

PGN 110 ESG and Calibration Survey

South African Long-term Insurers
2008 results



Introduction

This report documents the results of PricewaterhouseCoopers Actuarial and Insurance Management Solutions' (PwC AIMS) first survey of South African life insurers' approaches to valuing embedded investment derivatives using market consistent techniques.

The recently updated Professional Guidance Note 110 (PGN110) "Allowance for Embedded Investment Derivatives" requires market consistent valuation of derivatives embedded within life insurance policies. These complex options and guarantees include minimum investment guarantees and guaranteed annuity options, but also extend to any feature that depends non-linearly on market prices.

Market consistent valuation requires the embedded derivatives to be valued, as far as practical, in line with observable market prices for traded instruments. The aims of market consistent valuation are threefold:

1. Improve the accuracy of valuation of complex instruments by using advanced techniques from the world of financial economics.
2. Mark the instruments to market using current market prices to reflect the information processing power of reasonably efficient markets.
3. Create a more objective valuation methodology to improve comparability between insurers and across industries, and to reduce the scope for intentional or purely misguided manipulation of values.

Each of these points can be (and has been) debated at length. Some evergreen areas of debate include:

- Is financial economics, with its tendency to assume normality and discard uncomfortable observations, the best source of valuation techniques?
- Are markets efficient, or are they driven to extremes by greed and fear and otherwise distorted by the behavioural biases of the participants?
- What happens to the objective standard when the embedded derivatives we need to value have characteristics very different from anything observable in the markets?

Purpose of the survey

The calibration of Economic Scenario Generators (ESGs) to market prices has proved to be a challenge for many of our clients. The difficulties stem from the limited price data available for relevant securities, especially at long durations, and a lack of consensus in approach in the industry. This is compromising the objectivity and comparability of market consistent valuations.

The choice of long-term equity volatility assumption has been a particularly controversial area. Our experience has been that some estimates used in the past have been too low, given:

- The historical volatility of our market;
- Comparison against international benchmarks; and
- The relative concentration of our market in resource-based stocks.

Introduction

Under-estimation of long-term volatility has serious implications for the sufficiency of reserves, capital and the accuracy of pricing.

Correlations between asset classes factor into the prices of a very small group of traded securities. Thus, appropriate market consistent estimates of correlation currently do not exist.

The purpose of this survey is to build industry knowledge and consistency of the calibration of market consistent ESGs. This is a first step in achieving this aim and we are ready to discuss your own perspectives, problems and solutions on an individual basis.

Survey methodology

We asked six life insurers to complete a brief survey covering three categories. The first covered high level details of the ESG used. The second considered practical details such as number of scenarios and the policy data that was used. The final category covered the calibration details of all the standard asset classes considered.

The survey was conducted in the third quarter of 2008 and covered the respondents' calibrations as at 30 June 2008. The participants are all companies who perform most of their actuarial valuation work internally and the survey thus reflects the choices of these, typically larger, insurers. Smaller insurers are likely to use the methods and assumptions of their advisors, which may differ from the survey results.



Summary of key findings

Some of the key findings of the survey are summarised below. Further detail, together with a discussion of the findings, is provided in the last section of this report.

Models

- Five of the six participants currently use a suite of models from the UK-based firm, Barrie & Hibbert, and all of the participants reported using a risk-neutral approach.
- However, only two respondents answered that they used a risk-neutral model for Capital Adequacy Requirement (CAR) purposes, in line with the latest version (3.0) of PGN110.
- All respondents typically used at least 2,000 scenarios for their valuation. One company used 4,000 scenarios for all products and one company used a range from 1,000 to 4,000 depending on the product line. We view 2,000 scenarios as being the minimum acceptable level in most cases, and even then the standard error is large when calculating capital requirements.
- Half of the participants reported using grouped data (or 'model points') with monthly cashflows. The only company which reported using full data calculated cashflows on an annual basis.
- Four participants assumed a single duration of bonds which matches the portfolio, with only one using more advanced techniques to better match the characteristics of individual portfolios backing different lines of business.
- The range of swaption volatilities used is similar to that seen in the UK – the highest point at the short end was 18.8% and the lowest point at the long end was 11.6%.
- Most participants used the standard calibration in the Barrie & Hibbert model to set the long-term equity volatility assumption (28.4%). One used 25% and one appears to be using 30%. It seems likely that some companies are not making appropriate adjustments to reflect the moneyness of their contracts in force.
- The average property volatility assumption is lower than the typical 15% used in the UK. Based on this analysis, it appears that the property volatility assumption is one where South African insurers are being aggressive.
- There is little consensus on the magnitude of the appropriate correlations or even, in some cases, the sign of the relationship. Some companies assume much lower correlations overall than others, resulting in lower guarantee costs and capital requirements.
- In spite of the uncertainty associated with the correlation assumptions, only one respondent stated that they were unsure of the accuracy of their assumptions. The four other respondents who answered that question were fairly confident of the estimates.

Calibration

- There was a lack of consensus amongst participants on whether to calibrate against the swap curve or the bond curve, and a range of methods were used to extrapolate the yield curve.

What the results mean for your organisation

Refining calibration and modelling

Our industry has made great strides in modelling guarantees stochastically and improving the market consistent calibrations used in the models. These skills are going to become even more important as the industry moves towards Solvency II type approaches and robust internal capital models.

This survey shows that even in the areas of relatively strong consensus, some companies are using quite different assumptions. These differences regularly lean towards the optimistic. This optimism is combined with confidence which most respondents appear to have in certain aspects of the modelling where perhaps it isn't justified. Overconfidence as a heuristic bias has been explored in depth in the world of behavioural finance, with the common conclusion that overconfidence increases with expertise.

Respondents also differ in terms of the complexity of models used in terms of the frequency of cashflows and the grouping of policies. These models are a critical tool to measure and manage market risk and overly simplified models may hinder these functions.

Good progress has been made, but it would be worthwhile to formally assess your company's capabilities against best practice to help plan developments over the next cycle.

Evaluating costs of guarantees and hedging

Products with guarantees are capital intensive and tend to have low returns on this capital. The costs of hedging away even some of the market risks associated with the guarantees are typically viewed as prohibitive.

Accepting or bearing risk is often an appropriate risk management strategy, particularly for an insurer in the business of accepting and pooling risk. However, if the assumptions and models used to determine the cost of bearing the risk internally are optimistic, then capital market hedging structures are made to look unfairly unattractive.

On a more fundamental level, if in-force embedded derivatives are being undervalued due to optimistic assumptions, then the risk will be exacerbated through under-pricing guarantees offered on new products.

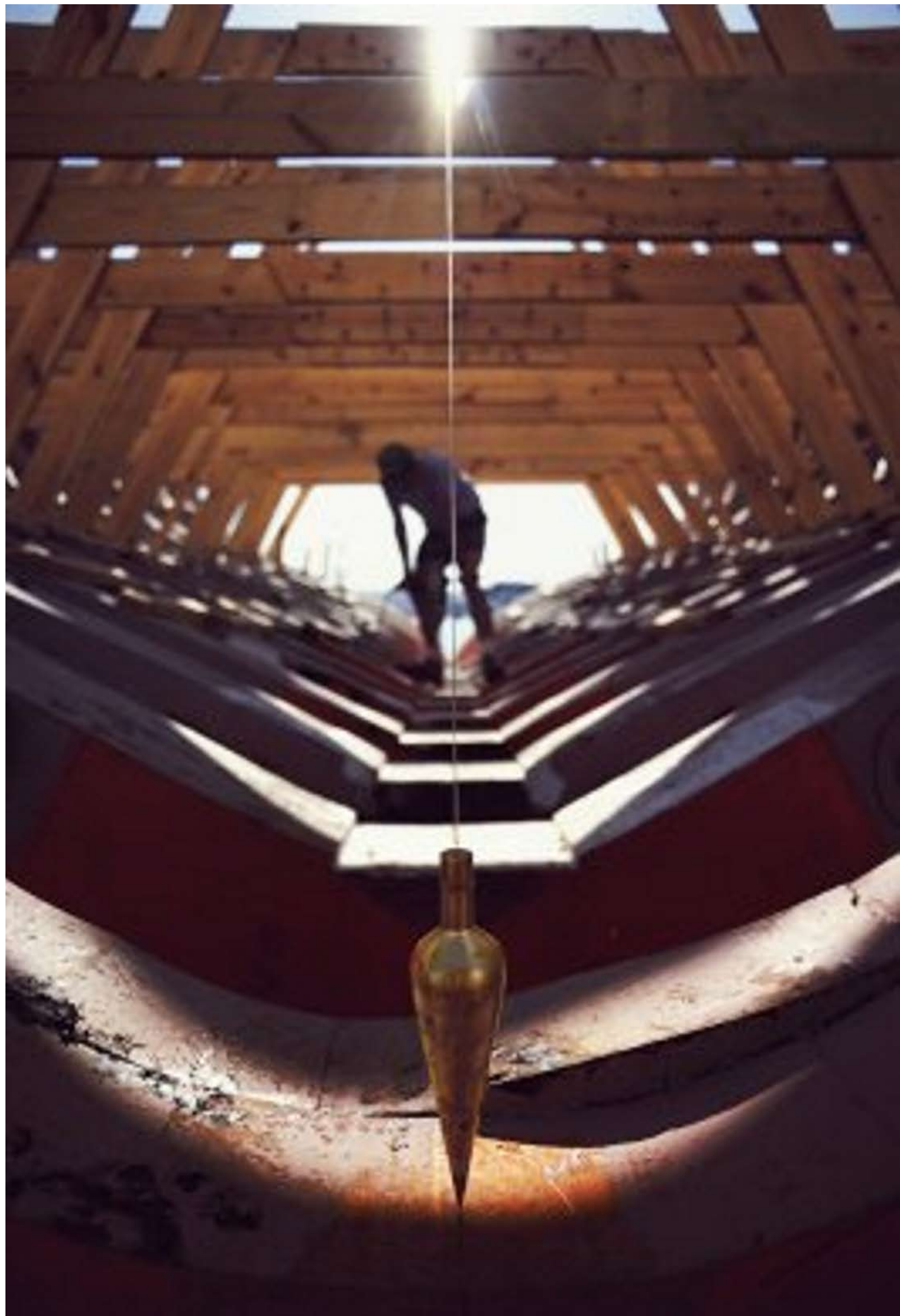
Understanding the risk

Finally, we believe each item included in our survey to be fundamental to stochastic guarantee modelling, but some clients needed assistance in determining the appropriate values to include in the survey. This suggests that critical estimates incorporated into these values are not yet understood at the key levels of insurance organisations. Practitioners in this area have quite different levels of skill, experience and understanding.

What the results mean for your organisation

With the developments in financial markets around the world this year, shareholders and regulators are looking ever more closely at risk management and governance practices around complex financial instruments. This is still a very new area and careful investment in the right internal and external resources is necessary to build long-term capability.

Statutory Actuaries, members of Actuarial Committees, CFOs, CEOs, Board members and, of course, auditors, would do well to reconsider whether they are comfortable with their understanding of the valuation methodology and key assumptions.



Results

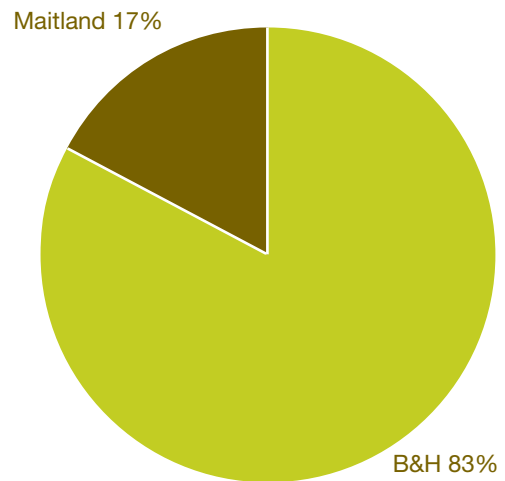
1. The ESG landscape in South Africa

The use of ESGs has developed and expanded rapidly in the last five years. Before the introduction of the original version of PGN110 in 2003, few insurers used stochastic modelling on a regular basis. A range of ESGs were used, from Random Walk models and implementations of the Wilkie and Thompson models to proprietary systems such as TSM and the Maitland model.

The models were implemented in quite different ways and with different results. Simple Random Walk models ensure consistency with Black-Scholes pricing and have an easily understood structure. The Wilkie and Thompson models feature coherent economic drivers and mean reversion, with the Thompson model specifically focused on the South African market. TSM enjoyed the proprietary support of a large firm and was used by several insurers in the UK as well.

Over the last five years, the ESG landscape has changed dramatically. The market is now concentrated in a single proprietary product. Insurers have realised that developing and maintaining ESGs is a specialised skill that is best out-sourced to the experts. Out of our six participants, five currently use a suite of models from the UK-based firm, Barrie & Hibbert. One company uses Maitland's ESG.

ESG systems used

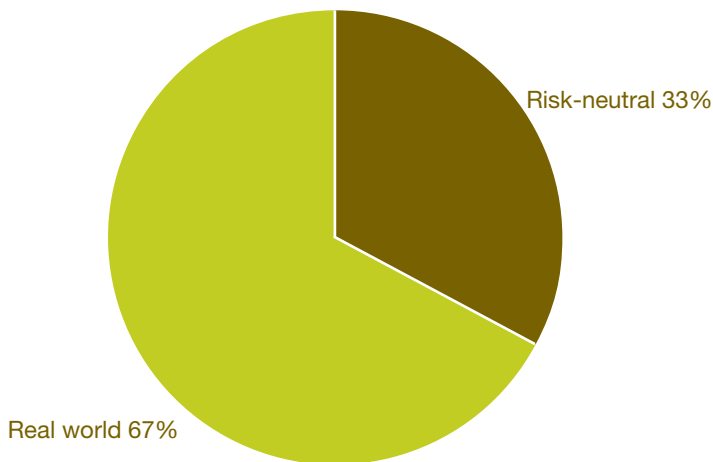


Barrie & Hibbert's models typically used the risk-neutral approach to market consistent valuations (rather than using state price deflators) so it is not surprising that all of the participants reported using a risk-neutral approach.

Results

Two respondents answered that they used a risk-neutral model for Capital Adequacy Requirement (CAR) purposes, indicating that they have adopted the approach to CAR modelling from the new version (3.0) of PGN110 (effective for year-ends from 31 December 2008). This approach brings the CAR in respect of embedded derivatives in line with the rest of the CAR calculation and also Solvency II developments.

CAR modelling methodology



The use of variance reduction techniques improves the accuracy of the model without resorting to increasing the number of scenarios. All insurers surveyed used one type of variance reduction, with those using Barrie & Hibbert employing antithetic sampling and the company using the Maitland model applying moment matching.

Variance reduction techniques come fairly close to being a free lunch. However, caution is required when calculating confidence intervals around results and in diagnostic tests when using variance reduction.

2. Running the models

In an ideal world, embedded derivatives would be valued for each policy using 10,000 or more scenarios, accurate monthly cashflows and realistic bonus declarations and investment decisions. However, stochastic models have significant runtimes, even on air-conditioned banks of the latest hardware running in parallel. When these extended runtimes meet tight reporting deadlines, the result is extensive compromise.

PGN110 requires at least 1,000 scenarios to be run and recommends 2,000. We view 2,000 as the minimum acceptable number for anything but the most trivial in-the-money guarantees. The further out of the money the derivatives are, the more scenarios are required to reduce the standard errors of the estimated values to acceptable levels.

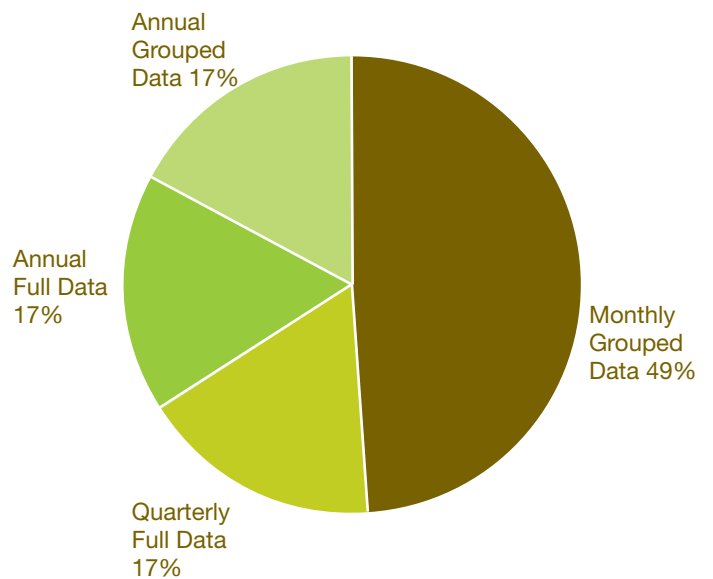
Results

The targeted sufficiency level under Solvency II is 99.5%. If we use 2,000 scenarios to estimate this point, we would typically expect only ten scenarios to contribute to the tail of the distribution beyond the 99.5th percentile. The sampling distribution of the 11th largest observation is quite broad, indicating uncertain estimates of capital requirements.

In this survey, all respondents typically used at least 2,000 scenarios for their valuation. One company used 4,000 scenarios for all products and one company used a range from 1,000 to 4,000 depending on the product line.

Another key element that influences the runtime of the models is whether monthly or annual cashflows are used. Monthly cashflows improve the accuracy in some cases, but can often contribute to a significant increase in runtime (sometimes more than a twelve times increase).

CAR modelling methodology



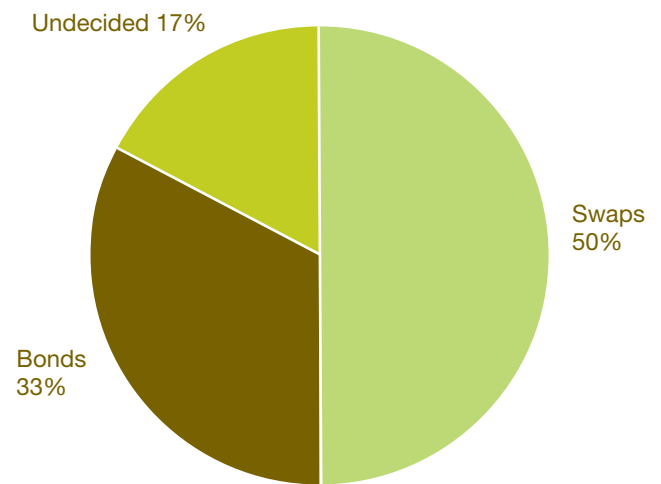
Half the companies used monthly cashflows. All the companies using monthly cashflows also used grouped data (where a group of policies is valued as a single, representative model point). Only one company used both annual cashflows and grouped policy data, reflecting a greater appetite for modelling and sample error.

3. Interest rate model calibration

The Barrie & Hibbert suite provides several different interest rate models from which to choose. For the five companies using the Barrie & Hibbert suite, all but one used the Extended Two Factor Black Karasinski model for nominal yields. One company used the monthly London Market Model. All of these five companies used the Two Factor Vasicek model for modelling real rates (with inflation modelled as a function of nominal and real yields).

These yield curve models need to be calibrated to the observed market yield curve. There is no consensus amongst the participants on whether to use swap rates or bond rates. The trend has been towards using swap rates, consistent with the CFO Forum's requirement under Market Consistent Embedded Values to use the swap curve. However, it is unclear which approach will be adopted for Solvency II. Given the recent gyrations of the South African swap curve in relation to the bond curve, it is also not clear which is the more robust benchmark.

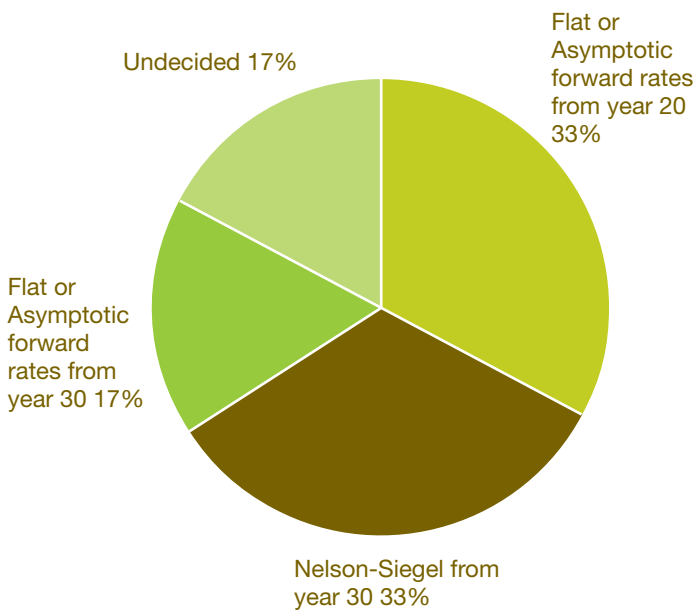
Yield Curve Calibration Target



Results

The durations of life insurance guarantees are often very long. There are limited bonds available of long duration to provide a true market yield curve. Respondents used a range of approaches to extrapolate the yield curve and one company is currently undecided.

Yield Curve Extrapolation Method



4. Swaption volatilities

Most respondents fit their models to a range of swaption terms rather than a single point. Four out of six targeted the options with a 20 year tenor, with the remaining two opting for a 10 year option tenor. In our experience, the differences between 10 and 20 year tenors are typically small.

The actual volatility values used ranged from a maximum of 18.8% at short durations to a low point of 11.6% for longer durations. This range is similar to that observed in the UK market.

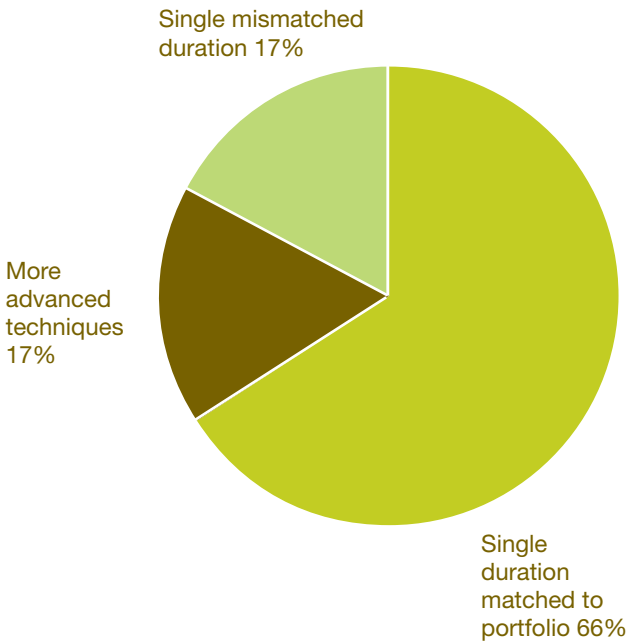
5. Bond returns

The interest rate model itself does not generate fixed income returns. Returns are generated by an asset pricing model and assumptions around the duration of bonds actually held.

Most respondents indicated that they use a single duration equal to that of their benchmark portfolio. However, there are indications that some companies are pursuing more advanced strategies to better match the characteristics of individual portfolios backing different lines of business. On the other hand, one respondent indicated that there is a sizeable mismatch between the bond duration assumed to generate returns in the model and the bonds actually held.

Results

Bond Portfolio construction

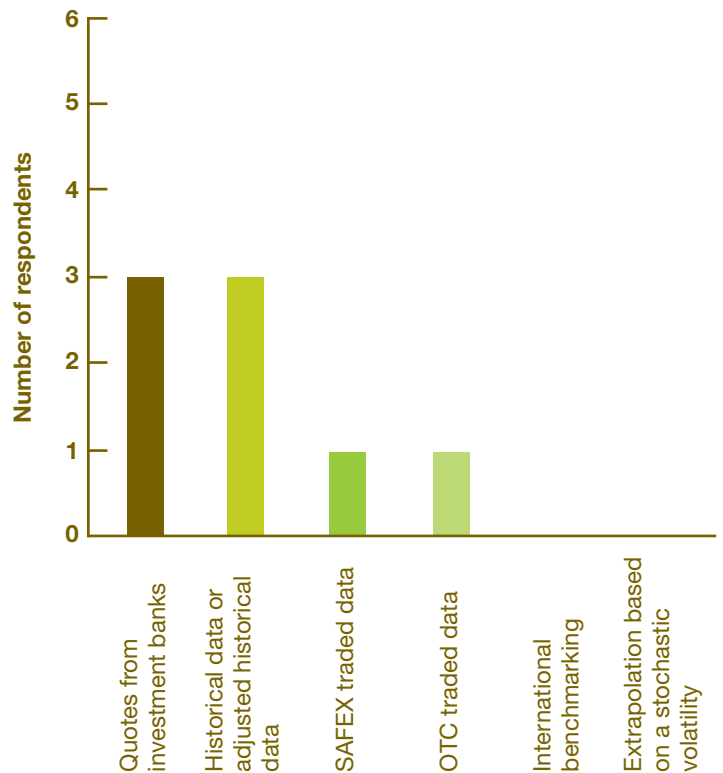


6. Equity implied volatility

Long-term equity implied volatility is a critical and uncertain input into the valuation of embedded derivatives. Guarantees written by life insurers can depend on equity volatility out to twenty years and further. There are no similar traded options in the market from which implied volatilities can be calculated.

Exactly half of our respondents were able to obtain implied volatility data for equity options out to terms of five years. The remaining half used data for terms of up to three years. Respondents used a variety of sources, with some companies using more than one. In the UK, standard calibrations are taken from as many as ten different sources, reflecting the greater breadth of the market.

Sources of volatility data

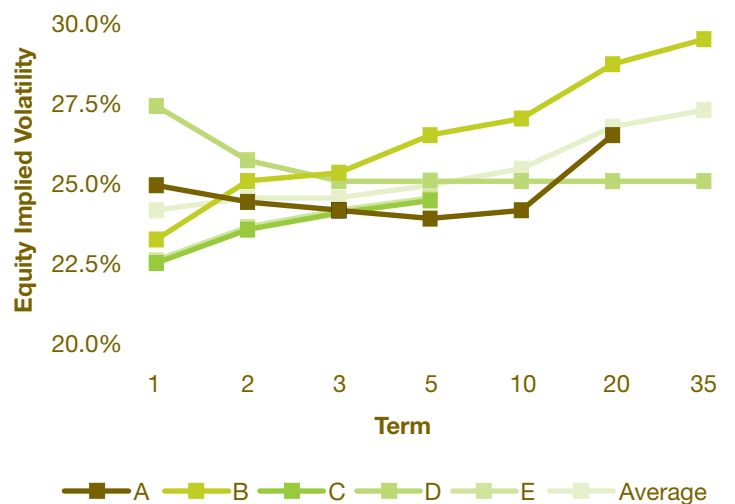


Results

Most companies use a deterministic, term-dependent volatility structure with a long-term volatility estimate of 28.4%. This represents Barrie & Hibbert's standard calibration at 30 June 2008 and represents a significant upward shift over previous calibrations. One company is significantly lower at 25% and one company appears to be using a 30% long-term assumption.

This increase can partly be attributed to an increase in local and global equity market volatilities, as measured by short-term historical standard deviation of returns and volatility indices such as the ViX and SAVI. However, as this is a long-term volatility assumption, fluctuations in short-term volatility should have a limited impact on this long-term assumption. It seems that this upward adjustment represents a distinct change in view as a result of additional thought and research being applied in this area.

The graph below shows the actual term structure of volatilities used by the respondents.



Respondent C and Respondent E are difficult to differentiate on this graph as they provided identical assumptions.

The average volatility term structure is upwards sloping, which is required given that short-term implied volatility from the market is currently below the long-term estimate of most companies. The term structure would likely look quite different if calibrations were performed during the heat of the financial market crisis of mid September. We would then expect higher short-term volatility estimates but with an unchanged or virtually unchanged long-term estimate.

7. AIMS' view on long term equity volatility estimates

We are comfortable that the level of volatility in the current standard calibration of the Barrie & Hibbert model is a sensible starting point for companies' own calibrations. At a market level, we would expect our base volatility calibration to be higher than the UK for the following reasons:

- As an emerging market, the volatility of our market is expected to be higher than a larger, more developed economy such as the UK.
- Our stock market is concentrated in a few large stocks and is heavily slanted towards resource-oriented stocks. This higher concentration will lead to higher volatility through lower diversification.
- Our currency is the sixth most traded currency in the world. In the context of the size of our economy and the size of transactional trade flows, this gives rise to significant exchange rate volatility which bleeds into our stock market.

These points address national and capital market issues. However, individual insurers should also be looking to adjust the standard calibration to reflect the specifics of their embedded derivatives and investment approach.

- Some UK embedded derivatives are quite far in the money. Very few of these guarantees are in the

money in South Africa. The well-known volatility "skew" or "sneer" (not a symmetric "smile") means that implied volatilities for out of the money puts will be higher than for in the money puts. Once we have included an allowance for skewness, our average calibration should again be above an otherwise similar UK insurer.

- The available market data for equity implied volatilities is for index options. If an insurer's investment policy is slanted away from the index in terms of either overall Beta exposure, or through different effective diversification compared with the market, then an adjustment to the volatility target should be made.

We are aware that some insurers are already making adjustments to the standard calibration to allow for skewness, with the resultant long-term equity implied volatility used being higher than 28.4%. However, all respondents stated that they calibrated to at-the-money volatility. In the UK, calibrations seem to suggest an approximate adjustment of 75bps for each 10% in or out of the money.

A range of assumptions are made for foreign equity, but the trend is clearly to assume a higher volatility than for local equity for most territories. Although the developed markets of the UK and US are expected to experience less volatility, the effect of additional exchange rate volatility more than offsets this.

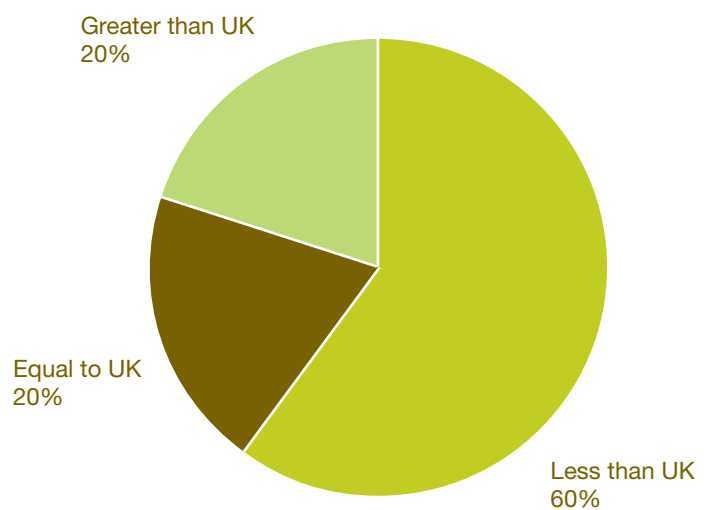
8. Property volatility

Property volatility is arguably more subjective than long-term equity volatility. Listed property stocks typically have some amount of gearing and are expected to be more affected by market risk than directly held property. On the other hand, appraisal value based estimates of property volatility understate the true volatility in the presence of smoothed appraisals. Geltner and many others have suggested “unsmoothing” algorithms based on assumptions of the nature of the underlying smoothing process.

The body of knowledge around property returns warns us of the dangers of assuming that property values have very low volatility. In the UK the typical property volatility assumption is 15% and it seems reasonable to use this as a minimum plausible assumption for our local property market.

The exact volatility used is difficult to determine since for most respondents property is valued by proxy. Property is typically valued by proxy either as a portfolio of bonds or as a combination of bonds and equity.

Property volatility assumption



The average property volatility assumption is lower than the typical 15% used in the UK. Based on this analysis, it appears that the property volatility assumption is one where South African insurers are being aggressive. The financial impact depends on the extent of property in the relevant portfolios, which differs across the survey participants.

9. Correlations

Correlations between asset classes cannot be set with reference to our market given the lack of data. The standard approach in the absence of observable market data is to use best estimates from historical time series. This implicitly assumes correlations to be constant and independent of market conditions. This has long been accepted as an approximation to the reality of correlations becoming stronger in times of financial distress. The recent market turmoil has made market participants reconsider the correlations between individual assets as well as between broad asset classes in times of market stress.

The property asset class again poses a particular problem. If property return data is actually smoothed, then estimates of correlation will be biased towards zero. Smoothed property returns will therefore give rise to lower estimated volatility and lower estimated correlations. Both these factors serve to decrease modelled guarantee costs and capital requirements. It is both expected and slightly concerning that the respondents with low estimates of property volatility also assumed lower correlation with other asset classes.

The table below shows the range of correlation estimates between each asset class.

		Equity	Foreign Equity	Bonds	Property
Equity	Lowest	100%	100%	20%	15%
	Highest	100%	100%	30%	78%
Foreign Equity	Lowest	20%	100%	-20%	5%
	Highest	100%	100%	19%	19%
Bonds	Lowest	5%	-20%	100%	5%
	Highest	30%	19%	100%	100%
Property	Lowest	15%	5%	5%	100%
	Highest	78%	19%	100%	100%

It is clear that there is no consensus on the magnitude of the appropriate correlations or even, in some cases, the sign of the relationship. A crude measure of the “average” correlation for each respondent (ignoring same-asset class correlations of 100%) produced a minimum of 10% and a maximum of 36%. Although this statistic is difficult to interpret intuitively, it does show that some of the differences in views around correlations could be described as “systematic”. Some companies assume much lower correlations overall than others, resulting in lower guarantee costs and capital requirements.

Results

Companies that assumed higher correlations viewed the impact of the correlation matrix on the results as moderate. Companies that assumed lower correlations viewed the impact on the results as small or none, which isn't surprising given that their assumptions are close to assuming no correlations.

In spite of all this uncertainty, only one respondent stated that they were unsure of the accuracy of their correlation assumptions. The other four respondents who answered that question are fairly confident of the estimates.





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Mark is a PwC Director and is head of the Actuarial and Insurance Management Solutions firm. His 27 years of actuarial experience include a significant amount of work in the life insurance and investment fields and he regularly consults to insurers on high level reporting and executive decisions. Mark is a member of the ASSA Life Assurance Committee.



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David consults to a number of life insurance companies in a broad range of areas, including market consistent valuations, capital and risk management, process improvement, mergers and acquisitions and strategy. His experience extends to the UK, China and the Middle East. David has significant expertise in capital and risk management and is a regular speaker on advances in embedded value techniques including market consistent developments.



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Christiaan first became involved with market consistent valuations in 2004 when he assisted numerous multinational UK-based insurers performing Realistic Balance Sheet valuations. More recently, he has applied his expertise in helping South African insurers to implement market consistent ESG's under the revised PGN110, and has advised companies in China and Taiwan in this area as well. Apart from broad experience in life insurance financial reporting locally and internationally, he also has significant expertise in credit provisioning for both banks and retailers.



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Colin leads the AIMS practice area which provides audit assurance on the actuarial balances of PwC's audit clients, including PGN110 reserves. His experience includes ensuring compliance with the first PGN110 guidance note covering real world models and the latest guidance notes covering market consistent models. Colin is also responsible for the AIMS employee benefits workstream and has wide experience in pensions and employment benefits work, including significant involvement in benefit alignment and risk management.

PricewaterhouseCoopers' Actuarial and Insurance Management Solutions

PricewaterhouseCoopers' Actuarial and Insurance Management Solutions (PwC AIMS) firm provides advisory and assurance services which cover a wide range of fields including long- and short-term insurance, employee benefits, healthcare, asset management and banking.

The team includes a number of qualified and experienced actuaries who have significant expertise in market consistent valuations. Our experience in this area includes:

- Research on the technical aspects of market consistent valuations, including the development of a sample ESG and implied volatility modelling.
- Audit work on our clients' liabilities calculated in respect of embedded investment derivatives (in accordance with PGN 110).

- Research on hedging the risks associated with holding liabilities calculated on a market consistent basis.

We also have market-leading expertise in embedded values, capital and risk management, Solvency II and revenue and profitability growth.

As part of a global network of AIMS firms which employ over 680 actuarial insurance specialists worldwide we draw on a wide base of knowledge and experience. In particular, our UK counterparts have significant expertise in the area of market consistent valuations. As part of the world's largest professional services firm, AIMS also has access to a wider range of skills and experience.

