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DYNAMIC SOLVENCY TESTING

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1 INTRODUCTION

Financial Condition Reports and Dynamic Solvency Testing

- 1.1 In March last year, the Faculty and Institute of Actuaries introduced a new guidance note, GN2, on Financial Condition Reports (FCRs). This encourages Appointed Actuaries to prepare an FCR, which is a written report into the current solvency position of the company or society and its possible future development. The FCR is expected to be more extensive than the report on the results of the annual valuation required under Section 18 of the Insurance Companies Act 1982 or Section 46 of the Friendly Societies Act 1992.
- 1.2 Dynamic Solvency Testing (DST) involves projecting forward the office's revenue account and balance sheet (and hence solvency position) using a range of different assumptions, in order to assess the ability of the office to withstand adverse changes in experience. GN2 notes that DST would normally be used to derive the background information underlying an FCR.

Overview of the paper

- 1.3 This paper contains:
- a review of the background to the introduction of GN2 in the UK, and a brief summary of similar developments in other countries (in Section 2);
 - consideration of some of the practical issues that arise when carrying out a DST investigation (in Section 3);
 - illustrative examples for both a unit-linked office and a with-profits office (in Sections 4 and 5 respectively);
 - consideration of issues that arise in connection with the production of an FCR (in Section 6); and
 - a brief summary (in Section 7).

Survey of Appointed Actuaries

- 1.4 In December 1996, we sent a questionnaire to the Appointed Actuaries of a cross-section of UK life insurers and friendly societies on the subject of FCRs and DST. 49 responses were received (including replies from 31 offices writing with-profits business). We refer to the results of the survey throughout this paper.

2 BACKGROUND

- 2.1 Although the introduction of formal guidance on FCRs and DST is only a recent development in the UK, there has been discussion on this topic within the actuarial profession for some time. Also, the United Kingdom is by no means the first country to introduce guidance or regulations for life insurance companies concerning FCRs and DST. Australia, the US and Canada have similar requirements.

FCRs and DST outside the UK

- 2.2 In Australia, it has been necessary to provide the Board with some form of annual Financial Condition Report since 1945. The FCR is prepared according to professional standards and has to be submitted to the regulator on a confidential basis. There have recently been some changes to valuation methods, partly in response to large sales of capital guaranteed products. The new system uses a two-tier approach with a published statutory minimum reserve and a Capital Adequacy Reserve (CAR), which is calculated on a stronger valuation basis. The CAR is not published but forms part of the FCR. If the company's assets meet the statutory minimum reserve but not the CAR, a plan must be produced to restore the capital adequacy position and no dividend can be paid. There is no requirement to carry out DST, however.
- 2.3 Insurance regulation in the US is at state level and used to be based on prescribed liability valuations with assets valued at book value (except for assets backing market value linked products). Until relatively recently the only need for additional solvency was that driven by the calculations carried out by rating agencies based on the company's mix of business. However, the failure of Executive Life and problems with junk bonds, real estate and commercial mortgages led to a more systematic three-tier approach to valuations being introduced by the National Association of Insurance Commissioners. The three tiers are:
- reserves which must be at least as great as reserves calculated on a prescribed basis;
 - a series of dynamic tests of liabilities against assets under multiple investment scenarios (including seven prescribed scenarios, described in 2.4 below) on a closed fund basis. The actuary must either be able to demonstrate that the prescribed reserves and their underlying assets are sufficient, or set up additional reserves; and
 - a minimum risk based capital requirement, which is determined by reference to investment fluctuation risks, mortality and morbidity risks, mismatch risks and other risks.
- 2.4 The seven prescribed investment scenarios in the US are:
- a 3% jump in interest rates;

- a slow rise in interest rates;
- a slow rise in interest rates followed by a slow fall;
- a 3% drop in interest rates;
- a slow fall in interest rates;
- a slow fall in interest rates followed by a slow rise; and
- level interest rates.

2.5 In 1992, the American Academy of Actuaries and the Society of Actuaries (SOA) set up a task force with the aim of providing education and guidelines to enable actuaries to produce Financial Solvency Reports (FSRs) to their Boards by 1995. However, there is currently no requirement to produce an FSR or carry out DST and progress has been slower than expected, partly because many insurers are concerned that the FSR would be made available to the regulators. Nevertheless, the SOA is anticipating that more dynamic financial analyses will be carried out in the future and has produced a handbook called “Dynamic Financial Condition Analysis” to assist actuaries with this.

2.6 In Canada, the 1992 real estate crisis and other economic problems caused serious financial difficulties for a number of companies and a number of measures were introduced to try to alleviate future problems. The basic statutory valuation uses the policy premium method (a gross premium valuation) with a provision for adverse deviations. This is intended primarily for financial reporting purposes and is relatively weak. In addition, however, there is a set of risk based capital requirements (Minimum Continuing Capital and Surplus Requirements - MCCSR), a requirement to set up a guarantee fund and a requirement to produce an FCR. The Canadian Institute of Actuaries has recommended 10 scenarios to be tested in the FCR, namely:

- an increase in mortality rates by 3% of the base rate per annum for five years (-3% per annum for annuities);
- an increase in morbidity rates by 3% of the base rate per annum for five years;
- a doubling or halving of withdrawal rates (whichever is more unfavourable for each product);
- an increase in new money interest rates of 0.6% per annum for five years (a total increase of 3%) with no change in either the shape of the yield curve or the investment policy;

- a decrease in new money interest rates of 0.6% per annum for five years (a total decrease of 3%) with no change in either the shape of the yield curve or the investment policy;
- level new sales;
- new sales growing at twice the rate assumed in the base scenario;
- a sudden increase in mortality and morbidity claims, in year 1 of the projection, to the level of the 95th percentile in the distribution of annual aggregate claims;
- a doubling of default rates for debt securities; and
- inflation of unit expenses at a rate 3% greater than assumed in the base scenario.

2.7 The Canadian Institute of Actuaries has also established a Standard of Practice on DST, which is referred to in the legislation and has the force of law. The FCR is available for the regulators to inspect on the company's premises.

Development in the UK

2.8 In the UK, under the auspices of the Joint Actuarial Working Party, which comprises representatives of the profession and the GAD and whose purpose is to discuss possible changes in the supervisory framework for life assurance, a working party was set up in April 1993. The terms of reference for the working party were to consider whether or not DST should be introduced formally into the solvency monitoring process in the UK, and also whether or not Appointed Actuaries should be required to prepare and submit an annual FCR to the regulators.

2.9 The preliminary conclusions of the working party in the autumn of 1993 included the following which have now generally been reflected in GN2:

- DST helps Appointed Actuaries to gain a better understanding of the key threats to solvency and, therefore, Appointed Actuaries should be required to carry out DST as part of their professional responsibilities;
- DST should be updated annually, or more frequently when circumstances demand;
- Appointed Actuaries should prepare, and present to their Boards, an annual FCR;
- the content of the FCR and the sensitivities and scenarios should not be prescribed but should be the responsibility of the Appointed Actuary;

- Five years was probably the right sort of projection period in general but the Appointed Actuary should consider whether choosing a longer period might provide further insights; and
- the regulators should not have automatic access to the FCR.

2.10 The working party also concluded that DST could not be considered in isolation from other parts of the valuation and solvency monitoring process, ie the basic statutory valuation reserves, resilience reserves and solvency margins. The recommendation at the time was that resilience testing, solvency and DST should be overviewed to avoid duplicating layers of conservatism and one approach would be to separately plot the course of the basic valuation reserves, the resilience test reserves and the statutory solvency margin. More specifically, the working party felt that, while a company should be able to demonstrate that it can meet its basic liabilities (including PRE) at all times, if DST indicated that under certain scenarios the company would not always be able to meet the resilience test and full solvency requirements, it might be enough for the Appointed Actuary to indicate a course of action which would restore complete solvency. This is an approach that is not referred to explicitly in GN2.

2.11 The working party was reconstituted early in 1994, reporting to the Research Committee of the Life Board with the aim of drafting guidance for Appointed Actuaries on financial condition reporting. As a first step, the working party sent a questionnaire to Appointed Actuaries of 153 life offices to find out how much work was already being done in this area and published the results at the end of 1994. 89 replies were received and some of the key findings were:

- 84% of the offices which carried out central projections also carried out financial projections using a range of different deterministic assumptions, but only 6% carried out any stochastic modelling;
- in nearly all the companies, where projections were carried out, the results were presented to the Board;
- 68% felt that additional professional guidance on investigating and reporting the financial condition of the life fund was required. Of these, 69% felt this should be advisory, 27% that it should be best practice and the remaining 4% that it should be mandatory; and
- most companies indicated that they would require between one and two years to comply with any requirement to carry out DST, and several smaller companies were concerned about the additional burden that might be placed upon them.

GN2

- 2.12 The new guidance note on Financial Condition Reports, GN2, took effect on 25 March 1996 and is classified as Recommended Practice. As mentioned in 1.1, Appointed Actuaries are encouraged to prepare an FCR to their Board, and the purpose of GN2 is to suggest a possible format and contents for an FCR. GN2 also outlines how DST would normally be used to derive the background information underlying the FCR.
- 2.13 Some of the key points contained in the guidance note are set out below. We also refer to the content of GN2 throughout the rest of this paper.
- DST is the principal technique which enables Appointed Actuaries to assess the ability of the office to withstand adverse changes in experience.
 - The Appointed Actuary should consider the actions which are open to the office to deal with particular circumstances and, where appropriate, make suitable recommendations.
 - Appointed Actuaries should use whatever techniques they consider appropriate to the business written by their office.
 - Stochastic techniques may be useful in some circumstances.
 - There are a list of points that “the FCR should normally include”, a list of factors that “it would be usual for the Appointed Actuary to comment in more detail on” and a further list of issues which the report might normally address.
 - A distinction is drawn between sensitivity and scenario testing (see 3.2).
 - The choice of projection term is important and while generally a term of five years is considered sufficient there are some areas of risk where the full effects only become apparent over a longer period.
 - Neither the particular variations in assumptions, nor the assumptions which need to be tested or reported, are prescribed - this is left to the judgement of individual Appointed Actuaries. However, GN2 provides a list of assumptions which there would need to be a specific reason not to test, a list of assumptions which may be of considerable importance in some companies but not others and a list of various factors to which the Appointed Actuary should be alert.
 - In each scenario tested, provision should be made for all elements of the statutory liability including an appropriate level of resilience reserve. It is interesting to compare this with the comments in 2.10.

3 PRACTICALITIES OF DYNAMIC SOLVENCY TESTING

- 3.1 In this section, some of the practical issues that arise when carrying out a DST investigation are discussed, including the choice of scenarios to consider, coping with the interactions between assets and liabilities, and the need to reflect the actions open to the company to protect its solvency position. Based on the results of our survey, we also discuss the impact that the requirements of GN2 are having on the systems and resource requirements of life offices.

Sensitivity vs scenario testing

- 3.2 GN2 distinguishes between sensitivity testing and scenario testing. Sensitivity testing is defined as testing the effect of changes to individual assumptions independently. For example, running the projections using the same assumptions that were used for the base projections but with higher inflation, then running the projections using the same assumptions that were used for the base projections but with higher interest rates and so on. In contrast, scenario testing is defined as testing the effect of changes to the values of related assumptions simultaneously in a mutually consistent manner. For example, one might model the scenario of a recession by assuming low new business volumes, high lapse rates and low inflation. GN2 recommends that certain assumptions, particularly those related to the economic environment, be tested as a group.

Choice of scenarios

- 3.3 As noted in Section 2, GN2 leaves it to the judgement of the Appointed Actuary to decide which assumptions need to be tested and how. However, it does state that there would need to be specific reasons for not testing variations in the assumptions for:

- future investment conditions;
- levels of new business, where this is written;
- expenses; and
- persistency.

- 3.4 GN2 also lists other assumptions which may be of considerable importance in some companies but not others:

- allocation of profits and/or special distributions of carried forward surplus to policyholders and/or shareholders;
- mortality and morbidity;
- taxation;
- exercising of options by policyholders;
- exercising of options by the company;

- effect of asset defaults;
- unit pricing bases; and
- risk of reinsurer default.

- 3.5 GN2 states that the Appointed Actuary should draw attention to the differing nature of the assumptions in the FCR, particularly in terms of predictability and the extent to which they are within the office's control. The assumptions that are varied in practice will depend on a number of factors. The nature of the products that the company has sold in the past and intends to sell in the future will be important, but so will the maturity of the company, the level of guarantees and the extent of the free assets. This is one of the reasons why the scenarios are not prescribed.
- 3.6 The results of the survey confirm that the vast majority of offices consider changes in future investment conditions, new business volumes and mix, expenses and persistency, and that most of the with-profits offices also consider changes to bonus rates. About two-thirds of the companies surveyed had considered the effect of changes in mortality and morbidity and about one-third had investigated the effect of changes in tax rates, valuation bases, premium rates and charges.
- 3.7 Having decided which assumptions to vary, it is necessary to consider how they should be varied. This is also left to the Appointed Actuary's judgement. Deciding on the size of the variations in assumptions for DST is one of the most difficult practical areas. How extreme should the scenarios be? For example, should one aim to choose scenarios so that there is only a 5% chance, say, of the actual outcome being worse than projected? In order to do this, the actuary would need to find some way of estimating how likely a particular scenario is. In any case, if scenarios are presented to the Board which show the company becoming insolvent, the Board will want to know how likely it is that such scenarios might occur. If no such scenarios are presented, it may be necessary to consider how likely it is that more extreme scenarios could occur in order to avoid giving a false sense of security.
- 3.8 The pattern of the variation of assumptions may also be important. For the investment scenarios in particular, it is important to test both sudden and gradual changes in the assumptions and also permanent changes and changes that are only temporary. The scenarios recommended in the US (see 2.4) provide an example of the different scenarios that might be tested for interest rates. Similar changes can be considered for other assumptions eg dividend yields.
- 3.9 More generally, the types of changes that might be considered for a particular assumption include, for example:
- a sudden change with a quick reversion to the original level;
 - a sudden change to a new permanent level;

- gradual changes to a new level; and
- cyclic variations around a central trend line.

These can all be regarded as simplified representations of how stock market yields have behaved at various times in the past and may reasonably be expected to behave at some time in the future.

3.10 Companies participating in our survey were asked how they had varied particular assumptions. The responses are summarised below:

- Investment income : immediate 2% falls and rises in interest rates and yields were popular variations, but a number of companies also considered gradual changes.
- Investment gains/losses : a 25% crash was modelled by a number of companies, sometimes with a gradual recovery, as was a 2% fall in growth rates.
- New business volumes : the changes used by different companies varied very widely. A number considered closure and zero growth and most considered varying percentages of the central volumes (up to 300%).
- New business mix : a number of companies felt that a change of mix would not be significant, but many considered a switch to more capital hungry products and changes to the relative proportions of single premium and regular premium business and of with-profits and unit-linked business.
- Expenses : typically, offices considered an increase of 10%-20%.
- Withdrawal rates : unit-linked offices tended to consider a doubling of withdrawal rates, whereas the increases considered by with-profits offices tended to be much smaller. This could be a reflection of different distribution channels.
- Mortality and morbidity : although one company considered an increase of 25%, most considered smaller increases (10% on average). A few offices considered a gradual deterioration (eg +3% per annum).

3.11 Roughly half of the companies surveyed indicated that they carry out scenario testing as well as sensitivity testing. The more common scenarios tested by participants in our survey were:

- high inflation and high interest rates;
- low inflation and low interest rates;
- rising interest rates, falling market values and increasing expenses;
- a substantial fall in interest rates and yields;

- a market crash (commonly by 25%-30%) sometimes with a weakening in the valuation basis (to reflect increased yields) and sometimes accompanied by a change in investment mix;
- a market crash in conjunction with high withdrawals or a loss of competitiveness;
- a market crash or a worsening in investment prospects but no reduction in bonus rates;
- a loss of competitiveness (falling sales and higher discontinuance) - sometimes in conjunction with lower investment returns, sometimes in conjunction with higher expenses;
- higher sales, lower withdrawals and higher expenses;
- a reduction in new business margins and higher new business volumes; and
- a reduction in efficiency (higher unit costs).

Other scenarios tested included consideration of the consequences of a failure of derivative-backed equity bonds to provide the full return required and the effect of a change in the tax regime to a gross roll-up basis.

Modelling the assets

- 3.12 The degree of sophistication with which the assets are modelled will depend on the company and the business being modelled, but it is important to note that a more detailed model may be required for consideration of volatile investment scenarios than the “traditional” level investment return scenarios often considered in the past. A simple model may project only the total investment return, net of tax in each projection step, perhaps separately for each class of liabilities. The next stage would be the ability to vary investment income, realised capital gains and unrealised capital gains separately and by asset class (eg UK equities, property, qualifying fixed interest etc). This increases the flexibility of the model generally and makes it easier to investigate the effect of changing the asset mix during the course of the projection, which is almost certainly necessary for with-profits offices. This is discussed further later on in this section.
- 3.13 However, there may be situations where the above is not sufficient and, instead, modelling is carried out by projecting market values, investment income and gains for individual assets (or perhaps asset model points). This can be of particular importance for companies where the matching of guaranteed liabilities to the appropriate fixed interest securities has a significant effect on results. By taking the redemption profile of the fixed interest investments held into account, the cash flow (mis)matching of the office can be modelled and the calculation of both valuation reserves and resilience test reserves will be less approximate.

- 3.14 According to the results of our survey, as one might expect, the asset modelling is more sophisticated for offices writing with-profits business than for those who do not. In particular, most with-profits offices are able to project different asset classes (eg UK equities, property, cash) separately, but few other offices have this capability. The survey results are summarised further below.

	Some with-profits business	No with-profits business
Can vary income and gains independently	81%	75%
Separate model points for different asset classes	73%	31%
Individual assets can be modelled	19%	8%
Assumptions can be varied from year to year	73%	63%

Some 27% of the with-profits offices surveyed said they were unable to vary the assumptions from year to year. This clearly limits the scenarios that can be examined by these offices.

Modelling the liabilities

- 3.15 The projection of the liabilities for DST work is likely to be similar to that for other financial projections. However, due to the fact that some relatively extreme scenarios are being considered, the projection may need to incorporate variations in, for example, bonus rates and the valuation basis throughout the projection. In many cases it will be essential to link movements in these assumptions to the projected development of the assets and the company's solvency position. We consider these complexities further in 3.21 to 3.27 below.
- 3.16 The calculation of the resilience test reserve in future time periods adds an additional level of complexity to the model. GN2 mentions specifically that the DST projections should include provision for an appropriate level of resilience reserve. It is unlikely that a simple assumption (eg that the resilience test reserve is a constant proportion of the basic reserves, which is an assumption used by some offices) will be appropriate for all the scenarios under consideration. In order to calculate this reserve accurately, it is necessary to recalculate the assets and liabilities on different bases at each step and, ideally, to optimise the allocation of different assets to different liability classes. In some investment scenarios it may also be appropriate to consider whether the standard resilience test might be weakened.
- 3.17 Only 25% of the offices surveyed had models which were able to calculate the resilience test reserves and a number of other offices identified this as one of their system's most serious shortcomings. A number of offices that did calculate resilience test reserves used approximate calculations and did not allow, for example, for the optimal allocation of assets to liabilities in the matching rectangle.
- 3.18 In order to be able to project terminal bonus rates accurately, it is necessary to project (individual) asset shares forward on with-profits business. However, only 54% of the companies writing with-profits business that responded to the survey actually projected asset

shares. This implies that, for the remaining companies, terminal bonus rates were either predetermined or calculated more approximately by reference to other factors (such as the investment return achieved in each step).

- 3.19 It is clear from the preceding paragraphs that the modelling process is significantly more complicated for with-profits offices than for unit-linked offices. For many unit-linked offices, one would expect the systems used for business plans and embedded value calculations to be adequate for DST modelling.

Use of model points

- 3.20 A large number of scenarios may be considered as part of a DST investigation and, depending on the size of the company and the sophistication of the model, run times for each scenario may be quite long. In view of this, companies will often use model point projections rather than individual policy projections for DST. In fact, the results of the survey indicate that only 26% of companies (13% of companies writing with-profits business) projected most of their business using individual policy projections rather than model points.

Interactions between assets and liabilities and using decision rules

- 3.21 For many companies, as already noted, it is unlikely that it will be appropriate to model the assets and liabilities in isolation for DST work. GN2 makes it clear that the Appointed Actuary should address the issue of what actions are open to the office to deal with particular circumstances. Projections which are based on, for example, fixed bonus rates, charges and investment mix will almost certainly overstate the dangers of insolvency by failing to take into account the actions that the company can take to protect itself - the projections would not be sufficiently dynamic.
- 3.22 In projecting the assets, it is not possible to reflect how the company might vary the investment mix without information concerning the profile of the liabilities (for example, the proportion of guaranteed to non-guaranteed liabilities and the projected outgo in the coming years) and concerning the company's solvency position (it may be necessary to switch out of equities into bonds to maintain statutory solvency).
- 3.23 On the liability side, bonus rates may depend on previous bonus rates, current yields, historic and expected investment returns, asset shares (which themselves clearly depend on investment returns), the company's solvency position and a bonus supportability projection. In setting the valuation basis, one needs to consider both the minimum statutory basis (which depends on the asset mix and the individual bonds held) and the strength of the valuation basis (which will be influenced by the company's solvency position). As far as the strength of the valuation basis is concerned, it may be sensible to assume the valuation basis is as weak as possible by adopting the statutory minimum basis, since one is testing the likelihood of insolvency. Other assumptions, such as charges on unit-linked business, new business targets and surrender values, may also be partly influenced by the assets.

“One step at a time” facility

- 3.24 Traditionally, financial projection systems projected each individual policy to expiry separately and then calculated aggregate results for the office. The solvency position at the end of Year 3, for example, is not then known until the projection is complete. If the company is insolvent at that stage, in order to tell whether adjusting the bonus rates and the investment mix would have enabled the office to remain solvent, it is necessary to rerun the model. Also, if assets and liabilities have been projected in isolation, it can be difficult to adjust the valuation basis appropriately. If the projection is to allow for decision rules which reflect the company's overall position and allow for full interaction between the assets and the liabilities, there are two options:
- carry out the projections for each scenario iteratively: this would involve carrying out the projection in the normal way and then looking at the results. If the development is unsatisfactory (eg unrealistic insolvency after three years, because no remedial action was taken), modify the parameters accordingly and rerun. If the results are still unsatisfactory, modify the parameters and rerun as often as is required; or
 - a step-by-step calculation process with an algorithm: this requires a different projection process. Each individual policy is projected for one step at a time only and the results are aggregated so that the overall position of the office can be determined at each step. Algorithms are then used to adjust bonus rates, the investment mix, the valuation basis etc., before proceeding with the next step of the projection.
- 3.25 The first approach, while laborious, is just about feasible for deterministic projections. It is not a practical proposition for stochastic projections however, because it would require manual analysis and reruns for each stochastic simulation. The second approach is clearly preferable, but does require a more sophisticated modelling system than the first approach.
- 3.26 One of the questions in our survey was designed to find out to what extent companies were allowing for interactions between assets, liabilities and other factors, and also how they were doing this. The question and an analysis of the responses received are set out on the following page. Parts of the question are relevant only, or primarily, to with-profits offices. Where this is the case, responses from offices not writing any with-profits business have been excluded.

Q: In some cases parameters in the model may be related to other assumptions and/or vary in future time periods depending on the results produced in previous time periods. For example, bonus rates may depend on historic investment returns, current yields, expected returns and the company's solvency position. These linkages may be ignored, estimated in advance using trial and error, or incorporated during the run of the projection using an algorithm in the program. Please indicate which of the following linkages were modelled.

Parameter	Link to	Linkage via		Not linked because	
		Algorithm	Estimate in advance	Considered immaterial	Too difficult
Valuation basis	Current yields	25%	67%	4%	4%
Valuation basis	Solvency	13%	37%	37%	13%
Reversionary bonus rates	Current yields	6%	47%	35%	12%
Reversionary bonus rates	Investment return	11%	50%	22%	17%
Reversionary bonus rates	Solvency	-	37%	53%	10%
Reversionary bonus rates	Previous RB rates	18%	64%	9%	9%
Reversionary bonus rates	Supportability calc	5%	65%	15%	15%
Terminal bonus rates	Asset shares	45%	45%	-	10%
Terminal bonus rates	Solvency	-	28%	44%	28%
Terminal bonus rates	Previous TB rates	30%	40%	5%	25%
Surrender values	Asset shares	55%	15%	20%	10%
Surrender values	Solvency	-	11%	56%	33%
Surrender values	Previous SVs	14%	36%	32%	18%
Unit-linked charges	Inflation	32%	55%	13%	-
Investment mix	Investment return	5%	53%	26%	16%
Investment mix	Solvency	12%	44%	19%	25%
Investment mix	Current yields	6%	47%	35%	12%
Investment mix	Liability profile	16%	52%	11%	21%
New business	Investment return	-	33%	60%	7%
New business	Solvency	3%	28%	45%	24%
New business	Inflation	10%	52%	28%	10%

- 3.27 The relatively high percentage of companies not modelling linkages, because they are considered too difficult (particularly in relation to bonus rates, surrender values, the investment mix and new business) is almost certainly one of the reasons why many companies are updating their modelling systems (see 3.38). In addition, companies usually rely on estimating parameters in advance rather than using decision rules based on the linkages to other parameters and results. This makes stochastic modelling almost impossible for these offices.

Projection term

- 3.28 GN2 states that the choice of the term over which to carry out projections is important and that a projection term of five years will generally be sufficient, but that there may be some areas of risk where the full effects become apparent over a longer period. There are scenarios where the development over five years can be quite different from the long term development and there is a danger of being misled by the short term. We suspect that the actuary will often look at the results of the projection over a longer period, even if these results are not presented to the Board.
- 3.29 The most common projection term for the companies surveyed was 20 years but, generally, only the results of the first five years were shown to the Board.

Length of projection step

- 3.30 The choice of the length of the projection step (ie monthly, quarterly, annually, etc) is not discussed in GN2. Clearly, the shorter the step, the longer the run time. The other key consideration, however, is the accuracy of the model. For example, using annual steps may overstate the risk of insolvency, because terminal bonus rates, surrender value bases and the investment mix are only adjusted once a year in the model whereas, in reality, the office could react more quickly in order to protect itself from adverse experience.
- 3.31 The results for the companies surveyed were:

Monthly steps throughout	48%
Annual steps throughout	28%
Monthly steps, then switch to annual	20%
Monthly steps, then switch to quarterly	2%
Quarterly steps throughout	2%

Stochastic modelling

3.32 GN2 mentions two uses of stochastic techniques in the context of DST, namely:

- to identify additional risks; and
- to compare the relative level of probability of adverse circumstances occurring.

Stochastic modelling normally incorporates the concept of scenario testing by assuming specific statistical relationships between the economic variables.

- 3.33 Stochastic modelling merits serious consideration for those offices where scenario testing on a deterministic basis has indicated significant risk from adverse economic experience. If only deterministic modelling has been carried out in these circumstances, then the Appointed Actuary may have difficulty in assessing both the absolute and relative probability of the different economic scenarios occurring. Stochastic modelling tends to provide a good measure of relative risks and at least some guide to the absolute level of risk. Furthermore, inspection of the stochastic simulations which give rise to insolvency may lead to consideration of some new economic scenarios on a deterministic basis which might otherwise have been overlooked.
- 3.34 The main disadvantage of stochastic modelling is cost, particularly if additional systems development is required. Run times may also be prohibitive without some simplification of the model (eg the use of model points). For stochastic modelling to be worthwhile the asset and liability models need to be sufficiently sophisticated. The model must allow for the ability of the company to adjust the investment mix and cut payouts in adverse scenarios in order to avoid significant overstatement of the risks the company faces.
- 3.35 Of the companies surveyed, 19% of the with-profits offices and 6% of the unit-linked offices had carried out some stochastic modelling. The Wilkie model was used in all cases.

Impact on systems and resources

- 3.36 To produce the financial projections envisaged by GN2 can require quite sophisticated systems and utilise significant human resources. A number of the questions in the survey were designed to find out quite what impact GN2 was having on the amount of financial projection work carried out by life offices.
- 3.37 Over 40% of the offices surveyed had carried out “substantially more” financial projection work in 1996 than in previous years, and a further 40% had carried out “slightly more” financial projection work. Half of the offices that said they had carried out substantially more financial projection work indicated that this was at least partly in response to the introduction of GN2 (35% that it was primarily in response to GN2). Where offices said that they had carried out slightly more financial projection work, almost 70% indicated that it was at least partly in response to GN2.

- 3.38 65% of the companies surveyed indicated that they had enhanced the computer model they use for solvency projections in 1996, and 69% that they planned to make enhancements to their model in 1997/8. 13% had replaced their model in 1996 and 20% indicated that they intended to replace their model in 1997/8. Amongst the with-profits offices these percentages were even higher: 50% planned substantial enhancements in 1997/8, 21% planned minor enhancements and 25% planned to replace the existing model. Where the model was to be replaced or enhanced, the majority of the companies indicated that the motivation for change was partially (but not entirely) in response to GN2.
- 3.39 Participants in the survey were also asked whether additional human resources had been, or were likely to be, required due to GN2 and, if so, how this additional resource requirement had been, or would be, met. Only 18% indicated that there had been, and would be, no additional resource requirement. For those companies which indicated that there had been, or would be, additional resource requirements, the clear majority said that this was being, or was to be, met primarily by reallocation of existing resources.

4 ILLUSTRATIVE EXAMPLE - UNIT-LINKED OFFICE

- 4.1 In this section we consider some of the DST investigations that might be carried out for an office writing unit-linked business in order to illustrate some of the issues that might arise when carrying out a DST exercise for the purposes of an FCR. There are additional points of interest when it comes to with-profits business and we consider these in the next section.
- 4.2 In order to simplify the example, we have considered an office writing just one type of business - a single premium pension policy. The charges on the policy consist of an initial charge, a regular policy fee and a fund management charge. The initial charge is designed to cover commission only. The regular policy fee and fund charge provide a contribution towards other expenses. Some of the expenses have been assumed to vary either in proportion to the number of new policies written or in proportion to the number of policies in force, but most expenses have been assumed to be fixed.

Base case

- 4.3 Every DST investigation is likely to start with the production of a base case projection. This would normally reflect the company's budget for the coming year and any longer term business plan that it has developed.
- 4.4 In our example, the company's business plan is based on an underlying assumption that new business levels will grow steadily in the future with expenses growing at a slower rate, reflecting the assumption that they are largely fixed rather than variable. The results of the base case projection are illustrated in Table 4.1. It has been assumed that all surplus arising is transferred to shareholder funds, and that any shareholder funds in excess of £2.5 million are paid out as dividends.

Table 4.1: Base case

All figures in £m	Year				
	1	2	3	4	5
Shareholder funds brought forward	2.00	2.24	2.50	2.50	2.50
Interest on shareholder funds	0.20	0.22	0.25	0.25	0.25
Surplus arising	0.16	0.90	1.71	2.61	3.60
Tax payable	(0.12)	(0.37)	(0.65)	(0.94)	(1.27)
	2.24	2.99	3.81	4.42	5.08
Assumed dividend payable	-	(0.49)	(1.31)	(1.92)	(2.58)
Shareholder funds carried forward	2.24	2.50	2.50	2.50	2.50
Required minimum solvency margin	0.63	0.63	0.63	0.63	0.63
Excess assets	1.61	1.87	1.87	1.87	1.87

- 4.5 It can be seen that the company is anticipating a steady increase in surplus arising over the term of the projection in the base scenario. This is because volumes of business in force and funds under management are growing faster than expenses.
- 4.6 While the purpose of dynamic solvency testing, as its name suggests, is primarily to consider the future solvency of the company, the recipients of the information may also be interested in the impact of varying assumptions on other results, such as the ability to pay dividends. In producing an FCR, the actuary needs to decide to what extent to focus on these other issues.

Selection of scenarios to be tested

- 4.7 Even if the actuary had not carried out any detailed financial modelling in the past, he is likely to have formed a view as to the sort of scenarios which might be expected to threaten the office's solvency position and might, therefore, start by considering these scenarios. Having said this, one of the reasons for carrying out a DST investigation is to see whether or not there are any scenarios which have an adverse effect on solvency that the actuary and the company were not aware of. For this reason, the actuary should be wary of going too far in pre-judging the results before carrying out the work.
- 4.8 In our example, commission and variable expenses are closely matched by the initial charge and regular policy fee. This means that the most important factors are the level of funds under management and the level of fixed expenses. It is likely, therefore, that the actuary will wish to consider the effect of varying each of the assumptions influencing these factors, namely:
- new business volumes;
 - withdrawal rates;
 - investment returns;
 - the level of the fund management charge; and
 - the level of expenses.
- 4.9 Initially, the actuary is likely to wish to consider, and possibly include in his FCR, the results of varying each of these assumptions in isolation. He may then be able to use the results from these sensitivity tests to identify those scenarios that are likely to be troublesome to the office. Scenarios which combine movements in two or more assumptions, both or all of which have an adverse effect on solvency, are obvious ones to consider.

Scenario A - Immediate fall in market values

- 4.10 One scenario which is often considered is a one-off immediate fall in market values. Because of the nature of our example office, this scenario has a particularly marked impact. Table 4.2 shows the results assuming an immediate 25% fall in market values.

Table 4.2: Scenario A - fall in market values

All figures in £m	Year				
	1	2	3	4	5
Shareholder funds brought forward	2.00	1.25	0.96	1.21	2.09
Interest on shareholder funds	0.20	0.13	0.10	0.12	0.21
Surplus arising	(1.32)	(0.56)	0.27	1.19	2.21
Tax payable	0.37	0.14	(0.12)	(0.43)	(0.80)
	1.25	0.96	1.21	2.09	3.71
Assumed dividend payable	-	-	-	-	(1.21)
Shareholder funds carried forward	1.25	0.96	1.21	2.09	2.50
Required minimum solvency margin	0.63	0.63	0.63	0.63	0.63
Excess assets	0.62	0.33	0.58	1.46	1.87

Note: it is assumed for simplicity that immediate tax relief can be obtained on losses.

- 4.11 The results show that, while this is clearly an adverse scenario, it does not threaten solvency. The Board may, however, be as interested in the impact on shareholder funds and the company's ability to pay dividends as on the solvency position. Under this scenario, dividends are first payable in Year 5, whereas under the base case scenario, the expectation is that dividends will be payable from Year 2.
- 4.12 Of course, had a larger fall in market values been assumed, solvency might have been threatened and the actuary may well wish to give consideration to the maximum fall that the company could bear without having to resort to additional capital. This is sometimes called "the worst survivable scenario" and is a concept that can also be used when considering other adverse scenarios.

Scenario B - Increase in competition

- 4.13 One of the factors that would normally be considered is a variation in new business levels. For some companies, high volumes of new business might be an issue. While this is a problem that few companies are likely to complain about, the actuary should, in such cases, investigate the maximum levels of new business that the company can write. For our example, however, there is little additional strain arising from new business and it is a reduction in new business levels which is a concern. This might arise from increased competition and could be considered in conjunction with an increase in withdrawal rates, another possible effect of increased competition.

- 4.14 Table 4.3 shows the effect on the financial projections for our example office of halving the new business levels, and doubling the withdrawal rates that were used in the base case projection.

Table 4.3: Scenario B - increase in competition

All figures in £m	Year				
	1	2	3	4	5
Shareholder funds brought forward	2.00	2.20	2.07	1.63	0.87
Interest on shareholder funds	0.20	0.22	0.21	0.16	0.09
Surplus arising	0.10	(0.41)	(0.87)	(1.29)	(1.68)
Tax payable	(0.10)	0.06	0.22	0.37	0.52
	2.20	2.07	1.63	0.87	(0.20)
Assumed dividend payable	-	-	-	-	-
Shareholder funds carried forward	2.20	2.07	1.63	0.87	(0.20)
Required minimum solvency margin	0.63	0.63	0.63	0.63	0.63
Excess assets	1.57	1.44	1.00	0.24	(0.83)

- 4.15 While this scenario does not have the immediate impact on solvency that the fall in market values (Scenario A) did, it is much more damaging in the long run and highlights the need for this office to ensure that funds under management grow at least as fast as its fixed overhead expenses if it is to avoid deficits arising in the future. The projection not only shows our example office losing money for its shareholders, but also actually becoming insolvent in Year 5.
- 4.16 This example, although simplified, can be used to highlight some of the issues that arise from carrying out a DST investigation. In particular, having identified a scenario such as this which leads to problems, a number of questions are raised, including:
- how realistic are the assumptions made?
 - how likely is this scenario to occur? and
 - what mitigating action could/would the company take?
- 4.17 With a situation like that projected under Scenario B, ie “creeping insolvency” rather than a short term risk, there is time for the company to take some action to protect itself, and it would be appropriate for the actuary to consider possible courses of action in his FCR. In this example, one course of action would be for the company to cut its overhead expenses, but it is more likely to want to do something to bring new business levels back up closer to the original budget levels and to curb the increasing withdrawal rates. Given that the scenario we are considering is one of increased competition, this is likely to require a reduction in charges.

Scenario C - Reduction in charges to restore competitiveness

4.18 It is obviously a question of judgement as to how new business levels and withdrawal rates might be affected by a reduction in charges, and different levels of charges will give rise to different answers to this question. The actuary can certainly not be expected to have all the answers to questions like this. It is, however, part of the role of the Appointed Actuary to consider such questions and to be aware of the financial consequences that might arise from decisions taken. DST is the tool which enables him to do this and the FCR provides a means of sharing the information gathered with the Board. The FCR may consider a number of 'What if....' scenarios. For example:

- what if charges are cut and it has little or no impact on new business volumes and persistency? If this was the situation, how much sooner might the company become insolvent or need more capital?
- what if, in order to restore new business volumes to their original levels, it was necessary to cut charges by, say, 20%. Would the company's financial position eventually improve in these circumstances? What if the required reduction in charges is more or less than 20%?

4.19 We illustrate in Table 4.4 below the consequences on our example office of cutting charges by 20% and assuming that this fully restores competitiveness.

Table 4.4: 20% cut in charges to restore competitiveness

All figures in £m	Year				
	1	2	3	4	5
Shareholder funds brought forward	2.00	2.20	1.22	0.56	0.28
Interest on shareholder funds	0.20	0.22	0.12	0.06	0.03
Surplus arising	0.10	(1.68)	(1.11)	(0.48)	0.22
Tax payable	(0.10)	0.48	0.33	0.14	(0.08)
	2.20	1.22	0.56	0.28	0.45
Assumed dividend payable	-	-	-	-	-
Shareholder funds carried forward	2.20	1.22	0.56	0.28	0.45
Required minimum solvency margin	0.63	0.63	0.63	0.63	0.63
Excess assets	1.57	0.59	(0.07)	(0.35)	(0.18)

- 4.20 The reduction in charges has a significant immediate impact on the company's profits, accelerating the decline in solvency compared with Scenario B. However, there is a turning point in Year 4 when the position starts to improve relative to Scenario B, but this is too late to prevent the company failing to meet the required minimum solvency margin at that point. A clear conclusion for our example office is that, if it proved necessary to cut charges by 20% in order to maintain new business volumes, there would be a need for further capital.
- 4.21 The example we have used in this section is obviously greatly simplified compared to the position for most offices. It has, however, served to illustrate how complicated some of the issues arising from a DST investigation can be. It may often be the case, as here, that the scenarios tested and results produced are artificial. This, however, does not necessarily matter. What is important is that it increases the actuary's understanding of the threats to the company's solvency and of the key issues that may arise. If the results are communicated well in an FCR, it should similarly improve the understanding of the Board.

5 ILLUSTRATIVE EXAMPLE – WITH-PROFITS OFFICE

- 5.1 Having considered some of the more general issues that can arise when carrying out a DST investigation in the context of a unit-linked office, we now turn to some of the additional complexities that arise when dealing with with-profits business. A key difference between unit-linked and with-profits business is that, whereas for unit-linked business the assets and liabilities are, almost by definition, closely matched, this is not the case for with-profits business. Consequently, the statutory solvency position for a with-profits office is more sensitive to investment experience and more attention needs to be given to the assumptions made regarding this in the DST investigation. Also, the calculations are made more complicated by the need to reflect the ability the office has to exercise control over both the level of payouts (via bonuses) and over the investment mix.

The example

- 5.2 For illustrative purposes, we have again used a simplified example - this time an office writing only traditional with-profit endowment policies. It has been assumed that the office pays reversionary bonus rates at a level which the Appointed Actuary considers supportable in the future and that maturity payouts are calculated as 99% of smoothed asset shares.

The model used

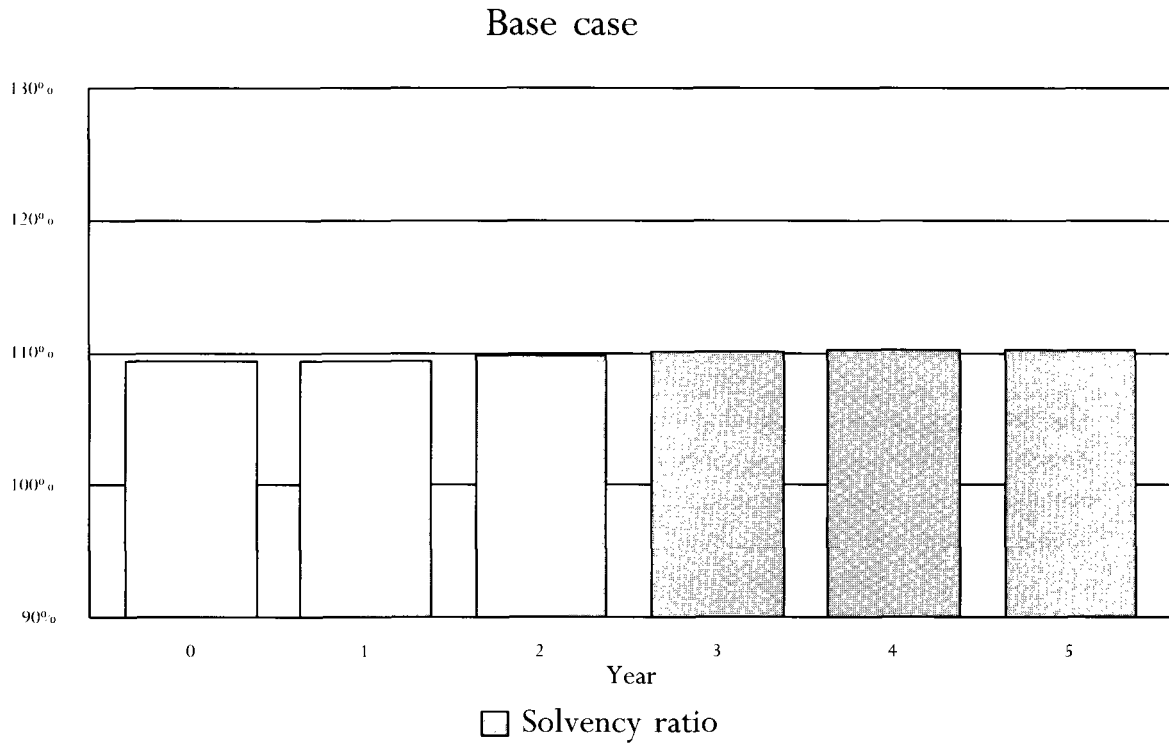
- 5.3 The model used projects both assets and liabilities. It also projects asset shares. Individual fixed interest investments were modelled separately with model points used to represent the equities. The model has a 'one step at a time' facility (see 3.24), which has been used so that at the end of each projection step:

- the asset mix is rebalanced to reflect a chosen decision rule. This is achieved by using positive cashflow to purchase appropriate assets and, if necessary, by selling one asset class to buy another;
- the valuation basis is reviewed and moved onto the statutory minimum basis after hypothecating the highest yielding assets to the liabilities;
- a resilience test is carried out, and an appropriate resilience reserve established.

The one step at a time facility also enables the use of an algorithm to review decisions on, for example, bonus rates in each projection step.

Base case

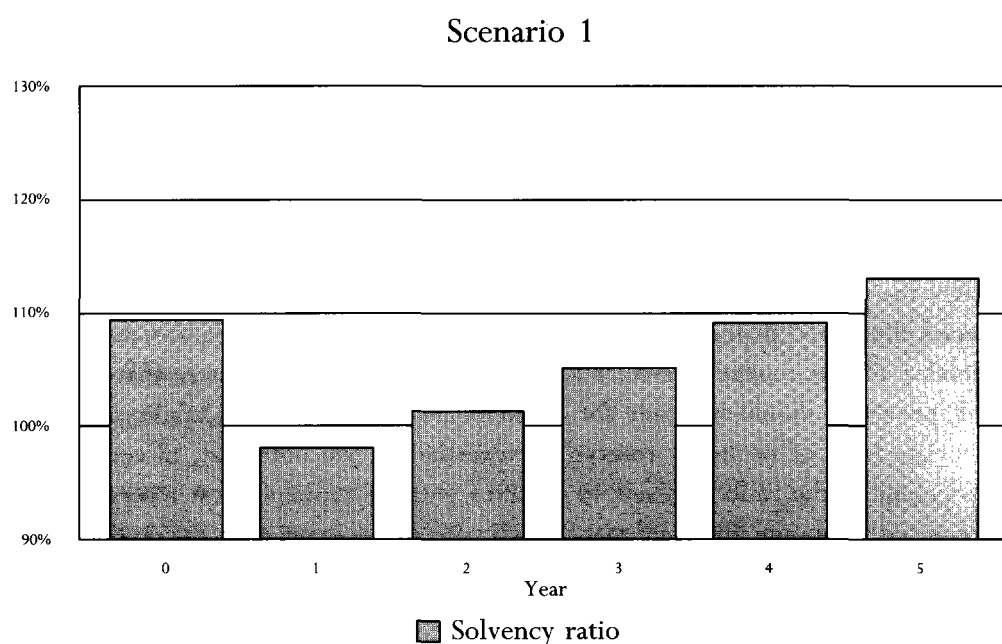
- 5.4 As in the unit-linked example, the starting point is a base case projection reflecting the company's best estimate of the future, as might normally be reflected in its budgets and business plan. In our example, the base case assumes level investment returns, level reversionary bonus rates, a fixed investment mix (70% equities, 25% fixed interest and 5% cash) and level new business volumes. The results of the base case projection are illustrated below.



- 5.5 The graph shows the ratio of total assets to total liabilities including the required minimum solvency margin (which we refer to as the “solvency ratio”). As is the case in all of the examples illustrated in this section, we have included the resilience test reserve in the liabilities. This is consistent with a requirement of GN2 which states that “in each scenario tested, provision should be made for all elements of the statutory liability including an appropriate level of resilience reserve”. Nevertheless, we note that, in certain scenarios, the development of the ratio of assets to reserves without resilience test reserves and/or without the required minimum solvency margin may also be of interest to the Appointed Actuary.
- 5.6 As illustrated above, the solvency ratio under the base case scenario starts at just under 110% and remains fairly stable for the following five years. This is a consequence of the way in which the example was constructed. The office is effectively in an almost stationary state.

Scenario 1 - Immediate fall in market values and increase in yields

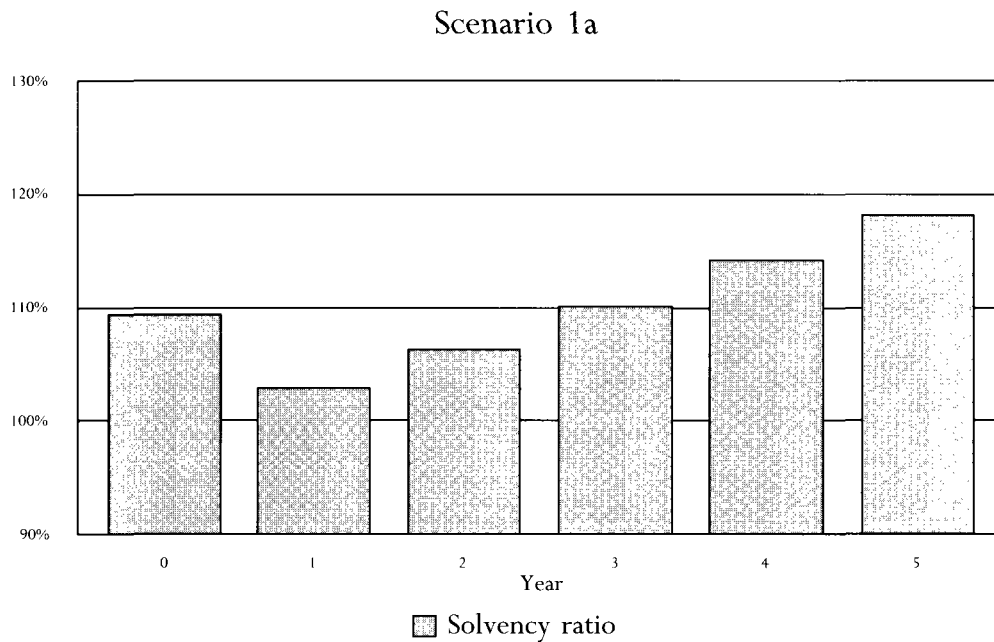
- 5.7 The first alternative scenario we have chosen to consider is an immediate fall in the market value of equities by 23% combined with a 30% increase in the redemption yield on fixed interest investments. As it has been assumed that the actual amount of dividends payable on the equities is unchanged, there is also a 30% increase in dividend yields. The value of the fixed interest investments modelled falls by 15% on average as a result of the increase in yields. Further, we have assumed that yields remain at this higher level and that there is no recovery in the equity markets (ie the fall in market values is a correction rather than a short term fluctuation).
- 5.8 The following graph shows what would happen if the office was to take no action to protect its solvency position in these circumstances. In particular, we have assumed that a fixed investment mix is maintained and reversionary bonus rates are unchanged. The implied terminal bonus rates fall but, because of smoothing, payouts exceed asset shares.



- 5.9 Our example office still has assets in excess of liabilities but cannot meet the required minimum solvency margin. The solvency ratio falls to around 98%. Of course, in practice, the company would take steps to restore solvency in this situation and the actuary is unlikely to present this scenario in his FCR without reflecting this fact. In particular, it could move out of equities into fixed interest investments in order to increase the valuation interest rates that could be used and reduce resilience reserves. As noted in 5.3, the model has been programmed so that it automatically adopts the statutory minimum valuation basis at all times.

Scenario 1a - as Scenario 1, but with a switch out of equities

- 5.10 The following graph shows how the results differ if, in order to protect the company's solvency position, the proportion of the assets invested in equities is reduced from 70% to 60% immediately after the fall in asset values.



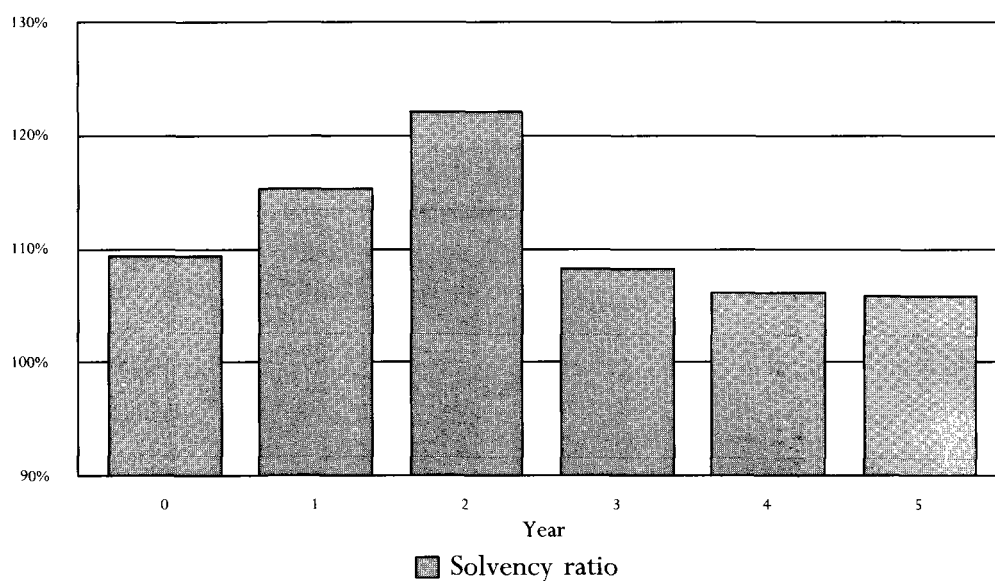
- 5.11 As a result of the switch out of equities, it is possible to reduce the basic net premium reserves by 2%, and the resilience reserve by 10%. This restores solvency to a satisfactory level.
- 5.12 Of course, reducing exposure to equities, particularly at a time when equities might be considered to be relatively cheap, may not be in the interests of policyholders in the long term. It may be appropriate, therefore, for the FCR to deal not only with the question of solvency, but also to consider how investment freedom might be constrained in different scenarios. One way of demonstrating the impact of constraints on investment freedom would be to include illustrations of the effect on projected payouts for specimen policies.

Scenario 2 - gradual rise in market values followed by a correction

- 5.13 We now consider an alternative investment scenario. Instead of an immediate fall in market values, we assume that the market in general, and the value of equities in particular, outperform compared to the base case scenario for two years, but that this is then followed by a sudden correction. Again, as the amount of dividend income is assumed to be

unchanged, yields fall over the two years but then return to the initial level at the time of the correction. If the investment mix is unaltered (ie maintained at 70% equities, 25% fixed interest, 5% cash) and reversionary bonus rates are unchanged, the results are as illustrated below.

Scenario 2

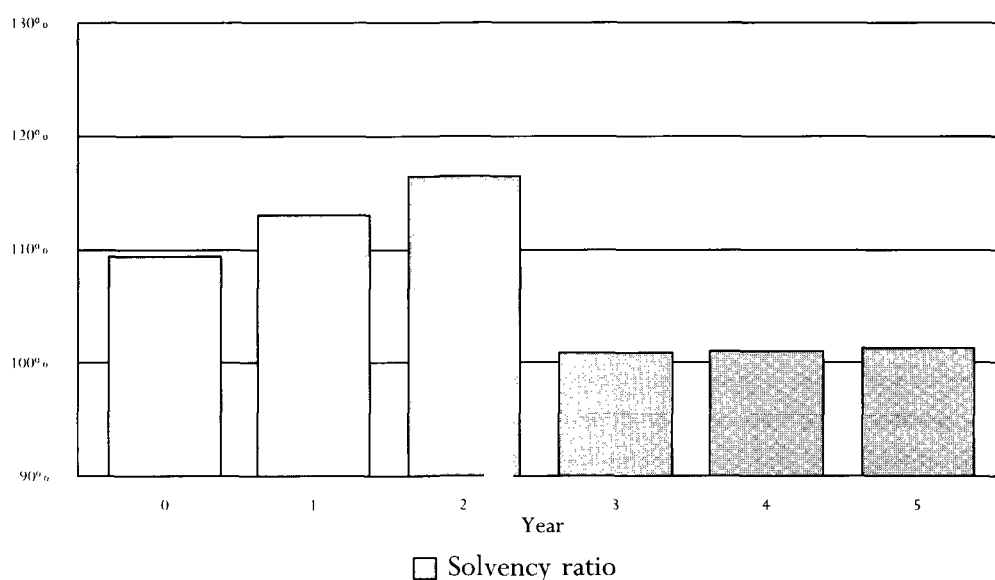


- 5.14 The favourable investment returns over the first two years of the projection increase the solvency ratio but, following the correction at the end of Year 2, it falls back to a level slightly below that anticipated in the base case scenario. The drift down in the solvency ratio after Year 2 reflects overpayment against asset shares in this period as a result of the smoothing formula adopted in our example.

Scenario 2a - as Scenario 2, but with a switch into equities as markets rise

- 5.15 Scenario 2 is not an adverse scenario in itself, provided that the office exercises restraint during a period of rising markets and improving free asset ratios. The purpose of the inclusion of Scenario 2 is for comparison with what would happen if, in this investment scenario, the office were to act inappropriately. It could be used to demonstrate to the Board the need to exercise restraint. For example, with the significant improvement in the solvency position in Year 1 and 2, options open to the office include increasing its exposure to equities. The following graph illustrates what would happen if the office gradually increased its exposure to equities from 70% to 85% over the period of rising markets. It is assumed that, following the fall in asset values at the end of Year 2, equity exposure is reduced back to 70%.

Scenario 2a



- 5.16 It can be seen that, during the two years of increasing equity markets, our example office is able to increase its exposure to equities while still showing an improvement in its published solvency position, although obviously not to the same extent as in the scenario where equity exposure is unchanged, because of the associated strengthening of the statutory minimum valuation basis. When the market falls back at the end of Year 2 however, the solvency ratio falls to a level that may well be considered unacceptably low. The office has only just enough assets to cover the required minimum solvency margin. Indeed, to ensure adequate solvency going forward, it may need to consider reducing its equity exposure to below 70%.

Other deterministic scenarios

- 5.17 We have considered only two deterministic scenarios to illustrate some of the issues that arise when carrying out a DST investigation for a with-profits office. In practice, the actuary would of course wish to consider many others. These would include, but not be limited to, scenarios involving variations in levels of new business, expenses and persistency, as well as other investment scenarios. For all of these scenarios, it will be necessary to allow for the office's ability to cut bonus rates and change the investment mix in order to remain solvent.

Stochastic scenarios

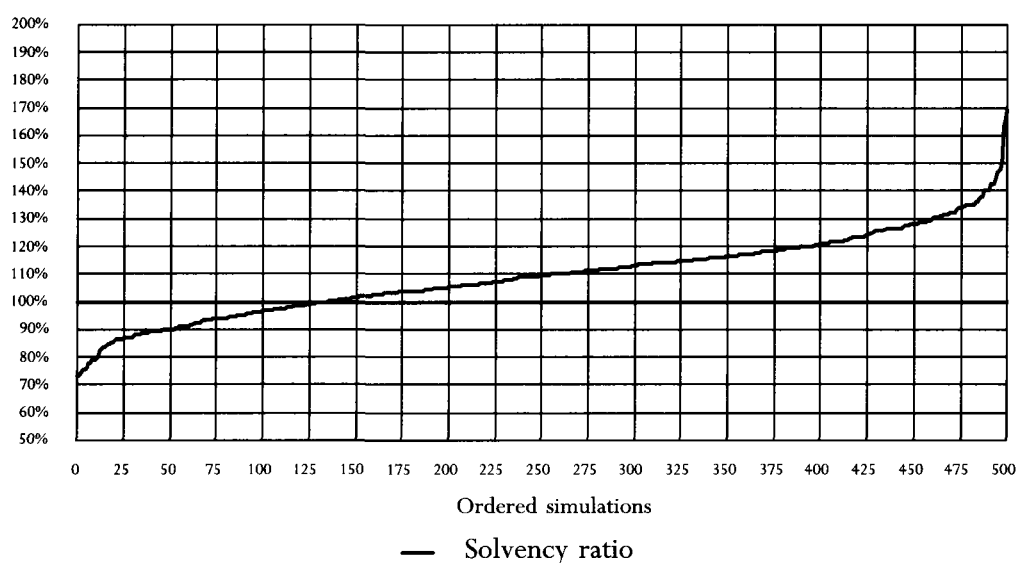
- 5.18 As already noted, sensitivity to investment experience is a significant issue for with-profits offices and there is a large variety of different scenarios that could be considered. Changes in asset values may or may not, for example, be accompanied by changes in the level of income and both the size and pattern of changes can vary. It can be difficult to be sure that all significant possible adverse scenarios have been considered when carrying out projections on a deterministic basis. It is partly for this reason that we believe stochastic modelling can add considerable value.

- 5.19 Stochastic modelling can help to identify the scenarios which expose the company to the highest risk of insolvency and can also be valuable in comparing the relative level of risk associated with different strategies. It is debatable to what extent stochastic modelling can provide a guide to the absolute risk of insolvency associated with a particular strategy since the results will depend on both the type of asset model used and the parameters used in the asset model. Having said that, by testing the sensitivity of the results to the parameters in the asset model and to the use of a different asset model, the Appointed Actuary may be better placed to form a view on the absolute risk of insolvency.

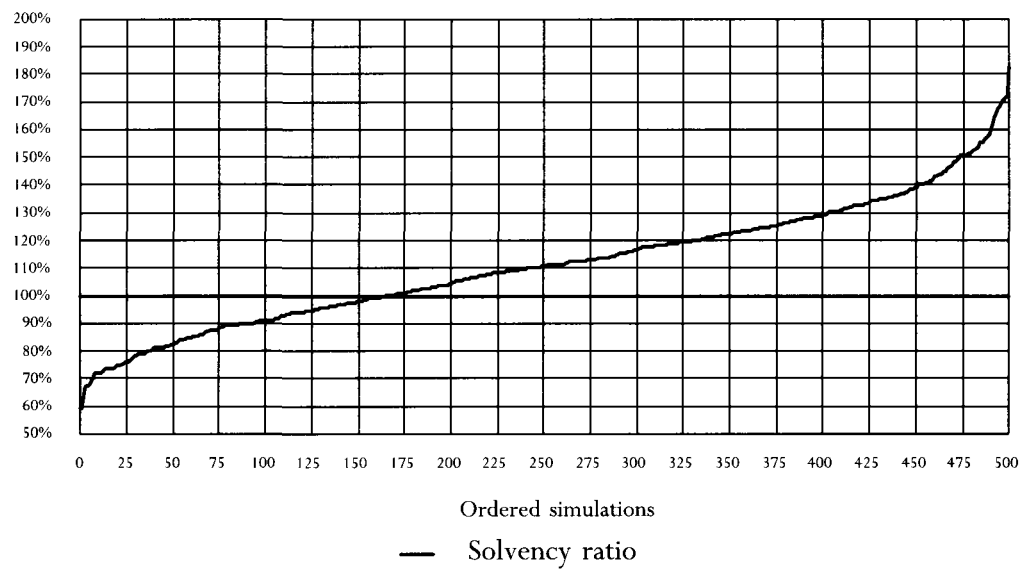
Example of a stochastic investigation

- 5.20 In order to carry out a stochastic modelling investigation, it is essential to have a model which operates on a 'one step at a time' basis and has an algorithm built in to enable factors like investment mix and bonus rates to be varied in each projection step. We demonstrate this below by showing the results of a stochastic modelling exercise carried out first on the assumption that the investment mix and bonus rates are unchanged, and then assuming that they are varied according to the prevailing economic conditions and the strength of the company's solvency position.
- 5.21 The graphs below show the solvency position for our example with-profits office at the end of Years 1, 3 and 5 respectively, assuming the same fixed investment mix and fixed reversionary bonus rates as for the base scenario. 500 stochastic simulations were carried out, the results of which have been ordered, for clarity of presentation, according to the projected solvency ratio.

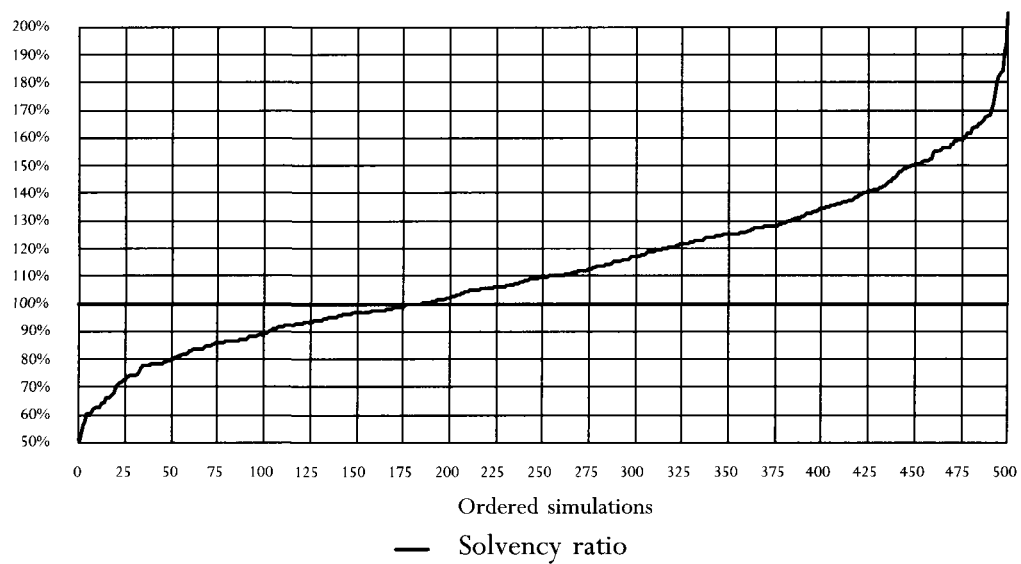
Solvency after 1 year - fixed r.b. rates and asset mix



Solvency after 3 years - fixed r.b. rates and asset mix



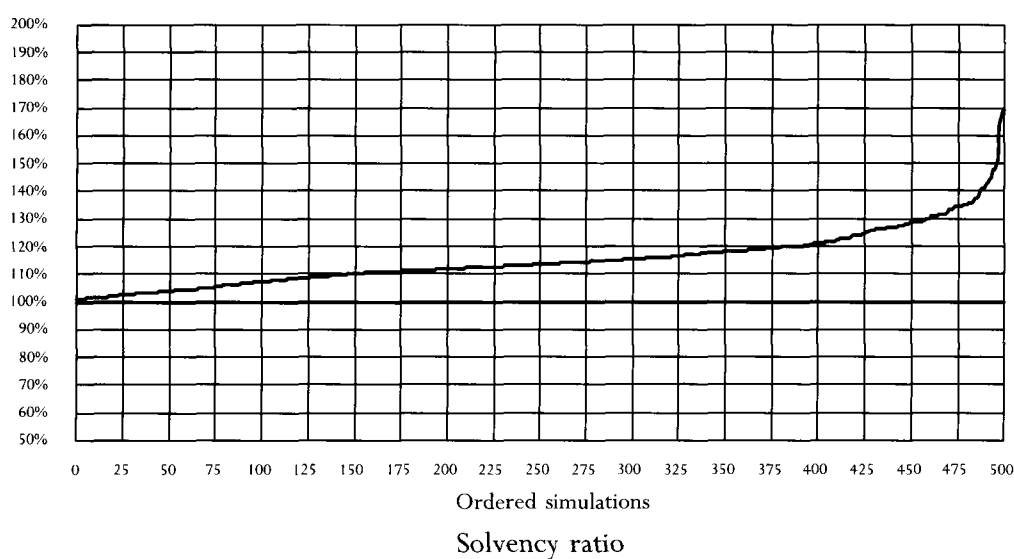
Solvency after 5 years - fixed r.b. rates and asset mix



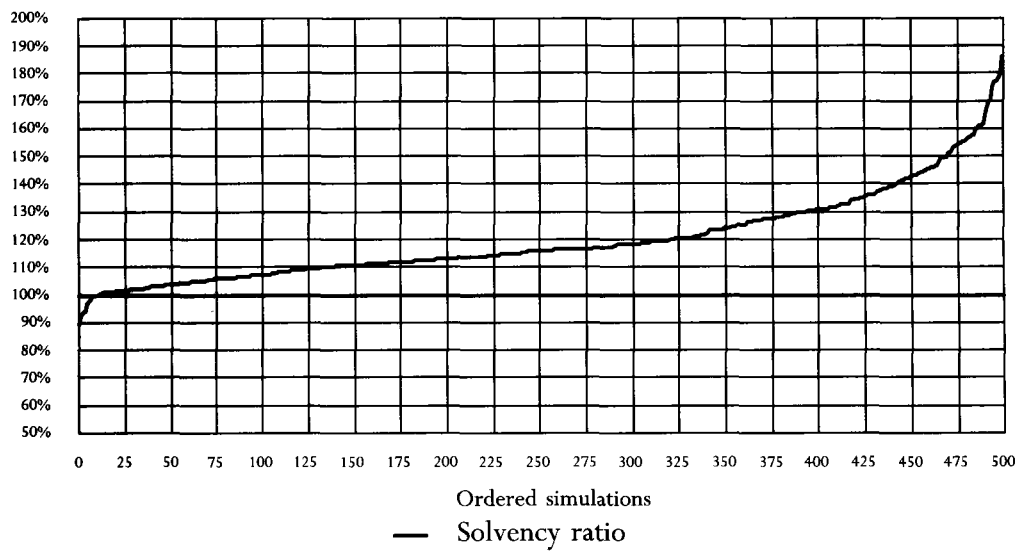
- 5.22 For 27% of the simulations the company is insolvent after one year. This percentage increases slightly for longer projection terms to 37% after five years. The median and mean results, on the other hand, are fairly stable. The variability of the results is much greater for solvency at the end of five years than for solvency at the end of one year, partly as a consequence of increasing variability in the total investment return for longer durations, but also due to the use of a fixed asset mix and fixed reversionary bonus rate assumptions.
- 5.23 By assuming a fixed investment mix and fixed reversionary bonus rates the above results overstate the real risk of insolvency. It is necessary to try to formulate decision rules for both of these items in order to obtain more realistic results. There may also be other factors that should be varied to reflect actual experience. For example, the company could vary the proportion of smoothed asset share paid out at maturity. The graphs below show the results for the same 500 simulations of the asset model, but using the following, purely illustrative, decision rules for the level of reversionary bonus rates and investment mix.

- Reversionary bonus rate: based on a supportability calculation with the added constraint that reversionary bonus rates must not move by more than 1% from one year to the next; and
- Investment mix 70% equities, 25% fixed interest, 5% cash if the excess of assets over reserves and the solvency margin is more than 5%; otherwise 35% equities, 50% fixed interest, 15% cash.

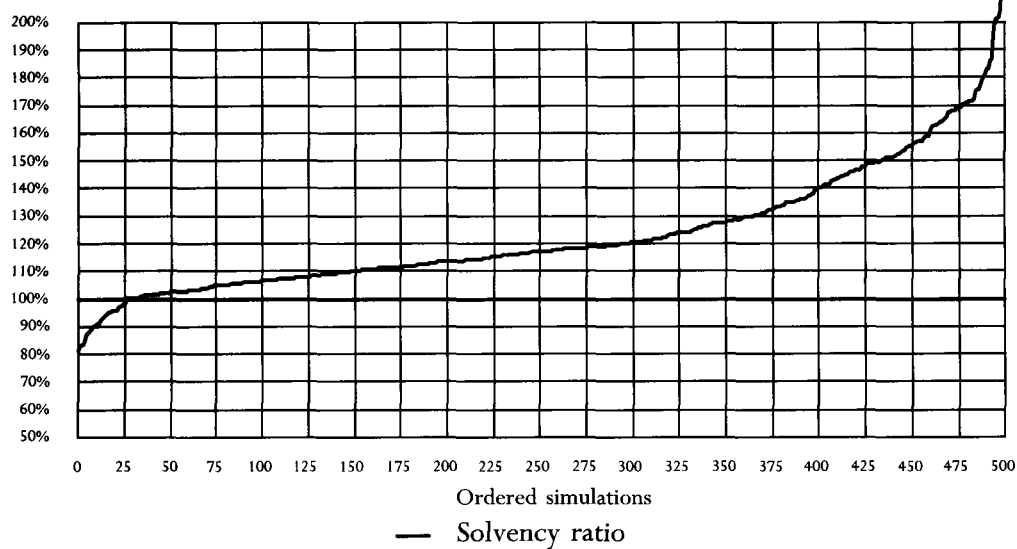
Solvency after 1 year - variable r.b. rates and asset mix



Solvency after 3 years - variable r.b. rates and asset mix



Solvency after 5 years - variable r.b. rates and asset mix



- 5.24 There are now no simulations where the office is insolvent at the end of Year 1 and only around 5% of the simulations where it is insolvent at the end of Year 5. Comparing these results to those produced by the investigation based on fixed reversionary bonus rates and a fixed investment mix clearly demonstrates how important it is to build decision rules into the model.

Choice of decision rules

- 5.25 The results produced by a stochastic investigation, or for that matter, a series of deterministic results, are obviously going to be very dependent on the assumptions made about how the office will react in different circumstances (ie the choice of decision rules). As demonstrated above, it is necessary to include decision rules to avoid significantly overstating the risk of insolvency. On the other hand, it is important that the assumed action is realistic so as not to give a false sense of security. The assumptions made should also be ones that both the Board and the Appointed Actuary are comfortable with. For example, it is quite likely that this would not be the case with our example office where, for illustrative purposes, we assumed equity exposure would be reduced from 70% to 35% if the solvency ratio fell below a certain level.
- 5.26 The results of the DST investigation carried out assuming different decision rules should be useful in determining an appropriate policy on matters like investment mix and bonus strategy. The actuary can use the FCR as a means of educating the Board on the risks associated with different strategies and/or the risks of digressing from an agreed strategy.

Summary

- 5.27 To summarise, we have noted in this section that for with-profit offices:
- the investigation of a variety of investment scenarios is critical;
 - DST modelling is much more complex than for unit-linked offices because of the need to reset valuation bases, adjust bonus rates, and adjust the investment mix; and
 - stochastic modelling is likely to be useful but requires the formulation of mathematical decision rules for the changes to the strength of the valuation basis, bonus rates and the investment mix, etc that the office would be likely to make.

6 THE FINANCIAL CONDITION REPORT

6.1 The concept of a Financial Condition Report was first formally introduced into the UK in March 1996, when the Faculty and Institute of Actuaries introduced a new guidance note (GN2), although, as has been noted in Section 2, there had been discussion on the subject for some time before then.

6.2 Part of our survey, which was carried out at the end of December 1996, was designed to obtain views on issues such as:

- the timing of the production of the FCR;
- the content of the FCR;
- any difficulties that had arisen in communicating the content to the Board;
- intentions regarding disclosure of the FCR to third parties; and
- the value added by the production of the FCR.

In this section, we report the results of our survey on these topics.

6.3 Two-thirds of the companies surveyed had already produced an FCR or equivalent reports, but very few of these had produced reports of this type before 1996. Almost all of the remaining companies expected to produce an FCR or equivalent before the end of 1997. Only two of the companies responding to our survey had no immediate plans to produce a report of this type.

Timing

6.4 GN2 suggests that, in the normal course of events, the FCR should be produced annually and our survey confirmed this to be the intention of all companies.

6.5 A large number of the companies surveyed said that they present the FCR with the annual valuation report and/or the report on bonus recommendations. Others saw the FCR as part of the budgeting or financial planning process and submit the FCR just before, or coincident with, papers on that subject. A small majority however, choose to present the FCR separately from other reports.

Content of the FCR

6.6 It is very likely that the actuary will have carried out more sensitivity and scenario tests than were actually included in the FCR. The results included in the FCR will also only be a summary of the figures produced and considered by the actuary in more detail. The key point is that the actuary will not want to swamp the Board with a mass of figures and results, but will wish to ensure that all of the key risks are identified. GN2 states that....

“The very least that it is reasonable for a Board to expect of the advice from the Appointed Actuary is that the company does not unknowingly run foreseeable risks which could jeopardise its financial well-being.”

- 6.7 Whenever a potentially damaging scenario is identified, the Board can reasonably expect the actuary to explain the options open to the company to deal with the situation. If no remedial action can be found, the actuary should make recommendations as to what might be done to avoid such circumstances. In either case the Board is also likely to be interested in the probability of the particular scenario occurring. However, this can be difficult to judge and only 10% of the companies surveyed said that they had tried to quantify the probability of particular scenarios occurring. This had been done either by reference to past experience or by using a stochastic model.
- 6.8 Although the FCR is intended to focus on projected solvency, the underlying projections can be used to produce other information, such as projected profits, bonus rates and embedded values. Most of the with-profits offices surveyed said that they presented information on projected bonus rates and policy payouts in the FCR, and just under half of all the companies surveyed included information on projected embedded values. Many respondents to the survey noted that where the projected increase in embedded value was presented the Board often expressed as much interest in this as in the threats to solvency.
- 6.9 It is also important not to lose sight of the fact that the FCR is not just intended to report on the results of the DST projections, but also needs to cover wider business risks, which often present a more serious threat to the company’s solvency position and may be harder to anticipate. GN2 lists various such factors to which the Appointed Actuary should be alert:
- concentrations of assets in particular risk areas;
 - derivatives;
 - assets containing unusual provisions which may be susceptible to particular risks;
 - sources of new business which have unusual characteristics;
 - impending major claims or litigation that might affect the company;
 - operational exposure to accidents, terrorism, or malicious damage;
 - unusual contracts or relationships which may have financial implications;
 - risks created by deficient product literature or policy documentation;

- loss of a distribution channel; and
- the effect in different scenarios of options and guarantees in the insurance liabilities.

Communication with the Board

6.10 Some of the companies surveyed said that they had not experienced any difficulty in communicating the results of DST to their Board. However, the majority (87%) of respondents said that they had experienced some problems. Difficulties experienced included:

- a lack of interest;
- scepticism (“actuarial mumbo-jumbo”);
- the difficulties in communicating complex issues to non-specialists;
- how to present extreme scenarios without causing undue concern;
- concern regarding the degree of conservatism in the selection of adverse scenarios;
- too much focus on assumptions rather than results;
- quantifying the level of risk associated with each scenario; and
- justifying the need to hold a resilience reserve after an investment shock.

Disclosure to third parties

6.11 Prior to the introduction of GN2, there was discussion as to whether the FCR should be automatically available to the regulator. In Canada, for example, the regulators can inspect the FCR on the company’s premises. The DST Working Party, however, concluded that in the UK the regulator should not have automatic access to the FCR, since:

- it could lead to calls for public disclosure of the FCR;
- an FCR indicating potential dangers might prompt premature actions by the regulator; and
- a low key approach initially would give Appointed Actuaries an opportunity to gain experience of DST and of preparing FCRs.

6.12 Although there is no automatic access, the FCR could still usefully be discussed less formally at the periodic meetings between the company and the regulator. The auditors of a company

would also usually have access to the FCR in the same way that they have access to other Board papers.

- 6.13 65% of the companies surveyed which had produced an FCR said that they had made it available to their auditors. However, less than 15% had made, or envisaged making, the FCR available to the DTI or GAD.

Is it a worthwhile exercise?

- 6.14 In view of the additional work involved and costs incurred in producing the FCR, it is interesting to ask whether or not it is a worthwhile exercise. While none of the Appointed Actuaries surveyed said that they had identified any new risks, 55% said that the production of the FCR had increased their understanding of the risks inherent in their business. Perhaps more importantly, 81% thought that their Board's understanding of these risks had been improved.

- 6.15 Of course this leaves 19% of respondents to our survey who did not consider that the FCR had provided either them or their Board with new benefits. The negative comments we received included the following which are of course the views of individual respondents and not of the authors:

- for an office with no with-profits business, it adds little value;
- a full FCR is too expensive;
- it gives rise to a significant additional actuarial workload at a time when offices are trying to contain costs; and
- the requirements for the FCR in the professional guidance are too specific and too long.

- 6.16 Other more positive comments included:

- the FCR had provided a useful way of pulling together information and presenting it to the Board;
- much value had been derived from the FCR as a communication exercise; and
- value had derived from the process of modelling as much as from the information that results.

- 6.17 One respondent to our survey noted that the production of an FCR was very useful from time to time but was not, in his view, necessary each year. It must be true that most of the benefits of the FCR will be derived the first time it is produced and that, unless the business changes significantly, it may become rather repetitive in subsequent years. However, it does not seem inappropriate to remind the Board of the important issues annually and this could be done in part by reference to a previous year's report, or by moving the detailed results derived in a previous year's report into appendices. Furthermore, it is a good discipline to

have to review in a formal way the risks that might be inherent in the business. Even if there are no new risks, the level of risk may vary from year to year depending on the experience of the office. The modelling work needed for the FCR may also form a useful part of the business planning process.

- 6.18 Finally, the companies surveyed were asked whether they would describe the production of an FCR as a very worthwhile exercise, something that provided useful information but at considerable cost, or something that added little value. The responses are analysed below:

FCR is:	All offices	Offices with some with- profit business	Offices with no with-profit business
A very worthwhile exercise	56%	55%	56%
Provides useful information, but at a considerable cost	29%	26%	33%
Adds little value	15%	19%	11%

- 6.19 Generally the responses seem favourable and the results do not indicate any real difference between the attitudes of with-profits and unit-linked offices.

7 SUMMARY AND CONCLUSION

- 7.1 The introduction of GN2 less than a year ago has clearly, based on the results of our survey, had a significant impact on the work carried out by life office actuaries in the UK. Almost all of the companies responding to the survey are, or will in 1997 be, complying with GN2 by producing an FCR or equivalent reports, whereas very few had done so prior to 1996. Also very many companies, partly as a direct consequence of the introduction of GN2, have enhanced, or are intending to enhance, their financial modelling capabilities.
- 7.2 As we have noted in earlier sections, DST is most complex for with-profits business. A sophisticated financial model is required in order to reflect the interaction of the asset and liability projections and to recalculate mathematical reserves and resilience test reserves in future periods. This is particularly true if it is intended to carry out a stochastic investigation, when it is always necessary to formulate decision rules with regard to, for example, the changes in investment mix and bonus rates that would be appropriate in different circumstances.
- 7.3 DST for a unit-linked office does not present as many challenges, as far as the modelling is concerned, as it does for a with-profits office. Nevertheless, difficult issues still arise. The actuary needs to use judgement in the choice of sensitivity tests and scenarios to consider. This involves deciding which assumptions to vary, the degree of variation that should be tested, and considering the likelihood of different scenarios occurring. It is also necessary to give thought to the mitigating action that the office might take in adverse scenarios and reflect this in the projections. While it may be clear what action is appropriate, it will not always be clear what the results of taking that action will be. For example, in a scenario of increased competition, it might be appropriate to cut charges to maintain new business levels at an economic level, but the impact of a particular reduction in charges on new business levels is difficult to assess.
- 7.4 Having carried out a DST investigation, it is necessary to communicate the conclusions reached to others and in particular to the Board. This is the purpose of the FCR and, as we have noted, it is not always easy to get the Board to focus on the key issues. The content and presentation of the FCR are therefore also important issues for the Appointed Actuary.
- 7.5 Finally, we note that, despite some concern expressed at the costs incurred, our survey suggests that a clear majority of Appointed Actuaries believe that the production of an FCR has increased their and/or their Board's understanding of the risks inherent in their business. This being the case, the introduction of GN2 can surely only be welcomed.

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