Practical applications of actuarial skill in risk management today

The extent of actuaries' activities is perhaps best illustrated by the economic capital models now being used for risk management, capital management and regulatory reporting. Banking and insurance regulators now require us to evaluate the additional capital required to ensure that the liabilities will still be covered after an extreme event (typically a 1-in-200 event) during the next twelve months. As well as forming the basis for agreeing the minimum capital required by UK regulators (and, when Solvency II comes into force in 2016, by all insurance regulators in Europe), actuaries use the results of this risk modelling to advise on risk mitigation, capital management and capital allocation within insurers. For example, risk appetites can be agreed with business units and monitored against actual performance and against business plan projections. Economic capital models can also inform proposed strategic actions and pricing and mergers & acquisitions.

The process commonly begins with risk identification, whereby each risk in the insurer's risk register is considered to decide if it is appropriate to include it in the model. As viewed currently, the risks commonly fall into five categories:

- Market risks, i.e. risks that arise from changes in the value of assets such as equity, property, interest rates, inflation, credit spreads
- Life insurance risks, e.g. risks relating to mortality, longevity, expenses, persistency
- General insurance risks, e.g. risks relating to catastrophe, claims reserving, premium adequacy
- Operational risks, such as IT failure, fraud, legal, strategic
- Group risks, e.g. contagion from one business unit to elsewhere in a group

The process continues with collection of data on past experience of the risks; this could come either from publicly available information (e.g. on financial markets or on catastrophes) or from the insurer's own experience. A range of techniques is available to analyse the data, and actuaries are accustomed to use their judgement to select an appropriate technique depending on the volume and reliability of data and on what is proportionate to the insurer's risk management needs and to the importance of the particular risk factor. For example, statistical analysis may be applied to the data to calibrate each risk, choosing the best probability distribution and fitting parameters. Principal component analysis may be used to split a risk into components, e.g. interest rates are commonly split into three components (level / slope / twist) and other market risks into two (level / volatility).

Following calibration of the frequency of each risk, its impact on the insurer's balance sheet must be assessed at different points of the probability distribution. The actuary must judge how many points are appropriate, and this can range from one (usually the 1-in-200 downside stress) to many. The impacts of most risks will be assessed using models of the insurer's business built for asset-liability management ("ALM"). Judgement must also be made on which risks have significant interactions, and the combined impact of stressing two or several risks will be assessed using the ALM models.

In a few cases where risks are not included in the ALM model and have few interactions with other risks, actuaries will build separate models for those risks (e.g. catastrophe and operational risks). The complexity of these models will be appropriate for the risks and, where a risk is sufficiently important, the model may incorporate Monte Carlo methods.

The next step in the economic capital process is to calibrate the dependencies between each pair of risks. As for the risk calibration, this can range from pairs where sufficient data is available to assess

the correlation statistically to pairs where an expert judgement process will be developed. Finally the dependencies are combined in a correlation matrix or a copula and applied to the impacts of all the risks in an aggregation process, to produce the aggregate impact on the balance sheet at various probability levels. This aggregate impact can be significantly less than the sum of the individual impacts, since many pairs of risks will be less than 100% correlated.

Other techniques are commonly used, which can be developed in conjunction with the economic capital model or by using less complex models, as appropriate. These include:

- Sensitivity testing (stressing one variable at a time). For example, the impact on a company's balance sheet of a 1% increase or decrease in interest rates might be assessed.
- Scenario testing (assessing the impact of a conjectured scenario where several variables are stressed). The recent Eurozone crisis has provided one model for the sort of scenario that can be used for this purpose, where interest rates, inflation, equity and property prices, and credit spreads on government and corporate bonds all move simultaneously, together with consequential changes in counterparty credit risk, new business levels, expense levels and certain types of operational risk such as fraud.
- Reverse stress testing (finding how severe a scenario needs to be to cause the failure of the business model). This usually involves identifying the most critical risk factor (or factors) for a business, and assessing how extreme the movement in that risk factor(s) needs to be for the capital to be used up. For example, the business model of the Northern Rock and other banks in 2008 was based on borrowing in the wholesale market, and the freezing up of that market led to Northern Rock's collapse.
