EIOPA
EUROPEAN INSURANCE
AND OCCUPATIONAL PENSIONS AUTHORITY

Financial Stability Report

June 2017

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PART II

Foreword by the Chairman

The implementation of Solvency II by the European insurance industry was a success. Within a very difficult macroeconomic environment, with historically low interest rates, the application of a more demanding risk-based solvency regime was carried out smoothly as a result of timely preparation and appropriate transitional periods. In an industry managing €11 trillion of assets and €8.7 trillion in technical provisions, this success is remarkable and has contributed significantly to the stability of the European financial sector.

Following Solvency II implementation no major shifts in portfolios' allocation have been observed so far and the European insurance sector is adequately capitalized with a median Solvency Capital Requirement ratio of 209%. Specific transition periods are used mostly by life insurance companies with long-term guarantees business. Transitional measures form an integral part of Solvency II and are intended to limit the procyclicality and to facilitate the entry into the new regime by giving companies the time needed to adapt to the new solvency requirements. An appropriate focus has been put by supervisors on the sustainability of the long-term promises and business models.

On the Occupational Pensions side, EIOPA launched the second EU-wide Stress Test that will provide further insights into the risks and vulnerabilities of the sector. It aims to assess the sector's resilience as well as to analyse the potential impact of market shocks on the real economy and financial markets.

Solvency II also brings significant improvements in the data available on the insurance sector which is a fundamental element to upgrade companies' risk management and supervisors' risk assessment. The access to better and more granular data on assets, liabilities and own funds of insurers, allows for a quantum leap in terms of risk-based supervision and financial stability analysis.

For the first time, this report provides analyses based on Solvency II data covering the whole year and reflects an analytical progress that brings additional insight into the financial stability assessment of the sectors. EIOPA will make additional use of Solvency II data, further develop tools to monitor and assess all relevant risks and mitigate them proactively.

Executive Summary

The European macroeconomic environment remains fragile, although with signs of a moderate recovery. Uncertainties on some political and market outcomes, such as several EU elections and further negotiations following the UK referendum as well as unclarity on future yield developments persist. Market data points to a low yield environment but with signs of upward movements.

In addition to market and geopolitical risks, the insurance industry faces challenges from emerging risks that can be difficult to address due to their dynamics, unpredictability and complexity. Cyber attacks involving virtual extortions and the increasing frequency and variety of terrorist attacks require the insurance industry to adapt to new sorts of demands.

The sector has continued to adjust to the new Solvency II (SII) regime, which entered into force in January 2016. Both assets and liabilities are measured on a market-consistent valuation basis which better reflects their risk profile. Especially in the case of life insurance or disability insurance products, interest rate levels and changes may have a major impact on the economic value of the balance sheet, since the potential long-term liabilities generally have a maturity that is longer than the associated financial investments. As of December 2016, the majority of solo insurance undertakings reported a Solvency Capital Requirement (SCR) ratio above 100%. The SCR ratio for the median insurance company is 209% in Q4. It corresponds to 217% for life insurance companies, 207% for non-life insurance companies and 210% for undertakings pursuing both life and non-life business at the same time. Return on Assets (ROA) dropped slightly below 1%, whilst the Return on Equity (ROE) remains in the 9% range for the median company. The net Combined Ratio (CR) in the non-life sector has also been relatively stable across business lines.

Reinsurance demand is still subdued, whereas the reinsurance capacity continues to increase. Thus, overall, the general environment remains largely unchanged. In 2016 natural catastrophe losses were back in the mid-range. The global reinsurer capital totalled USD 595bn at September 2016, an increase of 5% since the end of 2015. Alternative capital has continued to grow, albeit at a slower rate in 2015 and 2016. At the end of September 2016 the alternative capital amounted to USD 78bn which represents about 13% of total capital.

In the European occupational pension fund sector, total assets increased for the euro area based on preliminary data for 2016. The investment allocation remained broadly

unchanged and the average rate of return increased across the sample. The average cover ratios for defined benefit schemes slightly increased over 2016 compared to 2015 and remain a concern for a number of countries.

The EIOPA risk assessment further confirms the low interest rate environment as the main concern among national supervisors. In detail, assessing the quality of capital funds and solvency capital requirements reveals that some EU insurers have increased their total capital funds in the preparation of Solvency II, with a median value that is somehow stable from 2010 to 2016. An extensive analysis of the insurers' portfolios suggests that life insurers rely heavily on fixed income assets which make them more vulnerable to low interest rates than non-life insurers. Furthermore, on an aggregate level, holdings of different type of assets exhibit a large heterogeneity across individual insurers. With an increasing interconnectedness within the financial sector, insurers are extensively exposed towards the banking sector but at country level the heterogeneity across individual insurers' exposures towards banks is also high. Finally, although one of the main challenges remains maintaining profitability, the current data reveals a relatively stable picture of the European insurance market.

The report consists of two parts – the standard part and the thematic article section. The standard part is structured as in previous versions of the EIOPA Financial Stability Report. The first chapter discusses the key risks identified for the insurance and occupational pension sector. The second, third and fourth chapter elaborates on these risks covering all sectors (insurance, reinsurance and pension). The fifth chapter provides the final qualitative and quantitative assessment of the risks identified. This assessment is done in terms of the scope as well as the probability of their materialization using also qualitative questionnaires. Finally, one thematic article elaborates on the re-evaluation of the capital charge in insurance after a large shock (empirical and theoretical views).

About EIOPA Financial Stability Reports

Under Article 8 of Regulation 1094/2010, EIOPA is, inter alia, mandated to monitor and assess market developments as well as to undertake economic analyses of markets. To fulfil its mandate under this regulation EIOPA performs market intelligence functions regarding its supervisory universe, develops a market surveillance framework to monitor, and reports on market trends and financial stability related issues. The findings of EIOPA's market development and economic analyses are published in the Financial Stability Report on a semi-annual basis.

(Re) insurance undertakings and occupational pension funds are important investors in the financial market and provide risk sharing services to private households and corporates. In the financial markets, they act as investors, mostly with a long-term focus. Their invested assets aim to cover liabilities towards policy holders or members of pension schemes to which long-term savings products are offered, for example in the form of life assurance or pension benefits. Aside from offering savings products, (re)insurance undertakings provide risk sharing facilities, covering biometric risks as well as risks of damage, costs, and liability.

Financial stability, in the field of insurance and pension funds, can be seen as the absence of major disruptions in the financial markets, which could negatively affect insurance undertakings or pension funds. Such disruptions could, for example, result in fire sales or malfunctioning markets for hedging instruments. In addition, market participants could be less resilient to external shocks, and this could also affect the proper supply of insurance products or long-term savings products at adequate, risk-sensitive prices.

However, the insurance and pension fund sectors can also influence the financial stability of markets in general. Procyclical pricing or reserving patterns, herding behaviour and potential contagion risk stemming from interlinkages with other financial sectors, are negative examples that could potentially make the financial system, as a whole, less capable of absorbing (financial) shocks. Contrary to this, the investment behaviour of both pension funds and (re)insurers could also contribute to an overall market stabilization. Finally, (re)insurance undertakings might engage in non-traditional/non-insurance business such as the provision of financial guarantees or alternative risk transfer, which needs to be duly reflected in any financial stability analysis.

The Financial Stability Report draws on both quantitative and qualitative information from EIOPA's member authorities. Supervisory risk assessments as well as market data are further core building blocks of the analysis.

First half-year report 2017

EIOPA has updated its report on financial stability in relation to the insurance, reinsurance and occupational pension fund sectors in the EU/EEA (European Union and European Economic Area). The current report covers developments in financial markets, the macroeconomic environment, and the insurance, reinsurance and occupational pension fund sectors as of Q4 2016, if not stated otherwise. The cut-off date for market data is 29/05/2017.

PART I

1. Key developments

Although the global economic outlook has slightly improved, the European macroeconomic environment remains challenging. Uncertainties on some political and market outcomes, such as several EU elections and the forthcoming negotiations between the UK and the EU remain (Box 1). While domestic consumption and exports, favoured by supporting borrowing conditions and the weaker euro, drive the modest economic growth, these factors (combined with the recent increases in consumer prices in Europe) pose challenges to monetary policy measures.

Risks resulting from low interest rates and consequently potential search for yield behaviour remain high, albeit the latest figures point to an increasing inflation as reflected in higher short-term interest rates and an overall slight upward shift of the yield curves. It may suggest an increased likelihood of an interest rate reversal. Hence, the potential effects of scenarios such as a sudden substantial yield increase for the insurance sector should be carefully analysed.

In addition, the external environment like the tightening trend of the US monetary policy reinforces the strength of the US dollar and reflects in part the rise in bond yields in the US and in other countries across the world. In spite of the favourable effect for exports in Europe, emerging countries might suffer further capital outflows and increasing difficulties to pay off their debts, which may ultimately result in rising credit spreads. The discussion on the replacement of the Affordable Care Act (ACA)[1] in the US was characterized by high uncertainty. European insurance companies with a substantial share of their business in the US might be impacted, in particular if a less regulated market might boost profitability by excluding limits on factors such as the difference in premiums that can be charged to participants. However, the legislation is complex and many aspects have to be negotiated until a final conclusion will be reached.

Furthermore, the insurance industry faces challenges from emerging risks that can be difficult to address due to their dynamics, unpredictability and complexity. Ransomware, which is a type of cyber attack involving virtual extortion, is such an

[1] The ACA is a federal statute in the United States Congress signed into law on March 23, 2010. The law requires insurers to accept all applicants, cover a specific list of conditions and charge the same rates regardless of pre-existing conditions through some mechanisms introduced including mandates, subsidies and insurance exchanges. Moreover, ACA limits the percentage of premiums that insurers can devote to profit and administrative expenses and also requires regulators to evaluate the basis for rate increases. The new government announced intentions to immediately deliver a full repeal of the act.

example. However, if addressed properly, it can also be considered as an opportunity to broaden the current business models, for example by offering cyber insurance products.

Additionally, the insurance industry also needs to adjust to new sorts of demands reflecting a shift of the nature of terrorist attacks with increasing frequency. Small businesses could also start to consider purchasing insurance against this type of incidents. The inclusion of other causalities which often causes business interruption but not necessarily property damages might also be a necessary adjustment for traditional products against terrorism.

1.1. Low for long versus sudden spike scenario[2]

Market data points to a persistent low yield environment but with signs of upward movements (Figure 1.1 and Figure 1.2). The EUR 10-year swap rates have moved up albeit from extremely low levels. Similarly, short-term forward rates moved upwards. However, it is too early to decide whether this is a new long-term trend which may release the negative impact of the persistent low interest rate environment in some jurisdictions.

Figure 1.1 EUR swap curve (in %)

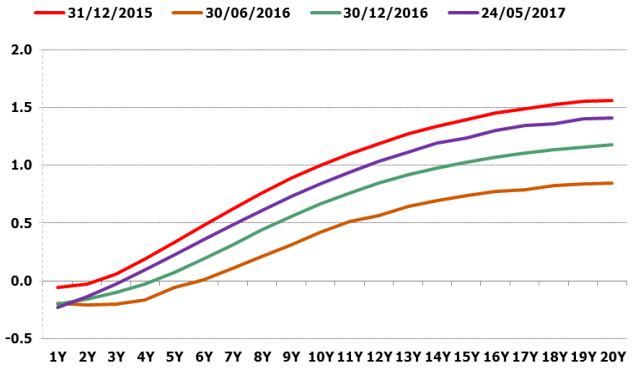
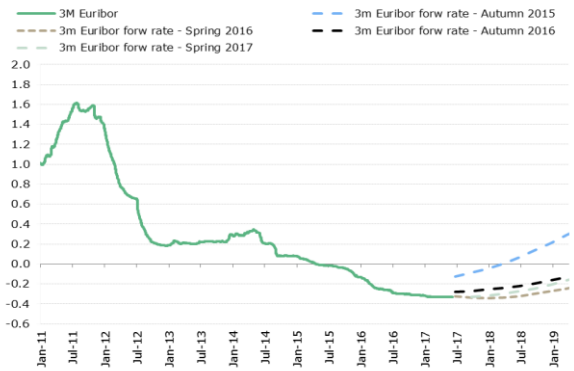


Figure 1.2 3M Euribor (in %)



Source: Bloomberg; Last observation for EUR swap curve: 30/05/2017; last observation for 3M Euribor: 08/06/2017

[2] The "low for long" scenario is defined as a situation when short and long-term nominal interest rates are assumed to remain low over the next decade, combined with a period of low economic growth. The rationale behind this scenario is that structural factors, such as demographic trends, total factor productivity or an increased preference for scarce safe assets, along with cyclical factors, have pushed interest rates down to low levels. See more on Macroprudential policy issues arising from low interest rates and structural changes in the EU financial system, ESRB (2016).

The inflation rate in the euro area has increased substantially (Figure 1.3 and Figure 1.4). In May 2017, the harmonised index of consumer prices (HICP) dropped to 1.4% from 1.9% in April 2017. The latest developments seem to be driven mainly by energy prices, reinforced by the euro depreciation. In addition, the heterogeneity across countries poses challenges for further developments of the monetary policy.

Figure 1.3: Inflation: HICP - All-items excluding energy and food (annual rate of change in %)

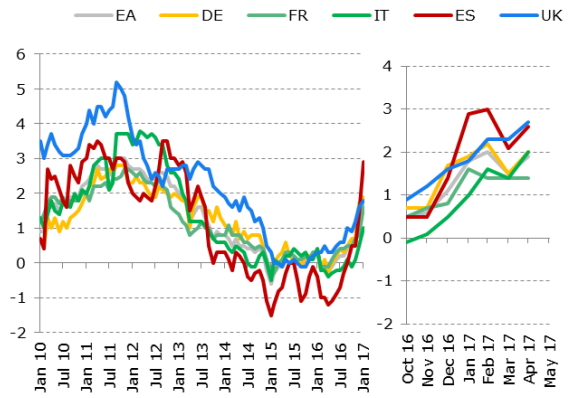
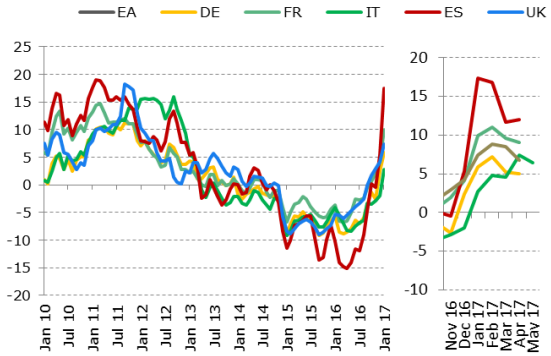


Figure 1.4: Inflation: HICP - Energy – (annual rate of change in %)



Source: ECB and Eurostat; Last observation: 30/05/2017

Government bond and euro area corporate yields remain at low levels (Figure 1.5 and Figure 1.6). A slight upward trend of the yield curve can be observed, although it seems to be more substantial for government bonds. Corporate bonds might develop in similar veins in the short to medium term.

Figure 1.5: 10-year government bond yields in %

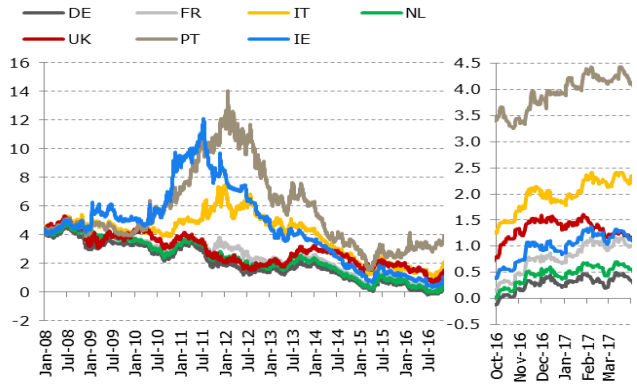
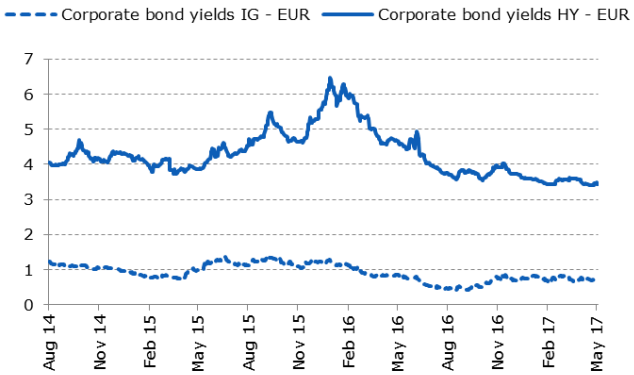


Figure 1.6 Corporate bond yields in %



Source: Bloomberg; Last observation: 30/05/2017. Note: IG (Investment grade) and HY (High yields)

Economic growth remains fragile in Europe, but with signs of a moderate recovery (Figure 1.7). The growth is mainly driven by domestic demand in the EU, but some countries still face difficulties to reach their pre-crisis levels.

Unemployment is below 10% since the beginning of 2015 in the euro area (Figure 1.8). Besides the high heterogeneity, the overall trend shows improvements across countries, with more resistant rates in France and Italy.

Figure 1.7: Real GDP (2007Q1=100)

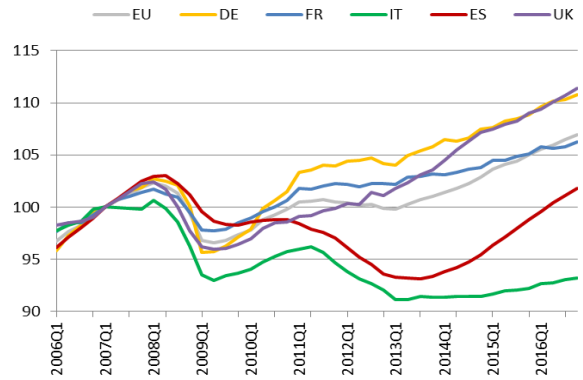
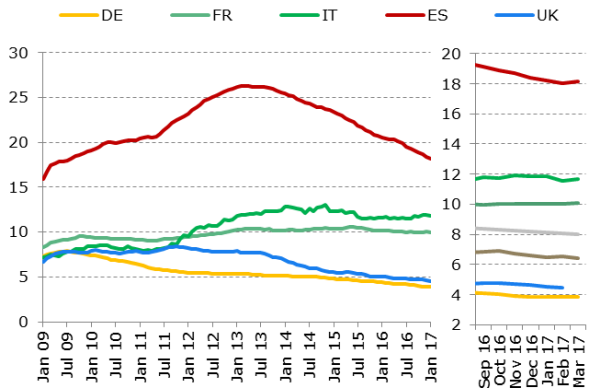


Figure 1.8: Unemployment rate



Source: ECB and Eurostat; Last observation: 31/12/2016 for the GDP figure and 30/05/2017 for the unemployment figure (data for UK available only until April 2017).

The ECB's quantitative easing policy based on asset purchases of EUR 80bn a month has recently been extended until at least December 2017 but was cut to EUR 60bn per month from April 2017 onwards. This move by the ECB indicates that a gradual move towards a less vigorous monetary stimulus becomes more likely. As the investment portfolios of insurers are typically dominated by fixed income securities (Chapter 5), a

yield curve steepening would have a rather beneficial impact on traditional life insurers' business partly easing the challenge of meeting the obligations towards policyholders when looking jointly at assets and liabilities. Typically liabilities are more sensitive to interest rates than assets due to the higher average duration. However, an increase in the yield curve might present a threat for some European insurance companies under an extreme scenario encompassing a material jump in the interest rates leading to a potential increase in lapses due to the availability of more profitable investments. Nevertheless, this effect might be counterbalanced by the coverages of insurance products which may not be comparable with other investment products and by surrender penalties designed to limit sudden lapses.

1.2. Uncertainty and Market Risks

Uncertainty and market risks are concepts closely related and with different meanings, but both are present in the essence of the insurance business. Uncertainty involves unknowns with no measurable probability or distribution of the outcome, which could be also associated with uninsurable events with potential transfer of costs either to individuals or to the public sector.[3] Even when the source of uncertainty has its foundations in political or economic events, it might still have an adverse impact on the insurance sector (Box 1). Sensitivity to geopolitical shocks and perspectives of rising debts may also impact country ratings with direct effects on risk premiums and subsequently insurers' portfolios.

Box 1: Impact of political risks on the European insurance sector

Geopolitical risks include a broad variety of risks such as wars, surges in immigration, terrorist threats and political tensions with potential socioeconomic and political effects. Overall, they might have negative consequences on insurance business.

Political risks have increased in a context of less predictable results of elections and decisive referendums in Europe. Although political risks are difficult to quantify due to their unpredictable nature, they bring opportunities for insurance companies ranging from business protection against sudden business interruption and damage in productions to interdictions in currency conversion. In order to investigate the potential impact of political risks on insurance, an event study was

[3] See Knight, Frank H. (1921). Risk, Uncertainty, and Profit. Boston: Houghton Mifflin.

conducted on four recent political events: elections in Spain, in the Netherlands, in the US and the UK referendum.[4] The results suggest that such events might influence the European insurance setor.[5]

An event study is based on statistical methods that evaluate the impact of a particular events on firms, for instance by estimating whether there is a evidence of significant abnormal returns around the day of the event, known as the event window. In the case of this exercise, the event window is defined as 5 days, i.e. two days before and two days after the event itself. This is necessary in order to consider the immediate consequences after the event as well as the possible noise from speculations that might have interfered the market shortly before.[6] Through ordinary least squares (OLS) regression analysis, it is possible to extract the parameters of the equation that represents expected return and explains the typical relationship between the stock returns and the reference benchmark index from a period of time (in this case, an estimation window of 100 days was used). [7] The expected returns obtained from this equation are compared with the actual returns from the event window to calculate the abnormal returns.

From the selected events, only the Dutch elections did not show evidence of impacting the insurance sector (Table 1). The significance test was performed at the 5% level.[8] This means that results below this threshold suggest a statistical significant impact of the event on the average cumulative returns across the companies.

[4] The Italian referendum and the elections in Austria were not included in the study as they happened on the same day which makes it difficult to distinguish their effects from each other. The French elections were also not included as the results were unknown by the time that this study was conducted. It is important to mention that future research using other methodologies is necessary to further investigate these cases. The employed methodology is in general more appropriate for completely unexpected events. However, certain outcomes can still be considered unexpected due to the contrast with previous pools and also due to the reported high degree of indecision from the voters.

[5] MacKinlay, A. C. (1997). "Event Studies in Economics and Finance," Journal of Economic Literature Vol. XXXV, Issue 1.

[6] The coefficients of the equation to calculate expected returns were estimated using the market approach employing the EUR STOXX 50 as the market benchmark regressor. The sample includes 64 European insurance companies and the insurance companies that are part of the EUR STOXX 50 were excluded from the sample to avoid endogeneity.

[7] Although a similar event study might be considered at national level, national reference benchmark indexes are not always available and in some cases the number of listed insurance companies might be limited.

[8] The test statistic is defined as: $= \frac{CAR}{var(CAR)1/2}$. CAR stands for cumulative abnormal return, which is the aggregated average abnormal return over the event window.

Table B.1.1: Results of the EIOPA event study on political risks

	Cumulative abnormal return (average)	P-value (5% significance level)
UK referendum	-4%	0.00
US elections	1%	0.04
Spanish elections	-3%	0.00
Dutch elections	-1%	0.45

The UK referendum was the event that had the strongest impact with an average abnormal return of minus 4% across the sample. Due to the importance of the UK insurance sector in Europe (25% in terms of total assets as of Q3 2016) and many uncertainties triggered by the outcome, the first reactions of the market were clearly negative.

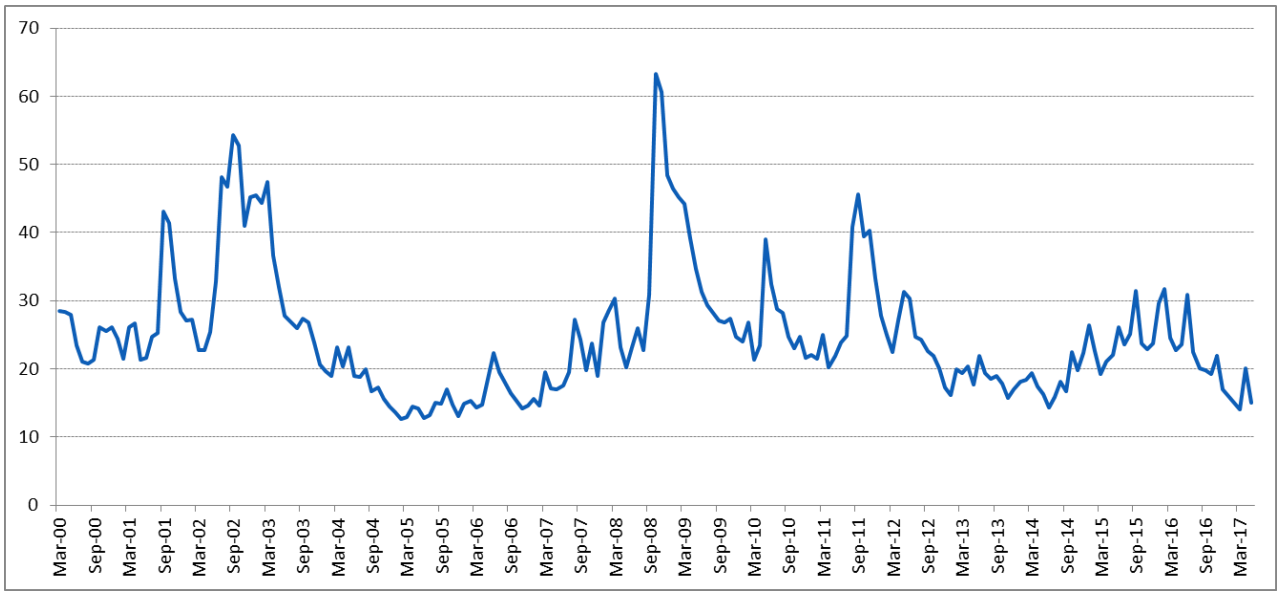
The elections in Spain in 2016 also had a negative impact on the sector. It was a repetition of the elections in 2015 with the result of the most fragmented Congress of Deputies in recent history not allowing any political party to achieve a majority.

Lastly, the analysis suggests that the elections in the US had a positive impact on the European insurance sector. This might be attributted to the previously announced plans to reform regulations in the insurance sector (known as the Affordable Care Act). The positive reaction of the market corresponds to investors' expectations that the European companies with business in the US could benefit from potential regulatory changes.

The most common approach to measure market uncertainty is by capturing its implicit volatility (Figure 1.9). Examples of indexes that fulfil this purpose are the Euro STOXX Volatility (VSTOXX) for Europe and the Chicago Board Options Exchange Market Volatility Index (VIX) for the United States.[9] These are weighted indexes that combine several market index options, with the notion that the greater the premiums on these options are, the higher uncertainty about the direction of the market is.

[9] Source: The VIX: Using The "Uncertainty Index" For Profit And Hedging. http://www.investopedia.com/articles/exchangetradedfunds/11/profit-from-vix.asp#ixzz4ZUL2MjvV

Figure 1.9: Euro STOXX Volatility



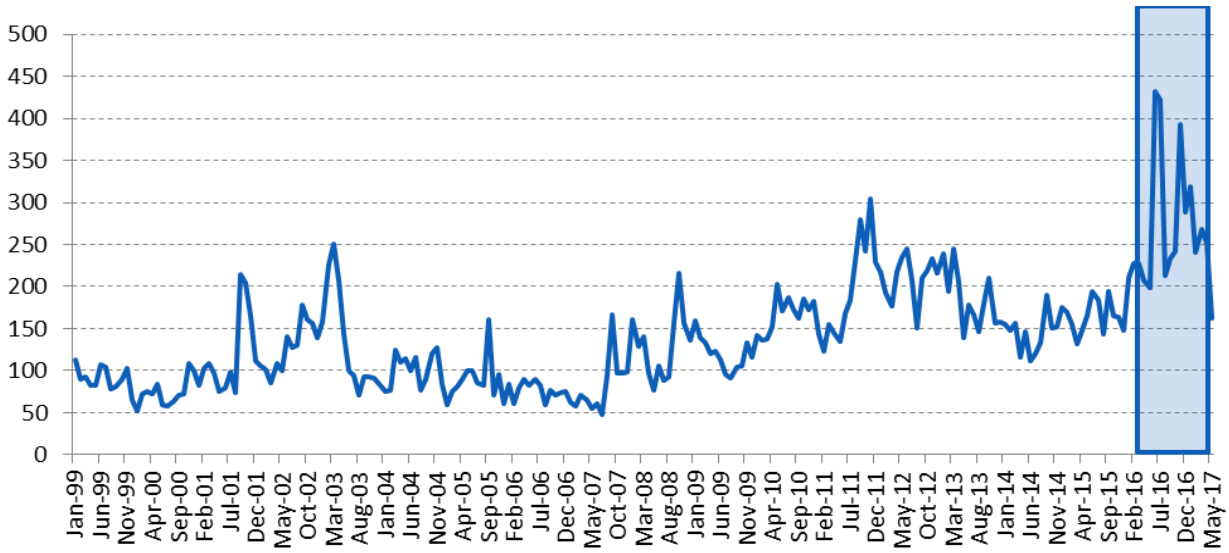
Source: Bloomberg; Last observation 30/05/2017. VSTOXX is a volatility index measures implied volatility of near term options on the EuroStoxx 50 index (Eurozone blue chip stock index with very liquid futures and options).

Surveys on economic and forecast errors, representing the predictability of economic variables, are also often exploited as a proxy for uncertainty (Figure 1.10). The idea behind is that the larger disagreements among forecasters imply higher uncertainty. The Economic Policy Uncertainty Index is another proxy used in the literature.[10] The methodology uses an index based on newspaper articles related to policy uncertainty.[11] The level of economic policy uncertainty has been sharply increasing and reached its peak in June 2016, when the UK referendum took place. In contrast, VSTOXX is at relatively lower levels, as it is driven by other market related factors as well.

[10] Scott R. Baker, Nicholas Bloom, and Steven J. Davis. 2016. "Measuring Economic Policy Uncertainty." Quarterly Journal of Economics, vol 131(4), pages 1593-1636.

[11] The authors standardise and average across newspapers to obtain monthly country-level and European Economic Policy Uncertainty indexes.

Figure 1.10: Economic Policy Uncertainty Index - Europe



Source: http://www.policyuncertainty.com/methodology.html*; Last observation: 30/05/2017*

Many studies acknowledge the impact of uncertainty on the real economy.[12] Unclear subsequent outcomes followed by geopolitical events might encourage a precautionary attitude towards certain investments with negative economic effects until some aspects become clearer. The existence of a clear relationship between growth in the insurance sector, in particular growth in gross written premiums (GWP), and key macroeconomic determinants is acknowledged in some studies. Evidence shows that nominal GDP is the key driver for non-life insurance business, while unemployment is a driving factor for premium growth on the life side (Christophersen and Jakubik, 2014).[13] Therefore, although further research is needed to investigate in detail the relationship between uncertainty and the insurance sector, it seems that uncertainty with macroeconomic or political origins might indirectly affect GWP through its negative impact on the real economy.

[12] It is estimated that temporary uncertainty shocks have strong adverse impacts on economic activity, contributing significantly to real GDP growth fluctuations in the euro area, with a 0.3 % fall followed in the second quarter after an uncertainty shock. Among the components of expenditure, real investment growth is found to be significantly more affected than real private consumption growth. The adverse impact on employment growth appears to be somewhat weaker in total, albeit more persistent. See: ECB (2016) "The impact of uncertainty on activity in the euro area", ECB Economic Bulletin, Articles, December, pp. 1-20.

[13] Christophersen, C., Jakubik, P. (2014): Insurance and Macroeconomic Environment, Financial Stability Report, EIOPA, May 2014.

Credit default swaps (CDS) remain low and volatile (Figure 1.11 and Figure 1.12). Political uncertainty rises across Europe and it might also be reflected in increases in the volatility of insurers' CDS in the future.

Figure 1.11: 5-year CDS in bps- Insurance

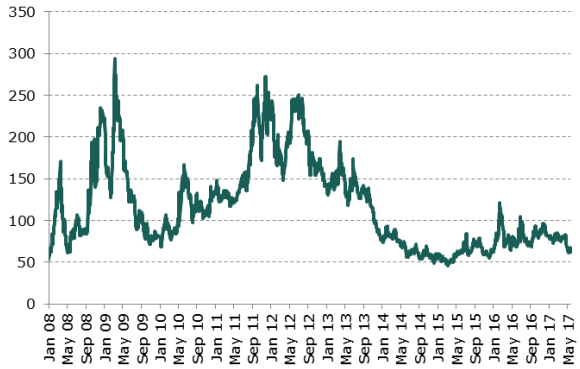
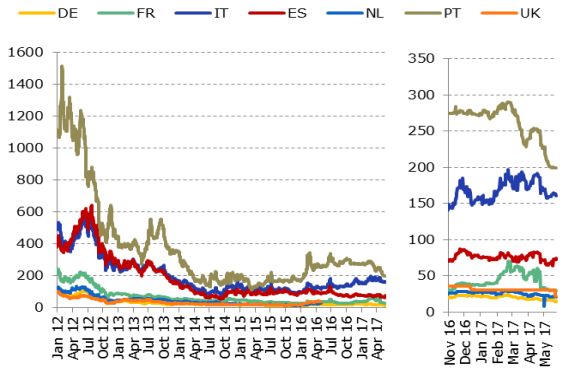


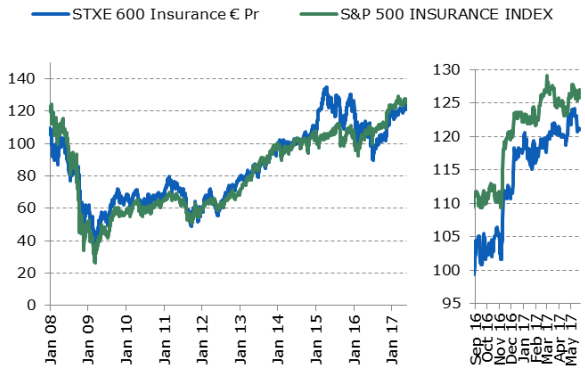
Figure 1.12: 5-year CDS in bps- Sovereign



Source: Bloomberg; Last observation: 30/05/2017

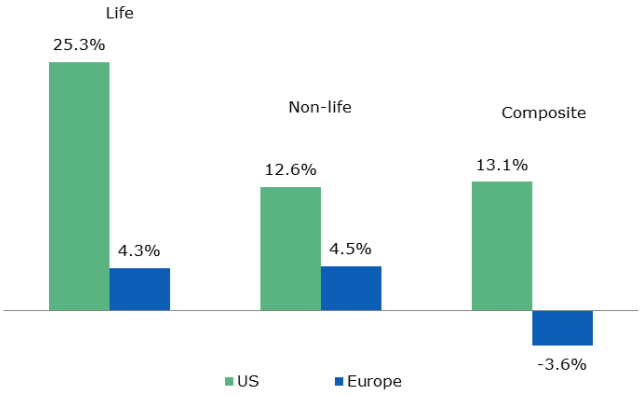
Share prices of European insurance companies have been volatile in the last years (Figure 1.13). Although European insurance stocks showed a superior performance to the US market until the beginning of 2016, the situation reversed strongly over last year. In 2016, the average of the US insurance sector index performance was 14.8% while it was minus 5.6% for the corresponding European Stoxx 600 Insurance index. This pattern can be observed for life as well as for non-life insurers (Figure 1.14). It can be partly attributed to more modest growth prospects in Europe, rising yields in the US and to some extent by positive expectations on reforms in the US insurance regulation. Overall, all these factors might have led to an overheating of the US equity market with potential corrections in the short-to-medium run reflecting uncertainties about regulatory reforms on the US regulation.

Figure 1.13: Insurance Sector Market Performance



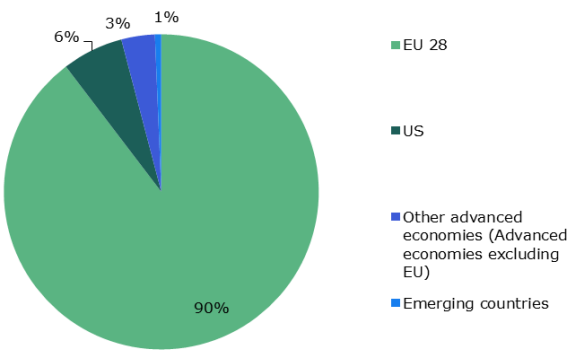
Source: Bloomberg Stoxx 600 Insurance for Europe and S&P 500 Insurance Index for US; Last observation: 24/05/2017

Figure 1.14: Insurance Sector Annual Market Performance in 2016 - by category



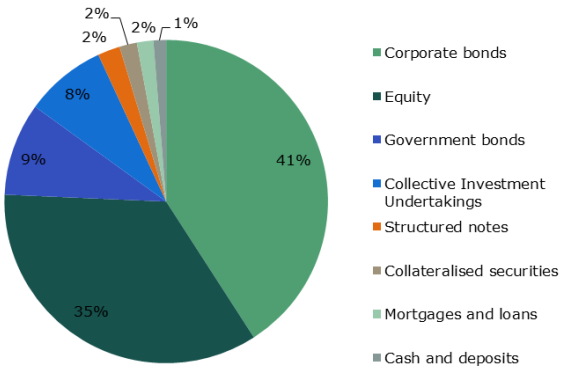
The exposure of the EU insurance investments is dominated by EU assets (90%). United States' assets appear as the second highest investment (6%), while the exposure to emerging market assets is rather limited (Figure 1.15 and Figure 1.16). European insurance companies hold 5.7% of their aggregate balance sheet in US assets, amounting to nearly EUR 566bn (Figure 1.16). The highest exposures to US assets are attributed to corporate bonds (41%), equity (35%) and government bonds (9%). Exposures to mortgages and collateralised securities are rather limited. European companies that have substantial investments and a considerable part of their business in the United States might be affected if major shocks and market corrections would occur in the US, especially on US bonds and equity.

Figure 1.15: Exposure of EU Insurance Sector by region



Source: EIOPA; Last observation: 30/09/2016

Figure 1.16: Exposures of EU insurers to US assets in %



Source: EIOPA. Last observation: 30/09/2016.

1.3. Emerging risks and the insurance sector

Some risks are more complex to quantify than others for different reasons, such as a lack of historical data, a high degree of imprevisibility or the dynamism and speed that the complexity of certain kinds of risks evolves. Currently, terrorism and cyber attacks are one of the most prominent examples.

In the course of an immediate impact of a terrorist attack, typically, it is possible to identify the responsible, the motivation behind it and to a certain extent how the attack was planned. However, the major unpredictability relies on whether that specific terror act was isolated or whether it was just the first of a series. This degree of imprevisibility and the potential enormous liability are clear burdens for the insurance industry, which led to the introduction of government terrorism insurance schemes. These schemes were implemented mainly after the terrorist attack of September 11, 2001 in the United States and vary across countries regarding their coverage and obligatoriness.

The traditional terrorism insurance is typically classified in the market under the political violence segment and tends to focus on property damage, to which claims on business interruption are often directly linked. However, the nature of the attacks is shifting to other causalities which often cause business interruption but not necessarily property damage. Some examples are cancellation of events, interrupted business and third-party liabilities. Therefore, the industry needs to adjust to new sorts of demands in an environment of high uncertainty, also considering that small businesses often do not purchase this type of insurance and might not have sufficient capital.

Along these lines, another risk that is gaining fundamental importance and can be even more challenging for insurers is cyber attacks. The level of sophistication of such attacks has been evolving and the target has been extended beyond data breaches or money stealing, but also hitting operational systems of critical infrastructure and transportation systems; in many cases motivated by political and ideological reasons.

Another aspect is the difficulty in attributing responsibility for cyber attacks. This characteristic facilitates the proliferation of crimes with a higher risk nature, such as cyber extortions as ransomware, which is a type of cryptoviral extortion attack that blocks the victim's device or holds the victim's data hostage, threatening to publish

private information or blocking access to the files until a ransom payment is effectuated (Box 2).

Box 2: Ransomware and Insurance

Ransomware is a type of cyber extorsion that could be considered nearly as a "virtual kidnap". WannaCry, the latest global incident, is particularly damaging because it is also a worm — not just a ransomware program. It consists on malicious softwares typically received via email attachments or internet downloads. These malwares retain data and block the access of the files until ransom is payed. A cyber-attack using ransomware could close down operations for a considerable period of time, leading to business interruption and reputation losses. This is a relatively high profit business, in general with a modest degree of complexity when compared to other types of malwares. The advent of cryptocurrencies encourages the proliferation of such attacks, as the confidentiality on the money transactions makes the capture of the hackers even more challenging. The frequency and sort of attacks have been sharply increasing in the past years. There are a few dominant families of ransomware, each with its own sub-variants. According to a recent study, total ransomware increased by approximately 330% from 2014 to 2016.[14] The insurance industry should therefore be attemptive on the potential higher demand for products against attacks of this nature. According to another survey, 24.6% of companies would be willing to pay a ransom to hackers to prevent a cyber attack and 14.0% would pay more than USD 1 mn to prevent the release of relevant information.[15]

There is no standard policy regarding this type of attack. The main distinction between ransomware insurance from other types of cyber insurances is the coverage of the costs of the extortion and in some cases also the costs of an expert to fix potential security gaps and improve the system to avoid future attempts. The victims often have a limited period of time to submit ransom attack claims. Some insurance companies require that the claim should be sent immediately after the ransomware attack while other insurers require notifications

[14] https://www.mcafee.com/au/resources/reports/rp-threats-predictions-2017.pdf.

[15] http://info.skyhighnetworks.com/rs/274-AUP-214/images/WP%20CSA%20Survey%20Cloud%20Balancing%20Act%200116.pdf

within 30 days or maximum 60 days. Moreover, policyholders normally are required to prove the incident by, for instance, showing ransom payments that were eventually effectuated or any internal efforts confirm the genuineness of the threat, mainly in case of companies. In general, contracts are restricted to certain types of ransomware incidents. Furthermore, most of the ransomware insurance policies may not allow the insured to assign its rights to third parties to act on their behalf.[16]

As cyber risk is a relatively recent risk and more difficult to identify compared to traditional ones, the lack of track records on incidents is an obstacle for the assessment of potential aggregate losses. Furthermore, increasing sophistication and complexity of cyber incidents makes the reliance on past events a limited parameter for predicting and estimating the probability of future events. Consequently the prices of cyber insurance are relatively high while coverage is usually limited – insurers often incorporate restrictive terms and conditions to lower the possibilities of incurring unforeseen business losses.

A major challenge for the insurance sector is not only quantifying and pricing virtual risks, but also protecting themselves against such attacks. The big amount of confidential data held by insurers is one of the reasons why they are considered an important target for hackers. Therefore it is critical for companies to address the opportunities but at the same time being alerted on the risks. As it is a relatively recent risk and more difficult to identify compared to traditional ones, the lack of track records on incidents is an obstacle for the assessment of potential aggregate losses.

[16] Insurance companies are also considered to be a potential target to this kind of incident due to the amount of data and information hold. Therefore, IT security, staff trainings and other measures to protect insurers should be in place.

2. The European insurance sector

The sector has continued to adjust to the new Solvency II (SII) regime, which entered into force in January 2016. The Solvency II Directive introduced significant changes and specific requirements related (among others) to different reporting formats, the best estimate of technical reserves, more stringent capital adequacy requirements, specific measurement and presentation requirements.

In 2016, the first year of the application of Solvency II, the reporting of insurance and reinsurance undertakings to National Supervisory Authorities (NSAs) is limited. In particular, according to the Solvency II reporting the impact of the LTG (long term guarantees) measures on the financial position have been reported to NSAs for the first time in 2017. Therefore, also the information available to EIOPA about the impact of these measures on undertakings is limited. While the 2016 stress test already provided some information on the impact of LTG measures, its full potential will only be reached during the course of 2017 (Box 3).

Box 3: Impact of the LTG (long term guarantees) measures

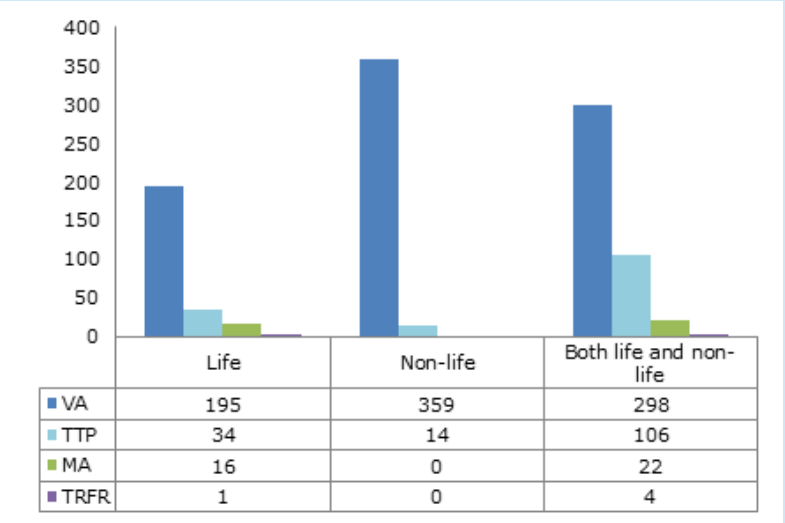
The Solvency II Directive (Art.77(f)) requires EIOPA on an annual basis until 2020 to report to the European Parliament, the Council and the Commission about the impact of the application of the so called long term guarantees (LTG) measures. The findings will form the basis for the review of the Solvency II Directive in this respect.

LTG measures are a series of measures amending the Solvency II Directive through the Omnibus II Directive in order to ensure an appropriate treatment of insurance products that include long term guarantees. The LTG measures include: extrapolation of the risk-free interest rates; matching adjustment (MA), volatility adjustment (VA), extension of the recovery period (ERP), transitional on the risk free rate (TRFR), transitional on technical provisions (TTP). The application of the MA, VA, TRFR and TTP is optional for undertakings. These measures are intended to limit procyclicality and to enable a smooth transition to the new regulatory framework of Solvency II providing companies with the necessary time to adapt, in particular in a challenging macroeconomic environment.

In December 2016 EIOPA published the first Annual Report on LTG measures in particular on their use and impact on the financial position of insurers in terms

both of solvency capital requirement ratio and technical reserves.[17] Insurance companies covered in the LTG report and using at least one of the measures amount to 69% of the technical provisions (901 insurance undertakings) of the EEA insurance and reinsurance market, representing together 24 different countries. The application of the MA, VA, TRFR and TTP is optional for undertakings. The remaining 31% did not make use of any of these optional measures. The results of the LTG report show that the most used measure is the VA while the least used is the TRFR.

Figure B3.1: Number of undertakings using the LTG measures



	Life	Non-life	Both life and non-life
VA	195	359	298
TTP	34	14	106
MA	16	0	22
TRFR	1	0	4

Source: EIOPA LTG Report

The impact of the measures were calculated for the representative smaple of life insurers applying the measures. The most pronounced impact was attributed to the MA measure while the least one could be observed for the VA measure.

Table B3.1: Impact of the LTG measures

	Initial SCR ratio	SCR ratio without the measure
MA	144%	75%
VA	206%	172%
TRFR	154%	102%
TTP	183%	115%

Source: EIOPA Insurance Stress Test 2016

Note: Each category refers to undertakings applying the respective measure.

[17] https://eiopa.europa.eu/Publications/Press Releases/2016-12-16 LTG Report_final.pdf

2.1. Overview and data

This Financial Stability Report presents EIOPA's risk analysis and assessment of the European insurance industry. With the implementation of the Solvency II regime in January 2016 substantial improvements as regards the risks' quantification and the reporting standards were introduced. Despite the regime implying a major change in the way insurance companies have to set up their balance sheet and calculate their solvency capital requirements, the initial transition has been rather smooth resulting in a relatively stable profitability and solvency position (section 2.2 and 2.3 in this chapter for further details).

EIOPA bases the analysis for this report on Quarterly Financial Stability Reporting Group (QFG), Quarterly Financial Stability Reporting Solo (QFS)[18] and Quarterly Prudential Reporting Solo.[19] [20]

The summary statistics of the amount of total assets, technical provisions (TP) and gross written premiums (GWP) for all insurance and reinsurance undertakings is shown below (Table 2.1). Total assets are on average EUR 100,071 mn in Q4 2016. Also, for the average company, EUR 81,322mn of insurers' liabilities are TPs, i.e. contractual obligations to policyholders. The average company wrote EUR 11,466mn GWP in 2016.[21]

Table 2.1: Summary statistics in EUR mn

Percentile	average	min	10th	25th	median	75th	90th	max	total
Total assets	100,071	12,334	15,862	23,567	50,943	105,593	269,926	688,888	8,606,153
TP	81,322	5,991	12,372	16,504	38,861	84,978	189,534	548,029	6,820,489
GWP	11,466	0	1,166	2,494	4,131	12,059	29,716	119,916	965,105

Source: EIOPA (sample based on 104 insurance groups in EEA)

Reporting reference date 31/12/2016

TPs are the largest item on the balance sheet (BS) (Figure 2.1). They are hence a key input into the Solvency Capital Requirement (SCR) calculation, which models

[18] It covers 94 groups and 24 solos.

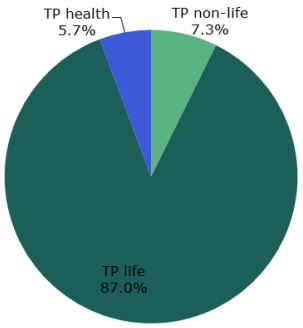
[19] It is based on 3076 solo insurance undertakings.

[20] The last available data for both groups and solos was 31/12/2016 (Q4) at the time of writing this report. The reference date for all indicators used in this report is hence Q4, unless otherwise indicated. The sample size for the different indicators may vary according to availability and consistency of the reported information.

[21] Note that not all companies report under financial stability reporting. For the full sample of 2640 solo undertakings subject to prudential reporting total assets are EUR 11trn, TPs EUR 8.7 trn and GWP EUR 3.8 trn.

the potential movement in the SII balance sheet over a one year time. Insurance companies' liabilities are mainly technical reserves for which market value is not available and the value is calculated as the expected value of all discounted cash flows. In terms of technical provisions, life insurance is by far the largest item per business line.

Figure 2.1: Technical Provisions (TP) - by type of business in %

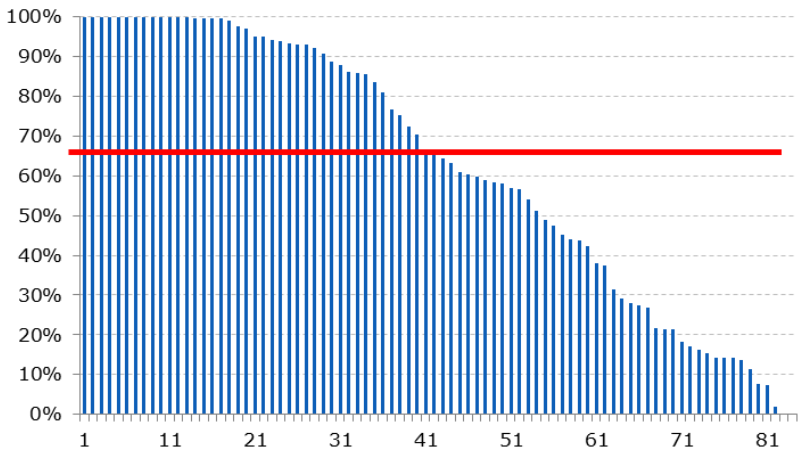


Source: EIOPA (sample based on 2640 solo undertakings in EEA)

Reporting reference date: 31/12/2016

The share of life business for each individual undertaking is shown in the data reported (Figure 2.2). Most insurance groups offer both life and non-life products. The business mix is slightly unbalanced towards life insurance business (with the median having a share of life business of 65% in Q4).

Figure 2.2: Gross Written Premiums (GWP) - Share life business in %

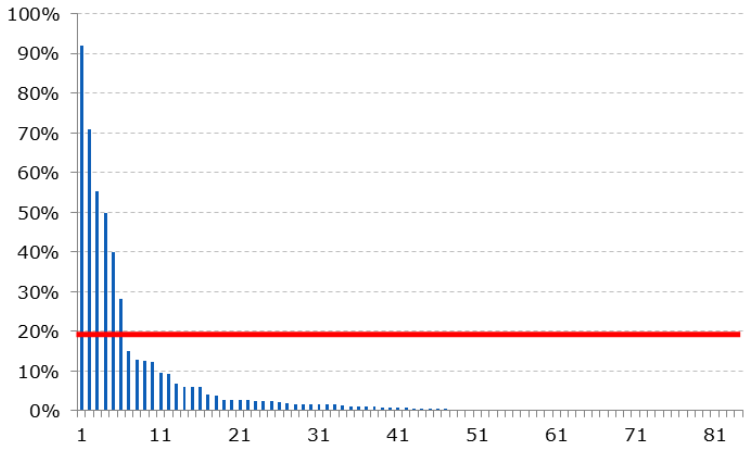


Source: EIOPA (sample based on 104 insurance groups in EEA)

Reporting reference date: 31/12/2016

The share of reinsurance business (in terms of gross written premium) for each individual undertaking can be calculated (Figure 2.3). Only six insurance groups have more than 20% of the share of GWP reinsured.

Figure 2.3: Gross Written Premiums (GWP) - Share reinsurance business in %

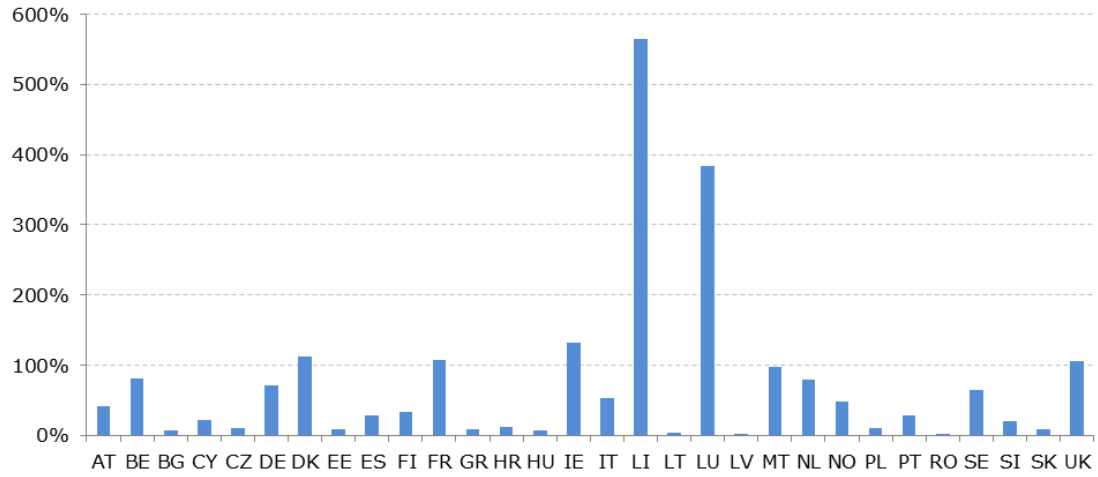


Source: EIOPA (sample based on 104 insurance groups in EEA)

Reporting reference date: 31/12/2016

The importance of insurance sectors substantially differs among European countries (Figure 2.4). Measuring the size of the sector by total assets as a percentage of GDP, it ranges from 2% in Latvia to very high ratios in Liechtenstein and Luxembourg where a lot of cross-border life business is written.

Figure 2.4: Total Assets (TA) - Share of GDP in %

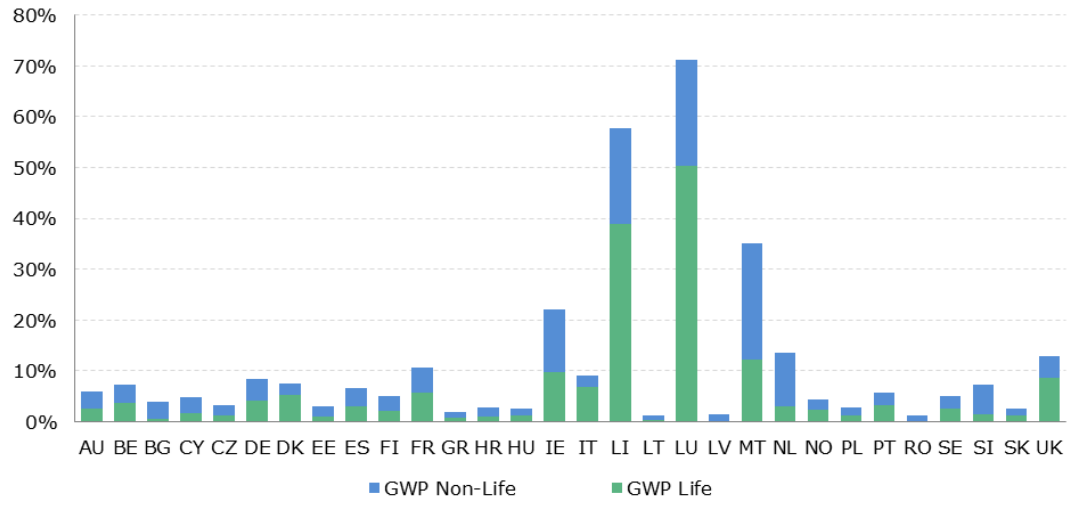


Source: EIOPA (sample based on 2640 solo undertakings in EEA) and ECB for GDP

Reporting reference date: 31/12/2016

Similarly, insurance penetration is a commonly recognised indicator of insurance activity, defined as gross written premium (GWP) as a percentage of GDP (Figure 2.5). Significant disparities are observed within European countries. Liechtenstein also ranks highest in terms of the penetration rates, both for life and non-life business. For non-life business Malta and Luxembourg are countries with high penetration levels (22.8% and 20.9% respectively). For life business, Luxembourg ranks highest (50.3%), while Latvia and Romania rank lowest (0.1% and 0.2%).

Figure 2.5: Gross Written Premiums (GWP) - Share of GDP in %



Source: EIOPA (sample based on 2640 solo undertakings in EEA) annualised GWP and ECB for GDP

Reporting reference date: 31/12/2016

Capital requirements for unit-linked products are less stringent but the higher risk for policyholders has to entail a closer supervision of the duty to provide proper advice (Table 2.2). There seems to be a general weakening of demand for life insurance products in the recent past, in line with the persistence of low interest rates which already weighs on new volumes of products.[22] In this perspective, the introduction of new products such as index-linked products needs to be monitored. [23]

[22] Note that Solvency II data needs to be developed over time.

[23] Index-linked policies should not be confused with unit-linked policies. For index-linked policies the greater part of the money is invested in zero coupon bonds and the remainder is invested in structured products linked to the indices that are therefore more risky.

Table 2.2: GWP-Life business: Unit-linked share in %

Percentile	31/12/2016
10th	0
25th	1
Median	18.6
75th	57.2
90th	93.1
Average	26.2

Source: EIOPA (sample based on 2640 solo undertakings in EEA),

Reporting reference date: 31/12/2016

Note: this average is obtained by the mean of the ratio where the numerator is gross written premium unit-linked (summed up across all insurers) and the denominator is gross written premium life (summed up across all insurers)

Compared to the previous year, no significant changes in the business model and strategy of insurance undertakings or in their overall risk profile have been observed. Elements of strategies continue to be - amongst others - the development of new products with no long-term engagement and low(er) guaranteed interest rates that are often no longer "fixed for life", and the application of cost cutting plans that allow a positive technical result to regain profitability. Many companies have also e.g. put (a part of) their business into run-off, whilst others have switched their internal structure from a subsidiary to a branch. Others also focused on capital strengthening exercises. These changes focus almost exclusively on the life insurance business that suffers increasingly from the ever-increasing difficult environment. Indeed, some insurance groups nowadays show a growing tendency to mainly focus on non-life products and some companies have recently also decided to no longer commercialise classic individual life contracts. Lately however, more drastically measures have been observed with some companies cutting certain high fixed guarantees by setting-up "new" contracts with the insured, and companies offering advantageous conditions for clients to buy back or surrender their hard-guaranteed products. In fact, the maximum guaranteed interest rate which can be offered on insurance products was lowered in many countries once more at the beginning of 2016. In addition, sometimes unsustainable profit participations could be reduced if the legal framework allows. This also applies to business models when dividend distributions can be cancelled entirely or deferred.

The lapse rate for life insurance companies is 2.11% for the median company in 2016 (Table 2.3). The current annual value demonstrates an overall low level of

lapses in the life sector for the median company. However, as the 90th percentile shows, in some countries people lapse their life insurance contracts. This is e.g. the case when the period of preferential fiscal treatment ends and guaranteed certain interest rates are no longer available. Also, the cancellation via the internet for term life insurance products is very easy and has an effect on lapse rates as well albeit it should be mentioned that this business line is usually a minor line of business. Annual solvency returns and/or quarterly return submissions should help to measure lapse rates adequately. Some countries already measure this risk on an on-going basis through different models such as traffic lights or quarterly stress tests which should facilitate to monitor the evolution of lapses in the future.

Table 2.3: Lapse rate in %

Percentile	31/12/2016
10th	0.27%
25th	0.97%
Median	2.11%
75th	4.55%
90th	6.98%

Source: EIOPA (sample based on 104 solo and group undertakings),

Reporting reference date: 31/12/2016

2.2. Profitability

Profitability results provide a quantified estimation of the insurance sector's vulnerability to the low interest rate environment and to a pronounced reassessment of risk premia.[24] The industry registered an almost unchanged profitability level. Yields in Europe, although improving slightly in the recent quarter, remain near historical lows and risks concerning the low profitability of financial entities pose key concerns to the financial system. Low yields have more seriously affected the profitability of life insurers, especially in some countries where there is a large stock of contracts with high guarantees. Hence, the development of business models guaranteeing lasting profitability for insurers, even in less favourable economic circumstances, is required.

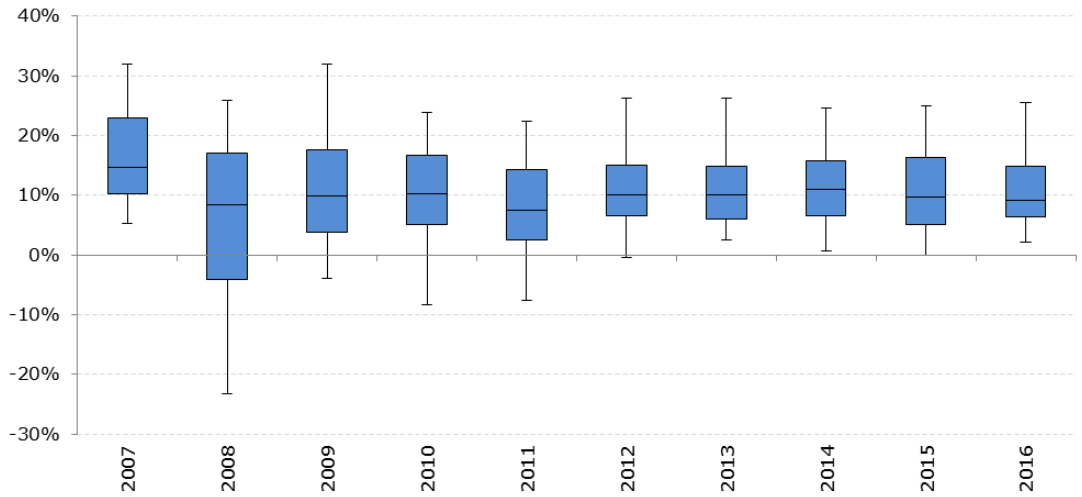
The Return on Equity (ROE) for the median company is 9.1% in 2016, against 9.7% in 2015 and 11% in 2014 (Figure 2.6).[25] As the low interest rate

[24] Profitability refers to ROA and ROE and not to fiscal profits or fiscal losses.

[25] Note that results for year-end 2016 are preliminary.

environment is ongoing, these good results should gradually dampen further in the future.

Figure 2.6: Return on Equity (ROE) in %

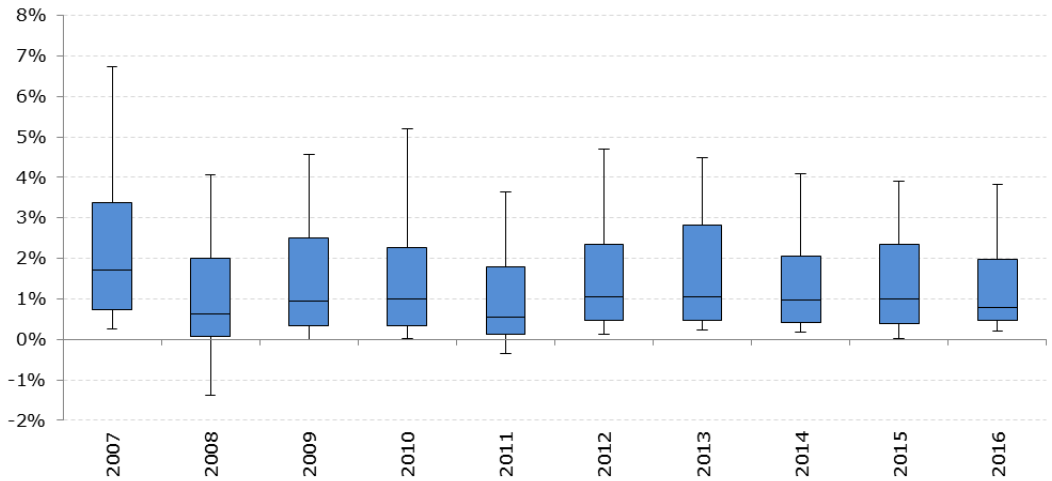


Source: S&P Capital IQ, 114 insurance undertakings and brokers from 23 EEA countries

Reporting reference date: 31/12/2016

The Return on Assets (ROA) for the median company continues to be stable (Figure 2.7). Based on our data, it is about 1% in 2016. However, insurers whose business models depend heavily on interest-rate-sensitive product lines such as traditional long-term savings products with fixed guarantees already see declining ROA.

Figure 2.7: Return on Assets (ROA) in %

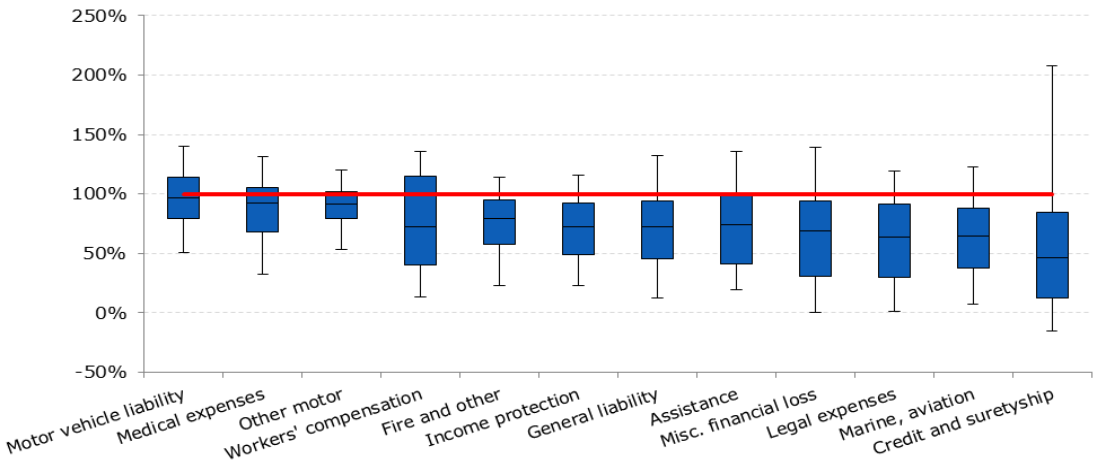


Source: S&P Capital IQ, 114 insurance undertakings and brokers from 23 EEA countries

Reporting reference date: 31/12/2016

The net Combined Ratio (CR) in the non-life sector has been relatively stable across business lines (Figure 2.8). Overall, the sector hence currently benefits from low underwriting risks, reflected by a median net Combined Ratio of below 100%. Whether the natural catastrophes claims in 2016 and early 2017 will have an impact on the Combined Ratio remains to be seen. With regards to the 90th percentile, the net CR averages more than 100% in Q4 2016. Especially the motor sector faces on-going high competitive pressures. As such, prices are suppressed, and the range of products available within this line is broad. It needs to be watched if national supervisors report increasing claims in the future. So far no increase in claims has been observed.

Figure 2.8: Net Combined Ratio across business lines (in %; median, interquartile range and 10th and 90th percentile)



Source: EIOPA (sample based on 1608 solo non-life undertakings in EEA)

Reporting reference data: 31/12/2016

2.3. Solvency

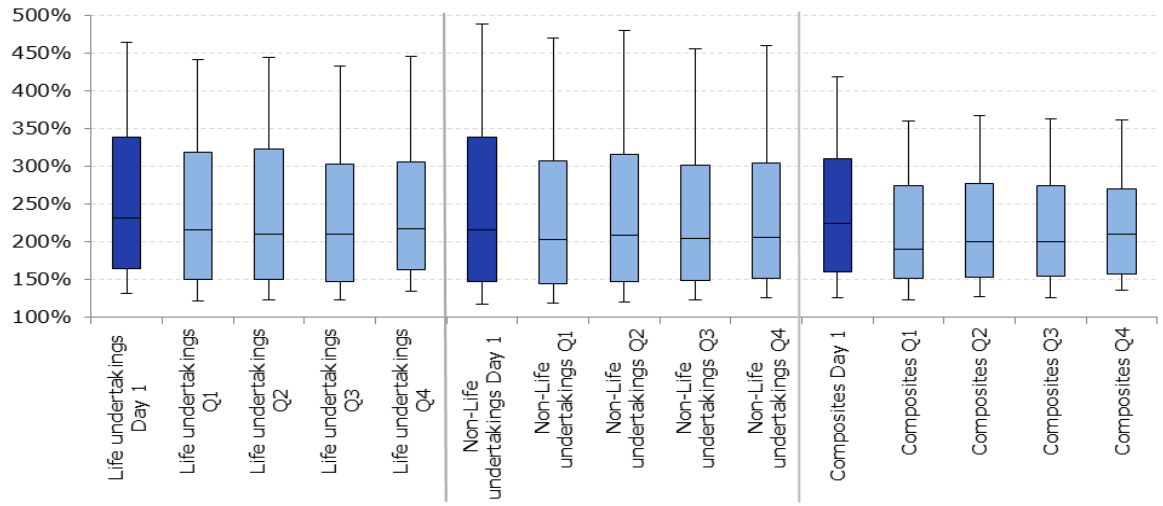
The Solvency Capital Requirement (SCR) can be calculated with a standard formula that is specified in the regulation or with an internal model that was approved by the NSA. It is also possible to calculate a part of the SCR with an internal model (partial internal model) and the remaining part with the standard formula. The SCR standard formula consists of modules for the different risks that an insurance and reinsurance undertaking is exposed to (in particular market risks, underwriting risks, counterparty default risks, operational risks). The risk that relates to the change of equity prices is captured in the equity risk sub-module of the standard formula. The MCR is usually lower than the SCR. It corresponds to the minimum level of security that is required under Solvency II. An insurance or reinsurance undertaking not complying with the

MCR would expose policyholders and beneficiaries to an unacceptable level of risk. If an insurer does not cover the MCR with own funds, its authorisation will be withdrawn unless the MCR is covered again within 3 months. The MCR is usually between 25% and 45% of the SCR.

The SCR ratio is the ratio of eligible own funds and SCR. Insurers have to maintain the SCR ratio of 100% or higher to comply with regulatory requirements. The MCR ratio is the ratio of eligible own funds and MCR. The MCR ratio needs to be 100% or higher to comply with regulatory requirements.

As of December 2016, the majority of solo insurance undertakings show a SCR ratio above 100% (Figure 2.9). The SCR ratio for the median insurance company is 209% in Q4. It corresponds to 217% for life insurance companies, 207% for non-life insurance companies and 210% for undertakings pursuing both life and non-life business at the same time. Solvency II levels for all insurance undertakings marginally improved in Q4 when compared with Q3 for the median company. This is mainly due to the increase in own funds.

Figure 2.9: SCR ratio (in %; median, interquartile range and 10th and 90th percentile)[26]



Source: EIOPA (sample based on 2640 solo insurance undertakings in EEA)

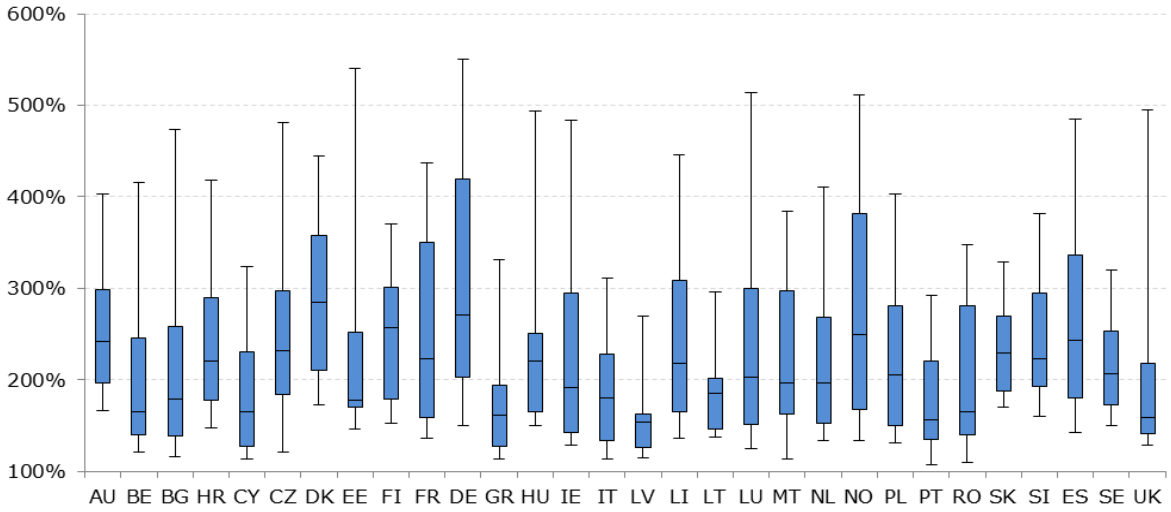
Reporting reference data: 31/12/2016

The same conclusion for the SCR ratio could be made at country level as well (Figure 2.10). The figures show that the SCR ratios are well above the prudential

[26] Please note that the graph does not show any observation below the 10th percentile.

requirement of 100% for the median company in all countries, ranging from 153% to 285% in Q4 2016.

Figure 2.10: SCR ratio by country (in %; median, interquartile range and 10th and 90th percentile)



Source: EIOPA (sample based on 2640 solo insurance undertakings in EEA)

Reporting reference data: 31/12/2016

2.4. Regulatory developments

In January 2017 the European Commission and the US Department of the Treasury and Office of the Trade Representative jointly announced the successful conclusion of negotiations of an Agreement between the EU and the USA on insurance and reinsurance. The Agreement covers three key areas of prudential insurance oversight: reinsurance, group supervision and exchange of insurance information between supervisors. Through this Agreement, collateral and local presence requirements for reinsurers operating on a cross-border basis between the EU and the USA will be removed, under certain conditions. Furthermore EU and US (re)insurance groups active in both jurisdictions will not be subject to certain requirements with respect to group supervision for their worldwide activities, but supervisors retain the ability to request and obtain information about worldwide activities which could harm policyholders' interests or financial stability. The Agreement also contains model provisions for the exchange of information between supervisors, which supervisors on both sides of the Atlantic are encouraged to follow. It is being notified to Congress in the USA and will be submitted to the EU Member States in Council in view of its formal

signature. The European Parliament's consent will also be needed for the conclusion of this Agreement.

In February 2017, EIOPA forwarded to the Commission its technical advice on possible delegated acts concerning the IDD Insurance Distribution Directive (IDD). The technical advice covers the following aspects: product oversight and governance; conflicts of interest; inducements; and assessment of suitability and appropriateness and reporting. In particular, the policy proposals on product oversight and governance arrangements aim to ensure that the interests of the customers are taken into consideration throughout the life cycle of a product, namely the process of designing and manufacturing the product, bringing it to the market and monitoring the product once it has been distributed. Moreover, the policy proposals on conflicts of interest, inducements as well as suitability/appropriateness aim to ensure that distribution activities are carried out in accordance with the best interests of customers and to ensure that customers buy insurance-based investment products which are suitable and appropriate for them.

As part of the IDD development, EIOPA submitted also to the Commission in February 2017 the draft Implementing Technical Standards (ITS) for the Insurance Product Information Document (IPID). These include the proposal of a standardised presentation format to be completed by insurance providers that will be given to customers prior to the sale of a non-life insurance product. The objective of the IPID is to ensure that the customer has the relevant pre-sales information about products to allow him to easily compare between different product offerings and to make an informed decision about whether to purchase a product.

As part of the process of the Capital Market Union initiative of the European Commission, EIOPA has received on 22nd February 2017 a call for technical advice as regards unjustified constraints to financing, in view of removing barriers to investments in unrated bonds and loans and in unlisted equity. Separately, this call for advice asks for information on the current application of the provisions related to strategic equity investments. EIOPA will base both of its advice on evidence and has engaged on discussions with stakeholders. The advices should be provided by February 2018.

According to the EU Audit Regulation[27], EIOPA issued in February 2017 guidelines addressed to insurance supervisory authorities for the purpose of facilitating the establishment and the maintenance of effective dialogue with statutory auditor(s) and audit firm(s) carrying out the statutory audit of insurance undertakings. The Solvency II Directive provides legal requirements on statutory auditors to report promptly any facts which are likely to have a serious effect on the financial situation or the administrative organisation of a (re)insurance undertaking. However, in addition to that duty, supervisory tasks can be supported by effective dialogue between supervisors and statutory auditors and audit firms. EIOPA's Guidelines are aimed to support a consistent, appropriate and proportionate supervisory approach in aspects such as the objectives of the dialogue with statutory auditors and audit firms, nature of the information to be exchanged, means and channels for communication as well as frequency and timing of the dialogue, among others.

On the 21st February 2017 the three European Supervisory Authorities (EBA, EIOPA and ESMA - ESAs) published a joint Opinion addressed to the European Commission on the risks of money laundering (ML) and terrorist financing (TF) affecting the European Union's financial sector. The Joint Opinion finds that problems exist in relation to firms' understanding and management of the ML/TF risk they are exposed to. The Opinion also highlights difficulties associated with the lack of timely access to intelligence that might help firms identify and prevent terrorist financing, and considerable differences in the way national competent authorities discharge their functions. These issues, if not addressed, risk diminishing the robustness of the EU's AML/CFT defences and more action is needed to ensure their effectiveness. This is particularly important as Member States move towards a more risk-based AML/CFT regime that requires a level of ML/TF risk awareness and management expertise, which not all firms and all sectors currently have.

In the wake of the global financial crisis the G20 summit in Pittsburgh agreed on a stricter regulation of derivatives transactions. After in-depth discussions both on the international and European level the Delegated Regulation (EU) 2016/2251 on OTC derivatives, central counterparties and trade repositories with

[27] Article 12(2) of Regulation (EU) No 537/2014 of 16 April 2014 of the European Parliament and of the Council on specific requirements regarding statutory audit of public-interest entities.

regard to regulatory technical standards for risk-mitigation techniques for OTC derivative contracts not cleared by a central counterparty entered into force in January 2017. It includes provisions for the exchange of initial and variation margin for non-centrally cleared OTC derivatives. While most pension funds and insurers will not be in the scope of the initial margin requirements, they will have to exchange variation margin.

3. The global reinsurance sector

The reinsurance market still suffers from an oversupply of capacity owing to the absence of large losses and the continuing capital-inflow into the reinsurance market. The rate of price declines reduced in 2016 further, but reinsurance prices have not yet found their floor. The January 2017 renewal reflected that trend. It seems that the reinsurance sector needs to slip into broad unprofitability before true pricing stabilisation can be found.[28]

3.1. Market growth

Reinsurance demand is still subdued, whereas the reinsurance capacity continues to increase. As a long-term trend primary insurers tend to retain more risks using improved risk management techniques. Furthermore, competitive markets as well as low investment returns force primary insurers to be increasingly price sensitive, whereas their and the reinsurers' capital position has improved due to the relative benign catastrophe activity in the last years.[29]

Thus, overall, the general environment remains largely unchanged. The rates continued to soften in 2016, even though the downward trend has slowed. Along with rate reductions also the terms and conditions for reinsurance placements improved further, e.g. expanded hours clause, broadened terrorism coverage and improved reinstatement provisions.

In 2016 natural catastrophe losses were back in the mid-range. After three benign years the losses totalled up to USD 175bn in 2016 (2015: USD 103bn) substantially above the inflation-adjusted 10-year average of USD 154bn. The insured losses also rose considerably, by about 56% to USD 50bn (2015: USD 32bn). This value is above the long-term average of the last 10 years (USD 45bn) as well as of the last 30 years (USD 34bn).

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[28] Artemis: http://www.artemis.bm/blog/2017/01/03/jan-renewals-set-tone-for-demanding-2017-in-reinsurance-willis-re/

[29] AON Benfield: Reinsurance Market Outlook January 2017, page 2 and page 3

Table 3.1.: The five largest natural catastrophes in 2016, ranked by insured losses (in USD bn)

Date	Event	Region	Overall losses USD bn	Insured losses USD bn
14/04-16/04/2016	Earthquakes	Japan	31	6
28/09-9/10/2016	Hurricane Matthew	Caribbean, USA	10.2	3.8
27/05-8/06/2016	Severe storms	Europe	6	3.2
10/04-15/04/2016	Hailstorm	USA	3.9	3
May 2016	Wildfires	Canada	4	2.9

Source: Munich Re, NatCatSERVICE

The highest losses for the insurance industry were caused by two earthquakes on the southern Japanese island of Kyushu close to the city of Kumamoto in April 2016. 69 people lost their lives, tens of thousands had to be temporarily housed in emergency shelters. Countless buildings were destroyed and many production facilities were damaged. The overall economic loss from the two earthquakes amounted to USD 31bn, of which only USD 6bn was insured due to the low insurance density for earthquake risks.

Asia was the region most hit by natural disasters in terms of overall economic losses, (approximately 40%). In terms of insured losses North America accounted for 60% of all insured losses (about USD 30bn). The most serious event here was Hurricane Matthew, which hit Haiti as category 4 and the USA as category 1 hurricane resulting in severe damage and around 550 fatalities in Haiti.

In Europe, the highest losses were caused by severe weather in May and June, both in terms of economic losses and insured losses. Most hit were France, the Netherlands and southern Germany. The overall loss from the storms in Europe totalled USD 6.0bn (approximately EUR 5.4bn), around the half of which was insured. The most severe event in terms of fatalities was a series of earthquakes in Italy. On August 24, a severe magnitude-6.2 earthquake struck central Italy. 299 people lost their lives, an additional 388 people were injured. The quakes caused catastrophic damage, whole towns were flattened. More than 4.000 people were left homeless as buildings collapsed. The combined overall economic loss from all quakes was USD 6bn, only a fraction of which was insured.[30]

Up to now the year 2017 was relatively benign. Natural catastrophes resulting in major insured losses did not occur.

[30] Swiss Re: Sigma 2/2017 Natural Catastrophes and man-made disasters in 2016, page 9.

3.2. Profitability

Altogether, the competitive pressure in the reinsurance sector will increase further. The combination of the continuing capital-inflow into the reinsurance market, benign catastrophe activity and increasingly low investment returns due to the ongoing challenging economic environment increases the profitability pressure in the reinsurance business. Moreover, the ability to release reserves from previous years appears to have been diminished, whereas the long-term business is getting less profitable or even unprofitable as the high interest rates calculated in previous rates are difficult to earn. Against this background getting risk-adequate prices at the upcoming renewals is crucial for the reinsurance companies.

A further deterioration in reinsurers' return on equity is expected, even assuming a normalised catastrophe load. Given the amount of cash on the sidelines waiting to be put to work, even after a hurricane Katrina the overall capacity is to be expected to remain where it is. The reinsurance industry has sufficient capital to avoid insolvency from events that may occur once in 100 or 250 years (the so-called "probable maximum loss" or PML). The average combined ratio (among the 20 Aon Benfield Aggregate companies) was well below 95% in the last 5 years.[31]

3.3. Solvency

The global reinsurer capital totalled USD 595bn at September 2016, an increase of 5% since the end of 2015 (USD 565bn).[32] Traditional capital rose by 4.7% to USD 517bn reflecting solid reinsurer earnings and unrealised gains on bond portfolios resulting from declines in interest rates.

Against the background of the ongoing finance and debt crisis the diversifying nature of catastrophe-exposed business attracts investors who are searching for higher yielding investments. Low corporate and sovereign debt yields are likely to continue to produce more capacity for catastrophe and other reinsured risks. While the non-traditional capital is mainly going into the non-proportional catastrophe business, this new capital seems to spill over into other reinsurance lines.

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[31] Artemis http://www.artemis.bm/blog/2016/09/15/reinsurance-rate-softening-to-continue-ils-to-grow-influence-sp-execs/

[32] AON Benfield: Reinsurance Market Outlook January 2017, page 2 and page 3.

3.4. Alternative sources of capital

Alternative capital has continued to grow, albeit at a slower rate in 2015 and 2016.[33] At the end of September 2016 the alternative capital amounted to USD 78bn which represents about 13% of total capital. The use of alternative capital has also allowed reinsurers to retrocede a significant proportion of their catastrophe risk to the capital markets, thereby keeping the industry's exposure to large catastrophe losses manageable.[34] The bulk of the USD 78bn were collateralised reinsurance transactions, but insurance-linked securities were also important. The total outstanding ILS (Insurance Linked Securities) amount was around USD 26.8bn (2015: USD 26.0bn) at the end of December 2016.

[33] Global Reinsurance Highlights 2016: Reinsurers approach a tipping point as profitability threatens to sustainable fall below the cost of capital, page 14

[34] Global Reinsurance Highlights 2016: Reinsurers approach a tipping point as profitability threatens to sustainable fall below the cost of capital, page 14

4. The European pension fund sector[35]

The current macroeconomic environment and ongoing low interest rates pose challenges to the European occupational pension fund sector. Low interest rates keep the pressure on pension funds. Especially, Traditional Defined Benefit plans (DB), which account for approximately 75% of the sector in terms of assets, are affected as these types of pension plans provide employees with a defined level of pension, sometimes conditional on market developments and a degree of risk-sharing between employers, current and future plan members. DB funds are often long-term investors, whose liabilities have a longer duration than the assets, potentially leading to long-term asset-liability mismatches that sometimes can be greater than those experienced in the insurance sector. Defined contribution funds (DC) are also affected by the low interest rate environment. However, by not having a strict liability structure they adjust instantly to the macroeconomic developments.

4.1. Latest market development

Total assets held by occupational pension funds slightly decreased during 2016 (-0.2%) in the EEA. In the Euro area (EA) total assets showed a substantial growth (+8%) in 2016 (Figure 4.1). The decline of total assets can also be attributed to the substantial exchange rate depreciation of the GBP over the EUR in 2016, negatively affecting the EUR value of total assets in the country with the largest IORP sector in Europe, the UK. The EA growth rate of total assets has been significantly higher during the course of 2016. In the NL, the second largest IORP market, the value of total assets increased by 10%. Finally, when looking at all other countries in the sample (excluding UK and NL) total assets also increased by 5% in value over the course of 2016.

The UK and the Netherlands account for about 83% of the European occupational pensions sector (Table 4.1). Cross-country differences of the importance of the sector are mainly driven by the relative share of private and public pension provision with both UK and NL providing its citizens with relatively modest flat-rate state pensions. Pension funds under Pillar I are not covered in this chapter.

[35] All data employed in this section refers to IORPs (Institutions for Occupational Retirement Provision pension funds).

Table 4.1: Total assets per country as a share of total assets reported for 2016

UK	NL	DE	IT	IE	ES	NO	IS	AT	SE	PT	DK	RO
46.3%	36.5%	5.6%	3.4%	3.0%	1.0%	0.99%	0.75%	0.56%	0.53%	0.49%	0.22%	0.21%
LI	**FI**	**LU**	**SK**	**GR**	**SI**	**PL**	**LV**	**HR**	**BG**	**HU**	**MT**	**Total**
0.18%	0.12%	0.05%	0.05%	0.034%	0.019%	0.012%	0.011%	0.003%	0.0002%	0.0001%	0.00005%	100.00%

Source: EIOPA

Note: Data is preliminary and subject to revisions. For the UK data refer only to DB and HY schemes only. Data for BE is not yet available.

The penetration rate of the occupational pension fund sector remained at the same level in 2016 compared to the previous year (29% for EEA and 22% for the EA) (Figure 4.2). This ratio is calculated as the total size of assets over GDP and gives an indication of the relative wealth accumulated by the sector. In most of the countries penetration rates did not change significantly. The highest increase was observed in the NL (+11%) and in IS (+9%).

Figure 4.1: Total Assets (in EUR trn)

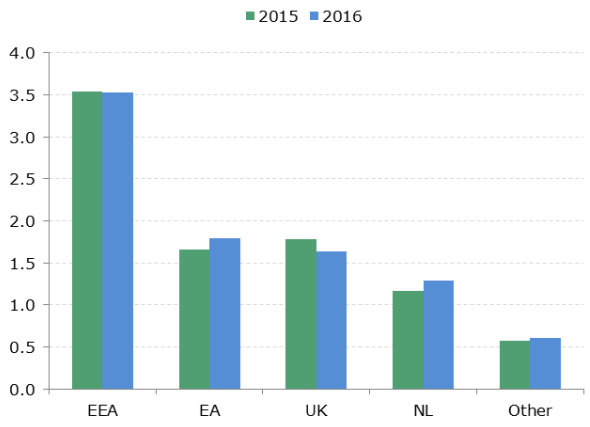
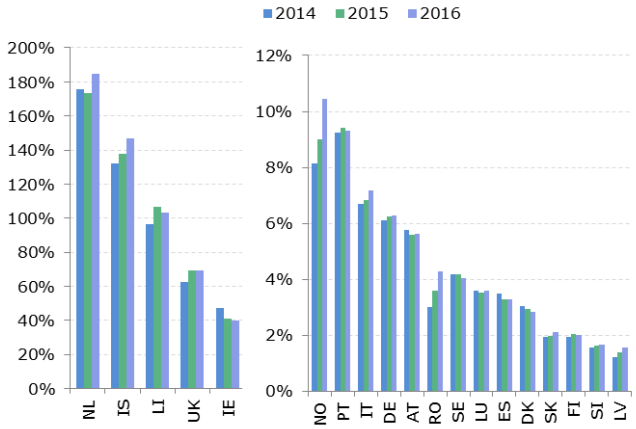


Figure 4.2: Penetration rates (total assets as % of GDP)



Source: EIOPA

Note: 2016 data is preliminary and subject to revisions. For the UK data refer only to DB and HY schemes. For Belgium, only the estimate of total assets was available at the level of EUR 29bn corresponding to a penetration rate of 7% at the end of 2016.

Figure 4.1 is based on data received by 25 countries (EEA) and 14 countries (EA) which provided total assets for 2016. The category 'Other includes all countries except UK and NL.

Figure 4.2 Penetration rates for GR, HR, PL, MT, BG, and HU is lower than 1%.

4.2. Investment allocation and performance of the sector

The investment allocation of pension funds has overall remained broadly unchanged in 2016 for the EEA compared to the previous year (Figures 4.3 and

4.4). However, when looking at the country breakdown in more detail some changes can be identified. In the euro area, a 2% increase in investments in equity can be observed, partly driven by the higher equity exposures in the NL. This change can be also observed in the 'other' category of the sample which includes all countries except the UK and NL. In aggregate terms, equity represents a higher share of investments in the pension fund sector than in the insurance sector (over 30 per cent for the EEA, EA, UK and the NL in 2016).[36]

The increased investments in equity might be driven by the ongoing low interest rate environment as well as by the positive market development in equity. As a consequence, the exposure of the pension funds to market risk has also increased. It is only the case of the UK, where IORPs continue to increase their investments in fixed income securities (mainly sovereigns) in an effort to de-risk balance sheets in view of the their maturing membership.

Figure 4.3: Investment Allocation in 2015 (in %)

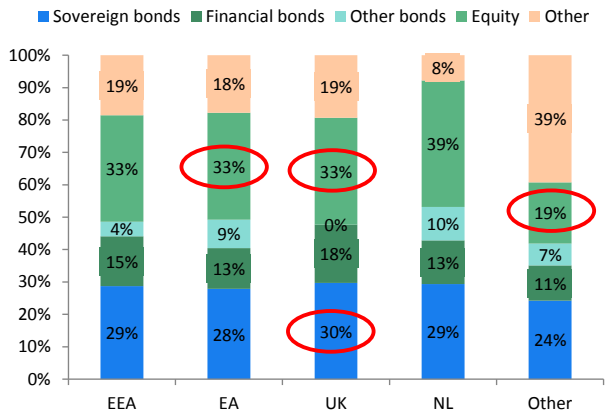
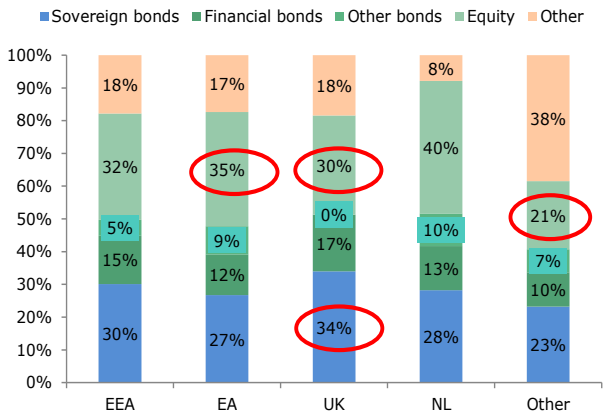


Figure 4.4: Investment Allocation in 2016 (in %)



Source: EIOPA

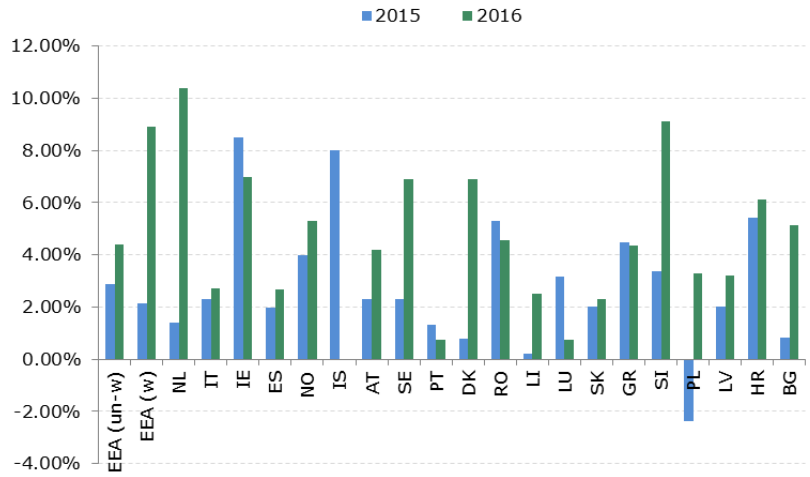
Note: Both charts are based on 22 countries for the EEA and 12 countries for the EA that provided the investment breakdown for 2016. Data for NO, FI, LU and BE is not yet available. Data for 2016 is preliminary and subject to revisions. Data for the UK figure DB and hybrid (HY) schemes only. The category 'Other' includes all the countries except UK and NL. Red circles represent major changes and trends commented in the text.

The average rate of rate of return on assets (ROA) has increased in 2016 (Figure 4.5). The average ROA in 2016 (un-weighted 4.4%, weighted 8.9%) has significantly increased since 2015 (un-weighted 2.9%, weighted 2.1%). This can be

[36] Not evenly distributed across the countries of the sample. Equity exposures may vary from 6% in DK and ES of total assets to 40% in the NL and 91% in MT.

partly attributed to the strong stock market performance during the final months of 2016.

Figure 4.5: Rate of Return on Assets (in %)



Source: EIOPA

Note: Data for 2016 is preliminary and subject to major revisions. Both the weighted and un-weighted averages for the EEA are calculated on the basis of the 20 countries that provided data and are depicted in the chart. The weighting is based on total assets. For ES the rate corresponds to the rate of return of all pension funds (including all costs).

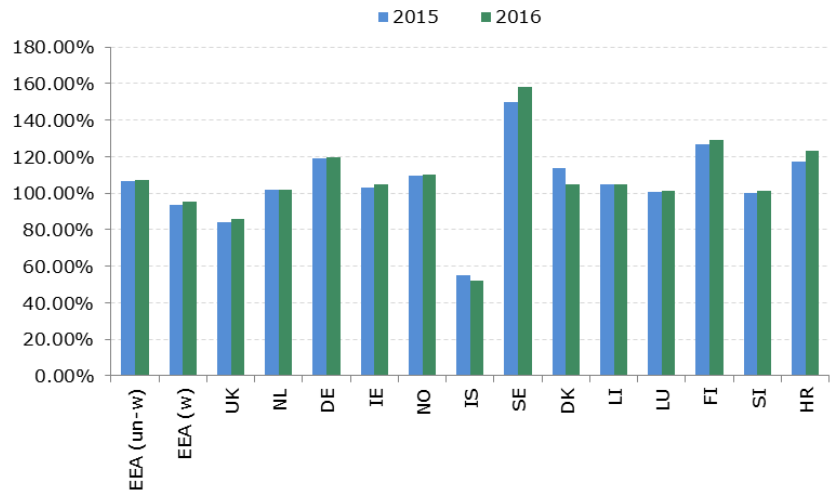
Please note that data on: UK, DE, FI, HU, MT and BE for 2016 are not yet available.

Coverage ratios for DB schemes slightly increased in 2016 (Figure 4.6).[37] For 2016, preliminary data indicates that the funding situation improved. Overall, the weighted average coverage ratio increased from 94% in 2015 to 95% in 2016 whereas the un-weighted average coverage ratio increased from 106.7% to 107.5% for the same period.

Coverage ratios below 100% are a cause for concern as they signal that IORPs have insufficient assets to pay future pensions. Low coverage ratios are dealt with in different ways in different countries across the EU. In a number of countries there is full sponsor support available and in some countries guarantees on DB plans exist. In other countries recovery of pension protection schemes is in place. In some cases changes to the value of the future benefits is possible and may become necessary in order to mitigate the consequences of the low cover ratios on future generations, if they persist. As such, these measures comprise transfers of risks across time as well as different actors, like pension funds, sponsors, members and beneficiaries and pension protection schemes (where relevant).

[37] Cover ratios are defined as net assets covering technical provisions divided by technical provisions.

Figure 4.6: National cover ratios (in %)



Source: EIOPA

Notes: Data for 2016 is preliminary and subject to major revisions. Both the weighted and un-weighted averages for the cover ratio are calculated on the basis of the 13 countries that provided data and are depicted in the chart. The weighting is based on total assets. Cover ratios refer only to DB schemes. Due to different calculation methods and legislation, the reported cover ratios are not fully comparable across jurisdictions.

5. Risk assessment

5.1. Qualitative risk assessment

A qualitative risk assessment is an important part of the overall financial stability framework. EIOPA also regularly conducts a bottom-up survey among national supervisors. Based on the responses of this survey among national supervisors, the key risks and challenges classified as the most imminent in terms of their probability and potential impact remain broadly unchanged.

The survey clearly suggests that risks related to the low interest rate environment and equity remain high over the last six months (Figure 5.1, 5.2 and 5.3). A prolonged period of low rates will be particularly challenging for both insurers and pension funds.

Low interest rate risk slightly decreased for the insurance sector since the last FSR and the pension sector alike but still remain the main risk (Figure 5.1 and 5.2). Contrary to this, equity risks increased further for the insurance sector, whilst it decreased for the pension sector over the last six months.

Figure 5.1: Risk assessment for the insurance sector

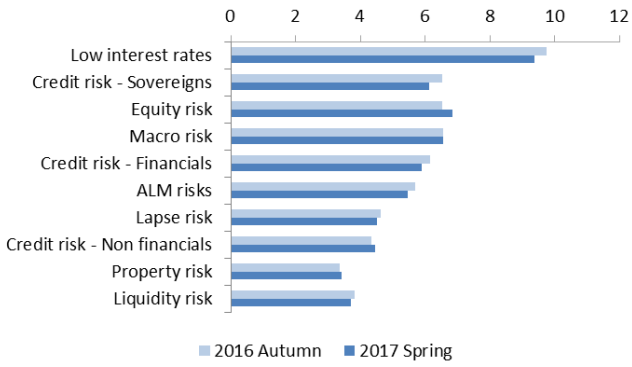
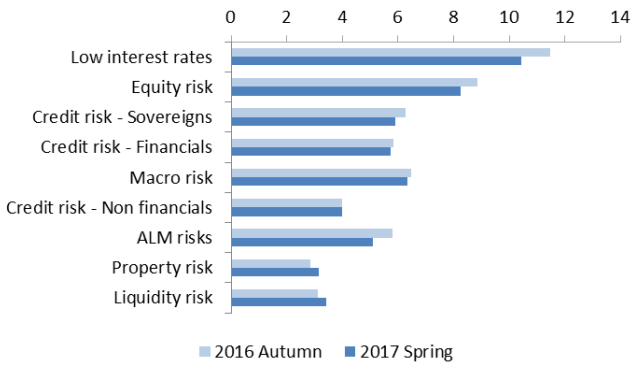


Figure 5.2: Risk assessment for the pension funds sector



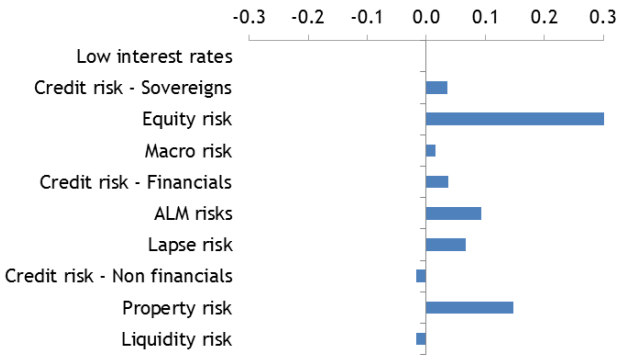
Source: EIOPA Spring Survey 2017

Note: Risks are ranked according to probability of materialisation (from 1 indicating low probability to 4 indicating high probability) and the impact (1 indicating low impact and 4 indicating high impact). The figure shows the aggregation (i.e. probability times impact) of the average scores assigned to each risk.

The highest increase is expected with regard to equity risk, property risk and ALM duration risk (Figure 5.3). In particular, investments in equity continue to increase although on average this increase is still small and there is no clear trend yet of an investment shift (Chapter 5.2.). In line with the current survey, the future expected risk of a prolonged period of low interest rates remains very low. On the contrary, liquidity risk is considered to be slightly lower in the last six months in

comparison to the last year. Note that in the current survey liquidity risk has increased for the pension sector, whilst it has decreased for the insurance sector in the same time. Property risk has been increasing for both the pension and insurance sector alike and is expected to increase in the future.

Figure 5.3. Supervisory risk assessment for insurance and pension funds - expected future development



Source: EIOPA Spring Survey 2017

Note: EIOPA members indicated their expectation for the future development of these risks. Scores were provided in the range -2 indicating considerable decrease and +2 indicating considerable increase.

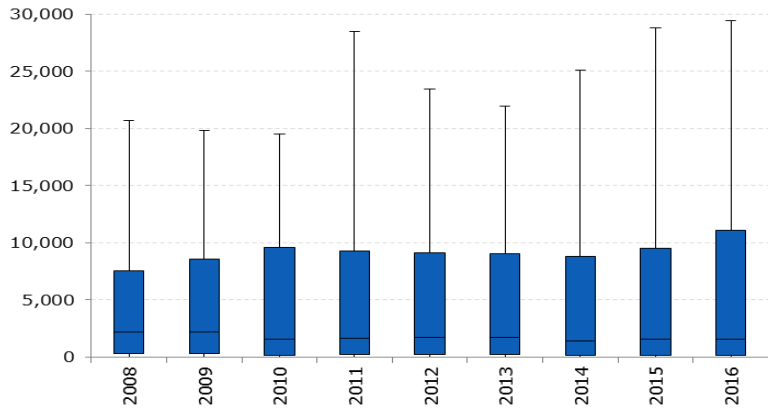
5.2. Quantitative risk assessment

This chapter further assesses the key risks and vulnerabilities identified in the previous chapters of the report. In detail, the quality of capital funds and solvency capital requirements is discussed in the context of the new Solvency II supervisory regime. Secondly, an extensive analysis of the insurers' portfolio is performed together with their exposures towards the banking sector. Finally, the profitability of insurers is evaluated; the return on assets projection for 2017 is included in the assessment. Furthermore, moving from no incentive for risk-based pricing to a risk-based approach leads to a change of insurance products. Shifts towards less capital-intense products and changes in asset allocation are expected to occur while the alignment of risk and capital management with Solvency II could be delayed by the use of transitional measures until 2032.

Some EU insurers increased their total capital funds in the preparation of the Solvency II Directive increasing their resilience towards adverse market

movements (Figure 5.4).[38] Even if the median value has remained somehow stable during 2010-2016, the interquartile range has risen from 2015 to 2016. This suggests that some insurers have increased their total capital funds.

Figure 5.4: Distribution of total capital funds of insurers (EUR mn)



Source: Bloomberg, 81 listed insurance undertakings

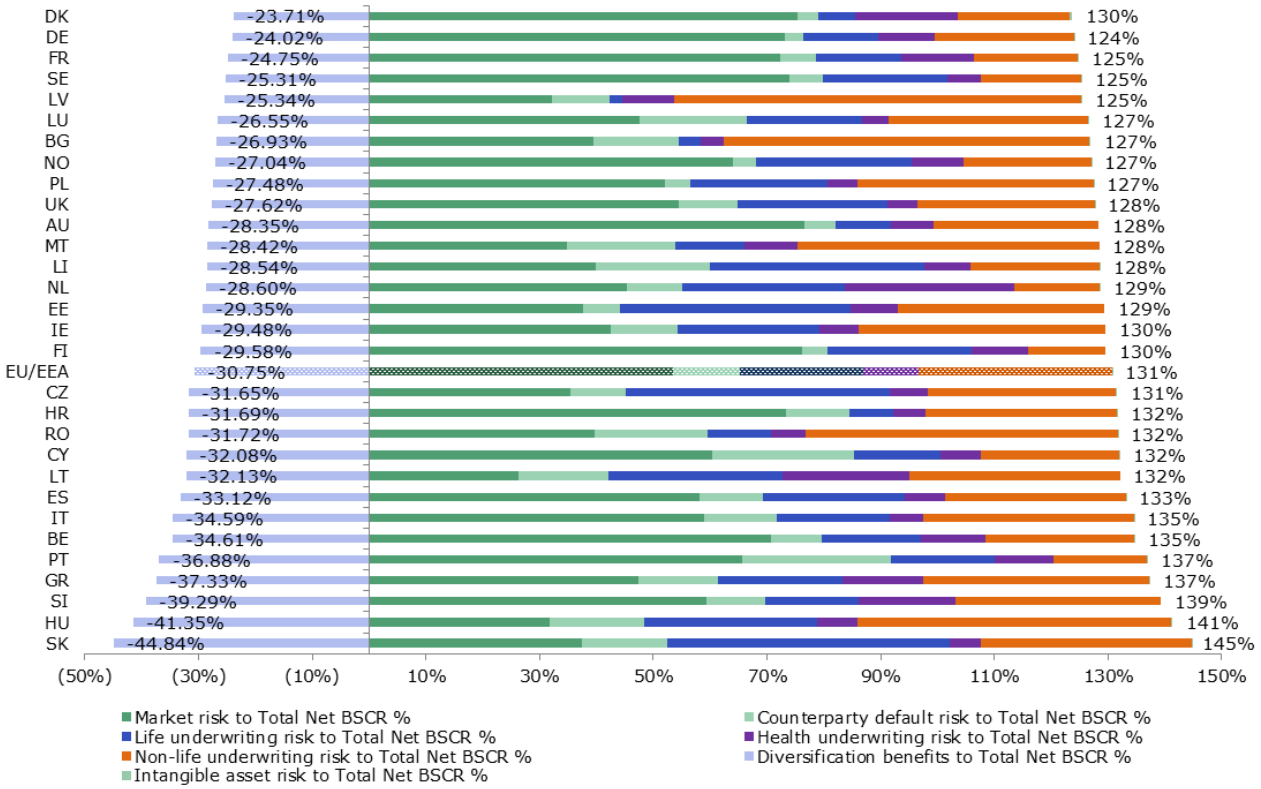
Reporting Reference Date: 31/12/2016

The Net Basic SCR reflecting insurers' risk profiles exhibits heterogeneity at country level (Figure 5.5).[39] The market risk varies from 77% in Austria to 26% in Lithuania before diversification risks. Non-life underwriting risks ranks second highest. It varies from 72% in Latvia to 14% in Finland. The diversification benefit has also a large impact on the Net Basic SCR. It ranges from minus 45% in Slovakia, to minus 41% in Hungary and minus 39% in Slovenia as opposed to minus 24% in Denmark, minus 24% in Germany and minus 25% in France. The EU/EEA average shows that more than half of the Net Basic SCR is composed of market risk while the diversification benefits reduce it by almost one third.

[38] Source: Bloomberg - Total capital fund is defined as total investments that shareholders and debtholders have made in a company and computed as the sum of Short Term Borrowings, Long Term Borrowings, Policy holders' Equity, Preferred Equity, Minority Interest and Total Common Equity.

[39] The diversification bar is calculated as the sum of diversification divided by the Total Net Basic SCR.

Figure 5.5: Breakdown of Net Basic SCR (Basic SCR, Standard Formula)



Source: EIOPA (S.25.01 "Solvency Capital Requirement - for undertakings on Standard Formula".)

Reporting Reference Date: 01/01/2016

Analysing the data regarding the composition of the investment portfolio allows appreciating the similarities and the differences in the style of the asset allocation between life, non-life insurers and undertakings pursuing both life and non-life insurance.

For life insurers, more than half of the portfolio is composed of fixed-income assets, relying heavily on corporate bonds (financial bonds represent 18% and non-financial bonds 11%) and government bonds (27%) (Figure 5.6a). This is due to the fact that life insurers are focused on asset-liability matching. Compared to the previous quarter, investments in equity and corporate bonds have slightly increased in the last quarter of 2016.

Non-life insurers typically have a lower duration of their liabilities so their asset allocation is less exposed to fixed income securities (Figure 5.6b). Equities compound 21% of their portfolio while government bonds are less than in the case of pure life insurers (20% of total investments). Compared to Q3 2016, investment in fixed income assets of non-life insurers recorded a slight increase in Q4 2016.

The investment portfolio of undertakings pursuing both life and non-life insurance comprised mostly fixed income securities (Figure 5.6c). In fact, about two thirds of assets make up this investment category.[40]

Figure 5.6a: Investment split for life insurance companies

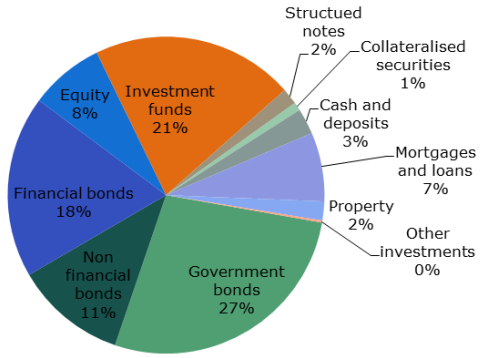


Figure 5.6b: Investment split for non-life insurance companies

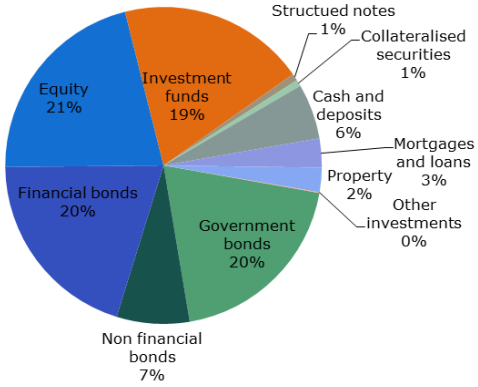
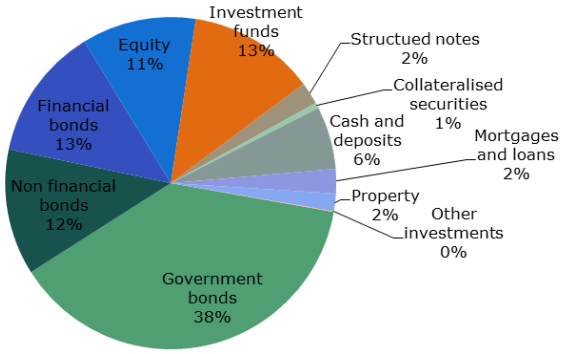


Figure 5.6c: Investment split for undertakings pursuing both life and non-life insurance business



Source: EIOPA (sample based on 2016 solo insurance undertakings in EEA)

Reporting reference data: 31/12/2016

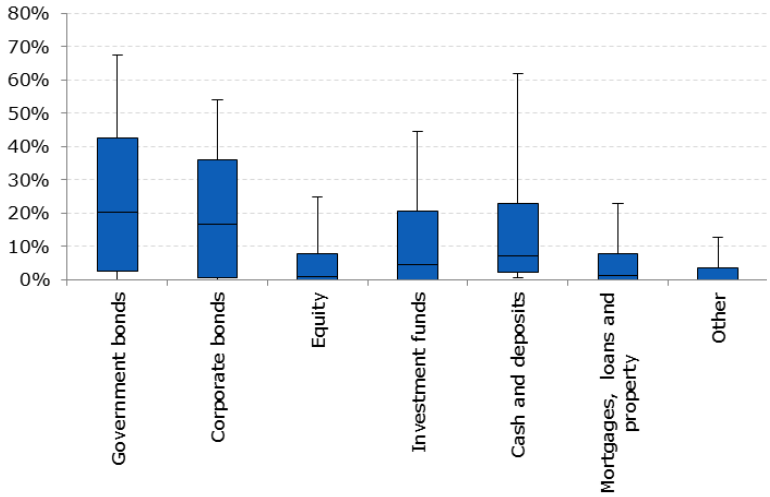
High exposures towards fixed income assets, in particular government and euro area corporate bonds, in the context of low yield environment could be translated to lower profitability (Figure 5.7).[41] For example, holdings of government bonds, as a share of investment, range from 0% to approximately 70% for the 10th and 90th percentile respectively.

[40] Equity does not include unit-linked business but includes participations that apply to CIU and equities so the equity part includes equity participations and the CIU part include the CIU participations.

[41] Equity does not include unit-linked business but includes participations that apply to CIU and equities so the equity part includes equity participations and the CIU part include the CIU participations.

Insurers with a high portfolio allocation to cash and deposits might be more vulnerable towards an inflation upswing (Figure 5.7). The boxplot illustrates that there are undertakings that allocate more than half of their portfolio in cash and deposits.

Figure 5.7. Type of investment as a share of total investment. Cross-sectional distribution in % for the median, interquartile range and 10th and 90th percentile



Source: EIOPA (sample based on 2016 solo insurance undertakings in EEA)

Reporting Reference Date: 31/12/2016

At country level, the heterogeneity across individual insurers is also high (Figure 5.8).[42] Insurers from Hungary (76.31%), Romania (68.34%) and Lithuania (65.32%) invest approximately two thirds of their portfolio in government bonds while insurers from Cyprus (10.70%), Finland (11.35%) and Denmark (12.43%) prefer other types of investments. Swedish insurers are the highest investors in equity (30.49%). For insurers relying heavily on government bonds home biased investment behaviour can be observed.

[42] Equity does not include unit-linked business but includes participations that apply to CIU and equities so the equity part includes equity participations and the CIU part include the CIU participations.

Figure 5.8: Investment split at country level

	Government bonds	Corporate bonds	Equity	Investment funds	Cash and deposits	Mortgages, loans and property	Other
AUSTRIA	21.38%	24.50%	19.41%	18.01%	3.73%	11.03%	1.94%
BELGIUM	50.25%	21.95%	5.46%	5.08%	3.06%	12.97%	1.24%
BULGARIA	49.16%	11.65%	9.76%	5.12%	13.88%	8.26%	2.17%
CROATIA	57.26%	2.07%	8.33%	6.97%	7.96%	17.29%	0.12%
CYPRUS	10.70%	22.96%	9.45%	21.96%	21.27%	12.77%	0.90%
CZECH REPUBLIC	53.01%	19.70%	9.96%	6.26%	6.04%	2.46%	2.57%
DENMARK	12.43%	29.71%	12.39%	39.01%	1.58%	3.54%	1.33%
ESTONIA	26.32%	48.17%	1.09%	6.58%	15.79%	1.57%	0.48%
FINLAND	11.35%	39.53%	9.01%	24.24%	5.45%	10.35%	0.07%
FRANCE	32.15%	33.03%	9.59%	16.58%	2.20%	3.22%	3.23%
GERMANY	18.36%	28.53%	12.28%	29.01%	2.59%	7.19%	2.05%
GREECE	55.89%	17.64%	3.51%	9.46%	7.15%	6.34%	0.01%
HUNGARY	76.31%	3.37%	4.14%	8.80%	4.95%	2.14%	0.28%
IRELAND	31.20%	28.48%	3.89%	4.88%	23.71%	4.87%	2.95%
ITALY	51.64%	19.08%	11.97%	9.19%	2.83%	1.64%	3.65%
LATVIA	49.71%	4.11%	1.64%	10.60%	29.50%	4.43%	0.01%
LIECHTENSTEIN	19.40%	31.87%	7.38%	3.48%	23.55%	8.23%	6.09%
LITHUANIA	65.32%	7.32%	1.72%	10.83%	10.00%	4.12%	0.68%
LUXEMBOURG	34.28%	25.66%	5.65%	15.75%	10.50%	6.16%	1.98%
MALTA	26.45%	20.46%	5.88%	12.11%	16.76%	12.52%	5.82%
NETHERLANDS	37.57%	13.12%	7.47%	6.51%	5.66%	25.93%	3.74%
NORWAY	14.34%	34.87%	15.31%	24.18%	2.17%	8.53%	0.59%
POLAND	55.30%	3.16%	17.68%	14.68%	5.06%	4.03%	0.10%
PORTUGAL	46.39%	28.64%	8.94%	5.58%	6.43%	2.80%	1.21%
ROMANIA	68.34%	7.44%	6.79%	1.49%	9.73%	5.99%	0.22%
SLOVAKIA	49.78%	31.82%	3.10%	4.62%	4.84%	5.51%	0.33%
SLOVENIA	39.03%	31.05%	13.90%	5.61%	4.22%	5.57%	0.61%
SPAIN	54.29%	22.01%	5.18%	4.32%	8.35%	4.32%	1.52%
SWEDEN	15.15%	27.75%	30.49%	16.27%	4.13%	5.72%	0.48%
UNITED KINGDOM	20.08%	31.54%	11.21%	16.17%	8.79%	9.72%	2.50%

Source: EIOPA (asset by asset template)

Note: Red - above 90th percentile, Blue - below 10th percentile

Reporting Reference Date: 31/12/2016

Insurers can use derivatives in their portfolio for hedging purposes according to the Solvency II regulation (Figure 5.9a, 5.9b and 5.9c). In Q4 2016, the market value of derivatives was less than 0.7% of the total investments. In total figures, the market value of derivatives was approximately EUR 80.86 bn while the notional value of the contracts reached approximately EUR 89.6 trn in Q4 2016. [43]

Put (call) options can be used to hedge (or leverage up i.e. increase the risk exposure) equity, whereas the purchase (selling) of credit default swaps can be used to hedge (leverage up) default risk. Swaps are used to hedge interest rate risk. Insurers may aggregate and hedge risks associated with certain blocks of invested

[43] The charts are computed using the absolute market values of the derivative contracts.

assets or liabilities together (a portfolio hedge), or may hedge individual assets against one or more risks.

Among the three types of undertakings, life insurers are the ones that make use of derivatives to hedge their portfolio risks. Swap contracts (57.06%) are the most common type of derivatives contracts followed by forward contracts (16.81%) and call options (16.43%). A similar position occurs for undertakings pursuing both life and non-life insurance business whereas non-life insurers tend to make use of forward contracts (78.46%) and call options (11.72%).

Figure 5.9a: Derivatives for life insurance companies

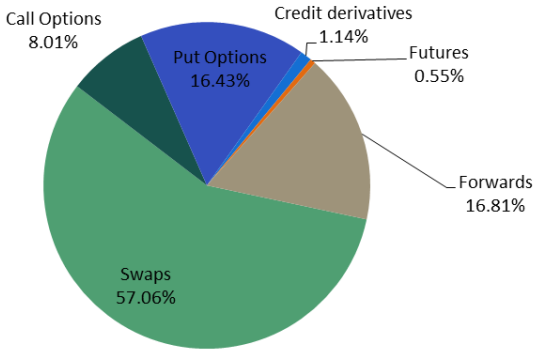


Figure 5.9b: Derivatives for non-life insurance companies

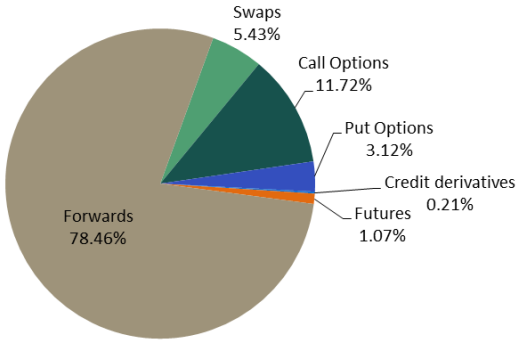
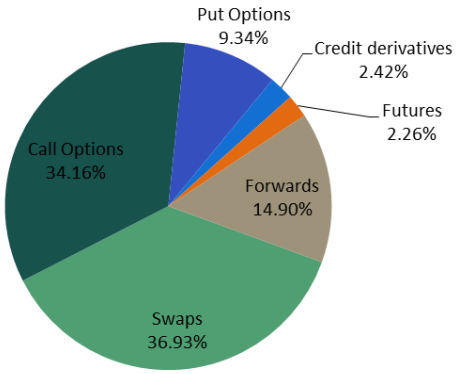


Figure 5.9c: Derivatives for undertakings pursuing both life and non-life insurance business



Source: EIOPA (sample based on 2016 solo insurance undertakings in EEA)

Reporting reference data: 31/12/2016

For a more detailed analysis of the investment portfolio, an explorative analysis that tries to identify structures within the data and similarities between the insurers' portfolios has been used. In this case, the cluster analysis (k-mean clustering method based on correlation distance) is used to identify groups of undertakings that have similar investment strategies.[44]

The analysis of the similarity of insurers' portfolios is important as it determines the degree of common investment behaviour with the potential impact on the market in a stress period. Relying on the SII reporting on the asset allocation, objective is to explore the composition of the insurers' investments from a systemic risk perspective spotting potential country and business based patterns and any other common behaviours and potential interactions among them.

For life insurers, four groups of insurers with similar investment strategies have been identified. The analysis was performed on 511 life insurers that reported Q4 2016 Solvency II data. According to the cluster analysis, the following groups of life insurers with similar portfolio strategies have been identified: Group 1 contains 216 undertakings, Group 2 contains 61 undertakings, Group 3 consists of 64 undertakings and Group 4 contains 170 undertakings.

Undertakings placed in Group 1 invest on average approximately two thirds of their assets in fixed income securities, insurers in Group 2 have, on average, approximately 62% of their portfolio allocated to investment funds while Group 3 insurers rely heavily on cash and deposits (on average, 76% of total investments). Group 4 is the group with the largest investments in government bonds allocating on average 80% of their portfolio to fixed income assets.

The average portfolio of each group is illustrated below (Figure 5.10).[45] In terms of total investments, Group 1 makes up for almost two thirds of total investments while Group 3 only for 6%. German life insurers represent one quarter of the sample in Group 1 whereas UK insurers represent one third of Group 2. Group 3 consists mainly of insurers from Liechtenstein, The Netherlands, Sweden, Belgium and Poland as well as other countries. Italian life insurers are the majority in Group 4.

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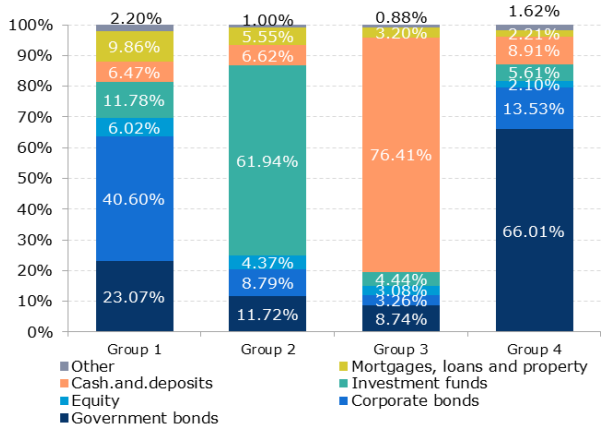
[44] The sample contains 511 life insurance undertakings, 1196 non-life insurance undertakings and 305 insurance undertakings pursuing both life and non-life insurance business for which data was available at the reporting reference date 31/12/2016

[45] Equity does not include unit-linked business but includes participations that apply to CIU and equities so the equity part includes equity participations and the CIU part include the CIU participations.

Figure 5.10: Average portfolio of clustered data for life insurance companies



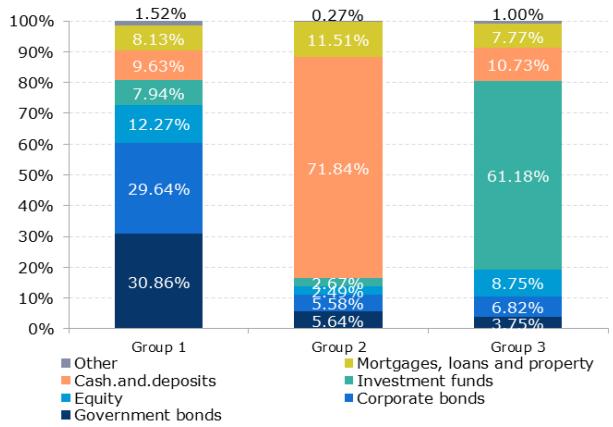
Source: EIOPA (sample based on 511 solo insurance undertakings in EEA)

Reporting Reference Date: 31/12/2016

The cluster analysis of non-life undertakings in the sample has divided the data in three groups of insurers with similar portfolios (Figure 5.11).[46] Group 1 encompasses 767 non-life insurers that allocate on average two thirds of their portfolio in fixed income assets, Group 2 covers 241 non-life insurers that rely strongly on cash and mortgages and Group 3 is formed by 188 undertakings that have almost two thirds of their assets allocated to investment funds. As a percentage of total investments, Group 1 incorporates approximately 85% of total investment of non-life insurers. DE, NL and ES non-life undertakings are the most frequently represented in the sample covered by Group 1 (almost one third). In Group 2, Irish insurers represent more than 30% of the number of undertakings, whereas Group 3 is dominated by FI and DE non-life insurers.

[46] Equity does not include unit-linked business but includes participations that apply to CIU and equities so the equity part includes equity participations and the CIU part include the CIU participations. See footnote 44

Figure 5.11: Average portfolio of clustered data for non-life insurance companies



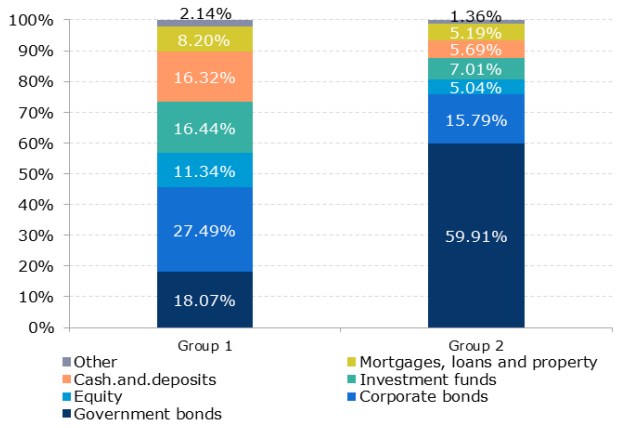
Source: EIOPA (sample based on 1196 solo insurance undertakings in EEA)

Reporting Reference Date: 31/12/2016

For undertakings pursuing life and non-life business, the cluster analysis led to the identification of two groups of insurers with similar investment strategies (Figure 5.12).[47] Group 1 contains 182 undertakings pursuing both life and non-life insurance business that cover 84% of total investments with a balanced allocation of the assets, in which fixed income securities, cash and deposits dominate the investment portfolio. Group 2 is formed of 123 insurers that allocate on average three quarters of their portfolio in fixed income assets. FR and ES insurers represent one third of the sample in Group 1 while Group 2 is dominated by IT and BE undertakings.

[47] Equity does not include unit-linked business but includes participations that apply to CIU and equities so the equity part includes equity participations and the CIU part include the CIU participations

Figure 5.12: Average portfolio of clustered data for insurance undertakings pursuing both life and non-life insurance business



Source: EIOPA (sample based on 305 solo insurance undertakings in EEA)

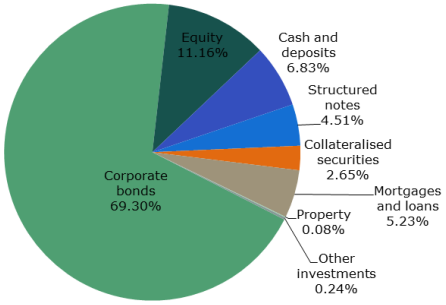
Reporting Reference Date: 31/12/2016

With an increasing interconnectedness within the financial sector, the ongoing situation in the banking sector creates concerns regarding the risks transferred to the insurance sector and the potential spillover effects on insures' balance sheets. The following section elaborates on the size of the European insurers exposures towards banks.

The insurance sector is extensively exposed towards the banking sector (Figure 5.13).[48] Total exposure towards the banking sector amounts to approximately EUR 1.67 trillion. This corresponds to 15.15% and 22.47% of insurers' total assets and total investments respectively. More than two thirds of this exposure is related to fixed income instruments. Collective investment undertakings have been excluded from this analysis as a look through approach is currently not possible.

[48] Equity does not include unit-linked business but includes participations that apply to Collective Investment Undertakings (CIUs) and equities so the equity part includes equity participations and the CIU part include the CIU participations.

Figure 5.13: Insurance sector exposure towards the banking sector, by investment category



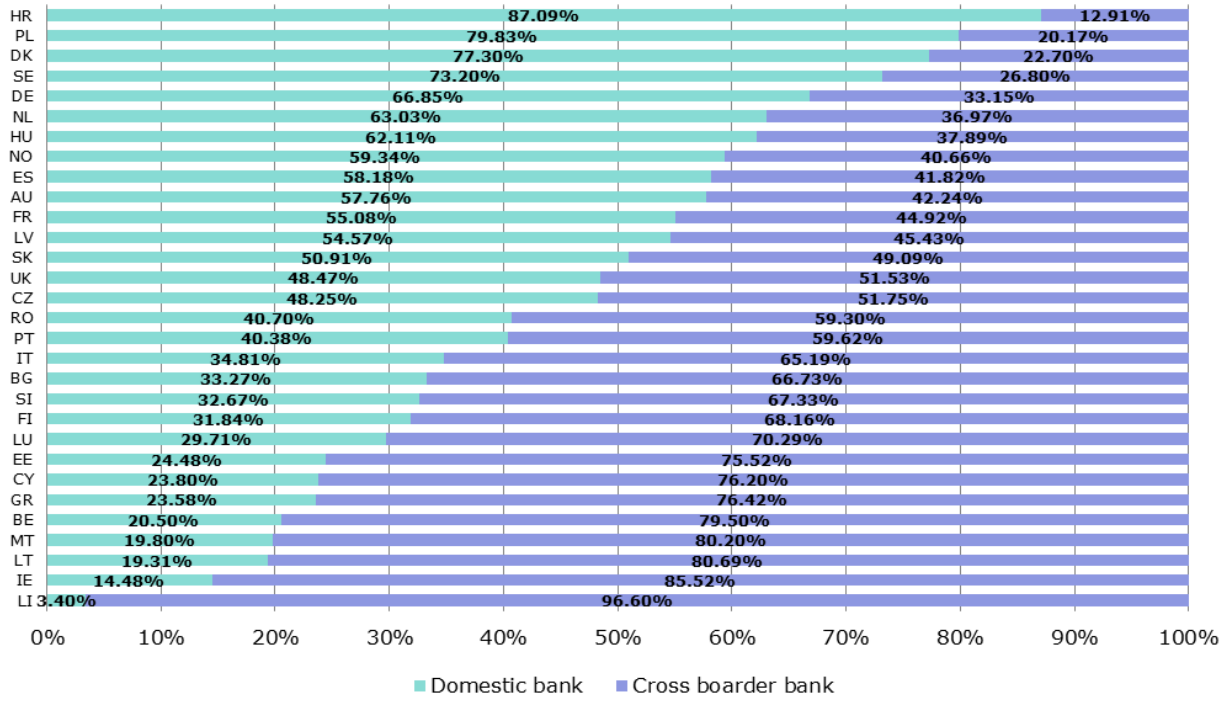
Source: EIOPA (sample based on 2016 solo insurance undertakings in EEA)

Reporting Reference Date: 31/12/2016

Insurers are exposed to the domestic as well as cross-border banking sector (Figure 5.14). Some insurers from countries such as Croatia (87.09%), Poland (79.83%) and Denmark (77.30%) tend to be more domestically exposed, while insurers from Lichtenstein (96.60%) and Ireland (85.52%) tend to be more cross-border exposed.

Cross-border exposure is a potential channel of risk transmission. Financial turmoil in the banking sector of one country might spill over due to cross-border holdings by insurers. But also, excessive domestic exposure, which can be seen as a lack of diversification, might be a potential weakness or source of risk.

Figure 5.14: Insurance sector exposure towards the banking sector, domestic versus cross-border in %



Source: EIOPA (sample based on 2016 solo insurance undertakings in EEA)

Reporting Reference Date: 31/12/2016

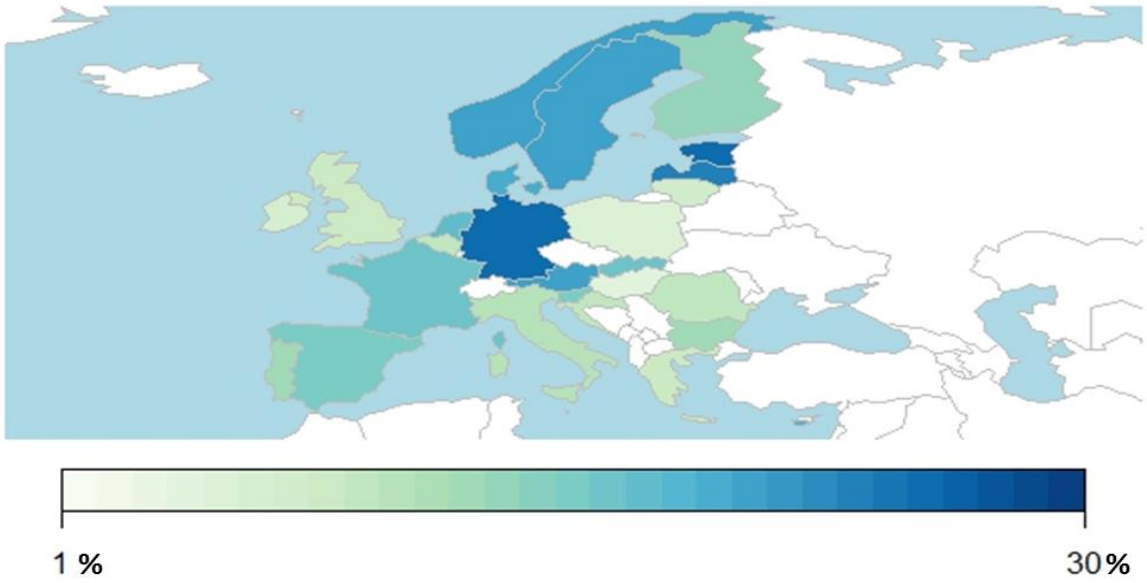
The map describes EU insurer's exposures towards banks[49] as a percentage of their total assets (Figure 5.15).[50] Total exposures include corporate bonds, equity, cash and deposits, structured notes, collateralised securities, mortgages and loans, property and other investment.

On an aggregated level, insurers from Malta have 27.29% of their assets exposed to banks, German insurers rank second with 25.84% of total assets exposed towards banks, whereas Estonian insurers are exposed towards banks by 25.67%. Insurers from countries like Luxembourg, Hungary and Liechtenstein have less than 5% exposure towards banks.

[49] The data presented in the following paragraphs are obtained by filtering the issuer with the NACE code K64 i.e. Financial service activities, except insurance and pension funding and by excluding K64.1.1 central banking

[50] The underlying data was computed as the percentage of total exposures towards banks of insurers in the amount of total assets at country level.

Figure 5.15: European insurers' exposures towards banks as a percentage of total assets



Source: EIOPA (sample based on 2016 solo insurance undertakings in EEA)

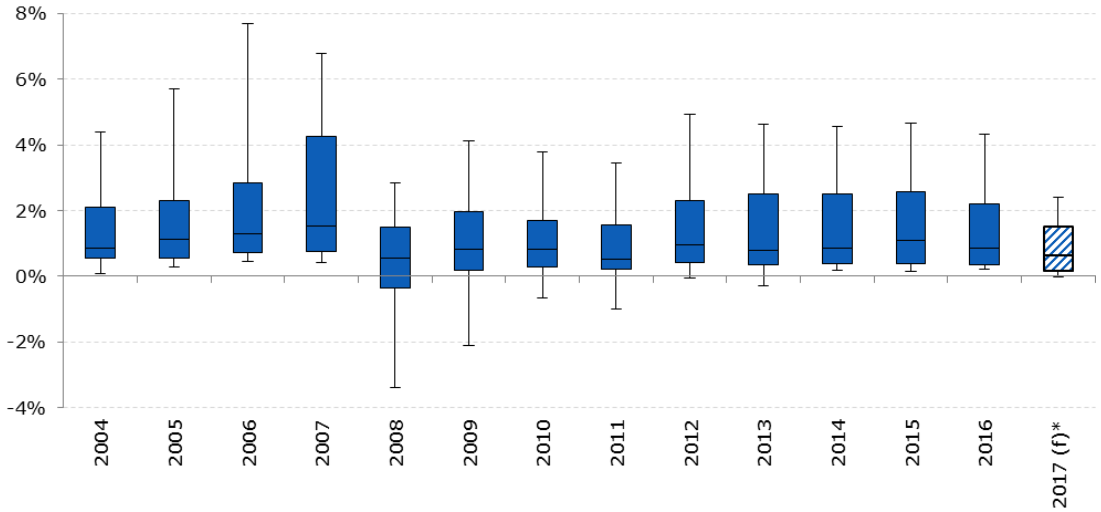
Reporting Reference Date: 31/12/2016

One of the main challenges for insurers remains maintaining profitability (Figure 5.16). This is not only due to the low yield environment but also due to low economic growth and the low quality of assets in some countries. Furthermore, conduct costs and growing competition from non-financial institutions amplified by high uncertainty and growing geopolitical risks negatively affect the profitability of insurers within EU.

The current data and projections reveal a relatively stable picture of the European insurance market in terms of ROA, with a median value of around 1% (Figure 5.16). In 2014 and 2015 the profitability increased and had a positive trend, but starting with 2016 the median ROA experienced a minor decrease. EIOPA's projection for 2017 indicates a further slight deterioration in the profitability of assets (Box 4).[1] Reallocation of the investments might be triggered by the low profitability of insurers focused on asset-liability matching. Especially in the case of life insurers, the constant pressure on profitability affects both the assets and liabilities side which will eventually lead to a deteriorating solvency position.

[1] This is in line with estimations obtained from Bloomberg. However, the EIOPA projection is slightly more conservative.

Figure 5.16: Distribution of ROA



Source: Bloomberg, Eurostat, EIOPA (sample based on 67 solo insurance undertakings in EEA)

Reporting Reference Date: 31/12/2016

*Note: * EIOPA own forecast*

Box 4: Profitability projection

As one of the main concerns remains the profitability of insurers, EIOPA elaborated a framework for deriving estimations for return on assets (ROA).

The sample considered encompasses 67 European insurers holding assets of EUR 7.794bn, covering approximately 70% of total assets held by European insurers. The time frame considered was 2004 to 2016 using Bloomberg for the company specific indicators and Eurostat for the macroeconomic variables. Values representing volumes (i.e. GDP) have been transformed using natural logarithm.

The starting point of the estimations has been the information provided by various financial indicators computed on the basis of financial statements combined with macroeconomic factors. The projection takes into consideration company specific factors like earnings per share, operational expenses but also macroeconomic variables as GDP, interest rates and inflation. The final model was estimated using a two-step generalised method of moments on a strongly balanced sample. As a control variable, lagged company specific factors were employed. For the evaluation of profitability, return on assets was used as a dependent variable.

The results suggest high sensitivity of the business to financial trends and macroeconomic changes.

6. Background information and Data description

Insurance sector

In 2016, the first year of the application of Solvency II, the reporting of insurance and reinsurance undertakings to NSAs is limited. In particular, the impact of the LTG measures on the financial position will be reported to NSAs for the first time in 2017.

In order to smooth the transition towards the new regulatory framework, Solvency II has put in place transitional measures, some of which will apply until 2032, by which time the balance sheet position of insurance companies will be fully estimated at market value. For a period of 16 years after the start of Solvency II (re)insurance undertakings may apply the transitional measure on the technical provisions and the risk-free interest rate.

Reinsurance sector

The section is based on information released in the annual and quarterly reports of the largest European reinsurance groups. The global and European market overview is based on publicly available reports, forecasts and quarterly updates of rating agencies and other research and consulting studies.

Pension fund sector

The section on pension funds highlights the main developments that occurred in the European occupational pension fund sector, based on feedback provided by EIOPA Members. Not all EU countries are covered, in some of them IORPs (i.e. occupational pension funds falling under the scope of the EU IORPs Directive) are still non-existent or are just starting to be established. Furthermore, in other countries the main part of occupational retirement provisions is treated as a line of insurance business respectively held by life insurers, and is therefore also not covered. The country coverage is 84% (26 out of 31 countries).[51] Data collected for 2016 was provided to EIOPA with an approximate view of the financial position of IORPs during the covered period. Several countries are in the process of collecting data and in some cases 2016 figures were incomplete or based on estimates which may be subject to major revisions in the next report at the end of the year. In addition, the main valuation method applied by each country varies due to different accounting principles applied

[51] Countries that participated in the survey: AT, BG, DE, DK, EE (only qualitative information), ES, FI, HR, GR, HU, IE, IS, IT, LI, LU, LV, MT, NL, NO, PL, PT, RO, SE, SI, SK and the UK.

across the EU. Moreover, data availability varies substantially among the various Member States which hampers a thorough analysis and comparison of the pension market developments between Member States. For RO, the data refers to 1st Pillar bis and 3rd Pillar private pension schemes only.

Country abbreviations

AT	Austria	**IT**	Italy
BE	Belgium	**LI**	Liechtenstein
BG	Bulgaria	**LT**	Lithuania
CY	Cyprus	**LU**	Luxembourg
CZ	Czech Republic	**LV**	Latvia
DE	Germany	**MT**	Malta
DK	Denmark	**NL**	Netherlands
EE	Estonia	**NO**	Norway
ES	Spain	**PL**	Poland
FI	Finland	**PT**	Portugal
FR	France	**RO**	Romania
GR	Greece	**SE**	Sweden
HR	Croatia	**SI**	Slovenia
HU	Hungary	**SK**	Slovakia
IE	Ireland	**UK**	United Kingdom
IS	Iceland	**CH**	Switzerland

PART II

Thematic Article

Re-evaluation of the capital charge in insurance after a large shock: empirical and theoretical views

Fabrice Borel-Mathurin[52], Stéphane Loisel[53], and Johan Segers[54]

The content of this study does not reflect the official opinion of EIOPA. Responsibility for the information and the views expressed therein lies entirely with the authors.

Abstract

Motivated by the recent introduction of regulatory stress tests in the Solvency II framework, we study the impact of the re-estimation of the tail risk and of loss absorbing capacities on post-stress solvency ratios. Our contribution is threefold. First, we build the first stylised model for re-estimated solvency ratio in insurance. Second, this leads us to solve a new theoretical problem in statistics: what is the asymptotic impact of a record on the re-estimation of tail quantiles and tail probabilities for classical extreme value estimators? Third, we quantify the impact of the re-estimation of tail quantiles and of loss absorbing capacities on real-world solvency ratios thanks to regulator data from Banque de France – ACPR. Our analysis sheds a first light on the role of the loss absorbing capacity and its paramount importance in the Solvency II capital charge computations. We conclude with a number of policy recommendations for insurance regulators.

Keywords: Insurance, Extreme Value Theory, Financial Regulation, Solvency II, Solvency Capital Requirement, Loss Absorbing Capacities, Stress Tests, Enterprise Risk Management.

JEL Codes: G01, G22, G28, G32

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[52] The views expressed in this paper are those of the authors and do not necessarily reflect those of the Autorité de Contrôle Prudentiel et de Résolution (ACPR), neither those of the Banque de France. †Email: fabrice.borel-mathurin@acpr.banque-france.fr

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Introduction

Modern financial regulation frameworks are designed to take into account the actual risks faced by financial institutions. This precision in evaluating the risks comes at a cost since improving accuracy tends to be pro-cyclical. [55] As a response to the potential increase of systemic risk, stress tests have increasingly become a common tool for insurance and banking supervision. In a nutshell, supervisors check the consequences of adverse shocks on the solvency, liquidity and stability assessment of undertakings. Since Basel I, financial regulation is based on the assessment of capital requirement and its coverage by undertakings. In this respect, undertakings would typically undergo assets and own-fund downfall after the simulation of the shock. Some companies pass the test and still hold enough capital after the stress test while some others do not.

This type of financial stability tests is suited for supervision. On the one hand, it helps monitor financial stability based on a horizontal and cross-sectional analysis of individual responses. On the other hand, it can include a forward-looking perspective. Moreover, some supervisors almost only rely on the outcome of such exercises. [56] Even if the use of such tests is more recent in the insurance sector than the banking sector, they come more and more on top of the agenda, see for example NAIC and EIOPA's recommendations arising after such exercises (e.g. European Insurance and Occupational Pensions Authority, 2014). Different aspects of stress test exercises need to be clarified: why stress testing? How should such exercises be organized to optimize supervision efficiency? How should the scenarios be selected and at which (quantile) level? How should the framework of the exercises be designed, e.g. which simplifying assumptions should be made?

In this study we only focus on the latter aspect with a glimpse on the European insurance stress test since those exercises are part of the more general Solvency II regulatory framework which has become fully applicable since January 2016. Since the CEIOPS quantitative impact studies performed in 2011, a consensus emerged in the European Union insurance supervisory community: the absence of Solvency Capital Requirement (SCR) reassessment after a shock was regarded as a prudent hypothesis. Indeed, it is often believed that the SCR is very likely to be smaller after

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[55] See for example Gordy (2003), « A risk-factor model foundation for ratings-based bank capital rules », *Journal of Financial intermediation*, which explains the mechanisms for the banking sector.

[56] This is for example the case of the NAIC or the FED for systemically important insurers following Dodd-Franck.

the stress test is applied than initially, for example after an adverse shock leading to a decrease in the market value of the portfolio. Keeping the SCR constant would therefore correspond to a cautious strategy.

This rationale seems natural when looking at a shock on the financial markets: if stock prices would fall by 40%, say, then a second 40% shock would only correspond to a 24% decrease with respect to the initial stock price. Besides, some countercyclical measures like the equity dampener may reinforce this phenomenon. [57]

However, as far as natural or man-made catastrophes in P&C risks ("Cat P&C risks") are concerned, if some extreme scenario occurs, then it is likely that the tail distribution of the corresponding risk has to be re-evaluated. A scenario with a return time of 150 years can, upon occurrence and after re-estimation in the light of the new data, become a scenario with a 90 year return time, as observed empirically by Mornet et al. (2016) for storm risk in France. This may of course lead to an increase in the SCR.

In addition, the loss absorbing capacities generated by deferred tax or technical provisions have limitations. After a large adverse event, these capacities may be strongly reduced, and this would lead to an increase in the SCR.

In this paper, we aim at explaining these opposite effects and quantify their combined impacts on the SCR in a simplified model and also with regulatory data. Our contribution is threefold. First, we build the first stylised model for re-estimated solvency ratio in insurance. Second, this leads us to solve a new theoretical problem in statistics: what is the asymptotic impact of a record on the re-estimation of tail quantiles and tail probabilities for classical extreme value estimators? Third, we quantify the impact of the re-estimation of tail quantiles and of loss absorbing capacities on real-world solvency ratios thanks to regulator data from ACPR featuring cases where re-computing leads to an increase in the SCR. Another striking outcome of our study is the importance of loss-absorbing capacity on solvency capital ratios.

Our paper is organized as follows. In Section 1, we explain how the Solvency Capital Requirement (SCR) is computed in Solvency II. In particular, we describe regulatory stress tests and loss absorbing capacity mechanisms. In Section 2, we present our simplified model for SCR re-estimation. Section 3 quantifies the asymptotic

[57] For more explanations on how the equity dampener is set up, see the consultation paper CP-14058 https://eiopa.europa.eu/Publications/Consultations/EIOPA-CP-14-058_ITS_Equity_dampener.pdf

underestimation when one neglects a record with a theoretical extreme value analysis point of view. In Section 4, we provide orders of magnitude of the different effects using French stress test data (relevant for the whole European Union). In the conclusion, we give some policy implications and we introduce some future research questions. This paper is an abridged version of the discussion paper (Borel-Mathurin et al, 2017) which covers the different parts with larger details.

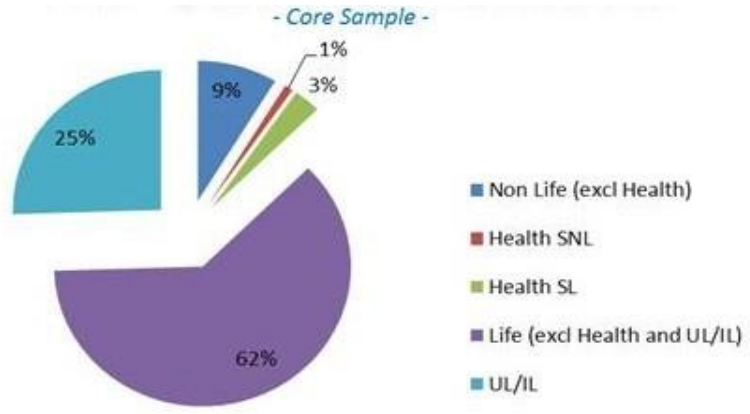
Solvency capital, stress tests and loss absorbing capacity in Solvency II: Prudential balance sheet of European insurers

In the insurance sector, estimating liabilities can be very tricky since no actual market value exists for in-force businesses. Generally, only model-based valuations are available: producing the balance sheet of an insurer is already a difficult task for life insurers, involving simulations. Technical provisions in the Solvency II framework (EU Parliament and Council, 2009) consist in an actualization of the projection of cash flows made by the undertaking. The calculation methodologies of the best estimate are defined in the Article 28 of the Delegated Regulation (Commission, 2015) and are completed in the EIOPA guidelines on Technical Provisions (European Insurance and Occupational Pensions Authority, 2015).

In 2014, EIOPA ("European Insurance and Occupational Pensions Authority") led a pan-European insurance stress test. This exercise was composed of a core exercise applied to 167 insurance groups of the EU market which included the 30 largest companies in Europe.[58] Baseline figures revealed that life technical provisions are predominant within this scope. As a consequence, market risk is actually the most important module in the aggregated SCR, see Figures 1 and 2. For this reason and to simplify the calculations, we will assume henceforth that the insurance company only depends on a single risk factor.

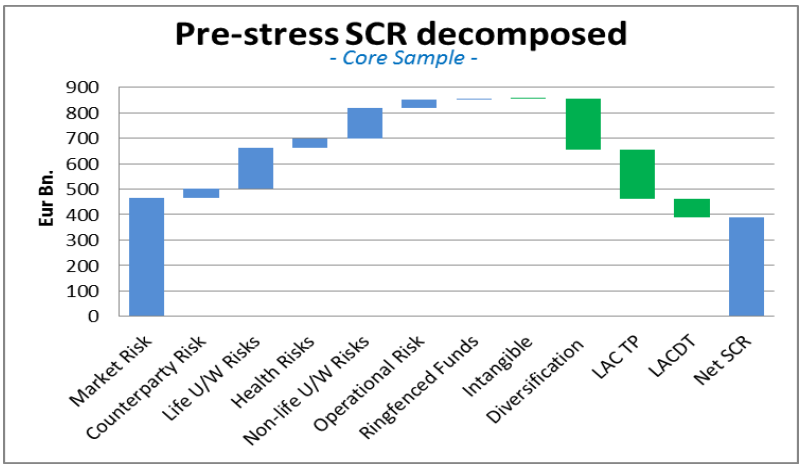
[58] This represents 55% of all gross written premiums. NCAs were allowed to add solo undertakings when unable to reach the 50% threshold with only the groups acting domestically

Figure 1: Technical provisions breakdown



Source: EIOPA Stress Test 2014

Figure 2: SCR Decomposition



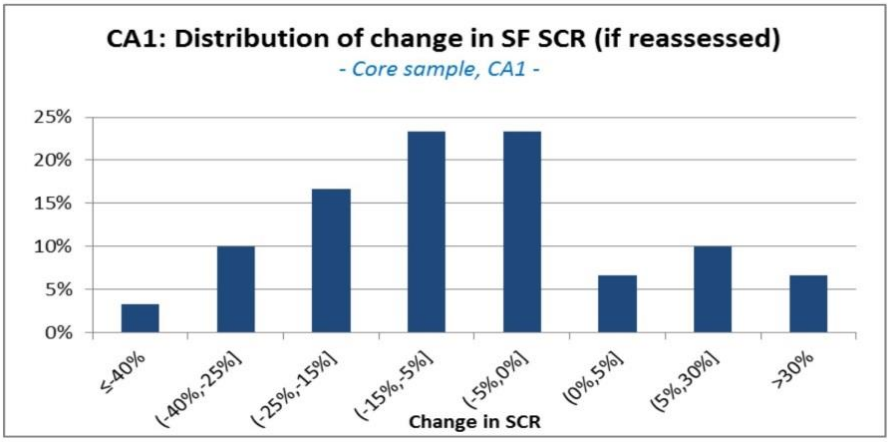
Source: EIOPA Stress Test 2014

Non-linear mitigations

Before the launch of Solvency II, CEIOPS[59] was responsible for determining which risk measure should be best suited to insurance industry.[60] Different approaches were tested for the liability valuation and already at this level the impact of the future bonuses seemed to be material.[61] The insurance industry is characterized by risk mitigation and so, Solvency II, being risk based, had to take this feature into account unlike Solvency I, which was based on fixed/all-inclusive calculations. In this regard, CEIOPS progressively introduced the concept of "loss absorbing capacity" (see appendix). Considering market risk as an example: the lower the value of the assets, the lower the risk. Besides, after a large financial shock one would expect net SCR sub-modules linked to market risk to decrease when risk exposure decreases so that any SCR re-evaluation after a large shock would benefit the undertaking thanks to a proportionality effect.

However, this one-to-one correspondence is not actually observed in the 2014 Stress test data (European Insurance and Occupational Pensions Authority, 2014): although very few undertakings reassessed their SCR post-stress – less than 30%, the reassessment was optional – a significant share (more than 40%) of the undertakings underwent an increase of their global net SCR in at least one of the market scenarios.

Figure 3: Distribution of reassessed SCR



Source: EIOPA Stress Test 2014

[59] Committee of European Insurance and Occupational Pensions Supervisors, the predecessor of the European authority for insurance supervision, EIOPA

[60] The results of this analysis, called "QIS" for Quantitative Impact Studies, can be seen on the EIOPA website: https://eiopa.europa.eu/publications/qis

[61] Approaches tested included the best estimate, the 60th, 75th and 90th percentiles, and the company view.

Indeed, taking a closer look at Figure 3, we observe that diversification effects can present some non-linearities, maybe due to the "modular" nature of their estimation. A very naive explanation to this counter-intuitive result could be that the post-stress reduction in the diversification abilities would be more significant than the reduction of risk exposure. Another simple idea would be that the addition of an extreme point changed the global shape of the underlying loss distribution. Interpretations based on both effects are developed in the following sections.

A simplified model for post-stress SCR

In this simplified model, we consider that the SCR is given by

$$SCR = [VaR_{99.5\%}(X) - E(X) - b]_+ , \qquad (2.1)$$

where X is a random variable corresponding to the 1-year random loss the insurer may face. Here, for simplification purposes, we consider only one risk factor, which can be financial or P&C cat. Of course, in the real world, there are many risk factors, aggregated either with the standard formula or by means of an internal model. We shall discuss the impact of diversification on our results in the sequel. The parameter b plays an important role: it corresponds to the loss absorbing capacity, and it is likely to be affected if a large event occurs.

After a shock, b is transformed into b' and X is transformed into

$$X' = a\tilde{X}, \qquad (2.2)$$

where a is a factor accounting for the change in the exposure, and $\tilde{X}$ is the revised version of X after taking the last shock into account.

If one considers mass lapse risk or pandemic risk, then the portfolio size is smaller after the first shock, so that $a < 1$. Similarly, if stock prices go down by 40%, then it is natural to consider $a = 60\% < 1$, even in absence of countercyclical measures. For P&C disasters, the situation is less clear: on the one hand, some buildings might be partly or fully destroyed, which makes the exposure temporarily decrease ($a < 1$) as there is less to be potentially destroyed by a second event. On the other hand, a first event might also cause some frailty and make the consequences of a second event potentially more severe, for example in case of floods or earthquakes where some cumulative effect or some replicas may be disastrous ($a > 1$).

If an event like a major, unpreceded earthquake, hurricane or terror attack occurs, then the probability and potential severity of such an event will automatically be re-evaluated by cat models like RMS, EQECAT or AIR or by internal models, following

Bayesian techniques. For most events, the impact on high-level Value-at-Risk is very likely to be much more important than the impact on the average. Therefore, we model this as a change from $VaR_{99.5\%}(X)$ to $VaR_{99.5\%}(\tilde{X})$, but for the sake of simplicity we do not update the average, considering that the impact on the average can be neglected: we assume that $E(X) = E(\tilde{X})$.

Of course, this assumption might be inappropriate in some cases, particularly for regime switching models like 3-state Hardy stock models or self-excited processes, in which the best estimate and the volatility tend to move in adverse directions when things go bad, and for mean-reverting models, where some mitigation is present when things go bad. For some other risks like sovereign risk or foreign exchange risk, some shocks may occur as jumps (CHF/EUR exchange rate in January 2016). The two types of risks that we consider in this paper, market shocks and large P&C claims, are thus both relevant for our study. The parameter b, accounting for the loss absorbing capacity, can be transformed into b' after a large event for several reasons. The loss absorbing capacity thanks to differed tax and thanks to technical provisions is not infinite, and it may happen that the new loss absorbing capacity after a large event is much smaller than before, that is, $b' \ll b$. Reinsurances, management action or use of countercyclical mechanisms such as the equity dampener are out of the scope of our study.

Three effects are present: the ones of a in (2.2), of b in (2.1), as well as of the tail quantile re-estimation. From a theoretical point of view, the impact of the first two ones is quite straightforward. The tail re-estimation effect, however, has not yet been studied in the literature and is a bit more technical. Therefore, in the next section, we quantify the change from $VaR_{99.5\%}(X)$ to $VaR_{99.5\%}(\tilde{X})$ after a record occurs in a P&C framework, in absence of loss absorbing capacity and for $a = 1$. As this is currently not taken into account, we formulate this as the underestimation of high quantiles when one ignores the record that has just occurred.

Pre-record estimation bias of tail estimators

Notation and framework

We take a P&C view on the random loss X underlying the SCR calibration. Let $X_1, X_2, \ldots$ be i.i.d. random variables corresponding to observations of X. [62] For simplicity, assume that their common distribution is continuous. Denote the ascending order statistics of $X_1, \ldots, X_n$ by $X_{n:1} < \cdots < X_{n:n}$.

Consider statistics of the type

$$T_n = t_n(X_1, \ldots, X_n),$$

where $t_n: \mathbb{R}^n \to \mathbb{R}$ is a permutation invariant function. Think of T_n as an estimator of some tail-related quantity: a tail quantile, a return level, ... The statistic T_n depends on the data only through the order statistics:

$$T_n = t_n(X_{n:1}, \ldots, X_{n:n}).$$

We want to understand the consequences of not re-estimating the risk distribution in a stress test associated to an extreme shock. We focus on the case where the shock is unpreceded: the very recent loss corresponds to a record, like for example the Bar-le-Duc claim in 1976 for motor third party liability or Lothar in 1999 for storm risk in France. In practice, such events might be relevant for different sub-risk-modules of Solvency II (underwriting, cat, ...) and their impact might be diluted with attritional claims during the year. To simplify, we assume here that X corresponds to the random variable whose

quantile is used to derive the Solvency Capital Requirement. We assume that at a given time instant, a record occurs: the new observation is larger than what has been observed before. When should we compute the statistic: right before or right after the record?

First, assume that the record occurs at "time" n, that is, $X_n > X_{n-1:n-1}$, or, in other words, the rank of X_n among $X_1, \ldots, X_n$ is equal to n. At a given sample size, the vector of order statistics is independent of the vector of ranks. We find that

$$[T_n \mid X_n > X_{n-1:n-1}] \sim T_n. \qquad (3.1)$$

That is, computing the statistic right after a record does not lead to any distortion. Second, assume that we compute the statistic right before a record occurs.

[62] i.i.d: independent and identically distributed

Specifically, suppose that X_{n+1} is a record: $X_{n+1} > X_{n:n}$. How does the occurrence of that event affect the distribution of T_n?

If X_{n+1} is a record in the stretch $X_1, \dots, X_{n+1}$, then $X_i < X_{n+1}$ for all $i = 1, \dots, n$, and the vector of order statistics $(X_{n:1}, \dots, X_{n:n})$ is equal to the vector $(X_{n+1:1}, \dots, X_{n+1:n})$. It follows that

$$[(X_{n:1}, \dots, X_{n:n}) \mid X_{n+1} > X_{n:n}] \sim (X_{n+1:1}, \dots, X_{n+1:n}). \qquad (3.2)$$

Equation (3.2) implies that

$$[T_n \mid X_{n+1} > X_{n:n}] \sim t_n(X_{n+1:1}, \dots, X_{n+1:n}). \qquad (3.3)$$

Computing the statistic right before the occurrence of a record has a clear impact on its distribution: compare (3.1) and (3.3).

The size of the effect depends on the function t_n. If T_n is a tail estimator, then the impact of omitting the largest observation could be potentially quite large. We work out two relevant cases for our initial problem in the following subsections.

Tail probability estimation error

We first investigate the question of tail probability re-estimation. After an extreme event, the CEO of an insurance company could ask the cat-modelling team: "What is the return period of yesterday's event?". The cat-modellers could in fact reply: "Well, two days ago I would have answered 200 years (tail probability 1/200), but today I'd rather say 120 years!". One can imagine the CEO's reaction...

The following example quantifies the change in the tail probability estimate. Example 1 (Tail probability). Let u be a high level. Aim is to estimate the tail probability $p = 1 - F(u)$. Note that the return level is equal to $1/p$. The simplest possible estimator is the empirical one, which is clearly unbiased ($E[T_n] = p$),

$$T_n = \frac{1}{n}\sum_{i=1}^{n} I(X_i > u).$$

If we ignore the information that at time $n+1$, a new record occurred and consider the case where $u = u_n \to \infty$ in such a way that $np = np_n = n\{1 - F(u_n)\} \to \tau \in (0, \infty)$, i.e., if $p \sim \tau/n$, then, calculating T_n with respect to $X_{n+1} > X_{n:n}$, the expected relative error converges to a nonzero limit:

$$\frac{1}{p}E[T_n \mid X_{n:n} < X_{n+1}] - 1 \to -\frac{1-e^{-\tau}}{\tau}, \quad n \to \infty \qquad (3.4)$$

The asymptotic expected relative error is negative and depends on the limit of the expected number of exceedances, τ, over the level u.

Tail-quantile error estimation

The fact that a 200-year event might become a 120-year event implies that the new 200-year event is much more severe after the extreme event. Motivated by the SCR re-estimation question, we now investigate the impact of a record on tail-quantile estimators.

Example 2 (Tail-quantile estimator). Let Q be the quantile function of F. The aim is to estimate a tail quantile, $Q(1-p)$, where the tail probability, $p \in (0,1)$, is small. Assume that F is in the domain of attraction of the Fréchet distribution with shape parameter $\alpha \in (0,\infty)$. We will only use classical tools of extreme value theory. The interested reader may consult for example the book of Beirlant et al. (2006) for a presentation of the Fréchet domain of attraction. Let $\gamma = 1/\alpha$ be the extreme-value index. Let $k \in \{1,\dots,n-1\}$ be such that $p < k/n$. A common estimator is based on the approximation

$$Q(1-p) \approx Q(1-kn)\{(k/n)/p\}^{\gamma}.$$

On a logarithmic scale, the estimator takes the form

$$\log \hat{Q}_{n,k}(1-p) = \log X_{n:n-k} + \hat{\gamma}_{n,k} \log\{(k/n)/p\},$$

where $\hat{\gamma}_{n,k}$ is an estimator of the extreme-value index γ. Using the expression of the Hill estimator, we find that the tail quantile estimator is linear in the order statistics $Y_{n:n-k} < \cdots < Y_{n:n}$, where $Y_i = \log X_i$. To evaluate the impact of ignoring a known record, let us compute the expectation of the estimator under the simplifying assumption that the random variables X_i are iid Pareto with shape parameter α, that is, $F(x) = 1 - x^{-\alpha}$ for $x \geq 1$. Equivalently, the random variables Y_i are iid Exponential with expectation equal to γ. In that case, $\log Q(1-p) = \gamma \log(1/p)$. A well-known representation of the order statistics from an exponential distribution yields

$$E\left[Y_{n:n-j+1}\right] = \gamma\left(\frac{1}{n} + \frac{1}{n-1} + \cdots + \frac{1}{j}\right), \qquad j \in \{1,\dots,n\} \tag{3.5}$$

Equation (3.5) yields the following expressions for the expectation of the estimator of the log tail quantile. Unconditionally, we have

$$E\left[\log \hat{Q}_{n,k}(1-p)\right] = \log Q(1-p) + \gamma\left(\frac{1}{n} + \cdots + \frac{1}{k} - \log(n/k)\right).$$

The second term on the right-hand side converges to zero relatively quickly. In contrast, conditionally on the occurrence of a record on the next day, we have

$$E\left[\log \hat{Q}_{n,k}(1-p)\,|X_{n:n} < X_{n+1}\right] = (1-a_k)\log Q(1-p) + \gamma\left(\frac{1}{n}+\cdots+\frac{1}{k}-(1-a_k)\log(n/k)\right),$$

Where $a_k = \frac{1}{k}\sum_{j=1}^{k}\frac{1}{j+1}$.

With this setup, the relative error occurs on the logarithmic scale, there is potentially a severe underestimation of the tail quantile: indeed,

$$(1-a_k)\log Q(1-p) = \log[\{Q(1-p)\}^{1-a_k}]$$

The relative error is thus given by $\{Q(1-p)\}^{-a_k} \approx (1/p)^{a_k\cdot\gamma}$.The larger the tail index γ and the smaller the tail probability p, the larger the relative error. The result remains valid for the more general Pareto distribution $F(x) = 1-(x/\sigma)^{-a}$ for $x \geq \sigma$, where $\sigma > 0$ is a scale parameter.

In the next section, we investigate the concrete impact of this phenomenon and of two other ones, risk exposure reduction and decrease in diversification elements, on real-world insurance regulatory capitals.

Illustration with real-world situations

In this section, we calibrate the three effects following two approaches: the first approach is related to actual risk levels used in financial regulations and the second one using the 2014 EIOPA stress test data of the French insurance regulator. We first provide orders of magnitude of the re-estimation effect on SCR in the insurance industry, in absence of loss absorbing capacity effect and for $a = 1$ in (2.2). Then, motivated by the design of the market risk SCR, we investigate the case where $a = 0.6$ and calibrate b in (2.1) and b' from real data. Finally, we study the case where $a > 1$ and we identify regions where one effect dominates the other one. On top of these empirical illustrations, we highlight the problem of the risk margin valuation, which strengthens our main conclusions on the SCR with a view on the whole prudential balance sheet.

Tail re-estimation effect

Parameter $\boldsymbol{\tau}$ – Tail probability estimation error. In the case of a natural catastrophe, the expected number of high-threshold exceedances, $\tau = np$, belongs to a broad range of values. In the case of a stress test, τ is close to 0. It is quite common to consider $\tau = 1 \times \frac{1}{200}$ which is a typical target used in the Solvency II framework $\left(n = 1,\ p = \frac{1}{200}\right)$.

The formula (3.4) for the expected relative error of the estimated exceedance probability due to the omission of the most recent record value as a function of τ is

illustrated in Figure 4. We see that $\tau = 10$ exceedances already give a 10% misvaluation of the tail probability. If the expected number of exceedances decreases to $\tau = 1$, the relative estimation error goes up to 63%

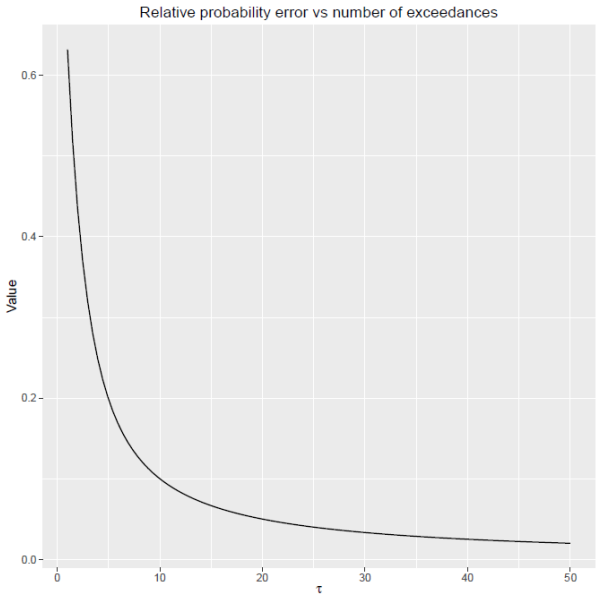
These numbers highlight the impact of the pre-record estimation bias. The effect is striking but cannot account for the error on the SCR, which is expressed on the quantile scale. We now consider the quantile error.

Parameter γ – Quantile estimation error. As a first-order approximation we can use the formula illustrated in Subsection 3.3 for the expected negative relative error of the quantile error

$$\delta_{p,k,\gamma} = (1/p)^{a_k \cdot \gamma} \qquad (4.1)$$

with $a_k \approx k^{-1}\log(k)$.

Figure 4: Relative probability error vs number of exceedances estimated with (3.4) quantile estimate



Source: EIOPA Stress Test 2014

In the context of the Solvency II, p should be equal to 0.005. For k, different values are plausible; the natural framework in Solvency II should be $k = 200$, since the current norm sets records up to 200 years of magnitude. In a Stress Test context, values of k in the range of 5 to 50 are also admissible.

As illustrated by the graphs in Figure 5, the difference between the actual quantile and its value just after the addition of a shock with magnitude γ times the expectation of the standard shocks can be very significant. For example, even with 200 records,

the addition of an event 10 times larger than expected would lead to a quantile more than twice the initial value! Note that we implicitly assimilated the change in the estimated 99.5% VaR to the change in the SCR. This is not true in general as the SCR might be defined in a more complex way. Besides, the Best Estimate of Liabilities would also be impacted. Nevertheless, for reasonable values of n and k, the change in the estimated average of X is small in comparison to the change in the 99.5%-Value-at-Risk level. Therefore, for simplicity, we assume here that the Best Estimate of Liabilities can be neglected in this first study, and we leave it for further research to quantify the change in the best estimate. In Figure 6, we focus on operational risk for banks, for which banking regulation imposes to compute the 99.9%-quantile of the one-year loss. Nešlehová et al. (2006) show that for banking operational risk, one cannot exclude that $\gamma > 1$, corresponding to infinite mean models. We therefore consider the impact of quantile re-estimation after a record: for finite mean models with γ close to 1, Figure 6 shows that the new result might be as large as 2.8 times the result without re-estimation. This shows that the phenomenon presented here deserves further research regarding banking supervision.

However, this first effect actually accounts only for changes in something equivalent to the gross BSCR (the "quantile error") before diversification (not considered here). Let us now investigate the concrete effect of Loss Absorbing Capacity on the net SCR.

The case a<1

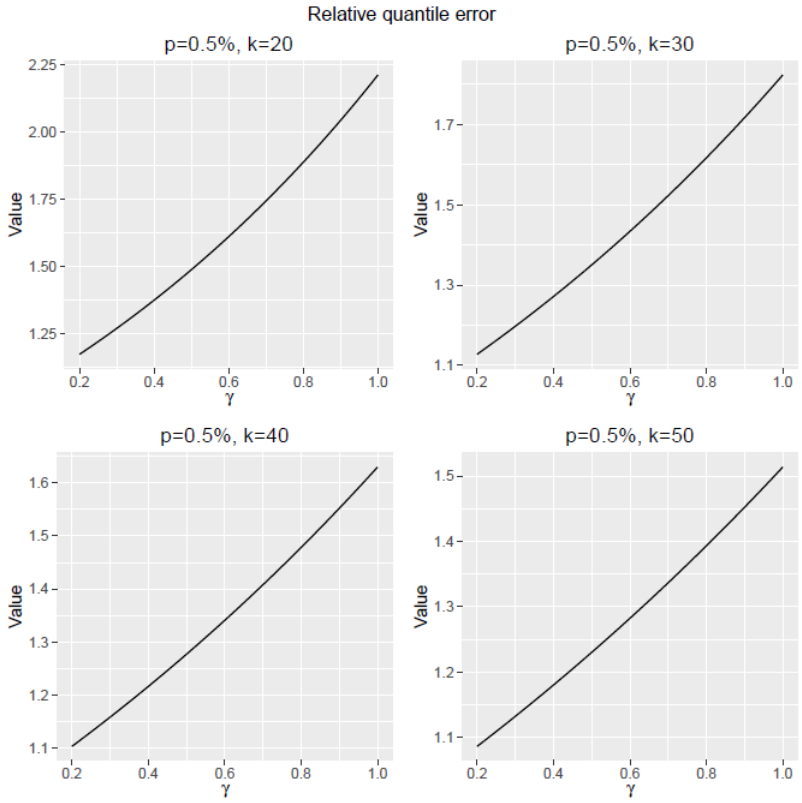
The naive model introduced in Section 3 can be calibrated with the 2014 stress test data. An identification of the different terms on the right-hand side of (2.1) implies that $VaR_{99.5\%}(X) - E(X)$ is equal to the gross BSCR (adding Operational risk, denoted by $gBSCR$) and b is the sum of the different diversification and loss absorbing mechanisms, in particular, the Loss-Absorbing Capacity with Technical Provisions and with Deferred Tax.

In absence of quantile re-estimation, after the shock, X becomes $X' = a \cdot X$ and the SCR becomes: $SCR(X') = a \times gBSCR - b'$. With this simplified setup, it appears very clearly why the risk could not depend on the scaling factor a and only on the potential increase of volatility of the profit and loss distribution. At this point, we emphasise that the desired quantile is not directly based on the exposure so that there might only exist a tenuous link between the risk exposure and the loss distribution.

The gross SCR is multiplied by a when $X' = a \cdot X$. Note that this property is very general and remains valid when the Solvency Capital is defined via a Tail-Value-at-

Risk as in the Swiss Solvency Test, or when one uses any distortion risk measure for economic capital in Enterprise Risk Management.

Figure 5: Relative quantile estimation error vs relative expected magnitude as a function of parameter γ for different values of p and k using equation 3.4

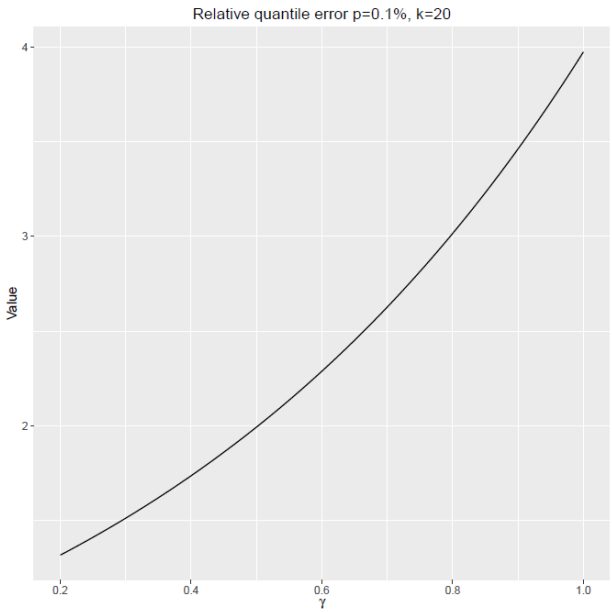


Source: Equation 3.4 in this article

This positive homogeneity property is also valid in the practical approach adopted during the genesis of Solvency II: practitioners often approximate $VaR_{99.5\%}(X)$ with $E(X) + c \cdot \sigma_X$, where σ_X is the standard deviation of X and $2.5 \leq c \leq 5$ is a multiplier close to 3 in the lognormal case and closer to 4 or 5 for loss distributions with heavier tails. To illustrate this setup, we create a company with 100Me total balance sheet representative of the ST2014 data.[63]

[63] The different prudential quantities in the table are computed from the companies which reassessed their SCR post-stress and had a positive increase in at least one of the financial stress scenarios.

Figure 6: Relative quantile estimation error vs relative expected magnitude as a function of parameter γ (for p = 0.001 and k = 20) using equation (4.1)



Source: Equation 4.1 in this article

Table 1: Toy company, pre-stress situation

Liabilities	100 Me
gBSCR	7.5 Me
b	5.25Me
Net SCR	2.23Me

Source: EIOPA Insurance Stress test 2014

First remark: the diversification and loss absorbing mechanism represents more than twice the net SCR, which demonstrates its importance in the Solvency II framework.

Table 2: Toy company, post-stress situation

in M€	ST (a ≈ 0.93)	a = 0.9	a = 0.8
Liabilities'	97.5	96.8	86
BSCR'	7.17	6.7	6
b'	4.45	4.02	3.27
Net SCR'	2.71	2.71	2.71

Source: EIOPA Insurance Stress test 2014 and authors' calculations

Another important consequence is that the variance of the profit & loss distribution plays a far greater role than the market risk exposure. Indeed, the a factor does not show up in the final estimation of the SCR. If we make another assumption and assume a perfect correlation between market exposure and the P&L, we would get:

$$SCR(X') = a \times gBSCR - b',$$

with[64] $a = 0.6$. In this simple model, the pre-stress net and gross SCR shown in Table 1 evolve[65] after the stress as presented in Table 2.

In fact, $a = 0.6$ corresponds to the pure shock for stocks and their spillovers. But given other risk modules and diversification and loss absorbing mechanisms it might be more consistent to choose[66] $a = 0.8$ or $a = 0.9$. We also provide numbers for $a = 0.8$ and for $a = 0.9$.

[64] This corresponds to a 40% decrease of the value of stock, comparable to the shock of the first scenario of the 2014 Stress test.

[65] The value of the LAC post-stress and BSCR' were not requested in the Stress Test exercise but could be reconstituted.

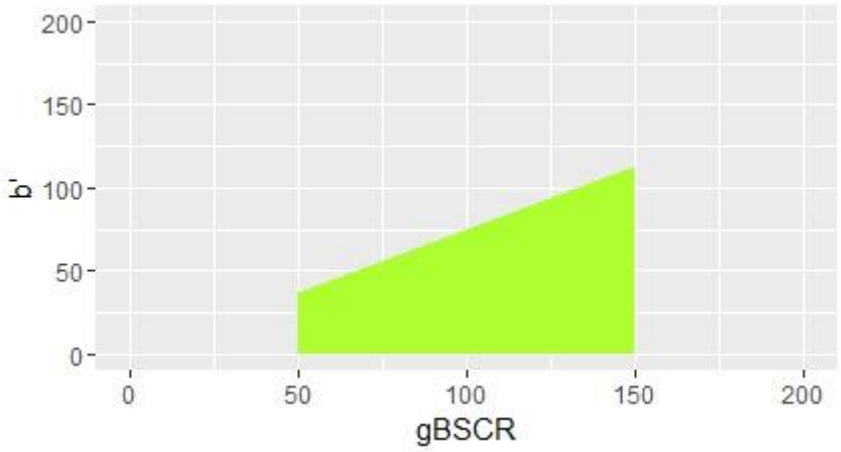
[66] As an illustration, the value was a =0.93 for the French companies in the ST2014 sample used her.e

For the completeness of the analysis, the value of b0 is deduced with the following equation (for $a = 0.9$, in M€):

$$b' = bBSCR' - NetSCR' = 7.17 - 2.71 = 4.45 = 0.77 \times b.$$

As discussed in Subsection 2.2, we observe in this simple example that the different diversification and loss absorbing mechanisms had to decrease much faster than the risk exposure. As a matter of fact, a reassessment of the SCR and at least the different LAC component should be mandatory in any forward looking exercise (ORSA, Stress test, etc.) when it is relevant. More generally, credibility of the different diversification modules should be checked thoroughly and be part of the annual risk review of any insurance supervisor. It is interesting to note that in the case of the French groups participating to the EIOPA Stress Test 2014 which reassessed their FDB post-stress, we have $\widehat{b'} = 0.26 \cdot b$,

Figure 7: : b' value with a positive increase of the net SCR



Source: EIOPA Insurance Stress test 2014

which empirically validates that this effect is quite substantial and our model is not too conservative.

The case a>1

The case $a > 1$ corresponds to the situation where the risk exposure increases after the shock: for example after a first earthquake or some floodings, the next event might have more severe consequences if it occurs soon, because some buildings have become more fragile or because the soil is already saturated with water. Another such situation, in the life insurance business, may occur in the case of mass non-lapse phenomenon, where remaining policyholders are more numerous than expected, for

example if they benefit from a high guaranteed minimum interest rate in a low or negative interest rate context.

To illustrate this point, we choose for b a market average and $a = 1.2$. So far, this figure has been provided as a percentage of the aggregate basic solvency capital requirement both for the participants of the 2014 EIOPA ST (European Insurance and Occupational Pensions Authority, 2014) and their French counterparts (Borel-Mathurin and Gandolphe, 2015).

The absorption capacity is $b = 38\% \times \overline{gBSCR}$. (resp. $b = 61\% \times \overline{gBSCR}$) for the whole setup of European groups participants (resp. the French groups), where we averaged over the corresponding samples. For values of gross BSCR ranging from 50% to 150% of the market average gross SCR, we plot in Figure 7 the sub-regions of the half-plane (b', gross BSCR) where the re-evaluated SCR is larger than the initial one.

Conclusions and policy implications

The Solvency II framework is characterized by the estimation of loss quantiles based on historical data. This framework allows for diversification and loss absorbing mechanisms and absorption capacities, that is, the ability to transfer future risk to the policyholders. In this paper, we studied the implications of the records of large losses on the one hand and, on the other hand, the magnitude of diversification elements of the prudential balance sheet such as loss absorbing capacities using deferred taxes or the technical provisions.

We computed the bias of estimators of tail probabilities and high quantiles of the loss distribution if the estimation is done immediately prior to the occurrence of a new record loss. We also proposed a stylized model to reassess the solvency capital requirement after a large record. The calibration using the data of the French participants to the 2014 EIOPA Stress test confirms our theoretical arguments and showed the very prominent role of the loss absorbing capacities in the Solvency II framework. Based on our data and as far as our estimations are concerned, the decrease in the reassessment of the solvency capital requirement is in the range of 23% to 74%. One of the regular criticism addressed to the Solvency II framework is the one-year horizon used for the quantile calculations, as it could produce a lack of stability in the determination of the solvency capital requirement. In this regard, our work stresses the volatility-inducing potential of the absorption capacities. This feature emphasizes the importance of the future management actions and other means of diversification and risk mitigation while calculating the Best Estimate of the

liabilities. Implications of our paper could have four facets: research, Enterprise Risk Management, supervision and regulation. As far as research is concerned, one might want to look ahead to a more advanced framework with a multi-dimensional setup. Insurance companies potentially undergo shocks from different risk factors simultaneously, the aggregation of which would introduce other effects to model. Another direction could be the use of these ideas in the banking sector, e.g. the calculation of the capital charge with VaRs such as Market risk in the Basel III framework.

Insurers, reinsurers and captives should take into account the impact of large events on their future ability to continue business. This study shows that re-evaluating the SCR after a shock should be part of a sound Enterprise Risk Management approach of risk measurement, risk controls and risk appetite determination.

The supervision duties should be modified in comparison to what was done in the Solvency I framework. Even in the standard formula, many levers exist and can be used while producing the prudential balance sheet. In this context, supervisory work should integrate the credibility checking of the projection hypotheses. Regarding prospective exercises, be it by the firm (e.g. ORSA) or the regulator (e.g. Stress Tests), we strongly recommend to always check the evolution of the solvency capital requirements after the occurrence of a shock, since letting these requirements remain constant cannot always be seen as a conservative assumption. Indeed, we showed in this paper that the risk exposure reduction does not necessarily decrease the value of the solvency capital requirement. In this regard we would strongly recommend that future exercises do not only specify the asset side but also the liability side and give guidance on the level of risk transfer to be operated with the technical provision.

Regarding banking supervision, our theoretical analysis and Figure 6 show that the re-estimation of the quantile of the operational loss is a very important question and deserves further research.

Finally, the regulatory bodies might have a closer look at the question of the accurate level of the chosen quantile and how to account for post-stress re-evaluation in the Solvency II framework. Such a study may motivate better ways to assess the prudential balance sheet figures estimations (SCR, MCR, etc.). A plausible response could consist of regulatory prescriptions such as floors or caps on the levels of the different diversification and loss absorbing mechanisms (LAC DT/TP, reinsurance or derivatives, and others). Moreover, the dynamic nature of capital requirements argues for simple multi-period stress tests instead of instantaneous ones.

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Appendix: Loss absorbing capacities

Before the launch of Solvency II, CEIOPS[67] was responsible for determining which risk measure should be best suited to insurance industry.[68] Different approaches were tested for the liability valuation and already at the quantile levels tested, the impact of the future bonuses were material.[69] The insurance industry is characterized by risk mitigation and so, Solvency II, being risk based, had to take this feature into account unlike Solvency I, which was based on fixed/all-inclusive calculations. In this regard, CEIOPS progressively introduced the concept of "loss absorbing capacity": at first in the QIS 2 specifications one could find the "risk absorbing proportion of$TP_{Benefits}$" or the "risk absorption" property of the future profit sharing only related to the discretionary nature of profit-sharing in almost all jurisdiction:

$$RPS = k \cdot TP_{Benefits}$$

assuming a linear relation between the Reduction for Profit-Sharing (RPS) and the technical provisions (TP) which relates to the future discretionary profits, and k was the risk absorbing proportion of those technical provisions. QIS 3 was only mentioning the "loss absorbing capacity" for the purpose of the valuation of contingent capital but confirmed the key role played by future bonuses granting those mechanisms some "risk absorption" abilities or properties. The QIS 2 linear relation was still mentioned but a more complex mechanism, called a "three-step approach" was introduced: for each risk sub-module two calculations should be performed: a net SCR module, denoted by $nSCR_{mod}$, and a gross one, denoted by $gSCR_{mod}$. The difference, KC_{mod}, between those two quantities is the "risk absorption ability" at the risk module level:

$$KC_{mod} = gSCR_{mod} - nSCR_{mod}$$

With this approach, the loss absorbing capacities were not assumed to be directly comparable to a specific balance-sheet element such as the with-profits technical provisions. As a consequence, this modular calculation made it unpredictable to any movement in the balance-sheet, were it on the liability or asset side. The QIS 4 specifications only refined this approach by defining more precisely what "loss

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[67] Committee of European Insurance and Occupational Pensions Supervisors, the predecessor of the European Insurance and Occupational Pensions Authority, "EIOPA"

[68] The results of this analysis, called "QIS" for Quantitative Impact Studies, can be seen on the EIOPA website: https://eiopa.europa.eu/publications/qis

[69] Approaches tested included the best estimate, the 60th, 75th and 90th percentiles, and the company view.

absorbing capacities" (LAC) were, whether it be linked to an asset or a liability element, insisting on the role played by deferred tax (LAC_{DT}) and absorbing capacities by the technical provisions (LAC_{TP}). Finally, the Solvency II directive gave legal perspective to the concept of loss absorbing capacity in its Articles 103 and 108; Article 111 let the implementing measures give more details on how to compute those loss absorbing capacities.

For any simulated sample path used for the projection of the liabilities entering in the valuation of the best estimate, key element of the Solvency II balance sheet, an undertaking might gain or lose some risk absorbing ability. As an illustration, in the life business, depending both on the market conditions (interest rates, stock prices, etc.) and on the level of the minimum guarantees granted to the insured, the undertaking running the best-estimate simulation might gain or lose some leeway with respect to the discretionary bonuses. In the end, any of the SCR sub-modules (net) whose calculation depends on a best estimate calculation will strongly be affected by these technical provisions' absorbing mechanisms. Finally, all those submodule loss absorbing capacities coming from technical provision or future discretionary benefits are gathered at the level of the SCR to account for a global diversification effect.

How does the mitigation actually work? In QIS 1 and 2, the risk-reduction mechanisms were initially designed and conceived by all the supervisors and regulators as constant elasticities to with-profit participations. In the final version of the regulatory texts, those mechanisms are not straightforward especially for the calculation of a modular risk module (scenario-based calculations). At first, the insurance company needs to compute the SCR net of all effects, which means that the amount of the risk-mitigation techniques are taken into account in the different best-estimate evaluations (baseline and module shock) and can change on a sample path basis. Then on a second round one has to evaluate the Gross SCR. For this purpose, all the computations need to be made while assuming only the cash flows coming from the guaranteed benefits are rediscounted when the relevant scenario affects the interest rate term structure. In the gross calculation phase, the cash flows arising from the future discretionary benefits are supposed to be constant.

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