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INVESTMENT GUARANTEES IN THE SOUTH AFRICAN LIFE INSURANCE INDUSTRY

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ABSTRACT

This paper explores the risks faced by South African life insurance companies arising from the provision of investment guarantees in products sold. The current thinking and practice of the larger South African life insurance companies regarding investment guarantees is set out following their responses to a survey.

The paper examines the forms of investment guarantee available and the business issues created by the writing of these guarantees. These include issues around the design and pricing of new business, as well as the risk management of in-force business.

The paper also compares existing methods used internationally to value life insurance business with investment guarantees, focusing on the use of stochastic models. The different allowances for risk within each valuation method and the appropriateness of these allowances when valuing investment guarantees are considered. The stochastic models compared include both statistically based real-world models and market-consistent state-price-deflator or risk-neutral models. Practical issues around the building of such asset–liability stochastic models are briefly discussed.

Finally, the authors put forward their own views of possible developments in the future within South Africa that may impact on life insurance business with investment guarantees, and the possible implications.

KEYWORDS

Investment guarantee; maturity guarantee; South Africa; non-profit guarantee; smoothed-bonus business; asset–liability matching; market risk premium; financial options; hedging; equity volatility; stochastic modelling; market-consistent valuation

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1. INTRODUCTION

1.1 BACKGROUND

1.1.1 In recent years we have seen many cases internationally in which investment guarantees provided by life insurers have bitten, in some instances with catastrophic results. These have generally been due to a combination of the sale of products with investment guarantees, inappropriate asset–liability matching and falling stock markets and bond yields. Appendix A describes how investment guarantees have

historically arisen in the life insurance industry, and Appendix B provides brief examples of some recent adverse effects outside of South Africa.

1.1.2 Such economic risks also exist in South Africa. The outlook for inflation is highly uncertain but long-term government policy is to control inflation and keep it low by historical standards. If such a policy is seen to be working then there will be downward pressure on government bond yields.

1.1.3 Whether investment guarantees could have such an impact on the South African life insurance industry depends, *inter alia*, on

– the extent to which products with investment guarantees have been written;
– the nominal levels of the guarantees for such products, given that nominal levels may have been set at times where nominal bond yields and expected returns were high;
– the appropriateness of the financial risk management of such business, in particular how well the assets and liabilities are matched; and
– the level of capital held and how this capital is managed.

1.1.4 Dardis (2002) sets out the current state of risk-position reporting in South Africa and incorporates feedback from the South African life insurers. Much of the feedback is related to products with investment guarantees, indicating that the financial management of such products is considered by the companies themselves to be an important part of their operations.

1.1.5 The authors felt that, given this background, the time was right to review the investment guarantees within the South African life insurance industry, the extent to which these guarantees are matched and how they are managed.

1.2 SURVEY OF INVESTMENT GUARANTEES

1.2.1 The main area of research in this paper was to determine current practice and thinking in the South African life insurance industry with regard to investment guarantees. For this the authors invited senior actuaries and management of ten of the biggest life insurers to take part in a survey examining the companies' investment guarantees and their current practice. Seven insurers agreed to take part.

1.2.2 The survey involved an informal series of discussions around the following key areas:

– the risk that investment guarantees will bite on in-force business;
– methods used to manage investment-guarantee risk;
– tools currently used to measure this risk;
– allowance for this risk in the statutory reserves;
– investment guarantees in new business;
– charges to policyholders for the cost of investment guarantees; and
– issues identified by the participants relevant to investment guarantees.

The results of the survey are used to illustrate concepts and describe the practical aspects of investment guarantees at relevant points throughout the paper.

1.2.3 The survey was used to help identify the following four products as the main products with investment guarantees sold in the South African market:

– the non-profit immediate annuity;

– the participating immediate annuity;
– the unit-linked savings product with a maturity guarantee; and
– the smoothed-bonus savings product with a maturity guarantee.

The basic features of these products are described in Appendix C. The authors focus on these products throughout the paper.

1.3 THE SUB-COMMITTEE ON RESERVING FOR MATURITY GUARANTEES

1.3.1 In 2001 a sub-committee of the Actuarial Society of South Africa (ASSA) was formed to examine the current reserving requirements for maturity guarantees and to make recommendations for the future. The work of the sub-committee was expected to be documented and presented at the ASSA convention in 2002.

1.3.2 At the time of writing the sub-committee had not finalised their recommendations but had indicated progress at a recent ASSA sessional meeting. It was indicated that the sub-committee might recommend stochastic methods to calculate the level of this reserve.

1.4 RELEVANT REGULATION

1.4.1 In this section the authors discuss how regulation affects the management of investment guarantees.

1.4.2 In South Africa, long-term insurers are required to calculate a financial soundness valuation reserve (FSV) and a capital adequacy requirement (CAR). ASSA's professional guidance note (PGN) 104 specifies the requirements that must be followed by the statutory actuary when calculating the FSV and CAR.

1.4.3 Internationally there have been significant developments in the thinking of accounting and statutory bodies regarding future regulation. These include the development of a draft statement of principles (DSOP) by the International Accounting Standards Board (IASB) for fair-value accounting[1]. This has led to a proposed fair-value statutory reporting framework for the UK. An overview of both the international accounting and the UK statutory developments is available in Abbink & Saker (unpublished: chapter 2); the DSOP is summarised in Appendix B. The report of the Fair Valuation of Liabilities Working Party of the Institute and Faculty of Actuaries was produced in Hairs *et al* (2002).

1.4.4 There is currently a sub-committee of ASSA that is reviewing the existing CAR provisions, particularly in the light of the international developments in fair-value accounting.

1.5 STRUCTURE OF PAPER

The remainder of this paper is structured as follows:

– Investment guarantees – the business issues (section 2)

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1 International Accounting Standards Board: Draft Statement of principles. http://www.iasc.org.uk/cmt/0001.asp?s=410776&sc={DB22EF52-D704-4FDF-9F5B-A1A900840034}&n=1001#DSOP

– Methods used to value investment guarantees (section 3)
– Possible future developments (section 4).

In addition, as already indicated, the appendices provide some additional information relevant to investment guarantees:

– Appendix A contains a brief history of how investment guarantees arose in the life insurance industry in the United Kingdom and South Africa;
– Appendix B presents some recent examples of adverse effects of investment guarantees on life insurance industries outside of South Africa; and
– Appendix C contains a brief description of the main South African products with investment guarantees.

2. INVESTMENT GUARANTEES – THE BUSINESS ISSUES

2.1 THE BUSINESS ISSUES

The business issues companies face in relation to investment guarantees are discussed below under the following headings:

– identifying the risks;
– risk management of in-force business;
– setting statutory reserves;
– the capital management of in-force business;
– current FSV and CAR methodologies – feedback from the survey;
– product design and pricing, and the marketing of new business;
– managing the expectations of policyholders; and
– managing the expectations of shareholders.

2.2 IDENTIFYING THE RISKS

All life insurers in South Africa provide investment guarantees on their products of one form or another. These guarantees can typically take very different forms:

– investment guarantees in non-profit business, e.g. retirement annuities;
– maturity guarantees in unit-linked or smoothed-bonus business; and
– investment guarantees in participating annuities.

2.2.1 INVESTMENT GUARANTEES IN NON-PROFIT BUSINESS

2.2.1.1 These guarantees are defined at outset and are always payable. They are generally well matched, the matching assets being fixed-interest stock, including South African government bonds (gilts), utility stock and corporate bonds. In practice it is difficult to use exact matching, so immunisation techniques are adopted.

2.2.1.2 For this business, actuaries have historically allowed for the additional risk premium of utility stock, corporate bonds and other streams of fixed-interest income over gilts to different degrees when setting the discount rate to value the liabilities. Some allowance for the risk premium has generally been deemed acceptable by actuaries as long as the discount rate is increased only for the part of the risk premium representing the liquidity premium and is not increased in respect of the default-risk component.

2.2.2 Maturity Guarantees in Unit-Linked and Smoothed-Bonus Business

2.2.2.1 The guarantees on unit-linked and smoothed-bonus business are financial options, which may or may not bite, depending on the performance of the underlying fund. A typical fund is invested in a balanced portfolio, a mixture of bonds and equities, and the level of the guarantee is generally defined as premiums rolled up at a rate of interest. In the rest of this paper, these guarantees are referred to as 'maturity guarantees'; when practitioners in South Africa refer to maturity guarantees this is what they are normally referring to.

2.2.2.2 The structure of such guarantees leads to a very different risk to that inherent within non-profit business, as the payout profile of such guarantees is highly geared to the level of the underlying fund at maturity. This gearing is demonstrated graphically in Appendix C.

2.2.2.3 There are variations in the form the investment guarantee can take. For example, a guaranteed investment return may either be compound over the term from issue to maturity, or apply each year. The guarantee may apply to the total premium or to the premium less specified deductions.

2.2.2.4 Significantly, smoothed-bonus business has an additional maturity guarantee, which increases over the term of the policy, due to the addition of vesting bonus. (For a description of vesting and non-vesting bonus see Appendix C.) This maturity guarantee can apply either on top of or as well as the standard maturity guarantee described above.

2.2.2.5 Historically, these maturity guarantees have not been backed by assets that hedge the guarantee, but the guarantee has not been onerous in a time of high inflation and low equity volatility. As we move into a lower inflationary environment, where equity market movements are becoming increasingly volatile, insurance companies need to understand how to value and cost such guarantees and how to hedge against the risk that the guarantees will bite.

2.2.2.6 In this paper we shall see that it is very difficult to exactly hedge these guarantees. Complications arise with the allowance for lapses. In addition, the nature of the investment guarantee is more complicated for smoothed-bonus business, where the guarantee is increasing with vesting bonuses. It is however possible to approximately hedge this business and we discuss valuation methodologies that assist in measuring the cost of such hedges.

2.2.3 Investment Guarantees in Participating Annuities

For participating annuities the level of the annuity payment builds up over time with vesting bonuses. This business tends to be invested in a balanced portfolio. Some companies match the level of current annuity payments with bonds.

2.2.4 Feedback from Survey

2.2.4.1 In our survey, companies were asked to describe the investment guarantees in the in-force business, indicate the size of the business (using the FSV as a measure) and judge the materiality of the risk.

2.2.4.2 For most companies, non-profit annuities comprise a large proportion of business in force but are considered to be the least material risk due to the matching of assets and liabilities. The extent to which insurers are allowing for the risk premium of non-gilt assets in matching and valuing non-profit annuities was not addressed in the survey.

2.2.4.3 Most companies differentiate between unit-linked and smoothed-bonus business when considering maturity guarantees. Investment-guarantee risk is considered more material for smoothed-bonus business.

2.2.4.4 Some companies differentiate between individual and group (or employee benefits) business when considering maturity guarantees. One company indicated that the conditions required before guarantees bite are more stringent for group business.

2.2.4.5 Most companies identified participating annuities as one of the more material risks. Some companies identified this product as the most material risk.

2.2.4.6 Most companies indicated that the above comments applied equally to in-force and new business.

2.3 RISK MANAGEMENT OF IN-FORCE BUSINESS

2.3.1 Areas of Risk Management

2.3.1.1 For the South African companies taking part in the survey, non-profit annuities, participating annuities and maturity-guarantee business contain the majority of the risks related to investment guarantees, and this section focuses on these products.

2.3.1.2 The primary areas of risk management for such business include:

- the identification of the investment guarantees in the in-force business;
- underwriting to avoid financial selection;
- the asset–liability matching of non-profit business;
- the limitation of exposure to market movements;
- the hedging of maturity guarantees in the market;
- the hedging of maturity guarantees internally;
- the monitoring of financial risks; and
- the management of smoothed-bonus business.

These areas are discussed below.

2.3.2 Identifying the Investment Guarantees in the In-Force Business

2.3.2.1 The identification of investment guarantees in an in-force block of business may on the surface appear a straightforward exercise. However, some of the policies on a company's books may have been in force for many years. There is a risk that records for earlier periods may not be complete or may not be familiar to the actuaries and management of the company.

2.3.2.2 In the UK the appointed actuary is obliged to list all the investment guarantees in the company's liabilities in the returns to the local regulator. This is not a specific requirement of South African legislation, but it is clearly necessary for the

statutory actuary to be familiar with all the investment guarantees in the business before being able to calculate an appropriate FSV.

2.3.2.3 Some companies indicated that in recent years there had been a formal investigation into what investment guarantees existed within their in-force portfolio.

2.3.2.4 Others indicated that they had a good feel for the more recent risks and so there was less of a need for a formal investigation into what investment guarantees existed. There may be a possibility that risks associated with the older business have not been fully captured, but these are unlikely to be material.

2.3.2.5 Two companies indicated that such a formal investigation had in the past led to either the identification of new investment guarantees or the realisation that particular guarantees were more onerous than had previously been assumed.

2.3.3 Underwriting to avoid Financial Selection

An important process in the management of investment-guarantee risk is the identification of possible policyholder selection and the mitigation of this risk. This can be achieved by financial underwriting by the life company both at policy inception and during the term of the contract. Possible actions by the company could include:

– taking care with policyholders who request an extension of the policy at maturity (should any guarantee still apply?); and
– restrictions on the application of the guarantee on switch or surrender.

The survey indicates that South African insurers are very aware of such considerations; no companies in the survey offered investment guarantees on switch or surrender and several companies indicated that strict rules were in place regarding the impact of policy extensions on maturity guarantees.

2.3.4 Asset–Liability Matching of Non-Profit Business

2.3.4.1 Life insurers use asset–liability matching techniques to reduce the financial risk associated with non-profit business. Perfect matching is not possible, so immunisation techniques are used instead. Dardis (2002) discusses how duration and convexity matching is prevalent in South Africa and referred to Maitland (2001), which addresses some of the weaknesses of the standard approach. This survey broadly echoes these findings; most of the participants indicated that they do match their non-profit annuity business. The frequency of matching varied from monthly to quarterly.

2.3.4.2 Matching is not a straightforward exercise and there is no one recognised methodology to perform matching.

2.3.4.3 Asset–liability matching can also be used to match the guaranteed portion of participating annuities. The liability cashflow is effectively split out into a nominal and a real component.

2.3.4.4 For both participating annuities and maturity-guarantee business, in economic scenarios where investment guarantees start to bite, the nature of the product changes to a non-profit product. If the insurer has not already hedged the guarantees, it may consider changing the investment policy to a matching policy appropriate for non-profit business. Such a change may be enforced if the financial strength of the insurer

is weak at the time and this is more likely following large market downturns. However, it is debatable whether companies would be willing to sell large equity holdings when the market is perceived to be at a low point.

2.3.5 Limiting Exposure to Market Movements

2.3.5.1 Unhedged maturity-guarantee business is exposed to the volatility of the financial markets, in particular the equity market.

2.3.5.2 Internationally, the historical correlation of equity portfolios and bond portfolios in the developed countries has been around 30% to 50%. As the correlation is less than 100%, the prices of balanced portfolios have exhibited less volatility than the prices of equity portfolios. This suggests that the overall risk that maturity guarantees will bite is less from balanced portfolios than from equity portfolios. In the survey, one company indicated that they do not offer maturity guarantees on equity portfolios, only balanced portfolios.

2.3.5.3 One company indicated that they offer maturity guarantees only for their own investment portfolios as opposed to external investment portfolios. This ensures that the company maintains control of the investments backing the maturity-guarantee business.

2.3.5.4 Exposure to market movements can be modelled using stochastic techniques. Whilst such techniques are examined in section 3, it should be noted that a key assumption is the level of volatility of the equity and bond markets, and the level of correlation between the two.

2.3.6 Hedging Maturity Guarantees in the Market

2.3.6.1 Companies may wish to hedge maturity guarantees to improve the asset–liability matching of this business. Exact hedges are likely to require the purchase of over-the-counter put option derivatives from a counterparty. Such hedges do not remove all risk. In particular the company can be left with significant credit or counterparty risk.

2.3.6.2 Counterparty risk can be minimised by collateral arrangements between the two parties, such as deposits with the insurer. The level of these deposits can be marked to market. However, it is unlikely that this risk can ever be entirely removed.

2.3.6.3 Besides counterparty risk, there are numerous limitations or complications in the use of derivatives, including the following:

- Such hedges may not be available directly in the market at all or may be available only with significant bid–offer spreads. This may be true in particular for longer-term business, where the sellers of such hedges may be scarce or non-existent.
- There may be a need for continual monitoring.
- There is a risk of tracker error.
- The practical costs associated with hedging may be significant relative to the size of the risk. Counterparties may therefore require a significant minimum level of business before they are willing to trade.
- The validity of any model used to price the cost of such hedges may be questionable over the longer term.

– There is a risk of moving the market on large trades.
– The tax position may be complicated or disadvantageous to the life company.

2.3.6.4 The survey indicates that the majority of maturity guarantees are currently unhedged. Some companies are looking into external hedging as a risk-management tool. One of the participant companies indicated that they regularly compare the cost of hedging maturity-guarantee risk in the market against the charge for the risk. By contrast, other companies indicated that it is difficult to find appropriate derivatives to externally match maturity guarantees. One company indicated that the use of external hedging would create additional counterparty risks, which would be unfamiliar and difficult to manage.

2.3.7 Hedging Maturity Guarantees Internally

2.3.7.1 The lack of availability of external hedging may lead an insurance company to hedge internally—perhaps only approximately. An internal hedge may consist in ensuring that capital held specifically to cover the risk that investment guarantees will bite is invested in assets that perform well when investment guarantees bite.

2.3.7.2 This additional capital is needed when maturity guarantees bite, which occurs when equity markets perform poorly. This suggests that equities are not a good investment strategy for this additional capital.

2.3.7.3 Cash has low or negative correlation with equity and bond markets. This would suggest that it may be appropriate to hold additional capital that is to some extent backed by cash.

2.3.7.4 In fact it is possible to approximately replicate a hedging strategy by, for example, investing the additional capital in a negative equity weighting if the occasion permits. This would ensure that the return on the capital is high when it is required and low when it is not required. This strategy requires being overweight in other asset classes, which in practice may be bonds, cash or futures.

2.3.8 Monitoring Financial Risks

Dardis (2002) describes in detail the monitoring of financial risks by South African life insurers, and this item is therefore not discussed further in this paper.

2.3.9 Managing Smoothed-Bonus Business

2.3.9.1 The declaration of vesting bonus in smoothed-bonus savings business and participating annuities leads to an increase in the investment guarantee underlying these products.

2.3.9.2 The extent to which bonuses are smoothed can affect the level of investment guarantee underlying the product. The more the insurance company smooths the bonuses credited to policyholders as compared with the underlying return on the backing assets, the less exposed maturing policyholders are to a downturn in the market when approaching maturity.

2.3.9.3 In the management of investment-guarantee risk, a metric is required to

measure the size of the loss in economic scenarios where the maturity guarantee bites. This requires a measure of the payout to the policyholder before guarantee to compare with the size of the maturity guarantee. For smoothed-bonus business, this measure is frequently the asset share, equal to premiums less cost of claims and expenses rolled up at the investment return on the assets backing the policy.

2.3.9.4 Such a measure needs to be recorded by the company in order to be available for the purposes of the management of financial risk.

2.4 SETTING STATUTORY RESERVES

PGN104 offers prescribed guidance on the calculation of the FSV. Section 2.1 of PGN104 states:

> 'The liabilities must be calculated on:
> – realistic (i.e. best-estimate) assumptions of the future experience (as further described in the balance of paragraph 2)
> – plus prescribed margins added to the best-estimate parameters (paragraph 2.15)
> – plus second-tier margins where the statutory actuary believes it appropriate (paragraph 2.16).'

For products with investment guarantees, this leads to the question of the meaning of 'best estimate'. In the following sections we consider this for some key assumptions for non-profit immediate annuities and maturity-guarantee business. Additional considerations for all smoothed-bonus business (i.e. both participating annuities and savings products) are then discussed.

2.4.1 NON-PROFIT IMMEDIATE ANNUITIES

2.4.1.1 Liabilities for non-profit immediate annuities are generally valued at a discount rate that is a function of the market yield of the underlying assets. The underlying assets for such business are generally a mixture of gilts and other fixed-interest stock. This leads to the following question in relation to non-profit annuities:

> 'Should the FSV best-estimate discount rate simply be the gilt rate of appropriate term or should it be increased to allow for the risk premium of other fixed-interest stock?'

2.4.1.2 There is a well-accepted argument that it is not appropriate to increase the liability valuation rate by the full amount of the risk premium over gilts. The argument is that the liabilities should be sufficient to allow for the probability of default of other fixed-interest stock.

2.4.1.3 There is then an argument about whether the valuation should take credit for any of the remaining risk premium. The rationale frequently used to enable credit to be taken is that the remainder is mostly made up of the liquidity premium.

2.4.1.4 This can be contrasted with a principle of DSOP which indicates that the use of the gilt rate of appropriate term, as the closest measure to the risk-free rate, is the most appropriate to use as the non-profit liability discount rate. This principle is based on the argument that any remaining risk premium reflects the risk aversion of investors in the more risky fixed-interest stock markets, given the possibility of variations in returns. This is discussed for all valuations in ¶¶3.3.6–9.

2.4.1.5 The use of the gilt rate to value non-profit liabilities removes entirely the ability of companies to increase published value by using riskier assets to back non-profit liabilities instead of gilts.

2.4.2 Maturity-Guarantee Business

2.4.2.1 For maturity-guarantee business the wording of PGN104 has historically led to the question:

> 'What best-estimate assumptions are appropriate to value the liabilities of maturity guarantee products?'

given that under a deterministic basis using recent gilt yields, maturity guarantees generally do not bite under best-estimate assumptions.

2.4.2.2 Some allowance for the possibility of maturity guarantees biting is clearly sensible. This may be suggested in paragraph 2.2 of PGN104, which states:

> 'Realistic assumptions should depend on the nature of the business.'

2.4.2.3 At the time of writing this paper the sub-committee for maturity guarantees had not finalised their work, but appeared likely to propose a new guidance note recommending the use of stochastic methods to determine an explicit statutory reserve for the maturity-guarantee component of such business.

2.4.2.4 If an explicit additional reserve were to be held to cover the maturity guarantee, a further question would arise as to how to invest the assets backing this reserve. It would seem reasonable to expect that a higher reserve should be held where a decision had been taken to hold a mismatched reserve. Appropriate asset–liability matching considerations for such a reserve are similar to those described in ¶2.3.7.4 above.

2.4.3 Additional Considerations for All Smoothed-Bonus Business including Participating Annuities

2.4.3.1 If deterministic methods are to be used to value smoothed-bonus business, a question arises over the allowance for the equity risk premium, in other words the excess of the expected equity return over the gilt rate, in determining the appropriate FSV discount rate. However, the significance of the answer is usually lower than for non-profit business, as there is often an explicit link between the best-estimate interest rate used and the bonus rate assumed in the valuation.

2.4.3.2 The allowance for the equity risk premium is significant when investment guarantees are biting or are close to biting under the assumptions used to calculate the liability, as the explicit link between valuation discount rates and assumed bonus rates may no longer apply.

2.4.3.3 When considering how close to biting the investment guarantee is, the following items should be considered:

- the costing rate used in pricing to determine the level of initial benefit given the initial premium;
- historical vesting bonus rates declared to date;
- any guaranteed minimum bonus rate applying in future;

– policyholder expectations regarding future bonus rates;
– allowance for future charges or expenses; and
– allowance for changes in bond yields under CAR scenarios.

2.5 CAPITAL MANAGEMENT OF IN-FORCE BUSINESS

2.5.1 We have discussed how the writing of business with investment guarantees generates a number of risk management issues for companies to address. But what capital management issues are there and how are these affected by writing such business?

2.5.2 A life insurance company has to determine the level of excess capital that is appropriate to be retained in the company.

2.5.3 The CAR is used to set the minimum statutory requirement for capital and is a good starting point. PGN104 defines the methodology used to calculate the CAR.

2.5.4 The CAR is a risk-based capital approach to the determination of capital requirements; in other words, the level of capital required is a function of the level and form of the underlying risks of the business.

2.5.5 Capital requirements for risks associated with investment guarantees are covered by the investment CAR, described in paragraph 6.2.h of PGN104.

2.5.6 Brealey & Myers (2000) set out a theory of why there are capital costs. In this theory a major component of these costs are agency costs, which occur due to the separation of ownership and management and conflicts between shareholders' and managers' objectives.

2.5.7 This suggests that shareholders, within reason, wish to minimise the excess capital held by the company, in other words, shareholders want the company to hold a lower rather than higher multiple of CAR.

2.5.8 Products with unmatched investment guarantees will have larger capital requirements than products with matched investment guarantees. In such circumstances this capital is needed to cover the risk that the guarantee will bite.

2.5.9 In fact, it is possible for financial services companies to reduce overall capital requirements by selling products with different forms or incidence of investment guarantee, where the overall risks are not perfectly correlated. An example for maturity-guarantee business is the sale of business that matures fairly evenly over time. This avoids the exposure of the insurance company to temporary falls in the equity market in particular maturity years or months. In this survey, two participant companies indicated that, for business with maturity guarantees, efforts were made to ensure that the volumes of business were well spread by maturity month.

2.5.10 In addition to determining the level of capital required, managers of life insurance companies have to determine how to invest this excess capital.

2.5.11 The calculation of the investment CAR incorporates allowances for different investment strategies, in particular the extent to which assets and liabilities are matched.

2.5.12 If capital is being held in part to cover the risk that maturity guarantees will bite, there is again the need to consider whether to invest this capital to match the risk.

2.6 CURRENT FSV AND CAR METHODOLOGIES – FEEDBACK FROM THE SURVEY

2.6.1 One general theme that was brought out by the survey participants is that the CAR is likely to be calculated with reference to the level of prudence used in calculating the FSV. The greater the level of overall prudence in the FSV, the less there is a need for a large CAR. In addition, the extent to which the assets backing the FSV match the corresponding liabilities will affect the level of CAR required and how it is invested.

2.6.2 All companies hold basic reserves to cover liabilities where investment guarantees are biting. For most companies this included little or no maturity-guarantee business, reflecting the fact that the guarantees underlying this business were generally not biting.

2.6.3 Three companies hold additional reserves that are at least partially earmarked to cover the risk that investment guarantees could bite in future for maturity-guarantee business. One other company indicated that it considered this risk adequately covered given various contingent reserves elsewhere and the first- and second-tier margins of prudence in the FSV basis.

2.6.4 One company using stochastic models to measure the risk that maturity guarantees will bite, uses the output of these models to help set the additional statutory reserve.

2.6.5 The other two companies holding additional reserves in respect of the risk that guarantees will bite use a retrospective approach. The general approach is to set the FSV equal to the accumulation of the previous year's FSV with interest earned on the assets backing the reserve.

2.6.6 One of these companies increases the retrospective FSV by an assumed level of charge for maturity guarantees for business remaining in force, and decreases the retrospective FSV for the accumulated FSV of policies that exit between valuations.

2.6.7 Two companies invest the additional reserves to cover maturity-guarantee risk in the same portfolio of assets as the underlying maturity guarantees, primarily balanced portfolios.

2.6.8 One of the companies holding these additional reserves indicated that the additional reserves were currently invested fully in bonds. This company indicated that it was considering moving to a more matched investment philosophy, going overweight in bonds, with negative weighting in equity.

2.6.9 When calculating investment CAR, all companies allow, where relevant, for maturity guarantees where the guarantee bites on a deterministic basis after the stipulated fall in asset value and change in bond yield. No company allows for the risk that maturity guarantees will bite beyond this level.

2.6.10 No management actions relevant to investment guarantees are taken into account when calculating ordinary capital asset requirements (OCAR) apart from the removal of non-vesting bonuses.

2.7 PRODUCT DESIGN, PRICING AND MARKETING OF NEW BUSINESS

In general when proprietary companies consider selling any form of new business, there are two conflicting considerations that need to be made:

– Given the product design, is the price at which the product is sold to policyholders sufficient to cover the outgo, and enable shareholders to make a profit commensurate with the risks they are accepting?
– Given the price, is the product design sufficiently attractive to prospective policyholders to ensure the marketing or sales process will be successful?

Most of the companies surveyed are selling new business with investment guarantees that are similar in magnitude, form and structure to the majority of investment guarantees embedded in the in-force business. This includes both maturity-guarantee business and non-profit annuities. The product design, pricing and marketing considerations are very different for these two product categories and are considered separately below.

2.7.1 Maturity-Guarantee Business

2.7.1.1 A key aspect of the marketing of maturity-guarantee business is to provide features of the product, in particular the form and level of guarantee, that, taking into account the overall charging level and structure, are attractive to prospective policyholders.

2.7.1.2 Charges applied to maturity-guarantee business may be explicitly split out into charges to cover the risk that guarantees will bite and other charges. Even if the policyholder is not aware of this split, it may still be defined internally by the insurance company. Alternatively, the company may only consider the total charge applied to maturity-guarantee business and assess whether it is sufficient to cover all risks and outgo and also enable the company to make sufficient profit.

2.7.1.3 The form of the charge for the guarantee is of similar importance. In the survey, general charges to policyholders for maturity-guarantee business were invariably described as an annual management charge (AMC). One of the survey participants charges a second explicit AMC specifically to cover the risk that guarantees will bite. The other participant companies indicated that they charge one AMC to cover all outgo including the risk that maturity guarantees will bite, as well as profit and expenses.

2.7.1.4 There are problems with the AMC form of charge when it is applied to maturity-guarantee business, including:

– The investment guarantee is frequently related to the investment return net of the AMC. This implies that the higher the AMC, the more likely the guarantee is to bite.
– The value of this charge is lower under poor economic scenarios where the risk that maturity guarantees will bite is higher.
– Depending on the definition of the guarantee, the value of this charge may be reduced—possibly to zero—at the times when investment guarantees bite. For example, this is true for smoothed-bonus business if the charge is implicitly made as the difference between the investment return earned on underlying assets and bonuses credited to policyholders.

2.7.1.5 A theoretically preferable form of charge to cover maturity-guarantee risk may therefore be an upfront charge made at policy inception. This form of charge has two particular advantages over the AMC form:

– An upfront charge can be invested directly in an asset to hedge the risk that maturity guarantees will bite, therefore mitigating this risk at policy inception.

– An upfront charge will avoid cross-subsidisation between different generations of policyholders.

However, the marketability of an upfront charge is questionable.

2.7.1.6 In considering the level of guarantee and the level and form of charge for the risk, the insurance company will consider whether it is making an overall profit to shareholders commensurate with the overall risks underlying the product, which are underwritten by shareholders.

2.7.1.7 When profit-testing such business, it is important that the following items related to maturity guarantees are allowed for:

– the expected cost of maturity guarantees biting;
– the cost of holding prudent statutory reserves to the extent that these cover a cost of maturity guarantees biting greater than an expected cost; and
– the cost of holding a CAR that incorporates additional prudence in the assessment of the cost of maturity guarantees biting.

The latter two items can be significant for longer-term business.

2.7.1.8 If the insurance company considers that the level of charge is not commensurate with the level of risk, one possibility would be to remove all guarantees from such a product altogether. However, equivalent savings business with no guarantees (and corresponding lower charges) may not be marketable; prospective policyholders may be inclined to invest in unit trusts instead.

2.7.1.9 One company surveyed indicated that it had decided to reduce the level of guarantee on new maturity-guarantee business and keep the level of charge unchanged. This was felt to be more marketable than to increase charges and leave the level of guarantee unchanged.

2.7.2 Non-Profit Annuities

2.7.2.1 A major consideration in the design of non-profit annuities is that assets must be available to match the liabilities. Some companies identified a lack of availability of long-term bonds as a real problem in matching non-profit investment guarantees.

2.7.2.2 A major consideration when profit-testing non-profit business is an appropriate discount rate to use. The authors believe that the gilt rate of appropriate term is an appropriate basis to use as a starting point for pricing, as well as fair-value accounting. For pricing, an adjustment to the gilt rate may be considered to allow not for a liquidity premium, but for the insurance company's own level of claims-paying credit risk. In practice, for a well-capitalised insurer, this adjustment may not be material. This concept is discussed further in Dullaway & Bice (2002) and is not referred to further in this paper.

2.8 MANAGING THE EXPECTATIONS OF POLICYHOLDERS

2.8.1 Life insurance companies need to consider to what extent policyholder expectations exist and how these expectations can be managed. These expectations are formed, *inter alia*, by:

– policyholder literature and communication, both at policy inception and throughout the term of the policy;

– past practice of the company;
– practice of the life insurance industry; and
– historical market performance, particularly if this is emphasised in policyholder literature.

2.8.2 A major component of policyholder expectations for guarantees with discretionary charges is the level of charge. To some extent there is an expectation that charges may not remain constant, given that the charge is discretionary and not fixed. On the other hand, there may be an expectation that the level of charge remains fairly stable and follows past levels to some extent.

2.8.3 Insurance companies may consider raising discretionary charges for maturity-guarantee business and participating annuities in economic scenarios where investment guarantees become more onerous and closer to biting. In such situations, some increase in charges may appear reasonable if the insurance company does not explicitly charge for investment guarantees elsewhere.

2.8.4 However, at the extreme, the insurance company may increase charges for policies approaching maturity to the extent that the guarantee bites, to cover the full cost of the guarantee. Such an approach is likely to be problematic as:
– the form of the charge is being changed from a prospective form to a retrospective form; and
– the guarantee is effectively being removed from the policyholder.

Such an event occurred in the UK, where in the final ruling of *The Equitable Life Assurance Society v Hyman* (2000) the Equitable Life was refused the right to use differential bonus scales to help pay for the cost of guaranteed annuity options for policyholders at retirement. This led to the Report of the Corley Committee of Inquiry (2001).

2.8.5 For smoothed-bonus maturity-guarantee business there are expectations around the extent to which the total bonus rate is declared as vesting bonus, if bonus rates are split between vesting bonuses and non-vesting bonuses. Vesting bonus rates lead to a direct increase in the level of investment guarantee and are more onerous.

2.8.6 The extent to which the insurance company smoothes bonus rates on either smoothed-bonus maturity-guarantee business or participating annuities also forms part of policyholder expectations. A higher level of smoothing leads to a more onerous investment guarantee as there are expectations that the insurance company will keep bonus rates higher for longer during adverse economic scenarios.

2.8.7 For all maturity-guarantee business there are likely to be expectations around the investment mandates set out for each balanced portfolio that policyholders can invest in. The method that a company may adopt to move to a more matched position in an adverse economic scenario where maturity guarantees start to bite is described in ¶2.3.4.4. However, in practice this may not be possible due to policyholder expectations; policyholders may wish to remain in a balanced portfolio with a similar asset mix to the historical mix.

2.8.8 Another form of policyholder expectation is that they are not exposed to risks they are unaware of. Such risks may include the risk that investment guarantees will bite on other products and that the policyholder will indirectly pay the cost of the

investment guarantee biting. For example, policyholders of smoothed-bonus savings business maturing in, say, thirty years may not be aware that they may be paying the cost of maturity-guarantee business maturing next year.

2.9 MANAGING THE EXPECTATIONS OF SHAREHOLDERS

2.9.1 Shareholders develop expectations in a similar manner to policyholder expectations; they are built up from past practice, company communication and industry practice.

2.9.2 Shareholders' main concerns regarding investment guarantees are to what extent they are taking on investment-guarantee risk and whether they are receiving sufficient reward for this risk.

3. METHODS USED TO VALUE INVESTMENT GUARANTEES

3.1 INTRODUCTION

3.1.1 This section compares a variety of methods used to value a life insurance company's cashflow, with particular focus on the valuation of the investment guarantees inherent in non-profit annuities, participating annuities and maturity-guarantee products. The results of the survey are then used to describe the methods of valuation currently used by South African life insurers. This section draws heavily upon Sheard *et al* (unpublished).

3.1.2 The main purposes of valuation are identified in ¶3.2 below. The various different methods of valuation are then discussed under the following headings:

- Background: allowing for risk in the model assumptions
- Deterministic approach
- Scenario- or stress-testing
- Stochastic methods based on statistical real-world investment models
- Market-consistent valuation techniques, which include:
  - the determination of the actual cost of transferring the risk into the market; and
  - the use of a market-consistent stochastic investment model, either a simplified option-pricing formula or Monte Carlo simulation
- Practical issues relating to Monte Carlo techniques
- Comparison of different valuation methods
- Methods of valuation used by South African insurers: feedback from the survey.

3.2 PURPOSE OF THE VALUATION

When considering the appropriateness of each method, it is important to identify the purpose of the valuation. We distinguish between:

- methods used for establishing a prudent provision for the guarantees, for example to determine reserves and capital requirements, and
- methods used for calculating the market value or fair value of the investment-guarantee risk for the purpose of transferring that risk, for example for the pricing either of new business or of the hedging of risk in the market.

Recent developments internationally indicate that prudent provision and capital requirements will move increasingly towards the fair value approach, but for purposes of this paper we have made a distinction between the two.

3.3 BACKGROUND: ALLOWING FOR RISK IN THE MODEL ASSUMPTIONS

3.3.1 The intended purpose of this section is to highlight that a market-consistent valuation contains an element of prudence to allow for market risk. It is not certain that a deterministic approach to valuation based on the best estimate plus specified margins, with a median approach to setting best-estimate assumptions, will achieve a similar level of prudence.

3.3.2 Brealey & Myers (2000) split all risks from an investor's perspective into:

- market risk (also known as systematic risk or undiversifiable risk), which includes all risks related to the performance of the financial markets; and
- non-market risk (also known as unique risk, non-systematic risk or diversifiable risk), which includes all other risks.

3.3.3 This differential is a useful tool when considering how to allow for the risk that actual experience will deviate from the valuation basis in a model. We can consider separately the basis assumptions which have an element of market risk, for example asset-class returns (which often drive the discount rate used), and those which have little or no exposure to market levels, for example mortality rates.

3.3.4 The result of a valuation that is explicitly adjusted for market risk is termed market-consistent or marked to market. This adjustment ensures that the value calculated is consistent with the levels of the equity market, bond yields and the prices of stand-alone options at the time of valuation.

3.3.5 One approach to a market-consistent liability valuation frequently used in practice is the assumption that all asset classes earn a risk-free rate and so the valuation does not capitalise the market risk premium. A proxy to the risk-free rate is the gilt rate in South African government bonds. This usually leads to the use of the gilt spot rate of appropriate term to discount liability cashflows in such a valuation.

3.3.6 In section 2, the risk premium inherent in non-gilt fixed-interest stock was discussed, as well as the equity risk premium inherent in equities. It is clear that the equity risk premium exists primarily due to market risk, but what about the risk premium in non-gilt fixed-interest stock?

3.3.7 We saw in ¶¶2.4.1.3–4 that this risk premium includes the probability of default, the liquidity premium and the risk aversion of investors in non-gilt fixed-interest stock. This risk aversion is a form of market risk; the occurrence of defaults is higher during stock-market downturns.

3.3.8 Merton (1974) described a method of estimating an appropriate risk premium for corporate bonds based on option pricing and equity volatility. The approach was based on arguments that the owners of a company issuing a corporate bond have the option to default and this option is more likely to be exercised when share prices are low. Once this option is allowed for in a valuation, it may be that the liquidity premium is small, the significant majority of the difference between the best estimate value of a

corporate bond and the market value being explained by the risk aversion of investors valued using option-pricing techniques. Such a result would lend support to the principle that the gilt rate with little or no adjustment is appropriate to discount non-profit cashflows in a liability valuation.

3.3.9 There are additional reasons why it may not be appropriate to increase the liability discount rate for the liquidity premium:

– Very few, if any, liability cashflows are so certain that they could be matched by a perfectly illiquid asset.
– If insurers made up a significant component of the holders of non-gilt fixed-interest stock, market yields would likely already reflect their own assessment of the risks of holding such stock.

3.3.10 In the calculation of the cost of the risk transfer, best-estimate assumptions may be used for non-market risk if it is believed that shareholders can largely remove such risk by holding diversified portfolios. However, assumptions relating to market risk should be adjusted to fully allow for this risk as it cannot be diversified away. We see in section 3.9 that, for stochastic projections, this result can be determined by taking the mean of the results under a market-consistent stochastic model.

3.3.11 In the setting up of provisions, risk is generally allowed for by the addition of margins to the best-estimate assumptions. This process generally does not differentiate between market and non-market risk. We see in section 3.6 that, for stochastic projections, this is achieved by accepting a high percentile value (i.e. a low risk of ruin) under a real-world stochastic model.

3.4 DETERMINISTIC APPROACH

3.4.1 This technique is used in South Africa to determine the statutory FSVs and the published measurement of value, viz. embedded value. Professional guidance notes PGN104 and PGN107 have been published in this regard. The deterministic approach is also used as standard practice in the life insurance industry in the profit-testing of new business.

3.4.2 This technique involves the discounting of all the cash flows to the valuation date, using a basis appropriate to the purpose of the calculation, which may be a best-estimate, possibly with some margins, depending on the purpose of the valuation.

3.4.3 For this technique the allowance for risk is usually made through one or both of:

– a risk-adjusted discount rate; and
– adjustments for risk to other elements of the deterministic basis.

3.4.4 Such adjustments tend to be based on judgement and do not explicitly differentiate between market and non-market risk. However, in determining what an appropriate level of adjustment might be, the extent to which market risk is significant may be considered.

3.4.5 As described in PGN104, the starting point in the FSV liability valuation is a best-estimate basis. Prescribed first-tier margins are added to various elements of the basis including the valuation discount rate, and in addition second-tier margins can be

added at the discretion of the statutory actuary. This leads to a higher value of the liabilities than a deterministic best-estimate basis.

3.4.6 Whether this higher value, and hence increased level of prudence, is sufficient to cover the risk that maturity guarantees will bite as well as all other risks is debatable.

3.4.7 As described in PGN107, for the embedded value, all these margins are released and discounted to enable a value of in-force business to be calculated. This is an asset of the life insurance company. The cash flows making up this asset are discounted using a risk discount rate to give a present value. The risk discount rate is calculated using an upward adjustment to a best-estimate discount rate. The size of this adjustment depends on the judgement of the actuary, who can use tools such as the capital asset pricing model to assist in making a reasonable adjustment.

3.4.8 For FSV, embedded value and profit-test calculations, actuarial practice historically has been to set the discount rate equal to the expected returns on the assets held, i.e. the earned investment return, net of tax (the 'net earned rate'). These expected returns may include an allowance for the risk premium in non-gilt assets, effectively capitalising this risk premium.

3.4.9 For non-profit business the discount rate is significant, particularly for annuities. The net earned rate is likely to be of similar magnitude to and a little higher than the gilt rate as this business is generally matched with a mixture of gilts and other fixed-interest stock.

3.4.10 For unit-linked business with no guarantees, whether or not an allowance is made for an equity or fixed-interest risk premium is less relevant, as there is no risk of an investment strain from investment guarantees. However, there are other reasons why the allowance for a market risk premium is relevant as the present value of some cash flows will be related to market risk. This is true when conducting a profit test or in setting rand (non-unit) reserves where the value of future AMC is usually significant.

3.4.11 When explicitly valuing the cost of maturity guarantees biting for unit-linked or smoothed-bonus business, the deterministic valuation technique is not adequate. Historical investment performance and expectations regarding future returns mean that these guarantees may not bite on a deterministic basis containing prudent margins. However, it is possible that future returns will not be as high as the assumed discount rate and therefore, in reality, these guarantees may bite in future. In these circumstances there is a real cost of the guarantee to the life insurance company in the future, yet there is no cost reflected in the valuation basis. The guarantee would bite if lower valuation discount rates were used; however, it is unlikely that a resulting value would take into account the payout profile of the maturity guarantee. There is therefore a need to move away from this approach to one that will allow for the cost of the guarantee biting associated with the risk of lower-than-expected future investment returns.

3.4.12 Conclusion

The deterministic approach to valuation is well understood in South Africa. It is generally appropriate for non-profit business, but contains recognised weaknesses in the valuation of maturity-guarantee and smoothed-bonus business.

3.5 SCENARIO- OR STRESS-TESTING

3.5.1 Under this method, which is an extension to the deterministic method described in section 3.4, a few investment scenarios are examined to help assess the potential significance of investment guarantees to the life insurance company. It is likely that different forms of adverse investment scenarios will be used, to gain an understanding of the risk and associated cost of the investment guarantees.

3.5.2 The choice of scenarios is typically a subjective decision by the actuary involved. This decision is usually based on the actuary's experience of the company and industry. There is a wide range of scenarios that may be considered. Possible examples of economic scenarios include:

- CAR investment scenarios as described in PGN104, which companies are obliged to use;
- the extent to which markets can fall before losses of a specified amount occur;
- a 'Japan-type scenario', which comprises an immediate equity-market fall of a specified percentage, a fall in future bond yields to a specified level, and a fall in future equity growth to a specified rate.

3.5.3 When considering appropriate stress tests, it is important to allow for the lack of diversification of various forms of market risk. For example, a Japan-type scenario can coincide with increased risk of bond defaults and other events related to the level of the market that might adversely affect the solvency of insurance companies.

3.5.4 The stress-test approach is a useful tool to enable the actuary to get a feel for the level of investment-guarantee risk in a block of in-force business and the financial effect of the biting of these guarantees. In addition it can be used to demonstrate sensitivity to other risks, for example mortality and persistency. The CAR is a good example of a risk-based-capital approach to valuation that enables the actuary to assess the interaction of a variety of risks using a combination of scenario tests.

3.6 STOCHASTIC METHODS BASED ON STATISTICAL REAL-WORLD INVESTMENT MODELS

3.6.1 INTRODUCTION

3.6.1.1 Stochastic models based on real-world data have been used by actuaries for some time. These models are based on an historical analysis of data in order to set key parameters that drive investment returns, bond yields and correlations. One of the more familiar real-world stochastic investment models is the Wilkie model (e.g. Wilkie, 1994).

3.6.1.2 Thomson (1994) developed a model for use in South Africa based on data from 1960 to 1993. This (or variations of it) has perhaps become the stochastic model most widely used in South Africa. This model was reviewed by Maitland (1996).

3.6.2 DESCRIPTION

3.6.2.1 In theory, the stochastic approach involves the parameterisation of key assumptions into a probability distribution. Typically, for stochastic models used to value

life insurance business, these parameterised assumptions are set to give means and variances of investment returns of a range of asset classes and correlations between these asset classes.

3.6.2.2 For practical reasons, when used by life insurance companies, this type of model does not usually take the form of a probability distribution. Instead, Monte Carlo simulation is used. The model is used to randomly generate a number of scenarios of projected total investment returns, bond yields and market values for a specified projection period. Each scenario has an equal probability of occurring.

3.6.3 Allowance for Risk and Assumptions used

3.6.3.1 Such models are often used to determine percentile results of capital required at the valuation date to meet future liability outgo. The allowance for risk is usually made by choosing a percentile result that is higher than 50%. The implicit thinking behind such an approach to the valuation of liabilities is, for a specified percentage, to come up with that amount of capital now which is sufficient to cover the true cost of the future liability cashflows that percentage of the time, assuming that the specification and parameters of the model are correct. Such models may therefore be used to calculate an FSV or CAR, or to determine internal capital requirements.

3.6.3.2 The percentage that is appropriate may vary depending on the purpose of the valuation. A valuation for FSV purposes will require a level of percentile result that is at least at the 50% level. A suitable level will depend on margins in the basis elsewhere, but a range may be 60% to 80%. PGN104 indicates that a 95% percentile result is appropriate for CAR for general valuation, although it does not currently prescribe a stochastic methodology.

3.6.3.3 In order to determine the capital required now to meet future liabilities, a common approach is to discount the future liability cashflows for each scenario at the interest rate earned on the assets in that scenario. This is generally achieved by using the unadjusted net earned rate for each scenario where, as for ¶3.4.8, the net earned rate reflects the asset mix of the assets backing the liability.

3.6.3.4 It is important to identify which liability it is we are referring to when deriving the net earned rate. For example, when calculating explicit maturity-guarantee reserves, we are referring to the reserve held to cover the risk that the maturity guarantee will bite. The assets backing such a reserve may be invested in a very different form to the underlying policyholder liability, which is generally invested in a balanced fund.

3.6.3.5 Stochastic models can be made sophisticated by allowing the asset mix of backing assets to vary, for example by switching to more prudent assets once guarantees come close to biting.

3.6.3.6 The use of the net earned rate does not directly allow for market risk. This risk is implicitly allowed for by use of a percentile result that is at least at the 50% level. We shall see in section 3.9 that some stochastic methods produce a mean value that has been adjusted for market risk without use of a percentile result. The output of a real-world stochastic model is a distribution of results, enabling the modeller to get a feel for the risks underlying the business.

3.6.3.7 Assumptions other than the discount rate are generally taken at best estimate, with no adjustment for risk. As with discount rates, 'best estimate' for other assumptions may mean something different in a stochastic model than in a deterministic model. For example, it may not be reasonable to assume high lapse rates in poor investment scenarios where maturity guarantees bite. In such scenarios, policyholder behaviour may reduce lapse rates, as policyholders become more aware of the value of the guarantees in their policies if they remain in force. For such assumptions, a 'best estimate' may mean an algorithm that is a function of the extent to which guarantees are likely to bite, and hence indirectly of the stochastic investment scenarios, rather than a point value.

3.6.3.8 The alternative approach with such models is to focus on the mean value of all the scenarios. In such circumstances, if no adjustment is made to the discount rate or the other assumptions to allow for market risk, this can lead to a present value that is materially inconsistent with the market values of the underlying assets, and so such results may not be meaningful. A possible method to adjust for market risk may be the use of state price deflators, as described in ¶3.9.3.

3.6.3.9 LIMITATIONS OF REAL-WORLD STOCHASTIC TECHNIQUES

This is considered generally for all Monte Carlo stochastic techniques in section 3.10.

3.6.3.10 CONCLUSION

Real-world stochastic techniques have been used in the life insurance industry for some time and their use has become increasingly familiar to actuaries. They allow for the cost of maturity guarantees or guaranteed bonus rates biting by means of varying investment returns. Such techniques can also allow for the effect of the investment strategy of the individual company on this cost, in other words, the company's asset–liability mismatch risk.

3.7 MARKET-CONSISTENT VALUATION TECHNIQUES

3.7.1 There are several methods of valuing a portfolio of investment-guarantee business in a manner consistent with the actual or theoretical cost of such guarantees in the market. These include:

– the determination of the actual cost of transferring the risk into the market; and
– the use of a market-consistent stochastic investment model, either a simplified option-pricing formula or Monte Carlo simulation.

These methods are discussed in detail in sections 3.8 and 3.9.

3.7.2 These methods can be used to help the company assess the cost of hedging their financial option risks internally or externally. They do not assist the company in directly determining the possible cost of such risks biting if the company has no plans to hedge the risks. However, a comparison of the result of such techniques with a method that allows for the assets actually held by the life company enables the company to assess the potential effect on value of mismatching.

3.7.3 An unhedged risk is more risky than a hedged risk and so it would appear

reasonable that an internally-held unmatched reserve should in theory be higher than the cost of hedging a liability. This would imply that a market-consistent liability value would be an appropriate minimum for an unhedged liability value.

3.7.4 Underlying this implication is the assumption that appropriate hedging instruments are available and the overall cost of hedging such a risk is reasonable. This may not occur if the risk cannot be approximately replicated by available financial instruments or if the practical costs of hedging are high relative to the size of the risk.

3.7.5 The obvious use of such techniques is to produce a value of liabilities consistent with the market value of assets at the valuation date. Ensuring that the liabilities are marked to market follows the principles of fair value accounting. Using the principles of no arbitrage, this consistency should reflect the cost of hedging the guarantees in the market.

3.7.6 The use of a market-consistent valuation method can be combined with a dynamic hedging algorithm to facilitate the internal hedging of investment-guarantee risk. This is not considered further in this paper. An approach to the calculation of an appropriate dynamic hedge for UK with-profits business can be found in Hibbert (unpublished).

3.8 THE ACTUAL COST OF TRANSFERRING THE RISK INTO THE MARKET

3.8.1 This valuation method is useful if the life insurance company is looking to externally hedge the financial options relating to its investment guarantee. This involves the purchase of derivatives that will meet the costs of investment guarantees should they bite. These derivatives are likely to be over-the-counter derivatives, as such derivatives are not readily available in the open market. Such a risk transfer still leaves counterparty risk with the life insurance company, which can be mitigated by use of margin.

3.8.2 A life insurance company can approach one or more investment banks, and ask for the price it would charge to accept transfer of the risk associated with a portfolio of maturity guarantees to the investment bank. This could be performed either for a specific tranche of new business, or a portfolio of in-force business.

3.8.3 The authors are not aware of a large liquid market in South Africa in which such guarantees, particularly longer-term guarantees, could be hedged. More generally, a liquid market may not always exist to transfer away this risk; for example, during times of exceptional market conditions, temporary liquidity squeezes may occur.

3.8.4 The process of obtaining quotes from counterparties does not directly enable the life insurance company to gain much understanding of the financial risks underlying a tranche of maturity-guarantee business.

3.8.5 This understanding is required if the company wishes to approximately hedge its risks internally or to better understand its risks to facilitate an informed decision about mismatching. The next step is to build a model that replicates the market value of the maturity guarantees. The basic structure of such models is generally a stochastic investment model.

3.8.6 The actual cost of transferring risk to the market is the true cost of the risk taken on by the company, as it is the amount the company would have to pay to remove

the risk. The actual cost is generally greater than the results of a market-consistent valuation model. The reasons for this are as follows:

– The principle of no arbitrage ignores the need for a market maker to make a profit. In other words, the real market cost of hedging such guarantees externally will include a bid–offer spread, which is not incorporated within the results of models such as option-pricing formulae and market-consistent stochastic techniques.
– The use of market-consistent formulaic and stochastic techniques ignores the risk that there will be very different levels of supply and demand in transferring risk such as the risk that maturity guarantees will bite. In particular, there may not be a party willing to take on longer-term maturity-guarantee risk.

3.9 THE USE OF A MARKET-CONSISTENT STOCHASTIC INVESTMENT MODEL

Market-consistent stochastic investment models are built to price financial options embedded in life insurance contracts. The underlying assumption in the use of such stochastic techniques is that the resulting liability will be fully hedged by a portfolio of derivatives. Hence the cost output from the model is a theoretical cost of hedging. Stochastic investment models are generally applied in one of two ways. Either some simplifying assumptions are made to the model, to derive a formula (known as a closed-form solution), or Monte Carlo simulation is used as described in ¶3.6.2.2.

3.9.1 THE USE OF AN OPTION-PRICING FORMULA

3.9.1.1 The underlying assumption in the use of an option-pricing formula is that the resulting liability will be fully hedged by a portfolio of derivatives. Hence the cost output from the model is a theoretical cost of hedging.

3.9.1.2 The most common set of option-pricing formulae are the Black-Scholes formulae. These can be used to easily determine the market price of simple options such as European call and put options on tradeable assets. As demonstrated in Figure C.4 of Appendix C, the payout function of the investment guarantee is similar to a put option, and such a technique could be used to value the cost of maturity guarantees biting.

3.9.1.3 Theoretical weaknesses of using such formulae for this purpose include the assumptions used to derive the formula. In addition, it may be difficult to accurately model the dynamics of a long-term insurance savings contract. In the first place, it may be difficult to determine the effect of lapses, which, in most cases, are a key determinant in the cost of the financial option. This impact may not be significant for business of short durations, for example terms of ten years or under, where the life company may be willing to retain some residual lapse-related maturity-guarantee risk. It may also be difficult to model additions to the guarantee via vesting bonuses on with- profits or smoothed-bonus business. This is a major driver of the risks associated with such business and so option-pricing formulae are difficult to apply. These weaknesses are significant in the valuation of maturity-guarantee and smoothed-bonus business.

3.9.1.4 Option-pricing theory has come a long way since the derivation of the Black-Scholes formulae, and it is now not necessarily used in practice, particularly for the

valuation of longer-term derivatives. The weaknesses lie in its assumptions: it assumes a fixed interest rate and a lognormal equity-price distribution. For longer-term durations it is sensible to allow interest rates to vary and it is questionable whether the lognormal distribution is appropriate. Most stochastic investment models include a stochastic interest-rate function as well as a stochastic equity-return function and allow these to interact. For equity prices, these stochastic models generally use distributions other than the lognormal.

3.9.1.5 This brings us to market-consistent stochastic models in which Monte Carlo simulation is used, rather than formulaic approaches, which facilitates the use of more sophisticated asset and liability models.

3.9.2 The Use of Monte Carlo Simulation

3.9.2.1 In the life insurance industry throughout the world, techniques are becoming prevalent to facilitate the use of market-consistent stochastic investment models with Monte Carlo simulation. Approaches that have been developed include:

– the use of state-price deflators; and
– the use of risk-neutral stochastic investment models.

In practice, modellers use the approach they find most straightforward to implement and maintain.

3.9.2.2 Such techniques can be thought of as the market-consistent stochastic modelling of embedded financial options. This is achieved by allowing for market risk in a manner that is consistent with the market values of assets, particularly the prices of stand-alone options. These techniques do not directly allow for non-market risk.

3.9.2.3 These techniques can be shown to be mathematically equivalent, and give the same valuation results. In practice, they are used with Monte Carlo simulation. A detailed explanation of state-price deflators and risk-neutral valuation, including a summary of the backing mathematics, can be found in Jarvis *et al* (unpublished). In addition, briefer discussion of both state-price deflators and risk-neutral valuation is provided in Mills (2002a; 2002b). State-price deflators and risk-neutral stochastic investment models are briefly discussed below.

3.9.3 State-Price Deflators

3.9.3.1 State-price deflators are discount rates for use in real-world stochastic investment models, which have been set to give a market-consistent present value across all the scenarios. This value is set ensuring the principle of no arbitrage is followed, in other words R100 units of equities, bonds or stand-alone options would be valued at R100 on the valuation date.

3.9.3.2 One particular advantage of these techniques is that the discount rates do not vary by asset mix or by liability. In particular, they are appropriate for all liabilities whose payout is a function of bond or equity prices, which includes maturity-guarantee products.

3.9.3.3 For the purpose of understanding these discount rates, they can be considered risk-adjusted discount rates to allow for market risk. These adjustments

effectively decrease the discount rate for poor investment scenarios while increasing the discount rate for good investment scenarios. An alternative way of understanding this is that the scenarios in which equities perform poorly are given more weight.

3.9.3.4 The process of creating a state-price deflator in each scenario relies on consistent adjustment in other scenarios. It is the relative adjustment for each scenario that ensures that the principle of no arbitrage is followed. In the valuation of liabilities for investment guarantees, the output of such a model should therefore be the mean discounted value across all scenarios. The percentile output of such a model is not meaningful if state-price deflators are used to produce the results.

3.9.4 Risk-Neutral Stochastic Models

3.9.4.1 An alternative approach is to use a different calibration of the same underlying stochastic investment model, called a risk-neutral model. This model requires the expected investment return assumption of all asset classes to be adjusted to the risk-free rate, while the other assumptions of the asset classes are generally left as for the real-world stochastic investment model. Exceptions may include adjustments to ensure the model results are calibrated to the market prices of stand-alone options, for example the volatility assumption may be that implied by the market prices.

3.9.4.2 In order for this method to work, the discounting for each scenario is at the risk-free rate. This rate may vary by scenario if a stochastic interest rate model is used.

3.9.4.3 A risk-neutral model should be used with care; any probabilities output from the model (e.g. the likelihood that a maturity guarantee will bite) are risk-adjusted and are not meaningful in themselves. Again, the only meaningful measure is the mean discounted value across all scenarios.

3.9.5 Practical Considerations of Stochastic Market-Consistent Methods

In the use of stochastic market-consistent methods there are a number of practical questions that need to be addressed by practitioners including the following:

- If Monte Carlo simulation is used, should state-price deflators or the risk neutral approach be used?
- To what market prices should one calibrate a model in order for it to be considered market-consistent?
- What yield curve should be used as risk-free?
- What adjustment, if any, should be made to the yield curve to allow for the company's own level of claims-paying credit risk?

These are not considered further in this paper. We compare below the use of formulaic and Monte Carlo simulation approaches to valuation.

3.9.6 Stochastic Market-Consistent Methods – Formulaic vs. Monte Carlo

Table 1 below compares and contrasts some of the features underlying the use of formulaic methods and Monte Carlo simulation.

TABLE 1. Comparison of formulaic methods and Monte Carlo simulation

Description	Formulaic methods	Monte Carlo simulation
Number of scenarios	1	large
Simple to understand	similar to Monte Carlo	similar to formulaic
Simple to derive	not usually—simplifying assumptions often required	no
Simple to run once derived	yes	no—computer power and time required
Allows stochastic interest rates	not Black-Scholes but other formulae exist that do	yes
Sampling error introduced	no	yes—reduced by using a larger number of scenarios
Allows dynamic bonus and lapse algorithms in liability model	no	yes

3.9.7 Conclusion

Market-consistent stochastic methodology is starting to become more widely used in the life insurance industry worldwide to understand investment guarantee risk. The output of such methods is the theoretical market value or fair value of the liability if perfectly matched by appropriate assets. The actual level of asset–liability mismatch does not affect the result.

3.10 PRACTICAL ISSUES RELATING TO MONTE CARLO TECHNIQUES

This section considers some of the main issues that need to be considered in the practical implementation of both real-world and market-consistent stochastic techniques when used with Monte Carlo simulation. These include:

– simulation within simulation;
– suitability of the asset model;
– the number of scenarios;
– the size of the liability data set; and
– the dynamism of the liability model.

The above list of issues is not complete. Nevertheless, the authors consider these to be some of the most important for the actuary to address when first using stochastic methods to value investment guarantees.

3.10.1 Simulation within Simulation

One of the main limitations of stochastic techniques is their inability to perform simulation within simulation. This would require a very large number of scenarios to be run, which is unlikely to be practically feasible. Simulation within simulation may be theoretically required for a number of reasons, for example in projecting present values accurately. There are methods to get around this limitation, but these are not considered further in this paper.

3.10.2 Suitability of The Asset Model

As with all models, stochastic models suffer from the risk of model and parameter errors. A primary source of this risk is the choice of asset model. This is true for both real-world and market-consistent stochastic models. To what extent particular asset models and the required assumptions can be considered suitable requires experience and is not considered further in this paper.

3.10.3 Number of Scenarios

3.10.3.1 Consideration must be given to the number of scenarios to be used. To improve accuracy, a larger number of scenarios is required. This minimises the risk of sampling error.

3.10.3.2 In general a larger number of scenarios is required when focusing on the tail of the distribution. For real-world stochastic models, the number of scenarios required therefore depends on the percentile result being considered.

3.10.3.3 In the use of market-consistent stochastic models for the costing of policyholder options, a large number of scenarios is required in order to accurately price the cost of a replicating hedge. This is because we are taking a mean result of all scenarios, which will be driven to a large degree by the extreme scenarios where embedded options significantly bite.

3.10.4 Size of Liability Data Set

3.10.4.1 In order to keep total run time down and run an appropriate number of scenarios, it may be necessary to use a liability data set based on model points rather than every policy.

3.10.4.2 The process of testing the adequacy of a model-point liability data set to represent the business is important and not straightforward. In particular it is necessary to test the adequacy of the model points by comparing the valuation result obtained from a model-point data set with that obtained from the full per-policy data set. This test should include the use of specific adverse stochastic investment scenarios, as well as a deterministic central investment scenario, to ensure that the cost of guarantees biting is modelled accurately in the grouped data set.

3.10.5 Dynamism of Liability Model

In order to obtain a valid valuation result, it is critical to ensure that the dynamic links between the stochastic investment model and the liability model and assumptions are sufficient and accurate. Key assumptions are those that are functions of market risk. These include lapse rates and option take-up rates for all business with embedded options, and bonus rates for smoothed-bonus business. This process is not considered further in this paper.

3.11 COMPARISON OF DIFFERENT VALUATION METHODS

3.11.1 DETERMINISTIC VS. STOCHASTIC

3.11.1 Some of the main characteristics of the various valuation methods described in section 3 are summarised in Table 2.

TABLE 2. Characteristics of various liability-valuation methods

Characteristic	Deterministic	Stress test	Real-world stochastic	Market-consistent stochastic
Number of scenarios	1	usually 2–10	large to very large depending on percentile result required	Very large
Suitable for non-profit business	yes	yes	no (1)	no (1)
Suitable to value maturity guarantees	no	no	yes	yes
Theoretical price of replicating portfolio consistent with market values	yes if non-profit and gilt rate used to discount	no	no	yes
Allows for extent of mismatch of liabilities and backing assets	not directly	not directly	yes	no

Note: (1) In general, stochastic approaches are unlikely to aid understanding of non-profit investment guarantee risk if the business contains no material embedded financial options.

3.11.2 EMBEDDED-VALUE VERSUS MARKET-CONSISTENT VALUATION

A comparison of the results of embedded-value valuation methodology and a form of market-consistent valuation methodology by product can be found in Abbink and Saker (unpublished).

3.11.3 WHICH VALUATION METHOD IS APPROPRIATE FOR DIFFERENT PRODUCTS AND PURPOSES?

3.11.3.1 This section describes which valuation method is likely to be the most appropriate for different purposes and products. This assumes that the valuation assumptions are fully adjusted for market risk where possible, both to calculate the cost of risk transfer and to set a provision.

3.11.3.2 For the purposes of setting a provision for non-profit annuities, a deterministic valuation may be made with margins in all the assumptions, including the discount rate. This assumes that gilts are available that match the liability.

3.11.3.3 For the calculation of the fair value of non-profit annuities, a deterministic valuation may be made at the gilt rate, but with no margins for non-market risk such as mortality.

3.11.3.4 For the purposes of setting a provision for unit-linked maturity-guarantee business, a real-world stochastic model should ideally be used, the result corresponding to a percentile of at least 50%. A market-consistent stochastic model can help determine an appropriate minimum value. For shorter-term business the allowance for lapses may not be significant, so, for the determination of the explicit cost of guarantees biting, a formulaic approach may be preferred. However, this will not allow for the mismatch of assets backing this reserve.

3.11.3.5 For the calculation of the fair value of unit-linked maturity-guarantee business, the mean result of a market-consistent stochastic model should ideally be used. Again, for the determination of the explicit cost of guarantees biting on shorter-term business, a formulaic approach may be preferred.

3.11.3.6 For the purposes of setting a provision for smoothed-bonus business including maturity-guarantee business and participating annuities, a real-world stochastic model should ideally be used, the result corresponding to a percentile of at least 50%. Here again, a market-consistent stochastic model can help determine the reasonability of the percentile result used.

3.11.3.7 For the calculation of the fair value of such business, the mean result of a market-consistent stochastic model should ideally be used. A formulaic approach is unlikely to provide sufficient business information, as it is unlikely to allow for the interaction of returns on assets and bonus rates on liabilities.

3.12 METHODS OF VALUATION USED BY SOUTH AFRICAN INSURERS: FEEDBACK FROM THE SURVEY

3.12.1 All companies participating in the survey indicated that they use a central deterministic projection to measure investment-guarantee risk. This finding is not surprising, as the deterministic method is required under FSV and embedded value guidance.

3.12.2 All companies indicate that they use stress-testing to indicate maturity-guarantee risk. Again this finding is not surprising, as stress-testing is required under CAR guidance.

3.12.3 Several companies use additional forms of stress-testing to measure investment-guarantee risk. Examples include consideration of the extent to which markets have to fall before the majority of investment guarantees start to bite. Actuaries feel that these additional calculations greatly help them to understand the risks underlying the business.

3.12.4 Three companies indicated that they use stochastic models to measure maturity-guarantee risk in maturity-guarantee business.

3.12.5 The three companies using stochastic models for the measurement of maturity-guarantee risk use real-world stochastic investment models. None of these companies use market-consistent stochastic investment models, although some are considering doing so.

3.12.6 Two other companies stated that they did not use stochastic methods but would consider doing so when the conclusions of the maturity-guarantee sub-committee were published.

4. POSSIBLE FUTURE DEVELOPMENTS

4.1 INTRODUCTION

4.1.1 In this section, no attempt is made to predict the economic future of South Africa. Given current economic uncertainty it is not possible to say whether or not we are about to enter a long period of low inflation, with resulting lower bond yields. Similarly, no prediction is made of the movement in local and international equity markets.

4.1.2 Instead, the authors describe what they think are the main future trends and developments in the management of investment guarantees by the South African life insurance industry. It may be that moving into a lower inflationary environment will speed up this process, but the authors believe that South African life insurers will move in this direction anyway, given trends in international accounting and regulatory standards, as well as pressure from shareholders and policyholders.

4.2 POSSIBLE FUTURE TRENDS IN SOUTH AFRICA

4.2.1 International Accounting and Regulatory Trends

There are significant trends in international accounting and regulatory bodies as described in section 1.4. The authors expect that South African accounting and regulatory practices will in time follow these trends.

4.2.2 Trends evidenced by The Survey

4.2.2.1 The trend to hold specific additional reserves to cover the risk that maturity guarantees will bite, will continue. Some companies are already pre-empting the findings of the ASSA sub-committee, while others wish to wait until the findings have been finalised.

4.2.2.2 For the management of maturity guarantees, several companies have adopted stochastic techniques in recent years and the authors believe this trend will continue. So far, these techniques have all been based on real-world stochastic models.

4.2.2.3 Few companies have so far used market-consistent techniques to cost maturity guarantees. For companies using stochastic techniques, a natural extension will be to start using suitable market-consistent stochastic investment models, particularly for new-business pricing. Other companies may start by using option-pricing formulae with simplified assumptions to enable approximate market-consistent valuations to be

conducted quickly, then start to develop the additional sophistication of market-consistent stochastic asset–liability modelling techniques using Monte Carlo simulation.

4.2.2.4 The management of smoothed-bonus business, including participating annuities, is likely to become more sophisticated. Stochastic asset–liability models including the use of dynamic bonus and lapse algorithms are already prevalent in other countries, and this is likely to develop in South Africa.

4.2.3 Pressure from Policyholders

4.2.3.1 Policyholders are likely to start to require greater clarity as to the charging structure of the products they purchase and the risks they are exposed to, to ensure that they are getting value for money. This trend is likely to prevail for all smoothed-bonus business.

4.2.3.2 In the UK, such developments have led to a much more transparent mechanism for the operation of with-profits business. One such mechanism is described in Clay *et al* (2001).

4.2.3.3 Policyholders may start to become more sensitive to the overall level of charge. Such pressures are more likely to occur if South Africa moves into an economic environment with lower nominal returns. A fund management charge of 2% a year is more noticeable if short term interest rates are, say, 6% to 8%, as opposed to the current level of around 10% to 12% a year.

4.2.4 Pressure from Shareholders

South African life insurance companies are currently required to publish embedded values as described in PGN107. While this represents a clearer picture of life company value than has been publicly disclosed in the past, it is likely that shareholders will start to demand even more information from companies in areas such as risk and capital management, and the appropriateness of charges for investment-guarantee products given the associated risks.

4.3 FINANCIAL RISK AND CAPITAL MANAGEMENT OF IN-FORCE BUSINESS

4.3.1 Developments in Valuation Methodology

4.3.1.1 Market-consistent valuation methodology for long-term savings products has developed significantly in recent years and the emerging techniques are likely to be increasingly adopted by South African life companies, whether or not South Africa adopts fair value published accounting and statutory practices.

4.3.1.2 Such developments may include the use of the gilt spot rate to value non-profit cashflows and unit-linked business with no guarantees, and the use of more sophisticated market-consistent techniques to value maturity-guarantee and smoothed-bonus business.

4.3.1.3 Such market-consistent techniques are likely to include option-pricing formulae to value shorter-term unit-linked maturity-guarantee business and stochastic

techniques to value longer-term unit-linked maturity-guarantee business and smoothed-bonus business.

4.3.2 Non-Profit Business

4.3.2.1 When valuing non-profit annuities, the authors expect that it will become more usual to discount cashflows at the gilt rate. As in ¶2.7.2.2, consideration may be given to the adjustment of the gilt rate to allow for the company's own level of claims-paying credit risk.

4.3.2.2 This may have a knock-on effect on the matching of asset and liability cashflows for annuities, to the extent that annuities are backed by non-gilt fixed-interest assets. Companies may prefer to hold a greater amount of assets in order to continue to hold non-gilt stock reflecting the additional risk taken on. This is necessary to cover the expected annuity cashflow as well as an allowance for any risk premium associated with the greater uncertainty over the future cashflows.

4.3.3 Maturity-Guarantee and Smoothed-Bonus Business

4.3.3.1 The financial management of maturity-guarantee business is likely to increase in sophistication. Market-consistent methods to determine the objective cost of the hedging of guarantees may start to be used.

4.3.3.2 Once this cost is determined, a natural extension is to reduce the underlying risks by using this level of capital to hedge the guarantee. This may be achieved by external hedging of the risk using derivatives. Alternatively, companies may start to use dynamic hedging techniques internally. These may involve holding specific reserves that are short on equities and long on bonds and cash. The frequency with which the asset mix backing such reserves is rebased will depend on the risk attitude of the company concerned, and the practical costs and difficulties associated with frequent trading.

4.3.3.3 Such hedging techniques can be performed by means of immunisation, by calibrating the asset portfolio to the liability portfolio using the Greeks as a measure of risk (Dardis, 2002).

4.3.3.4 Hedging needs to be a dynamic process and it is unlikely that such an approach will be effective if not done frequently. However, increasing the frequency of trading increases transaction costs.

4.3.3.5 Alternatively, companies may prefer not to hedge, but instead to accept some degree of mismatch by holding higher levels of equities than hedging strategies imply and maintaining such a position for the long term. Such an asset strategy has the advantages that long-term returns are expected to be higher (assuming the equity risk premium is positive) and that assets do not have to be traded regularly; however, it has the disadvantage that a greater level of capital should be held.

4.3.4 A Control Cycle

Insurance companies are already using a control cycle to manage their risks and capital. We believe that this process will be naturally extended to incorporate model risk and parameter risk when adopting new valuation techniques.

4.4 DESIGN AND SALE OF NEW BUSINESS

4.4.1 The product design and pricing of new business is likely to be one of the first areas where new valuation methodology becomes prevalent.

4.4.2 This will produce information to company management as to whether new business is as profitable as deterministic techniques would suggest. Whether there is pressure to change the overall level of charge, or indeed to change new business strategy, will depend on the results of the use of market-consistent techniques.

4.4.3 The development of new valuation methodology has in the past led to changes in new-business strategy in other countries. For example, in the UK, insurance companies stopped selling new unit-linked maturity-guarantee business once they determined the expected cost of guarantees biting using statistical real-world stochastic methodology, as described in Appendix A.

4.4.4 There may be pressure to change the form of charges for maturity-guarantee business, to remove the negative correlation between the value of the charge and the risk that maturity guarantees will bite. This will depend on the ability to sell products with such front-end loads.

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APPENDIX A
A BRIEF HISTORY OF INVESTMENT GUARANTEES

A.1 Perhaps the first recognised sale of both with profit and non-profit business using actuarial methodology was by the Equitable Life in the UK in the 18th century. Initially such business was designed primarily to meet consumers' needs for protection rather than savings.

A.2 In that period, mortality rates were uncertain, so, in order to offset the prudence of the pricing basis and to become more competitive, the Equitable Life began the practice of distributing mortality surplus arising to policyholders by way of reduced premiums. The driver for the change from non-profit business to with-profit business was therefore not the distribution of investment profits but rather the distribution of mortality profits.

A.3 Insurers soon began to introduce products with an element of savings as well as protection. From the outset, such business contained investment guarantees in the form of guaranteed rates of income to policyholders. Companies invested primarily in bonds, which more than covered the guaranteed income, and the products were therefore well matched.

A.4 The move to invest in equities occurred during the 20th century and led to the problem of having to distribute significant unrealised capital gains.

A.5 In the UK this led to the development of the terminal bonus in the second half of the 20th century as a method of distributing such surplus at maturity.

A.6 In South Africa this was superseded by the declaring of non-vesting bonuses. This form of bonus provides the policyholder with more information about the value of his or her policy, but does not directly increase certainty over the final payout. Such business became more familiar as smoothed-bonus business.

A.7 Unit-linked business was introduced to the life insurance industry in the 1960s as a result of the growing unit-trust industry, and the South African life insurance industry was one of the early pioneers of such business. Given the practice of giving investment guarantees on smoothed-bonus business, such guarantees were also fairly routinely given to unit-linked business.

A.8 This practice continued in the UK until the cost of such guarantees was estimated in the report of the Maturity Guarantees Working Party (1980). The conclusions of this report led many insurers in the UK to halt the sale of new unit-linked business with such guarantees. A few insurers continued to provide guarantees but started charging for this

cost, particularly the cost of having to hold significant additional capital. The latter companies soon found that policyholders were not willing to pay a fair price for these guarantees.

A.9 In South Africa the practice of offering such guarantees has continued up to now, although the economic environment has been more conducive to providing such guarantees at low cost, or at no cost at all. It remains to be seen whether this will continue.

APPENDIX B
EXAMPLES OF RECENT ADVERSE EFFECTS OF INVESTMENT GUARANTEES OUTSIDE OF SOUTH AFRICA

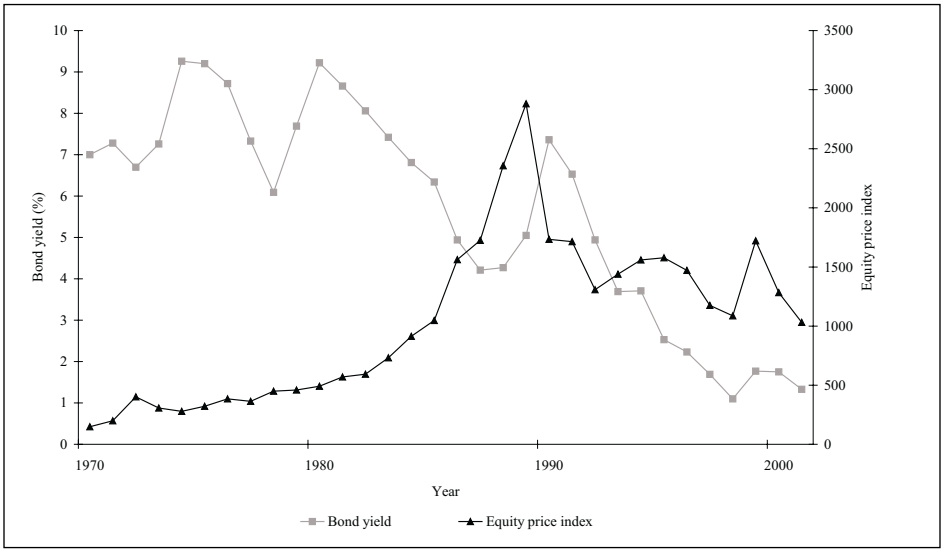
B.1 This appendix focuses on recent adverse effects of the sale of unmatched products with investment guarantees by life insurance companies, and of falling bond yields and equity prices. The focus here is on Japan and the UK, although there have been adverse effects elsewhere.

B.2 To demonstrate the extent to which bond yields and equity prices have fallen, the levels of government bond yields and equity price indices in Japan and the UK are shown in graphs below for the period from 1970 to 2001. At the end of this appendix, a similar graph is given for South Africa. While total return indices would better indicate the impact of holding equities on the returns of balanced investment portfolios, the general pattern indicated by equity price indices is expected to be broadly the same.

B.3 JAPAN

The Japanese government bond yield and equity price index are shown in Figure B.1 for the period 1970 to 2001.[2]

Figure B.1. Government bond yield and equity index: Japan, 1970–2001



2 Sources: government bond yield: IMF (2002); equity price index: TOPIX

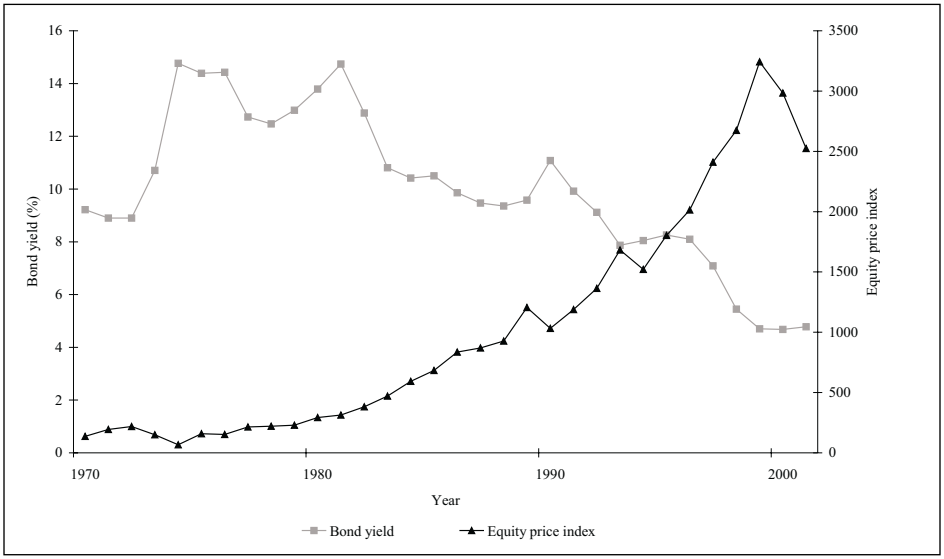
B.4 Since 1997, eight insurers have either become insolvent or entered corporate rehabilitation. The first company to declare insolvency was Nippon Daido Life in April 1997. The funds represented by these insurers represent over 10% of the total funds managed by the Japanese life insurance industry. As a result of these events, guaranteed benefits on more than 10 million policies have had to be reduced. (Freeman & Fujiki, 2001)

B.5 This occurred as a result of the sale of large volumes of unmatched participating savings business and unmatched deferred-annuity business, investment guarantees reaching up to 6,25% in the late 1980s and early 1990s. These were typically backed with equity and property, and corporate debt and loans with high concentration. (*ibid.*)

B.6 UNITED KINGDOM

The UK government bond yield and equity price index are shown in Figure B.2 for the same period.[3]

Figure B.2. Government bond yield and equity index: UK, 1970–2001



B.7 In the UK, life insurers used to issue large volumes of deferred-annuity contracts with guaranteed annuity options at retirement. The underlying investment guarantees on business sold in the 1970s typically reached a level of 6% to 8%. In recent years, declining bond yields combined with improving mortality have forced these insurers to establish large reserves to cover these guarantees.

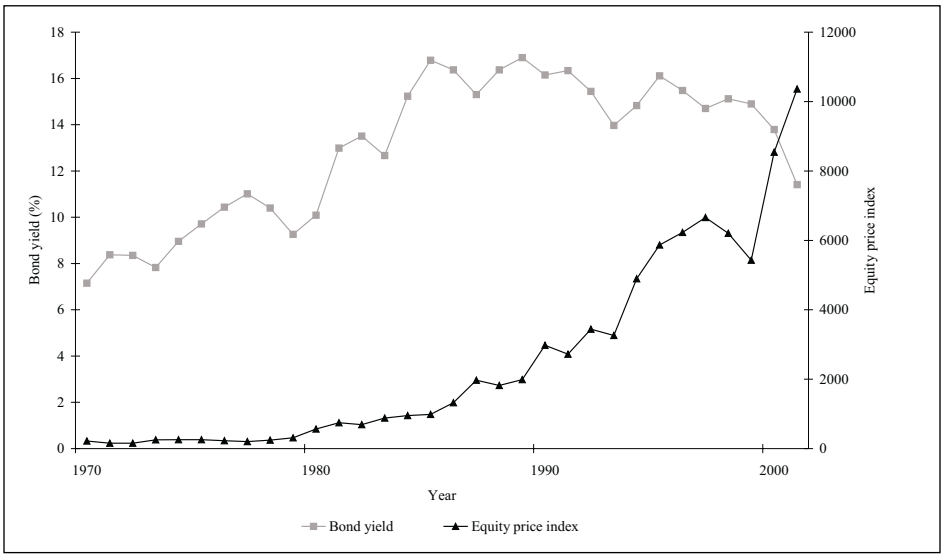
3 Sources: government bond yield: IMF (2002); equity price index: FTSE all-share index

B.8 The most public example of adverse effects of the sale of this business has been that of the Equitable Life. The developments are detailed in Corley Committee of Enquiry (2001), which produces recommendations for the actuarial profession among other parties.

B.9 SOUTH AFRICA

Figure B.3 demonstrates that South Africa has not yet entered a period of low inflation and bond yields.[4]

Figure B.3. Government bond yield and equity index: South Africa, 1970–2001



B.10 It remains to be seen whether this will occur, and if so the effect this will have on South African life insurance companies.

4 Sources: government bond yield: IMF (2002); equity price index: JSE all-share index

APPENDIX C
DESCRIPTION OF SOUTH AFRICAN PRODUCTS WITH INVESTMENT GUARANTEES

C.1 This appendix describes the main products with investment guarantees sold in the South African market, as identified using the results of the survey. These are:
– the non-profit immediate annuity;
– the participating immediate annuity;
– the unit-linked savings product with a maturity guarantee; and
– the smoothed-bonus savings product with a maturity guarantee.

C.2 There are other products with investment guarantees that occur to a lesser extent in South Africa. These products, which include the following, are not considered further in this paper, viz.:
– the with-profit deferred annuity;
– the with-profit savings product with a maturity guarantee where policyholders share in all surplus (often called '90:10' business); and
– non-profit business where the risk arising from the investment guarantee is not as material as other risks (e.g. term assurance).

C.3 NON-PROFIT IMMEDIATE ANNUITY

C.3.1 The non-profit immediate annuity tends to form a significant proportion of the business of South African life companies with investment guarantees. Six companies interviewed contained in-force volumes of this product and most indicated that the business is well matched.

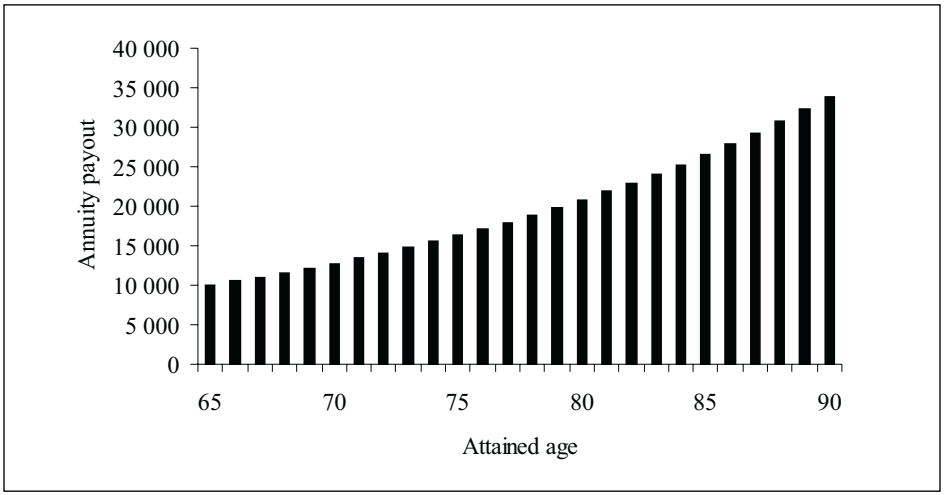
C.3.2 The majority of non-profit immediate annuities are sold to provide income for retiring persons. These may be sold individually or as part of a group contract with a pension scheme. They are usually purchased with a single premium at retirement, which may be a result of the proceeds of a separate savings contract with the company.

C.3.3 Non-profit immediate annuities provide income for the remainder of an individual's life. The pattern of this income is defined at outset, and is usually level or increasing at a fixed rate.

C.3.4 Figure C.1 provides an example of how an annuity payout may vary over time, with an increase rate of 5% to a policyholder aged 65 at inception and an initial annuity level of R10 000 a year.

C.3.5 This business is usually matched with gilts and corporate bonds. In practice it is difficult to use exact matching and immunisation techniques are adopted.

Figure C.1. Non-profit annuity payout by attained age



C.3.6 There is, of course, significant longevity risk associated with this business, which is not examined in this paper although this can significantly affect investment-guarantee risk. Longevity risks have become prevalent in developed countries, but the extent of the risk in the South African life insurance industry remains to be seen. Such risk can be reinsured, but in the current market there are difficulties in finding reinsurers willing to take such risks on.

C.4 WITH-PROFIT IMMEDIATE ANNUITY

C.4.1 With-profit immediate annuities are fairly common in South African, four of the seven life insurance companies interviewed having in-force volumes of this product.

C.4.2 Such annuities are also intended to provide an income for life during retirement. The payout is not pre-determined at outset, but increases with bonuses during the remainder of the individual's life.

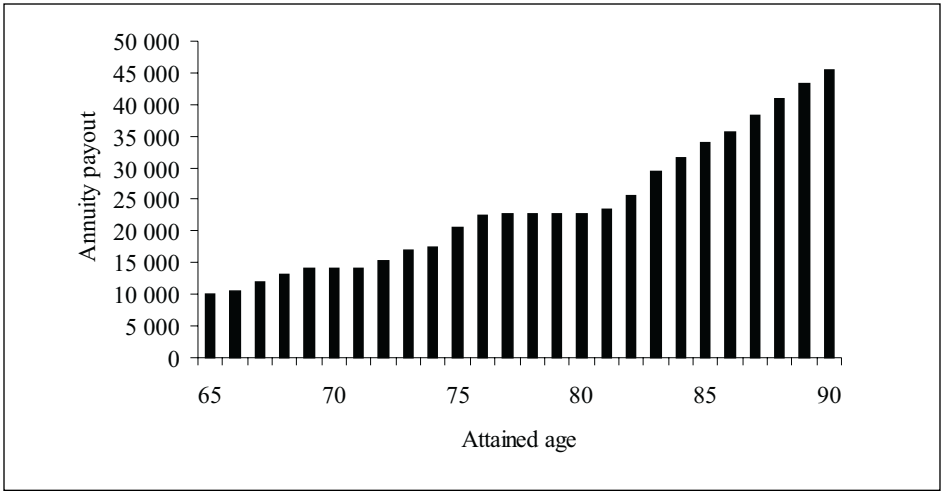
C.4.3 Bonuses for these products tend to be 'vesting'. In other words, these bonuses are guaranteed once declared and cannot be reduced or removed by the life insurance company at a later date, as opposed to 'non-vesting' bonuses, which, once declared, can be removed at a later date. Such removal may have adverse consequences, e.g. possible negative impact on future new-business sales.

C.4.4 Bonuses tend to be a function of:
– investment returns, which are a function of the composition of the underlying assets;
– the smoothing philosophy applied to this business;

– the level of charges; and
– the costing rate used to convert the single premium to a level annuity.

C.4.5 This leads to a payout function for a policyholder that is not predictable at outset. Figure C.2 provides an example of how an annuity payout may vary over time, with an initial annuity level of R10 000 a year and bonuses that vary by policy year but have a minimum of 0%.

Figure C.2. Illustrative smoothed-bonus annuity payout by attained age



C.4.6 It is possible to match the guaranteed level of annuity with fixed-interest stock. However, such a match is only partial. The return on the other assets backing this business must then be non-negative.

C.4.7 This structure can be contrasted with the structure of some of the participating annuities in the UK market. Several different structures are described in Wadsworth *et al* (unpublished). Many of the latter structures include the use of non-vesting and vesting bonuses, which reduces the build-up of investment guarantees.

C.5 UNIT-LINKED SAVINGS PRODUCT WITH A MATURITY GUARANTEE

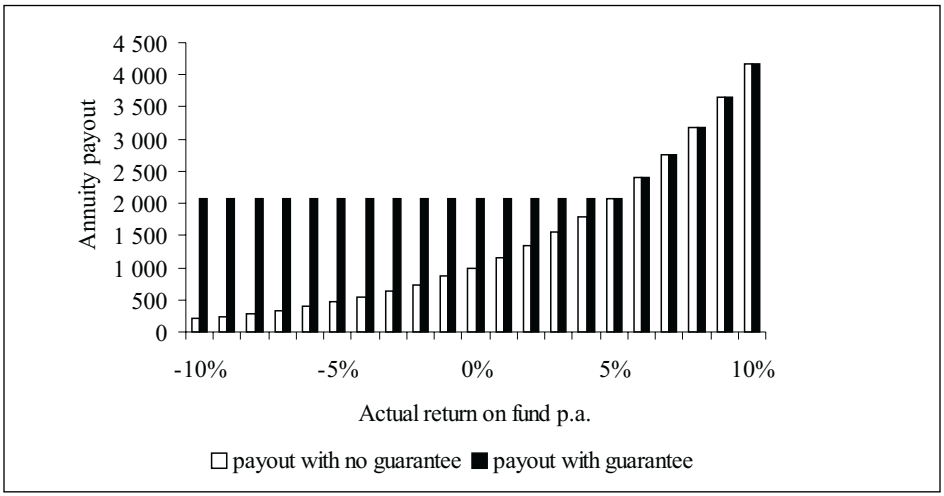
C.5.1 The unit-linked savings product with a maturity guarantee is prevalent in South Africa, five of the seven life insurance companies interviewed having in-force volumes of this product.

C.5.2 To help understand this product, we consider as a simple example, a R1000 single-premium policy with a 15-year term. The standard return to maturity is the return

on a balanced portfolio of the insurance company. At maturity there is an underlying guarantee to pay a minimum of the single premium rolled up with interest at 5% a year. Such a structure is not atypical of savings contracts sold by South African companies, although the guaranteed interest rate may appear high compared with recent new-business contracts sold.

C.5.3 In Figure C.3 the payout on maturity of such a contract is compared with the same contract without a guarantee for various annual returns on the fund up to maturity.

Figure C.3. Payout on maturity for a unit-linked product with a maturity guarantee



C.5.4 We can now consider the excess payout at maturity due to the maturity guarantee. Where the guarantee bites, this is the guaranteed payout less the value of the balanced portfolio. Where it does not bite, the excess is zero. This is demonstrated in Figure C.4.

C.5.5 Note that this value is expressed at maturity and not at policy inception. We can derive a value as at policy inception, but it is not clear what discount rate should be used. The value discounted to inception at the rate earned on the balanced portfolio is shown in Figure C.5 as a function of that rate.

C.5.6 The extent to which the level and shape of this curve differs from Figure C.4 demonstrates the significance of choosing an appropriate discount rate.

C.5.7 The shape of the payout of the guarantee (sloping downwards towards the bottom right) can be seen to resemble the payout on a simple put option. Such a product can therefore be thought of as a combination of a put option and an underlying savings

vehicle. This suggests option-pricing theory may have a role to play in valuing the investment guarantee.

Figure C.4. Excess payout at maturity

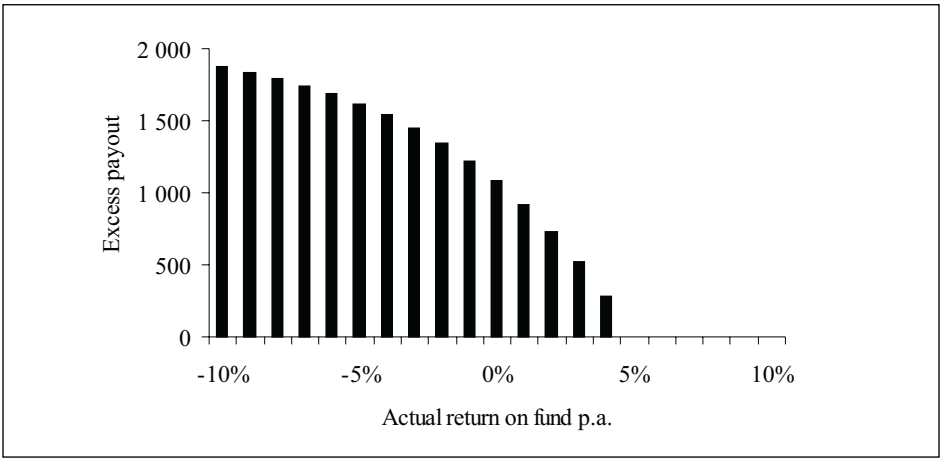
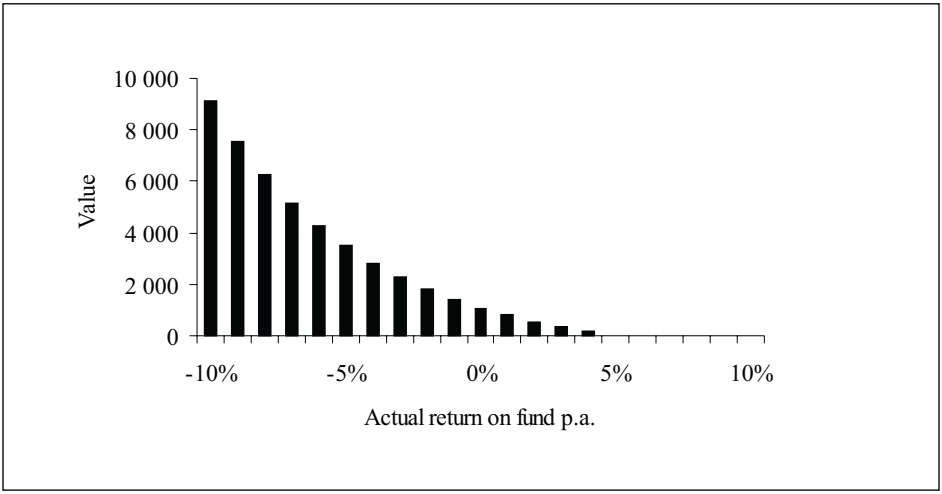


Figure C.5. Value at inception of excess payout at maturity, discounted using rate of return earned on balanced portfolio



C.5.8 Companies can purchase derivatives to match such investment guarantees, although such matching is difficult, mainly due to the lack of such derivatives, in particular guarantees that are affected by future lapse experience.

C.6 SMOOTHED-BONUS SAVINGS PRODUCT WITH A MATURITY GUARANTEE

C.6.1 This product is prevalent in South Africa, six of the seven life companies interviewed having in-force volumes of this product.

C.6.2 This product is similar in basic structure to the corresponding unit-linked products, the basic investment guarantee at policy inception again being a return of premiums at a guaranteed rate of interest.

C.6.3 The difference arises with the method used to increase the value of the fund. This often has a significant impact on the level and form of the guarantee provided during the term of the contract.

C.6.4 Instead of the value of the fund being a function of the investment performance of the balanced portfolio of the life office, it is a function of smoothed bonus rates that are set at the discretion of the life office. As for with-profit immediate annuities, these smoothed bonus rates are a function of the investment return of the underlying fund and the smoothing policy of the firm.

C.6.5 However, for this business, South African companies tend to declare a mixture of a non-vesting bonus and a fully vesting bonus, most of the bonus having historically being declared in non-vesting form. Smoothed-bonus business exists where bonus rates are fully vesting (i.e. there is no non-vesting bonus) and for some companies this product structure is becoming more prevalent for new business.

C.6.6 In addition, non-vesting bonuses are often converted into vesting bonuses on a pre-determined basis. For example, several South African companies have a 10% conversion rate.

C.6.7 Vesting bonuses lead to a direct increase in the level of the investment guarantee. It is therefore not possible to determine in advance the level of investment guarantee at maturity, as this is a function of the bonus rates declared up to maturity. The holder of a smoothed-bonus policy is protected from a large fall in the underlying assets just before maturity more than the holder of a unit-linked product with a maturity guarantee. These products are therefore popular with risk-averse investors who wish to gain exposure to equity and bond markets but wish the downside risk associated with such markets to be limited to some extent.

C.6.8 It is difficult for companies to match the investment guarantees underlying this business. Besides the difficulties in allowing for lapses, there are complications in predicting future bonus rates. A counterparty is unlikely to enter into a derivative arrangement with the life insurance company unless there are strict controls over the declaring of future bonuses, otherwise the counterparty would be at risk of anti-selection.