PwC Solvency II Life Insurers' Capital Model Survey

Summary Report

November 2019

pwc

PwC's capital models survey focuses on the calibration of risks that are used when determining the Solvency Capital Requirement. This survey covers Internal Model and Partial Internal Model life insurance companies in the UK.

Participants

We would like to express our thanks to the following firms which took part in our survey:

- AEGON UK
- AVIVA UK Life
- Just Retirement Limited
- Legal & General Group Plc
- Lloyds Banking Group Plc
- M&G Prudential
- NFU Mutual
- Phoenix Group
- PIC
- ReAssure
- Rothesay Life Plc
- Royal London Mutual Insurance Society Limited

Contents

1. Introduction

Welcome to the 2019 life insurers' Solvency II capital models survey. This report aims to capture aspects of the methodology and the stresses applied in the year-end 2018 capital models across a wide range of risks and any changes in the calibrations over 2018, in order to help your business compare its model and assumptions with peers in the market. This can provide valuable insights at a time when many insurers continue to be in discussion with their regulators over planned model changes, while others are in the process of seeking internal model approval for the first time.

The survey covers the evaluation of capital for the majority of risks, drawing on information from twelve of the UK's largest life insurers. Each year we determine specific questions on selected 'hot topics'. For 2019 we have considered the PRA's recent decision to allow a dynamic volatility adjustment within internal models, the approach taken to transitional measures on technical provisions, monitoring of model drift and the use and maintenance of proxy models. We capture information on a wide range of risk calibrations and compare it to the results collected in recent years of this survey.

The survey covers a diverse range of UK participants, eleven of which are currently using either an approved internal model or a partial internal model. Where there is not an approved internal model, or where the standard formula is used for certain risks within a partial internal model, we asked for information on an economic capital calibration as it stood at 31 December 2018.

Our thanks go to the firms which took part for kindly sharing their time and their insights.

Regards,

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Purpose and use of this report

This report has been prepared to be shared with the public. We accept no liability (including for negligence) to you or anyone else in connection with this report. The report should be read in its entirety; reading individual sections in isolation may result in misinterpretation.

The report contains information obtained from survey participants. We have not sought to establish the reliability of the information or otherwise verify the information so provided. Accordingly no representation or warranty of any kind (whether express or implied) is given by PwC to any person as to the accuracy or completeness of the report.

This report is a summary of the detailed PwC survey which covers aspects of the methodology and the stresses applied in the year-end 2018 capital models across a wide range of risks and any changes in the calibrations over 2018. The survey considers Internal Model and Partial Internal Model life insurance companies in the UK. Participants have received a more detailed version of this report, however the key messages summarised here are consistent with the detailed report.

In some areas, not all participants responded to the questions asked. This will have been for various reasons, e.g. where participants employ the standard formula calibrations to calculate a capital requirement or where the question is not relevant to the participant's business. In these instances, the total number of responses is less than twelve; however we have ensured that results disclosed in this report are always from a sufficiently credible set of responses. Where we have received an insufficient number of responses to meet this objective, we have refrained from disclosing quantitative results.

Compliance with TAS requirements

The Financial Reporting Council ('FRC') requires actuaries to comply with Technical Actuarial Standards ('TASs') for various types of actuarial work. We also believe that it is normally appropriate to apply the requirements of the TASs to other work conducted by actuaries. Given the nature of the work, however, we have not attempted to follow the requirements of the TASs on this assignment. You will need to consider the impact of this limitation on your interpretation of our work and results.

Materiality

We have defined materiality as a capital component that is above 5% of the total diversified SCR. This definition is applied consistently throughout the report.

Key to trend graphs

For all of the graphs that show trends over this and previous years of our survey, the dates represent the year-end to which the calibration corresponds (rather than the year in which the survey was published) and the following key applies:

In certain areas where we received limited data, we show only the maximum, minimum and mean.

2. Key messages

In this section we summarise the key themes emerging from the results provided by our participants.

2.1. Material risk exposures

Credit, longevity, persistency and equity risks remain the highest individual contributors to participants' undiversified and diversified Solvency Capital Requirement ('SCR'). While we asked for less information on these risks in the survey this year, they continue to be the largest sections of the report. We also consider the calibration of less material market and life risks and of operational risk, and the aggregation of all risks.

2.2. Result highlights

It is now nearly four years since the first round of internal model approvals and, after we started to see some stabilisation in the calibrations of the major risks last year, we have streamlined the survey this year to focus on the results of the calibrations rather than the data and methodology used to produce them. However, we continue to see tweaks to the methodology applied for every risk for which we asked the question, as well as the refreshing of data within many of the calibrations.

Credit risk continues to be the market risk most subject to methodology changes, which is perhaps unsurprising given its significance to most participants. There is little consensus in how the calibrated spread stresses have changed over the year, either in direction or in magnitude, but the average stress for a 10-year A-rated bond has increased significantly for financial bonds (largely due to one participant) and decreased slightly for non-financial bonds. Updates to the calibrations for other market risks are largely due to refreshing the data on which they are based.

Longevity risk continues to be the life insurance risk most subject to methodology changes, which again is unsurprising given its significance to most participants. The average change in expectation of life from the longevity base stress increased slightly over the year, continuing the recent pattern of small fluctuations around a fairly stable level with no obvious trend, as did the average change in expectation of life from the longevity trend stress. While the best estimate expectation of life reduced markedly during 2018, there has been no general strengthening of the longevity stress to offset the reduction.

The PRA continues to introduce certain relaxations to their supervisory approach, although they are not currently being widely adopted. The use of a volatility adjustment which varies under stress is now permitted but so far only two participants indicated that they plan to introduce a dynamic volatility adjustment. The PRA's proposals on the recalculation of the transitional measure on technical provisions were open for consultation at the time that the survey was carried out and, at that stage, only one participant intended to alter their recalculation approach as a result.

While making concessions in some areas, the PRA has identified other areas of concern where it is focusing attention. The approach when supervising firms with illiquid assets remains high on this list, with a particular focus on equity release mortgages and the extent to which benefit can be taken for them within the matching adjustment. Given the delay in the implementation of changes to the Effective Value Test that were open for consultation during last year's survey, we have not yet seen changes in methodology or assumptions in our survey results.

Also on the PRA's list for focus over the next year is the use of proxy models, which is very common among participants in our survey, and model drift, where their concern is that the capital requirements calculated by internal models become gradually weaker over time. We gathered information which may indicate that the PRA has some justification to be concerned about model drift, but in many cases the observed movements can be rationalised and one year is too short a period over which to assess model drift reliably.

3. Hot topics

Within this section we present our findings on four 'hot topics' included in our survey this year: the PRA's recent decision to allow a dynamic volatility adjustment within internal models, the approach taken to transitional measures on technical provisions, monitoring of model drift and the use and maintenance of proxy models. The treatment of equity release mortgages, which remains an area of focus for the PRA, is covered in the next section.

- Two of participants currently intend to update their internal model to allow for the dynamic volatility adjustment.
- The transitional measure on technical provisions expressed as a proportion of the Solvency Capital Requirement varies substantially between survey participants, and has been recalculated up to six times since Solvency II implementation in 2016.
- Model drift will be an area of focus for the PRA over the next 12 months. Between year-end 2017 and year-end 2018, the average change in the ratio of internal model SCR to best estimate liabilities was -3.6% and the average change in the ratio of internal model to standard formula SCR was -8.7%.
- The majority of participants use a proxy model when calculating the SCR to assess losses from a large number of one-year scenarios. A quarter of these propose to make changes following the "Dear Chief Actuary" letter sent in June 2019.

3.1. Dynamic volatility adjustment

Following Consultation Paper (CP) 9/18 in April last year, the PRA published Supervisory Statement (SS) 9/18 on the modelling of the volatility adjustment (VA) for internal model firms. The SS sets out the PRA's expectations of internal model firms when determining the risks that might arise from the dynamic volatility adjustment (DVA) when modelling Solvency II market risk stresses within the SCR calculation.

The PRA originally stated that internal models should not allow the VA to change under stress. The updated view allows the VA to move with the modelled credit spreads in the own funds projection. The SS outlines the points that firms need to consider within the model change application when seeking approval to use the DVA, including consistency of parameters with the best-estimate liability calculation; constraints on adjustments which may result in capital benefits; constraints on excessive capital relief on options and guarantees; and the dependency between risks when changing the discount rate methodology. The dynamic application of the VA would be expected to result in a lower credit spread stress within the SCR for business where the VA is applied.

Only a couple of participants indicated that they intended to update their internal model to allow for the dynamic volatility adjustment. None of the respondents said that they had changed their view on whether they plan to adopt the DVA since July 2018.

3.2. Transitional measure on technical provisions

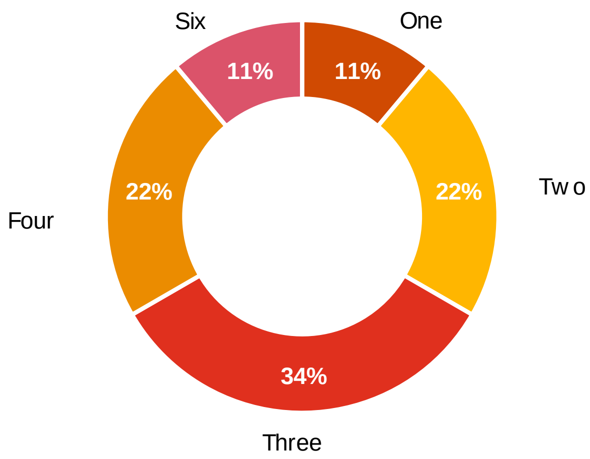
Since the implementation of Solvency II on 1 January 2016, firms have been allowed (subject to PRA approval) to apply a transitional measure on technical provisions (TMTP) to dampen the initial impact of any increase in net technical provisions. This impact is measured relative to the more onerous of the Solvency I Pillar 1 or Pillar 2 bases and is reduced over a period of 16 years. The TMTP can be applied to business which also uses either the matching or volatility adjustment.

In May 2019, the PRA published a consultation paper (CP 11/19) proposing an update to the supervisory statement (SS 6/16) on the maintenance of TMTP under Solvency II. The PRA has recognised that the operation of the TMTP is overly burdensome for firms and has investigated a range of methodologies to simplify the TMTP recalculations, which has resulted in additional guidance being proposed. The additional guidance focuses on the use of simplified methods to recalculate the TMTP and the consistency of Solvency I and Solvency II methodologies.

Almost all of the respondents currently have a TMTP. The TMTP expressed as a proportion of the SCR varies considerably between survey participants (between about 25% and 60%); this is a narrower range than we observed last year but it remains a material contributor to the overall solvency ratio for some participants.

Figure 3.1 shows how often participants have reset the TMTP since Solvency II implementation. We would expect all participants to have performed at least one recalculation since 2016 given the biennial Solvency II requirement, however the majority of participants have reset the TMTP more than once.

Figure 3.1 Number of TMTP recalculations since Solvency II implementation.



There is no consensus as to whether the current operation of the TMTP is overly burdensome and only a small number of participants are currently considering making changes to the recalculation of the TMTP following the PRA's consultation.

When asked about the length of time required to obtain both internal and supervisory approval for a TMTP reset, participants provided a range of responses between one and six months in total.

3.3. Model drift

Model drift describes the weakening of capital requirements calculated by internal models over time such that they no longer reflect the underlying risks to which the company is exposed.

David Rule, Executive Director of Insurance Supervision at the PRA, noted in his speech of May 2019 that, for life insurers in aggregate in 2016 and 2017, both standard formula capital requirements and best estimates of liabilities rose by considerably more than internal model capital requirements. There are a number of factors that could have caused this trend, including model drift.

The "Dear Chief Actuary" letter in June 2019 noted that model drift will be an area of focus for the PRA over the next 12 months. The PRA will continue to monitor trends in modelled SCR at firm level, and is especially vigilant about material SCR reductions and weakening of risk calibrations where these cannot be adequately justified.

We asked participants for their year-end 2017 and year-end 2018 best estimate liability (BEL) and the SCR calculated both on their internal model basis and using the standard formula. Using this information, we calculated the change in ratio of the internal model SCR to BEL and the change in ratio of internal model to standard formula SCR. We then asked the participants to comment on what they consider to be the key drivers of the changes in the ratios and how they expect this trend to develop going forward.

The average change in the ratio of internal model SCR to BEL was -3.6% and the average change in the ratio of internal model to standard formula SCR was -8.7%. This suggests that the capital requirement under the internal model has reduced relative to the calculation under the standard formula. A number of participants have attributed the reduction to events and changes within the business and another common theme was the treatment of ERMs, which have a more onerous stress under the standard formula.

The majority of participants that expressed a view expect the ratio of the internal model SCR to BEL to continue to decrease over time. The responses for the ratio of the internal model to standard formula SCR were broadly similar, with participants again noting that the standard formula is more onerous for certain asset classes of which companies are increasing holdings, such as ERMs.

3.4. Proxy models

Proxy models are used as an approximation of more complex valuation models. For life insurers they are typically used to approximate the capital required from a large number of scenarios, with a lower run-time than the existing internal models. If these proxy models are of poor quality, the calculated regulatory capital requirement will be incorrect, even if the underlying valuation models are correct. Additionally, the poor quality could have an impact on decisions which rely on the output of proxy models, such as capital allocation, pricing and risk management.

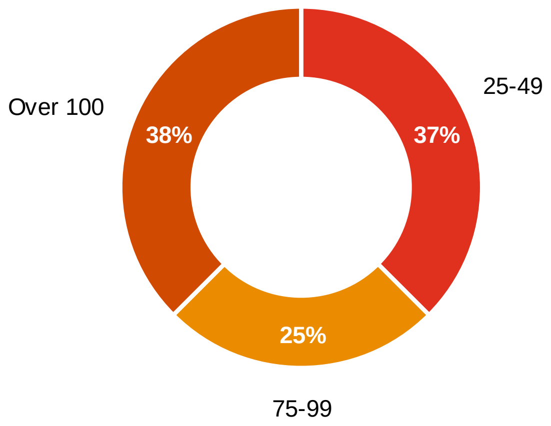
David Rule noted in his speech of May 2019 that the quality of proxy models was mixed across the market and that standards of validation also varied. In addition, the "Dear Chief Actuary" letter in June 2019 noted that proxy models will be an area of focus for the PRA over the next 12 months. The PRA is keen that firms recognise the risks associated with such complex modelling, do not place too much reliance on the proxy model output and make sufficient allowance for the risk of model error.

The majority of participants use a proxy model when calculating the SCR. We asked participants a range of questions about the use of proxy models, including their calibration and validation.

All participants that use a proxy model adopted the model as part of the internal model approval process (IMAP). Just over half of the participants that responded noted that they have not updated the proxy model since IMAP. It is more common to calibrate the model at the reporting date rather than at other times of the year;

We asked how many validation tests are performed on the proxy model, where validation tests are defined as the runs of the underlying asset and liability models to assess proxy model error. Figure 3.2 shows the number of validation tests performed by participants

Figure 3.2: Number of validation tests performed on the proxy model



Validation tests can either be performed in-cycle (before capital results are finalised) or out of cycle. Half of the participants perform validation tests in-cycle. It is also common to have a mixture of timings, to allow for more tests to be performed out of cycle. Only a small number of participants perform all tests out of cycle.

In addition to the above:

- Most participants target validation tests mainly around the critical scenario, rather than looking across more of the distribution;
- A small majority of participants set tolerances to quantify the potential model error within their proxy models, with a variety of approaches to setting the tolerances and a range of actions to be taken if a tolerance is breached;
- At the time of responding to the survey, only a small proportion of participants intended to develop their proxy model as a result of the "Dear Chief Actuary" letter.

4. Equity release mortgages

Illiquid unrated assets such as equity release mortgages (ERM) have been increasingly used by life insurers with large annuity books in recent years to optimise their capital position under Solvency II. Given the subjectivity involved in valuing and managing ERM and the materiality of this asset class, such assets have been receiving an increasing amount of regulatory scrutiny over recent years.

In July 2017, the PRA issued a supervisory statement (SS 3/17) which set out its expectations for insurers investing in illiquid, unrated assets (including ERM) within their Solvency II matching adjustment (MA) portfolios. The supervisory statement focused on the PRA's expectations for internal credit rating assessments, the assessment of and allowance for guarantees embedded within ERM (specifically the 'no negative equity' guarantee (NNEG)) and the extent to which the fundamental spread properly reflects the insurers' exposure to NNEG risks. In July 2018, the PRA consulted (in CP 13/18) on updates to this supervisory statement, proposing a more prescriptive calculation of the value of the NNEG within the Effective Value Test (EVT) it had introduced. These proposals were finalised in December 2018 (in PS 31/18), with a year's delay to implementation (to 31 December 2019) and some amendments which reduced the potential burden of the minimum calibration of the EVT. A further consultation (CP 7/19) took place earlier this year and the long-term process for and frequency of future reviews of the assumptions prescribed for the EVT were finalised in September.

The increased regulatory scrutiny of ERM highlights the importance of ensuring that the relevant risks are properly modelled in the base and stressed valuations. The PRA continues to reaffirm its position regarding ERMs, namely 'that restructured equity release mortgages are a suitable asset to back annuities as part of an appropriately diversified portfolio'. A number of insurers have restructured their ERMs, splitting the cashflows into loan notes with different levels of security. Valuation of these loan notes can be particularly challenging.

We asked participants for a range of quantitative and qualitative information on their current calibrations, data and the methodology for their base and stressed assumptions. We note that, due to the requirements of the updated SS 3/17, there may be significant changes to these calibrations in the future, e.g. the property assumptions used in valuing the NNEG risk.

- In line with prior year, participants' 1-in-200 property level stresses sit within the range 19% to 36%. The property volatility stress is typically an addition to the best-estimate volatility assumption of between 4% and 10%.
- A Black-Scholes formula remains the most common method for valuation of the NNEG risk.
- When revaluing the restructured ERM assets under stress, the most common approach is in line with last year's survey results, i.e. the underlying ERM assets are stressed and the senior notes and junior notes are revalued in line with the base valuation methodology (which typically values the junior note first).

4.1. Property growth

The majority of participants indicated that they rely solely on data produced by Nationwide, in contrast to last year when Halifax and Bank of England data was also commonly used. Data periods used ranged from 20 to 50+ years.

The majority of participants use a statistical distribution to model changes in property prices, and a number of distributions were given.

Participants model property growth in various ways, with the most common approach being to use a margin over RPI or the RPI swap curve, with the margin ranging from 0.5% to 1%.Other approaches include using the risk-free rate or applying a margin above the risk-free-rate.

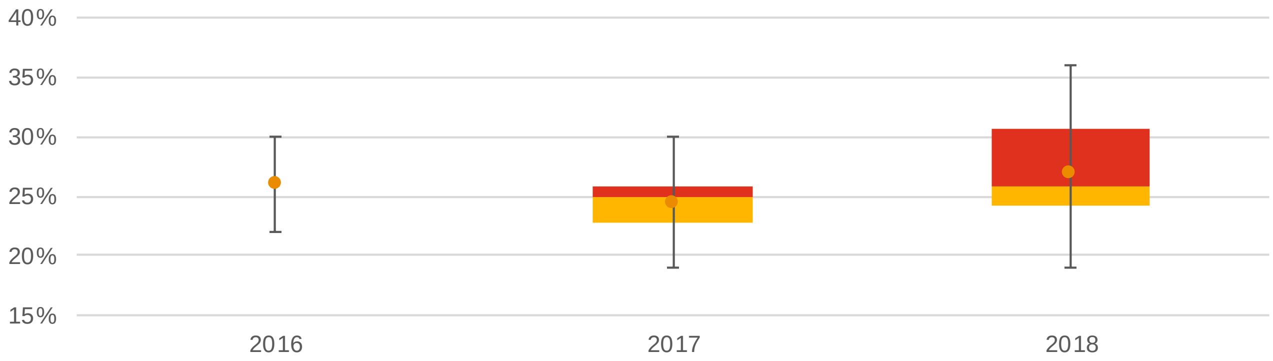
In order to determine the stressed property growth assumption, reductions applied to the best estimate growth rate varied between 1.23% p.a. and 1.75% p.a.. Those using a risk-free rate apply a stress in line with the interest rate calibration.

4.2. Property level

The majority of participants use Nationwide data alone in order to set the ERM property level stress. Land registry and Halifax data are also used by a small number of participants in combination with other sources. The range of data sources is narrower than observed in our survey last year. The period of data used in the calibration varies widely, from 20-30 years to over 50 years.

The 1-in-200 calibrated property level stresses for ERM are summarised in Figure 4.1 and compared against equivalent informaiton from the last two years' surveys. We received insufficient responses for the 2016 calibration to be able to present quartile information, but have included the mean and range of responses for comparison.

Figure 4.1: Property level stress calibrated at the 1-in-200 level for ERM

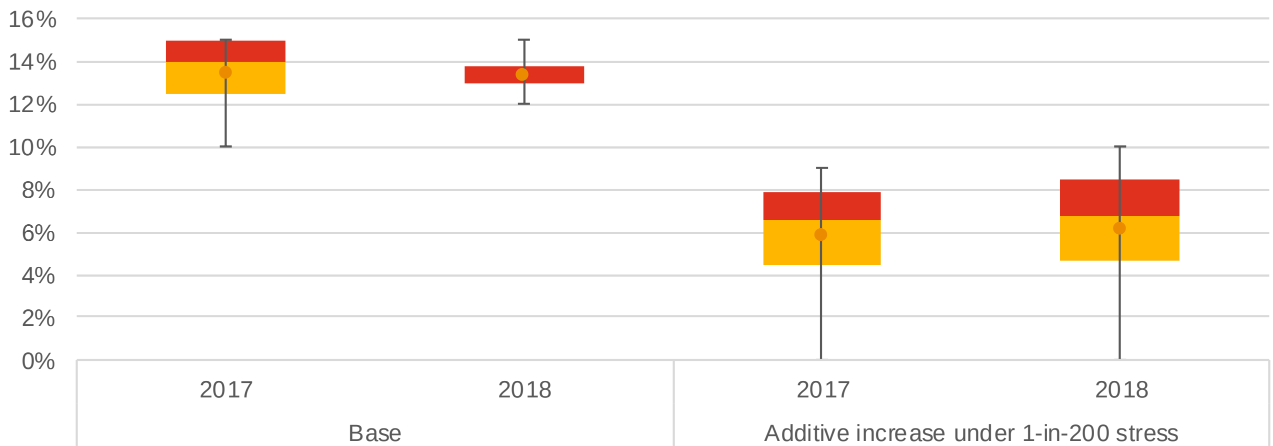


4.3. Property volatility

Participants use a variety of data sources to calibrate the base and stressed property volatility assumptions, including Halifax, Nationwide and Land Registry.

We asked participants to provide the assumed ERM property volatility in base and stressed conditions. Figure 4.2 summarises the range of base assumptions adopted by participants as well as the additive increase to the assumption under stress, and shows equivalent information from last year's survey for comparison.

Figure 4.2: Base and 1-in-200 property volatility assumptions for ERM.



4.4. Other assumptions and model choice

Most participants use internal data for setting prepayment assumptions, alongside additonal sources such as Aviva Equity Release Funding data.

Almost all participants make an allowance for property dilapidation costs when modelling the projected property price. There is a range of approaches adopted, including using an explicit reduction in value at point of sale or making an allowance either explicitly or implicitly through the property growth and / or volatility assumptions.

The majority of participants confirmed that a Black-Scholes formula is used when valuing the NNEG in the base balance sheet, as opposed to a stochastic model, and it is most common to use a real-world as opposed to risk-neutral approach. The value of the NNEG as a proportion of the fair value of the ERM portfolio ranged between 2% and 30%.

4.5. Restructuring ERM cash flows

It is possible to restructure ERM cash flows into securitisations (senior and junior notes), with the senior note cash flows structured in such a way that they can be demonstrated to be eligible for the MA and therefore for inclusion in the MA portfolio. We note the following observations from the responses we received:

- When valuing the senior notes and junior notes, it is more common to value the junior note first and determine the senior note value using the equation of value, with a range of approaches followed for setting the discount rate used to value the junior note.

- When revaluing ERM assets under stress, all participants that responded described an approach whereby stresses are applied to the ERMs and then the base valuation methodology is applied, e.g. revaluing the junior note under stress and defining the senior note to be a balancing item. Participants adopt a variety of approaches for modelling the fundamental spread (FS) on the securitised assets under stress, e.g. stressing the FS consistently with other similar credit rated assets.

- The majority of participants confirmed that stress tests are applied to the value of ERM in order to inform the internal credit assessment, with Moody's published tests and Fitch published tests both used.

5. Market risk

Solvency II states that the market risk module of the standard formula shall reflect the risk of loss or adverse change in the financial situation resulting, directly or indirectly, from fluctuations in the level and in the volatility of market prices of assets, liabilities and financial instruments. It shall properly reflect the structural mismatch between assets and liabilities, in particular with respect to duration. Similar considerations would be expected to inform market risk calibrations of an internal model.

In this section, we consider various components of market risk. For each risk, we asked participants for a range of quantitative and qualitative information on their risk calibrations as applied in their Solvency II internal model, with a focus on the credit risk elements.

5.1. Credit risk

Changes in approach over the year

The majority of participants noted that they made changes to the credit risk calibration (encompassing both spread risk and transition and default risk) over 2018. Of these, most made changes to both the data and methodology used to set the calibration while the remainder made changes to just one of these components. The effects on the strength of the resulting calibration varied in direction.

A small number of participants stated that the changes were driven by external factors alone, with around half stating that the changes were driven by internal factors alone. The remaining participants cited both internal and external factors. .

5.1.1. Credit spread

Solvency II defines spread risk as the risk arising from the sensitivity of the values of assets, liabilities and financial instruments to changes in the level or in the volatility of credit spreads over the risk-free interest rate term structure.

- The majority of participants' model credit spread risk separately from transition and default risk.
- The average 1-in-200 increase in spread for a 10-year A-rated financial bond (402bps) has decreased by 1bp (2017: 403bps). The average 1-in-200 increase in spread for a 10-year A-rated non-financial bond (259bps) has decreased by 5bps (2017: 264bps). There is a significantly larger change in spread (c50bps increase) for financial bonds when only firms which participated in both years are considered, which is broadly offset by a change in those participating; the change in participants has a much smaller effect on the average for non-financial bonds.

Methodology

Treatment of credit transition and default

The majority of participants indicated that they model spread separately from transition and default; none of these has changed their approach since last year's survey.

Assets other than corporate and sovereign bonds

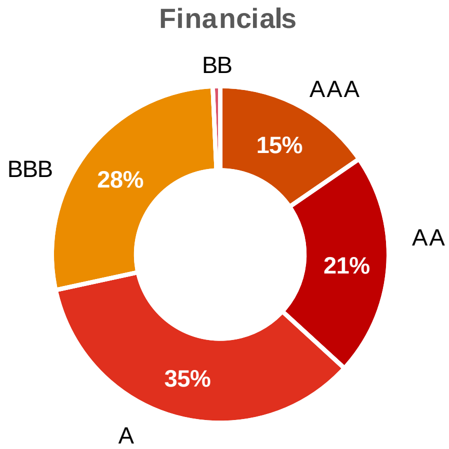
Most participants indicated that they hold assets other than corporate and sovereign bonds. The most common asset classes are equity release mortgages, commercial mortgages, infrastructure and social housing loans. Just over half of these participants calculate separate credit spread stresses for assets other than corporate and sovereign debt, which in some cases involves using the same underlying model calibrated to different data.

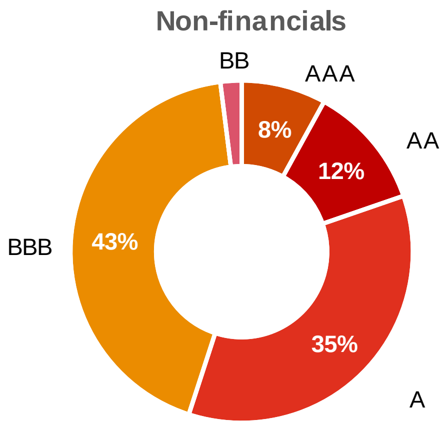
Results

We asked participants for details of their calibrated credit spread stresses by sector (financial / non-financial) and credit rating. The summarised results can be seen in Figures 5.2 to 5.7, in each case combined with equivalent data from the last five years of this survey to show the movement over time. We also collected data for bonds of term 25 years this year but do not display it because the longest term for which we collected data in previous surveys was 20 years and so we currently have no comparative data.

To set the results in context, we also present information on the average split of the bond portfolio by credit rating, separately for financial and non-financial corporate bonds. Figure 5.1 shows that the stresses for A-rated financial bonds are of most relevance overall, while for non-financials there are material holdings of both A- and BBB-rated bonds.

Figure 5.1: Average exposure to financial and non-financial corporate bonds





Financial corporate bonds

The following graphs show the stresses for **financial corporate bonds** only. As expected, there is a general increase in calibrated stress as bond rating decreases. Note the change in scale of the y-axis between different terms and, within each term, between higher and lower rated bonds.

There is no consistent trend in the calibrated stresses over time, nor evidence of convergence to a narrower range of stresses as modelling evolves. This is perhaps to be expected given the range of modelling approaches and differences in the composition of asset portfolios, resulting in different combinations of term and rating being more important to different participants.

Figure 5.2: Calibrated basis point yield increase for credit spread by credit rating for financial corporate bonds (5 year term, 1-in-200).

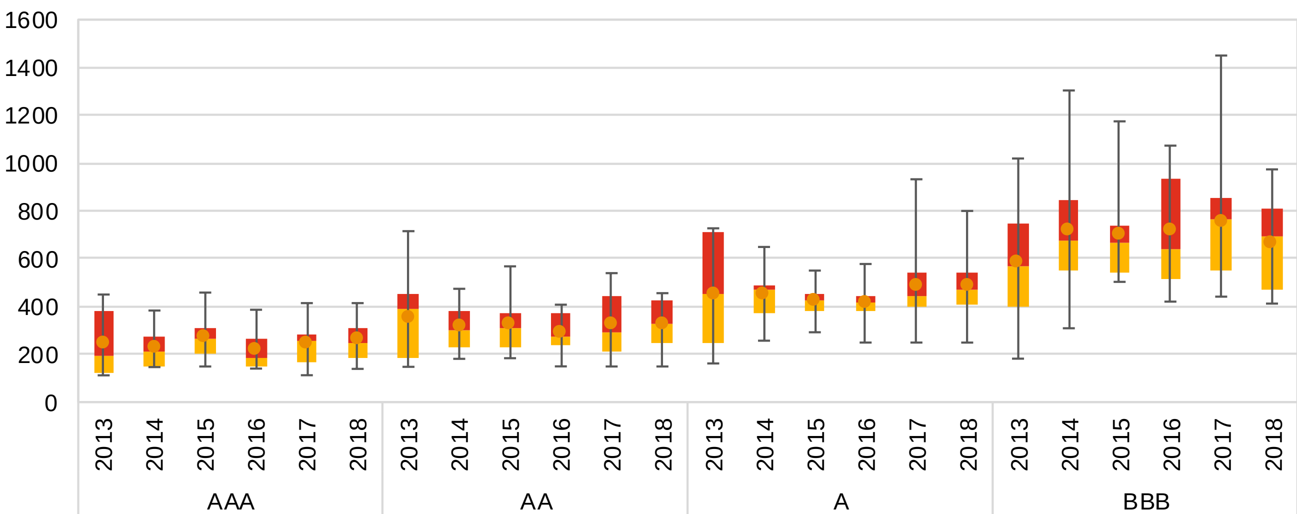


Figure 5.3: Calibrated basis point yield increase for credit spread by credit rating for financial corporate bonds (10 year term, 1-in-200).

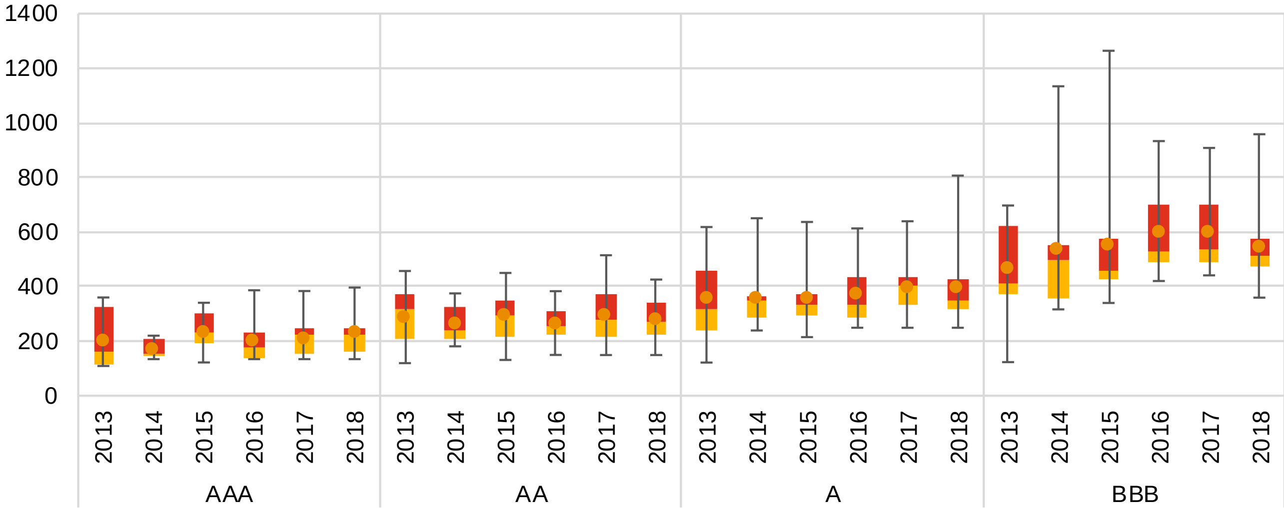
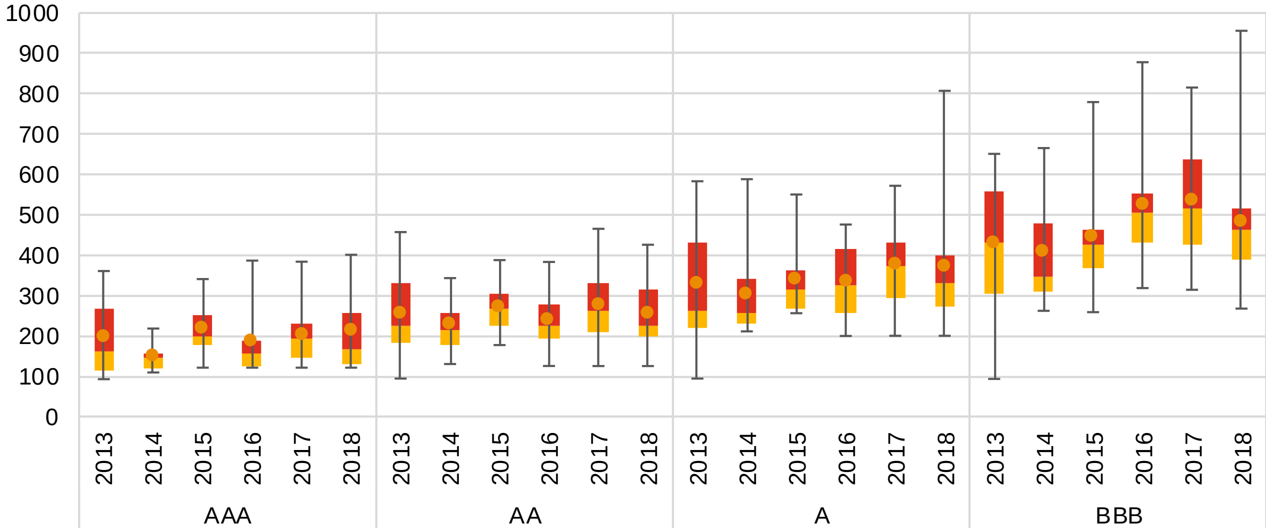


Figure 5.4: Calibrated basis point yield increase for credit spread by credit rating for financial corporate bonds (15 year term, 1-in-200).



Non-financial corporate bonds

The following graphs illustrate the calibrated stresses for **non-financial corporate bonds** only. Again, note the change in scale of the y-axis between different terms.

There is no consistent trend in the calibrated stresses over time, although perhaps some evidence of a general drift downwards for AA-rated and A-rated bonds, nor evidence of convergence to a narrower range of stresses as modelling evolves. As for financial bonds, this is perhaps to be expected given the range of modelling approaches and differences in the composition of asset portfolios, resulting in different combinations of term and rating being more important to different participants.

Figure 5.5: Calibrated basis point yield increase for credit spread by credit rating for non-financial corporate bonds (5 year term, 1-in-200).

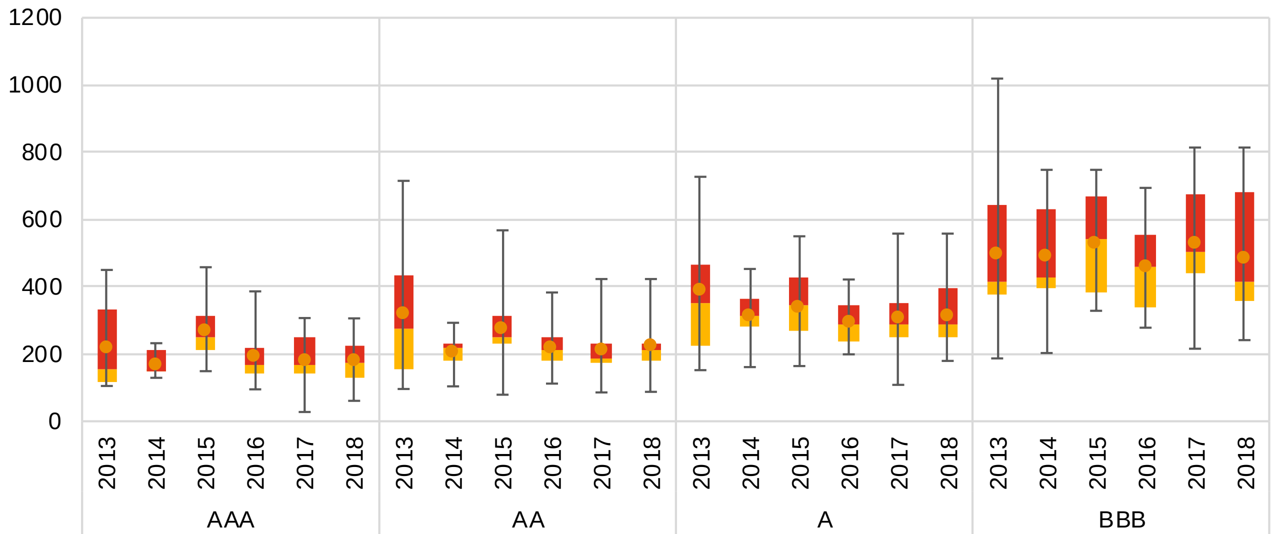


Figure 5.6: Calibrated basis point yield increase for credit spread by credit rating for non-financial corporate bonds (10 year term, 1-in-200).

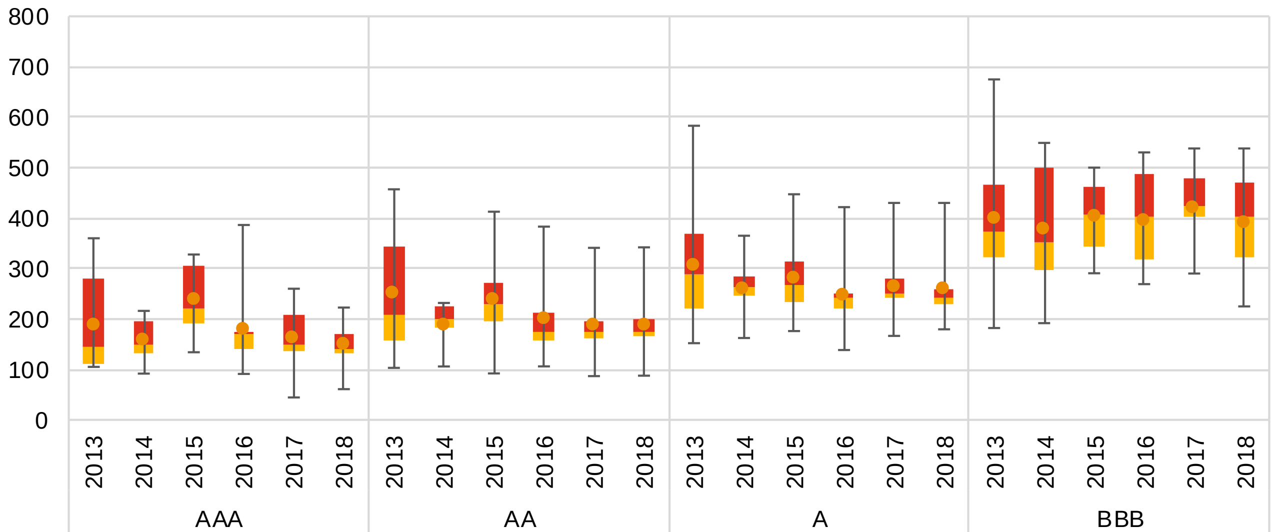
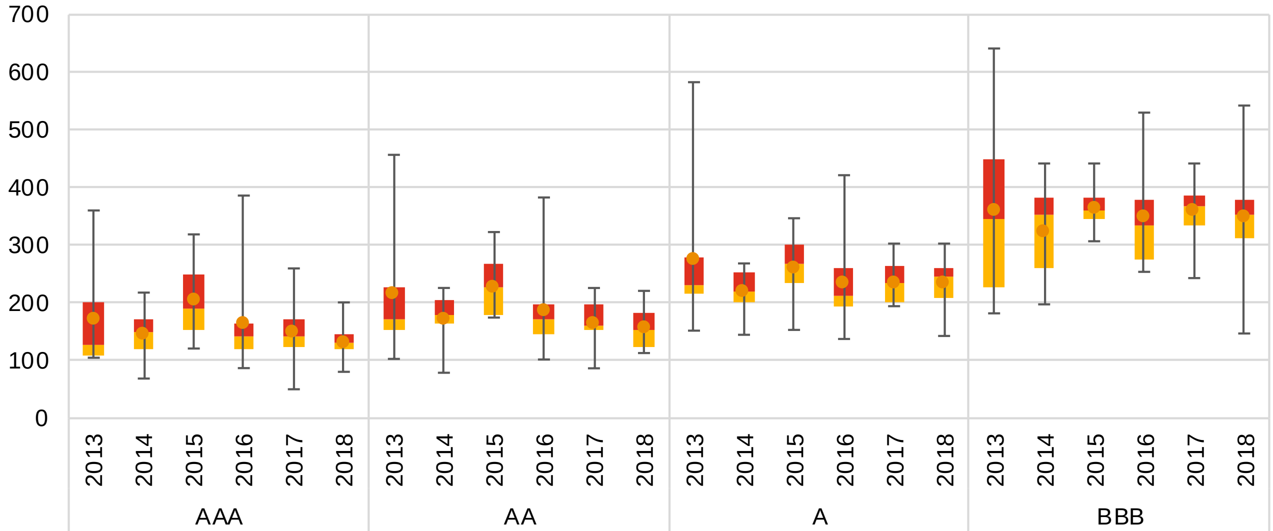


Figure 5.7: Calibrated basis point yield increase for credit spread by credit rating for non-financial corporate bonds (15 year term, 1-in-200).



UK gilt stresses

We also asked participants for details of the 1-in 200 stresses applied to UK gilts where modelled separately. We received insufficient responses to be able to present graphical information this year. At the 1-in-200 level, the average stresses applied by participants increased relative to last year - 105bp at term 5 (2017: 94bp) and 106bp at term 10 (2017: 95bp).

5.1.2.Total credit stress

Losses can also arise from the sensitivity of the values of assets and liabilities to changes in market assessments of the risk of future migration and/or default. Before the advent of Solvency II, insurers generally modelled credit risk holistically, focusing on spread changes to reflect movements in total return/value.

The matching adjustment calculation and associated split of transition and default risk from spread risk, combined with regulatory pressure, has led to the majority of insurers choosing to reflect spread, transition and default elements separately within their modelling.

We asked for information on the transition and default stresses applied by participants at the 1-in-200 level, however, we did not receive enough respondes to present this information. We also asked for the combined credit risk stress, the results of which are shown below.

The following graphs illustrate the calibrated stresses for the combined credit risk stress separately for **financials and non-financials.** Note that this is the results from the survey this year only as we do not have sufficient prior year data to present a comparison over a longer period of time.

Figure 5.8: Calibrated basis point yield increase for combined credit risk stress by credit rating for financial corporate bonds (1-in-200).

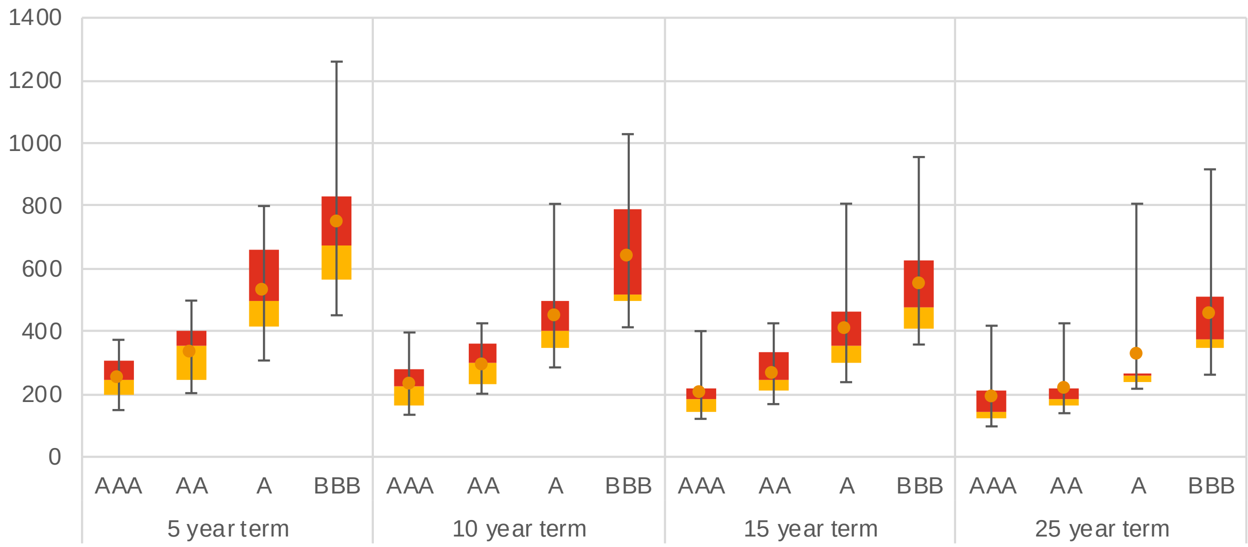
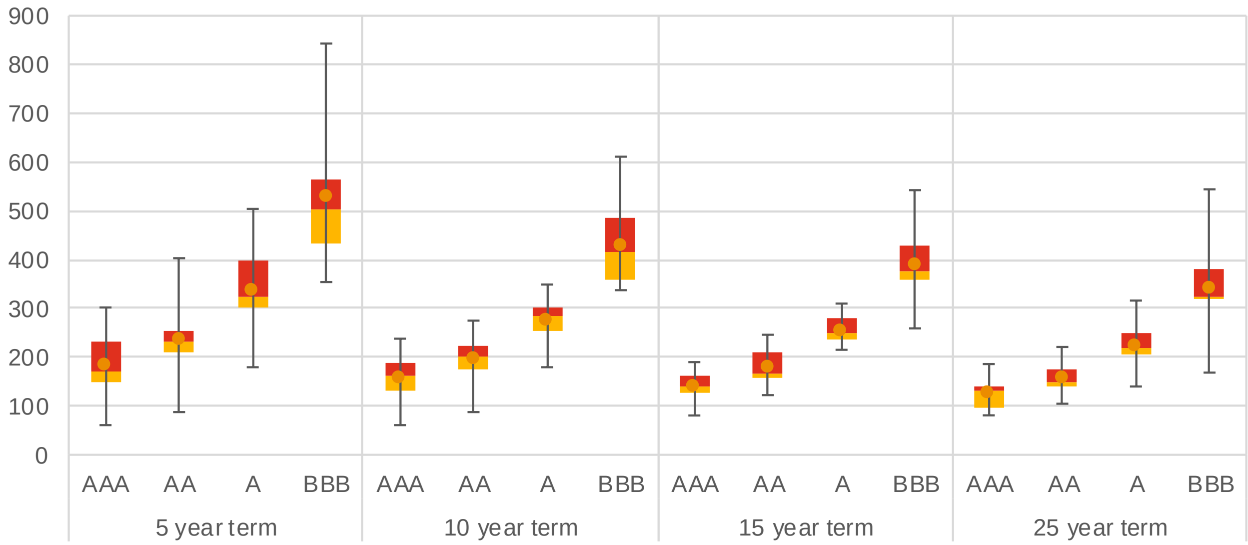


Figure 5.9: Calibrated basis point yield increase for combined credit risk stress by credit rating for non-financial corporate bonds (1-in-200).



5.1.3.Matching adjustment

The Matching Adjustment (MA) calculation reflects the yield over and above the risk-free rate earned on an asset portfolio ring-fenced to back designated liabilities, less the fundamental spread in respect of transition and default risk. When credit spreads widen in a stressed scenario, the MA offsets some of the impact on the MA portfolio assets through an increase in the MA and hence in the discount rate used to value the MA liabilities.

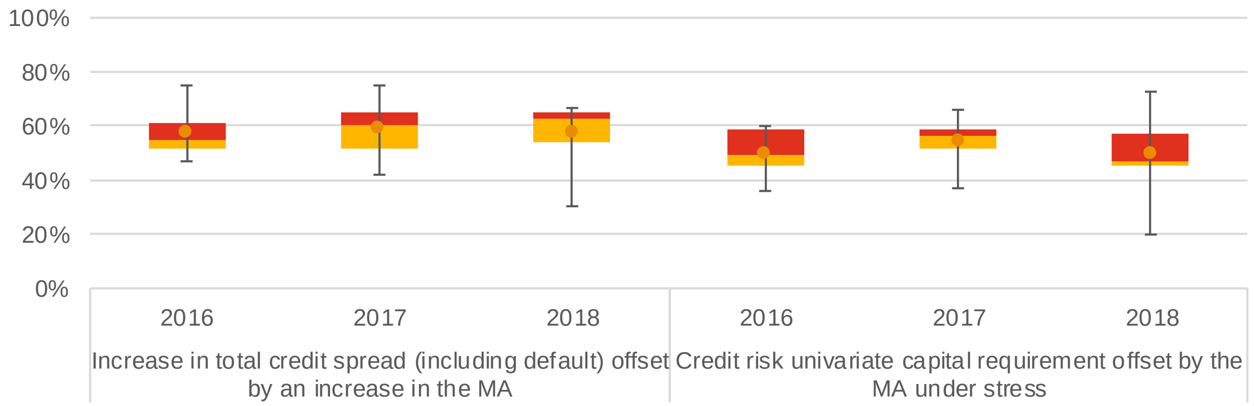
In order to use an MA in the valuation of the Solvency II balance sheet, PRA approval is required. However, considerable variation remains over the modelling of the MA under a credit spread stress and ongoing management of MA portfolios.

The majority of participants apply an MA within their business, typically applying it to both individual and bulk annuity business.

- The proportion of the increase in credit spread that is offset by an increase in the assumed MA varies between 30% and 67%, which is a wider range but generally lower than the proportions observed last year.
- The offset in credit risk univariate capital requirement varies between 20% and 73%; it is more common for this to be lower than the proportion of spread offset, but this is not the case for all participants.
- Participants are broadly equally split as to whether or not to reduce the MA under a longevity stress.

We asked participants to describe the end result of a widening in total credit spread (including transition and default) for MA portfolios, as well as the percentage offset on the credit risk univariate capital requirement from the MA under stress. The results are summarised in Figure 5.10 below, along with those from the previous two years' surveys. Since the prior year, there has been a slight reduction in the average offset for both credit spread (-2%) and univariate capital requirement (-4%).

Figure 5.10: Impact of increase in total credit spread offset by increase in MA.



The offset in credit risk univariate capital requirement broadly correlates in percentage terms to the offset in the increase in total credit spread. As in previous years there was no strong consensus as to the size of either allowance, but there is now a more widespread view that the offset in credit risk univariate capital requirement is generally lower than the offset in total credit spread.

About half of respondents do not change the MA under a longevity stress, while the others allow for recalculation. However this question was not answered by all participants.

5.2. Equity

Solvency II defines equity risk as that arising from the sensitivity of the values of assets, liabilities and financial instruments to changes in the level or in the volatility of market prices of equities.

Changes in approach over the year

Half of the participants noted that they made changes to the equity risk calibration over 2018. Of these, all refreshed the data used within the calibration, with one also making a methodology change. The changes generally resulted in a weaker or broadly neutral calibration.

Results

We asked participants for the calibrated stresses for equity level and volatility risk. The movements in the calibrated stresses over the past six years for equity level stresses and three years for equity one year volatility stresses are shown in Figure 5.11 and Figure 5.12 respectively below, in each case based on all data received in the year in question. The mean has remained relatively stable over the most recent years and there is no evidence of a trend in the range of stresses.

Figure 5.11: 1-in-200 calibrated basis point equity level stresses.

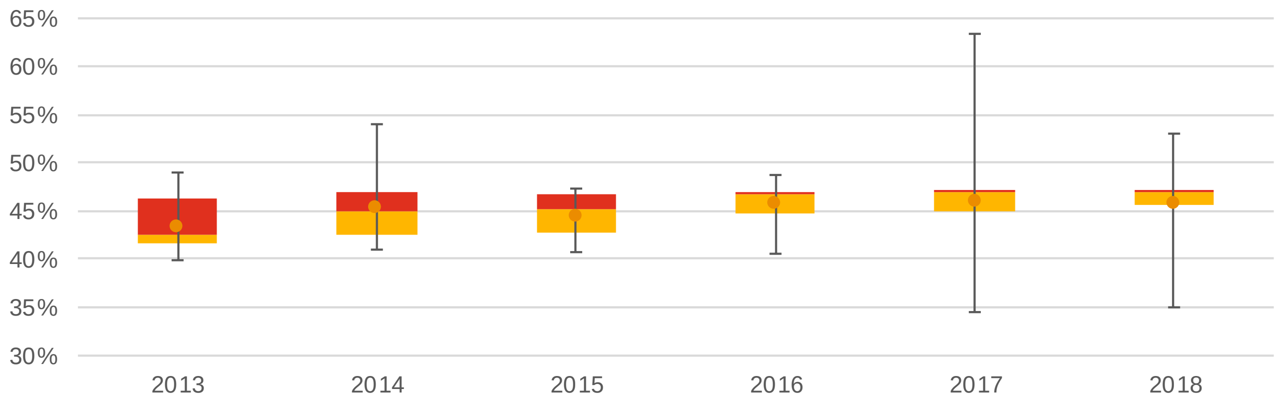
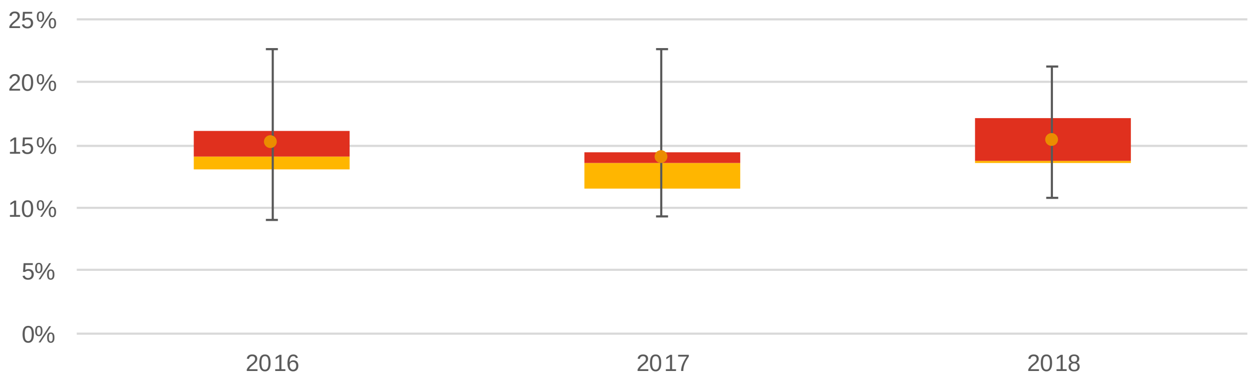


Figure 5.12: Trend in 1 year 1-in-200 calibrated basis point equity volatility stresses



Less than half of participants stated that they apply the same 1-in-200 equity stress calibration across all equity types, while the rest set separate stresses for different equity holdings, typically differentiating by currency and private and non-private equity. However, we did not receive sufficient data to be able to present separate calibrations for any of these subdivisions.

5.3. Interest rate

Solvency II defines interest rate risk as the risk of loss or adverse change in the value of assets and liabilities due to unanticipated changes in interest rates and volatility.

- The magnitude of stresses is generally higher for upward than for downward stresses and tends to decrease for longer terms, but there is little consensus on the variability by term.
- The mean for the 1-in-200 calibrated interest rate up stresses has decreased by approximately 0.20% across all terms. The mean for the 1-in-200 calibrated interest rate down stresses has stayed relatively stable since last year, with changes ranging between -0.04% and 0.07%.

Changes in approach over the year

Around half of participants noted that they made changes to the interest rate risk calibration over 2018. Of these the majority stated that the change was only due to the refreshing of data used within the calibration. The others made changes to both the data and methodology used to set the calibration. There was no consensus on the overall impact that the changes had on the strength of the calibration.

It was more common for the changes to be driven by external rather than internal factors, with some participants stating that both internal and external factors drove the change.

Results

We asked participants for the upward and downward changes in the risk-free zero coupon bond spot yield for varying terms calibrated at the 1-in-200 level. The results are summarised and compared to those obtained in last year's survey in Figure 5.13 and Figure 5.14 below, in each case based on all data received in the year in question.

The downward stresses are smaller in magnitude than the upward stresses for all participants. The mean has decreased for the interest rate up stresses and remained relatively stable for the interest rate down stresses. This year the range of stresses for interest rate up has increased, whereas for interest rate down, apart from the 5 year term, the range of stresses has decreased.

Figure 5.13: 1-in-200 calibrated interest rate up stresses.

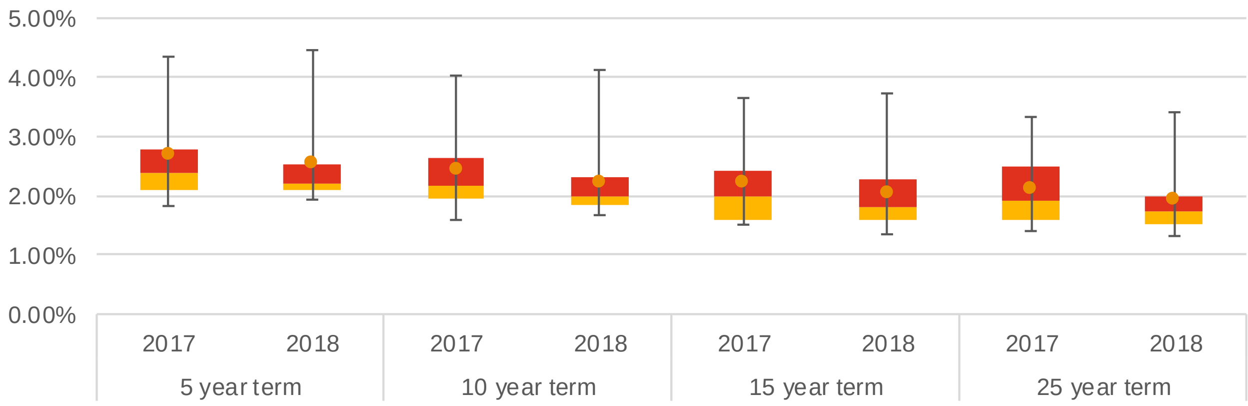
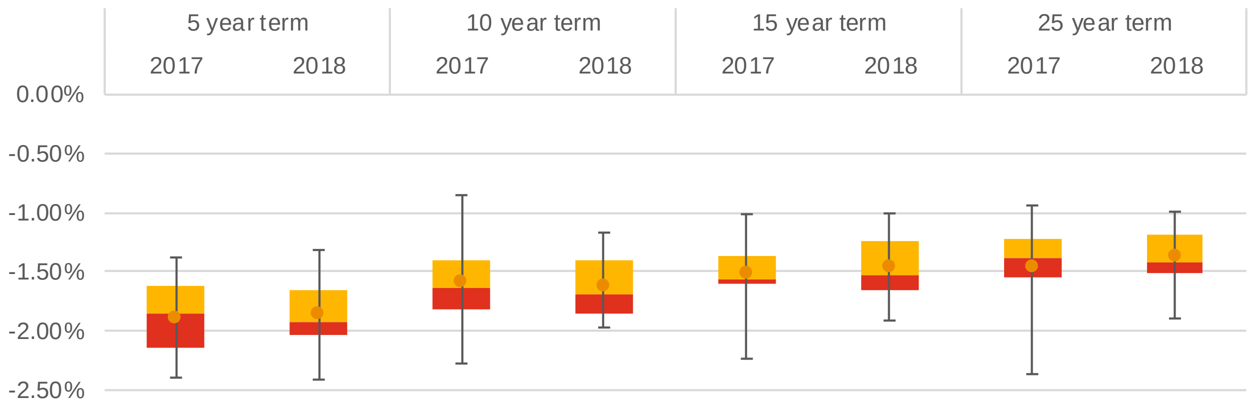


Figure 5.14: 1-in-200 calibrated interest rate down stresses.



The volatility stress ranged between about 15% and about 50% for participants which provided comparable information. Some participants use models for the interest rate volatility which are not directly comparable.

5.4. Currency

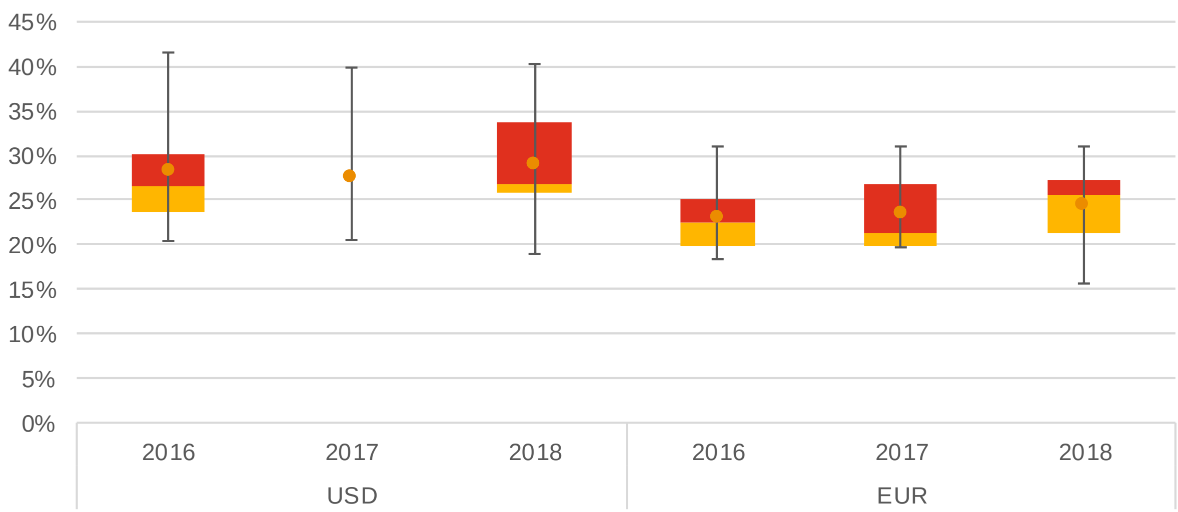
Solvency II defines currency risk as that arising from the sensitivity of the values of assets, liabilities and financial instruments to changes in the level or in the volatility of currency exchange rates.

Results

We asked participants for the calibrated stresses for each currency relative to GBP and received sufficient data to include the results for EUR and USD. Most participants apply different stresses for USD and EUR.

The results are summarised and compared to those from the previous two years' surveys in Figure 5.15 below, in each case based on all data received in the year in question. The range of stresses observed for EUR (16% to 31%) is slightly wider than in last year's survey (20% to 31%), however there is no consistent trend in the calibrated stresses over time. No quartiles are presented for USD last year due to a lack of responses.

Figure 5.15: Calibrated 1-in-200 currency stresses.



5.5. Inflation

Changes in approach over the year

A small proportion of participants noted that they made changes to the inflation risk calibration over 2018. All of them stated that the change was only due to the refreshing of data used within the calibration, which resulted in a broadly neutral impact on the calibration.

Methodology

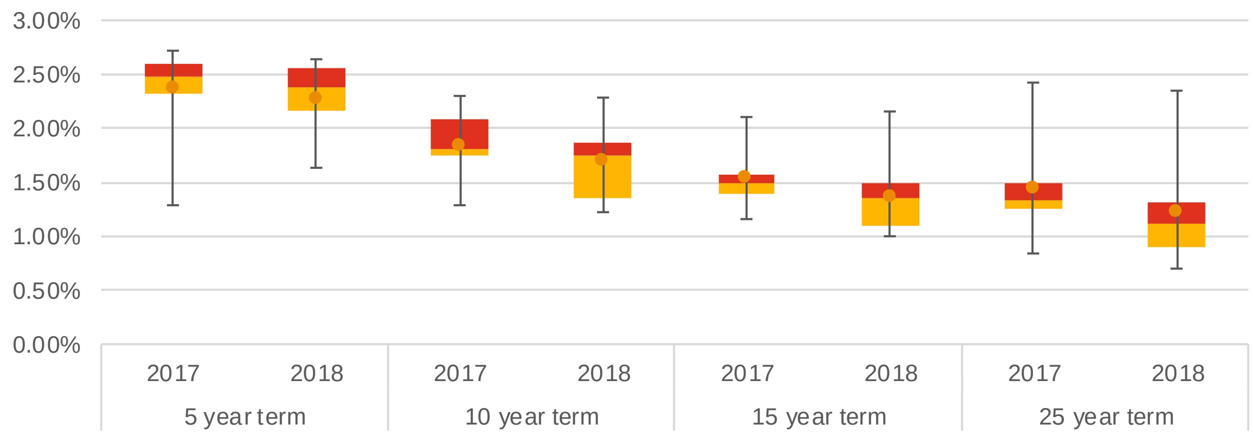
We asked participants whether the market risk inflation calibration was also used for inflation in the liability valuation, e.g. of expenses or index-linked benefits. Just over half make use of the market risk inflation calibration within the liability valuation.

A minority of participants apply separate inflation stresses to linked assets of different currencies.

Results

Figure 5.16 shows the change in the implied inflation spot yield, calibrated at the 1-in-200 level over the past two years, in each case based on all data received in the year in question. Over 2018 there appears to be a reduction for all stresses, although we do not have data from earlier years to confirm whether this is a longer term trend.

Figure 5.16: 1-in-200 calibrated inflation stresses.



5.6. Property

Solvency II defines property risk as the risk of loss or adverse change in the value of assets and liabilities due to unanticipated changes in the level or in the volatility of market prices of real estate.

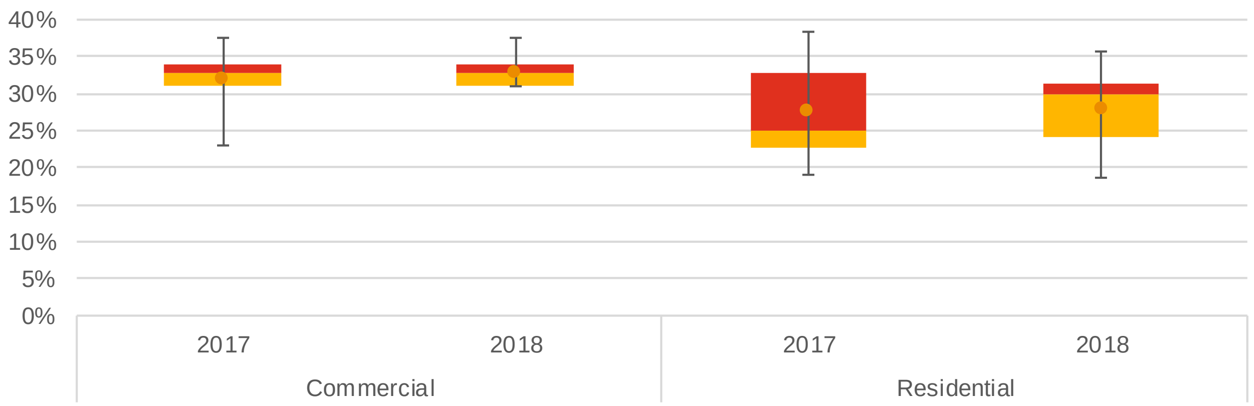
Changes in approach over the year

A small number of participants noted that they made changes to the property risk calibration over 2018. Of these, all stated that the change was only due to the refreshing of data used within the calibration and that the impact on the calibration was broadly neutral.

Results

Around half of the participants apply stresses which differ between commercial and residential property. The movement in the calibrated stresses over the past two years is shown in Figure 5.17 below, in each case based on all data received in the year in question.

Figure 5.17: Calibrated 1-in-200 property level stress for residential and commercial properties.



There was insufficient data to provide the volatility stress calibrations, however the responses we received ranged from 4% to 10% additive stresses for both commercial and residential property at the 1-in-200 level.

6. Life insurance risk

Solvency II states that the life underwriting risk module of the standard formula shall reflect the risk arising from life insurance obligations. Similar considerations would be expected to inform life insurance risk calibrations of an internal model.

In this section, we consider the components of life insurance risk. For each risk, we asked participants for a range of quantitative and qualitative information on their risk calibrations as applied in their Solvency II internal model.

6.1. Longevity

Longevity risk, as defined by Solvency II, is the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level, trend or volatility of mortality rates, where a decrease in the mortality rates leads to an increase in the value of the insurance liabilities. Longevity risk affects contracts where benefits depend on the likelihood of survival, for example annuities, pure endowments and specific types of health contract.

- The average changes in expectation of life from the longevity base and trend stresses are little changed from those observed last year.
- The average overall longevity stress applied by participants at age 65 has increased from 2.99 to 3.00 years for males and 2.87 to 2.90 years for females.
- For the majority of participants, there has been no strengthening of the longevity stress to offset the large reductions in the best estimate expectation of life over the year.

Changes in approach over the year

Over half of participants noted that they made changes to the longevity risk calibration over 2018. Of these, most made changes to both the data and methodology used to determine the calibration. A small number made changes to just one of the data or the methodology. The impact of the changes on the strength of the resulting calibration varied across participants. The majority reported that the changes were made as a result of both internal and external factors.

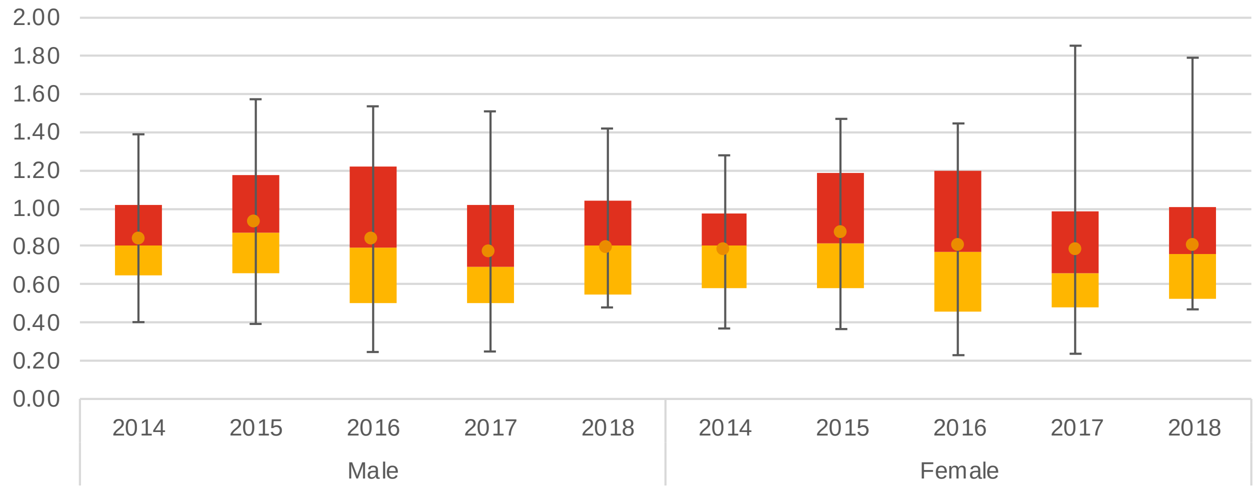
Results

We asked participants for a range of quantitative information on their longevity risk calibration, as applied to immediate annuities, at a 1-in-200 level and combined it with equivalent data from the last four years of this survey to show the movement over time. None of the participants told us that they distinguish the stresses by smoker status and so the results below are all applicable to both smoker and non-smoker annuities.

Base stress

Figure 6.1 shows the impacts in years of the 1-in-200 longevity base stresses for 65-year-old male and female annuitants in this and the previous four years of the survey, in each case based on all data received in the year in question.

Figure 6.1: Change in expectation of life (in years) for 65-year-old non-smoker under a 1-in-200 base longevity stress.



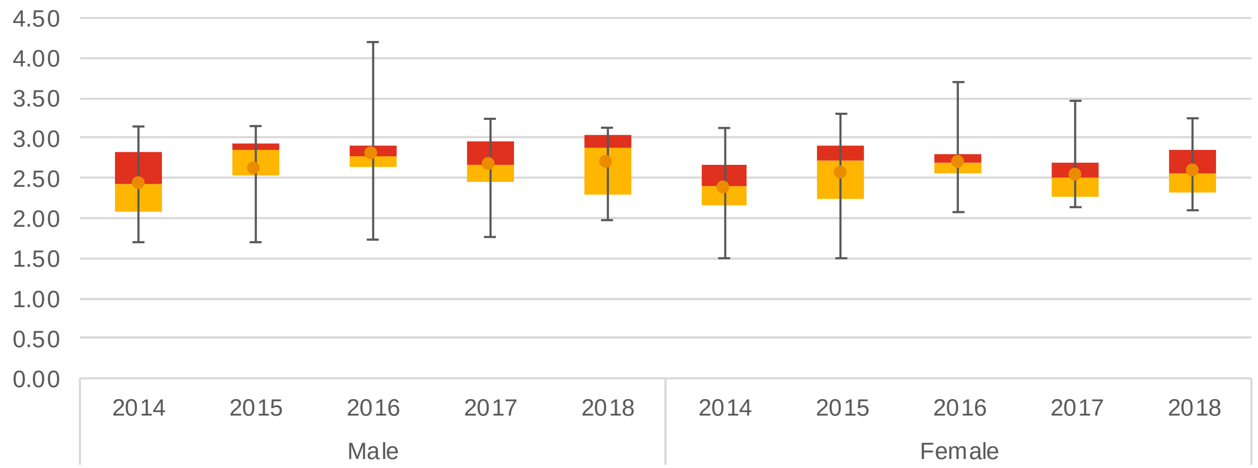
There is no evidence of a long-term trend in the impact of the stress, with only small increases or decreases in the mean observed from year to year.

The average increase in expectation of life is 0.80 years for males and 0.81 years for females. These averages show small increases compared to the average stresses disclosed in last year's survey, where the equivalent figures for males and females were 0.78 and 0.79 years respectively.

Trend stress

Figure 6.2 shows the impacts in years of the 1-in-200 longevity trend stresses for 65-year-old male and female annuitants in this and the previous four years of our survey, in each case based on all data received in the year in question.

Figure 6.2: Change in expectation of life (in years) for 65-year-old non-smoker under a 1-in-200 longevity trend stress.



The average increase in expectation of life from the trend stress is (as in prior years) much higher than that from the base stress, for both males and females. Again, however, there is no obvious trend in the size of the trend stress, and there has been a widening in the interquartile range in the survey this year.

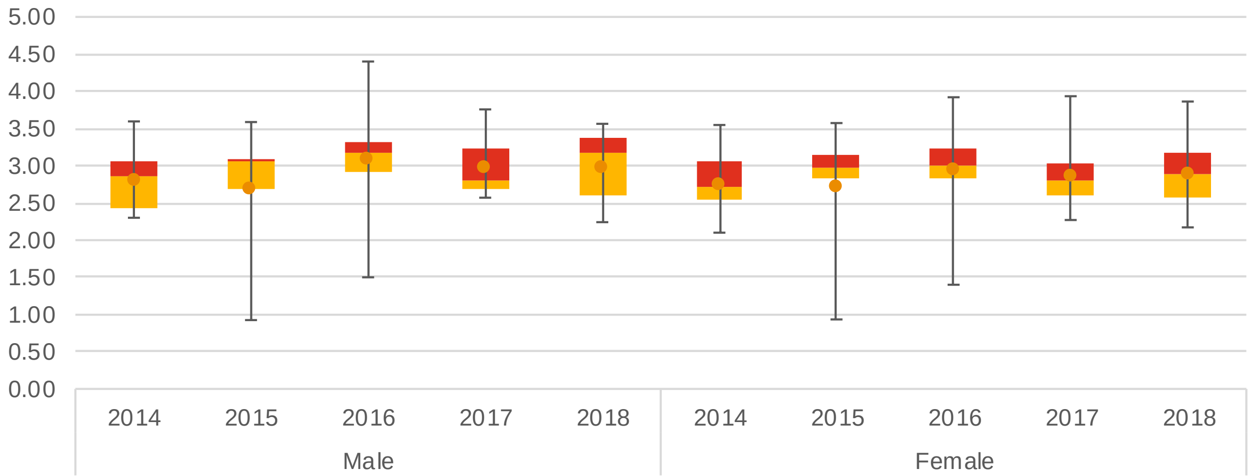
The average increase in expectation of life from a 1-in-200 trend stress is 2.69 years for males and 2.59 years for females. This is a small increase relative to the figures seen last year, which were 2.68 years and 2.55 years respectively.

Overall 1-in-200 longevity stress

For most participants the effect of the overall longevity stress is the same as the impact of the combined 1-in-200 longevity base and trend stresses but, since not all participants use a two-risk-factor modelling approach, we have presented the final overall stress.

Figure 6.3 shows the impacts in years of the overall 1-in-200 longevity stresses for 65-year-old male and female annuitants in this and the previous four years of our survey, in each case based on all data received in the year in question.

Figure 6.3: Change in expectation of life (in years) for 65-year-old non-smoker under an overall 1-in-200 longevity stress.



As the trend stress is the more significant driver, the pattern is similar to that in Figure 6.2, as would be expected.

The average increase in expectation of life from an overall 1-in-200 longevity stress is 3.00 years for 65-year-old males and 2.90 years for 65-year-old females. Averaging across all the participants in each year, these averages show a very small increase this year, with the corresponding figures last year being 2.99 for males and 2.87 for females.

6.2. Persistency

Persistency risk, as defined by Solvency II, is the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level or volatility of the rates of policy lapses, terminations, renewals and surrenders.

- The average persistency level stress selected by participants is 45.2% for non-linked term assurances, 49.7% for unit-linked personal pensions and 48.2% for with-profit endowments. The non-linked term assurances average has increased by a few percentage points relative to last year and the average for unit-linked personal pensions has remained the same. We did not survey with-profit endowments last year.
- The average mass lapse stress selected by participants is 24.4% for non-linked term assurances, 27.9% for individual unit-linked pensions and 26.2% for with-profit endowments. Where comparisons are available, this shows little change from prior year.

Changes in approach since prior year

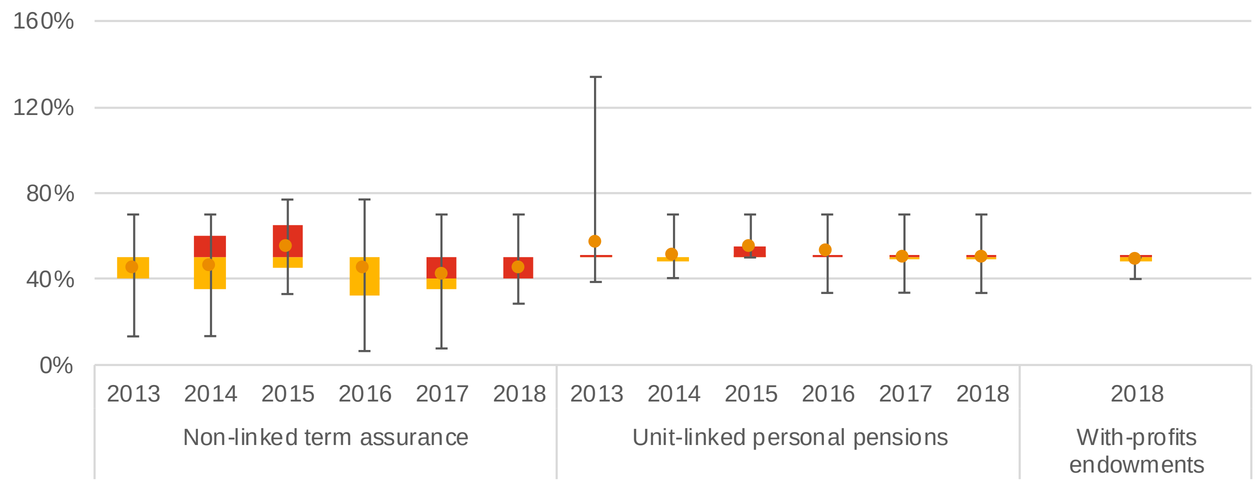
A very small number of participants stated that they made changes to the persistency risk calibration over 2018. Changes were made to just one of the methodology or the data used to determine the calibration. The changes generally resulted in stronger calibrations and were made as a result of both internal and external factors.

Results

Level stresses

Figure 6.4 shows the magnitude of our participants' persistency level stresses for both non-linked term assurance and unit-linked personal pension business, combined with data from the last five years of our survey. It also presents level stress for with-profits endowments this year; we do not have comparable information from earlier years as we previously gathered information on a different with-profits product. The magnitude of participants' persistency level stresses for each product type is expressed as a percentage change to current best estimate lapse rates. The graph is based on all data received for each year in question.

Figure 6.4: Trend in the 1-in-200 level persistency stresses expressed as percentages

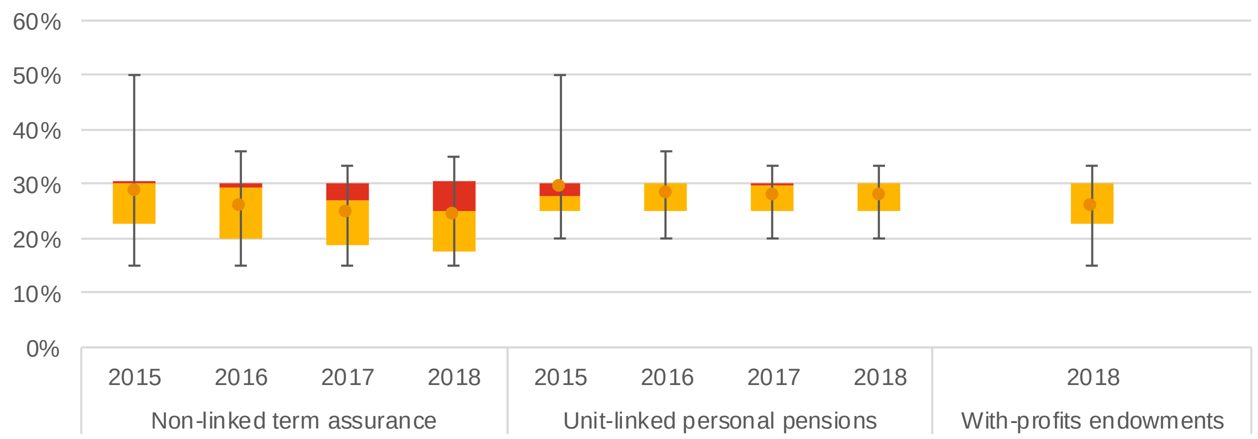


The results show that the average stress selected by participants is 45.2% (2017: 41.3%) for term assurances and 49.7% (2017: 49.7%) for individual unit-linked pensions. The average stress applied to with-profit endowment products is 48.2% (no prior year comparison).

One-off stresses

Figure 6.5 shows the magnitude of our participants' one-off stresses for non-linked term assurance and unit-linked personal pension business, combined with data from the previous three years of our survey. As above, only this year's stress for with-profits endowments is presented, as we do not have comparable information from earlier years. The graph is based on all data received for the year in question.

Figure 6.5: Trend in the 1-in-200 mass lapse stress expressed as a percentage of current in-force business



The results show that the average stress selected by our participants is 24.4% (2017: 24.7%) for non-linked term assurance and 27.9% (2017: 27.8%) for individual unit-linked pensions. The average stress for with-profit endowments is 26.2% (no prior year comparison).

6.3. Expense

Expense risk, as defined by Solvency II, is the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level, trend or volatility of the expenses incurred in servicing insurance or reinsurance contracts.

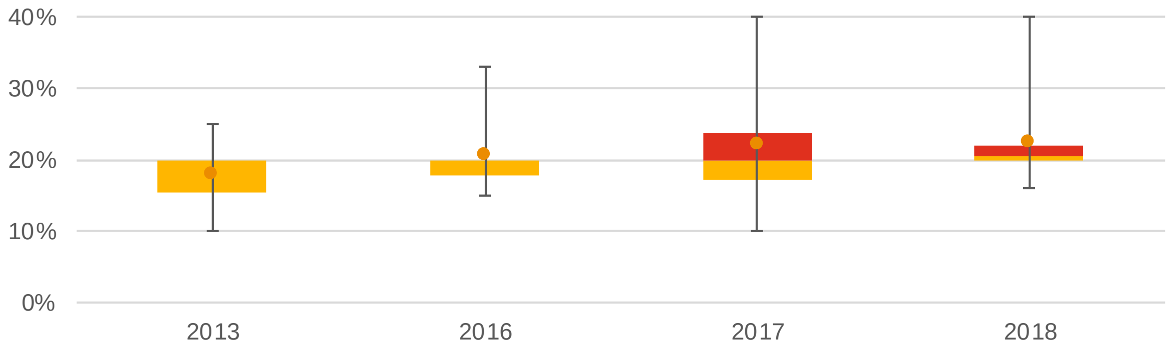
Changes in approach since prior year

Just under half of participants noted that they made changes to the expense risk calibration over 2018. Of these, a small number made changes to the data only, with the majority making only methodology changes. The general impact was a weakening of the calibrations. All participants stated that the changes were driven by internal factors.

Results

Our survey at year-end 2016 included expense risk for the first time since the year-end 2013 calibration. Figure 6.6 therefore shows the effect of the 1-in-200 expense level stress on the best estimate assumption over the past three years as well as at year-end 2013, in each case based on all data received in the year in question. There is little overall change in the mean stress, but some degree of convergence around that mean after a widening last year.

Figure 6.6: Impact of 1-in-200 expense level stress expressed as a percentage of best estimate maintenance expense assumptions.



6.4. Mortality

Mortality risk, as defined by Solvency II, is the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level, trend or volatility of mortality rates, where an increase in the mortality rate leads to an increase in the value of insurance liabilities. It affects predominantly protection contracts, such as term assurance.

Changes in approach since prior year

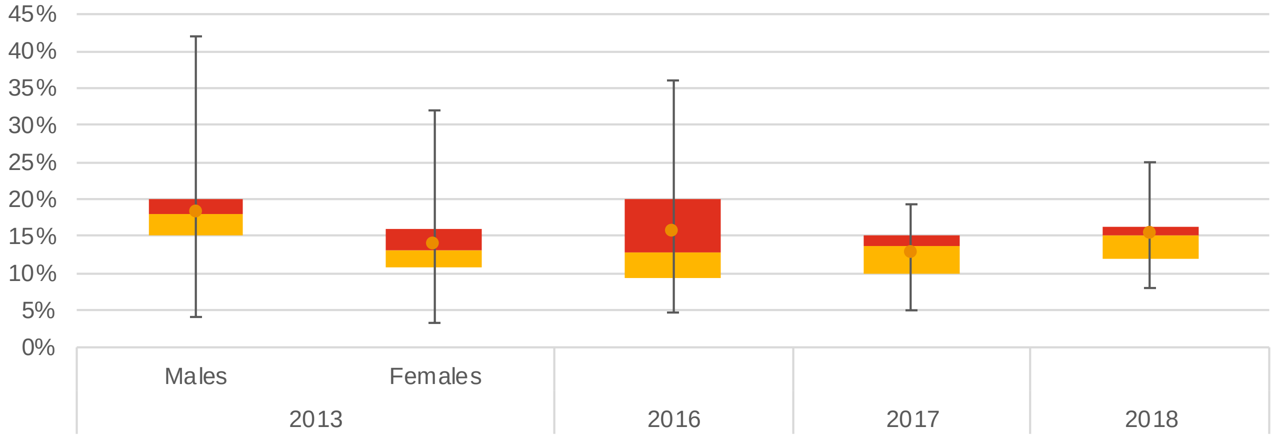
Very few participants stated that they made changes to their mortality risk calibration over 2018.

Results

Our survey at year-end 2016 included mortality risk for the first time since the year-end 2013 calibration and showed that all participants had removed any differentiation between males and females in the calibrated stresses. We also found no differentiation between ages or between smokers and non-smokers.

The base mortality stresses are presented in Figure 6.7, separately for males and females as at year-end 2013 but as a single stress applied to both genders in later years. The range of responses for the mortality base stress has slightly increased from the prior year, due to a change in participants that answered this question. .

Figure 6.7: 1-in-200 mortality one-off stresses (per mille)



6.5. Morbidity

Morbidity risk, as defined by Solvency II, is the risk of loss, or of adverse change in the value of insurance liabilities, resulting from changes in the level, trend or volatility of disability, sickness and morbidity rates. It affects predominantly health contracts such as critical illness insurance and income protection.

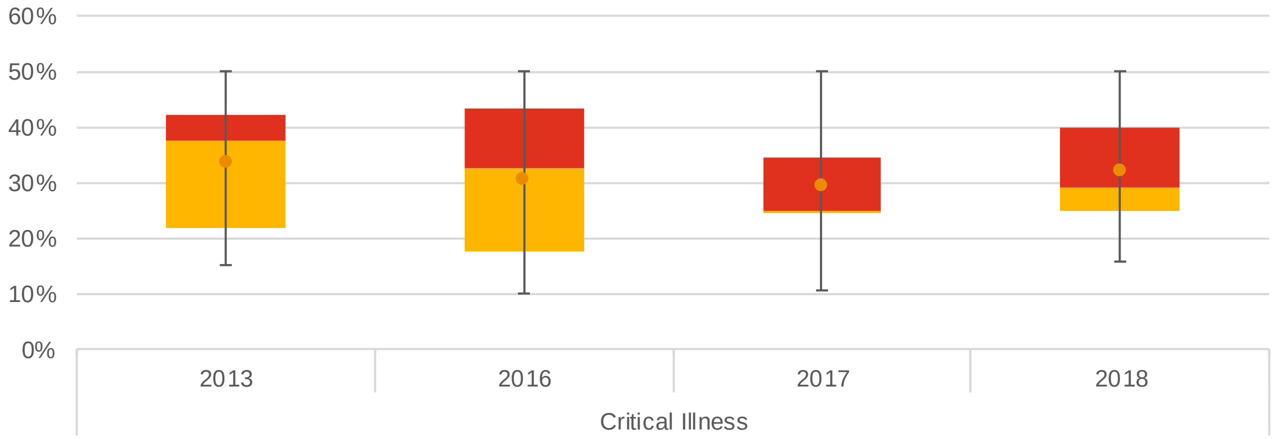
Changes in approach since prior year

As with mortality, very few participants stated that they made changes to their morbidity risk calibration over 2018.

Results

Our survey at year-end 2016 included morbidity risk for the first time since the year-end 2013 calibration. The results for base morbidity stresses for critical illness policies are presented in Figure 6.8, for each of the last three years and for year-end 2013. While the overall range of stresses has narrowed slightly from last year, the interquartile range has widened, although not to the degree observed at year-end 2016.

Figure 6.8: 1-in-200 morbidity base stresses for critical illness.



7. Operational risk

Solvency II defines operational risk as the risk of loss arising from inadequate or failed internal processes, people and systems, or from external events (including legal risk).

- Operational risk, while material for a number of participants, is a smaller component of the SCR than life insurance or market risk for all participants. However, underlying data continues to be less robust than for other risks.
- Across the survey participants, there is a preference for modelling frequency of losses using Poisson distributions and severity of losses using Lognormal distributions.

Changes in approach over the year

Most participants noted that they made changes to the operational risk calibration over 2018. Of these, the majority stated that the change was only due to the refreshing of data used within the calibration. A small number of participants stated that the change was due to a change in the methodology adopted. The impact of the changes on the strength of the calibrations varied in direction across participants.

Participants were evenly split as to whether changes were driven by internal factors or a mixture of both internal and external factors.

Methodology

We asked participants to provide us with information on their high-level approach to incorporating operational risk into the overall SCR. Almost all participants integrate the operational risk capital requirement with other risk modules with an allowance for diversification.

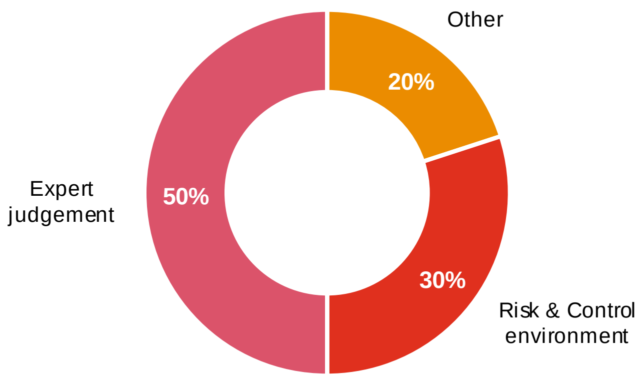
On average, participants hold capital for 12 operational risk categories, however responses ranged from 6 to 18.

Quantification of operational risk for each risk category

Once operational risk is broken down into risk categories, these categories can then be broken down further into risk scenarios. For example, a risk category within operational risk could be process failure and a risk scenario within this category could be the risk of preparing incorrect financial statements. Below we refer to a “scenario-based approach” and a “category-based approach”. Scenario-based refers to calculating capital for a risk category based on one or more dominant scenarios (e.g. cyber attack). Category-based, on the other hand, refers to calculating capital by selecting parameters to represent all risk arising from that risk category in aggregate.

Most participants use a scenario-based approach to calculate their operational risk capital. We asked participants how risk scenarios are selected. The results are shown in Figure 7.1.

Figure 7.1: Scenario selection



Calibration of frequency and severity distributions

All participants which provided information use a form of frequency-severity modelling for each of the operational risk categories, generally using a statistical distribution for each component. The choice of distribution is shown in Figure 7.2 for frequency and Figure 7.3 for severity of loss.

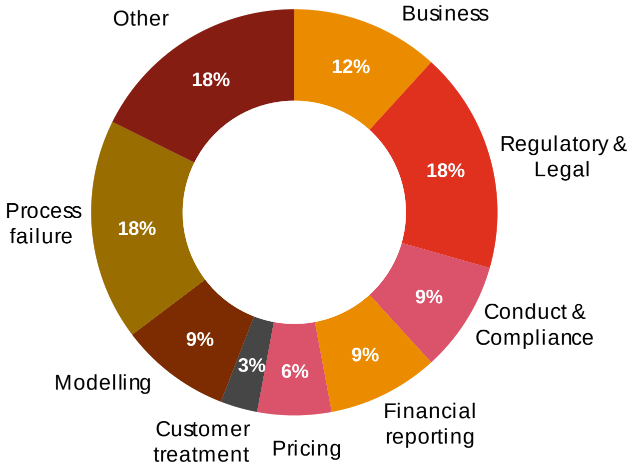
Figure 7.2: Models fitted for frequency of loss calibrations.

Figure 7.3: Models fitted for severity of loss calibrations.

Largest risk categories

We asked each participant to state their top three risk categories. The results varied but have been categorised into broad risk groups in Figure 7.4.

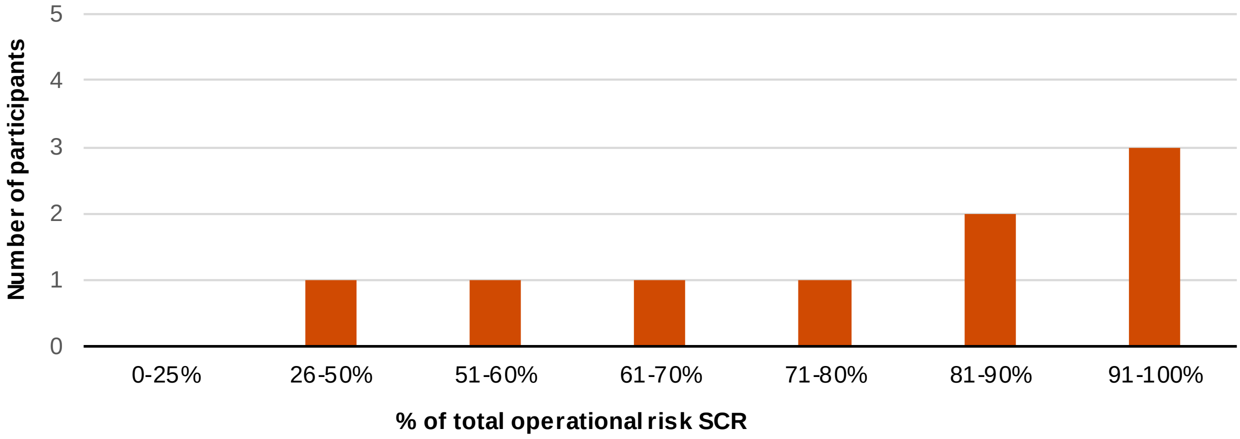
Figure 7.4: Top three risk categories



The most common top operational risk categories were process failure risks, regulatory and legal risks and "other" risks. Process failure covers a broad range of actuarial processes, such as reinsurance and finance processes. Other types of risks noted by participants were problems with technology, breaches of terms and conditions and financial crime.

We then asked participants how much of their total operational risk capital requirement arises from their top three risk categories. The results are shown in Figure 7.5.

Figure 7.5: Proportion of operational risk capital requirement arising from the top three risk categories.



8. Risk aggregation

This section considers the approaches participants use in aggregating their individual risks to determine the total SCR, including the resulting diversification benefit.

- The majority of participants combine individual risk drivers in a single step, without first calculating a capital requirement for specific risk modules, such as market or life insurance risk.
- The range of diversification benefits produced is slightly wider than last year – just below 30% to 70% compared to about 35% to 65% last year.
- Dependency assumptions are broadly in line with those observed in last year's survey.

8.1. Changes in approach over the year

Around half of the participants noted that they made changes to the aggregation over 2018. There was a relatively even split between participants that updated one of data or methodology, or both at the same time. There was no consistent view as to the impact of these changes on the resulting diversification benefits. It was slightly more common for participants to state that internal drivers caused the change in the calibration, but a number also cited external factors.

8.2. Risk aggregation approach

We asked participants about their approach to the aggregation of the SCR and whether risks were first aggregated into modules or whether all individual risks are combined in a single step. Consistent with the prior year survey, the most common approach is to aggregate all risks within a single step and not to calculate specific risk modules, such as life insurance risk or market risk.

Dependency between risks

We asked participants to provide their correlations between certain pairs of risks. We have applied the following definitions for the various levels of dependency.

- High: 100% – 67%
- Medium: 66% – 34%
- Low: 33% – 1%
- Nil: 0%

While most participants do not calculate risk modules separately, we have separated the rest of this chapter into sections covering:

- Dependencies between market risks;
- Dependencies between life insurance risks;
- Cross-dependencies between market and life insurance risks.

Within each section, we report on the resulting dependency assumptions.

8.3. Market risks

The availability of data means that the setting of dependency assumptions is less subjective for correlations in normal times, but it becomes far more subjective in stressed conditions and is a key area requiring the application of expert judgement.

As observed in previous surveys, all participants for which it is relevant assume a medium or high correlation between credit spread and equity risks. The assumptions are broadly consistent with the Standard Formula's prescribed high correlation (75%).

Dependency assumptions between other pairs of market risks are summarised below:

- Between **interest rate level** and **interest rate volatility** risk, correlations range from zero to high, with the majority adopting either a zero or low correlation.
- Between **credit spreads** and **interest rate level,** dependencies range from zero to medium, with most participants using a low correlation.
- Between **equity** and **interest rate level,** dependencies range from zero to medium, with most participants using a low correlation.
- Dependencies between **property** and other market risks are typically medium (with **credit spreads** and with **equity**) or low (with **interest rate level**).

We note that there is more variation in assumed dependencies between market risks than in those between life insurance risks, which is a pattern we have seen in previous years' surveys.

8.4. Life insurance risks

The setting of dependency assumptions between life insurance risks is highly subjective and is a key area requiring the application of expert judgement.

Dependency assumptions between pairs of life insurance risks are summarised below:

- The majority of participants continue to assume zero dependency between **longevity trend** and **persistency level** risks, with the remainder assuming a low dependency.
- Participants mostly assume a low correlation between **longevity trend** and **longevity base risk**, with the remainder assuming a zero correlation.
- In line with last year, the majority of participants assume independence between **mortality** and **persistency**.
- Most participants assume independence of **expenses** and both **longevity** and **mortality** risk, with a small number assuming a low correlation.
- For **expenses** and **persistency**, there is a spread from zero to medium..
- Participants assume a wider range of correlations between **mortality** and **longevity** risks, although the highest proportion opt for a low correlation..

8.5. Aggregation between life insurance and market risks

As observed in previous years, all participants assume either low or zero dependency between **longevity** and **credit** risks and most participants assume low correlation between **persistency** and **credit** risks.