Stochastic Asset Liability Modelling Working Party

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Stochastic Asset Liability Modelling Working Party

Pressures of work meant that the Working Party met only a limited number of times and mapped out a work programme and discussed some key issues. It was felt that in the timescale available it was not possible to complete all the work required and that therefore this will need to be continued in subsequent years. This report is therefore very much a preliminary one to outline some key issues and to provide a basis for discussion for the profession going forward. In particular, the Working Party would find it very helpful for comments to be made on the topics considered.

Terms of Reference

The Working Party took the following as its terms of reference.

1 To review the current state of the art in asset liability modelling including currencies and also the use of hybrid contracts such as insurance options.

2 To clarify the objectives of such work.

3 To undertake / document research as appropriate.

Stochastic or Deterministic Scenarios

Notwithstanding the title of the Working Party, it was felt that work in this area as far as actuaries are concerned should not be confined to stochastic modelling. There were not an insignificant number of cases or even possibly majority where a deterministic scenario approach was more appropriate. It was often much easier to evaluate models in terms of the physical world in the context of the deterministic scenario and also could often be easier for the actuary to explain to the end user.

Computing time is often an issue with stochastic models. This is especially important with a large complex organisation. Approximations may be necessary for day to day running of such models and this is an area where research is being carried out outside the actuarial profession.

Asset Liability Issues in Other Areas

Stochastic asset liability modelling is not just of interest to the general insurance actuary but there is also interest in the life and pensions and banking areas. Indeed both the life and pensions boards have working parties in this area and the profession needs to undertake more coordination in this field.

Pension Funds

The focus for pension fund modelling is the recently introduced Minimum Solvency Standard. In particular, stochastic asset liability modelling is used to answer the following questions:

- What is the probability of the fund's solvency position falling below a specified level in a stated period of time given an initial investment allocation and level of pension contributions?

- What is the probability that the sum of pension contributions and special payments into the fund will exceed a specified amount during a stated period of time, given an initial investment allocation and minimum solvency criterion.

It is possible to incorporate various "decision rules" into the model, depending on the solvency position. For example, the model may have a mechanism by which pension contributions are assumed to increase or investment strategy is assumed to be modified if the solvency position falls below a specified level.

Life Assurance

The focus for life assurance modelling also tends to be solvency-related. It is usual for there to be a mechanism within the model which relates reversionary and terminal bonus rates to the investment returns generated by the stochastic asset model. There are also typically a number of linkages between the asset and liability elements of the model. For example, surrender and lapse rates may be related to economic conditions.

Asset Liability Issues in Banking

Actuaries are not involved to any great extent in this area. The Working Party would be interested in any volunteers who have experience in this area. It is however something that the profession needs to investigate further as activity in the banking field is much more developed. The banks make extensive use of risk based capital systems and use a variety of techniques to evaluate them. Similarly the various derivative markets use models of varying complexity to determine margin requirements. Margin requirements would be appropriate for those who have liabilities in this area. This is an area where the Working Party intends to do more work.

Application of Work in Other Fields to General Insurance

For pensions funds and life assurance companies most of the stochastic variability lies on the asset side of the balance sheet. Liabilities are fixed in monetary terms, related to salaries or related to investment returns. There is a much greater element of stochastic variability on the liability side of the balance sheet of a general insurance company, involving for example variable claim amounts, the insurance cycle and exposure to catastrophes. This means that, although stochastic asset liability modelling work undertaken for pension funds and life assurance companies is transferable to general insurance, the models used for general insurance companies will inevitably be more complicated.

The Working Party's initial reaction is that the banking liabilities and assets are somewhat different from the insurance industry and may not be directly applicable. However the interesting aspect is how such organisations have been using as a modelling to manage their affairs.

Time Horizons

The time horizon for which the work of particular studies required is extremely important. Some investment models are suitable for short term activities, others more appropriate for long term. Similar issues arise on the liability side though these are probably less important.

Review of Investment Models

The purpose of this section is to review the principal features of the investment models which are potentially available for stochastic asset liability modelling.

There are two main types of investment model:

- Random walk models, in which the future is independent of the past, except that the model has a mean and standard deviation derived from past experience.

- Models where there are correlations from time period to time period. In such a model, a sharp fall in investment markets may be more likely to be followed by a rise than a further fall. An example of such a model is the Wilkie investment model, which is described in the paper entitled "More on a stochastic asset model for actuarial use: presented to the Institute of Actuaries on 24 April 1995.

Most investment models are either linear or log linear in their basic forms.

There are a number of variants from these basic models including the following:

- It is possible to build elements of non-linearity into these models by, for example, setting a minimum interest rate or reducing the probability of negative inflation.

- It is possible to link the standard deviation underlying the model to an economic variable such as inflation, to achieve an element of heteroscedascity.

Some models are designed to operate over the short term, whereas others are more appropriate for long term modelling. Long term investment models tend to be used by pension funds and life assurance companies. However, short term models may be of more interest to general insurance companies in view of the shorter term nature of their liabilities. In principle, short term models should be more appropriate for general insurance companies because they are able to incorporate extraneous econometric information such as factory price inflation and other government estimates and forecasts. However, the benefits of this are diluted because economic forecasts frequently prove to be inaccurate. For example, the Bank of England has consistently overestimated retail price inflation during the past few years. Some would argue that longer term models are

appropriate for general insurance companies if used with appropriate initial conditions.

There are a number of drawbacks which apply to many investment models:

- Many models use the Normal distribution. However, experience suggests that this may be a fallacious assumption. There is a tendency for outcomes to bunch either in the middle of the distribution or at the extremes.

- Many random walk models only model total return and do not consider separately yield and capital appreciation.

- There are a number of interest rate models which are used in option pricing, for example Ho & Lee; Rendleman & Barter; Cox Ingersoll & Ross. However, there tends to be no link in these models with inflation and equity market performance.

- Even the most basic models are complex and not easy to understand and interpret. This comment applies with even greater force to enhanced model, incorporating for example the features described in 4 above.

Confidentaility of Investment Models

One of the problems the Working Party faced when contemplating evaluating the appropriateness of investment models is confidentiality. Where models have been developed for proprietary trading needs, there is a clear conflict. Even longer term models were felt by some organisations to have projection value. While this may be understandable it is an impediment to development in this area. It also creates problems for the profession or even individual actuaries establishing public acceptability for the models and approach used.

Review of Liability Models

The models can be regarded as being separated so as to analyse two different risks; the underwriting risk and the reserving risk. In addition to these it is important for the actuary to consider the impact of model error. Clearly this is a very complex topic and well beyond the scope of this analysis at this stage. However it is an important source of variation and just ignoring it is going to lead to misleading results.

Underwriting Risk

There are normally two types of approach. Frequency / severity models and the Central Limit Theorem.

Frequency / Severity Models

These are perhaps the most common approach. Claims frequency is modelled separately from severity often using either a Poisson or Negative Bissonial distribution. Claims severity is then looked at separately using appropriate distribution models often a log normal or pareto distribution being used. The convolution of the distributions is then usually found by simulation though other approximate methods are used to sometimes

speed up computation. Much has been written in this area and it is a topic worthy of discussion in its own right. It is also important to note that separate distributions will be required for each class of business. It will also be necessary to understand that cross correlations between classes and other aspects of the model are very important..

Central Limit Theorem

For many classes of business for these types of models the central limit theorem is appropriate and a normal distribution can be utilised for a combined frequency / severity distribution. This can reduce the amount of computation required substantially.

Reserving Risk

This is an area where work is being carried out by the profession. Reserving risk can be regarded as the "run off" of underwriting risk. Cross correlations between classes of business as well as between years are important.

Insurance Cycle

The insurance cycle has a major impact on the insurance industry. Various efforts have been attempted to incorporate it. The Finnish work in this area has super imposed cycles on its methodology. Time series analysis can be used to satisfactorily model. Some of the more predictable cycles such as motor. It is however an area where much research is required but is nevertheless important.

Gross or Net

Whether the modelling is done gross or net will depend on the circumstances of the organisation and the extent of the reinsurance programme.

Reinsurance Bad Debts

Whether the modelling is done gross or net, it is necessary to factor in reinsurance bad debts. This is a difficult area and where further research is required. Clearly some companies can fail and it is possible to build up models based on past failures. It is also important to realise that the events for which reinsurance may be required are those which are likely to put pressure on reinsurers.

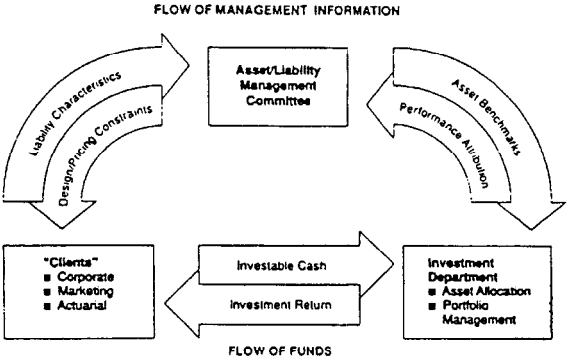
Economic Variables

Much work has been done on investment models and liability models separately. However economic variables affect both sides of the balance sheet and these need to be factored in. Currency mismatching and inflation rates are also issues where some economic research has been carried out but where only a limited amount of effort has been made to incorporate this into the insurance industry modelling process.

Uses of Asset Liability Modelling

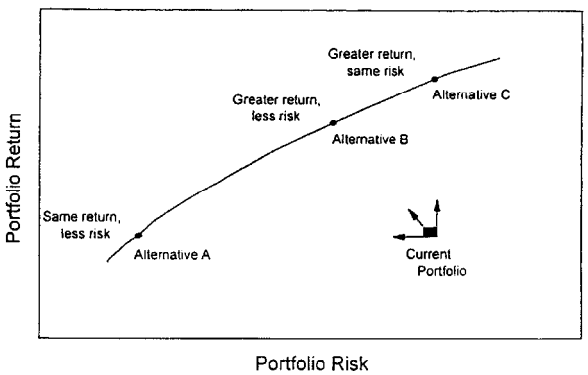
Integrating asset management and liability issues is a clear advantage of such models. Apart from the technical complexities, organisational get in the way. The structure required is included.

Integrating Investment Performance and Company Performance



Efficient frontier concepts apply equally to asset / liability models as they do to asset models. The greater generality allows trade off's between liability risks and asset risks. This is illustrated in the diagram below.

The Efficient Frontier Concept Comes From Modern Portfolio Theory



Solvency Issues

Clearly asset liability modelling is undertaken to evaluate solvency issues. The topic has been discussed in much of the Finnish work and the Daykin & Hay paper. However much of this work is based on the techniques involved and not on what appropriate solvency standards are. They are also normally couched in probability of ruin type approaches. However other issues are important. One is that it is tantamount to fraud for an insurance company to offer a policy that it does not have the capital to meet even though the probability of ruin or loss is acceptable to it.

Model error is also an extremely important point here. It is difficult enough to evaluate what is an acceptable probability of ruin given the model specification. Ignoring the model error renders the original concept unhelpful. Here it is especially important to remember we are actuaries and not just statisticians.

Capital Requirements

For most organisations solvency is probably not the most sensitive criterion. For most financial institutions, its solvency should be paramount. Certainly regulators are going to be concerned about this. However it is likely that the threshold of pain for an organisation becomes too great well before its solvency is threatened. Consequently it will have different capital requirements in order to maintain stability. These may be couched more in terms of short term deviations of results rather than long term probabilities of ruin.

Risk Based Capital

This is a whole new area for the insurance industry and actuaries. Lloyd's and the US authorities are doing much work in this area. The introduction of risk based capital systems will add an extra constraint into asset liability modelling.

Insurance Derivatives

Much work has been going in recent years to develop alternative risk transfer mechanisms. The most common of these are the insurance derivatives introduced by CBOT. Volume is continuing to increase and an encouraging number of contracts are being allowed to expire. However volumes do not as yet satisfy anybody for this to be described as a success though the trends are still in the right direction.

A number of players claim that there is quite a lot of specially negotiated or OTC deals. If so this is likely to encourage more trading on CBOT. Even OTC arrangements are likely to feed off each other. The problem in assessing the volume in this area is that as the potential players are endeavouring to establish market leadership, there may well be some exaggeration in the amount of business that is being claimed to be undertaken. Nevertheless there is clearly growing interest in this area.

CBOT is introducing a crop insurance contract. This is important as it will encourage some further diversification. Crop insurance, of course, fits more neatly into the other activities of CBOT and effectively provides a means of diversification for soft commodity

traders. If this leads to more activity in this area it is likely to encourage interest in other insurance derivatives.

CBOT also has plans to list nine state and regional Catastrophe Insurance Options contracts. The contracts will be based on a new benchmark index of insured catastrophe loss estimates provided by Property Claims Services "PCS", a subsidiary of the American Insurance Service Group.

The underlying instrument for the new PCS insurance options will be the PCS loss indices which will track insured loss estimates on an industry-wide basis from catastrophe events identified by PCS for each state and region listed. The value of each index will be computed daily by PCS.

Small and large cap options will be listed for each index. The small cap options contract tracks aggregate industry loss estimates between $0 and $20 billion. The large cap options contract will track aggregate industry loss estimates between $20 and $50 billion. Hedgers and investors not only have a choice between a small or large cap contract for each index, but also in choosing a six or twelve month developing period after the loss period.

It is worth noting that the concept of insurance futures has more-or-less disappeared and that all the trading action on CBOT is in call option spreads. This is much more akin to a layered excess of loss contract. It is likely that this trend will continue.

There has been some effort to develop a UK insurance index. This is almost certainly a necessary forerunner to the development of any UK contracts. It is also likely that if a UK index is successfully set up it will be the forerunner of several European indices. Some dialogue has been taking place between the ABI and the Index Working Party. While no announcements are imminent it is not inconceivable that we could see a UK index within the next two years.

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