SOME PRACTICAL ASPECTS OF STOCHASTIC ASSET AND LIABILITY MODELLING OF UK WITH PROFITS BUSINESS

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ABSTRACT

This paper considers issues relating to the sound financial management of with profits business of the types currently available in the United Kingdom. We describe how these issues can be addressed using stochastic asset and liability modelling, and we give examples of the form of results that can be obtained in practice.

Quelques aspects pratiques de la modélisation stochastique actif/passif des entreprises britanniques à but lucratif

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Résumé

La présente étude examine les questions ayant trait à la bonne gestion financière des types d'entreprises à but lucratif qui existent actuellement au Royaume-Uni. Nous décrivons l'application de la modélisation stochastique actif/passif à ces questions et donnons des exemples de la forme des résultats qui peuvent être obtenus dans la pratique.

UK Background

1 With profits policies have been issued in the UK for many years. In the early years, the underlying investments were largely fixed interest, and profits were allocated periodically to policyholders over the term of the policy by means of bonuses payable on death or maturity - a simple reversionary bonus equal to a percentage of the sum assured. Once allocated, the bonuses earned to date were guaranteed. Over the last four decades the underlying investments have increasingly included a significant element of equity or property investment. The form of bonus distribution has changed in order to accommodate these types of investment. The simple reversionary bonus was replaced with a compound reversionary bonus, equal to a percentage of the sum assured and previously declared bonuses. A 'super-compound' reversionary bonus has become common, equal to a percentage of basic sum assured plus a different (and higher) percentage of previously declared bonus. Also terminal bonuses - non-guaranteed bonuses payable on death or maturity which could be altered or removed at any time - have become common. The development of these different bonus structures has partly been in response to the increased proportion of equity-type assets, and partly influenced by a desire to minimise statutory reserving strains.

2 A further development over recent years has been the introduction of unitised with profits (UWP) contracts. These are essentially unit-linked contracts linked to a with profits unitised fund. All UWP contracts provide a guarantee that on maturity the values of units purchased with each premium will be not less than the values at the date of purchase increased by the bonus declarations to date. Some contracts guarantee that units purchased to date will accrue at least a minimum rate of bonus, for example 3% per annum. Some contracts also apply this guarantee to units to be purchased in the future. UWP contracts typically have front-end and other explicit charges and can have lower new business strain than conventional with profits contracts. They also have other features including switching facilities to or from other unit-linked funds.

3 During the years of strong equity performance in the post-war period many life companies saw their assets rise in value more rapidly than their liabilities, in part due to a delay in responding to the increase in overall investment returns by way of increased bonus rates. Over the period there has been a significant increase in the size of non-guaranteed terminal bonus rates, which for longer term policies can now represent over half of the maturity proceeds. Reserves are not strictly required to be held for these terminal bonuses. However, in recent years lower overall investment returns have been earned than were necessary to support the levels of bonus declared. This has led to a general reduction in the financial strength of offices writing with profits business, and a reduction in declared bonus rates.

4 As a result, with profits policies have suffered a degree of criticism in the financial press. Part of this is due to the unreasonable expectation that bonuses could be maintained at high levels even when investment conditions became less favourable, and companies which have offered these products must take some of the blame for allowing this misconception to develop. Other criticisms of with profit contracts have been:

- Equity investment has in the past out-performed other forms of investment over long periods, and with profit contracts, which invest in property and fixed interest investments as well as equities, are likely to produce lower returns than a 100% equity product.
- The expense charges levied on with profits contracts are hidden.
- The very high proportion of non-guaranteed terminal bonuses attaching to with profits policies makes the guarantee of limited value.

Issues arising

5 These pressures have led both life company management and regulators to focus greater attention on the financial management of with profits business. Some of the questions that have been raised are:

- What level of guarantee should be included in with profits products?
- How should the potential cost of the guarantee be assessed and what level of reserves should be held?
- What should be the balance between reversionary bonuses and terminal bonuses?
- How should the level of bonus to be declared in varying investment conditions be determined?
- How should investment policy be determined, and in particular what proportion of assets can safely be invested in equities and property?
- How should the amount of free assets of the company be managed?
- How much with profits business can a company accept without endangering its financial stability?

These questions are inter-related, and to some extent the issues centre around devising an effective strategy for offering with profits contracts on a basis which provides attractive potential investment returns and benefits to policyholders and at the same time meets the company's own objectives, for example preserving or increasing the amount of free assets or meeting shareholder requirements.

Modelling

6 In this paper we discuss how stochastic modelling can be used to shed light on these issues, and give some examples. The examples given are of hypothetical products and portfolios of business, but they are based on exercises which have been carried out in practice.

7 The modelling consists of a series of projections of assets and liabilities of a with profits contract or portfolio of contracts. Investment returns are modelled stochastically using the "Wilkie model" - as described in Professor A D Wilkie's paper to the Faculty of Actuaries (1986) - but with the revised parameters presented by Professor Wilkie to the 1992 International Congress of Actuaries, which are shown in the Appendix. For the purposes of this paper 500 stochastic simulations have been carried out for each investigation; in practice for some investigations it may be necessary to carry out a greater number of simulations.

8 Assumptions need to be made about mortality experience, policy discontinuance rates, taxation, expenses and commission. Statutory actuarial reserving requirements and requirements for profits to shareholders may also need to be taken into account. This has been done using standard actuarial techniques, and these assumptions are not discussed further in this paper. Maintenance expenses have been assumed to be linked with future inflation rates, but otherwise these assumptions are assumed not to be dependent upon the stochastic asset projections. In particular, policy discontinuance rates have not been linked to the stochastically projected economic conditions, although this is a refinement that could have been adopted.

9 Apart from the above assumptions, and those inherent in the stochastic asset model, the other key assumptions that need to be made in the projections are:

- What mechanism is used for deciding on the level of reversionary and terminal bonuses to be declared each year during each different financial projection?
- What investment strategy is adopted initially, and how does this change year by year as the portfolio matures, and as the company's financial strength fluctuates?
- What proportion of the asset share is targeted to be paid out at maturity, where the asset share equals the accumulation of premiums paid, less the

cost of expenses, commission, mortality and taxation, at the investment return earned on the fund?

10 We have incorporated an automatic mechanism for determining bonus declarations each year, based upon the following process.

- In each year of the projection a bonus reserve valuation is carried out to determine the rate of future bonus supportable using realistic assumptions about future experience. For this purpose it was assumed that for the following five years the investment return achieved would be broadly equal to the fixed interest yield available at the bonus reserve valuation date, following which there would be a gradual reversion to the central investment returns assumed in the stochastic asset model, based on the actual investment allocation.
- The bonus reserve valuation assumes that the target terminal bonus rate is 30% of total reversionary bonus, and that a compound reversionary bonus is declared. It has also been assumed that the full asset share is to be paid out at maturity.
- The rate of reversionary bonus declared each year is assumed to be equal to 50% of the rate declared in the previous year plus 50% of the rate calculated in the bonus reserve valuation as supportable throughout the remainder of the term.
- The rate of terminal bonus declared each year is equal to 60% of the rate declared the previous year on similar policies then maturing plus 40% of the rate calculated as supportable from the bonus reserve valuation at the start of the year after allowing for the actual rate of the reversionary bonus declared at that time. No change is made to terminal bonus rates during the year.

These assumptions are not intended to be definitive, or representative of an actual company's practice, but can be used as a base against which to assess different

strategies. They allow for smoothing of bonus rates, since stability of payouts is an essential feature of with profits business.

11 Initially we look at a conventional with profit endowment for a term of 25 years, annual premium of £600 and sum assured of £14,000, for a mutual life office. It is assumed that the underlying investment allocation is fixed at 70% equities, 30% fixed interest (average outstanding term 13 years) in all future circumstances. Surrender payments are assumed to equal 100% of asset share, ie no residual profit is made on surrender. In order to investigate the possible effect on a company of issuing a contract of this type, we calculate the amount of capital support that would be needed at outset, if with the benefit of hindsight the future experience for each simulation was known in advance. Hence the amount of initial capital is calculated which if invested in the fund is sufficient to meet the ultimate cost of any excess of policy proceeds over the accumulated premiums less outgoings. No account is taken at this stage of any reserves required to be held. What is being measured therefore is the potential actual ultimate cost or profit to the fund of a bonus distribution and investment allocation strategy, particularly in adverse economic conditions.

Results for a single policy

12 Figure 1 shows, for 500 simulations, the capital required at outset, expressed as a multiple of annual premium. The simulations have been ranked according to the amount of capital required. It will be noted that for the median simulation there is a small overall profit to the office, an indication that the assumed bonus declaration mechanism is on average slightly conservative.

13 Figure 2 shows the capital required at outset for selected simulations. Thus the worst simulation required initial capital of over two times the annual premium, and 5% of simulations required initial capital of over three-quarters of an annual premium. The most favourable simulation releases capital of about 1.3 times the annual premium.

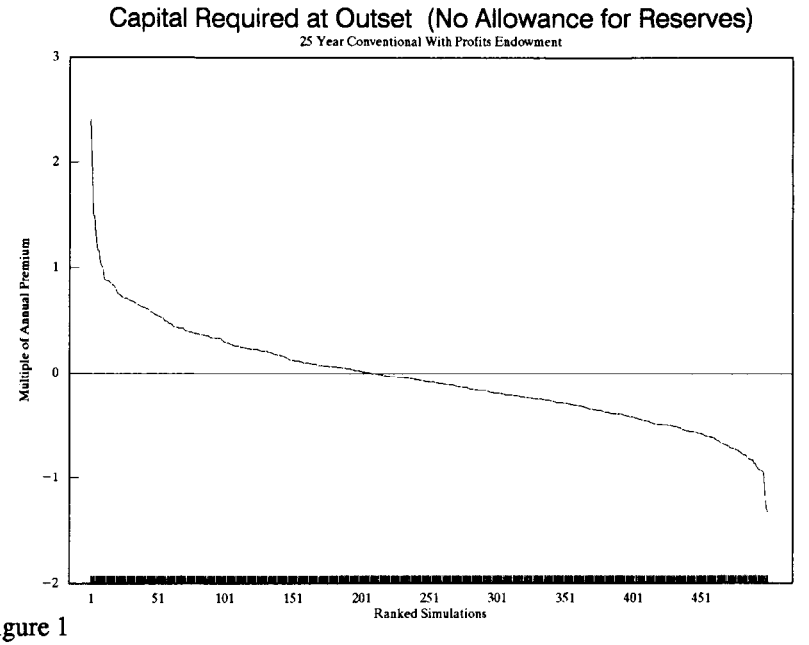

Figure 1

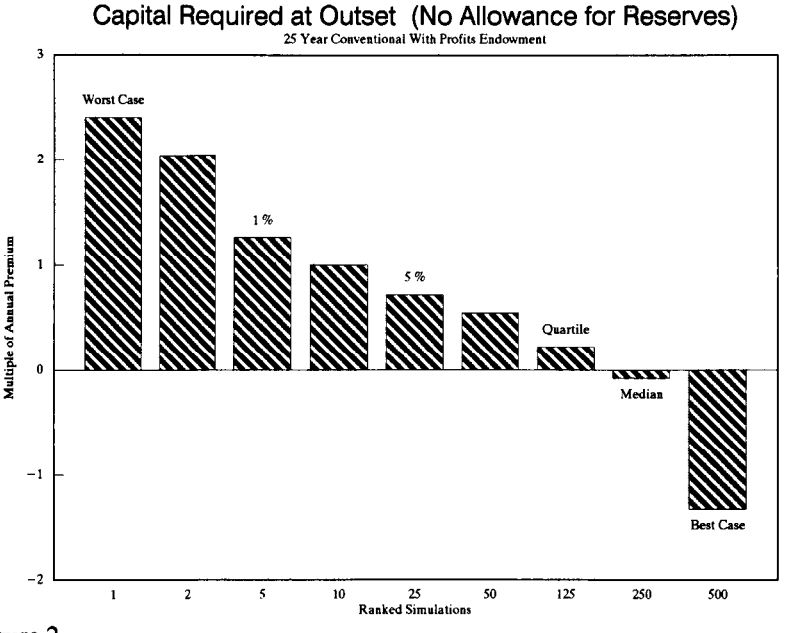

Figure 2

14 Figure 3 shows the equivalent position for a UWP contract which incorporates no guarantee of future bonus. The adverse simulations show a slightly better position than was the case for the conventional endowment, but the differences are not very great.

15 Figure 4 shows the equivalent amount of initial capital required when allowance is made for the minimum statutory reserves, resilience test and UK solvency margin. The resilience test included is a requirement to hold sufficient assets to cover the effect of significant fluctuations in market values and interest rates. At the time of preparing this paper it was known that the resilience test previously advocated by the regulators was about to change, but the details were not available. The resilience test allowed for was that proposed by a working party of the Institute and Faculty of Actuaries. This resilience test made allowance for additional reserves required following movements of ± 20% in fixed interest yields and an increase in equity yields of 1.5% per annum (with no change in the actual amount of equity dividends). The UK solvency margin requirement for these products is 4% of reserves plus 0.3% of the difference between sum assured and reserves. The amount of capital shown is the minimum amount needed to meet any future excess of reserves, resilience test requirements and solvency margin over the amount of assets at that time, and includes any ultimate excess of benefit outgo over income. As before, this initial capital is assumed to be invested in the same way as the other assets. The worst simulation requires initial capital of about six times the annual premium, whereas the median simulation requires initial capital of about 90% of an annual premium. Even the best simulation requires about 40% of an annual premium. The amount of capital required is very much more than was shown to be required to meet ultimate losses; for example for the median simulation in Figure 4 the amount of capital is sufficient to meet potential losses in all but the

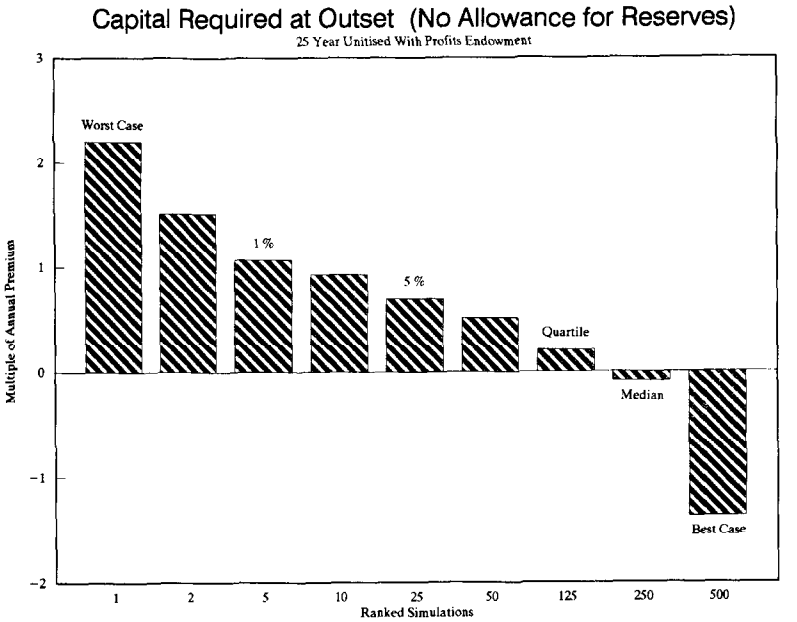

Figure 3

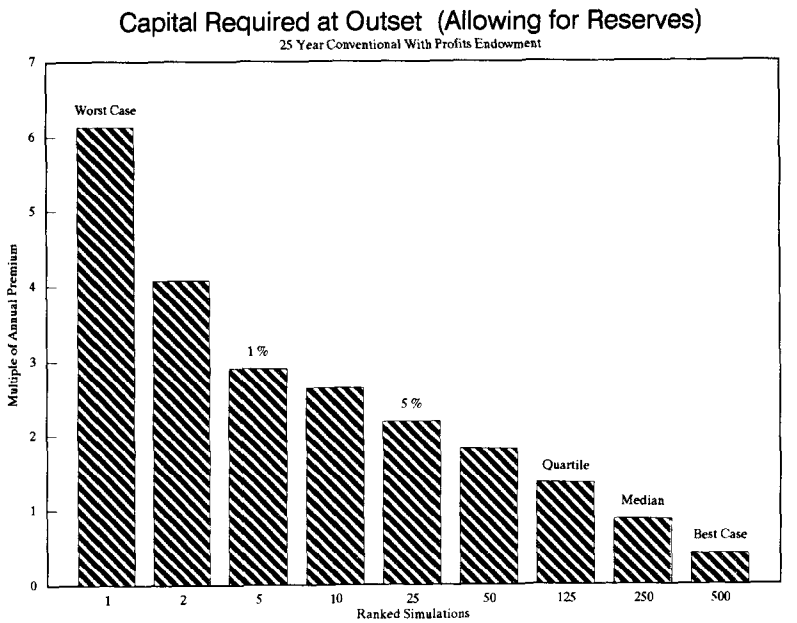

Figure 4

worst 3% or so of cases as shown in Figure 2. However, it should also be emphasized that the assumptions are in practice conservative, and that the position would be improved considerably if some of the assumptions were changed, for example:

- the approach to bonus declaration and smoothing could be more radical in the worst scenarios
- bonuses could be targeted at less than 100% of asset shares
- a more conservative investment policy could be adopted in the worst scenarios
- surrender payments are likely to be less than 100% of asset shares
- in the worst scenarios, some relaxation in the reserving approach may be possible.

16 Figure 5 shows a comparison between the capital required at outset, allowing for reserves, for a UWP contract with no future guarantees and that for a conventional with profits endowment, which was shown in Figure 4. The amount of initial capital required for the UWP contract is substantially less than for the conventional endowment, when reserves are taken into account. For the median simulation, under one-half of the capital is required, and at the adverse 95th percentile the capital required is about 62% of that needed for the conventional contract.

Results for a portfolio of policies

17 The exercise can be repeated for a portfolio of policies. The portfolio is assumed to be 100% with profits contracts, ie no non-profit policies are included in the fund. The make-up of in force business by duration in force has been constructed to be representative of a typical UK with profits portfolio at the present time. Figure 6 shows the capital currently required for the portfolio in order to meet any future excess benefit outgo, without providing for statutory reserving requirements, if all contracts are conventional endowments. Here the capital

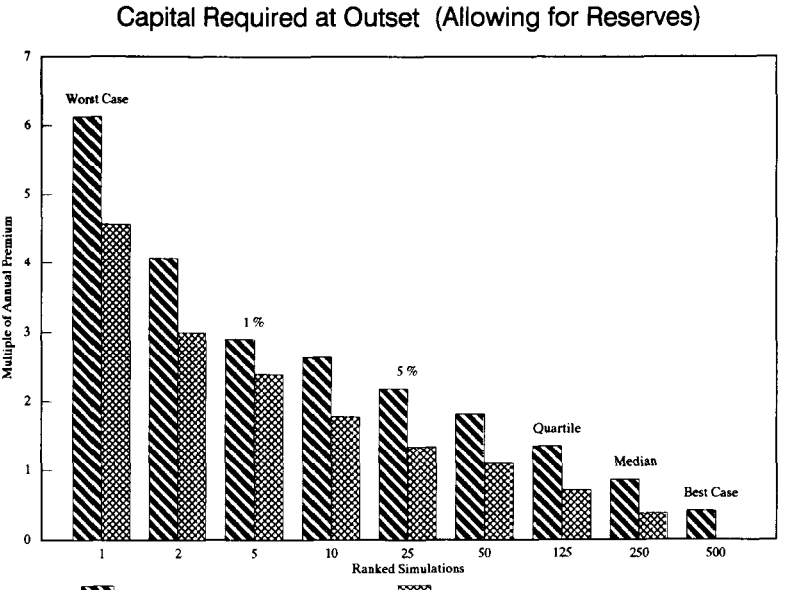

Figure 5

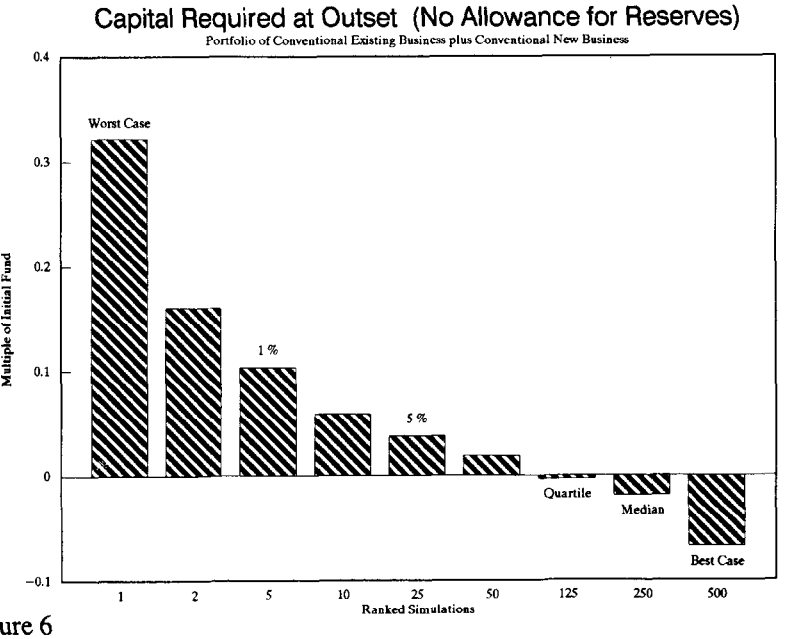

Figure 6

required has been expressed as a percentage of the initial fund (equal to the total asset shares), rather than the annual premium in force. The initial fund at the start point of the projection represents about ten times the annual premiums in force. Future new business has been included, but only for five years, with the amount of new annual premiums in the first year approximately equal to one-ninth of the total annual premiums in force at outset. New business is then assumed to increase at 5% per annum. The ratio of asset shares to liabilities (including solvency margin and resilience test) at outset for this portfolio is 96% (ie additional capital support of 4% of the fund is necessary).

18 Comparisons can be made between future assets and liabilities, including the solvency margin and resilience test. Table 1 shows how for a portfolio of conventional with profits business the ratio of assets to liabilities may change in five years time after writing five further years of new business.

Table 1

Conventional with profits portfolio

Ratio of asset shares to liabilities (including solvency margin and resilience test) after a further five years of new business	
	%
Worst case	66
5th percentile	81
Lower quartile	91
Median	97
Upper quartile	104
Best case	141

For the median simulation the ratio of asset shares to liabilities has changed slightly after five years from 96% to 97%. The wide spread of results indicates the significant

risks that would be involved in this investment and bonus strategy. The comments made at the end of paragraph 15 should however be borne in mind.

Effect of different types of product

19 A comparison can be made of the effect of different product designs on the amount of capital required for the portfolio. Table 2 compares the capital required, making no allowance for reserves, under different simulations for different combinations of products. Two versions of UWP contracts are included, one with no guarantee about future growth (except that unit values will not reduce, ie a 0% growth guarantee), as illustrated previously, and the other with a guarantee that existing units and those to be purchased in the future will grow at 3% per annum.

Table 2

Capital Required at Outset (no allowance for reserves)

		Proportion of initial fund					
Existing business	**New business**	**Worst Case**	**Lower 1st Percentile**	**Lower 5th Percentile**	**Lower Quartile**	**Median**	**Best Case**
		%	%	%	%	%	%
(1) Conventional	Conventional	32	10	4	-	(2)	(7)
(2) Conventional	Unitised with profits 3% future guarantee	34	10	4	-	(2)	(7)
(3) Conventional	Unitised with profits No future guarantee	29	10	3	-	(2)	(7)
(4) Unitised with profits No future guarantee	Unitised with profits No future guarantee	17	5	1	(1)	(3)	(7)
(5) Conventional	Nil	29	9	3	-	(2)	(6)

20 Table 2 shows a very large difference between the capital required under the adverse simulations for conventional existing and new business (1), and unitised with profits business with no future guarantee of unit growth (4). Thus for the worst case an additional 32% of the initial fund is required for conventional business, compared

to 17% for UWP with no guarantee. There is a 1% chance that more than 10% of the initial fund will ultimately be lost for the conventional product, whereas for the UWP product with no future guarantee there is a 1% chance that 5% or more of the initial fund will be lost. The table also shows that adding in five years new business is not very significant, in terms of the effect on capital required at the outset.

Effect of different investment and bonus strategies

21 As indicated in paragraph 15, the results shown so far have been based on a number of assumptions which might be regarded as conservative. In Table 3 the capital required at outset, again not allowing for reserves, is compared for a number of different investment and bonus strategies. No new business is included, and all the business is assumed to be conventional. The different strategies are:

(1) Investment allocation 70% equities, 30% fixed interest, average term 13 years (as before).

(2) Investment allocation 80% equities, 20% fixed interest, average term 13 years.

(3) Investment allocation 70% equities, 30% fixed interest, average term 5 years.

(4) Investment allocation 70% equities, 30% fixed interest, average term 13 years initially, but switching to 5 year fixed interest near maturity or in adverse conditions.

(5) Terminal bonus unsmoothed.

(6) Terminal bonus smoothed over a longer period, the rate declared each year being 75% of the rate declared the previous year plus 25% of that supported by the bonus reserve valuation.

The assumptions for strategies 2 to 6 are as for strategy 1, except as indicated above.

22 Table 3 shows the results for these strategies in the same format as Table 2.

Table 3

Capital Required at Outset (no allowance for reserves)

Strategy	Proportion of initial fund					
	Worst Case	Lower 1st Percentile	Lower 5th Percentile	Lower Quartile	Median	Best Case
	%	%	%	%	%	%
(1) Standard version (70% equities, 30% fixed interest)	29	9	3	-	(2)	(6)
(2) 80% equities, 20% fixed interest	42	13	5	-	(1)	(7)
(3) 70% equities, 30% fixed interest of term 5 years	26	8	3	-	(2)	(7)
(4) 70% equities, 30% fixed interest switching to fixed interest term 5 years near maturity or in adverse conditions	5	5	3	2	1	(4)
(5) Terminal bonus unsmoothed	29	8	3	-	(1)	(4)
(6) Terminal bonus smoothed over longer period	30	10	3	-	(2)	(8)

23 Strategy 2 shows that an investment strategy of 80% equities and 20% fixed interest significantly increases the potential losses in the adverse simulations, compared to the 70%/30% strategy. Strategy 3 shows the slightly reduced capital requirements in the adverse simulations arising from a shorter term fixed interest strategy. Strategy 4 demonstrates the very substantial reduction in potential capital losses if the investment allocation is switched into fixed interest near maturity or in adverse conditions; this assumption is arguably rather nearer what would be likely to happen in practice. Strategies 5 and 6 show that changes in the degree of smoothing of terminal bonus have a relatively minor effect on potential capital losses.

24 The variations in investment strategy shown above will also have an effect on the likely policy proceeds for with profits policyholders. These can be calculated for each simulation and will be an important factor to be taken into account in determining an overall strategy.

Conclusion

25 By carrying out investigations of the type illustrated in this paper, conclusions can be reached about optimal product design, investment strategy and product management. In our view the value of the investigations derives not only from the calculated results, but from the insight gained through comparison of the differences between alternative strategies, and from developing a framework within which to address and monitor the issues that arise from the management of with profits business.

Appendix

Stochastic asset model parameters

The parameters used by the 1992 Wilkie model are set out below. Neutral initial conditions are assumed (ie random fluctuations in the years before the projection start date are ignored).

Parameter name	Parameter description	Value
QMU	Mean inflation rate	0.05
QA	Inflation autoregressive parameter	0.6
QSD	Inflation standard deviation	0.04
YW	Yield transfer parameter	1.95
YMUP	Yield mean (per cent)	3.8
YA	Yield autoregressive parameter	0.5
YSD	Yield standard deviation of YE	0.16
DW	Dividend transfer parameter	0.8
DD	Dividend moving average parameter	0.2
DX	Dividend transfer parameter	0.2
DY	Dividend transfer parameter from yield	-0.175
DMU	Dividend mean growth	0.0135
DB	Dividend moving average parameter	0.55
DSD	Dividend standard deviation	0.06
CW	Consols transfer parameter	1
CD	Consols moving average parameter	0.045
CMUP	Consols mean real yield (per cent)	3.1
CY	Consols parameter on yield residual	0.15
CA1	Consols autoregressive parameter 1	0.9
CA2	Consols autoregressive parameter 2	0.0
CA3	Consols autoregressive parameter 3	0.0
CSD	Consols standard deviation	0.175
CMIN	Minimum value of Consols yield	0.005