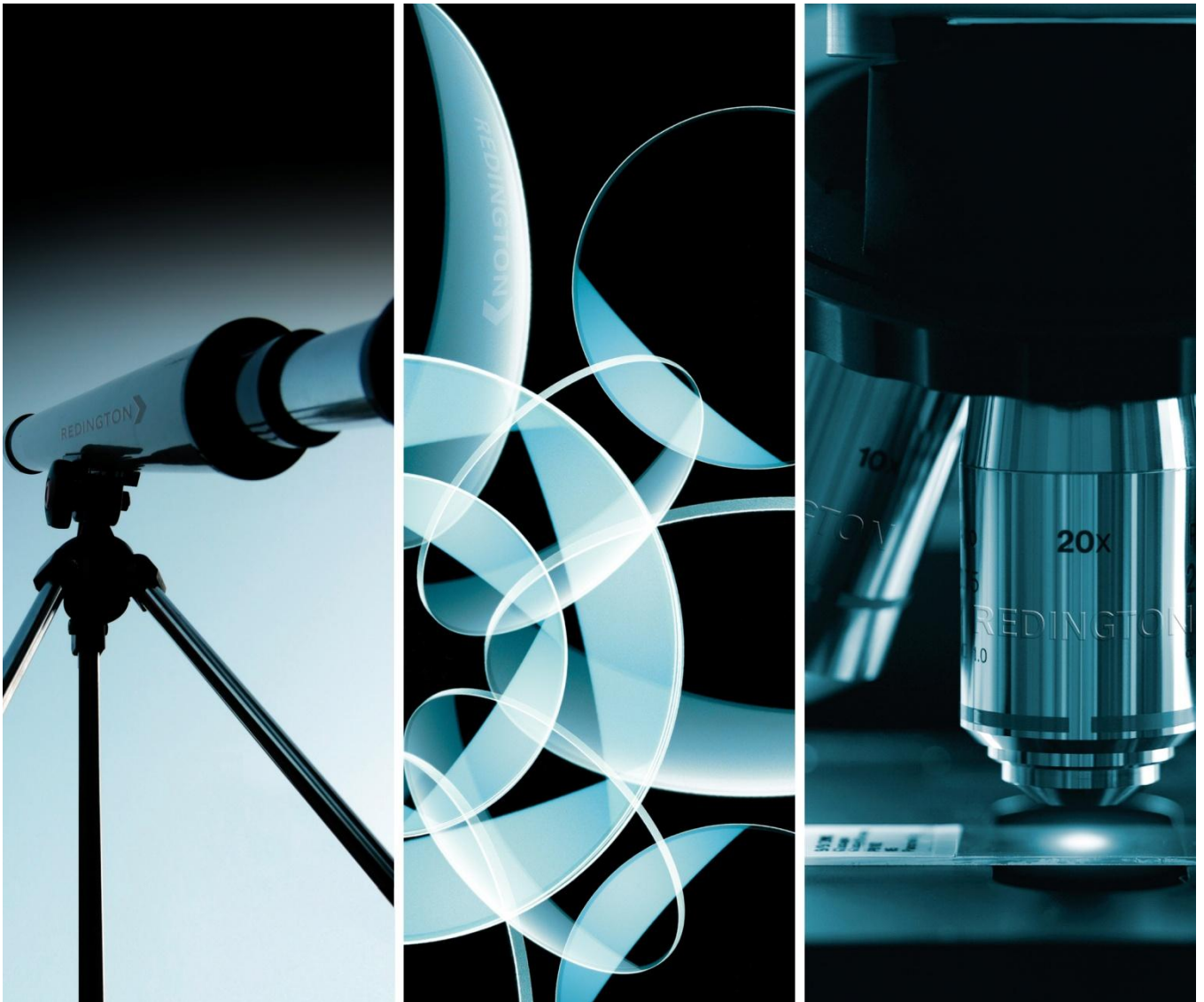


To the Board of the Pension Protection Fund

The introduction of investment risk as a risk factor in the formula of the Risk-Based Levy



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1 Introduction

1.1 In November 2008, the Pension Protection Fund (“PPF”) published [The Consultation on the Future Development of the Pension Protection Levy](#). Chapter 5 of that consultation presented five possible options for collecting the data required to calculate an investment risk factor. As a result of the industry’s response to that consultation, an update was published in July 2009. Some key considerations arising from the five options presented and can broadly be categorised into:

- the ability of the investment risk factor to recognise the range of investment strategies used by all schemes.
- the fairness of an option or threshold approach that could result in more than one reporting process.
- the appropriateness of using stress tests as a method for measuring investment risk.

1.2 A Steering Group and supporting Technical Reference Group were formed to take a fresh look at the issues that were raised.

1.3 In March 2010, the PPF published a summary of the issues and ideas arising from the Steering Group’s work that could form the basis of the next round of consultation. Some of the key principles set out in that document were:

- To take a “longer”-term view – i.e. it should be possible to estimate a scheme’s levy for a number of years.
- A “bottom-up” approach to setting the levy, but looking through the economic cycle to ensure stability, in particular the use of smoothed asset and s179 liabilities and fewer insolvency probabilities
- Preference for a single stress test on all schemes, although consideration also for a supplemental option for more sophisticated stress tests where this better reflects the true scheme risks.

1.4 That publication also stated that the PPF had retained consultants to work with it on the options for developing the levy, including in particular calculating the levy parameters that might be used.

1.5 This report contains Redington Limited’s advice to the Board of the Pension Protection Fund on the introduction of investment risk as a risk factor in the formula of the Risk-Based Levy. The two other areas in which consultancy was commissioned were:

- assessing the “fairness” of any new Risk-Based Levy formula. This is being carried out by David McCarthy and Anthony Neuberger; and
- assessing how a pension plan’s governance structure could be reflected in its levy. This work is being led by Rachel Brougham of Mercer.

- 1.6 In Section 2, we state the scope of Redington's advice contained in this report.
- 1.7 Section 3 is a review of existing research and practice from other regulatory regimes in the pension and insurance sectors across a number of countries.
- 1.8 In Section 4, we analyse the volatility of a pension scheme's section 179 ("s179") funding ratio – a key parameter used in the model built by David McCarthy and Anthony Neuberger.
- 1.9 Section 5 sets out Redington's view on how the overall volatility of a pension scheme's section 179 funding ratio can be decomposed into individual risk factor stresses that can then be applied to a scheme's liabilities and assets. We further construct and compare a number of alternative ways of applying these stress tests, varying mainly in complexity. We also set out how the stresses would be defined and the instructions needed for calculation.
- 1.10 Section 6 details the estimated impact of allowing for investment risk in the Risk-Based Levy.
- 1.11 Section 7 considers the implementation of the stress test and in particular the additional data capture and costs that might be borne by the PPF and pension schemes.
- 1.12 In Section 8, we present a recommendation on how investment risk might be reflected as a risk factor in the risk-based levy and comment on how this links to the considerations from the previous consultation and Steering Committee feedback.

2 Scope

2.1 Redington has been asked to:

- Review other regulatory regimes and the extent to which stress tests are used.
- Design and calibrate a single stress test to be applied to all pension plans, as well as a more sophisticated supplemental option for stress tests. The per plan cost of carrying out these stress tests should also be estimated.
- Carry out an analysis of the impact of the proposed stress tests, including how it affects the distribution of the risk-based levy.
- Review with the PPF the implementation issues that may be raised by the proposed stress tests.
- Support the PPF in drafting guidance and the consultation documents, as well as reviewing the related responses.

2.2 Whilst the nature of the work carried out by the three consulting workstreams is distinct, the interdependency has become apparent through the course of our work, particularly with the “fairness” work. Although that work is reported on separately, one of its input parameters is the volatility of pension scheme’s s179 funding ratios. Redington were asked to provide s179 funding ratio volatilities for 500 sample schemes and this element of work is included in this report.

2.3 Initial results from our work were presented to the Technical Reference Group in early April which resulted in some follow-up analysis.

2.4 We would like to thank the PPF, David McCarthy, Anthony Neuberger, the Technical Reference Group for their help and input into our work. We would also like to thank RiskMetrics Group, whose risk model supports part of our work.

2.5 Our analysis has been carried out using an anonymised data set from the PPF’s own database at 31 March 2009, reflecting 5,728 schemes’ returns. All analysis was carried out prior to the 12 August 2010 Department for Work and Pensions consultation on changing compensation indexation from RPI to CPI in the Pension Protection Fund from 31 March 2011.

3 Review of other regimes

3.1 In this section, we compare and contrast various common approaches to risk analysis that are applied in financial institutions and how they have been applied in example regulatory regimes.

Approaches to risk management

3.2 There are a wide range of approaches to risk management. Common approaches include:

- Value at Risk (VaR)¹ – typically used for assessment of risk in trading books within banks and also for various risk-based capital regimes
- “PV01” or “Delta ladders”² – used to assess exposure in bank trading books to various risks including interest rates and inflation
- Stress and scenario tests – currently often used either where more sophisticated techniques are not suitable or to supplement other techniques

3.3 In recent years, VaR has come to be the primary measure of risk for a wide variety of purposes including. For example:

- In the reporting of risk management of bank trading books in the Notes to Financial Statements (e.g. using RiskMetrics developed by JP Morgan)
- Insurance risk-based capital (UK, Switzerland, Sweden and Solvency II in the EU)
- The Dutch FTK³ regime for pension funds, and
- Pension fund risk-budgeting

3.4 However VaR has been the subject of considerable criticism, particularly the reliance on it leading up to the credit crisis. These criticisms can be broadly summarised as:

- VaR does not adequately allow **extreme tail events** (so-called “black swans” by Nassim Nicholas Taleb⁴) that appear to occur more frequently, or with more extreme impact than suggested by the models

¹ Value at Risk is defined as a threshold value such that the probability that the loss on a portfolio of financial assets over a given time horizon exceeds this value is a given probability. Typical time periods include 1-day or 1-year. Typical probabilities include 5% or 0.5%.

² PV01 is the impact that a 1 basis point move in rates has on the present value of a portfolio. Delta ladders are typically used to represent this impact in different portions of the portfolio.

³ The Financieel Toetsingskader (FTK) financial framework requires funds to meet minimum solvency tests and to put in place recovery plans if they fail these tests. It is covered in more detail later in this section.

⁴ As presented in his book, *The Black Swan: The Impact of the Highly Improbable*

- A more general version of the above argument is that the **statistical distributions** underlying the models do not adequately reflect reality.
- The calculations and assumptions are often viewed as coming from a calculation “black box” and **lack sufficient transparency or rigour**, particularly the assumption of stable volatilities and correlations as well as decisions of type of VaR and time series
- Use of VaR for **longer-term projections** is problematic, for example in long-term risk budgeting, as it requires either significant computational complexity or some extremely simplifying assumptions (e.g. for assessing credit default risk)
- There are **difficulties in simplifying the calculations** so they can be applied simply to a wide range of users, particularly the less sophisticated.

3.5 These problems have been recognised and reflected by many users in their assessment of risk. Often VaR is supplemented by stress and scenario tests e.g. the Swiss Solvency Test (SST) and recent Bank capital assessments in both the UK and US.

3.6 Even when VaR is used it is frequently calculated as a set of stress tests that are combined via a correlation matrix that is often not derived from market data

Regulatory regimes – Insurance

3.7 Risk-based capital regimes have been in place for a number of years in various jurisdictions including US, Canada, Australia and Finland (which is believed to have the earliest example dating from 1953). All of these regimes are based on various forms of stress and scenario testing as the more sophisticated risk measurement techniques, particularly Value at Risk were either not available or required too much processing power at the time.

The UK

3.8 Since 2004, the regulation by the FSA of the UK insurance industry has been based on an Individual Capital Assessment (ICA) (as part of regulations generally referred to as PS04/16⁵) which is a risk-based capital regime based on VaR measures calibrated to a 99.5%⁶ confidence interval.

3.9 However, prior to 2004 the assessment of risk and the corresponding prudence in reserves (as opposed to capital), was in part assessed using combinations of stresses under the Resilience Test regime. These Resilience Tests were not generally market consistent as they were used in conjunction with discount rates for reserving purposes set based on the ‘reliable’ yields expected to be earned on assets.

⁵ PS04/16 refers to [Policy Statement 04/16](#) published by the FSA in 2004 and titled *Integrated Prudential sourcebook for insurers*

⁶ Equivalent to a 0.5% probability under the earlier definition of Value at Risk.

- 3.10 In the later years of their use, the Resilience Tests were also modified to allow for some level of smoothing of assets by adjusting the equity stresses for falls that had occurred between previous peaks in the market and the valuation date.
- 3.11 Even under PS04/16 for some smaller offices the calculation of an ICA is undertaken by applying stress tests to the key variables and then combining them via a correlation matrix into a diversified VaR.
- 3.12 Furthermore, financial reporting under various Embedded Value methodologies has involved disclosure of sensitivities to key risks via the results of stress tests.

Outside the UK

- 3.13 Various other European countries have considered forms of risk-based capital approaches with VaR-based approaches in Switzerland and the Netherlands. Whilst Switzerland has adopted this approach in the SST, it was ultimately not adopted for insurers in the Netherlands, although it has been adopted for pension funds.
- 3.14 Also the EU is developing the Solvency II regime for implementation in 2012 which has similarities to both the UK and Swiss regimes. In particular it allows for the use of a simplified Standard Model based on stress tests and combining them via a correlation matrix with preset calibration for the parameters. The alternative of using a company's own Internal Model to assess capital requirements is subject to a detailed and quite onerous review and approval process by the relevant local regulator

Regulatory regimes – Pensions

- 3.15 Perhaps the most comparable entity to the PPF is the Pension Benefit Guaranty Corporation (the PBGC) in the United States, where sponsors are charged premiums to fund the pension benefits due from insolvent businesses. As in the UK, the US government has stated that it is not a guarantor of the PBGC. The PBGC charges a flat premium (comparable to the PPF's scheme-based levy) and variable premium; however whilst the PBGC's variable premium does reflect the level of underfunding in a plan, it does not reflect the creditworthiness of the sponsoring employer and does not take into account the level of risk within a plan's investment strategy.
- 3.16 Generally pension schemes and their regulators have been slower to use more sophisticated risk measurement than insurers although the development of Liability Driven Investment (LDI) approaches has seen VaR and other tools such as delta ladders introduced as means of highlighting the risks and demonstrating the effectiveness of various strategies. To the extent that the provision of pensions is through insurance contracts in some jurisdictions, notably Scandinavia, it could be argued that some pension schemes are subject to quite extensive risk measurement requirements.

3.17 However, the one major exception to this is the FTK regime in the Netherlands (described below) where a more sophisticated approach is taken. It is also worth noting that recent developments in financial reporting have also seen additional disclosures of the results of stress tests on some of the assumptions used in the reported value of obligations on sponsors to their pension schemes.

The Netherlands

3.18 The FTK regime is supervised by De Nederlandsche Bank (DNB). In concept it is similar to Solvency II, incorporating both quantitative and qualitative elements in assessing pension scheme funding. On the quantitative side, the two key elements are a short-term solvency test and a long-term continuity analysis. The former is much like a stress test on the solvency position, although it is derived from the concept of a capital buffer.

3.19 The solvency test requires that funds must have sufficient capital to ensure there is a 97.5% probability that the funding ratio does not fall below 100% over a one-year time horizon. This test can be applied by one of three methods:

- a standardised model, where stresses to key risk factors are prescribed by DNB. The risk factors used are interest, equity (with distinction made between developed markets, emerging markets and private equity), real estate, currency, commodities, credit and underwriting risks.
- an internal model. This requires approval by DNB, but allows funds to incorporate the possibility of management actions to limit risk, e.g. stop-loss coverage. A complete model is expected to utilise stochastic processes and is expected to cover control and governance procedures.
- a simplified test, applying to a small number of schemes with high funding levels and low investment risk, requires the funding ratio to remain in excess of 130%.

Conclusion

3.20 Overall for the more sophisticated financial institutions it is clear that VaR plays an important role in both risk and capital requirements. Very often this is supplemented by additional stress and scenario tests to overcome some of VaR's shortcomings.

3.21 Whilst VaR might therefore be an approach to be considered by the PPF, it is complex and costly to implement. The requirement for extensive additional data capture and calculation by either the PPF or individual pension schemes (which would require certification) may render this approach inappropriate for the mass PPF audience and preference would therefore be focussed on stress tests.

3.22 Stress tests might also help the PPF meet its aim for "fairness" as it can be demonstrably applied consistently across schemes. In addition, feedback on the use of the PPF's Long Term Risk Model has already provided the industry's views on such parameter/model-based approaches.

- 3.23 Some pension schemes may already have the required level of governance in place to carry out more sophisticated analysis of their pension risks. The PPF may wish to consider giving schemes the option of more detailed stress tests, along the lines of the “standard vs internal” model approaches of the SST, FTK and Solvency II.
- 3.24 Having said this, it is also important to distinguish between a risk-based supervisory regime (e.g. the FSA requirements or the FTK in the Netherlands) and risk assessment for the purposes of a levy (e.g. the PPF), particularly where the latter is outside of any risk-based regulatory framework. This is particularly important because a lot of the motivation behind the supervisory boards’ use of standardised models is to encourage firms/schemes to develop more bespoke risk management tools in-house. For the PPF, it may be overly onerous to expect schemes to develop sophisticated risk frameworks for only one part of the current regulatory regime. Should the UK pensions regulatory regime move to a risk-based supervisory regime, then this should be reconsidered.

4 Analysis of section 179 funding ratio volatility

4.1 The McCarthy-Neuberger report on arriving at a “fair” levy is being published alongside this report as part of the PPF’s consultation. A key input parameter into the McCarthy-Neuberger model is the volatility of a pension scheme’s funding ratio on a s179 valuation basis. We were therefore asked to calculate and provide the volatilities for 500 sample schemes – these are set out in [Appendix A](#).

4.2 To ensure that this was a valid metric to use, we analysed:

- whether the s179 funding ratio is normally distributed
- the sensitivity of the s179 funding ratio volatility

4.3 This section sets out how the volatilities were calculated and the analysis carried out.

Methodology for calculating volatilities

4.4 The risk of each pension scheme is modelled using a Monte Carlo simulation approach.

4.5 We first define the portfolio of pension scheme assets and s179 liabilities as a function of the underlying risk factors. Whilst the risk factors to which a pension scheme is exposed will vary from scheme to scheme, there is a lot of commonality, for example equity price, equity index level, interest rates at different tenor points, inflation at different tenor points or credit spreads.

4.6 The limited number of asset classes recorded by Exchange and the fact that s179 liabilities are calculated on spot yields rather than a term structure means that the risk factors that can be used for this particular project are a simplified version of a full model.

4.7 Each risk factor is then simulated according to a statistical distribution, with defined volatilities and correlations between each of the risk factors. These parameters are derived from historical market data. For our base case, we have taken daily historical market data for the period 1 January 2006 to 31 March 2009.

4.8 For assets, there is insufficient data collected via Exchange to identify each scheme’s underlying asset benchmarks. Therefore, we have assigned benchmarks based on our experience of UK pension schemes as set out in Table 1.

4.9 For s179 liabilities, Exchange captures the breakdown by member type, pre/post April 1997 and also average ages from which it is possible to estimate the liability duration⁷. In aggregate, half of the s179 liabilities were in respect of accrual on or after 6 April 1997. We have carried out our base case volatility analysis assuming all schemes have this aggregate split.

⁷ The PPF has previously indicated how this estimation can be done in its [Transformation Appendix](#) to its determination under Section 175(5) of the Pensions Act 2004.

Table 1: Asset benchmarks

Asset type ⁸	Benchmark
UK equity	FTSE 100 Total Return Index
Overseas equity	MSCI World Index
Property	FTSE All Property Index Total Return
Hedge funds ⁹	HFRX Global Hedge Fund Index
Corporate bonds	Merrill Lynch Sterling Non-Gilts Index
Nominal Gilts	FTSE Actuaries UK Gilts Index over 15 years
Index-linked gilts	FTSE Actuaries UK Index-Linked Gilts Index over 5 years

4.10 The risk factors used in our model for this work, together with the assumed statistical distributions and volatilities are summarised in the following table. Although our model does use the full term structure of nominal and real yields, we have shown the 30-year rates as a sample.

Table 2: Risk factor statistical distributions and volatilities

Risk factor	Statistical distribution	Volatility ¹⁰
Credit spread	Lognormal	1.42%
Property	Lognormal	8.38%
Hedge funds	Lognormal	10.75%
UK equity	Lognormal	25.68%
Overseas equity	Lognormal	21.87%
30-year gilt rate	Normal	0.78%
30-year gilt break-even ¹¹ inflation	Normal	0.71%

4.11 The simulations are run 10,000 times, with each simulation providing an asset value, a s179 liability valuation and hence funding ratio. We calculate the absolute difference between each simulated funding ratio and the current funding ratio, with volatility being the standard deviation of these differences.

4.12 We have assessed the potential inclusion of longevity risk as part of this project in [Appendix B](#). Our conclusion is that due to the significant proportion of pension scheme investments that are currently held in return-seeking assets, together with the current lack of data on which to calibrate a market-consistent model, on balance we do not believe that longevity risk should be included. We recommend that the PPF keep this under regular review to monitor any trend of investment away from return-seeking assets and also any emergence of a traded market in longevity risk.

⁸ As recorded on Exchange. Cash is assumed to be risk-free. Where indicated, contingent assets have been assigned to the appropriate asset class, otherwise they are treated as cash. Insurance policies have been treated as cash due to the wide-ranging types of insurance policies.

⁹ For modelling purposes, we have combined “commodities” and “hedge funds” under the same risk factor due to the very wide range of possible strategies these descriptions can cover.

¹⁰ Based on data from 1 January 2006 to 31 March 2009.

¹¹ Gilt break-even inflation is the difference between nominal and real gilt yields.

S179 funding ratio volatilities

- 4.13 The table below shows how the s179 funding ratio volatility varies with liability duration and the proportion of the scheme's investment in matching assets. It assumes all schemes are 80% funded (this is the aggregate funding level across all schemes at 31 March 2009). A full distribution of the volatility across the 5,728 sample schemes is in the second half of [Appendix A](#).

Table 3: Sample output s179 funding ratio volatilities

S179 Funding Ratio Volatility					
	Liability duration (years)				
Bond Allocation	10	15	20	25	30
10%	17%	18%	20%	22%	24%
20%	14%	16%	18%	20%	22%
30%	12%	14%	16%	18%	20%
40%	10%	12%	14%	16%	18%
50%	8%	10%	12%	14%	17%
60%	6%	8%	10%	12%	15%
70%	4%	6%	8%	11%	13%

- 4.14 The table shows that the schemes with the high volatilities are those with a high duration and/or a low bond allocation. Schemes with low volatilities are those with high bond holdings. Chart A4 (in Appendix A) shows that there is a trend for schemes with greater matching assets to have lower volatilities, although where the allocation is entirely to matching assets, the lowest volatilities are still around the high single digits.

Testing for normality

- 4.15 Although the model assumes that each risk factor follows either a normal or a lognormal distribution, the aggregated distribution of the funding ratio is not necessarily normal or lognormal. It is important to test how close the funding ratio is to being normally distributed to ensure it is a suitable measure for down-side risk.
- 4.16 To do this, we tested six sample schemes for "goodness of fit" to a normal distribution using the Kolmogorov-Smirnov Test. The six schemes were selected to represent a range of asset allocations, particularly in terms of equity exposure and duration, with a selection being assessed with and without duration hedging.
- 4.17 Full results are included in [Appendix C](#). We found that only schemes with a high equity allocation and little/no hedging of duration risk passed the normality test. Whilst there is insufficient data held by the PPF to indicate the level of hedging in individual schemes, the data does show that a significant proportion of the assets in the universe of schemes is held in equity and so would be more likely to pass the normality test.
- 4.18 For schemes with significant matching asset portfolios or a significant amount of interest rate or inflation hedging, the funding ratio volatility is less likely to follow a normal distribution and

hence this measure would tend to overstate the risk, although the level of risk is still significantly lower than unhedged/unmatched portfolios. This impact is shown in [Appendix C](#), but it is a bias of the fairness model that the PPF should consider.

4.19 We recommend that the PPF keeps under review the use of s179 funding ratio volatility as a driver of its fairness assessment, particularly should the trend of pension scheme investment be towards higher bond allocations and should increasing maturity of pension schemes begin to reduce the duration of their liabilities.

The sensitivity of the s179 funding ratio volatility

4.20 We have tested the base case volatilities for changes in two key parameters:

- funding ratio
- underlying time series

4.21 The results of these tests can be found in [Appendix D](#).

4.22 In summary, the volatility of the s179 funding ratio for a pension scheme is sensitive to both the funding ratio itself and the period of time over which the Monte Carlo model is calibrated. This may be mitigated to some extent by smoothing assets, s179 liabilities and stress tests over a number of years for Risk-Based Levy purposes; however we would recommend that the output from the fairness workstream is tested on a range of different input funding ratio volatilities.

5 The proposed stress tests

- 5.1 This section considers how to break down an aggregate funding ratio stress of 1× volatility into individual risk factor stress tests and how they can then be applied to each scheme’s asset and liability portfolio.
- 5.2 We understand that output from the work carried out by Anthony Neuberger and David McCarthy, in addition to confirming that an aggregate stress test varies in proportion to the volatility for a given funding level and sponsor creditworthiness, also suggests that the calculation of a fair levy should apply different levels of stress dependent on a scheme’s funding ratio and the credit worthiness of its sponsor. Appropriate allowance for this could be made by scaling the stresses derived in this section to the relevant multiple of volatility, although this could have consequences on predictability and stability of levies for individual schemes.

Method for determining the individual factor stresses

Assessment Process

- 5.3 We first take the undiversified components of the volatility for each risk factor and scale them to an array of stress tests by the ratio of the diversified and undiversified volatilities. For each of the 5,728 pension schemes, we build a model that applies a constant multiple of this array of individual risk factor stresses to the assets and liabilities. In the absence of additional information, the PPF asked us to carry out the analysis on two alternative bases:
- a. assuming all assets classified as “other” are assigned to the risk factor with the highest stress
 - b. assuming all hedge funds are also classified as other, on the basis that this category covers an extremely wide range of risks
- 5.4 The constant multiple is then optimised to minimise the standard deviation of the absolute difference between:
- the ratio of the stressed assets to the stressed s179 liability valuation, and
 - the volatility of the funding ratio (this being the approximation to the “fair” levy described above)
- subject to the average absolute difference being zero.
- 5.5 This was initially carried out using base scenario described in the previous section, i.e. time series from 1 January 2006 to 31 March 2009 and the PPF data at 31 March 2009. The resulting risk factor stresses are as follows:

Table 4a: Base case risk factor stresses

Credit	Interest rates	Inflation	UK Equity	Overseas Equity	Property	Cash	Hedge Funds	Other
+123bps	-67bps	+61bps	-22.2%	-18.9%	-7.2%	0%	-9.3%	-22.2%

Table 4b: Base case risk factor stresses assuming hedge funds are classified as “other”

Credit	Interest rates	Inflation	UK Equity	Overseas Equity	Property	Cash	Other
+120bps	-66bps	+60bps	-21.7%	-18.5%	-7.1%	0%	-21.7%

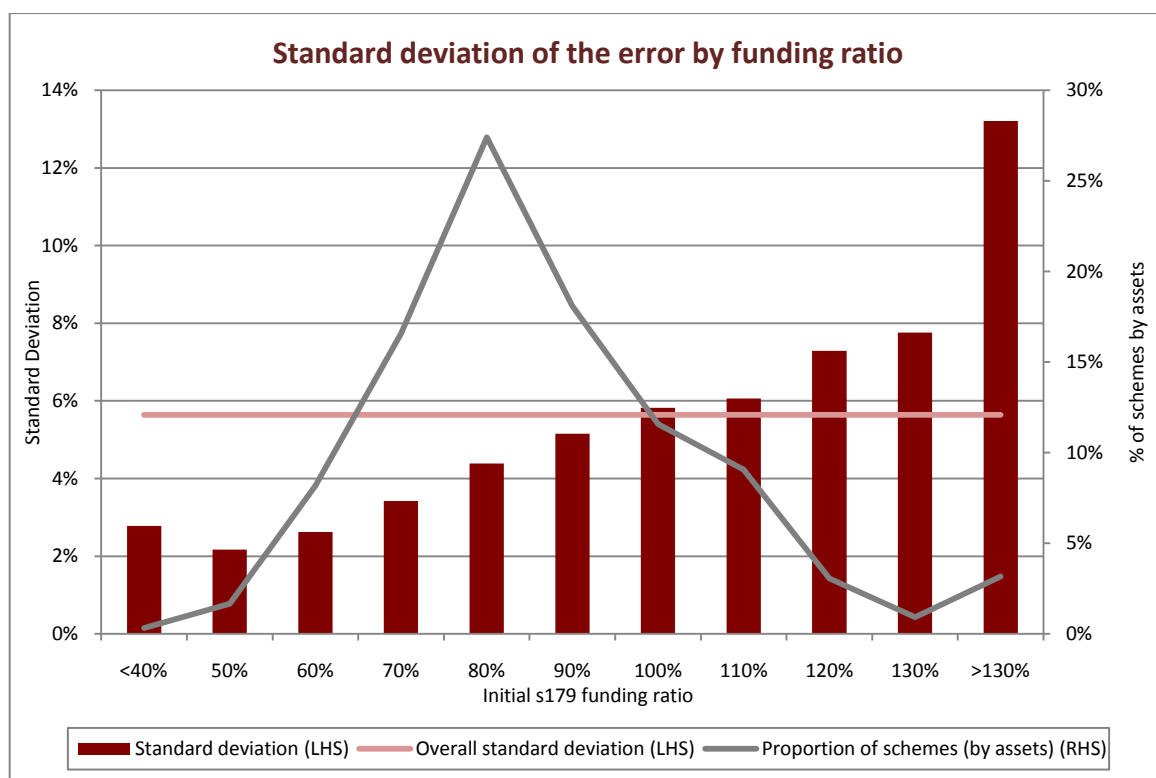
- 5.6 The standard deviation of the optimisation with hedge funds separately identified is 5.64%. The standard deviation of the optimisation with hedge funds included under “other” assets is 5.74%.
- 5.7 We can see that the impact of classifying all hedge funds as “other” does not have a material impact on the risk factor stresses as the amount of assets identified to be in this category is relatively small. For the remainder of the report, we use only the second approach, i.e. classifying all hedge funds investment as “other”.
- 5.8 It is possible that the standard deviation might be reduced by allowing the average absolute difference between the stress on the funding ratio and the volatility of the funding ratio to be non-zero. The table below shows that by allowing this average absolute difference (labelled as “average difference”) to increase from zero to 1% or 2%.

Table 5: Alternative risk factor stresses

Average difference	Credit	Interest rates	Inflation	UK Equity	Overseas Equity	Property	Cash	Other	Standard deviation
0%	+120bps	-66bps	+60bps	-21.7%	-18.5%	-7.1%	0%	-21.7%	5.74%
1%	+111bps	-61bps	+56bps	-20.1%	-17.1%	-6.6%	0%	-20.1%	5.48%
2%	+102bps	-56bps	+51bps	-18.5%	-15.8%	-6.0%	0%	-18.5%	5.24%

- 5.9 Whilst the standard deviation of the differences reduces when the constraint on the absolute size of the error is relaxed, it is not a large reduction. We have further analysed how this error varies across pension schemes by funding level.

Chart 6: How the standard deviation of the error varies by funding ratio



5.10 Chart 6 shows that the majority of the standard deviation (left hand scale) comes from schemes that are very well funded; however we can also see that the majority of schemes in the PPF’s universe have funding ratios to the middle and left hand side of the chart.

5.11 For example, for schemes where the funding ratio is at or below 90%, the standard deviation of the error would be less than the 5.74% standard deviation for all schemes together. Considering only the more representative schemes, the standard deviation would be more in the region of 4%.

5.12 We believe that most of the difficulty in reducing the error comes from trying to fit one single set of stress tests to all pension schemes. The PPF may wish to consider further the balance between the requirements of the Steering Group and how well the one single set of stress tests can replicate the underlying risks.

Factors that will constrain the accuracy of applying the stress tests

5.13 Before presenting the proposed stress tests, we consider some of the factors that will determine the level of detail within the stress tests.

Table 7: Issues to consider for setting the level of detail within the stress tests

Issue	Description
Large number of schemes	Whatever the solution, it should be easily applied across a large number of schemes with differing characteristics.
Data availability	Exchange currently captures a certain amount of data. If any further data is required, this will add additional costs for collection, processing and verifying this data
Range of scheme sizes	A large proportion of the schemes will be small, so simplicity and cost will be key issues
£179 assumptions	As the £179 liability value is based on spot gilt yields, any analysis based on yield curves and/or swap rates is likely to be difficult to utilise
Fairness	With the difficulty of achieving a 'fully fair' levy assessment there does not seem to be much merit in too detailed or 'accurate' assessment of investment risk, particularly given the issues highlighted above
Investment governance	The PPF would like to encourage good governance of investment decisions. Consideration needs to be given as to whether this can be achieved by any investment risk stress tests, or if a separate assessment of a scheme's governance can be used. This latter approach is the subject of a separate consultancy project

Options for consideration

5.14 Taking into account the analysis and constraints above, we initially arrived at four options for incorporating investment risk into the Risk-Based Levy

- A. Make no allowance in the risk-based levy formula for investment risk.
- B. Use a set of pre-defined asset and liability stress tests to be applied by the PPF to all schemes.
- C. Allow more flexibility in the stress tests by allowing schemes to more accurately reflect their investment strategies.
- D. Fully bespoke stress tests on assets and liabilities, including allowance for full yield curve stresses on liabilities.

5.15 Option A is essentially the existing approach to setting the Risk-Based Levy, i.e. it makes no allowance for investment risk. We recognise that this is still an option for the PPF to consult on and whilst we do not explicitly consider this option further within this report, it is implicitly compared against the other options in the impact analysis showing the potential redistribution of the levy.

5.16 Option D moves the process beyond many of the stated objectives of Steering Group. It is akin to the "internal model" approach adopted by the FSA. Although this option can reflect each scheme's individual circumstances there are a number of issues against it:

- It cannot be applied to all UK pension schemes, both due to costs/complexity or the immense amount of oversight and review needed by the PPF or independent sign-off.

This is particularly the case as the PPF's approach to regulation, by necessity, is less involved compared to the FSA (e.g. the FSA carries out site visits).

- It is not necessarily appropriate under the current definition of s179 as this does not use a full yield curve, so may be spuriously accurate.
- Our experience suggests that few, if any, schemes will be using the s179 level of liabilities as a hedging target.
- It will be open to challenge for lack of transparency, as was the case for the PPF's proposal in 2008 to use its own Long Term Risk Model.
- Finally, and perhaps most importantly, it is difficult to justify the requirement for pension schemes to construct internal risk models for the purposes of an annual levy. As discussed in section 3, in other regimes where a more bespoke approach is taken (e.g. the FSA, or the Netherlands), this is because the whole regulatory regime is based on that model and the supervisory bodies are encouraging the development of more sophisticated risk assessment capabilities within the entities they regulate. If the UK occupational pensions regime were to move to a broader risk-based regime, it would be appropriate to revisit this option.

5.17 Whilst some schemes may have the capacity to run a full internal risk model, the overriding constraint that reduces the viability of this option is the methodology for valuing the s179 liabilities. The use of a single discount yield across the full duration of liabilities essentially means that the PPF's calculation of the stressed s179 liabilities (described for options B and C in paragraph 5.22 below) will be broadly the same as the scheme's own calculation, in which case the additional information provided by a full internal risk model would be only the asset-side stress tests, which collapses option D into option C.

5.18 The rest of this section focuses on options B and C.

Option B

How would it be applied?

5.19 Under this option, all asset and liability stress tests would be calculated by the PPF. Asset stress tests would be based on annual scheme data submitted on Exchange. There is sufficient data captured via Exchange to exclude insured s179 liabilities and their associated insurance asset values; however the precise relationship between these two figures is not clear as schemes are likely to insure the full scheme benefit rather than the PPF compensation level (on which the s179 liabilities are assessed). It might be reasonable for the PPF to ask schemes to confirm that the benefits that have been insured are at or above the level of PPF compensation.

5.20 To translate risk factor stresses to asset value stresses, the relevant risk factors stresses are applied to the benchmark for each asset class as defined earlier in Table 1. In the absence of additional information, the PPF has indicated that it would attribute the highest stress test to the "other" asset category. For the period to 31 March 2009, the resultant asset value stresses would be:

Table 8: Translating risk factor stresses to asset value stresses

Corporate bonds	Nominal Gilts	Index-linked gilts	UK Equity	Overseas Equity	Property	Cash	Other
-4.6%	+9.8%	+19.1%	-21.7%	-18.5%	-7.1%	0%	-21.7%

5.21 For asset classes exposed to only one risk factor (e.g. equity or property), the stress test on the asset value is the same as the stress on the risk factor. For asset classes that combine more than one risk factor (e.g. corporate bonds or index-linked gilts), the asset value stress test will be a combination of the relevant risk factor stresses.

5.22 s179 liability stress tests would also be calculated by the PPF. The PPF will have already calculated, where necessary, the s179 valuation at the appropriate date using the methodology stated in the Transformation Appendix¹². This value can be further adjusted to the following “stressed” yields using an identical methodology to the Transformation Appendix.

Table 9: Defining the yields for calculating the stressed s179 liability valuation

Yield ¹³	Current definition	Stressed definition
A	Half of the sum of the FTSE Actuaries’ Government Securities Index-Linked annualised Real Yields over 15 years assuming: a) 5% inflation; and b) 0% inflation.	Current less 126bps
B	The annualised yield on the FTSE Actuaries’ Government 20 year Fixed Interest Index	Current less 66bps
C	The annualised yield on the FTSE Actuaries’ Government 15 year Fixed Interest Index.	Current less 66bps
D	Half of the sum of the FTSE Actuaries’ Government Securities Index-Linked annualised Real Yields over five years assuming: a) 5% inflation; and b) 0% inflation.	Current less 126bps

5.23 The advantages of this approach are that:

- it is simple and can be applied consistently across all schemes
- it does not require any additional asset-related information to be captured.

5.24 The disadvantages of this approach are that:

- it does not have the flexibility to reflect specifics of scheme investment strategies, in particular translated the risk factor stresses to asset value stresses may discourage schemes from efficient hedging techniques that use derivatives as the benefit may not be reflected.
- the simplification of risk factor stresses to asset value stresses opens up the possibility for pension schemes to influence the outcome of the calculation in their favour.

¹² The [Transformation Appendix](#) is appended to the PPF’s determination under Section 175(5) of the Pensions Act 2004.

¹³ As defined in the PPF’s guidance on assumptions to use when undertaking a Section 179 valuation (version A5, October 2009)

A possible variation

5.25 We have further considered whether it would be possible to group the stress tests into a smaller number without losing the accuracy. We have tested carrying out a single liability stress together with one stress test on “matching assets” (in which we have combined government and corporate bonds) and one on “non-matching assets” (all other assets). This resulted in the following (optimised) stress factors:

Table 10: Grouping the risk factors into a smaller number of stress tests

Average difference	Liability stress	Matching asset stress	Return seeking stress	Standard deviation
0%	24%	20%	-16%	5.63%
1%	23%	20%	-15%	5.37%
2%	21%	19%	-14%	5.11%

5.26 It can be seen that the grouped approach does not reduce accuracy by any significant amount. Whilst simpler to calculate, the added complexity of deciding on the appropriate matching together with the fact that all eight data items are collected anyway makes it more of an academic alternative. This is particularly the case for more complex investment and/or hedging strategies. In addition if the liability stress is assessed at an aggregate level, it will be less representative of any individual pension scheme.

Option C

How would it be applied?

5.27 Under this option, the liability stress test would still be carried out by the PPF in line with the description in paragraph 5.22 above. The asset stress test would be submitted by the schemes via Exchange, potentially along with an external verification.

5.28 This would include, reflecting the actual duration of fixed income portfolios, including duration hedging assets. In addition, treatment of various other types of investment could be reflected by reflecting the changes in the underlying risk factors, including equity options, interest rate swaps, inflation swaps and other derivatives. We believe this is an area where the level of sophistication in a scheme’s governance structure may need to be considered to avoid “anti-selection”, for instance schemes could put an equity collar in place around 31 March each year purely to reduce their pension protection levy. Schemes could be given a list of investment types that would automatically trigger the need to use this option; schemes may be allowed to opt for this approach themselves.

5.29 The advantage of this approach is that it can more accurately reflect a scheme’s specific investment strategy.

5.30 The disadvantages of this approach are that:

- it introduces anti-selection risk, i.e. that a scheme could choose whichever of options B and C gives the smaller levy. To counter this, the PPF could require that some schemes

must use option C, for example schemes over a certain size or with significant amounts of hedging.

- there will be an additional cost for schemes in calculating the stressed asset values. For schemes with strong investment governance, it may be quite straightforward. For pooled funds, it is possible that asset managers could provide “stressed” valuations to all pension fund investors. We have approached a small number of pooled LDI asset managers and in principle, it might be possible to provide either stressed valuations or additional sensitivity data to enable schemes to assess the stressed valuations more easily. We recommend that the PPF considers approaching them more formally.
- it would require the PPF to collect an additional set of “stressed assets” with accompanying verification procedures.
- it is likely that for the vast majority of schemes, hedging/insurance objectives will not be based on the s179 liability valuation.

5.31 Our preferred approach would be for stress tests on derivative-type assets to be applied accurately (i.e. re-pricing based on the risk factor stresses) which would in our experience necessitate significant input from the asset manager and/or investment consultant. However we recognise that this might be a costly route and discuss alternative lower cost routes (with potentially lower accuracy) in section 7.

A possible variation

5.32 An alternative approach would be for all schemes to submit much more detail on their investment strategy to the PPF (for example, similar to the FSA’s Form 48¹⁴ for insurance business). This would give the PPF enough information to reflect a scheme’s individual investment strategy when calculating the stresses. This would be very onerous for the PPF due to the large number of schemes. It would also lead to increased expense for pension schemes. This would need to be compared with the potential additional cost to schemes for calculating the asset stresses.

Smoothing

5.33 All of this analysis so far is based on data at 31 March 2009. As discussed in the previous section, the volatility of the s179 funding ratio is sensitive both to the period of time and hence historic asset and liability experience that is included in the model, as well as the initial funding ratio of a scheme.

5.34 Whilst the use of smoothing techniques is not immediately congruous with a market-consistent model, the use of smoothed asset, s179 liability and stress tests is likely to reduce the volatility of the Risk-Based Levy, which would help it meet the longer-term predictability objective set by the Steering Group.

¹⁴ This can be found at http://www.fsa.gov.uk/pubs/forms/Appendix9_3_Form48.pdf

5.35 We are therefore relatively indifferent between the period of smoothing to be used, although it needs to be sufficiently long such that the predictability objective set by the Steering Group can be assessed and demonstrated. If smoothing is to be adopted over, say, a three-year period and the new formula is effective from 2012, then we would suggest that 3-year periods of data are taken for each year-end, i.e:

Table 11: One possible way of defining the smoothing process

Date of asset valuation	Date of s179 liabilities	Data underlying stress tests
31 March 2009	31 March 2009	1 April 2006 to 31 March 2009
31 March 2010	31 March 2010	1 April 2007 to 31 March 2010
31 March 2011	31 March 2011	1 April 2008 to 31 March 2011

5.36 This way, the impact of each additional year of information will have a smaller effect than without any smoothing.

5.37 If, under option B, the asset stress tests are also rounded, this could further add to the stability. One way would be to round the asset stress tests to the nearest 0.5%, as follows:

Table 12: Translating risk factor stresses to asset value stresses

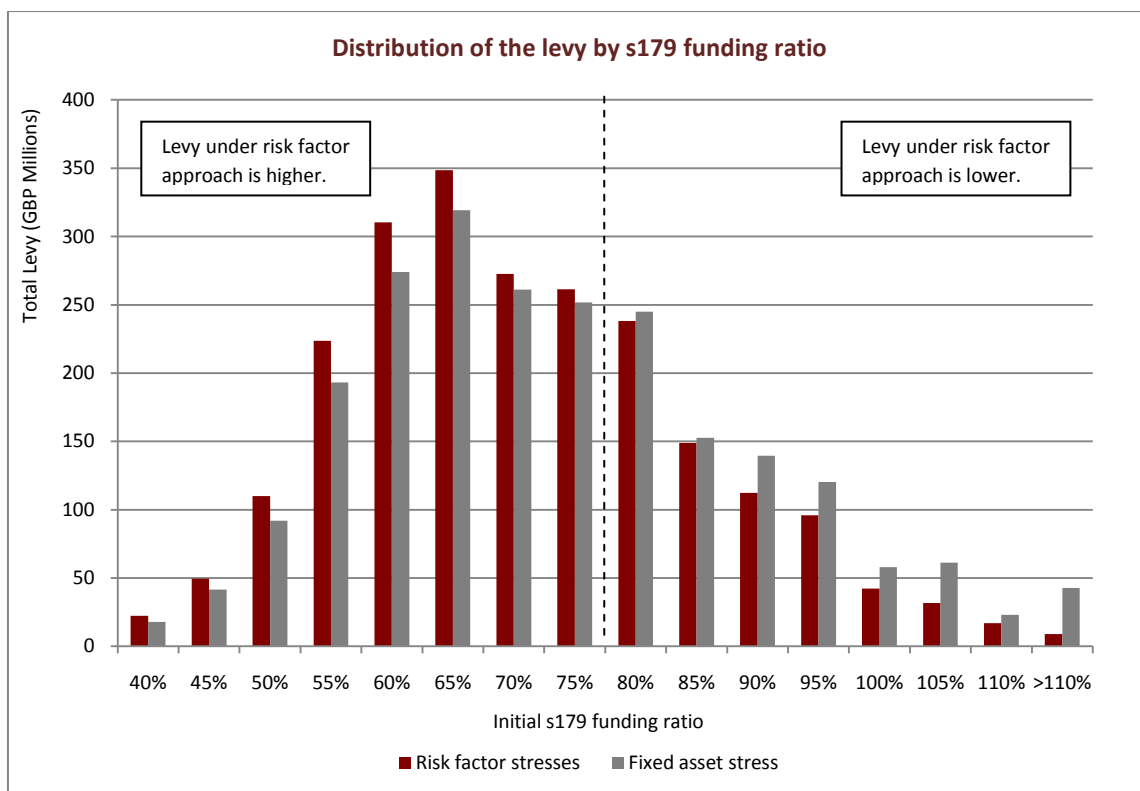
Corporate bonds	Nominal Gilts	Index-linked gilts	UK Equity	Overseas Equity	Property	Cash	Other
-4.5%	+9.5%	+19.0%	-21.5%	-18.5%	-7.0%	0%	-21.5%

6 Impact analysis

Levy distribution

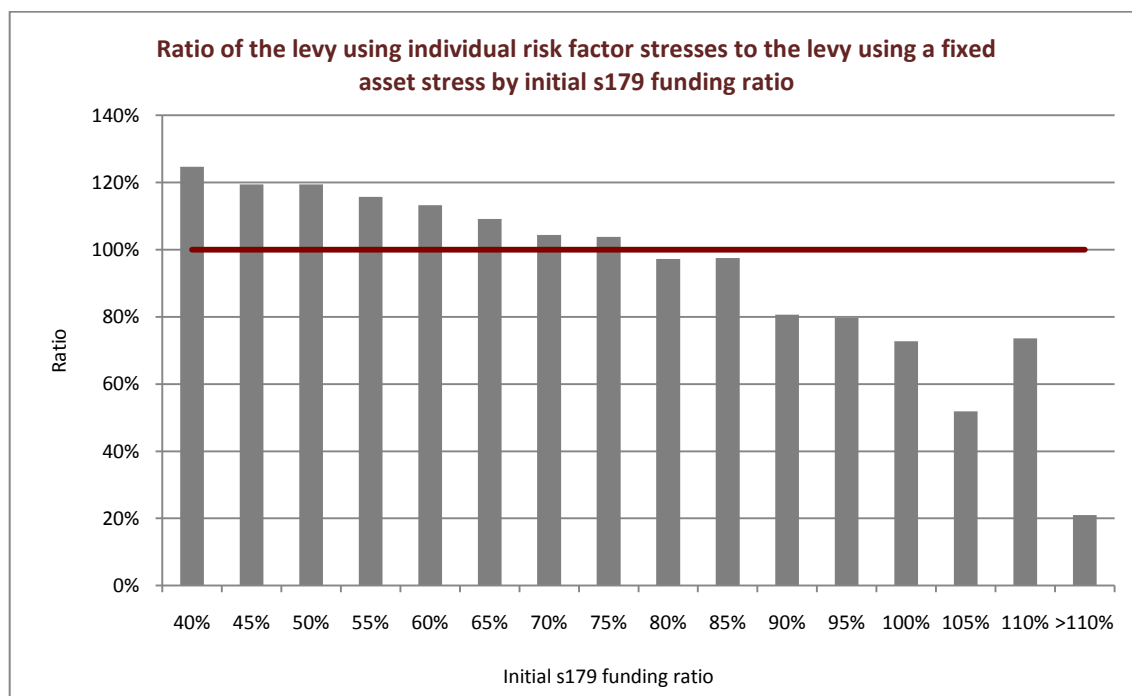
- 6.1 The PPF has proposed that the underfunding should be calculated as the stressed value of the s179 liabilities less the stressed value of the assets (with a minimum of zero). This is then multiplied by the probability of insolvency over the year to arrive at the Risk-Based Levy.
- 6.2 In this section, we analyse how the introduction of investment risk into the Risk-Based Levy would alter the distribution of the levy by comparing the levy under Option B in the previous section, with an alternative where all scheme asset values are stressed by a fixed percentage. For the purposes of illustrating purely the redistribution, we have chosen this fixed percentage such that the aggregate levy is equal.
- 6.3 It should be noted that we are unable to compare Option B and Option C as there is insufficient data to do this.
- 6.4 At this point it is worth mentioning one aspect of the analysis that often can be ‘optically’ confusing. We have measured the volatility in terms of the *funding ratio* i.e. assets divided by liability value, but the individual stress tests get applied via a levy formula that effectively looks at the *absolute deficit* (i.e. the difference between assets and liability value). The result can be that the change in deficit looks a lot larger than the volatility.
- 6.5 This arises because when looking at the variability of *absolute deficit*, it is customary to divide it by the “pre-stressed” value of the liabilities. Whereas when measuring the volatility of the *funding ratio*, this will include stressed asset and stressed liability values – as a significant part of the volatility arises from the liabilities the size of the denominator will be larger in this scenario and hence lead to a lower value for the volatility measure. We are comfortable that this is just an ‘optical’ issue and does not affect the rationale for converting the volatility to individual stresses.
- 6.6 The following charts compare the impact of introducing stress tests across schemes with different s179 funding ratios.

Chart 13: Distribution of the levy by s179 funding ratio



6.7 Chart 13 shows that for schemes with funding ratio lower than 80%, the introduction of risk factor stress tests would increase their proportion of the risk-based levy.

Chart 14: Ratio of the levy using individual risk factor stresses to the levy using a fixed asset stress by initial s179 funding ratio



6.8 The following charts compare the impact of introducing stress tests across schemes with different proportions of assets in return-seeking assets.

Chart 15: Distribution of the levy by proportion of return-seeking assets

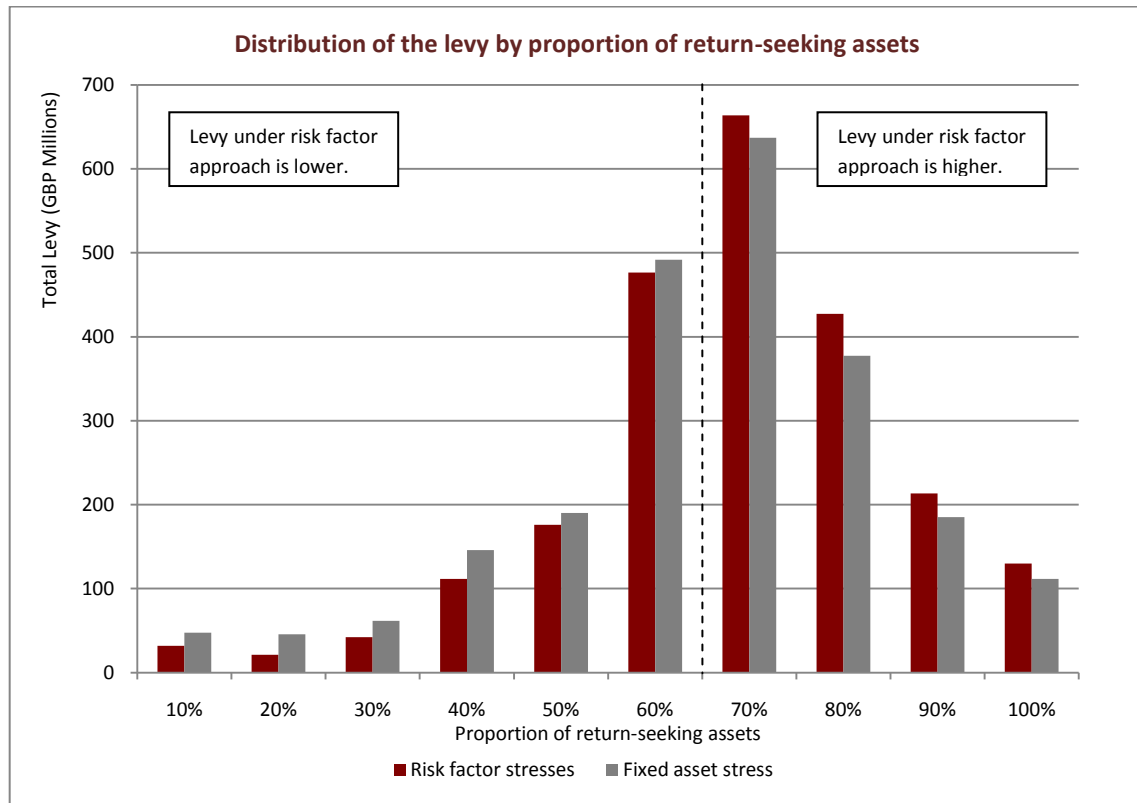
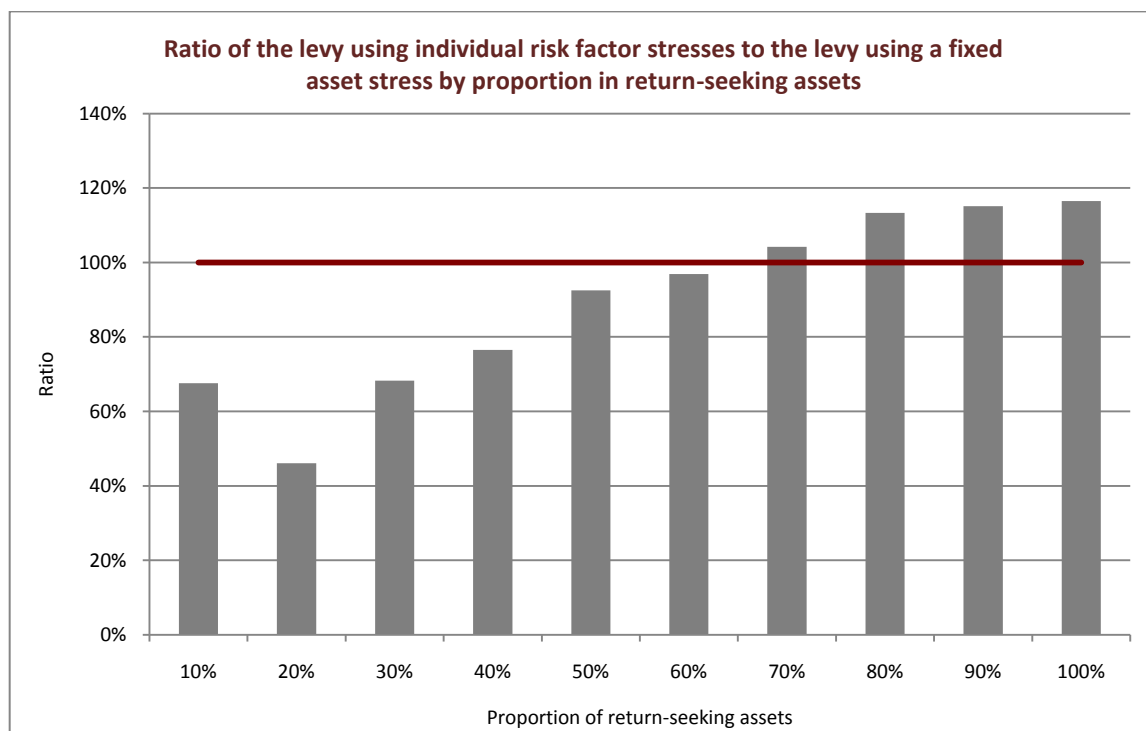


Chart 16: Ratio of the levy using individual risk factor stresses to the levy using a fixed asset stress by proportion in return-seeking assets



6.9 The charts show that the proposed individual risk factor stresses will redistribute the levy away from schemes with higher funding ratios and lower proportions of return-seeking assets to those with lower funding ratios and higher proportions of return-seeking assets.

Comparison with other regimes where stress tests are used

6.10 We would caution against direct comparison of the proposed stress tests for pension protection levy purposes with other regimes (e.g. the FTK regime in the Netherlands). Firstly, the overall objectives of the stresses tests are different. Also, the aggregate level of stresses are different, for example the one standard deviation used in Section 5 equates to a confidence level of c84%, whereas insurance solvency regimes are typically set at higher levels, e.g. 97.5% or 99.5%.

7 Implementation considerations

7.1 Changing the formula for the Risk-Based Levy will necessitate some changes to the data provided by pension schemes via Exchange, and also changes to the PPF's own internal processes.

Who will use option C

7.2 Option B requires no additional data provision on pension scheme assets, although schemes will be required to indicate if they have specific investments which will automatically require them to use option C. Such strategies commonly include:

- Equity derivatives (e.g. futures, total return swaps, or options)
- Interest rate swaps or swaptions, including pooled "LDI" funds
- Inflation swaps, including pooled "LDI" funds
- Credit default swaps

7.3 In Appendix E, we have set out examples of some of the questions and explanations that might be added to Exchange to assist schemes in determining whether using option C is required or not. The intention is only to identify such strategies where they explicitly form part of a scheme's asset allocation as recorded in its Statement of Investment Principles. Derivatives used by asset managers for the purposes of efficient allocation/day-to-day management are not covered.

7.4 Some schemes may want to choose option C even without any of the above derivative exposures should they feel that the benchmarks being used to derive the asset value stresses are materially different to their actual asset holding or investment strategy – this will be particularly the case for fixed income assets, where the asset value stress is a combination of up to three risk factor stresses (interest rate, inflation and credit), or for particular mandates with active management, where benchmark may not provide a fair representation of the underlying risks.

7.5 One of the considerations raised by the previous consultation was whether allowing schemes to choose between options B and C is likely to be unfair, particularly given larger schemes with more resources may benefit from looking at both options and choosing the one that gives the lower levy. Any system that allows options is going to offer arbitrage opportunities; however the PPF will have the ability to compare the option C stressed asset values with the option B stressed asset value and will therefore be able to investigate any significant difference. In addition, we believe there is benefit from exploring the possibility that pooled funds, including life office investment funds, could provide stressed asset values to pension schemes which could be more cost effective on an aggregate basis.

Implementing option C

7.6 Those pension schemes that either choose to or are required to opt for Option C will need to calculate the stressed value of the asset portfolio.

- 7.7 The pricing of these derivative instruments is complex. Our preference would be for the stress tests on these assets to be applied accurately, by which we mean re-pricing at the relevant date allowing for the risk factor stresses. In most cases, this approach would likely require significant input from the asset manager and/or investment consultant.
- 7.8 Whilst this re-pricing would be relatively straightforward for asset managers and/or investment consultants to do, it will undoubtedly increase the associated cost of applying the stress tests. As an alternative, simpler approaches could be taken and calculated by the schemes themselves. For example, for equity options, rather than re-pricing market value, schemes could calculate the change in the intrinsic value¹⁵ of the option instead, and use this to assess the impact of the stress. We assume that the underlying market value of the option would be in the original asset value.
- 7.9 Similarly, for interest rate and inflation swaps, the asset manager/investment consultant could be asked to provide the scheme with the impact of a 1 basis point change in risk factor (which is either typically provided on a regular basis or is readily available) and the scheme can scale this up to reflect the size of the actual stress test. This would be a broad brush estimate of the actual impact as the accuracy of this scaling approach diminishes with higher durations and larger stresses (i.e. the multiple of the scaling). In general, the approximate method will understate the true impact of the stress. Again, the market value of the swaps is assumed to be in the original asset value.
- 7.10 We illustrate this difference for an example portfolio of interest rates swaps. This example portfolio commenced on 1 January 2010, with a notional exposure of £5m across five different duration buckets. We have assessed the subsequent value of the portfolio at 31 July 2010 and calculated the stressed value using both approaches. We have used the stresses at 31 March 2009 (in line with Table 4b) for illustrative purposes.

Table 17: Illustration of the different approaches to calculating stress tests for interest rate swaps

Maturity (years)	Notional exposure	Present value at 31 July 2010	PV01	Accurate stress test of 66 bps	Approx stress test of 66 bps	Total accurate stressed value	Total approx stressed value	Difference
		(A)	(B)		(C)=(B)×66	(A)+(B)	(A)+(C)	
10	1,000,000	97,356	979	66,886	64,639	164,242	161,995	1.4%
20	1,000,000	101,062	2,063	145,660	136,157	246,722	237,220	3.9%
30	1,000,000	52,769	3,006	219,545	198,402	272,314	251,170	7.8%
40	1,000,000	12,75	3,887	293,727	256,520	306,432	269,225	12.1%
50	1,000,000	1,311	4,826	377,496	318,507	378,807	319,818	15.6%
Total	5,000,000	265,204	14,761	1,103,314	974,225	1,368,517	1,239,429	9.4%

All figures are £ unless otherwise indicated. PV01 is the sensitivity of the portfolio to a one basis point change in interest rates

¹⁵ The *intrinsic value* of an option is the value that would be realised if the option expired immediately. The *market value* also takes into account the *time value* of the option arising from potential changes in *intrinsic value* between the valuation date and actual future expiry date, which is primarily driven by the volatility of the underlying instrument. For the holder of an option, the intrinsic value is theoretically lower than the market value.

- 7.11 In Appendix F, we provide examples of what guidance might be offered to pension schemes if this simpler approach is adopted.
- 7.12 To limit the impact on schemes that are required to use option C, the PPF may want to consider only requiring those schemes to provide the additional asset stresses on the specific asset classes that triggered the requirement rather than all assets. With the anticipated growth of schemes investing in derivative-type contracts to manage their interest rate and inflation risks, this might be an acceptable compromise.

Considerations for the PPF

- 7.13 Under Options B and C, the PPF would need to be able to extend its methodology for rolling forward s179 liabilities to also include the calculation of the stressed liabilities under the adjusted yields in table 9.
- 7.14 Under Option C, the PPF will need to be able to store the additional stressed asset values it receives from pension schemes and is likely to want a high level verification process. At the moment, the PPF carries out basic validity tests on data inputs to ensure the values make sense (e.g. flagging negative numbers, or percentages that add up to something different to 100); however we are not aware of any test that are carried out on the data itself.
- 7.15 Similar validity checks can be carried out on stressed asset values, but by definition it will be difficult to provide general guidance on how a stressed asset value might compare to the unstressed value. Extreme results could be flagged for further investigation – for fixed income portfolios, this could be done by using the stressed asset values to derive an implied duration, which might be easier to compare.
- 7.16 The PPF may want to consider external verification of stressed asset values; however there are a number of issues to consider if this is to be pursued:
- Current asset values on Exchange are provided at the latest s179 valuation date and are therefore audited. Even if an asset manager were to provide the value of a stress test, it would not necessarily be to the same level of comfort as an auditor and may be at different date to the latest s179 valuation date.
 - Should the simpler approaches be taken (in line with those discussed in 7.9 and 7.10 above and as illustrated in Appendix F), the PPF could consider asking for documentary evidence of all underlying inputs.
 - Not uniquely applying to stress test data, but the PPF is reliant on schemes disclosing all relevant positions as it would not be possible to identify any gaps in data.
- 7.17 In all cases, should a change in levy formula be implemented, the PPF will need to update its process for taking data from Exchange and turning it into levies for each pension scheme.
- 7.18 This is summarised in the table below, together with estimated additional consultancy costs that might be incurred by pension schemes:

Table 18: Estimated additional costs that would be incurred by pension schemes

Option	Additional data needed	Additional PPF cost	Estimated additional Scheme cost
B	Stressed s179 liabilities	Extra liability calculation	None
	Stressed asset figures	Cost of calculating the stresses	None
C	Stressed s179 liabilities	Extra liability calculation	None
	Stress asset figures	Data capture/verification	£2,000 to £5,000

7.19 The additional scheme cost is difficult to estimate as it depends on a large number of factors and in practice could be much greater than £5,000 as it will depend on:

- the complexity of the pension scheme's investment strategy
- whether stress tests are calculated by the scheme itself or an external asset manager/investment consultant
- whether the scheme is reflecting its own benchmark or each individual asset position (for example benchmarks may not reflect the underlying risk for some actively managed portfolios)
- the presence of an investment sub-committee that might have a detailed knowledge of the asset sensitivities and (perhaps with the support of a consultant) may have the information readily available or easily obtainable
- whether the scheme's assets are held in segregated or pooled funds – typically for pooled funds, a pension scheme might receive a lower level of detail on the underlying asset positions. As mentioned before, there may be benefit in exploring more formally whether fund managers (e.g. pooled fund managers, or life office product providers) might be asked to provide stressed asset valuations or additional information to assist schemes to carry out the stress tests more easily so that these costs can be minimised. For example, with LDI funds, the fund manager may be able to provide a "PV01" calculation (which represents the sensitivity of the portfolio to a 0.01% change in yields), which can then be scaled up to provide an approximate stress test.

8 Recommendation

- 8.1 As explained in Chapter 3, we believe that stress tests are an appropriate way for the PPF to incorporate investment risk into the formula for the risk-based levy, particularly by reference to the approaches taken in other regimes. We believe that it is preferable for these stress tests to be defined by risk factor rather than by asset type. This is because using risk factors can more accurately reflect a pension scheme's investment strategy both in terms of the asset categories recorded on Exchange, but also additional hedging/derivative strategies that are increasingly being adopted by pension schemes. This was discussed in section 5. In more accurately reflecting the breadth of investment strategies utilised by pension schemes, risk factor stresses also would meet a further consideration from the previous consultation. On this basis, we would recommend Option C for all schemes. This is similar to the Option 4 (out of five) presented in Chapter 5 of the previous consultation, albeit on a mandatory, rather than voluntary basis.
- 8.2 However, we recognise that Option C will increase the amount of work needed by each pension scheme, and hence the amount of data collection and verification required by the PPF. This was discussed in section 7. This may suggest a preference for option B for practical purposes, although ultimately the chosen option will need to balance the advantages and disadvantages of each option.
- 8.3 An alternative is for the PPF to calculate the stressed asset and liability values for all schemes (option B) with schemes required to submit more refined asset stresses under option C if either
- i) they had a certain type of investment strategy, or
 - ii) they choose to.
- 8.4 Due to their complexity, our preference would be for these refined asset stresses to be calculated by an external asset manager/investment consultant, but we have also presented an option where simpler, but less accurate, methodologies could be adopted by pension schemes. This is similar to Option 3 presented in the previous consultation, but with Option 4 applied on a mandatory basis for those schemes with a certain type of investment strategy. Examples of guidance that might be used to support schemes carrying out their own stress tests is included in Appendices E and F.
- 8.5 One further consideration raised as part of the previous consultation – and also highlighted by feedback from the Steering Group – was a concern that providing schemes with more than one option might unfairly disadvantage smaller schemes with fewer resources. Whilst providing an option will inevitably lead to a certain level of arbitrage, the PPF will be able to monitor the difference in the asset stresses under the two options and we believe there is merit in more formally approaching pooled fund managers and life office product providers to discuss the possibility of providing stressed asset valuations.

8.6 In its previous consultation, the Board of the PPF saw a potential long-term solution to be bespoke modelling carried out by at least the larger schemes. We do not necessarily see this as a viable option, particularly if the UK pensions regulatory regime does not itself move to a risk-based framework.

Appendix A

Funding ratio volatilities

500 sample schemes

Set out below are the 500 sample scheme volatilities we provided to David McCarthy with some of the basic scheme data at 31 March 2009. Details of how the volatilities have been calculated are in section 4. We also show a scatter chart of the 500 volatilities against the proportion of each scheme’s assets held in non-matching assets.

Chart A1: The distribution of s179 funding level volatilities across the 500 sample schemes

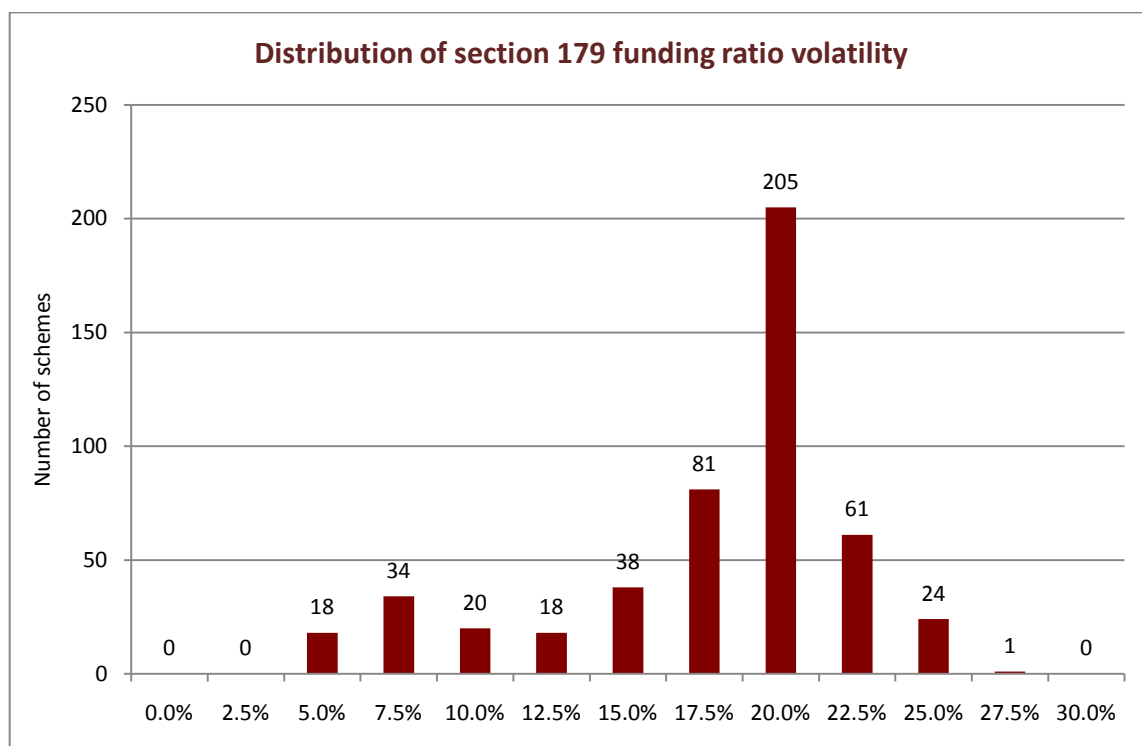
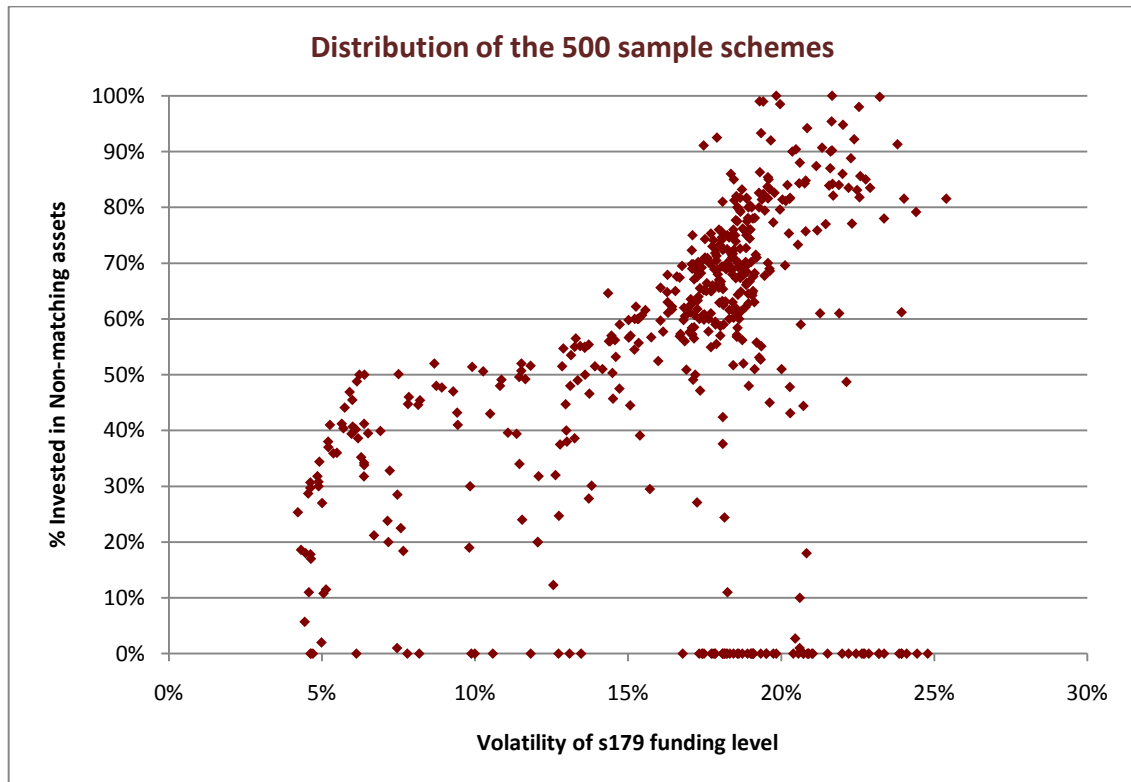


Chart A2: Plot of s179 funding level volatility against proportion invested in non-matching assets for the 500 sample schemes



All 5,728 schemes

The charts below show the distribution of the funding level volatilities for all 5,728 pension schemes for which we were provided data and a scatter chart of those 5,728 volatilities against the proportion of each scheme’s assets held in non-matching assets.

Chart A3: The distribution of s179 funding level volatilities across the 5,728 schemes

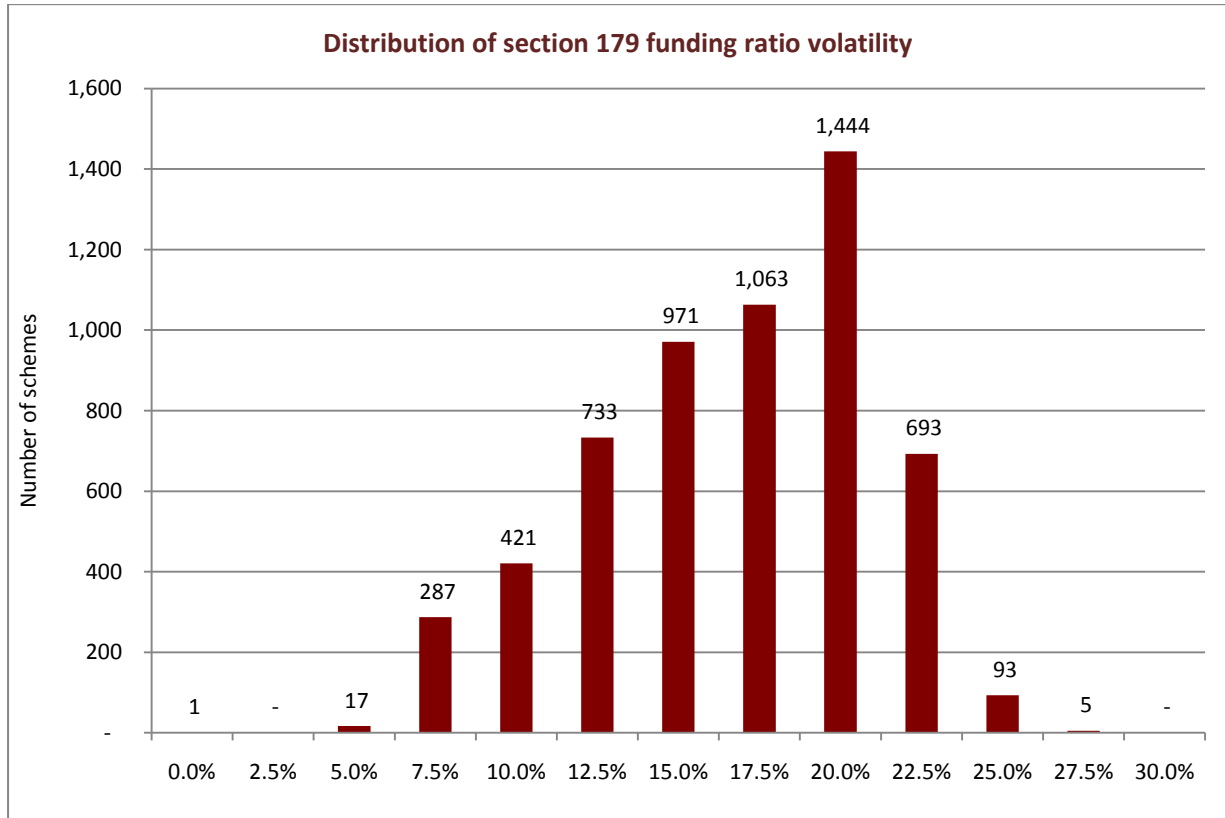
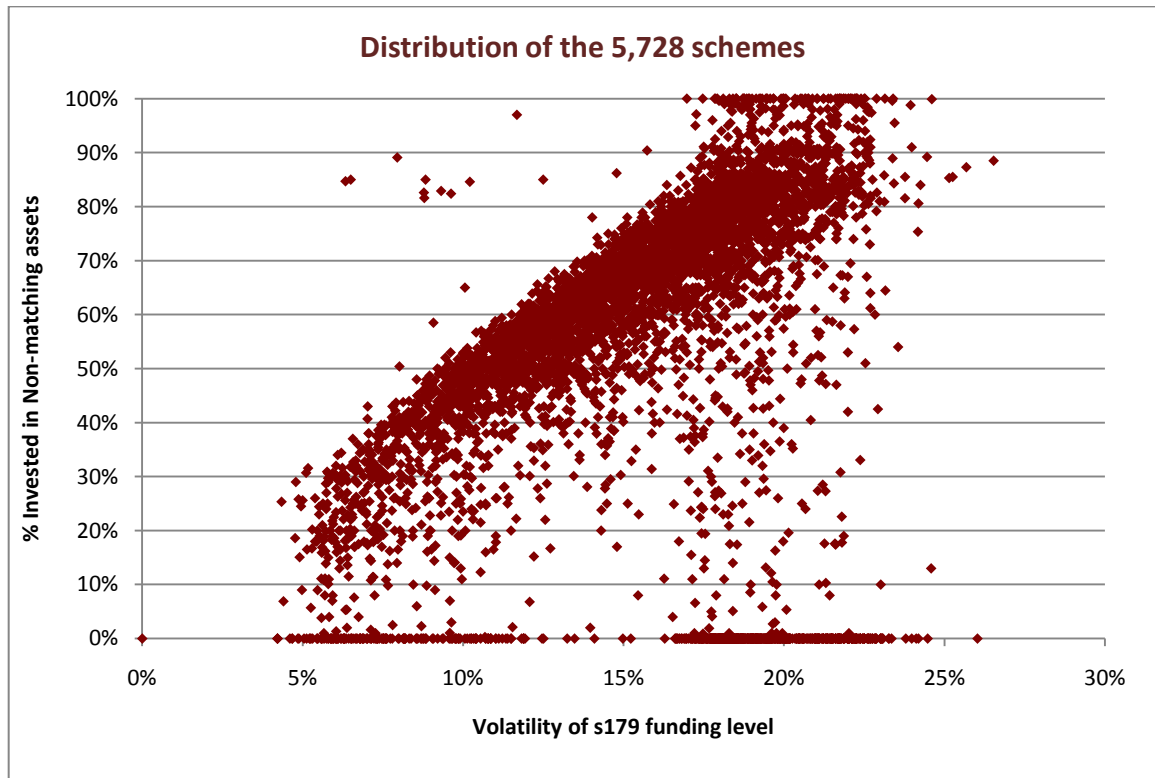


Chart A4: Plot of s179 funding level volatility against proportion invested in non-matching assets for the 5,728 schemes



Appendix B

Longevity risk

There are two areas of consideration when assessing the appropriateness of including longevity as a risk factor in the stress tests

What is an appropriate longevity stress?

Simple deterministic stresses that are often used in practice (for example, assuming the life expectancy of all members increases by one year) are intuitive to understand, but arguably fail to adequately reflect the underlying risk.

More complex stress tests that are more representative of the underlying risks of individual schemes are likely to be too onerous for all but the most sophisticated of pension funds, particularly in the format of the current assumptions being used for s179 valuations.

In addition, in a market-consistent model, such as the one built for this analysis, the lack of market data on longevity risk means it is difficult to calibrate consistently.

What is the impact?

We have assessed the impact of incorporating longevity risk into our Monte Carlo model.

The table below shows the attribution of risk (in this case measured by a 1-year Value-at-Risk at the 1-in-20 confidence level) within a typical pension portfolio before and after incorporating longevity risk. It shows that although longevity risk on its own is not insubstantial (in this case 5.17% of liabilities), the overall contribution to risk is not significant (0.53%) due to its diversification against other risk factors, although this increases as the other risks are hedged and/or reduced (see Table B5 below)

Chart B1: The attribution of Value at Risk of a sample pension scheme without allowing for longevity risk

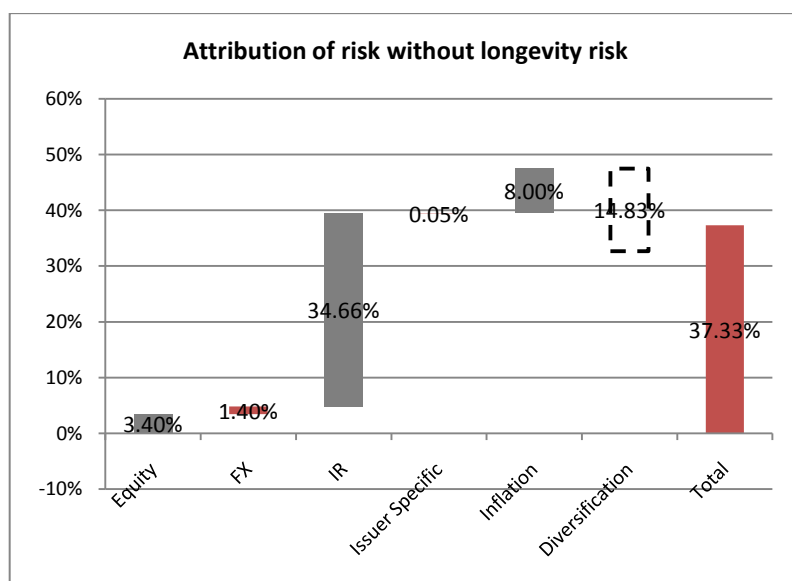
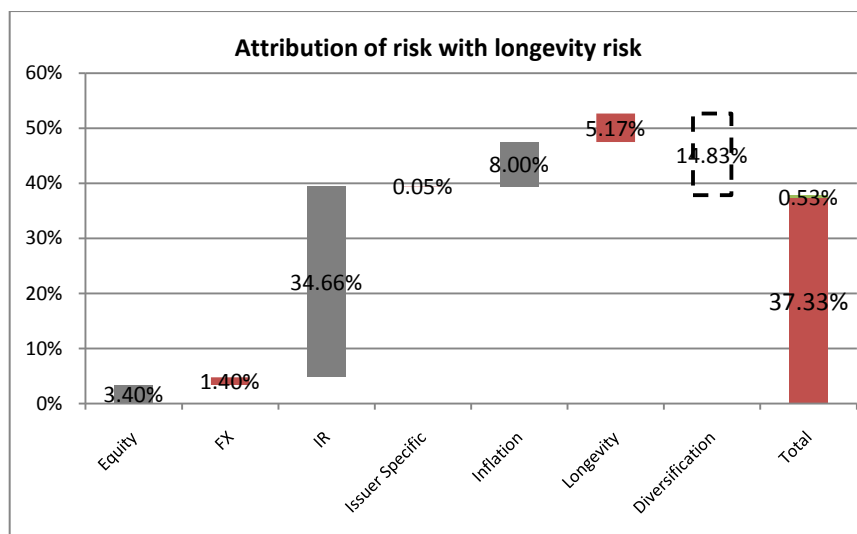


Chart B2: The attribution of Value at Risk of a sample pension scheme with allowance for longevity risk



The following table shows how the same Value at Risk measure, before and after the inclusion of longevity risk, varies by the proportion of assets held in equity and also the amount of hedging in place in a scheme. It can be seen that the schemes where longevity risk does have a significant impact are those schemes where they have managed away most of their equity, inflation and interest rate risk.

Table B3: Table showing risk without allowance for longevity risk

Liability hedge	Proportion of equity										
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%
0%	39.1%	36.9%	34.7%	32.7%	30.8%	28.9%	27.3%	25.7%	24.6%	23.7%	23.0%
20%	35.6%	33.4%	31.2%	29.0%	26.9%	25.0%	23.0%	21.3%	20.0%	19.0%	18.3%
40%	32.6%	30.2%	27.9%	25.5%	23.4%	21.2%	19.1%	17.2%	15.5%	14.2%	13.6%
60%	30.2%	27.6%	25.1%	22.6%	20.2%	17.8%	15.5%	13.3%	11.4%	9.7%	8.9%
80%	27.8%	25.3%	22.7%	20.2%	17.6%	15.1%	12.5%	10.1%	7.8%	5.7%	4.4%
100%	26.4%	23.8%	21.2%	18.6%	16.0%	13.4%	10.7%	8.2%	5.7%	3.5%	2.0%

Table B4: Table showing risk with allowance for longevity risk

Liability hedge	Proportion of equity										
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%
0%	39.4%	37.2%	35.1%	33.1%	31.3%	29.4%	27.8%	26.2%	25.1%	24.2%	23.6%
20%	36.0%	33.8%	31.6%	29.4%	27.4%	25.6%	23.6%	21.9%	20.7%	19.7%	19.0%
40%	33.0%	30.7%	28.4%	26.0%	23.9%	21.8%	19.8%	18.0%	16.3%	15.1%	14.5%
60%	30.6%	28.1%	25.6%	23.2%	20.8%	18.6%	16.4%	14.3%	12.6%	11.0%	10.3%
80%	28.3%	25.8%	23.3%	20.8%	18.4%	16.0%	13.6%	11.3%	9.3%	7.7%	6.8%
100%	26.9%	24.3%	21.8%	19.3%	16.8%	14.3%	11.9%	9.7%	7.7%	6.2%	5.5%

Table B5: Table showing the increase in risk by including longevity risk (from Table A3 to Table A4)

Liability hedge	Proportion of equity										
	100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0%
0%	0.3%	0.4%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%
20%	0.4%	0.4%	0.4%	0.5%	0.5%	0.5%	0.6%	0.6%	0.7%	0.7%	0.7%
40%	0.4%	0.4%	0.5%	0.5%	0.6%	0.6%	0.7%	0.8%	0.8%	0.9%	1.0%
60%	0.4%	0.5%	0.5%	0.6%	0.7%	0.7%	0.8%	1.0%	1.1%	1.3%	1.4%
80%	0.5%	0.5%	0.6%	0.7%	0.7%	0.9%	1.0%	1.2%	1.6%	2.0%	2.4%
100%	0.5%	0.6%	0.6%	0.7%	0.8%	1.0%	1.2%	1.5%	2.0%	2.8%	3.6%

The tables above show that whilst for the majority of positions, the addition of longevity risk does not significantly increase the overall risk, the risk for those schemes that fall into the lower right hand corner, i.e. with low proportion of equity and significant amounts of liability hedging, is significantly impacted.

Currently, there is insufficient data being held by the PPF to accurately assess the level of hedging of each scheme; however the tables below shows the proportion of schemes (both by number and by asset value at 31 March 2009) by the proportion of assets in equity and Redington's estimate of the level of hedging based on the benchmarks chosen for the asset classes.

Table B6: Distribution of the 5,728 pension schemes by number of schemes

Liability hedge ratio	Proportion of equity										
	90% to 100%	80% to 90%	70% to 80%	60% to 70%	50% to 60%	40% to 50%	30% to 40%	20% to 30%	10% to 20%	0% to 10%	
0%	1.8%	8.0%	12.0%	15.7%	10.9%	6.8%	2.8%	1.6%	0.9%	14.2%	
20%	0.0%	0.0%	0.1%	1.1%	3.8%	5.8%	2.9%	1.6%	0.7%	1.0%	
40%	0.0%	0.0%	0.0%	0.0%	0.3%	0.7%	1.1%	0.9%	0.6%	1.0%	
60%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.4%	0.3%	0.8%	
80%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.4%	
100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.6%	
Total	1.8%	8.0%	12.1%	16.8%	15.0%	13.5%	7.2%	4.7%	2.8%	18.0%	

Table B7: Distribution of the 5,728 pension schemes by size of assets

Liability hedge ratio	Proportion of equity										
	90% to 100%	80% to 90%	70% to 80%	60% to 70%	50% to 60%	40% to 50%	30% to 40%	20% to 30%	10% to 20%	0% to 10%	
0%	0.4%	4.3%	5.3%	13.3%	15.2%	9.7%	2.4%	4.2%	0.7%	1.2%	
20%	0.0%	0.0%	0.0%	1.0%	7.1%	11.4%	4.4%	2.5%	0.9%	1.5%	
40%	0.0%	0.0%	0.0%	0.0%	0.3%	1.8%	2.7%	2.1%	2.9%	1.0%	
60%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	1.3%	0.5%	
80%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	
100%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%	0.4%	
Total	0.4%	4.3%	5.3%	14.3%	22.6%	22.8%	9.6%	9.4%	6.5%	4.7%	

Conclusion

Whilst there are a significant number of schemes in the PPF's universe that have little/no return-seeking assets, the distribution by asset size is more evenly distributed, peaking around 50% and with little hedging. In these categories, the incorporation of longevity risk would likely have a relatively small impact.

We recognise that there is likely to be an increasing trend away from return-seeking assets into matching assets over time, but together with the fact that there is no data on which to calibrate the inclusion of longevity risk into a market-consistent model, on balance, we would not recommend the inclusion of longevity risk in the Risk-Based Levy calculation at the current time.

This should be kept under regular review to monitor any trend of investment away from return-seeking assets and also any emergence of a traded market in longevity risk and improved data collection allows it to be incorporated in an effective and cost-efficient manner.

Appendix C

Testing the distribution of the s179 funding ratio for normality

The Kolmogorov-Smirnov test can be used to test the goodness-of-fit of a sample with a reference probability distribution. In this case, for each of the six sample schemes (some with swaps overlays), we are comparing the 10,000 simulated funding ratios and testing it against a normal distribution. The null hypothesis that the sample is distributed normally is rejected at the 95% confidence level if the parameter α is less than 5%.

The results were as follows:

Table C1: The output of the Kolmogorov-Smirnov test on the six sample schemes

Scheme	1	2	3a	3b	4a	4b	5a	5b	6a	6b
Funding level	90%	85%	80%	80%	75%	75%	70%	70%	60%	60%
Asset allocation										
Equity	70%	60%	50%	50%	40%	40%	30%	30%	20%	20%
Bonds	30%	30%	30%	30%	40%	40%	50%	50%	60%	60%
Property	-	10%	10%	10%	10%	10%	10%	10%	10%	10%
Hedge Funds	-	-	5%	5%	5%	5%	5%	5%	5%	5%
Cash	-	-	5%	5%	5%	5%	5%	5%	5%	5%
Swaps (notional)	-	-	-	20%	-	40%	-	60%	-	80%
Liability duration	25	23	23	23	21	21	19	19	17	17
α	15%	3%	0.06%	0.8%	0.01%	1.5%	<0.01%	<0.01%	<0.01%	<0.01%
<i>Distance between 16th and 84th percentiles in funding level</i>										
Sample	45.2%	39.3%	36.4%	34.4%	30.5%	24.8%	25.2%	16.8%	20.6%	9.5%
Normal distribution	46.9%	40.7%	37.8%	35.6%	31.9%	26.2%	30.0%	18.8%	22.4%	12.8%

The top half of the table shows that the funding ratio volatility is more likely to follow a normal distribution for schemes that have a high proportion of assets allocated to equity and other return-seeking assets. As previously shown in Tables B6 and B7 in Appendix B, the schemes in the PPF's universe have a relatively broad spread of equity exposure (peaking around 50%) and low levels of hedging.

There will therefore be a significant number of schemes where the "fairness" model assumption that the funding ratio follows a normal distribution does not hold.

The bottom half of the table shows the width of the funding level distribution between the 16th and 84th percentiles of both the sample simulation and a normal distribution that is fitted to have the same mean and variance as the sample simulation. We have chosen these percentiles as they represent the points that are one standard deviation away from the mean in both directions.

We can see that the sample simulations in all cases have a narrower distribution around the mean than the normal distribution, highlighting the fact that a normal distribution tends to overstate the risk. However, as we move towards portfolios with more matching assets and/or hedging, although the normality test fails, the absolute level of the funding level volatility can be seen to fall and hence using a normal distribution still captures the majority of the benefit of the risk management actions.

Appendix D

Testing the volatility of the s179 funding ratio for different parameters

Table D1: Volatility of s179 funding ratio assuming 80% funding ratio, with model parameters based on daily market data between 1 January 2006 and 31 March 2009

S179 Funding Ratio Volatility					
	Liability duration (years)				
Bond Allocation	10	15	20	25	30
10%	17%	18%	20%	22%	24%
20%	14%	16%	18%	20%	22%
30%	12%	14%	16%	18%	20%
40%	10%	12%	14%	16%	18%
50%	8%	10%	12%	14%	17%
60%	6%	8%	10%	12%	15%
70%	4%	6%	8%	11%	13%

Table D2: Volatility of s179 funding ratio assuming 106% funding ratio, with model parameters based on daily market data between 1 January 2006 and 31 March 2009

S179 Funding Ratio Volatility					
	Liability duration (years)				
Bond Allocation	10	15	20	25	30
10%	22%	24%	26%	29%	32%
20%	19%	21%	23%	26%	29%
30%	16%	19%	21%	24%	27%
40%	14%	16%	18%	21%	24%
50%	11%	13%	15%	19%	22%
60%	8%	11%	13%	16%	20%
70%	6%	8%	11%	14%	18%

106% is the aggregate funding level of the PPF7800 index at 31 March 2008 and was therefore chosen to show how the volatilities might move year-to-year. As can be seen, the funding ratio volatility is very sensitive to the initial funding level assumed.

Table D3: Volatility of s179 funding ratio assuming 80% funding ratio, with model parameters based on daily market data between 1 January 2006 and 31 December 2007

S179 Funding Ratio Volatility					
	Liability duration (years)				
Bond Allocation	10	15	20	25	30
10%	8%	9%	11%	12%	14%
20%	7%	8%	10%	11%	13%
30%	6%	7%	9%	11%	12%
40%	5%	6%	8%	10%	12%
50%	4%	6%	7%	9%	11%
60%	3%	5%	6%	8%	10%
70%	3%	4%	6%	8%	10%

Table D4: Volatility of s179 funding ratio assuming 80% funding ratio, with model parameters based on daily market data between 1 January 2007 and 31 March 2009

S179 Funding Ratio Volatility					
	Liability duration (years)				
Bond Allocation	10	15	20	25	30
10%	20%	22%	24%	27%	29%
20%	18%	20%	21%	24%	27%
30%	15%	17%	19%	22%	24%
40%	12%	14%	16%	19%	22%
50%	10%	12%	14%	17%	20%
60%	7%	10%	12%	15%	18%
70%	5%	7%	10%	13%	16%

The last three years have seen extremely volatile markets. As a result, the period over which the model is calibrated has a significant effect on the resulting volatilities. This can be mitigated somewhat by smoothing the outcomes over a number of years, but it suggests that the “fairness” workstream should be tested for a range of input volatilities.

Appendix E

Example questions and explanations on Exchange to assist schemes in determining whether they are required to use Option C rather than Option B

1. Does your scheme have direct investments¹⁶ in any of the following equity derivative strategies?

An equity derivative strategy is one where the scheme has entered into a contract with another party to pay or receive a series of payments (or one single payment) whose value is determined by the future movement of equity markets.

Equity derivative strategy	Scheme action
Equity futures: These contracts promise to pay the scheme the return on an equity index (e.g. FTSE 100, or S&P 500)	Ensure the notional value of the future is identifiable in your submission.
Equity total return swaps: These contracts promise to pay the scheme the return on an equity index (e.g. FTSE 100 or S&P 500) in return for a series of payments from the scheme to the counterparty.	Ensure the notional value of the total return swaps is identifiable as equity in your submission
Equity options: These contracts typically protect the scheme from equity markets falling below a certain level, in return for paying an upfront premium (e.g. a “put option” or “put spread”). In some cases, schemes may also have agreed to limit their gain from rising equity markets, in return for receiving an upfront premium (e.g. a “call option” or “call spread”). Most other commonly used strategies are typically combinations of buying or selling put or call options (e.g. “put collar”)	Scheme is required to calculate a stressed value

2. Does your scheme have any direct investments¹⁶ in interest rate derivative strategies?

An interest rate derivative strategy is one where the scheme has entered into a contract with another party to pay or receive a series of payments (or one single payment) whose value is determined by the future movement of interest rates. They are more commonly known as “LDI” investments and typically consist of interest rate swaps and protect the scheme’s funding level volatility from interest rate movements.

¹⁶ “Direct investment” refers to the use of derivatives as an explicit part of the trustees’ investment strategy and as documented in the trustees’ Statement of Investment Principles. It does not refer to derivative strategies used by asset managers for efficient management of their portfolios and therefore indirectly part of the investments.

If you have these strategies, you will need either need to request the stressed valuation from the asset manager/investment consultant or carry out the calculation yourself with some information from the asset manager. In the latter case you should ask your asset manager for the “PV01” of the portfolio, i.e. the sensitivity of the portfolio value to a 0.01% change in interest rates.

3. Does your scheme have any direct investments¹⁶ in inflation derivative strategies?

An inflation derivative strategy is one where the scheme has entered into a contract with another party to pay or receive a series of payments (or one single payment) whose value is determined by the future movement of inflation rates. They are more commonly known as “LDI” investments and typically include inflation swaps and protect the scheme’s funding level volatility from changes in inflation.

If you have these strategies, you will need either need to request the stressed valuation from the asset manager/investment consultant or carry out the calculation yourself with some information from the asset manager. In the latter case you should ask your asset manager for the “PV01” and “IE01” of the portfolio, i.e. the sensitivity of the portfolio value to a 0.01% change in interest rates and inflation respectively¹⁷.

4. Does your scheme have any direct investments¹⁶ in credit default swaps?

A credit default swap is where the scheme has agreed to make a series of payments to buy or sell protection against the default of a corporate bond or corporate loan. They are commonly used by pension schemes to manage sizeable exposures to corporate bond/loan issuers.

If you have these strategies, you will need either need to request the stressed valuation from the asset manager/investment consultant or carry out the calculation yourself with some information from the asset manager. In the latter case you should ask your asset manager for the “CDD01” of the portfolio, i.e. the sensitivity of the portfolio value to a 0.01% change in credit spreads.

¹⁷ Although the primary risk factor within inflation swaps will be inflation risk, the market value of the swaps contract will also have sensitivity to interest rates. On day 1, this sensitivity will be zero (for an unfunded swap).

Appendix F

Example guidance on applying risk factor stress tests to asset strategies

Equity derivatives

The stress on the equity option is simply the change in the intrinsic value of the option. The calculation is set out below and should be carried out separately for each option that the scheme has.

Input parameters

Strike price of option:	S
Level of the underlying index at 31 March [2009]	P
Notional option exposure	E
Equity stress test at 31 March [2009] (note this may be different for UK and non-UK equity)	d

Intrinsic value calculations

A. Equity put option

- | | |
|---|--|
| 1. Calculate current intrinsic value option | $\text{Value}_0 = \max [0, E \times (S - P) \div S]$ |
| 2. Calculate stressed level of index | $P_{\text{stress}} = P \times (1 + d)$ |
| 3. Calculate stressed intrinsic value of option | $\text{Value}_1 = \max [0, E \times (S - P_{\text{stress}}) \div S]$ |
| 4. Calculate stress test to apply | $\text{Equity}_{\text{stress}} = \text{Value}_1 - \text{Value}_0$ |

B. Equity call option

- | | |
|---|--|
| 1. Calculate current intrinsic value option | $\text{Value}_0 = \max [0, E \times (P - S) \div S]$ |
| 2. Calculate stressed level of index | $P_{\text{stress}} = P \times (1 + d)$ |
| 3. Calculate stressed intrinsic value of option | $\text{Value}_1 = \max [0, E \times (P_{\text{stress}} - S) \div S]$ |
| 4. Calculate stress test to apply | $\text{Equity}_{\text{stress}} = \text{Value}_1 - \text{Value}_0$ |

Adjustment to total asset value

If the scheme has bought the option, the $\text{Equity}_{\text{stress}}$ should be added to the overall asset value, i.e. the option increases the overall asset value.

If the scheme has sold the option, the $\text{Equity}_{\text{stress}}$ should be subtracted from the overall asset value, i.e. the option decreases the overall asset value.

This example has been constructed to illustrate potential scenarios.

Example: A pension fund has an unexpired put option that it bought on the UK FTSE 100 Index with a strike price of 3,800 and notional value of £100m. It has also sold a call option on the US S&P 500 Index with a strike price of 550 and notional value of £75m, which is also unexpired. At 31 March 2009, the market value of the fund's assets is £500m and the levels of the UK FTSE 100 Index and US S&P 500 Index are 3,926 and 798 respectively. It has no other derivative strategies.

Calculations:

A. Intrinsic value of put option on UK FTSE 100 Index

Strike price = 3,800

Level of Index at 31 March 2009 = 3,926

Notional exposure = £100m

Equity stress test at 31 March 2009 = -21.7% (from table 4b)

1. Current intrinsic value = $\max [0, £100m \times (3,800 - 3,926) \div 3,800] = £0m$
2. Stressed value of Index = $3,926 \times (1 - 21.7\%) = 3,074$
3. Stressed intrinsic value = $\max [0, £100m \times (3,800 - 3,074) \div 3,800] = £19m$
4. Equity_stress = $£19m - £0m = £19m$

B. Intrinsic value of call option on US S&P 500 Index

Strike price = 550

Level of Index at 31 March 2009 = 798

Notional exposure = £75m

Equity stress test at 31 March 2009 = -18.5% (from table 4b)

1. Current intrinsic value = $\max [0, £75m \times (798 - 550) \div 550] = £34m$
2. Stressed value of Index = $798 \times (1 - 18.5\%) = 650$
3. Stressed intrinsic value = $\max [0, £75m \times (650 - 550) \div 550] = £14m$
4. Equity_stress = $£14m - £34m = -£20m$

Overall stressed asset value = $£500m + £19m - (-£20m) = £539m$

The vast majority of equity option-based strategies can be deconstructed into a number of the above component parts. For example, a zero cost collar is made up of buying a put option and selling a call option (at different strike prices). A put spread is a combination of buying a put option and selling another put option at a different strike price. Each element of these can be valued separately and the stresses added together.

Interest rate derivatives

The stress calculation calculates the increase in the value of the derivative associated with the interest rate risk factor stress test.

Input parameters

PV01 of the portfolio at 31 March [2009] (from the asset manager – this is the sensitivity of the portfolio value to 1 basis point, or 0.01% change in rates)	PV01
Interest rate risk factor stress test at 31 March [2009]	d (basis points)

Calculations

Calculate impact of stress test on portfolio $PV01 \times d$

Typically, pension funds will be receiving the fixed leg of an interest rate swap, in which case the absolute value of the stress test should be added to the overall asset value.

If the fund is paying the fixed leg of an interest rate swap, the absolute value of the stress test should be deducted from the overall asset value.

This example has been constructed to illustrate potential scenarios.

Example: A pension fund has £5m notional of interest rate swaps, for which it is paying floating rate and receiving fixed rate. At 31 March 2009, the asset manager has advised that the present value of this swaps contract is £265,204 and the PV01 of this swaps portfolio is –£14,761.

The total value of the pension fund's assets at 31 March 2009 is £25m. The fund has no other derivative contracts.

Calculations:

Interest rate stress test at 31 March 2009 = –66bps (see table 4b)

Stress test on interest rate swaps portfolio = –£14,761 × –66 = £974,226

The absolute value of the stress test should be added to the total asset value as the fund is receiving fixed rate payments.

Overall stressed asset value = £25m + £974,226 = £25,974,226

Inflation derivatives

The stress calculation calculates the increase in the value of the derivative associated with the inflation risk factor stress test.

Input parameters

IE01 of the portfolio at 31 March [2009] (from the asset manager – this is the sensitivity of the portfolio value to 1 basis point, or 0.01% change in inflation)	<i>IE01</i>
PV01 of the portfolio at 31 March [2009] (from the asset manager – this is the sensitivity of the portfolio value to 1 basis point, or 0.01% change in rates)	<i>PV01</i>
Market value of inflation swaps contract	<i>Value</i>
Inflation risk factor stress test at 31 March [2009]	<i>d_inf</i> (basis points)
Inflation risk factor stress test at 31 March [2009]	<i>d_rates</i> (basis points)

Calculations

Calculate impact of inflation stress test on portfolio	$IE01 \times d_inf$
Calculate impact of interest rate stress test on portfolio	$PV01 \times d_rates$

Typically, pension funds will enter inflation swaps as the receiver of the inflation linked payments. In this case, the absolute value of the inflation stress test should be added to the overall asset value. If the fund is paying inflation-linked payments, the absolute value of the inflation stress test should be deducted from the overall asset value.

If the market value of the inflation swaps contract is positive, the absolute value of the interest rate stress test should be added to the overall asset value. If the market value of the inflation swaps contract is negative, the absolute value of the interest rate stress test should be deducted from the overall asset value.

This example has been constructed to illustrate potential scenarios.

Example: A pension fund has £5m notional of inflation swaps, for which it is paying fixed rate and receiving inflation. At 31 March 2009, the asset manager has advised that the market value of this swaps contract is -£250,908, the PV01 of the contract is £908 and the IE01 of the contract is £12,643.

The total value of the pension fund's assets at 31 March 2009 is £13m. The fund has no other derivative contracts.

Calculation:

Inflation stress test at 31 March 2009 = 60bps (see table 4b)

Interest rate stress test at 31 March 2009 = -66bps (see table 4b)

Inflation stress = -£12,643 × 60 = £758,580

Interest rate stress = £908 × -66 = -£64,680

The absolute value of the inflation stress should be added to the overall asset value as the fund is receiving inflation-linked payments. The absolute value of the interest rate stress should be deducted from the overall asset value as the market value of the swaps contract is negative.

Overall stressed asset value = £13m + £758,580 - £64,680 = £13,693,900

Credit default swaps

The stress calculation calculates the increase in the value of the derivative associated with the credit risk factor stress test.

Input parameters

CDD01 of the portfolio at 31 March [2009] (from the asset manager – this is the sensitivity of the portfolio value to 1 basis point, or 0.01% change in credit spreads)	<i>CDD01</i>
Credit risk factor stress test at 31 March [2009]	<i>d</i> (basis points) e.g. +120 at 31 March 2009 (see table 4b)

Calculations

Calculate impact of stress test on portfolio $CDD01 \times d$

If the scheme has bought credit protection, the absolute value of this stress test should be added to the asset value. If the scheme has sold credit protection, the absolute value of this stress test should be subtracted from the asset value.

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