 2

Strong anticipation of policy implementation due to shifting political landscape leads to substantial market corrections.

Possibility 3

Shift in public opinion and investor sentiment results in adjustment in certain asset prices.
THE MODELLING OF CLIMATE-RELATED RISKS POSES SIGNIFICANT CHALLENGES THAT CANNOT BE SOLVED WITHIN TRADITIONAL APPROACHES

Deep uncertainty
Inherent uncertainty about development and impact
Presence of singular high-impact events, domino effects, tipping points...

Non-linearity and fat tails
Dominated by inherently non-linear effects
Significant tail events skew possible outcomes materially

Forward-looking nature
Impacts of man-made climate change only visible on recent time scale
Impossible to calibrate model on historical data

Endogeneity
Future development is largely dependent on political decisions
Possible economic trajectories can differ vastly

COMMONLY CITED CHALLENGES

The essential ingredient of any quantitative approach towards the evaluation of climate-related risks is a forward-looking valuation based on established climate change scenarios. Based on these principles, we present a practical approach for ORSA purposes in the following section.

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The general approach presented here is a forward-looking approach that uses established valuation methods.

**Scenario construction**
- Scenario narrative and time horizon
- Definition of scenario variables
- Scenarios based on IAMs

**Economic Impacts**
- Selection of economic KPIs impacted by the policy scenario
- Quantification of economic impacts based on scenario variables

**Risk factor shocks**
- Revaluation of Equity and Fixed Income based on valuation models
- Asset Distinction based on ESG factors

**Portfolio impact**
- Aggregation at portfolio level via mapping
- Calculation of SCR with updated valuation factors

The herein described process is geared towards EIOPA-guidelines. The valuation methodology is adapted from the CLIMAFIN-methodology and focuses on practical aspects for implementation.

DIFFERENT CLIMATE POLICY SCENARIOS MAY BE CHARACTERIZED BY THEIR EXPOSURE TOWARDS PHYSICAL AND TRANSITION RISK

General scenario narratives may be characterized along two dimensions:

1. Total level of actual mitigation of climate change risks
2. Whether the policy actions occur sudden or anticipated.

The categorization is to be understood in a relative sense, the scale “orderly-to-disorderly” can be interpreted in a continuous sense.

The total level of transition or physical risk largely depends on the narrative of the scenario:

1. Strong policy action can mitigate physical risks but may come at the cost of significant transition risk, particularly if it is not introduced in an orderly fashion.
2. Prominent occurrences of physical risk may trigger sudden and drastic policy changes, e.g. the German Energy transition as a direct consequence of the Fukushima disaster.

Since on short- to mid-term, we expect transition risk to be much more material, we focus on scenarios which lie above the diagonal.

1. See e.g. Network for Greening the Financial System (NGFS), A call for action: Climate change as a source of financial risk, (April 2019)
Impacts of climate policy are usually studied using complex Integrated Assessment Models (“IAMs”). Particular IAM results were used in various quantitative assessments of climate financial risks, such as:

- **ECB** in *Financial Stability Review May 2019*, “Climate change and financial stability”
- **ACPR** in *Analysis et Syntheses*, “L’exposition des assureurs français au risque de changement climatique” (in French)

The construction of transition risk scenarios based on IAM results is also the approach recommended by EIOPA\(^1\).

In general, IAMs may differ with respect to modelling focus, technical properties and functional assumptions\(^2\). The LIMITS database\(^3\) is the de-facto standard reference for practitioners, the scientific community and the IPCC for assessing impacts of climate policies based on IAMs.

In order to quantify possible impacts, we need to select a scenario from which we choose a relevant set of scenario variables which are benchmarked against current developments.

- Scenarios are characterized by policy targets (e.g. carbon concentration\(^4\)) and socio-political assumptions such as social responsiveness, time horizon and strength of policy action.
- Scenario variables should reflect possible policy action that are relevant to the portfolio exposure at a suitable level of regional granularity.
- The most obvious scenario variable is the price of CO\(_2\) emissions, since this is the most straightforward economic driver of policy action.
- Further options are e.g. target energy mixes, energy usage and emissions of particular sectors, ...

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2. See e.g. Guivarch, Rogelj, Carbon Price in 2°C scenarios explored (2017), for overview on IAM characteristics
3. LIMITS Project Homepage: www.feem-project.net/limits/, LIMITS Database: https://tntcat.iiasa.ac.at/LIMITSDB/
4. Typical target concentration of policy scenarios in line with the 2°C target are 450 or 500 parts per million (ppm) atmospheric CO\(_2\) in the year 2100.
ECONOMIC IMPACTS ARE DETERMINED AS SHOCKS ON SELECTED QUANTITATIVE KEY PERFORMANCE INDICATORS

• Economic KPIs are selected with respect to relevant portfolio exposure and the revaluation framework in Step 2. Examples for valuation-relevant KPIs are GDP, profitability, asset returns, market shares or future growth prospects.

• The KPIs can be selected at different levels of regional as well as sectorial granularity, depending on relevant portfolio exposure. Shocks on economic KPIs are determined based on the scenario variables from the previous step.

• Although the different LIMITS IAMs may differ in regional granularity, the LIMITS project has defined 10+1 “super regions” which should provide a sufficient regional distinction for most use cases.

• A practical distinction by sectors is provided by the Climate Policy Relevant Sectors (CPRS). CPRS are regrouped from NACE 4 digits with respect to their GHG emissions, allowing for a better assessment of policy impacts.

Example 1
An instantaneous shock on CO₂-prices leads to a shock on profitability due to an increased cost basis.

Example 2
A different energy mix imposed by the regulator results in a redistribution of energy market shares and possible stranded assets.

CPRS classification

1. Fossil
2. Utility
3. Energy-intensive
4. Buildings
5. Transportation

For shocks on equity, we leverage traditional equity valuation models in order to assess the impact of the economic shocks on equity indices.

Shocks on equity valuation

- From the values of the shocked KPIs, we can calculate shocks on equity valuation using fundamental valuation models such as the Dividend Discount model:

\[ P_E = \frac{\sum_{t=1}^{\infty} \text{Dividend}(t)}{(1 + r)^t} \]

- An alternative possibility is to use suitable relative valuation models (e.g. EV/EBITDA) or regression over significant explanatory variables.

- The approach can be varied based on (CPR-)sector-specific characteristics such as price elasticities or the ability to pass-through costs.

- Standardized ESG characteristics can be used in order to differentiate between “greener” and “browner” issuers or sectors, e.g. by carbon-intensity of revenue.

- Using this approach, valuation shocks can be assessed at various levels of granularity – from single-issuer level up to aggregated regional level.

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**Equity valuation shocks** can be performed at various levels of granularity, taking into account ESG- and other characteristics.

<table>
<thead>
<tr>
<th>Bottom-up valuation, Industrial</th>
<th>Top-down valuation, Energy</th>
<th>Hybrid valuation, Transportation</th>
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<tr>
<td>Profit margins (pre-shock)</td>
<td>Market shares (pre-shock)</td>
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<td>Adjusted valuation</td>
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<td>Growth expectations</td>
<td>Growth expectations</td>
<td>Growth expectations</td>
</tr>
<tr>
<td>Carbon taxes</td>
<td>Target energy mix</td>
<td>Hist. demand transportation</td>
</tr>
</tbody>
</table>

Risk factor shocks

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**THE METHODOLOGY FROM EQUITY VALUATION IS LEVERAGED USING STRUCTURAL CREDIT RISK MODELS IN ORDER TO UPDATE DEFAULT/MIGRATION PROBABILITIES**

**Shocks on fixed income valuation**

- For reassessment of credit spread and default risks, link the impacts from the equity valuation on the underlying fixed income valuation by employing a Merton-type structural credit risk models enhanced by a deterministic climate risk shock $\Theta_t(P, i)$:
  \[
  dA_t = (\mu + \Theta_t(P, i))A_t \, dt + \sigma A_t \, dW_t
  \]

- The shock $\Theta_t(P, i)$ depends on the issuer $i$ and the policy scenario $P$. It can be calibrated by assigning a suitable equity index, on which a shock can be calibrated using the already established method for equities. Similar to standard approaches in the credit risk context, the calibrated shock relative to its volatility is then used as proxy for a shock on asset returns.

- Within structural credit risk models, default and migration probabilities are induced by exceeding certain limits of the equity base:
  \[
  A_t = A_0 \cdot (1 + \varphi(t) + \zeta_t(P, i)) < L_t
  \]
  where $\varphi$ is the random shock following a lognormal distribution, and $\zeta_t(P, i)$ the deterministic asset shock corresponding to $\Theta_t$.

- Via the calibration based off the equity shock, the severity of the additional shock may also strongly depend on how climate-friendly the issuer is. This assessment should also include second-round effects, particularly for issuers with only indirect exposure (see slide 22).

- The ESG-dependency can also be made explicit by decomposing the model asset return into a systematic and an idiosyncratic component:
  \[
  \zeta_t(P, i) = R_t \cdot r_{\text{sector}}(P) + \sqrt{1 - R^2_t} \cdot r_{\text{ESG}}(P, i)
  \]

This way, sector impacts and ESG-specific impacts can also be calculated separately.
Further considerations for the calculation of Coverage ratios

The details for the calculations of the coverage ratio based on the impact assessments in Step 2 depend on whether the Standard Formula or an Internal Model is used. The following considerations are relevant in both settings:

- **The re-valuation of equity investments** on individual climate scenarios is fully provided by the method outlined in Step 2, potentially including an additional mapping step to include second-round effects (see next slide).

- **The re-valuation of the fixed income assets** on individual climate scenarios using the method outlined in Step 2 is based on a translation from stressed migration outlooks into market value changes. This approach can be performed in different ways and could e.g. leverage on existing structural credit risk models in the context of internal models.

- In the context of an **ORSA scenario construction under a Solvency II** a climate risk scenario
  - Changes the market value of assets according to the framework outlined in Step 2
  - May also change the extent of stresses for equity, spreads and counterparty default in the SCR assessment where the new stress levels can be inferred using the framework set out before
  - The same holds true for a potential revision of the correlations, where **adverse correlations** between exposed sectors also have to be taken into account.
SECONDARY EXPOSITIONS THROUGH INDIRECT HOLDINGS CAN SIGNIFICANTLY ENHANCE CLIMATE RISK

For a complete assessment, secondary exposures on the equity or credit risk side also have to be taken into account. This can either be done via direct mapping or estimate based on existing studies or regression models.

DATA AVAILABILITY IS GENERALLY AN ISSUE WHEN IT COMES TO THE ASSESSMENT OF CLIMATE CHANGE RELATED RISKS

Practical considerations on data availability

Our approach relies on data that is **directly available** either from sources present within typical insurance companies or subject of published academic research:

- **The equity valuation step relies on classical basic equity valuation data** available from typical data providers. Further ESG data that is incorporated within the valuation step is also available from the same sources.

- **For scenario data, we are looking to employ published IAM results from academic working groups.** A typical reference is the LIMITS database\(^1\). The NGFS has also published a set of relevant climate transition risk scenarios\(^2\), which are based on the same IAMs as LIMITS.

- **For calibration of a baseline scenario which is to be shocked,** there are two possibilities:
  - employ public databases such as the World Bank\(^3\) or OWID\(^4\) in order to construct accurate scenario data for the status quo
  - take an available scenario from the IAMs either from the predefined baseline scenarios, or by expert judgement.

- **The EU Taxonomy on Sustainable Finance\(^5\)** is expected to enter into force in 2021. Integration of newly available data from the taxonomy is expected to significantly improve the possible granularity of the suggested valuation framework.

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1. [https://tntcat.iiasa.ac.at/LIMITSDB/](https://tntcat.iiasa.ac.at/LIMITSDB/)
2. NGFS, NGFS Climate Scenarios for central banks and supervisors (June 2020)
4. [https://ourworldindata.org/](https://ourworldindata.org/)
This approach focuses on transition risk, since we consider physical risks to be less relevant on short- to medium time horizons.

Transmission channels under consideration with respect to EIOPA guidelines

- In the discussion paper, EIOPA stresses the importance of the interlinked nature of physical and transition risks discussed on slide 11.
- This approach focuses on transition risk and its impact on market and credit risk in particular. As a consequence, the range covered by this approach are scenarios where the physical risk is rather immaterial for the respective insurer.
- Depending on the insurer’s primary line of business, physical risks may however indeed be immaterial on short- to medium time horizons.

As an example, for a typical life insurer, sources of physical climate change risk are possibly increased mortality or invalidity rates on the underwriting side and property risks on the market side.

Considering that asset allocations are typically strongly dominated by fixed income and SCR attributions are typically dominated by market risks, impacts through physical risk transmission channels are likely to be immaterial compared to market transition risks in the context of SII coverage ratios.

THE PRESENTED APPROACH IS ABLE TO COVER DIFFERENT LEVELS OF GRANULARITY WITH RESPECT TO SCENARIO SPECIFICATION

Granularity of scenario specification with respect to EIOPA guidelines

- EIOPA considers 6 different aggregation levels of scenario granularity. The approach outlined here drills down to a granularity of broad economic factors at the minimum, but is also able to assess implications at single issuer level.
- For a first estimate, a granularity level between broad economic factors and sector implications seems reasonable:

  “[…] EIOPA considers the most appropriate aggregation level for a bottom-up ST at this stage to be, at least, a specification that includes impacts at an economic sector whose shocks shall be calibrated, where applicable, at country and regional level[...]”

However, for the analysis of further risk mitigation factors such as ESG criteria, an incorporation of relevant issuer-level key figures may be advantageous. Within this approach, this is also possible in a standardized and automated fashion.

The presented approach is generally within the guidelines on stress-testing given by EIOPA with a particular focus on transition risk. Its practicability will be demonstrated in the subsequent case study.

THE SAMPLE LIFE INSURER UNDER CONSIDERATION HAS ITS PRIMARY EXPOSURE TOWARDS EUROPEAN FIXED INCOME

Baseline Asset Allocation by asset type, region and rating

- The majority of assets are fixed income (83%). The remaining mainly consists of real estate, equity and funds.
- For simplicity, we differentiate only by broad regions and not by sector in this case study.
- Hence, economic impact assessment for scenarios only at regional level as well.

- We consider two sample insurers:
  - “Classic insurer”: No specific ESG investment focus
  - “ESG-oriented insurer”: Investment tilted towards positive ESG-characteristics
- The tilt is realized by assuming that every issuer is qualifies as “ESG leaders” for index providers.
- Apart from the ESG tilt, both carry the same baseline attributions.

Since the vast majority of assets of European insurers are typically also from European issuers, the primary exposure is the impact of climate policy on European markets.
THE MAIN DRIVER OF SCR LIES IN MARKET RISK, WITH UNDERWRITING RISKS PLAYING A SUBORDINATE ROLE

Baseline market value balance sheet and SCR contribution
In EUR M

| MV Assets | 20,167 |
| MV Liabilities | 18,693 |
| Equity | 454 |
| Other Own Funds | 621 |
| Market | 1,268 |
| Life | 486 |
| Health | 185 |
| LAC | -784 |
| SCR | 1,155 |
| OF | 1,474 |

Methodology

- The baseline market value balance sheet and coverage ratio is identical for both classic and ESG insurer, since they only differ in ESG characteristics.
- The SCR is calculated according to the Standard Formula. In particular, European government bonds are assumed to be risk-free.
- Market risks are the dominant type of risk driving the SCR. Stresses on market risk factors outweigh stresses on life/health risk factors by a significant margin.
- As a consequence, we see the SCR impact of physical risk on this insurer would be far less material compared to the strong market impacts of transition risks.

- For both standard and ESG insurers, we calculate 2 climate policy ORSA scenarios, using the methodology as laid out in the previous section.
- The shock is calculated on the initial balance sheet, the standard formula stresses remain the same.
### RELEVANT POLICY SCENARIOS ARE SELECTED FROM LIMITS-WP1 FROM ONE PARTICULAR INTEGRATED ASSESSMENT MODEL

<table>
<thead>
<tr>
<th>LIMITS Working Package</th>
<th>Working Package 1 – Global mitigation pathways for limiting global temperature increase below 2°C</th>
</tr>
</thead>
</table>
| Functional Model properties | • The selected IAM GCAM\(^1\) is a partial equilibrium model  
• Recursive dynamics: The economic agent sets prices based on status quo and does not have perfect foresight of technological and socioeconomic developments  
• High reactivity, relative to other IAMs. Consumers already react to moderate price signals |
| Socio-political Assumptions |  
**RefPol** | “Reference Policy”: Mild regional climate policy up to 2020, full cooperation starting in 2020 |
|  | **StrPol** | “Strong Policy”: Stronger regional climate policy up to 2020, full cooperation starting in 2020 |
| Long-term scenario target | 500 | 500 ppm atmospheric CO\(_2\) in 2100 |
|  | 450 | 450 ppm atmospheric CO\(_2\) in 2100 |

1: Global Change Analysis Model: http://www.globalchange.umd.edu/gcam/

### Basic scenarios with readily available interpretation

- In this context, GCAM is a „Middle-of-the-road“-selection: Recursive dynamics leads to higher short-term prices, while high reactivity leads to lower CO\(_2\)-prices. As a result, the price trajectory is somewhere in the middle compared to other IAMs

### Main determinant of disruptiveness of the scenario compared to status quo.

- StrPol is more on the disorderly side, while RefPol corresponds to a more orderly transition

### Strength of climate protection target.

- The stronger target of 450 ppm corresponds to a ~70% chance of reaching the 2°C, while the weaker 500 ppm corresponds to a ~50% chance.
THE WP1-SCENARIOS EXHIBIT DIFFERENT LEVELS OF TRANSITION RISK, DEPENDING ON THE SOCIO-POLITICAL ASSUMPTIONS AND LONG-TERM TARGETS

- Under full cooperation, the GCAM (inflation-adjusted) CO₂-prices converge under the same policy target. RefPol-Scenarios start out at lower prices and are hence less disorderly compared to the StrPol-Scenarios.
- In Europe, effective CO₂-prices are already on a moderate level (ca. 10 USD/t CO₂ e). For other regions, the available data shows no notable level of effective emission prices.
- Developed countries are generally subject to higher CO₂-price shocks under the policy scenarios than emerging markets. The relative CO₂-prices across different regions may vary across different IAMs.
- For further analysis, we focus on the relatively weak RefPol-500 and the substantially stronger StrPol-450 scenario. The transition risk associated with the other two scenarios lies in between.

1: Recent effective CO₂-prices were derived from UNFCCC (June 2019) and CDIAC: National Carbon Emissions and the World Banks Carbon Pricing Dashboard [https://carbonpricingdashboard.worldbank.org/].
THE ECONOMIC IMPACTS ARE MEASURED ON AN AGGREGATED REGIONAL LEVEL WITH PROFITABILITY AS THE MAIN KPI

Methodology

• At the scenario level, we distinguish between the 10 LIMITS-superregions. For impact assessment, we calculate the impacts on 3 regional equity indices.

• We assume a short-run price elasticity of 0, i.e. increased costs due to policy are carried by the business. As a first approximation, this assumption is justified, since consumer prices are typically not adjusted in the short-term.

• As a consequence, the primary shocked KPI is business profitability due to increased emission costs. The magnitude of the profitability shock depends on
  – Difference between scenario and current price
  – CO₂-intensity of revenue sources of the index.

• Note that for the ESG-tilted portfolio, ESG leaders have lower CO₂-intensities on average, hence the respective impact will be smaller.

Impact

• The margin shocks on both North America and (developed) Asia Pacific are relatively high due to relatively high price shocks, although the CO₂-intensity is moderate.

• The margin shock on the European index is substantially smaller, since pre-existing CO₂-prices are substantially higher, while the CO₂-prices from the scenarios under consideration are moderate.
The impacts on equity and fixed income also depend on general market exposure towards climate policy scenarios

Methodology

- **Equity Shock**: Gordon Growth model with constant payout ratio. Second-order effects are calculated via regression, assuming an equity beta of 1 for the financial sector.
- **Fixed Income Shock**: Merton-Modell with deterministic shocks based on equity shocks relative to historic volatility.

Impact

- **Limited impact** on Europe on RefPol-500 due to existing climate protection measures (~5% down shock)
- For StrPol-450, **substantial impacts** (15% and more) on European and Pacific markets: High percentage of industrial-heavy companies, which are more exposed to policy shocks due to lower overall profitability and more reliance on supply chains.
- **Limited impacts on North America**, despite strong absolute profitability shocks. Market capitalization there is dominated by tech companies, which are more resilient against climate policy shocks.
- The effects on European bonds mirror those on equity. For the weaker RefPol-500, scenario, downgrade probability increases by a factor of 1.6 on average, while in the strong scenario, the probabilities increase by a factor of 3.3 on average.
### Methodology

- Equity impact is straightforward from the portfolio composition.
- Spreads are updated using the downgrade probabilities as explanatory variable. Government bonds are not stressed.
- The Solvency II ratios are calculated on the stressed balance sheet according to the standard formula.

### Assessment of the SCR shocks

- Since the exposure is primarily European, the shocks on the European risk factors are the relevant drivers.
- Consistent with the calculated risk factor shocks, the impacts of the weaker scenario RefPol-500 are rather limited due to European securities already being subject to moderate levels of climate policy.
- The stronger scenario, on the other hand, may weaken competitiveness of the industrial-heavy European markets substantially, with more severe shocks as a consequence.

### ESG-oriented life insurer

- The risk mitigation observed for the more ESG-tilted portfolio is quite substantial, particularly in the more adverse scenario.
- In the RefPol-scenario, the impact of the policy shock on the ESG insurer is almost negligible.
DESPITE A NUMBER OF SIMPLIFICATIONS, THE CASE STUDY HAS MEANINGFUL INSIGHT TO OFFER WITH RESPECT TO BOTH IMPACTS AND METHODOLOGY

General remarks on the presented case study

The presented case study is subject to a certain set of assumptions and limitations:

• For the construction of the policy scenarios, we are using the price of CO₂-emissions as the main driver of climate policy.
• For the economic impacts, we are not dividing the economies into different sectors. Consequently, valuation shocks are calculated under a rather generic approach without accounting for possible sector-specific behavior.
• We only considered scenarios based off GCAM scenarios. The same scenario under a different IAM may have a materially different impact, especially since regional CO₂-price levels may differ between IAMs.

Nonetheless, the case study has meaningful insight to offer. In particular, the case study demonstrates that the impact of transition risks on the Solvency II ratio for a typical life insurer is likely to be material under certain scenarios. The risk may be substantially mitigated by shifting towards a more ESG-oriented investment approach. This general assessment is consistent with various other studies that investigate the impact of climate risk on asset values, such as

• “Climate change and financial stability”, ECB in Financial Stability Review May 2019,
SUSTAINABILITY RISK UNDER SOLVENCY II

01 Introduction and Regulatory Environment
02 Basic Concepts and Challenges
03 Practical Modelling Approach
04 Case Study – Coverage Ratio Impact on a Sample Insurer
05 Conclusion and Outlook
THE PRESENTED APPROACH IS DESIGNED TO MEET ANTICIPATED REGULATORY REQUIREMENTS FOR PILLAR II INTEGRATION OF SUSTAINABILITY RISK

Closing thoughts

- The integration of climate risk into the risk assessment under Solvency II is essential in order to incentivize the transition of the financial sector into a low-carbon economy. Regulators are currently discussing approaches for integrating sustainability risk into Pillar II as well as Pillar I requirements. Methods and approaches are still evolving by the month.

- Currently, EIOPA is drafting an opinion on the use of climate change risk scenarios in Pillar II requirements (ORSA). Various regulators have made clear that the assessment of climate scenarios is expected in the context of ORSA.

- The presented case study shows that insurers can expect to have a significant exposure towards transition risk. Scenarios which seek to limit the exceedance probability of the 2°C-target by more than 50% put significant pressure on portfolios which are not aligned with the 2°C target. The transition risk may be substantially mitigated by repositioning the portfolio towards more ESG-oriented issuers.

- The described methodology provides a practical and transparent approach for the assessment of transition risks that is in line with EIOPA guidelines. It may serve as a blueprint for integrating sustainability risks into Pillar II requirements. For internal model users, it may also serve as a baseline for the integration into Pillar I requirements.

1. EIOPA-BoS-20/561: Consultation Paper on draft Opinion on the supervision of the use of climate change risk scenarios in ORSA.

The quantitative assessment of sustainability risks will play an increasingly significant role in the further development of the Solvency II regulatory requirements. Insurers should be ready to meet these requirements – with regard to both their individual risk exposure as well as process-wise integration.
SELECTED LITERATURE ON CLIMATE CHANGE RISK FOR INSURERS

**Introductory reading**

Network for Greening the Financial System (NGFS), *A call for action: Climate change as a source of financial risk*, (April 2019)

European Insurance and Occupational Pensions Authority (EIOPA), *Consultation Paper on an opinion on sustainability within Solvency II*, (June 2019)

**Publications by regulators**

International Association of Insurance Supervisors (IAIS), *Issues Paper on Climate Change Risks to the Insurance Sector* (July 2018)


EIOPA, *Consultation on Opinion on use of climate change risk scenarios in ORSA* (Oct. 2020)

**More quantitative and technical aspects**


SELECTED COLLABORATIONS OF OLIVER WYMAN ON FINANCIAL IMPACTS OF CLIMATE CHANGE

Our climate-related collaborations (not exhaustive)