SENSITIVITY ANALYSIS OF CLIMATE-CHANGE RELATED TRANSITION RISKS

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EXECUTIVE SUMMARY

Climate-change, and the policies taken to limit it, mitigate its consequences or adapt to it, are set to be transformative drivers of change in the 21st century. Financial regulators and supervisors are increasingly devoting resources to understanding the risks and the consequences of this transformation, and to encourage firms themselves to assess the risks and opportunities it brings. EIOPA has established a comprehensive strategy and work-plan to this effect under the umbrella of sustainable finance. This report contributes to that work and represents a learning exercise that aims to inform future work at EIOPA, including potentially future stress testing.

Using data reported under Solvency II and available to EIOPA, combined with external data sources, this sensitivity analysis represents a first assessment of climate-change related "transition" risks in the portfolio of European insurers. In detail, by mapping individual holdings of corporate bonds and equity, including through investment funds, to issuers operating in either fossil fuel extraction industries (e.g. coal mining), carbon-intensive industries (e.g. steel and cement production), vehicle production or the power sector, the report identifies asset holdings worth several hundred billions in these sectors.

While these amounts in most cases are manageable compared to the overall holdings because insurers hold relatively well-diversified portfolios (and many insurers have already announced divestment plans for high-carbon assets), it is still clear that these investments may expose the insurance sector to transition risks in the event of a drastic alignment of the economies to an outcome in line with the aims of the Paris agreement to limit global warming.

In order to quantify these risks, this report therefore employs a "what-if" scenario analysis based on the identified holdings and government bond holdings to provide insights into possible values at risks under the scenarios and assumptions employed. The "what-if" scenarios draw input from several external sources and combine them in a consistent narrative calibrated on the current holdings of European insurers. However, it should be noted that this is a learning exercise and that the methodology and availability of data for these types of analysis is constantly evolving. The scenarios and methodology chosen in this report therefore reflect meaningful progress in terms of quantifying possible transition risks at European level, but should not be seen as constituting final scenarios or necessarily the only possible or most suitable approach. Insurers, regulators and supervisors all benefit from continuous progress in our understanding of climate-change related risks, and we are still at an early stage of fully exploring potential impacts.

Overall, using the methodology and assumptions described in this report, losses on equity investments in the high-carbon sector can be high, reaching more than 25% on average for these particular equity holdings (before accounting for any counterbalancing investments in e.g. renewable energy). These losses are in particular driven by investments in fossil fuel extraction, especially oil and gas, but also by investments in car production based on traditional internal combustion engines. The losses on the corporate bond portfolio are smaller than those for equities, but are largely driven by the same sectors. Holdings in the coal power sector, however, account for a somewhat larger share of losses for corporate bonds than for equities. Holdings in cement and steel production, and aviation, are generally smaller and these sectors do not therefore contribute much to the total losses explored in this report.

However, the overall impact on the balance sheets of the insurance sector is counter-balanced both by investments in renewable energy and the fact that the high-carbon investments considered in this report account for a small part of the total investments of European insurers. Solvency II is a risk based regime, and insurers therefore generally hold well diversified portfolios, and the overall size of the losses also reflects this. However, losses on the non-unit-linked part of the portfolio could reach 4-5% when compared to the reported excess of assets over liabilities in some cases depending on the scenario and assumptions presented in this report. It should be noted, however, that this report does not explore changes to the liabilities and therefore does not consider any impacts on measures such as own funds or capitalisation.

Naturally, as this is a first exercise carried out at this level on a top-down basis (using only data already available), there are a number of caveats that should be noted. First, it was not possible to map the full portfolio of European insurers, so the results represent a subset. Second, certain sectors that may also react to a typical "policy shock", most notably the agriculture and real estate sectors are not considered due to data limitations. Third, effects stemming from shocks to GDP or other macroeconomic variables are not included in this assessment. Fourth, the calibrations of the price adjustments rely on extrapolations and sometimes somewhat limited data, and consider changes that might stem from events that might happen by the end of this decade. These calibrations are naturally fraught with intense uncertainty. Finally, this report does not consider physical risks. Such risks are potentially substantial and can impact not only the asset side, but also the liability side and even business models. While this report provides an example of such risks in the form of an initial analysis of flood risk, more work is needed to understand those risks in depth and to cover more perils that are likely to be impacted by climate change.

Impacts of climate-change will clearly have transformative power in the 21st century. This report considers part of the challenges faced by European insurers in this context, namely asset-side transition risks. Equally, or potentially even more important, is the impact of changes in climate on the insurance business in general, and even the insurability of certain risks. These risks are also under intense scrutiny in the supervisory community and EIOPA are working with national competent authorities, market participants and the research community to further improve our understanding and assessment of these risks.

INTRODUCTION

Climate-change, and the policies taken to limit it, mitigate its consequences or adapt to it, are set to be transformative drivers of change in the 21st century. Understanding these changes is key for governments, regulators, businesses and citizens. While the challenges are multi-faceted, a key transformative change will be the energy transition away from fossil fuels and greenhouse gas intensive industries and consumption, together with the development of new, greener technologies.

If the world is to have a reasonable chance of meeting its ambition of limiting global warming to 2 degrees above pre-industrial levels, we will need to reach net zero carbon emissions by mid-century. This means that individual firms, industries and economies that are heavily fossil fuel dependent or otherwise emission intensive, will need to transition away from those dependencies. During this process, it is likely that investments in climate-policy relevant sectors may be exposed to risks of re-pricing and certain assets may even become virtually worthless, so called stranded assets.

Financial regulators and supervisors are increasingly devoting resources to understanding the risks and the consequences of this transformation, and to encourage firms themselves to assess the risks and opportunities it brings.

EIOPA has established a comprehensive strategy and work-plan to this effect under the umbrella of sustainable finance[1]. This report[2] contributes to that work by, using data exclusively available under Solvency II reporting together with data available via external partners, assessing in the most detailed way yet, the exposure of the European insurance sector to firms and technologies in sectors that are likely to be affected by the energy transition and emission reduction. This report focuses on asset-side transition risks that may arise during this alignment of the economy and quantifies potential price effects and the sensitivity of the balance sheet to those changes. The focus of this report is on corporate bonds, equity and government bond holdings.

This report presents results of a sensitivity analysis that focuses on a "what-if" scenario. This scenario is not calibrated to represent severe stresses, but rather to support the industry and the supervisory community to understand potential impacts under a set of conditions and assumptions. It brings in recent research and analytical work from different sources and strives to combine them in an overall framework. It is a learning exercise that aims to inform future work at EIOPA, including potentially future stress testing. For example, the key sectors, drivers and price sensitivities analysed in this report, could potentially form a basis for considering risks to the sector in one or several scenarios adapted to a possible stress testing regime. It also supports future work on data preparation for such potential exercises.

Naturally, as this is a first exercise carried out at this level on a top-down basis (using only data already available), there are a number of caveats that should be noted. First, it was not possible to map the full portfolio of European insurers, so the results represent a subset. Second, certain sectors that may also react to a typical "policy shock", most notably the agriculture and real estate sectors are not considered due to data limitations. Third, effects stemming from shocks to GDP or other macroeconomic variables are not included in this assessment. Fourth, the calibrations of the price adjustments rely on extrapolations and sometimes somewhat limited data, and consider changes that might stem from events that might happen by the end of this decade. These calibrations are naturally fraught with intense uncertainty. Finally, this report does not consider physical risks. Such risks are potentially substantial and can impact not only the asset side, but also the liability side and even business models. While this report provides an example of such risks in the form of an initial analysis of flood risk, more work is needed to understand those risks in depth and to cover more perils that are likely to be impacted by climate change.

1 See www.eiopa.europa.eu/browse/sustainable-finance_en

2 The initial planning of this analysis which was presented and discussed in the EIOPA Workshop on climate-change related risks in early 2020 was adapted as a consequence of the COVID19 pandemic. In detail, EIOPA and NCAs have agreed to limit the information request to industry as a result of the pandemic (https://www.eiopa.europa.eu/content/update-other-measures-impacted-covid-19-pandemic_en) noting in particular that the "data request to complete data available for top-down element and qualitative survey to groups reporting for FS purposes as agreed in the roadmap for the 2020 exercise on climate-related transition risks will be cancelled. The report will be performed with the available information". This report therefore focuses almost exclusively on asset-side transition risks and relies only on data already available to EIOPA or through partners. However, some discussion of other risks is given in separate chapter.

RISKS RELATED TO CLIMATE CHANGE

Climate change is widely recognized as an important source of risks to the financial sector. These risks are generally discussed along two dimensions. First, longer-term risks stemming from global warming and its consequences for natural catastrophes (extreme weather), property, health, settlement structure, agriculture, food production and insurability of risks. Second, the more immediate risks to current asset holdings due to a (required) shift away from emission-intensive production, consumption and power production with fossil fuels.

The risks related to climate-change for the insurance sector has been discussed in a wide area of publications, most recently for instance in EIOPA's consultation paper on stress test methodology[3] and in ESRB (2020). In this report, the risks are therefore only briefly presented. As the focus of this study in asset side risk, the brief discussion is concentrated on asset side transition risks that may be common to most insurers. However, physical risks, which in particular depends on the type of insurer and the line of business, is covered for completeness.

ASSET SIDE TRANSITION RISK

Both life and non-life insurers hold large asset portfolios built up using paid-in premiums. The returns on these assets or the realisation of the assets themselves are used to pay out to claims by policyholders in line with the policy. While there are buffers in place, most notably the capital requirement, losses on the asset side may in extreme cases impair an insurer's ability to meet its obligations.

Certain risks to the asset side, the so-called "transition risks" can arise from the process of adjustment towards a low carbon economy. A range of factors influence this adjustment, including climate change-related developments in policy and regulation (policy shock) or the emergence of disruptive technology (technology shock). Shifting sentiment and societal preferences, or evolving evidence, frameworks and legal interpretations may also lead to transition risks.

Insurers may be exposed to these risks through the holdings of corporate bonds and equity of private companies. Another source of transition risks may arise through holdings of governments bonds. For these bonds, the climate-related transition risks would relate to the carbon intensity of the economy as a whole, i.e. how dependent is government revenue on the (taxation of, or share in) profits generated in carbon-intensive industries such as car manufacture, heavy industry (especially cement), fossil fuel production (and energy generation) and/or export of those fuels.

In this paper, we explore scenarios and narratives that are based on a policy shock, i.e. an abrupt and not foreseen (by financial markets) policy change which brings future CO_2 emissions in line with a 2 degree scenario.[4] The narrative is explained in detail in a separate chapter in this report.

LIFE UNIT-LINKED AND INDEX LINKED PORTFOLIOS

For most insurance business, losses on the assets side will have to be borne by the insurer (but there are certain mechanisms in place for ensuring long-term business).[5] However, for life unit-linked and index-linked portfolios, the policyholder will generally take part of, or all of, the resulting losses.[6] While the overall impact and losses may be the same, a key difference is how it would then impact the insurance sector specifically and the financial sector generally.

3 See https://www.eiopa.europa.eu/content/second-discussion-paper-methodological-principles-insurance-stress-testing_en

4 It should be noted that several insurers are already actively divesting from high-carbon sectors. However, the sensitivity analysis explored in this report assume that the full impact of the price adjustments are not foreseen.

5 Except for some profit-sharing mechanisms in life business that are not considered unit-linked

6 This is not to say that unit-linked is completely insulated from these losses: Some linked business may have certain guarantees. Moreover, even without guarantees, lower asset volumes will indirectly reduce profits through lower collected management fees

PHYSICAL RISKS AND OTHER RISKS FROM CLIMATE CHANGE

Physical risks from climate change concern longer term shifts in the climate (such as changes in precipitation, extreme weather variability, sea level rise, and rising mean temperatures). Macroeconomic impacts from physical risk could arise from both an increase in the frequency and severity of severe weather events (acute impacts), and gradual climate change (chronical impacts).[7] As reported in ESRB (2020) and NGFS (2019), the estimated negative impact on GDP could range from -10% to almost -25% by the end of this century if the global increase in temperatures reaches 5 degrees or more. These longer term shifts are generally expected to affect the frequency and intensity of weather events such as heatwaves, floods, wildfires and storms. Box 1 discusses one particular peril more in depth.

On the asset side, the changes in frequency and intensity of weather events may bring about valuation changes other than those discussed above. For instance, direct holdings in property may be vulnerable if climate change leads to more severe natural catastrophes. Holdings of government bonds may also be vulnerable in such cases[8] through impact on government finances and future income generation through taxation.

Long-term changes in climate and increases in natural catastrophes could certainly also impact the insurance business models in general, and certainly have pricing and revenue implications and consequences on the liability side. Insurers would at least to some degree have the ability to reprice products if changes are gradual, but the extent of this possibility is still being debated (see for instance EIOPA Discussion paper on non-life underwriting and pricing in light of climate change).

7 Acute impacts result from an increase in extreme weather events. These events can lead to business disruption and damages to property as well as increase underwriting risks for insurers and impair their assets. Chronic impacts, particularly from increased temperatures, sea levels rise and precipitation, may affect labour, capital and agriculture productivity.

8 Physical risks could disrupt supply chain/production in certain sectors, which could then also affect the value of those assets correct (e.g. agricultural production, transport)

BOX 1: THE CLIMATE CHANGE IMPACT ON FLOOD RISK FROM AN INSURANCE PERSPECTIVE

This sensitivity analysis focuses on transition risks, i.e. risks of losses on investments as economies undertake a transition away from fossil fuels and carbon-intensive production, and does not aim to quantify or assess potential physical risks. However, the increase in losses due to the physical impacts of climate change in terms of frequency, severity, pattern and correlation of disasters, particularly if this transition does not take place, or takes place slowly, could potentially be substantial. In order to give a brief introduction and a view on potential effects, this box presents initial findings and work related to one key peril and possible impact from climate change on flood risks.

The European Environment Agency has reported that climate change is already having wide-ranging consequences for human health, the environment and economies across Europe.[9] In particular, climate-related extremes such as heat waves, heavy precipitation and droughts are increasing in frequency and intensity in many regions. Without further international climate action, global average temperature and associated physical risks will continue to increase[10], raising underwriting risk of (re)insurers, jeopardising asset values and potentially challenging their business strategies[11].

In the context of climate change, multiple perils such as floods, droughts, wildfires are relevant for the insurance sector. However, flood risk is considered a useful focal point as it is one of the costliest natural disasters in Europe. It is also one of the natural hazards against which adaptation and mitigation measures are highly effective.

Current insurance sector exposure to flood risk

While publicly available and regulatory reporting data on the level of individual perils is somewhat scarce, some insights into the importance of key perils can be obtained by analysing Solvency II data reported to EIOPA in relation to the calculation of the solvency capital requirement by standard formula undertakings. Looking at aggregated results for insurance undertakings[12] using the standard formula to calculate natural catastrophe risk charge, non-life and composite undertakings are heavily exposed to flood risk in Europe. The total exposure in three key regions for which data was reported (FR, DE and UK) represents 72% of total exposures across all regions. Moreover, the natural catastrophe risk charge for the flood risk module accounts for 57% of the total natural catastrophe risk charge after diversification and mitigation. In terms of capital charges, the flood risk module is the second most relevant hazard among the standard formula perils after windstorm and followed by earthquake, hail and subsidence.

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9 EEA (2017), Climate change, impacts and vulnerability in Europe 2016. EEA Report No 1/2017. EEA (2020), EEA climate state and impact (CLIM) indicators.

10 IPCC, Global warming of 1.5°C, An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, (2018).

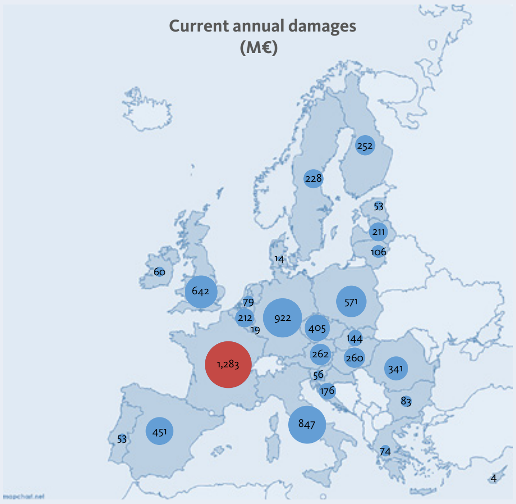
11 See, IAIS (2018), Issues paper on climate change risks to the insurance sector.

12 The sample is based on 623 solo undertakings reporting a positive flood risk charge and using the standard formula. In terms of total assets, the sample represents more than 45% of the EEA non-life, composite and reinsurance market.

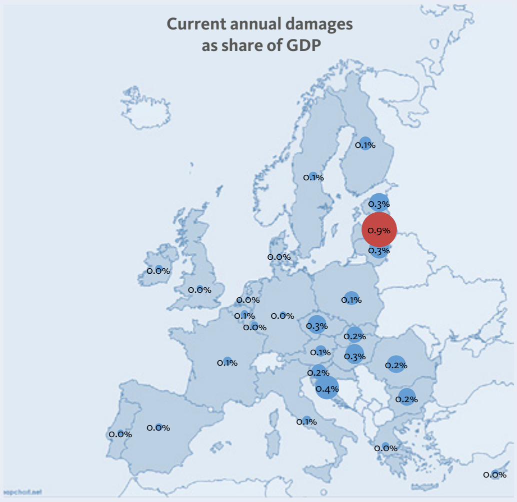
Current and expected climate change impact on river flood

Based on the EEA loss indexes[13], between 1980 and 2017, weather and climate-related events caused approximately 453 billion euro[14] in economic losses in the EEA area. Meteorological events (storms) and hydrological events (floods, mass movements) represent both 31% of these losses. The 2002 flood in Central Europe and 2000 flood in Italy and France are among the most expensive weather related events occurred in the EU since 1980 causing respectively 21 billion and 13 billion euro losses. The historical disaster database EM-DAT[15] is an additional open data source that helps providing further insights on the frequency and economic impact of past flood events. According to the EM-DAT records, 330 flood events occurred in the EEA area (including UK) accounting for more than 40% of total economic losses reported for natural catastrophes since 1995. Flooding is one of the most frequent and destructive natural perils. Riverine flood is the most frequent and the most destructive flood type. Based on the EM-DAT data[16], more than 60% of flood events are caused by river inundation and these events generated close to 70% of the overall historical economic losses reported since 1995. However, the figures should be interpreted with caution as the economic and insured losses are not always available or are based on estimations[17].

According to the JRC Peseta IV study on river flood[18], at present, riverine floods cause annually 7.8 billion euro damages in the EU and UK (around 0.06% of current GDP) and affect more than 170,000 people every year.



Source: JRC Peseta IV.



Source: JRC Peseta IV, Eurostat.

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13 Please see: https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2

14 In 2017 values.

15 EM-DAT: The Emergency Events Database - Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be,Brussels, Belgium. The Emergency Events Database is a publicly available global database on natural and technological disasters maintained by the Centre for Research on the Epidemiology of Disasters.

16 The EM-DAT dataset contains specific information on the total damages caused by 142 flood events occurred in EEA and UK since 1995. Additionally, it provides further information on the total and insured losses for a subset of these events (54).

17 Detailed information on the total damages is available only for slightly less than 45% of the reported flood events.

18 The JRC Peseta IV study on river flood simulates the changes in river flow under different climate scenarios (1.5°C, 2°C, 3°C warming), by mid- and end-century, and estimates the impacts on economy and society under future socioeconomic conditions. The changes in temperatures are converted into the corresponding changes in frequency and severity of floods using biophysical models, which are then transformed into financial losses for the entire economy. European Commission, JRC Technical Report, PESETA IV project – Task 5, (2020), Adapting to rising river flood risk in the EU under climate change.

The PESETA IV study also considers possible changes in the annual damages under different warming outcomes. In particular, if no further mitigation and adaptation measures are taken, economic losses will grow to nearly 50 billion euro[19] a year by the end of this century under 3°C global warming scenario. However, limiting global warming to 1.5°C would halve the economic losses and population exposure to river flooding relative to unmitigated climate change. Finally, the implementation of adaptation measures could influence the hazard and the vulnerability components of weather-related risk and therefore minimize the impact of climate change on flood risk in a cost-effective manner. Based on the Peseta report, these strategies could reduce by more than 70% the economic losses and population exposed by the end of the century.

Impact on insurance sector exposure to flood risks

Most (re)insurers use stochastic flood models to manage their inland flood risk. These models use a combination of observed climate data and mathematical simulation methods to simulate multiple flood events in an attempt to capture all the possible floods that might occur in cities and countries around the world in the near future. The impact of these events is evaluated in terms of expected losses and distributions of possible losses by combining the simulated hazard for the flood events with detailed exposure maps and vulnerability models that consider the vulnerabilities of different types of buildings. These models are designed to represent current and near future climate, since this is the time-period of most relevance to the insurance industry. They are not typically designed to quantify future risks rising from climate change due to the expected changes in frequency and severity of future weather related events.

In the context of its Technical Expert Network on Catastrophe Risks, which brings together the regulatory community, researchers and market participants, EIOPA has explored how to assess the impact of climate change on future flood insured risks. For instance, a recent study from the commercial model vendor RMS[20] sheds some light on the likely magnitude of changes in flood risk for the European insurance sector. RMS used the EURO-CORDEX[21] simulated changes in daily maximum rainfall (as provided by CMCC)[22] to adjust their riverine and pluvial-flood model in order to estimate the expected changes in losses for (re)insurance undertakings under different Representative Concentration Pathway (RCP)[23] scenarios and time horizons.

The results of the study show that average annual insurance losses[24] due to inland flooding are expected to increase under all scenarios with a higher impact in Northern/Western European countries compared to Southern/Eastern areas. Although, especially for the most extreme and long-term scenarios, the projected loss increases are subject to a high level of uncertainty, it is possible to expect a clear impact of climate change on the (re)insurance sector in terms of increased average annual flood losses (between 26% and 80%, relative to the RMS reference view) already by mid-century, with all other factors remaining constant. In particular, these results assume that no action would be taken to counteract increasing flood risk through mitigation or adaptation measures, such as changes in building codes and practices, and/or increased investment in flood defence systems. If targeted risk-reduction efforts are made, the modeled impacts could likely be reduced. The study also

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19 Expected annual damage (2015 values) for all EU countries taking into account future socioeconomic conditions (2100 economy) and 3°C warming climate scenarios.

20 For further information please see https://www.rms.com/europe-flood-whitepaper

21 In line with similar study on future precipitation patterns in Europe, EURO-CORDEX results project an increase in extreme rainfall most of the year in Northern and Central Europe. For further details, please see: https://euro-cordex.net/index.php.en.

22 Changes in 95th percentile of daily maximum rainfall expected under the RCP4.5 scenario for 2041-2070 period (relative to the base period 1981-2010).

23 The results are presented for three RCPs scenarios: RCP 2.6, RCP 4.5 and RCP 8.5. The RCP 2.6 scenario is a so-called "peak" scenario and it aims at keeping global warming likely below 2°C above pre-industrial temperatures. The RCP 4.5 is considered a moderate-emissions-mitigation-policy scenario and a stabilization scenario as it assumes that radiative forcing level stabilizes before 2100, while RCP 8.5 is considered a high-end emissions scenario and it assumes that no efforts are put in place to limit greenhouse gas emissions. For further details, please see: https://ar5-syr.ipcc.ch/topic_futurechanges.php

24 The average annual loss is the expected loss per year, averaged over many years.

provides insights on the expected increase in annual aggregate loss[25] for the 200-year return period (RP)[26] under different RCP scenarios. Consistently with the findings previously described, the Northern-western European countries would be the most impacted. Under the RCP2.6 scenario, the expected increases in losses are similar by mid- and end-century for both regions (~30% for the North-western, and ~20% for South-eastern region), while the results diverge under the other scenarios. For example, under the RCP4.5 pathway, the annual aggregate[27] losses for the 200-year RP for flood in Northern-western European countries are projected to increase by 51% in 2050 and by 90% by 2090. The corresponding impacts are again milder in South-eastern countries, where modelled losses show an increase of 31% and 42% by 2050 and 2090 respectively, under the RCP4.5 pathway.

Modelled increase in average annual insured losses (% change compared to current RMS reference view)		RCP 2.6		RCP 4.5		RCP 8.5	
Region	**Countries**	**2050**	**2090**	**2050**	**2090**	**2050**	**2090**
North/West	BE, FR, DE, IE, LI, LU, CH, UK	35%	35%	52%	85%	80%	276%
South/East	AT, CZ, HU, IT, PL, SK	26%	26%	40%	62%	58%	212%

Source: RMS

Naturally, the uncertainty around estimates 30-70 years into the future is substantial due to uncertainties in the EURO-CORDEX climate projections, the underlying risk model, and the methods used to combine the two. Furthermore, the PESETA IV and the RMS results are difficult to compare in detail, because they describe changes relative to different baselines. However, they show changes of similar magnitude. This can give us increased confidence in both sets of results, since they are based on different models and methodologies.

While the incorporation and active implementation of climate-change risks in insurers' models and business planning are still somewhat in an early phase, these studies highlight the benefit of combining climate-change research and insurance modelling expertise to improve capacity for this type of analysis in the insurance sector.

25 Based on the sum of all event losses each year.

26 A return period loss describes the likelihood of a loss of a given *size*, and not of a specific event or events, occurring within a given time frame (e.g. in 200 years).

27 Based on the sum of all event losses each year.

ASSESSING ASSET-SIDE TRANSITION RISKS IN THE PORTFOLIO OF INSURERS[28]

A first step in understanding climate-relevant transition risks, and investors' exposures to such risks via their asset portfolios is to get a view on how much of their assets are likely to be invested in climate-policy relevant sectors, firms and technologies. These sectors are typically related to the power, fossil-fuel, transport or manufacturing industries. Property and agriculture are often also considered in the context of climate-policy (these are outside the scope of the sensitivity analysis, see discussion on page 8).

While there is currently a massive growth in data providers who can support investors in assessing such exposures, it is still challenging to get a consistent overview of a full portfolio which may contain thousands of individual investments and ISINs. For regulators wanting to assess the portfolio of many undertakings, this challenge is even bigger.

In the EU, NACE sector classifications for assets have therefore been used relatively extensively as a starting point for assessing climate-change related transition risks. For instance, these classifications form the backbone of the EU taxonomy for sustainable activities.[29] Moreover, the 2019 EIOPA stress test for occupational pension schemes relied on NACE sector classifications and EuroStat data on greenhouse gas emission intensities to assess emissions implicit in the portfolios of major pension schemes.

The main benefit of relying on widely available NACE sector codes is data availability and the fact that, at least in principle, a vast majority of assets can be classified. NACE sectors are routinely reported under Solvency II. Using the methodology outlined in Battiston et al (2017), it is also possible to use the NACE classifications to define (groups of) climate-policy relevant sectors. EIOPA employed this approach in its December 2018 Financial Stability Report (EIOPA (2018)).

There are however well-known drawbacks to this high-level classification. A main challenge is that a firm may operate in many different sectors, and subsequently any asset issued by that firm could potentially be classified both as climate-policy relevant by some investors and not relevant by other investors. In Solvency II reporting, there is for instance evidence that reporting undertakings are classifying the same assets with different NACE codes. A second challenge is that the NACE sectors are very broad, especially in certain key climate-relevant sectors like power generation (it is not really possible to separate out e.g. renewable power generation using NACE sectors). The EU taxonomy for sustainable activities resolves this by adding additional description of key economic activities and further criteria to be "taxonomy-compliant".

A more advanced method is to assess individual firms and the emission intensity implicit or explicit in their value-generation (and ideally to account for Scope 1, 2 and 3 emissions[30]). Using firm level data from Carbon4finance, it is possible to illustrate, for the insurance sector portfolio, how the estimated emission intensity per NACE sector, and also by identified climate-policy relevant sectors using NACE codes[31], varies widely within each category.

These findings are useful to illustrate the importance of using – where feasible – firm level rather than sector level data. However, even firm level data would depend on a certain degree of averaging emission across all sectors and operations of a firm. A possible approach, and the one used in the main part of this study, is therefore to assess individual firms (and their ultimate parents) and their activities and technology separately and link it to the physical production carried out by the company.

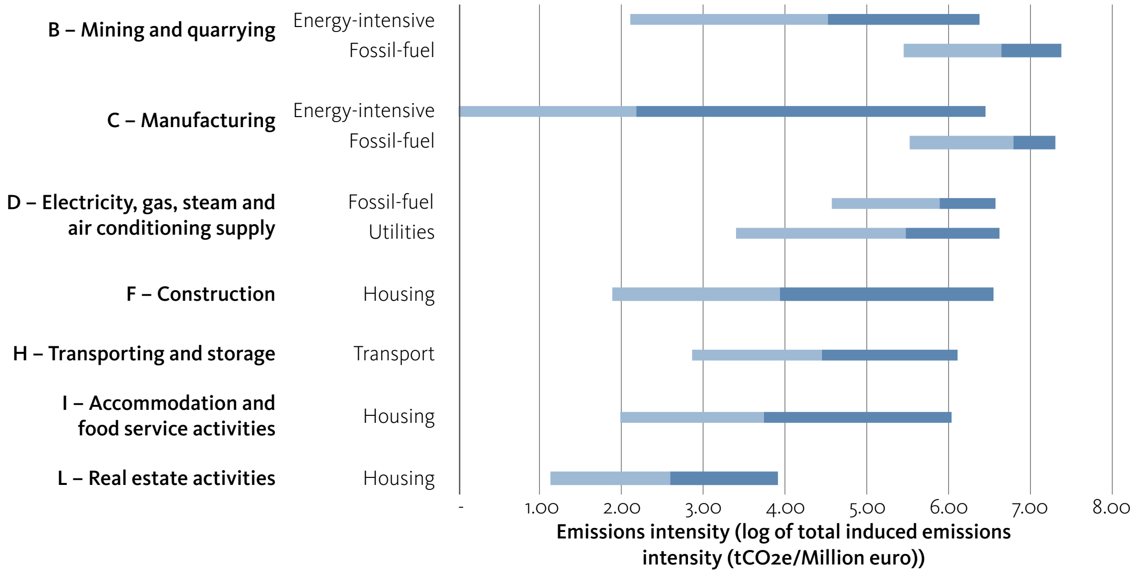
28 All aggregated numbers and shares provided in this report refer to EEA excl. UK unless otherwise specified or unless they specifically refer to country-level aggregates.

29 See Scholer and Barbera (2020)

30 Scope 1 refers to all direct emissions from the activities of an organisation. Scope 2 includes indirect emissions from electricity used. Scope 3 includes all other indirect emissions.

31 As discussed above, and in the December 2018 Financial Stability Report (EIOPA (2018))

Figure 1. Distribution of emission intensity in firms classified according to NACE Sectors and identified climate-policy relevant sectors



Source: EIOPA and Carbon4finance. The light blue bar starts at the 10th percentile and the dark blue ends at the 90th percentile. The split is at the median.

MAPPING EQUITY AND CORPORATE BONDS TO INDIVIDUAL FIRMS, TECHNOLOGY AND PHYSICAL PRODUCTION[32]

Mapping holdings to carbon intensity is a fruitful way to assess exposure. However, in order to assess possible price sensitivities, it is necessary to also have a model that links carbon intensity in a quantifiable way to e.g. a transition scenario. In this analysis, we therefore map equity and corporate bonds to individual firms and the technology they use in the production. This approach is carried out in collaboration with 2° Investing Initiative (2DII) and provides the means for also calibrating potential price changes in a "what-if" scenario for equity and corporate bonds.[33]

The analysis relies on information for listed equity and corporate bonds which is obtained through this cooperation.[34] The scope is defined by the availability of data and methodology of the 2DII PACTA toolset.[35] The focus of this work is on listed corporate bonds and equity holdings and on the automotive, fossil fuel extraction and power sectors.[36] The transport, cement and steel sectors are covered in terms of identifying the assets, but price adjustments are not modelled in the PACTA service.

While the PACTA toolset covers key climate-policy relevant sectors in terms of their contribution to overall CO_2 emissions, it is not exhaustive. In particular, property investments and investments in the agriculture sectors are very likely to be climate-policy relevant, but are not covered in this analysis due to lack of consistent data and methodology. Investments in the real estate sectors account for about 8% of total investments at EEA (excl. UK) level.[37] Investments reported to be in the agriculture sector account for less than 0.1%. Second round effects in the financial sector are also out of scope.

32 This analysis is based on reporting by 1894 undertakings reporting on a solo basis under Solvency II. For the analysis of corporate bonds and equity, 1569 of these undertakings were found to hold assets relevant to this report.

33 As part of this collaboration, 2DII provided a bespoke implementation of the PACTA service and resources.

34 Preliminary findings were made available in the workshop discussion paper on this website: https://www.eiopa.europa.eu/content/workshop-climate-change-related-risks_en

35 The 2DII PACTA methodology is free and open-source, see https://2degrees-investing.org/pacta/. EIOPA has used a bespoke implementation in cooperation with 2DII for this work.

36 Assets reported to be issued by real estate corporations are excluded from the analysis. Covered bonds are also excluded. The full list of CICs included are 21, 22, 25, 28, 31, 34, 41, 42, 44. In this report "corporate bonds", "equity" and "funds" refer to these CICs only unless otherwise specified. Assets with negative reported market value has been excluded.

37 Unless otherwise specified in this report, EEA represents EEA excl. UK. When UK data is included, it is noted explicitly.

HOLDINGS MAPPED TO ISSUERS BY SECTOR

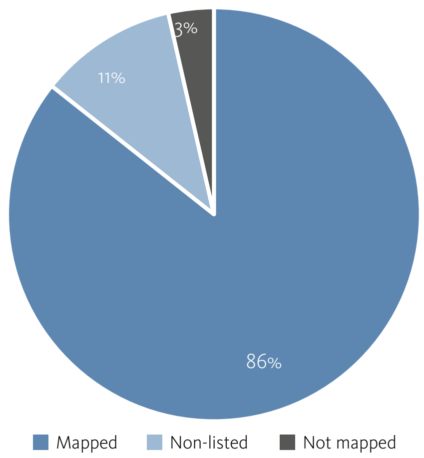
The first part of this analysis includes mapping each security to its issuer, its ultimate parent (i.e. the final owner) and the key sectors of operation. The next sections present the results of this mapping to financial data using the PACTA toolset for each of the main asset classes considered in this analysis.

CORPORATE BONDS HOLDINGS

For corporate bonds holdings the most important asset classes were considered (i.e. common corporate bonds (plain-vanilla), convertible bonds, hybrid bonds and subordinated bonds). These cover about ¾ of all assets classified as corporate bonds at the highest level of classification (CIC code 2) in the insurance portfolio. Covered bonds and money market instruments were excluded from the analysis. For this analysis, this means that corporate bonds holdings in the EEA excl. UK for about 1.2 trillion euros have been considered (1.45 trillion euros if UK is included).

In this context, mapping coverage is an indication of the share/volume of corporate bonds where it was possible to match the Solvency II asset information with data available in the PACTA service. For each of these assets where a match was possible, it is also possible to assign the asset to a climate-policy relevant sector, or to define it as not climate-policy relevant. For corporate bonds, an overall mapping share of 86% was achieved. The mapping share

Figure 2. Mapping coverage – Corporate bonds – All undertakings – Incl. unit-linked – EEA excl. UK

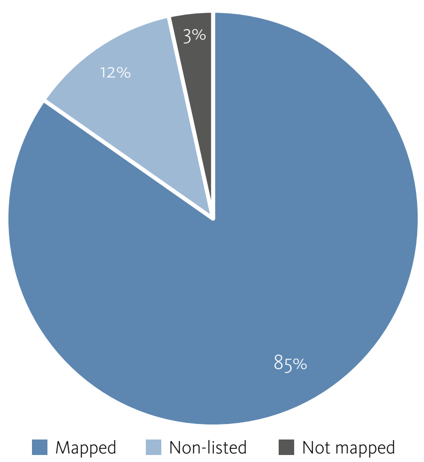


Source: Solo insurance undertakings reporting under Solvency II.[32] 2019 Q4.

is also fairly stable across unit-linked and non-unit-linked portfolios. The PACTA service covers *listed* bonds and equity. Accounting for the fact that a certain share of bonds are reported as non-listed by the insurance undertakings, Figure 2 shows that the main reason why an asset was not mapped, is the fact that it is not listed. Only 3% of the corporate bonds were completely unmapped.

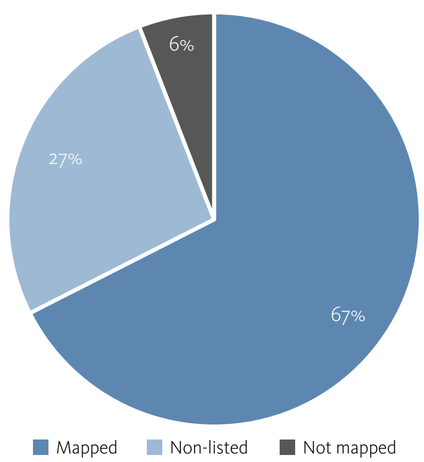
To illustrate the difference between life and non-life, Figure 3 and Figure 4 show that the mapping coverage for each of the two undertakings types. Indeed, mapping was lower for non-life undertakings compared to life as shown below (composites and re-insurance are not shown and

Figure 3. Mapping coverage – Corporate bonds – Life undertakings – Incl. unit-linked – EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

Figure 4. Mapping coverage – Corporate bonds – Non-life undertakings – EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

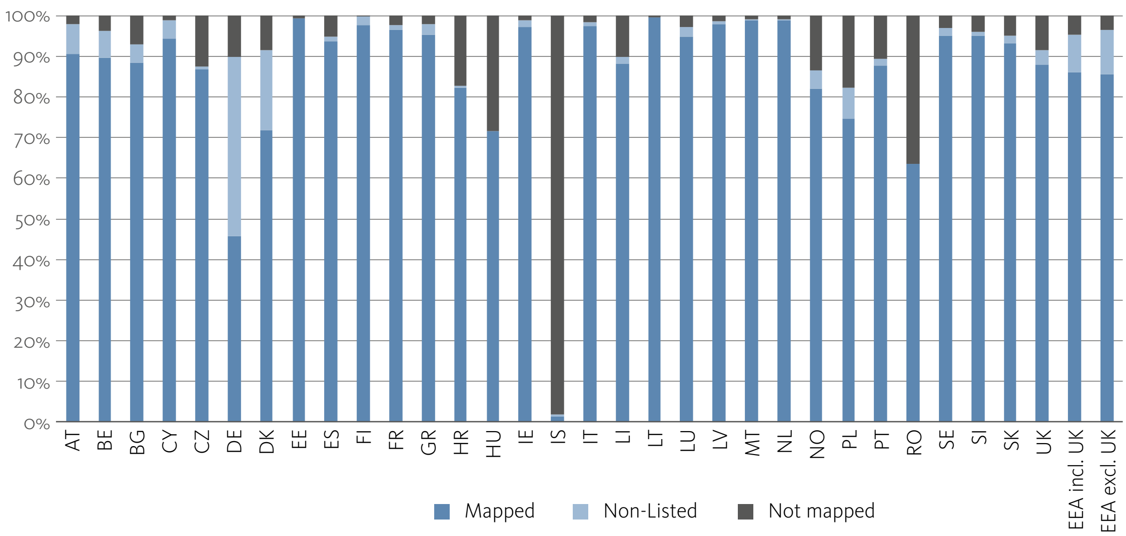
explain the difference between Figure 3 and Figure 4 when compared to the aggregate Figure 2. Mapping for composites and re-insurance were 95% and 86% respectively). The main reason is that non-life undertakings have a larger share of non-listed corporate bonds on their portfolio.

Beside some variability depending on undertaking type, there is also a certain degree of heterogeneity among countries. However, the share on non-listed corporate bonds largely explains the difference. One clear outlier, however, is Iceland. For Iceland, it was not possible to reconcile the Solvency II data with the data available through PACTA. The corporate bonds that were not mapped were exclusively Icelandic assets for which no data could be found in the PACTA service. While this obviously has an impact on the reliability of the analysis for this country in particular, the relevant assets held by Icelandic undertaking in this context was 0.002% of the total sample and therefore negligible in the context of EEA.

For all the corporate bonds that were mapped, it is possible to assign either a climate-policy relevant sector, or define it as not immediately climate-policy relevant in the context of PACTA (as discussed above, property investments, investments in agriculture and also investments in the financial sector could be considered climate-policy relevant, but is out of scope for this exercise). For the EEA excl. UK, the figure below shows the portfolio allocation as a share of the mapped investments (excluding non-listed corporate bonds).

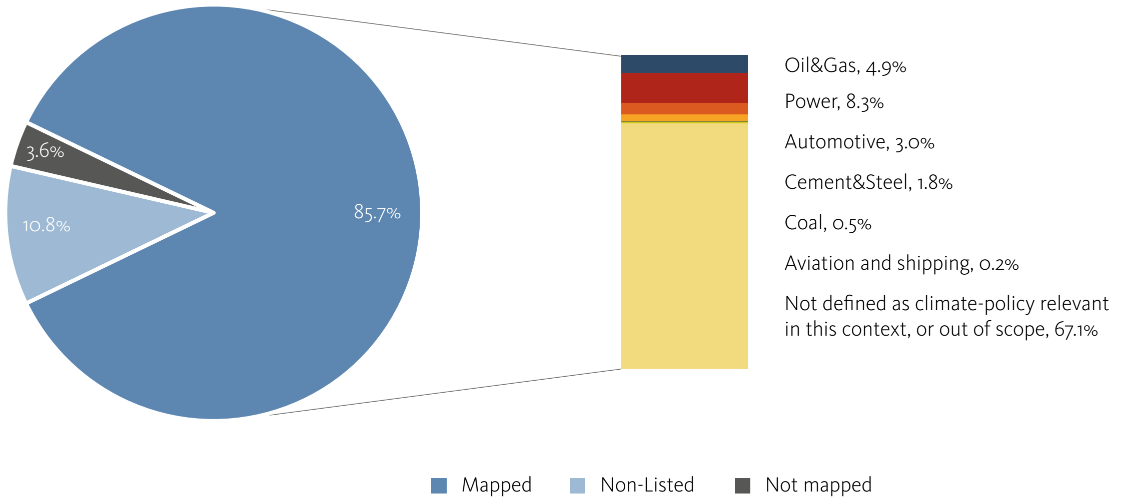
For corporate bonds, the difference between the unit-linked and non-unit-linked portfolios is relatively minor. On a country-level basis, there is a certain degree of heterogeneity, but the relative dominance of the power-sector was evident in the asset portfolios in most countries. The power sector is fundamental in terms of climate change. The energy transition required to limit global warming and meet the targets defined by the international community means that power generation needs to shift away from fossil fuel to renewable energy, with potentially large consequences for the valuation of the assets in this sector.

Figure 5. Mapping coverage – Corporate bonds – All undertakings – Incl. unit-linked – Per country of holder



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

Figure 6. Share of corporate bonds in key climate-policy relevant sectors. [38] All undertakings. Incl. unit-linked. EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

EQUITY HOLDINGS

In terms of coverage, the findings for equity holdings[39] are somewhat less clear compared to corporate bonds in terms of coverage and availability of the required financial data to map to individual firms and sectors covered by the PACTA framework.

First of all, the overall mapping share is smaller than for corporate bonds, with about 1/3 of the equity holdings being matched to assets covered in the PACTA service. At first sight, this seems like a low coverage, especially when compared to 86% for corporate bonds. However, a key reason for this low share is that a large part of common and preferred equity holdings are actually participations or holdings in related undertakings and such investments account for more than 70% of the non-unit-linked equity investments. These holdings are generally in other insurance undertakings and not in PACTA sectors. If we exclude or correct for these participations, only 2% of the equity holdings remain "unmapped".[40] Moreover, there is a big difference between the mapping shares of the unit-linked and non-unit-linked portfolios. While we are able to map almost the full equity holdings in the unit-linked portfolio (97%), the mapping share is much lower for the equity holdings in the "traditional" portfolio. The difference, however, is almost entirely explained by the large share of participations held in the traditional portfolio.

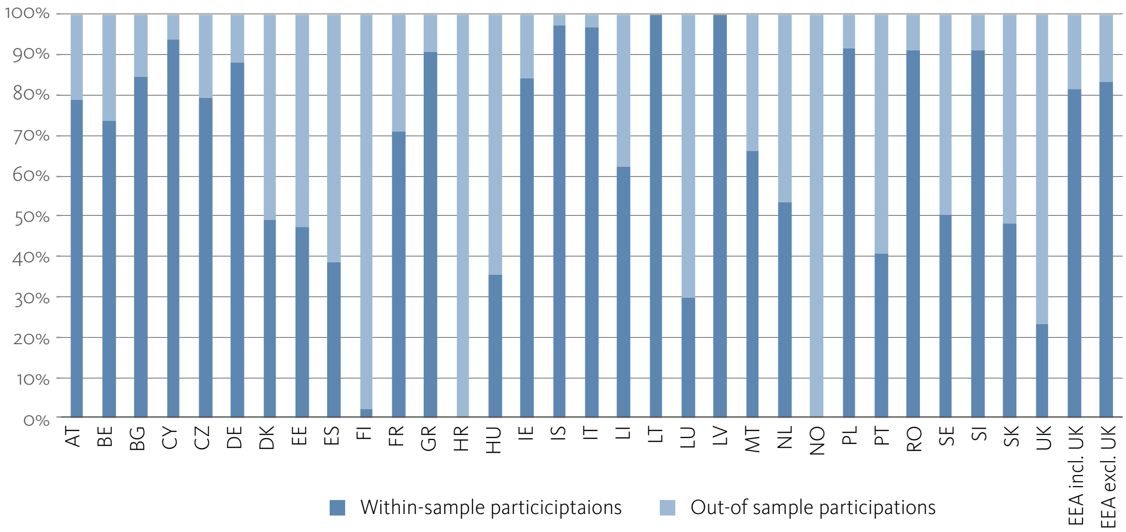
The issue of participations in the traditional portfolio is evident also for re-insurance undertakings in particular. Moreover, the fact (as is shown in Figure 7) that more than 80% of the participations are within sample, i.e. insurers in the sample holdings participations in other insurers in the sample, means that we can largely conclude that when we look at the EEA holdings of climate-relevant exposures, participations and holdings in related undertakings usually are holding within sample and therefore covered by the overall sector-level findings.

38 The label "not defined as climate-policy relevant in this context, or out of scope", refers to assets which was possible to identify in the PACTA tool, but was assigned sectors not included in PACTA (e.g. real estate) or not considered climate-relevant with the methodology and approach presented in this report.

39 The main CIC sectors for equity, 31 and 34 (common and preferred equity), which accounts for about 85% of the total CIC 3 holdings are considered

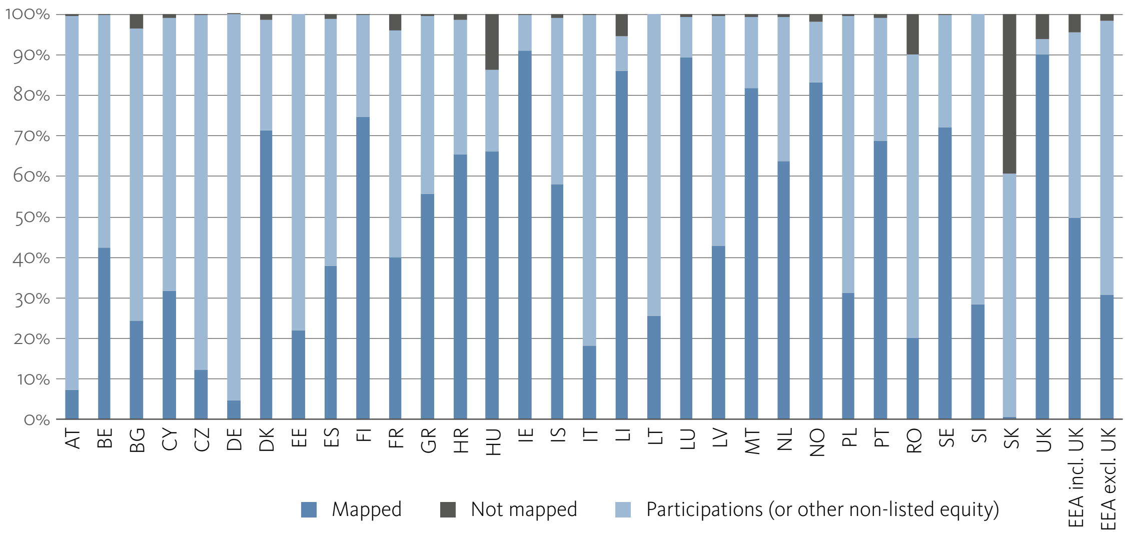
40 Participations were not excluded completely from the input data because some participations could be mapped, indicating that there could be minor reporting errors or certain group structures where financial data was available. While including participations in the input data does reduce "mapping coverage" as presented here, it does not affect any of the results

Figure 7. In-sample vs out of sample participations – Equity – All undertakings – Per country of holder



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

Figure 8. Estimation of mapping coverage corrected for participations – Equity – All undertakings – Per country of holder

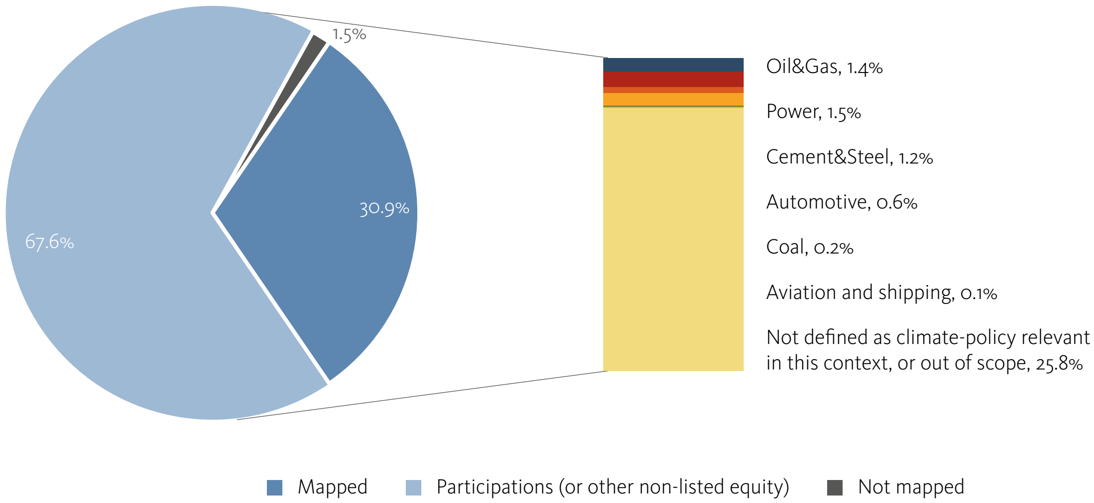


Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

On a country-by-country basis, the coverage is somewhat heterogeneous, but on average high when participations in related undertakings are taken into consideration. As can be seen in Figure 8, the average mapping excl. UK was slightly above 30%, but almost all the rest were participations. Mapping for composites and life insurers were highest (45% and 64%) largely due to unit-linked holdings and non-life and re-insurance companies had the highest share of participations and therefore also lower "mapping" in the PACTA service (17% and 5% respectively, but the missing parts were almost entirely explained by participations or non-listed equity).

Overall, the coverage for equity holdings are also seen to be high because a large share is participations and not likely to be in climate-policy relevant sectors. The issue of par-

Figure 9. Share of equity investments in key climate-policy relevant sectors. [38] All undertakings. Incl. unit-linked. EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

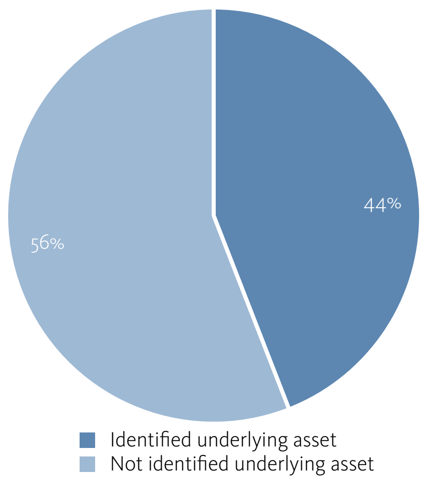
ticipations is not at all an issue in the unit-linked portfolio where coverage is very high, and is mainly related to non-life and re-insurance undertakings. In total, equity holdings of 278 billion euro were mapped (661 billion if including UK). In terms of sector breakdown, there is not a clear visible difference between the unit-linked and non-unit-linked portfolio. The figure below shows the full portfolio.

HOLDINGS THROUGH COLLECTIVE INVESTMENT UNDERTAKINGS (INDIRECT HOLDINGS THROUGH FUNDS)

Solvency II data only allows for look-through with very general asset categories. Investments in funds (collective investment undertakings) account for about 1/3 of all investments by insurers and information about the actual underlying asset is therefore of key importance.[41]

Taking advantage of the data available via the PACTA service, it is possible to identify 44% of the underlying assets in these fund holdings. This is important because it adds 871 billion euro to the pool of assets that can be considered for this exercise. While the share is below 50%, it still has to be understood in the context that there is almost no information available about the assets in a fund regularly reported to the supervisor.

Figure 10. Share of investments in funds (CIUs) where the underlying asset could or could not be identified. All undertakings. Incl. unit-linked. EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

Overall, on an EEA level, the holdings in climate-policy relevant sector is about 6% of the mapped investments (or about 3% of the total holdings in CIUs), comparable to direct equity and corporate bond investments.

41 Equity funds, debt funds and asset allocation funds (CIC 41, 42 and 44) are considered in this analysis. These account for about ¾ of all investments in funds. The main categories not included are private equity, money market funds and real estate funds.

Figure 11. Distribution of identified holdings per asset type and sector relevance – Investment funds – All undertakings – Incl. unit-linked – Per country of holder

Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

SUMMARY OF HOLDINGS IN CLIMATE-POLICY RELEVANT SECTORS AND TECHNOLOGIES AND LINKS TO PHYSICAL ASSETS AND PRODUCTION (TECHNOLOGY)

Holdings of corporate bonds and equity

As shown in the sections above, it was possible to assess about 2.3 trillion in corporate bond and equity holdings excl. UK (or 3.4 trillion incl. UK). About 350 billion euro of these were identified to be in climate policy relevant sectors described above (539 if UK is included). This is 3.1% (4.8% incl. UK) of total investments (incl. all asset classes) and 8.3% (9.3% incl. UK) of all relevant corporate bonds, equity and funds investments.

The parts that have been classified as non-climate policy relevant in this context are mainly investments in financials, public administration or property.

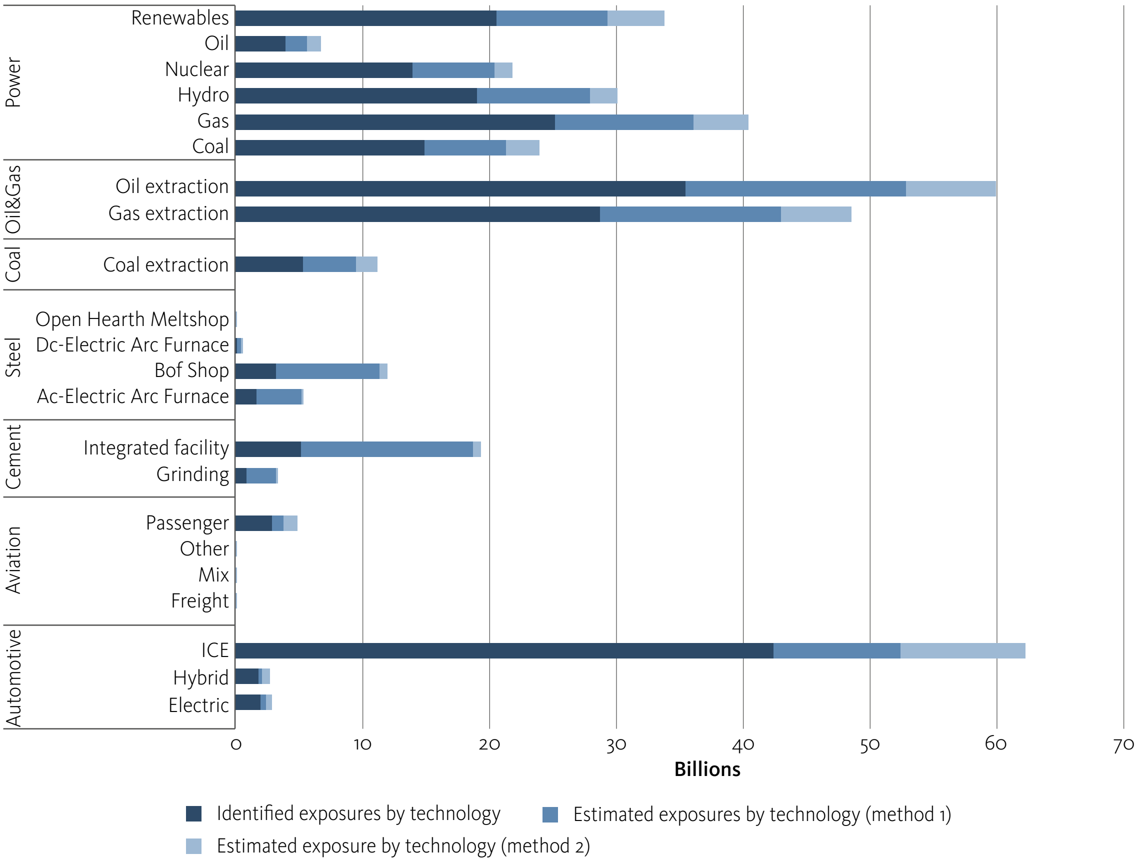
For a large share of assets which a sector identification (but not all), it is possible to further identify the technologies used in production. A security may be mapped to several technologies depending on the operation of the issuing company. Using the data available in PACTA, we can positively identify the technology used for investments worth around 344 billion euro if we include UK and 227 billion euro if UK is excluded. Similarly to what was reported in the preliminary findings[42], this represents about 3% of total investments (incl. all asset classes) or 5.4% and 6% of the relevant corporate bonds, equity and funds investments (excl. and incl. UK respectively). More importantly, it represents 10% of all the investments that the PACTA toolset was able to map. Moreover, it is important to note the caveat that this excludes unmapped assets, agriculture and property (as well as the indirect effect on the financial sector).

In order to highlight the uncertainty around the mapping, and to account for the difference between those assets where the sector could be identified and those assets where both sector and technology could be identified, it is possible to extrapolate the identified shares. It is further possible to account for the part of the portfolio that was not mapped. By showing the impacts of these "extrapolations", it is possible to get a fairly consistent view of the likely holdings of the types of climate-policy relevant exposures we consider in this exercise (i.e. the ones in PACTA) within each technology. Figure 12 shows the three resulting estimates of the holdings.

The dark blue bar shows the amount that was positively identified and data on sector and technology was available. The *additional, lighter blue, bar* adjusts for the fact

42 See https://www.eiopa.europa.eu/content/workshop-climate-change-related-risks_en

Figure 12. Value of investments in key climate-policy relevant sectors. Corporate bonds and equity, incl. look through of funds (CIUs). All undertakings. Incl. unit-linked. EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4. The sectors coal and Oil&Gas represent fossil fuel extraction. In the power sector, it represent the fuel used to generate energy.

that technology was not available for some investments and presents the amount if we assume that the technology share is the same for those investments as for those where technology could be positively established. This leads to slightly higher estimates of the holdings (method 1).

The second additional bar (lightest blue) assumes that the non-listed and non-mapped corporate bonds have the same share of climate-relevant exposures as the mapped corporate bonds. The same assumption is done for equity, but in this case it is assumed that participations are not directly climate-relevant in this context (since second round effects are not in scope). For funds, the share of climate-policy relevant exposures are assumed to be the same in the part where the underlying asset is identified and where it is not.[43] This leads to the highest estimate of holdings (method 2).

It should be noted that all of these three represent conservative estimations of the overall holdings because even the highest estimation does not account for holdings in other asset classes than those defined for this study (e.g. covered bonds were not included, but might still contain climate-policy relevant holdings).[44]

While Figure 12 shows the amounts identified and extrapolated in billions of euro for the EEA (excl. UK), Table 1 shows how these holdings translate to a share of equity, corporate bonds and funds per country. Table 3 in the appendix provides further details.

43 For simplicity, this assumption has been applied aggregated at country-level, not for individual insurers.

44 The small amounts held in shipping are excluded in the price sensitivity analysis due to limited data.

Table 1. Holdings of climate-relevant technologies in PACTA as a share of relevant equity, corporate bonds and funds (see Footnote 36)

	Electric vehicles	Hybrid vehicles	ICE vehicles	Aviation	Cement production	Coal production	Gas production	Oil production	Coal power	Gas power	Hydro power	Nuclear power	Oil power	Renewable power	Steel production	Total
AT	0.0%	0.0%	0.6%	0.0%	0.1%	0.2%	0.8%	0.9%	0.4%	0.4%	0.4%	0.3%	0.1%	0.3%	0.3%	4.8%
BE	0.0%	0.1%	1.2%	0.1%	0.2%	0.2%	1.0%	1.2%	0.5%	0.9%	0.7%	0.5%	0.2%	0.7%	0.1%	7.4%
BG	0.0%	0.0%	1.0%	0.1%	0.0%	0.0%	3.0%	1.4%	0.5%	0.2%	0.2%	0.4%	0.0%	0.1%	0.5%	7.6%
HR	0.0%	0.0%	1.1%	0.0%	0.0%	0.0%	0.4%	0.3%	0.3%	0.4%	0.3%	0.1%	0.1%	0.5%	0.1%	3.7%
CY	0.1%	0.0%	1.3%	0.1%	0.4%	0.4%	0.8%	1.1%	0.6%	0.7%	0.3%	0.3%	0.2%	0.3%	0.5%	7.1%
CZ	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	1.3%	0.7%	1.2%	0.3%	0.4%	0.8%	0.0%	0.4%	0.2%	6.3%
DK	0.0%	0.0%	0.2%	0.1%	0.1%	0.0%	0.3%	0.4%	0.2%	0.3%	0.1%	0.1%	0.1%	0.4%	0.1%	2.2%
EE	0.0%	0.2%	3.4%	0.2%	0.1%	0.2%	0.7%	0.7%	0.4%	0.5%	0.7%	0.6%	0.6%	0.5%	0.3%	9.0%
FI	0.0%	0.0%	1.1%	0.1%	0.1%	0.0%	0.3%	0.4%	0.2%	0.3%	0.4%	0.3%	0.1%	0.3%	0.2%	4.0%
FR	0.0%	0.1%	1.2%	0.1%	0.2%	0.2%	1.0%	1.2%	0.5%	0.9%	0.6%	0.6%	0.1%	0.7%	0.1%	7.4%
DE	0.0%	0.0%	0.5%	0.0%	0.0%	0.1%	0.2%	0.3%	0.1%	0.2%	0.1%	0.1%	0.0%	0.2%	0.0%	1.9%
GR	0.0%	0.1%	1.8%	0.2%	1.2%	0.6%	1.0%	1.2%	0.5%	0.8%	0.6%	0.5%	0.1%	0.7%	0.3%	9.8%
HU	0.0%	0.0%	0.5%	0.1%	0.1%	0.0%	1.0%	1.0%	0.2%	0.2%	0.1%	0.0%	0.0%	0.2%	0.1%	3.5%
IS	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
IE	0.1%	0.1%	1.2%	0.1%	0.2%	0.2%	0.8%	1.1%	0.3%	0.5%	0.3%	0.2%	0.1%	0.4%	0.2%	5.9%
IT	0.0%	0.0%	1.3%	0.1%	0.2%	0.2%	0.9%	1.1%	0.6%	1.0%	0.7%	0.3%	0.2%	0.7%	0.2%	7.6%
LV	0.0%	0.1%	1.6%	0.0%	0.1%	0.0%	0.9%	0.7%	0.6%	0.7%	1.1%	0.5%	0.6%	0.3%	0.1%	7.5%
LI	0.0%	0.1%	2.0%	0.1%	0.2%	0.2%	0.8%	1.0%	0.3%	0.4%	0.2%	0.2%	0.1%	0.3%	0.3%	6.2%
LT	0.0%	0.0%	0.9%	0.1%	0.1%	0.1%	1.0%	0.7%	0.4%	0.6%	1.1%	0.5%	0.9%	0.5%	0.2%	7.1%
LU	0.0%	0.1%	1.4%	0.2%	0.2%	0.2%	0.8%	1.2%	0.3%	0.5%	0.3%	0.2%	0.1%	0.4%	0.3%	6.1%
MT	0.1%	0.1%	2.0%	0.4%	0.3%	0.4%	1.6%	2.0%	0.5%	0.8%	0.5%	0.8%	0.1%	0.6%	0.3%	10.5%
NL	0.0%	0.1%	1.6%	0.0%	0.2%	0.2%	0.7%	0.9%	0.5%	0.7%	0.5%	0.3%	0.1%	0.7%	0.1%	6.7%
NO	0.0%	0.0%	0.4%	0.1%	0.0%	0.0%	0.9%	1.2%	0.2%	0.4%	1.5%	0.1%	0.0%	0.4%	0.1%	5.5%
PL	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.6%	0.3%	0.4%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%	2.2%
PT	0.1%	0.1%	2.7%	0.6%	0.3%	0.2%	1.5%	2.4%	1.1%	1.5%	2.6%	0.5%	0.2%	0.8%	0.4%	14.8%
RO	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.1%	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.0%	0.7%
SK	0.0%	0.1%	2.7%	0.0%	0.2%	0.1%	1.1%	0.9%	1.5%	0.7%	0.5%	1.4%	0.1%	1.6%	0.4%	11.3%
SI	0.0%	0.1%	2.3%	0.2%	0.1%	0.2%	1.0%	0.8%	0.3%	0.3%	0.3%	0.2%	0.3%	0.7%	0.3%	7.0%
ES	0.0%	0.1%	2.4%	0.2%	0.1%	0.3%	1.3%	1.3%	1.1%	1.6%	1.4%	1.1%	0.2%	1.6%	0.2%	12.8%
SE	0.5%	0.0%	1.3%	0.1%	0.1%	0.0%	0.3%	0.5%	0.1%	0.2%	0.1%	0.1%	0.0%	0.2%	0.1%	3.7%
UK	0.0%	0.0%	0.8%	0.2%	0.2%	0.3%	1.2%	1.4%	0.6%	0.8%	0.4%	0.4%	0.1%	0.7%	0.4%	7.6%
EEA incl. UK	0.0%	0.0%	0.9%	0.1%	0.2%	0.2%	0.8%	1.0%	0.4%	0.6%	0.4%	0.4%	0.1%	0.5%	0.2%	6.0%
EEA excl. UK	0.0%	0.0%	1.0%	0.1%	0.1%	0.1%	0.7%	0.8%	0.4%	0.6%	0.5%	0.3%	0.1%	0.5%	0.1%	5.4%

These findings will form the basis for the assessment of price sensitivity in the second part of this report. With the method and assumptions explained above, we can investigate the effects of price adjustments to the equity and corporate bonds (incl. those in CIUs) that have been related to physical production in the CIC codes included in the analysis.[45]

Holdings of government bonds

The value of government bonds may also react to changes in the economic activities stemming from the energy transition discussed in this report, although the transmission mechanism is different and less direct than for equity and corporate bonds. The analysis is therefore complemented with an assessment of these holdings. The value of the initial holdings of government bonds are more straight-forward to identify as they are reported directly on a line-by-line by security under Solvency II. The reported information contains information about the issuer, the holder, the duration and price and quantity.[46] The table below gives an extensive overview of Government bond holdings by EEA (and UK) insurers as of 2019Q4.

45 Assets that have been mapped to other sectors, covered bonds or assets issued by real estate corporations are not shocked. The aviation, cement and steel sectors are covered in terms of identifying the assets, but price adjustments are not modelled in the PACTA service.

46 EIOPA also makes key data publicly available through the EIOPA Insurance Statistics

Table 2. Holdings of government bonds by holder and issuer. Including unit-linked.

Holdings in climate relevant technologies (Extrapolation: None). Share of equity, corporate bonds and funds

	Issuer country																														Total holdings	
Holder country	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GB	GR	HR	HU	IE	IS	IT	LT	LU	MT	NL	NO	PL	PT	RO	SE	SI	SK	Other EEA or outside EEA	eur. mn.	% of total investm.
AT	23.2%	8.8%	0.3%	0.0%	1.2%	7.1%	0.1%	0.0%	5.7%	2.3%	8.9%	0.0%	0.0%	0.2%	0.3%	3.6%	0.0%	3.0%	1.3%	5.9%	0.3%	3.0%	0.0%	4.2%	1.0%	1.0%	0.0%	2.7%	4.9%	11.1%	23,567	18%
BE	3.9%	53.2%	0.1%	0.0%	0.2%	4.7%	0.0%	0.0%	5.4%	0.6%	12.9%	0.2%	0.0%	0.0%	0.0%	1.9%	0.0%	4.5%	0.3%	1.4%	0.1%	1.3%	0.0%	0.9%	1.2%	0.1%	0.0%	0.4%	0.8%	5.6%	141,758	41%
BG	0.1%	0.4%	43.6%	0.0%	16.4%	0.2%	0.0%	0.0%	2.6%	0.0%	0.7%	0.0%	0.2%	0.5%	5.4%	0.5%	0.0%	2.6%	0.4%	0.0%	0.1%	0.1%	0.0%	12.2%	1.7%	4.0%	0.0%	1.0%	1.6%	5.7%	1,551	46%
HR	0.5%	0.2%	0.3%	0.5%	0.0%	0.8%	0.0%	0.0%	1.7%	0.0%	0.3%	0.0%	0.0%	88.8%	0.1%	0.6%	0.0%	1.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.3%	0.6%	1.2%	0.0%	0.3%	0.9%	1.7%	3,241	58%
CY	0.9%	0.6%	0.0%	37.5%	0.2%	2.5%	0.0%	0.0%	2.8%	0.2%	2.3%	0.0%	3.2%	0.0%	0.2%	0.7%	0.0%	13.1%	0.3%	1.6%	0.2%	1.8%	0.1%	3.1%	2.1%	2.2%	0.0%	0.9%	1.4%	22.1%	395	11%
CZ	0.8%	0.1%	0.3%	0.0%	87.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%	0.3%	0.0%	0.0%	0.2%	0.0%	1.1%	0.0%	0.1%	0.0%	2.4%	0.0%	0.3%	0.0%	0.2%	1.6%	4.7%	6,594	42%
DK	0.1%	2.8%	0.0%	0.0%	0.1%	22.0%	37.7%	0.0%	4.9%	1.4%	5.4%	0.2%	0.0%	0.0%	0.3%	0.7%	0.0%	4.2%	0.0%	0.4%	0.0%	1.7%	0.3%	0.4%	0.1%	0.2%	2.2%	0.1%	0.0%	14.7%	38,985	11%
EE	3.8%	2.3%	0.5%	0.0%	3.5%	14.7%	0.0%	0.0%	4.1%	1.5%	7.3%	0.0%	0.0%	1.8%	1.7%	1.0%	0.6%	0.9%	8.0%	2.8%	0.0%	0.5%	0.2%	9.4%	1.3%	0.2%	0.0%	2.9%	8.0%	23.1%	272	14%
FI	7.2%	4.2%	0.0%	0.0%	0.0%	31.6%	0.2%	0.1%	1.9%	22.2%	11.7%	0.5%	0.0%	0.0%	0.0%	1.2%	0.0%	0.0%	0.0%	0.8%	0.0%	9.9%	0.1%	0.0%	0.6%	0.1%	0.2%	0.1%	0.0%	7.5%	3,186	4%
FR	2.6%	5.2%	0.0%	0.0%	0.1%	2.9%	0.0%	0.0%	6.0%	0.4%	64.0%	0.1%	0.0%	0.0%	0.0%	1.3%	0.0%	6.1%	0.0%	2.4%	0.0%	1.0%	0.0%	0.4%	0.4%	0.0%	0.0%	0.2%	0.2%	6.4%	748,606	28%
DE	4.6%	6.8%	0.1%	0.0%	0.1%	40.0%	0.2%	0.0%	5.5%	1.1%	9.0%	1.3%	0.0%	0.1%	0.1%	1.8%	0.0%	1.5%	0.3%	2.9%	0.0%	1.7%	0.1%	1.5%	0.3%	0.4%	0.1%	0.6%	0.9%	18.9%	366,189	16%
GR	0.6%	2.6%	0.0%	0.6%	0.0%	5.4%	0.0%	0.0%	5.7%	0.3%	6.8%	0.0%	57.2%	0.1%	0.0%	1.9%	0.0%	7.1%	0.1%	1.2%	0.0%	1.4%	0.0%	0.8%	1.9%	0.1%	0.0%	0.2%	0.4%	5.6%	9,206	53%
HU	0.0%	0.0%	1.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.4%	0.0%	0.0%	96.7%	0.0%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.4%	0.0%	0.1%	0.1%	0.5%	4,423	50%
IS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	235	22%
IE	3.8%	3.8%	0.0%	0.0%	0.6%	12.7%	0.2%	0.3%	5.1%	1.1%	18.8%	8.2%	0.0%	0.0%	0.2%	6.7%	0.1%	10.1%	0.0%	0.7%	0.0%	3.5%	0.3%	0.6%	1.0%	0.4%	0.8%	0.2%	0.3%	20.3%	45,871	12%
IT	0.4%	1.1%	0.2%	0.1%	0.0%	1.1%	0.0%	0.0%	6.6%	0.1%	3.2%	0.1%	0.0%	0.1%	0.0%	0.9%	0.0%	80.5%	0.0%	0.7%	0.0%	0.6%	0.1%	0.3%	0.9%	0.5%	0.0%	0.3%	0.2%	1.9%	417,014	44%
LV	3.4%	2.0%	1.0%	0.0%	0.3%	7.2%	0.0%	0.0%	1.2%	3.4%	2.0%	0.0%	0.0%	0.6%	0.1%	0.0%	0.0%	0.0%	32.6%	1.3%	0.0%	4.5%	0.0%	19.7%	0.0%	1.4%	0.0%	0.0%	0.2%	19.1%	513	40%
LI	2.0%	2.4%	0.0%	0.0%	0.0%	14.0%	0.4%	0.0%	3.6%	1.4%	9.3%	3.7%	0.1%	0.0%	0.0%	1.5%	0.0%	5.7%	0.2%	5.4%	0.0%	3.0%	1.3%	0.3%	1.5%	0.4%	0.1%	0.6%	0.5%	42.6%	1,172	5%
LT	2.1%	2.1%	2.1%	0.0%	0.2%	3.8%	0.0%	0.0%	2.6%	0.4%	3.9%	0.0%	0.0%	9.6%	1.8%	1.5%	0.0%	1.9%	42.2%	0.6%	0.0%	1.0%	0.0%	8.9%	0.0%	4.5%	0.0%	0.8%	0.7%	9.3%	693	59%
LU	2.6%	7.8%	0.0%	0.0%	0.4%	9.1%	1.1%	0.0%	3.7%	1.3%	19.9%	4.1%	0.1%	0.2%	0.1%	0.9%	0.0%	7.6%	0.1%	5.0%	0.0%	2.9%	0.9%	1.6%	0.9%	0.1%	0.7%	0.2%	0.9%	27.7%	19,692	9%
MT	3.7%	0.8%	0.0%	0.0%	0.0%	4.1%	0.0%	0.0%	3.5%	1.4%	5.6%	14.2%	0.1%	0.1%	0.0%	0.4%	0.0%	9.0%	0.0%	1.4%	17.6%	1.8%	0.7%	0.2%	0.3%	0.4%	0.0%	0.2%	0.1%	34.2%	2,443	22%
NL	7.8%	7.6%	0.0%	0.0%	0.4%	24.3%	0.1%	0.0%	3.9%	2.6%	13.3%	0.4%	0.0%	0.0%	0.0%	1.6%	0.0%	2.2%	0.1%	1.3%	0.0%	23.5%	0.0%	0.3%	0.6%	0.1%	0.0%	0.1%	0.3%	9.3%	132,811	29%
NO	2.4%	3.5%	0.0%	0.0%	0.0%	6.7%	1.6%	0.0%	0.2%	3.6%	12.2%	2.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	3.4%	0.0%	0.3%	42.4%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%	19.1%	15,800	8%
PO	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%	95.9%	0.0%	0.4%	0.0%	0.0%	0.0%	2.6%	18,216	43%
PT	0.7%	2.0%	0.0%	0.0%	0.0%	1.7%	0.0%	0.0%	15.3%	0.1%	3.9%	0.0%	0.4%	0.0%	0.0%	0.4%	0.0%	17.7%	0.0%	0.7%	0.0%	1.1%	0.0%	0.1%	53.8%	0.1%	0.0%	0.1%	0.0%	1.9%	23,160	43%
RO	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.1%	0.0%	0.5%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.3%	0.0%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	96.9%	0.0%	0.1%	0.0%	0.4%	1,846	51%
SK	2.4%	2.4%	0.5%	0.0%	1.4%	0.4%	0.0%	0.0%	2.4%	0.1%	5.2%	0.0%	0.5%	0.5%	0.7%	1.6%	0.0%	0.5%	0.7%	7.2%	0.0%	1.6%	0.0%	5.7%	1.3%	1.6%	0.0%	1.8%	56.9%	4.7%	2,315	35%
SL	2.7%	3.2%	0.2%	0.7%	0.5%	8.2%	0.0%	0.0%	6.2%	1.1%	7.7%	0.3%	0.9%	2.4%	0.8%	1.8%	0.3%	5.1%	0.8%	1.5%	0.0%	4.9%	0.1%	2.9%	4.1%	1.3%	0.1%	29.8%	1.8%	10.6%	2,724	33%
ES	0.2%	0.5%	0.0%	0.0%	0.0%	0.5%	0.0%	0.0%	83.8%	0.0%	1.3%	0.1%	0.0%	0.0%	0.0%	0.3%	0.0%	9.8%	0.0%	0.2%	0.0%	0.3%	0.0%	0.0%	1.2%	0.1%	0.0%	0.1%	0.0%	1.5%	163,041	54%
SE	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	1.1%	0.0%	0.0%	0.9%	0.1%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	2.6%	0.0%	0.3%	1.9%	0.2%	0.0%	0.0%	74.8%	0.0%	0.0%	15.9%	24,776	8%
UK	0.2%	0.4%	0.0%	0.0%	0.0%	2.6%	0.1%	0.0%	0.2%	0.2%	2.1%	70.3%	0.0%	0.0%	0.1%	0.0%	0.0%	0.6%	0.0%	1.3%	0.0%	0.4%	0.1%	0.1%	0.1%	0.0%	0.1%	0.0%	0.0%	20.9%	319,688	13%
EEA incl. UK	2.5%	6.5%	0.1%	0.0%	0.3%	9.6%	0.7%	0.0%	10.0%	0.6%	23.3%	9.3%	0.2%	0.2%	0.2%	1.2%	0.0%	16.8%	0.1%	1.8%	0.0%	2.2%	0.4%	1.3%	1.0%	0.3%	0.8%	0.3%	0.4%	9.8%	2,539,982	22%
EEA excl. UK	2.8%	7.3%	0.1%	0.0%	0.4%	10.6%	0.8%	0.0%	11.4%	0.7%	26.3%	0.6%	0.3%	0.2%	0.2%	1.4%	0.0%	19.2%	0.1%	1.8%	0.0%	2.5%	0.4%	1.4%	1.2%	0.3%	0.9%	0.3%	0.5%	8.2%	2,220,295	25%

SENSITIVITY TO VALUATION CHANGES

Using the information described in the previous section about holdings (and extrapolated holdings) in corporate bonds, equity and government bonds, this section aims to discuss and quantify potential price and balance sheet sensitivities to "what-if" scenarios where the economies are required to re-align and dramatically reduce the CO_2 footprint.

In detail, the aim of this section is to assess and quantify possible price changes in a scenario designed to lead to net-zero climate emissions by mid-century. Some assumptions will have to be employed in order to carry out this sensitivity analysis. The main assumptions are related to data issues, extrapolation and model choices. Whenever such assumptions have been made, it will be made clear in the text and key results will be shown that also illustrates the effect of the assumptions.

TRANSITION SHOCK NARRATIVE IN THIS REPORT

A general and fully calibrated scenario covering all climate-related risks is currently not yet available for general implementation and most available literature uses bespoke solutions developed for a specific purpose. There are several reasons for this. The main reason is the relatively limited maturity of this field. Another reason is different timelines for the impacts for the different types of risks, which means that focus is often partial (i.e. on transition risks or on long-term climate risks) and difficult to combine.

This work therefore draws on different parts of the literature related to asset-side transition risks and considers a narrative that is consistent across asset classes in terms of general approach. It represents what-if scenarios that draws on available research in an overall consistent narrative, and effort has been made to select and/or adjust parameters and variables to ensure that the scenarios and shocks per asset class are consistent with this narrative. However, the actual implementation will depend on available research and will differ somewhat between asset classes and depend on the data availability for the different assets.

A LATE AND SUDDEN POLICY SHOCK

In this report, we consider a scenario where delayed policy action is taken to abruptly move the economy to a path that is more likely to result in a 2 degree outcome than the current (baseline) pathway, in line with the Paris agreement to limit global warming compared to pre-industrial levels.[47] In detail, we assume this policy change takes the form of an increase in carbon price per ton by the end of this decade set in order to limit carbon concentration to around 450-500 ppm. This refers to the concentration of CO_2 at the end of century that is, based on current knowledge, most likely to be consistent with a 2°C aligned scenarios (see e.g. Menishausen et al., 2009).

This policy action means that the economy will have to re-align and it is assumed that production and output in the sectors considered in this report will change. For instance would we see a shift away from internal combustion engine (ICE) vehicles, fossil fuel extraction and power generation based on non-renewable energy. Because the policy is late to be enacted and emission reduction is only gradually achievable, the response will have to be "stronger" to make up for the CO_2 emitted before the policy was enacted (this is what is meant with a "delayed" policy action in this context).

As pointed out by the European Systemic Risk Board (ESRB (2020)) and by several academic and industry papers, climate risk does not appear to be fully reflected in asset prices so far. In line with previous studies, we therefore consider that this policy shock would have an impact on market prices that is not currently anticipated.

The actual implementation of this scenario therefore requires at least two key components. First, a model or a view on how the production, profit or value-added will change in each sector. And second, a model or methodology to consider how this shift will affect market prices of the assets held in the insurance portfolio. The next sections explain in detail how these components are derived for each of the asset types considered.

47 These types of scenarios are usually referred to as a "late and sudden" policy scenario.

PRICE SENSITIVITY OF EQUITY AND CORPORATE BOND HOLDINGS

For corporate bonds and equity, were asset price changes will be a function of the required change in production and a function of the misalignment with the 2 degree scenario, we use a carbon budget accounting method where we assume green-house gas (GHG) emissions are targeted to reach the outcome described above. The main scenario is implemented by assuming that the production shock is a function of the difference in capacity between the late and sudden transition and the International Energy Agency's (IEA) Sustainable Development Scenario (SDS, often referred to as a "2 degree scenario").[48] A supplementary scenario is calibrated based on the IEA "Beyond 2 degrees" (B2DS) scenario, which requires slightly stronger policy action. It can be interpreted as a scenario that is likely to have a higher probability of limiting global warming to 2 degrees (or below).

This approach links production directly to a carbon budget and is consistent with the generally framed narrative we are using in this analysis. The resulting alignment in production is translated to shocks to the assets as an instantaneous shock under the assumption that the portfolio of the insurers remains constant and that the shock is not already priced in. Full details of the approach is available in Hayne et al (2019).

ASSETS WITH DETAILED PRODUCTION DATA

For each of the considered technologies, the equity and corporate bond holdings of EEA insurers have been mapped (see the sections on holdings of assets in climate-policy relevant sectors) to the current relevant physical production levels, with projections for future production levels computed[49] and extrapolated using data available to 2DII. This data is sourced from different market intelligence agencies and used for the PACTA tool developed by 2DII.

The projections of implicit production in the insurance portfolio have been mapped to the trajectories described by the IEA's output from their models for SDS (and B2DS).[50]

48 Full details available here: https://www.iea.org/reports/world-energy-model/sustainable-development-scenario

49 The portfolio weights are considered constant, only production volumes are projected.

50 Further details on how the assets are linked to current and planned production, and how that production is mapped to financial assets are available here: https://www.eiopa.europa.eu/content/workshop-climate-change-related-risks_en

Taking advantage of the detailed data available in the PACTA tool, we calculate production levels consistent with the IEA scenarios in the following sectors: Power, Oil&Gas, Coal and Automotive.[51] The difference between what is currently projected and what would have to be required under the IEA scenarios forms the basis of understanding how much production would have to be cut (or increased) given a policy shock. Production levels can also be combined with price data made available by the IEA based and available as results of the IEA set of integrated assessment models (IAMs).

Equity prices

The energy transition required by the policy shock will impact companies' revenues and expenses, with the amplitude of the effect varying depending on the sector and market in which they operate. These changes in the companies' profits will subsequently impact their market value. We rely on standard valuation approaches to capture these changes. We calculate the changes at technology level. In detail, in order to calculate equity shocks, we start by calculating for each individual technology, net profits under the two scenarios as

Net Profits = (Production Volume * Price * Net profit margin)

From Gordon's (1959) formulation of future dividends' flows, we know that equity market price in a given year is linearly dependent on the expected dividends that year. We further assume that dividends for a given year are proportional to the net profits of a company for this year. Aggregating the production profiles to technology level, we can estimate the Net Present Value of this technology (i.e. of the sector and technology) based on future cash flows.

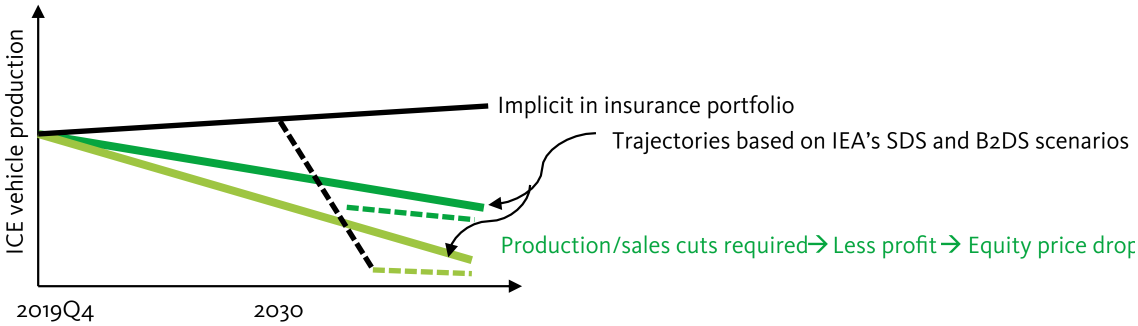
$$V_{E,t_0} = a \sum_{t_0}^{t_b} \frac{P_t}{(1+r)^t}$$

With P_t the net profits made in year t, t_b the date until we model cash-flows (2040), r the risk free rate assumed to be 2% for simplicity and a the proportionality coefficient between net profits and dividends.

The difference between V_{E,t_0} under the projected production plans (or in some cases the IEA "no new policies scenario") and the IEA SDS or B2DS, is the equity value put at risk by the transition. This means that consistent with the

51 Assets reported to be issued by real estate corporations are excluded from the analysis. Covered bonds are also excluded. The full list of CICs included are 21, 22, 25, 28, 31, 34, 41, 42, 44. Assets with negative reported market value has been excluded.

Figure 13. Illustrative example of methodology for production alignment and modelling of production adjustments



scenario, we have calculated a price change for each of the identified technologies which can be brought back into the insurance portfolio to understand the impact of the shock.

These shocks are endogenous to the model and depend on the actual investments of European insurers.[52]

FOR IDENTIFIED TECHNOLOGIES THAT COULD NOT BE MODELLED

For the technologies in the aviation, cement and steel sectors, it is not possible to model price sensitivities using the PACTA toolset. However, since the sectors and technologies could be identified, we rely on the price sensitivities employed by The Prudential Regulation Authority (PRA) at the Bank of England 2019 Climate-change scenarios that were incorporated in their 2019 stress test (see The Prudential Regulation Authority, 2019).

The price adjustments employed by the PRA were considered exploratory and calibrated to be in line with the same type of scenario that have been employed in this analysis. Importantly, similarly to the method described above for technologies modelled using the PACTA sector, the PRA considered a delayed and disorderly transition scenario that was assumed to have its impacts coupled with a decreased sectorial output. Moreover, the PRA also related price adjustments for fuel extraction and power generation to the IEA SDS scenario projections. While certain technical aspects of the implementation might differ somewhat, the price adjustments are still considered informative and reasonable in the context of this sensitivity analysis, in particular because it is a learning exercise.[53] Finally, since the volume of investments in these sectors are relatively small, the impact of minor adjustments to these factors would not be material at relevant levels of aggregation used in this report.

ESTIMATED PRICE ADJUSTMENTS

Figure 14 shows the resulting price adjustments employed for equity using the approach described above. The chart shows the calibrated adjustments for the main scenario (based on IEA SDS) and the supplementary scenario calculated to highlight possible differences in terms of how the level of ambition and climate-change target might affect the results.[54]

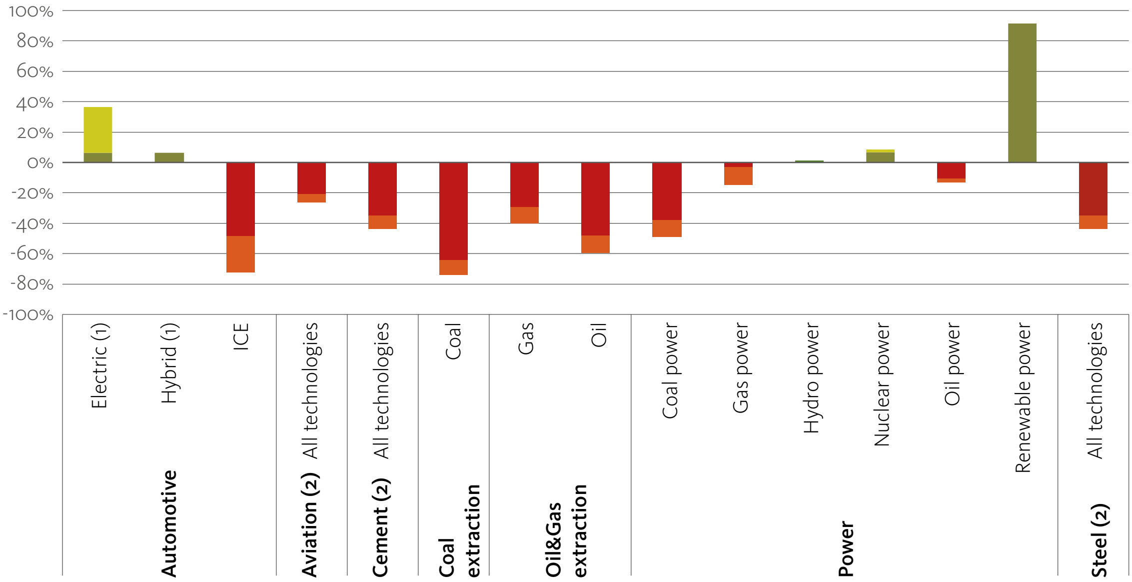
As can be seen in Figure 14, the effects of the supplementary scenario is mainly visible for the key high-carbon technologies, with production of ICE vehicles and coal and oil

52 A set of simplifications have been employed. First, the approach overlook possible interactions between sectors (in reality, emissions may decrease less than needed in an industry and more than needed in another leading to different implementation of a "2 degree scenario"). Second, in the absence of alternative solutions, it features a simplistic price dynamic and neglects changes in net margins for some sectors (see on Hayne et al 2019). The scenarios presented in this report are based on the IEA reference scenarios. However, as this is a learning exercise, it should be noted that other scenarios could also be explored, potentially via the PACTA service. Of particular interest could be the scenarios built on the concept of the "Inevitable Policy Response", a term describing a set of transition pathways that while delayed, suggest that a combination of policy, technology, and consumer behaviour will at some point set the economy on a sustained decarbonisation pathway.

53 The average difference between the SDS and B2DS results for the fossil fuel extraction technologies have been used to adjust the technologies were the price adjustment was sourced from the Prudential Regulation Authority to generate the supplementary adjustments also for those technologies.

54 In order to ensure consistency in narrative, the supplementary scenario (based on B2DS) employs same methodology in terms of relying on production plans or the IEA "baseline" scenario of current policies for each technology. For the relatively low carbon exposures of hybrid car production, hydro and renewable power generation, the difference in price adjustment was small (not visible in the chart). In the case of oil power generation, the technology with the least identified exposure and therefore somewhat limited data, the supplementary scenario adjustment is based on the calibrated difference between the B2DS and SDS for oil extraction in order to ensure a consistent narrative.

Figure 14. Price sensitivities per sector and technology for equity investments. Dark colour bars show the adjustments for the main scenario and the lighter bars show the additional impact under the supplementary scenario.



Source: EIOPA, 2DII and The Prudential Regulation Authority at the Bank of England (2019). Calibration based on 2019Q4 data for all solo insurance undertakings. (1) indicates that the main scenario calibration was based on the baseline (current policies scenario) and not the production profile. (2) indicates that the source for the main scenario calibration is the Prudential Regulation Authority at the Bank of England (2019).

extraction in particular. The effects on renewable power and coal power were smaller and is a result of the output of the IEA scenarios on which the scenario is based.

CORPORATE BONDS

The changes in net profit stemming from the production change also means that the probability of default (or credit ratings) could change, and it may be more difficult to raise money in high-carbon sectors. While the dividend model can be applied quite easily to equity, a similar modelling of probability of defaults is more resource intensive and an implementation is not yet available as part of the PACTA tool. This study therefore follows the Prudential Regulation Authority (2019) at the Bank of England and considers the impact on corporate bonds by applying a flat multiplier of 15% compared to the impact on equities (so that the impact on corporate bonds equals 0.15 times the impact on equities)[55]. This is clearly a simplification, but reflects the lack of an available model to more accurately capture the more complex impact on corporate bonds. The factor 15% was decided based on conversations with market participants.

55 Where possible, the difference in issuer entities and holdings and therefore production plans between corporate bonds and equity has been taken into consideration so that the corporate bond shocks are also calibrated on actual holdings of bonds.

GOVERNMENT BONDS

For government bonds, similarly to what was done for corporate bonds and equity, a climate scenario was considered where emissions concentration targets are set to ensure a reasonable likelihood of meeting a 2 degree outcome,. While the value of government bonds may react to changes in the economic activities stemming from the energy transition, the transmission mechanism is different and less direct than for equity and corporate bonds. In order to complement the analysis with an assessment of holdings of government bonds, this report relies on available research that matches the overall narrative. In particular, following the application in Battiston et al (2019), the reaction of the whole economy is modelled using economic sectors based on Climate Policy Relevant Sectors (CPRS Rev 2) and NACE sectors. In a disorderly transition, the climate policy shock affects the performance of issuers in each sector via a change in economic activities' market share, cash flows and profitability. This affects the sectors gross value added in the economy and in turn the probability of default for sovereigns.

We closely follow the approach by Battiston and Monasterolo (2019) which is based on the CLIMAFIN model developed by Battiston, Mandel and Monasterolo (2019)[56].

56 The "CLIMAFIN Handbook"

This work focuses on the analysis of a disorderly policy transition on sovereign bonds, through the channel of firms' profitability to sectors' Gross Value Added (GVA). In practice, we replicate the work presented in Battiston et al (2019) and reported in the December 2019 EIOPA Financial Stability Report. This approach prices forward-looking climate transition risks in the value of individual sovereign bonds, by including the characteristics of climate risks (i.e. uncertainty, non-linearity and endogeneity of risk) in financial valuation, using policy-relevant 2°C-aligned climate mitigation scenarios described in Kriegler et al. 2013.

In detail, we consider the policy scenario presented in Battiston et al (2019) as RefPol2030-500. This scenario is consistent with the one used for equity and corporate bonds both in terms of timing (end of decade) and origin and concentration targets. The scenario assumes delayed action and a transition by the end of the decade. It assumes concentrations targets of 500 ppm reached on the basis of (unconditional) Copenhagen pledges with fragmented countries' action and disorderly transition.

The model analyses the impact of the shock on profitability, market share and gross value added (GVA) for selected sectors. In detail, the classification is based on (a refined) classification of the Climate Policy Relevant Sectors (CPRS Rev 2), which cover key sectors that are relevant in a transition-risk perspective (e.g. fossil-fuel extraction and electricity). The CPRS were originally introduced in Battiston et al. (2017). This serves as a basis to calculate the impact on fiscal revenues of sovereigns and finally on sovereign fiscal assets and default probability, which affects the value of sovereign bonds. In detail, in a disorderly transition, a climate policy shock affects the performance of issuers in the sectors via a change in economic activities' market share, cash flows and profitability, eventually affecting the GVA of the sector. Because the role of fossil fuels and renewable energy technologies in the sovereign's GVA and fiscal revenues can considerably affect the fiscal and financial position of a country, countries that have already started to align their economy to the low-carbon transition may face better refinancing conditions. Full details are given in Battiston et al (2019).

We use the results of this calculation to calibrate a set of shocks per issuer of Government bonds. Similarly to corporate bonds and equity, we also calculate a supplementary scenario to show the sensitivity of the choices. In addition to the main scenario described above, we also employ the calibrations based on the scenario StrPol-450 in Battiston et al (2019). This is a more ambitious scenario with lower overall emissions, in line with the supplementary scenario used for equity and corporate bonds.[57] Figure 15 shows the weighted average price adjustment per country of holder.

Figure 15. Weighted average price adjustment based on country of holder. Dark red indicates price adjustment in the main scenario, and the light red indicates additional price decline in the supplementary scenario.

Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4. Calculations based on Battiston et al (2019)

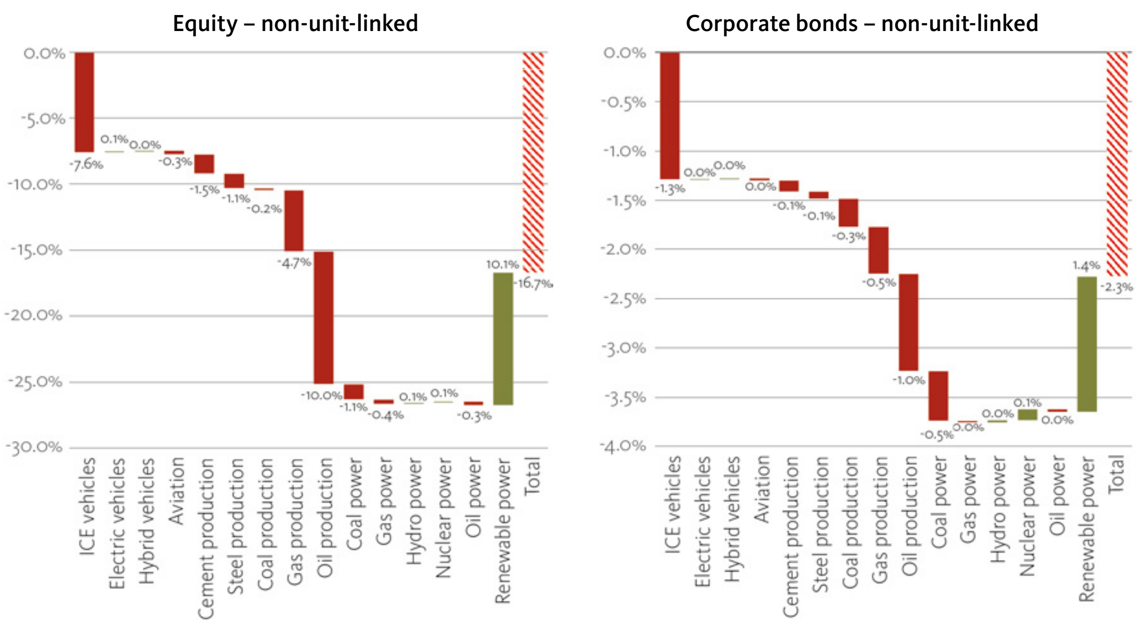
57 In cases where missing data lead to less than complete coverage, the calibrated losses in % were also applied to the holdings of government bonds that were not explicitly assessed in the model. For IS, an average price adjustment was applied due to insufficient data.

RESULTS

Looking at the corporate bond and equity investments (and those via funds), Figure 16 and Figure 17 (the latter shows the unit linked portfolio only) show the change in value of investments when compared to their initial value. Taken at face value, equity holdings vulnerable in the type of "what-if" scenario assessed in this report may be quite sensitive to the transition and loose more than 25% of their value. The impact on bonds are lower, reflecting the fact that profitability declines are likely to impact equity prices first (and in line with the assumptions for corporate bonds employed and described above). However, in terms of overall impact, the insurance sector also stands to potentially gain from the transition through investments in renewable power generation (and somewhat in electric/hybrid vehicle production). There is also some positive impact on investments in nuclear in this scenario, due to the relatively lower CO2 emissions from this sector (and how this sector is modelled in the IEA scenarios).

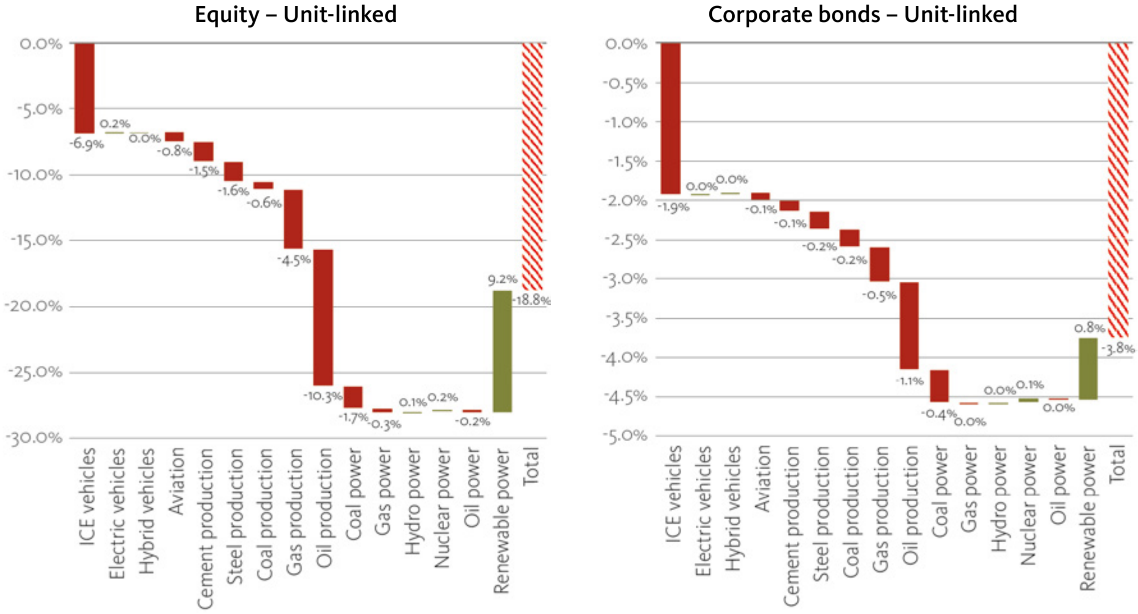
Overall, therefore, while high-carbon assets – especially equities –may experience substantial losses, the overall impact on assets in climate-relevant sectors may be somewhat smaller when accounting for gains in e.g. renewable energy investments (the grey bar show the overall impact) and for the lower impact on bonds. In this context, however, it is key to bear in mind that the price adjustment for renewable power generation assumes that capacity can be built sufficiently fast. The positive price adjustment was quite high in the calibrations employed – the main reason for that is that the sector as a whole needs to dramatically increase output to meet the sustainable development scenario. It is likely easier to reduce capacity (i.e. lose money on high-carbon assets) than to expand capacity, so this balance might be more difficult to achieve in practice.

Figure 16. Change in value of re-priced equity and corporate bonds (incl. look-through where possible). Values given as share of initial holdings in assets for which a price-adjustment was applied. Non-unit linked investments. Main scenario. EEA excl. UK



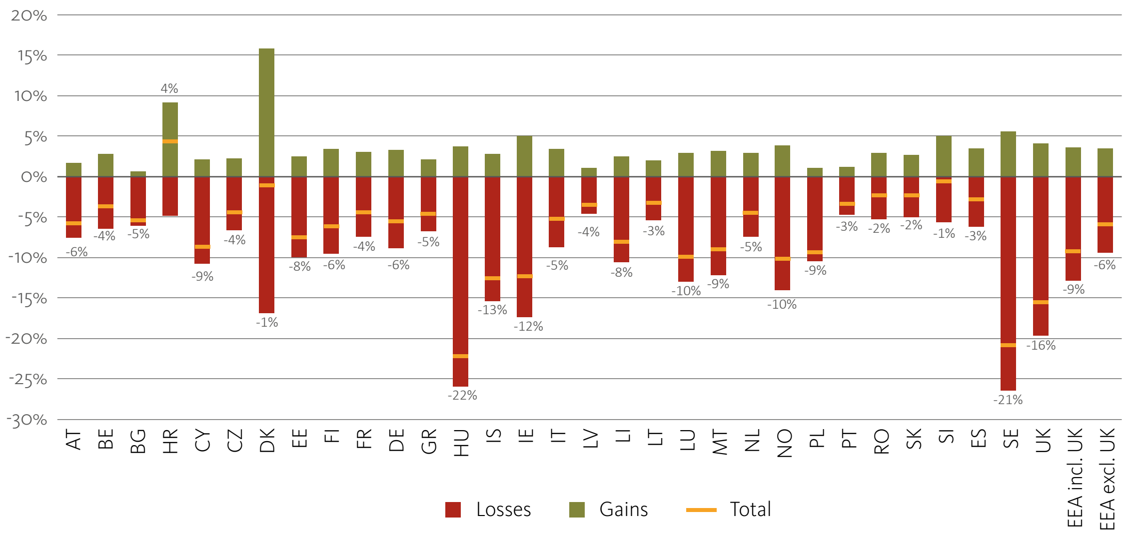
Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

Figure 17. Change in value of re-priced equity and corporate bonds (incl. look-through where possible). Values given as share of initial holdings in assets for which a price-adjustment was applied. Unit-linked investments. Main scenario. EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

Figure 18. Change in value of re-priced equity, corporate bonds and fund investments. Values given as share of initial holdings in assets for each country for which a price-adjustment was applied. Unit-linked and non-unit-linked. Main scenario. Per country.



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

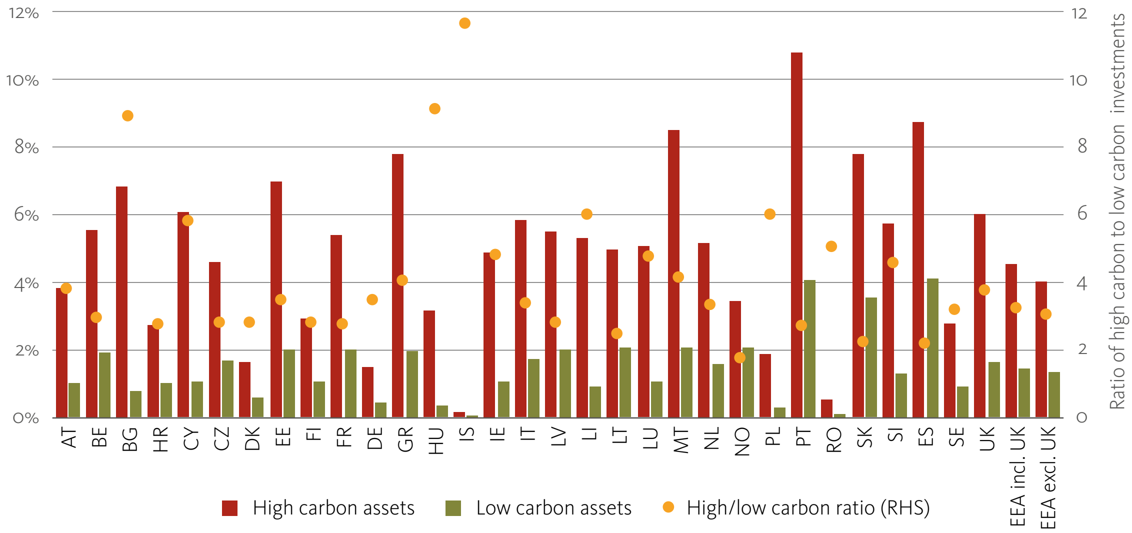
While Figure 16 and Figure 17 show the price impact on individual technologies for the EEA as a whole, Figure 18 shows how this can impact individual countries. In particular, the figure shows the relative price change for assets with a positive price change and for assets with a negative price change. The decline of 6% for EEA excl. UK corresponds to the "Total" column in Figure 16 and Figure 17, but is calculated for corporate bonds and equity together in Figure 18.

Figure 19 sheds some light on the variability in terms of the impact in individual countries by presenting the ratio of high-carbon vs low-carbon assets in the country-level portfolio. While not completely uniform, there is a clear tendency that countries with a high "high carbon/low carbon" share tends to have a larger negative impact in Figure 18. Moreover, there is a slight tendency that smaller insurers have a somewhat higher "high-carbon" to "low-carbon" ratio. However, as shown in Table 1 and Figure 14, the final impact is naturally explained by the detailed asset holdings and the price shocks. In particular for HR, the high-low carbon share is still above one (but among the lowest), despite Figure 18 showing that in terms of price adjustments, the holdings in low-carbon will outweigh the high-carbon assets. The reason is relatively large holdings in equity in renewable power sectors, while high-carbon assets (which would get negative price adjustments) tend to be corporate bonds.

Overall, these findings indicate that losses on individual assets and especially high carbon asset classes can be substantial in terms of percentage change, especially for equity holdings. However, the impact on the aggregate portfolio is likely to be much smaller, because the holdings in key climate-policy relevant sectors considered here are small compared to the overall portfolio. Figure 20 shows the change in the value of investments as a share of the assessed holdings in the relevant assets (i.e. not only those assets that were subject to price change). The overall impact for EEA insurers is less than 0.5% in the non-unit-linked portfolio, and about 0.7% in the unit-linked portfolio.

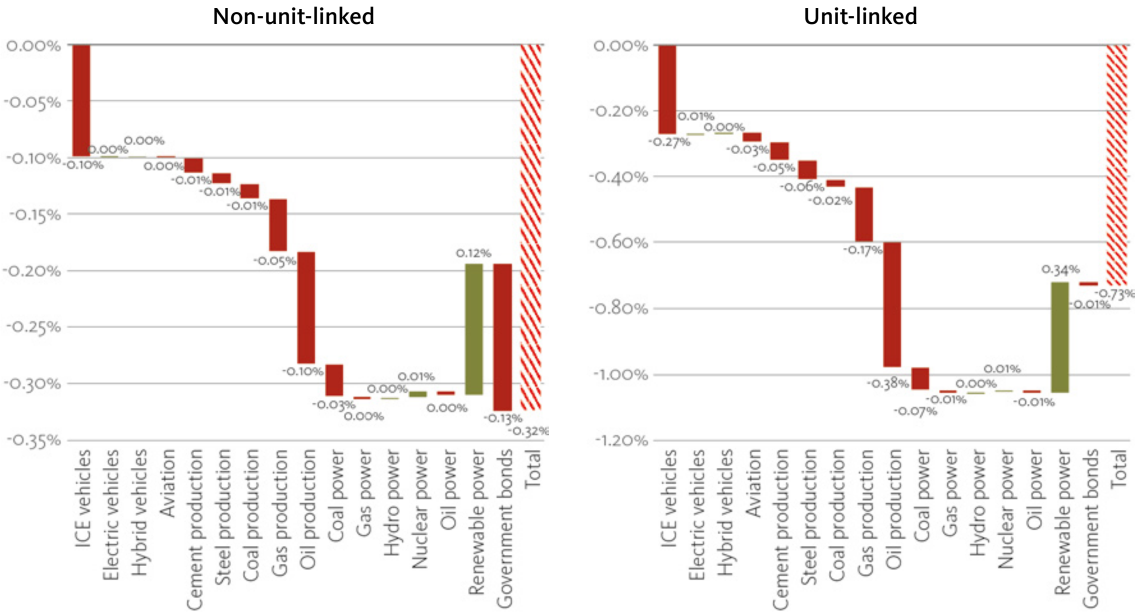
While 0.32% may seem small, it is important to bear in mind that it is scaled to all assessed investments. As mentioned earlier in this report, the asset holdings of insurers are generally kept to cover liabilities, which in EEA is on average valued to more than 85% of the assets. This means that the impact of relatively small losses on the overall asset portfolio can be larger compared to the "free assets", namely the excess of assets over liabilities (eAOL).

Figure 19. Holdings of high carbon vs low carbon assets identified (equity, corporate bonds and fund investments). Unit-linked and non-unit-linked. Per country.



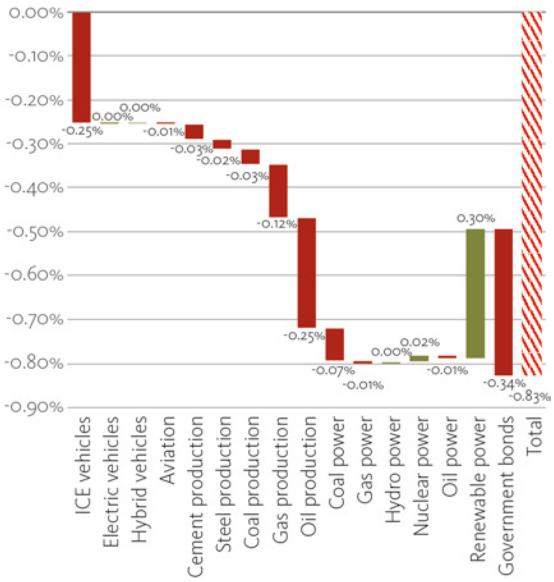
Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4. High-carbon assets defined assets for which the scenario prescribes a price decline. Low-carbon assets are defined as assets for which the scenario prescribes a positive price change (i.e. renewable, hydro and nuclear energy, and electric/hybrid vehicles).

Figure 20. Change in value of re-priced equity, corporate bonds (incl. look-through where possible) and government bonds. Values given as share of share of the (assessed) full holdings. Main scenario. EEA excl. UK



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

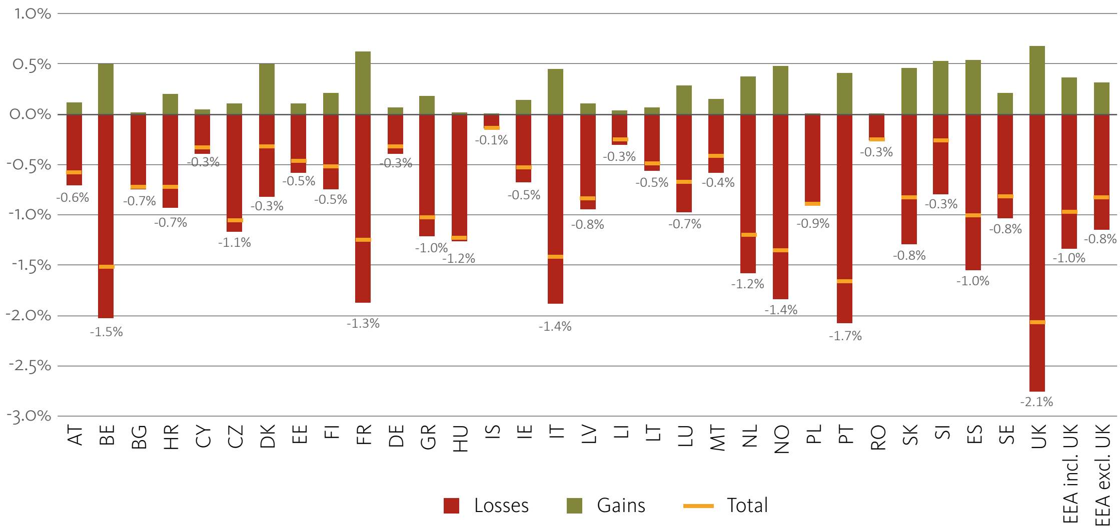
Figure 21. Change in value of investments as a share of excess of assets over liabilities. Equity, corporate bonds (incl. look-through where possible) and government bonds. Non-unit-linked. Main scenario.



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4. Excl. unit-linked assets

Figure 22 relates the losses (or gains) of the non-unit-linked assets to the value of excess of assets over liabilities for each of the country included in this analysis. The losses include the price changes for government bonds, which explains why all countries in this figure report overall losses. Table 4 in the Appendix provide further information by also including each of the technologies considered on a country-level basis. The figure shows that the losses on non-unit-linked business alone would represent between 0.1% and up to 2.1% of the excess of assets over liabilities (if we assume the main scenario and no extrapolation – see the next section for a discussion about the sensitivities to these assumptions). It is, however, important in this context to bear in mind that these do not represent estimations of eAOL after the price adjustments, but rather serve as a scaling of the losses. Indeed, losses on the asset side would not be directly brought into the excess of assets over liabilities (or own funds) of insurers due to a series of factors not included in this assessment. In particular, there are many loss absorbing mechanisms which would mitigate the actual impact of possible losses due to transition risks on the insurers' balance sheets. Profit sharing mechanisms would certainly alleviate pressure on own funds and the volatility adjustment would also likely offer a substantial counter-cyclical effect. Overall, these figures should not be considered estimates of post-stress eAOL since they do not reflect any changes

Figure 22. Change in value of re-priced equity, corporate bonds, fund and government bond investments excluding unit-linked. Values given as share of excess of assets over liabilities. Main scenario. Per country.



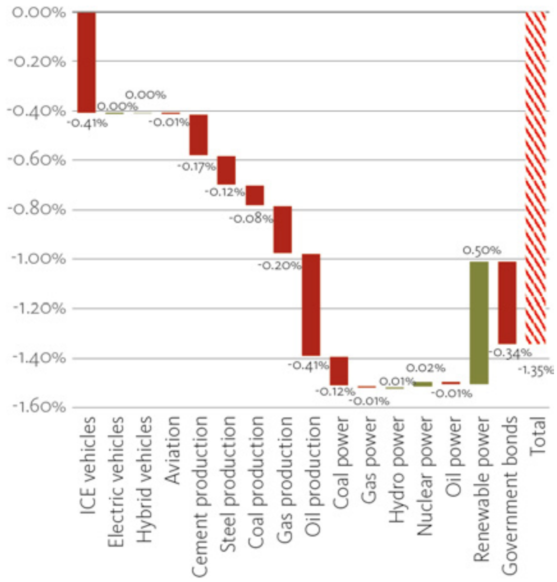
Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4. Excl. unit-linked assets

to liabilities offsetting the estimated assets side decrease. While eAOL is chosen as a scaling parameter, the difference between countries in Figure 22 are also due to country-specific variations in the level of eAOL that are independent from climate considerations and must be seen in relation to the overall holdings and price adjustments presented earlier.

SENSITIVITY TO SCENARIO AND EXTRAPOLATION

As highlighted throughout this report, there is naturally uncertainty both about the actual holdings and of the estimated price change. This section therefore explores some of the sensitivities to assumptions about those factors. In particular, Figure 23 shows that the losses on the non-unit-linked portfolio of government bonds, corporate bonds, equity and funds would increase to 1.35% (up from 0.8%) with a reasonable assumption about the holdings that were not possible to map in this exercise (see the explanation to Figure 12).

Figure 23. Change in value of investments as a share of excess of assets over liabilities accounting for non-mapped investments (Method 2). Equity, corporate bonds (incl. look-through where possible) and government bonds. Non-unit-linked. Main scenario.

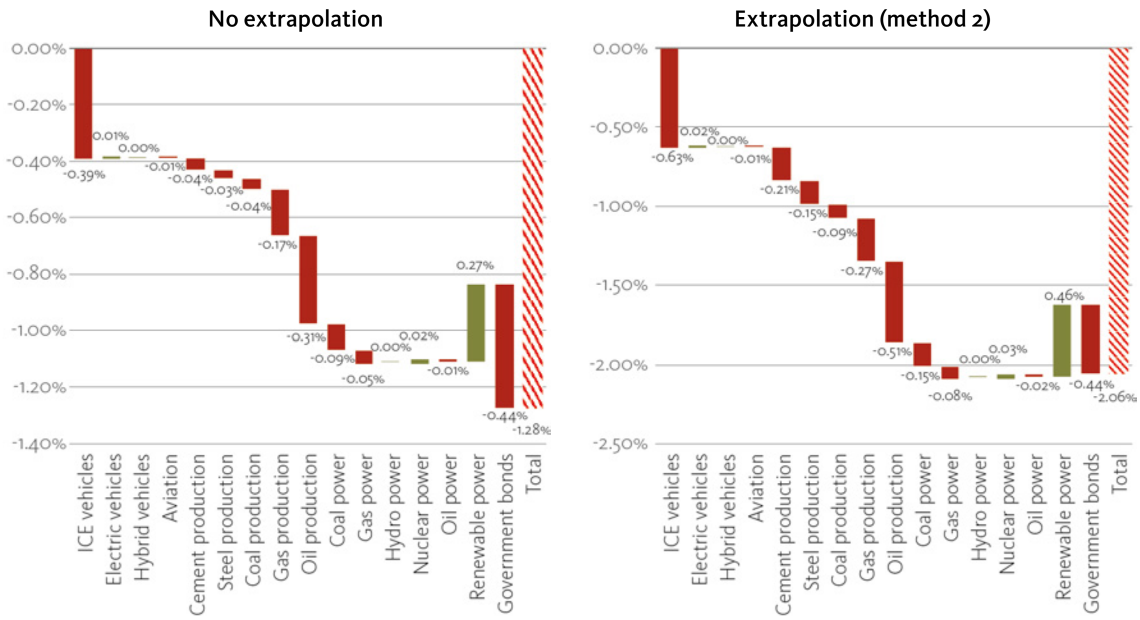


Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

Moreover, Figure 24 shows that the losses in the non-unit-linked portfolio alone would reach 1.3% when compared to the excess of assets over liabilities if the more "severe" scenario was employed, and more than 2% if the holdings were extrapolated to account for non-mapped assets.

Correspondingly, Table 5 in the Appendix shows that in this case (full extrapolation and supplementary scenario), the losses scaled to eAOL could reach up to 5% in some countries.

Figure 24. Change in value of investments as a share of excess of assets over liabilities accounting for non-mapped investments with and without extrapolation. Equity, corporate bonds (incl. look-through where possible) and government bonds. Non-unit-linked. Supplementary scenario.



Source: Solo insurance undertakings reporting under Solvency II. 2019 Q4.

CONCLUSION AND NEXT STEPS

The results presented in this report clearly identify and quantify potential climate-change related transition risks in the investment portfolio of European insurers. While the exposures are manageable compared to the overall holdings because insurers generally hold relatively well-diversified portfolios, it is still clear that these investments may expose the insurance sector to transition risks in the event of a drastic alignment of the economies to an outcome in line with the aims of the Paris agreement to limit global warming. Indeed, the results in this report show that with relatively conservative estimates for both holdings and price adjustments, losses on equity investments in the high-carbon sector can be high, reaching up to 25% on average for these particular equity holdings (before accounting for any counterbalancing investments in e.g. renewable energy).

The overall impact on the balance sheets of the insurance sector is counter-balanced both by investments in renewable energy and the fact that the high-carbon investments considered here account for a small part of the total investments of European insurers. Losses on bonds are also lower than those on equities. Solvency II is a risk based regime, and insurers therefore generally hold well diversified portfolios, which is reflected in the overall size of the losses. Despite this, impacts compared to excess of assets over liabilities, a relevant measure of impact, are however, non-negligible and may be substantial under the more “severe” assumptions and scenarios considered in this analysis.

Naturally, as this is a first exercise carried out at this level on a top-down basis (using only data already available), there are a number of caveats that should be noted. First, it was not possible to map the full portfolio of European insurers, so the results represent a subset. Second, certain sectors that may also react to a typical “policy shock”, most notably the agriculture and real estate sectors are not considered due to data limitations. Third, effects stemming from shocks to GDP or other macroeconomic variables are not included in this assessment. Fourth, the calibrations of the price adjustments rely on extrapolations and sometimes somewhat limited data, and consider changes that might stem from events that might happen by the end of this decade. Such calibrations are naturally fraught with intense uncertainty. These caveats may lead to both more or less severe outcomes than the ones presented in this report. Moreover, this report does not consider physical risks. Such risks are potentially substantial and can impact not only the asset side, but also the liability side and even business models. While this report provides an example of such risks in the form of a preliminary analysis of flood risk, more work is needed to understand those risks in depth and to cover more perils that are likely to be impacted by climate change.

Impacts of climate-change will clearly have transformative power in the 21st century. This report considers part of the challenges faced by European insurers in this context, namely asset-side transition risks. The impact of changes in climate on the insurance business in general, and even the insurability of certain risks is equally important. These risks are also under intense scrutiny in the supervisory community and EIOPA are working with national competent authorities, market participants and the research community to further improve our understanding and assessment of these risks.

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LIST OF ABBREVIATIONS

2DII	2° Investing Initiative
B2DS	Beyond 2 degrees scenario
eAOL	Excess of assets over liabilities
EIOPA	European Insurance and Occupational Pensions Authority
ESRB	European Systemic Risk Board
IEA	International Energy Agency
NACE	Statistical Classification of Economic Activities in the European Community. NACE from the French term “Nomenclature statistique des Activités économiques dans la Communauté Européenne”
NGFS	Network for greening of the financial system
PACTA	Paris Agreement Capital Transition Assessment
RCP	Representative Concentration Pathway
RP	Return period
SDS	Sustainable development scenario

APPENDIX

Table 3. Detailed country-level breakdown of identified exposures in each technology and the share of exposures compared to total investments

Holdings in technologies as share of climate relevant exposures (without extrapolation) and total climate-relevant exposure as share of total investments with and without extrapolation

																Climate relevant exposure (excl. government bonds) as share of total investments excl. government bonds			Climate relevant exposure (excl. government bonds) as share of all investments		
	Electric vehicles	Hybrid vehicles	ICE vehicles	Aviation	Cement production	Coal production	Gas production	Oil production	Coal power	Gas power	Hydro power	Nuclear power	Oil power	Renewable power	Steel production	No extrapolation	Extrapolation method 1	Extrapolation method 2	No extrapolation	Extrapolation method 1	Extrapolation method 2
AT	0.2%	0.5%	13.2%	0.4%	2.7%	3.5%	17.5%	18.0%	7.9%	7.4%	7.5%	6.8%	1.4%	6.0%	6.9%	3.2%	4.6%	4.9%	2.6%	3.8%	4.1%
BE	0.3%	0.8%	16.1%	1.6%	3.1%	2.4%	13.0%	15.5%	6.5%	11.7%	8.8%	6.7%	2.1%	9.1%	2.0%	3.9%	7.6%	7.7%	2.3%	4.5%	4.5%
BG	0.1%	0.3%	13.6%	1.0%	0.2%	0.1%	39.6%	18.8%	6.5%	2.7%	2.8%	5.2%	0.4%	1.7%	7.0%	3.9%	5.9%	6.1%	2.1%	3.2%	3.3%
HR	0.4%	1.2%	30.1%	0.3%	0.5%	0.2%	9.9%	7.6%	7.9%	9.5%	8.3%	3.8%	2.6%	13.5%	4.0%	1.5%	1.8%	3.1%	0.6%	0.8%	1.3%
CY	1.1%	0.6%	18.1%	1.6%	5.6%	5.4%	11.3%	15.2%	9.1%	10.4%	3.9%	4.3%	2.2%	4.8%	6.5%	4.3%	5.9%	6.8%	3.9%	5.3%	6.0%
CZ	0.2%	0.2%	11.6%	0.2%	0.3%	0.1%	20.4%	11.6%	19.8%	5.5%	7.1%	12.9%	0.5%	6.3%	3.3%	4.0%	6.5%	7.2%	2.3%	3.8%	4.2%
DK	0.8%	0.4%	7.6%	2.3%	3.8%	1.7%	13.0%	17.2%	10.4%	11.2%	4.2%	3.5%	3.3%	18.0%	2.6%	1.0%	1.7%	2.4%	0.9%	1.5%	2.1%
EE	0.5%	2.0%	37.5%	2.5%	0.9%	2.1%	7.3%	7.4%	4.9%	5.6%	8.3%	6.2%	6.4%	5.6%	2.8%	6.6%	9.4%	11.3%	5.7%	8.0%	9.7%
FI	1.2%	1.1%	27.5%	3.2%	2.8%	1.2%	7.6%	10.4%	4.6%	8.3%	10.1%	7.2%	2.0%	7.1%	5.9%	2.9%	4.6%	4.7%	2.8%	4.4%	4.5%
FR	0.3%	0.7%	16.3%	0.9%	2.5%	2.0%	13.0%	16.4%	6.4%	12.0%	8.4%	8.4%	1.9%	9.2%	1.5%	4.8%	7.5%	7.8%	3.5%	5.4%	5.6%
DE	0.6%	1.2%	23.7%	0.7%	2.4%	4.7%	11.8%	14.0%	7.0%	9.6%	6.8%	4.4%	1.6%	9.6%	1.8%	1.2%	1.8%	3.4%	1.0%	1.5%	2.8%
GR	0.3%	0.8%	18.9%	2.5%	12.6%	6.3%	10.3%	12.1%	5.3%	8.3%	6.0%	5.5%	0.8%	7.6%	2.6%	6.1%	9.1%	9.1%	2.9%	4.3%	4.3%
HU	1.0%	0.4%	13.0%	2.6%	3.8%	0.5%	29.1%	29.2%	4.6%	4.5%	2.2%	1.2%	0.7%	5.1%	2.2%	2.4%	2.9%	4.9%	1.2%	1.5%	2.5%
IS	2.1%	0.3%	4.8%	45.5%	0.6%	0.2%	8.4%	23.5%	3.2%	4.1%	1.2%	1.1%	0.6%	3.2%	1.1%	0.1%	0.1%	0.2%	0.1%	0.1%	0.2%
IE	0.9%	1.0%	20.7%	2.5%	3.7%	3.1%	14.3%	18.5%	5.4%	9.1%	4.7%	3.3%	1.5%	7.6%	3.6%	4.1%	5.9%	5.9%	3.6%	5.2%	5.2%
IT	0.4%	0.7%	17.5%	1.2%	3.1%	2.1%	12.2%	14.5%	7.5%	13.7%	9.1%	3.9%	2.3%	8.9%	2.8%	5.8%	8.5%	8.7%	3.3%	4.9%	4.9%
LV	0.6%	0.7%	21.8%	0.6%	1.1%	0.6%	11.5%	9.8%	8.5%	9.7%	14.9%	6.4%	8.2%	4.0%	1.6%	4.5%	7.5%	7.7%	2.7%	4.5%	4.6%
LI	0.5%	1.5%	32.5%	1.7%	3.3%	3.1%	12.7%	16.5%	4.3%	5.8%	3.7%	3.2%	1.1%	5.5%	4.5%	3.9%	5.2%	5.8%	3.7%	4.9%	5.5%
LT	0.1%	0.4%	12.6%	1.2%	1.5%	1.5%	14.7%	9.7%	5.2%	8.8%	15.1%	6.4%	13.1%	7.4%	2.3%	5.0%	6.6%	6.9%	2.0%	2.7%	2.8%
LU	0.6%	0.9%	23.0%	2.9%	2.8%	3.3%	13.7%	18.8%	4.8%	7.8%	4.9%	4.1%	1.3%	7.1%	4.2%	3.9%	5.9%	6.1%	3.6%	5.3%	5.5%
MT	0.5%	0.7%	19.0%	3.8%	2.9%	3.9%	15.0%	19.2%	4.4%	7.8%	5.2%	7.2%	1.4%	6.0%	3.1%	3.6%	4.9%	5.1%	2.8%	3.8%	3.9%
NL	0.4%	1.3%	24.1%	0.7%	3.3%	2.5%	10.9%	13.6%	7.2%	10.8%	7.0%	4.5%	1.4%	10.1%	2.2%	3.0%	4.6%	4.8%	2.1%	3.3%	3.4%
NO	0.7%	0.3%	7.3%	1.9%	0.8%	0.2%	17.3%	22.2%	3.0%	7.8%	27.1%	1.9%	0.9%	7.0%	1.6%	3.4%	5.4%	5.5%	3.1%	4.9%	5.0%
PL	0.1%	0.3%	13.9%	0.3%	1.2%	0.6%	28.9%	13.9%	16.5%	6.7%	5.8%	5.5%	1.0%	2.7%	2.6%	1.7%	2.2%	3.8%	1.0%	1.3%	2.2%
PT	0.4%	0.5%	18.3%	3.8%	1.8%	1.4%	9.9%	16.0%	7.3%	10.0%	17.4%	3.4%	1.0%	5.5%	3.0%	9.9%	13.3%	13.6%	5.6%	7.5%	7.7%
RO	0.1%	0.0%	1.2%	2.1%	0.2%	0.2%	50.1%	13.8%	5.4%	8.3%	2.7%	10.4%	1.7%	3.6%	0.5%	0.4%	1.0%	1.2%	0.2%	0.5%	0.6%
SK	0.3%	0.9%	24.2%	0.3%	2.0%	0.8%	9.9%	7.8%	13.2%	6.2%	4.0%	12.4%	0.8%	13.7%	3.3%	7.6%	10.7%	11.6%	4.9%	6.9%	7.5%
SI	0.5%	1.2%	32.3%	3.3%	1.6%	2.3%	14.6%	10.7%	5.0%	4.1%	3.7%	2.8%	4.0%	10.0%	3.9%	5.4%	8.2%	8.7%	3.6%	5.5%	5.8%
ES	0.4%	0.5%	19.0%	1.5%	0.8%	2.2%	10.0%	10.1%	8.6%	12.7%	10.5%	8.2%	1.6%	12.4%	1.5%	8.0%	10.6%	11.0%	3.7%	4.9%	5.1%
SE	13.4%	0.6%	36.1%	3.2%	2.5%	0.3%	7.8%	13.7%	3.0%	4.9%	2.6%	2.3%	1.1%	5.4%	3.1%	2.5%	4.1%	4.3%	2.3%	3.8%	4.0%
UK	0.5%	0.7%	10.5%	2.4%	2.6%	4.1%	15.7%	18.7%	8.2%	10.3%	4.7%	5.8%	1.7%	9.5%	4.8%	5.5%	8.9%	9.0%	4.8%	7.7%	7.8%
EEA incl. UK	0.8%	0.7%	15.9%	1.7%	2.6%	2.9%	13.7%	16.7%	7.1%	10.8%	7.1%	6.0%	1.7%	9.2%	3.1%	3.9%	6.1%	6.6%	3.0%	4.7%	5.1%
EEA excl. UK	0.9%	0.8%	18.7%	1.3%	2.6%	2.4%	12.6%	15.6%	6.6%	11.1%	8.4%	6.1%	1.8%	9.0%	2.2%	3.4%	5.2%	5.8%	2.6%	3.9%	4.4%

Table 4. Loss and gain in % of excess of assets over liabilities per country for non-unit-linked investments. Main scenario and no extrapolation

	Government bonds	Electric vehicles	Hybrid vehicles	ICE vehicles	Aviation	Cement production	Coal production	Gas production	Oil production	Coal power	Gas power	Hydro power	Nuclear power	Oil power	Renewable power	Steel production	Total
AT	-0.2%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	-0.1%	-0.6%
BE	-0.8%	0.0%	0.0%	-0.3%	0.0%	-0.1%	-0.1%	-0.2%	-0.4%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	-1.5%
BG	-0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.7%
HR	-0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	-0.7%
CY	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
CZ	-0.8%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-1.1%
DK	-0.2%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	-0.3%
EE	-0.1%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.5%
FI	-0.1%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	-0.1%	-0.5%
FR	-0.4%	0.0%	0.0%	-0.4%	0.0%	-0.1%	-0.1%	-0.2%	-0.5%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.6%	0.0%	-1.3%
DE	-0.2%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.3%
GR	-0.6%	0.0%	0.0%	-0.1%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	-1.0%
HU	-1.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.2%
IS	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
IE	-0.1%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	-0.1%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.5%
IT	-0.7%	0.0%	0.0%	-0.3%	0.0%	-0.1%	0.0%	-0.2%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.4%	-0.1%	-1.4%
LV	-0.5%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.8%
LI	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
LT	-0.4%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.5%
LU	-0.1%	0.0%	0.0%	-0.3%	0.0%	0.0%	-0.1%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	-0.7%
MT	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.4%
NL	-0.6%	0.0%	0.0%	-0.3%	0.0%	0.0%	-0.1%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	-1.2%
NO	-0.1%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	-0.4%	-0.9%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	-1.4%
PL	-0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.9%
PT	-0.4%	0.0%	0.0%	-0.5%	-0.1%	-0.1%	0.0%	-0.2%	-0.5%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.4%	-0.1%	-1.7%
RO	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
SK	-0.5%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	-0.8%
SI	-0.3%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	-0.3%
ES	-0.7%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	-0.1%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.5%	0.0%	-1.0%
SE	0.0%	0.0%	0.0%	-0.6%	0.0%	0.0%	0.0%	-0.1%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	-0.8%
UK	-0.2%	0.0%	0.0%	-0.5%	-0.1%	-0.1%	-0.2%	-0.4%	-0.8%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.6%	-0.3%	-2.1%
EEA incl. UK	-0.3%	0.0%	0.0%	-0.3%	0.0%	0.0%	-0.1%	-0.2%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.3%	-0.1%	-1.0%
EEA excl. UK	-0.3%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	-0.8%

Table 5. Loss and gain in % of excess of assets over liabilities per country for non-unit-linked investments. Severe scenario and extrapolation method 2.

	Government bonds	Electric vehicles	Hybrid vehicles	ICE vehicles	Aviation	Cement production	Coal production	Gas production	Oil production	Coal power	Gas power	Hydro power	Nuclear power	Oil power	Renewable power	Steel production	Total
AT	-0.2%	0.0%	0.0%	-0.2%	0.0%	-0.1%	-0.1%	-0.1%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	-0.8%	-1.7%
BE	-1.0%	0.0%	0.0%	-0.6%	0.0%	-0.5%	-0.1%	-0.5%	-0.9%	-0.3%	-0.2%	0.0%	0.1%	0.0%	0.8%	-0.2%	-3.4%
BG	-0.7%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.2%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.2%
HR	-1.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	-1.0%
CY	-0.1%	0.0%	0.0%	-0.2%	0.0%	-0.1%	-0.2%	-0.1%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	-0.1%	-0.9%
CZ	-1.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.3%	-0.2%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.1%	-0.1%	-1.8%
DK	-0.2%	0.0%	0.0%	-0.3%	0.0%	-0.1%	-0.1%	-0.3%	-0.5%	-0.4%	-0.1%	0.0%	0.0%	0.0%	0.9%	-0.2%	-1.3%
EE	-0.1%	0.0%	0.0%	-0.7%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-1.0%
FI	-0.1%	0.0%	0.0%	-0.8%	0.0%	-0.1%	-0.1%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.3%	-0.4%	-1.7%
FR	-0.5%	0.0%	0.0%	-0.8%	0.0%	-0.5%	-0.1%	-0.5%	-1.0%	-0.2%	-0.2%	0.0%	0.1%	0.0%	0.8%	-0.2%	-3.3%
DE	-0.2%	0.0%	0.0%	-0.5%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	-1.0%
GR	-0.8%	0.0%	0.0%	-0.3%	-0.1%	-0.3%	-0.1%	-0.2%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	-1.9%
HU	-1.3%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.2%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-1.8%
IS	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%
IE	-0.2%	0.0%	0.0%	-0.4%	0.0%	-0.1%	-0.1%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.2%	0.0%	-1.2%
IT	-0.9%	0.0%	0.0%	-0.7%	0.0%	-0.2%	-0.1%	-0.4%	-0.7%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.5%	-0.2%	-2.8%
LV	-0.7%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-1.3%
LI	0.0%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.5%
LT	-0.5%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	-0.7%
LU	-0.2%	0.0%	0.0%	-0.6%	0.0%	-0.1%	-0.2%	-0.3%	-0.5%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.4%	-0.1%	-1.7%
MT	-0.1%	0.0%	0.0%	-0.2%	0.0%	-0.1%	-0.1%	-0.2%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.2%	-0.1%	-0.9%
NL	-0.7%	0.0%	0.0%	-0.7%	0.0%	-0.2%	-0.1%	-0.3%	-0.6%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.5%	-0.3%	-2.7%
NO	-0.2%	0.0%	0.0%	-0.5%	-0.1%	-0.1%	-0.1%	-0.8%	-1.4%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.8%	-0.2%	-2.7%
PL	-1.1%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.4%
PT	-0.6%	0.0%	0.0%	-0.9%	-0.1%	-0.2%	-0.2%	-0.4%	-0.9%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.4%	-0.3%	-3.4%
RO	-0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.5%
SK	-0.6%	0.0%	0.0%	-0.6%	0.0%	-0.1%	0.0%	-0.3%	-0.3%	-0.2%	0.0%	0.0%	0.1%	0.0%	0.4%	-0.2%	-1.9%
SI	-0.3%	0.0%	0.0%	-0.5%	0.0%	0.0%	0.0%	-0.2%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	1.0%	-0.1%	-0.6%
ES	-1.0%	0.0%	0.0%	-0.5%	0.0%	-0.1%	-0.1%	-0.3%	-0.5%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.6%	-0.2%	-2.3%
SE	0.0%	0.2%	0.0%	-1.1%	0.0%	-0.3%	-0.3%	-0.1%	-0.3%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.3%	-0.4%	-2.3%
UK	-0.3%	0.0%	0.0%	-1.0%	-0.1%	-0.2%	-1.1%	-0.9%	-1.5%	-0.5%	-0.2%	0.0%	0.1%	0.0%	1.1%	-0.4%	-4.9%
EEA incl. UK	-0.4%	0.0%	0.0%	-0.7%	0.0%	-0.2%	-0.2%	-0.3%	-0.6%	-0.2%	-0.1%	0.0%	0.0%	0.0%	0.5%	-0.2%	-2.4%
EEA excl. UK	-0.4%	0.0%	0.0%	-0.6%	0.0%	-0.2%	-0.1%	-0.3%	-0.5%	-0.1%	-0.1%	0.0%	0.0%	0.0%	0.5%	-0.1%	-2.1%

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