

A proposal for amending GN27 Appendix 2 Paragraph A: a methodology for producing pension increase assumptions for current pensioners for MFR purposes, in particular dealing with the problem of increases with floors and caps.

By Brian Wilson and Paul Greenwood on behalf of the Technical Support and Research Committee

1. The Problem

- 1.1 The current approach and wording of GN27 produces sensible answers for cap and collar adjustments when the forward inflation rate is of the order of 4%pa to 5%pa. The profession's problem is that the market has moved substantially away from that level. The current Guidance Note (taken in conjunction with comments by the Profession at CPD meetings) means that many actuaries are using techniques to derive cap and collar adjustments that are both inappropriate to current market conditions and can vary considerably. At extreme the variation has produced figures for liabilities varying by as much as 25% between different actuaries.
- 1.2 This illustrates the current considerable uncertainty in the profession on how to calculate MFR values in situations where the guaranteed pension increase is subject to a cap and/or a floor and/or a multiple of RPI other than one. This problem is particularly acute for pensions in payment, where current gilt yields are used to determine the value of pensioner liabilities. Diverse values are being used which, sooner or later, will cause practical problems (eg in M&A work) if a common methodology is not accepted. The reputation of the profession may be tarnished as a result.
- 1.3 Whilst the proposals in this paper are primarily concerned with assumptions used to value pensions in payment, we also recommend a change in one specific long-term assumption used for non-pensioner liabilities, that for pension increases for post-88 GMPs, and that the general approach used for cap and collar adjustments for pensions in payment is also applied to long-term assumptions.
- 1.4 The disparate answers being produced are to a large extent the result of the current GN27 requirement for valuing LPI liabilities. GN27 currently requires the addition of 0.5% to the yield on index-linked gilts to obtain the net yield for valuing LPI liabilities. This addition was appropriate when GN27 was first drafted and when forward inflation was of the order of 4%pa. Currently forward inflation is less than 2%pa and LPI liabilities in payment are being under-valued by about 4% relative to the liability calculated on a market-based valuation methodology. The 0.5% addition is no longer defensible.
- 1.5 The larger discrepancies are occurring where there is a floor to guaranteed pension increases, often of 3%pa. Many actuaries interpret the current guidance as requiring that the liability value is calculated using the *greater* of the liabilities calculated on a fixed gilt or index-linked gilt basis. Others apply different methodologies to arrive at very different answers.
- 1.6 Whilst it is appreciated that any substantive amendment of GN27 in the direction of a market-based valuation methodology is properly the subject of the major overhaul of the

guidance currently under discussion with the DSS, the Technical Support and Research Committee recommends that a change in this particular area is imperative in order to obtain consistency of approach within the profession.

- 1.7 A further consideration is that it is understood that Banking regulations now require reserves for options (a not dissimilar problem to that addressed in this paper) to be calculated on a "mark to market" basis, which in practice means the use of a Black-Scholes or similar methodology, which is the approach proposed below. We feel that the profession should be taking the lead in the use of modern methodologies if we are to attract the right people into the profession. Our current reserving methods look distinctly old fashioned. We understand that the leading life offices are now using Black-Scholes methodologies for valuing annuities with zero floors.
- 1.8 Whilst a proposal that would add up to 4% to the MFR pensioner liabilities of many schemes is not a pleasant prospect for clients of the profession, the profession also has a public interest requirement to fulfil. It is a fact that LPI annuities are now more expensive than the MFR basis as a result of low interest rates.
- 1.9 Moreover, pensioner mortality has almost certainly improved to the extent of at least one year in the rating of the mortality table since GN27 was drafted. This latter amendment will almost certainly be considered as part of the more substantive revision of GN27. An additional one year rating would add between 3% and 4% to liabilities. It is arguable that increasing liabilities in two bites rather than one is more palatable.

2. Proposed Method

- 2.1 The methodology we are proposing is based on Black-Scholes and uses the ideas first put forward by David Wilkie in his paper "The Use of Option Pricing Theory for Valuing Benefits with 'Cap and Collar' Guarantees" published in the Transactions of the 23rd International Congress of Actuaries, Helsinki, July 1988. This is the only accepted published methodology and has been repeated, with refinements, in a number of published papers over the course of the last ten years. Unfortunately, as pointed out above, this does not fit the current MFR requirement set out in paragraph A of Appendix 2 to GN27, as the required addition of 0.5% to the I-L gilt yield for valuing LPI pension increases is not sustainable on any financial economic model once implied forward inflation moves significantly from 4%pa.
- 2.2 When the longer-term revision of the MFR basis is being considered it may be appropriate to use a rather more sophisticated financial economics model. The Black-Scholes assumes no correlation between inflation in adjacent years. It may be possible to put forward a more cohesive proposal in a few months time for the longer-term review based on work currently being carried out by Andrew Smith and others. Until this is published, however, we would suggest sticking with the well-known Black-Scholes methodology.
- 2.3 The Black-Scholes model we have used takes as variables:

f_i = fixed income yield (annualised)

il = index linked yield (annualised)

k = multiple of inflation granted

cap = maximum increase (ie achieved when inflation = cap/k)

$floor$ = minimum increase

and returns a suitable assumption for increases by placing values on a put option for the floor and a call option for the cap.

The formulae used for the put and call options are:

$$put = (k + floor) * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{(k + floor) * (1 + il)}{k * (1 + fi)} \right] + \frac{\sigma}{2} \right) \\ - k * \frac{1 + fi}{1 + il} * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{(k + floor) * (1 + il)}{k * (1 + fi)} \right] - \frac{\sigma}{2} \right)$$

and

$$call = k * \frac{1 + fi}{1 + il} * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{k * (1 + fi)}{(k + cap) * (1 + il)} \right] + \frac{\sigma}{2} \right) \\ - (k + cap) * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{k * (1 + fi)}{(k + cap) * (1 + il)} \right] - \frac{\sigma}{2} \right)$$

Φ being the cumulative normal distribution function.

We are proposing that the volatility σ be taken as 2.3% as this is the value at which the current LPI assumption is reproduced on the long-term assumptions. A rather larger value would be justified from empirical evidence.

The pension increase assumption is of the form

$$p(fi, il, k, cap, floor)$$

as set out in Appendix A.

- 2.4 We have produced an Excel model that produces the answer on the above basis on inputting the fixed gilt and index-linked gilt yields and the pension increase cap, floor and RPI multiplier parameters. If the methodology were acceptable, this model could be placed on the Institute web site for downloading and use by any member of the profession. This would not be a "black box" as the formulae would all be totally transparent. It is, however,

extremely simple to use, only requiring the inputting of the three basic scheme-related constants and two gilt yields.

- 2.5 For members of the profession who have not mastered a computer, or who cannot access the Institute's web pages, we would propose setting out in a memorandum (which would not be a part of the Guidance Note) how to calculate the required values using published normal distribution values.
- 2.6 There has been concern expressed that scheme actuaries should not be being required to use a formula that they could not themselves derive. We would propose a series of workshops across the country educating members on the basics of option pricing theory and the Black-Scholes formula. This is now part of the Institute examination material, and all scheme actuaries (including, dare we say it, Pensions Board members) should be attending CPD appropriate to the demands the profession is requiring of them. We are not suggesting that scheme actuaries should be familiar with the whole of the Derivatives course, only those parts of it that are necessary for a basic understanding of the Black-Scholes formula.
- 2.7 For consistency, a natural extension of the use of the Black-Scholes methodology to pension increases with caps and floors would be to use it for calculating the pension increase assumption for fully index-linked pensions. The wording in Appendix A to this memo assumes that this would follow. At 31/12/98, using current GN27 requirements, the net discount rate would be that on index-linked gilts (1.95%pa) giving an increase assumption of $1.0448/1.0195 - 1 = 2.48\%$. Placing a value on the zero floor would increase the pension increase assumption to 2.65%, requiring a net discount rate of 1.78%pa. This would increase MFR liabilities for index-linked pensions in payments by approximately 1.5%.
- 2.8 The further change we would recommend to the long-term assumptions set out in paragraph B.1 of Appendix A to GN27 is to reduce the assumed rate of increase in post 1988 GMPs from 2.75% to 2.5%. This assumption will then be the same as the assumption in retirement when forward inflation is 4%pa. This reduction in liability will also partially offset any increase in liability for pensions in payment.
- 2.9 On the question of the algorithm for long-term MFR pension increase assumption, it should be noted that the Andrew Wilson algorithm published in the Actuary does not permit negative inflation and so gives the same answer if the floor is zero or if there is no floor. The long-term future of the Andrew Wilson methodology must therefore be questioned. In any event it would need to be modified to take account of the proposal in 2.5 above. A ready alternative would be to use the Black-Scholes formula in conjunction with the long-term assumptions and we recommend that an additional paragraph B3 be added to Appendix 2 to GN27 to this effect.

3. Summary of Recommendations

- 3.1 We recommend that the Black-Scholes methodology for valuing pensions with caps and floors be introduced into GN27 without waiting for the major review currently under way.
- 3.2 We recommend that the same methodology is used, for consistency, for valuing pensions with a full RPI guarantee, but with a zero floor.
- 3.3 We recommend that the long-term pension increase assumption for valuing post-88 GMPs be reduced from 2.75% to 2.5%.
- 3.4 We recommend that the long-term pension increase assumption for all pensions with caps and floors, or with only floors, be valued using the Black-Scholes methodology, inputting the long-term assumptions.
- 3.5 We recommend a series of workshops across the country educating members on the basics of option pricing theory and the Black-Scholes formula.

17 March 1999

APPENDIX A

Proposed revised wording for GN27 Appendix 2 Paragraph A

Pensioner liabilities should be valued using the gross redemption yield on the FT-Actuaries Fixed Interest 15 year Index. The pension increase assumption to be adopted, in cases where the guaranteed increase is dependent on the level of inflation, should be derived from the following Black-Scholes formula:

Annual pension increase = market-derived increase ignoring any floor or cap (A)

plus

allowance for market-derived increase for any floor (ie a "put" option = B)

minus

allowance for market-derived increase for any cap (ie a "call" option = C)

where, if fi = annualised gross redemption yield on the FT-Actuaries Fixed Interest 15 year Index

il = annualised index-linked gross redemption yield on the FT-Actuaries Index-Linked over 5 year (5% inflation) Index

k = guaranteed multiple of inflation

cap = maximum guaranteed annual increase

$floor$ = minimum guaranteed annual increase

$$A = k * [(1 + fi)/(1 + il) - 1]$$

$$B = (k + floor) * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{(k + floor) * (1 + il)}{k * (1 + fi)} \right] + \frac{\sigma}{2} \right) - k * \frac{1 + fi}{1 + il} * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{(k + floor) * (1 + il)}{k * (1 + fi)} \right] - \frac{\sigma}{2} \right)$$

$$C = k * \frac{1 + fi}{1 + il} * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{k * (1 + fi)}{(k + cap) * (1 + il)} \right] + \frac{\sigma}{2} \right) - (k + cap) * \Phi \left(\frac{1}{\sigma} \ln \left[\frac{k * (1 + fi)}{(k + cap) * (1 + il)} \right] - \frac{\sigma}{2} \right)$$

$$\sigma = 2.3\%$$

Φ being the cumulative normal distribution function.

APPENDIX B

Proposed wording for GN27 Appendix 2 new Paragraph B3

Pension increase assumptions should be derived as in paragraph A above, but using the long-term assumptions in paragraph B1.

17 March 1999