Chapter 22 – Liability Valuation Methods

Additional Space for Notes

Introduction

This chapter discusses some of the practical issues that arise in the calculation of policy liabilities. It also looks at alternative valuation methods that have been used in the past in Australia and overseas.

Mechanics of Valuation

A valuation system must be capable of producing results that are:

- accurate;
- available quickly;
- on alternative bases (for sensitivity testing, analysis of profit, embedded value and capital adequacy calculations); and
- in the format required for general purpose financial statements and APRA reporting forms.

The valuation system should be economical to maintain and run.

These objectives have to be balanced against each other and the particular approach adopted will vary considerably between life companies, depending on such factors as the size and nature of the business in force and legacy systems. Foreign-owned companies may have to satisfy both local and overseas reporting requirements.

The purpose of the valuation being undertaken must be borne in mind (whether for external or internal users of the information). This will have a bearing on the format required for the final results, the degree of precision required and the data required in the valuation records.

Preparation and Assembly of Data

A company's policy administration system contains the policy details necessary to perform a valuation. Some life companies have several administration systems to record data for different types of policies. This is often a result of merger and acquisition activity or the introduction of new products over time. It can be difficult and expensive to move policies from older systems to more modern systems. A data extract from the system will be created at each valuation date to provide the data required for valuation purposes.

The information recorded for valuation purposes in respect of each contract in force at the valuation date will vary according to the type of policy and valuation method. For example, the data for yearly renewable term business will normally include:

- policy number
- sex
- smoking status
- date of entry
- date of birth
- sum insured

- base premium (i.e. before any extra premium)
- extra premiums (if any)
- mode/frequency of premium payment
- benefit indexation
- rider benefits

Claims are typically managed on a separate computer system. Information from this system is required to calculate reserves for outstanding claims and for the analysis of profit.

For traditional business a similar set of data is required with adjustments being made for information specific to these contracts, e.g. bonus information, surrender values and maturity dates.

For investment-linked business the number of units of various types will be recorded. A data file of unit prices at the valuation date is required but unit prices do not need to be included in the policy data as the same set of prices applies to all policies. For investment account business the account balance will be recorded. For both investment-linked and investment account policies the amount of any surrender penalty at the valuation date, or data to calculate or estimate this, will be needed.

Profit margins and cumulative losses (if any) for related product groups need to be brought forward from the previous end of year valuation. These items would be recorded within actuarial systems, not within the policy administration systems.

Consistency checks will normally be carried out. Examples of checks include:

- in force at last valuation plus aggregate "ons and offs" should equal in force at this valuation for number of policies, premiums and sums insured. Increases and decreases to premiums and sums insured must be accounted for;
- reconciliation of valuation data with "snapshots" obtained directly from policy administration systems; and
- comparison of the average of premiums in force at the start and end of the year with actual premium income for the year.

Further checks will be placed on the valuation results through the analysis of profits. This is discussed in Chapter 25.

The Appointed Actuary must discuss the quality and accuracy of the data in his/her Financial Condition Report (refer to Professional Standard 200 of the Actuaries Institute).

Grouping

When a projection method is used to calculate policy liabilities, policies are usually valued individually and the results are then summarised into groups for checking and presentation. However, older valuation systems may group policies prior to performing the projection in order to reduce the processing time required.

In the past, computer run times were much longer than they are now. It was often necessary to group policies with similar characteristics in order to keep run times within reasonable bounds.

Grouping is best avoided, if possible, as it introduces approximations into the calculations. There is also greater potential for errors arising through the grouping process.

If grouped data is used, "model points" must be constructed. A model point is a single "average" policy designed to represent a number of individual policies with similar characteristics. An example of a model point would be all yearly renewable term policies for male non-smokers currently aged 45. The model point would be a single policy with an average sum insured, premium, duration, etc. The liability for the policies represented by the model point would be obtained by multiplying the liability for the model point by the number of policies it represents.

This process leads to inaccuracies in the projections. For example the projection will not contain any policies with short or long durations. If lapse rates vary by policy duration, the allowance for lapses in the projection will be inaccurate. A change to short duration lapse rates will have no impact on the best estimate liability. Similarly, select mortality rates will have no effect if the average duration is beyond the selection period.

The process can be made more accurate by increasing the number of model points. If lapses vary by policy duration, it might be necessary to create separate model points for a range of different durations, rather than having a single model point with the average duration. A balance needs to be struck between greater accuracy (which requires more model points) and a shorter processing time (which requires fewer model points).

For simple products or products with small volumes of business in force it may be reasonable to represent the whole product line by one model point. For other products, the volume or complexity of the business may necessitate the use of a large number of model points. Typically, unbundled investment products require fewer model points than risk products as risk products can have more rating factors, e.g. age, sex, smoking status and occupational class. For investment account or investment-linked business, the design of any early termination charges will have an impact on the number of model points required. Superannuation business generally requires model points to be grouped according to attained age (or alternatively by entry age and duration), because termination rates peak when superannuation fund members reach retirement age.

If grouped model points are used, the process for determining the model points must be validated by comparing the valuation results based on the model point projection with the results based on individual policy projections. The validation can be carried out in between reporting dates when there is less time pressure on the valuation department. Further, the model points opening position (i.e. the total sums insured, annual premiums and policy counts for the model points after applying any scaling factors) must be reconciled to the actual opening position at the reporting date.

If stochastic modelling is to be performed, it is usually necessary to use a small number of model points rather than individual projections for each policy. A stochastic model may require thousands of simulations to be run, especially if it is being used to analyse the tail of the probability distribution for capital management purposes. Stochastic models also need a random number generator and additional assumptions regarding the probability distributions of the random variables.

Consistency between Models

Models are often developed for a range of different purposes. A life company can potentially have different models for the purposes of pricing, valuation of policy liabilities, appraisal values, capital management, monthly reporting and business planning. This is more likely to occur if these activities are carried out in different parts of the company. Simplified models can sometimes be used for monthly reporting and business planning so that results can be obtained very quickly and/or on a range of alternative bases.

If different models are used, regular consistency checks need to be carried out. For example it can cause considerable embarrassment if the pricing model says that a new product will be profitable, but after the product has been launched the valuation system says it is unprofitable.

Differences between the results produced by models can arise due to differences in modelling techniques, the selection of model points and/or the assumptions used. It is important that all assumptions are explicitly described in model documentation. Hard-coding of assumptions within models should be avoided as this can lead to difficulties in identifying what assumptions have been made. For example, stepped premium risk business often has an expiry age of 100, but assumptions for mortality and lapse rates are very unreliable at high ages due to the lack of relevant experience data. A model might avoid the area of uncertainty at high ages by terminating the projection at age 80, rather than continuing all the way through to age 100. If the model is designed in this way, the end point for the projection should be coded as an input to the model, rather than hard-coded within the model. This assumption should also be well-documented, so that all users of the model are aware of it.

Types of Models

The two types of models that are most commonly used for valuation purposes are spreadsheets and proprietary projection models.

Spreadsheets are readily accessible and can be used on any personal computer. They have the advantages of being very flexible, easy to write and easy to modify. The disadvantages are:

- difficulty in auditing and detecting errors – the formulae usually rely on cell references. Dependent cells can be in different parts of the spreadsheet. This makes the formulae difficult to understand and check. Studies have shown that most spreadsheets used for business purposes contain undetected errors. The risk of undetected errors increases with the size and complexity of the spreadsheet;
- slow processing times – this can be a problem if individual policy projections or stochastic modelling are necessary;
- poor documentation – textboxes and comments can be used to document spreadsheets, but these are normally not well structured and may be difficult to maintain;
- poor version control – it may not be clear what revisions have been made since the last version and unintended changes may be introduced. This problem can be overcome to some extent using protection and passwords;
- poor programming practices – untrained users can often be allowed to modify spreadsheets using adhoc programming methods;

- inputs and outputs may not be clearly indicated – assumptions can be hard-coded within formulae and can therefore be difficult to find and change; and
- difficulty of making modifications – the three dimensional spacial layout of a spreadsheet makes revisions more difficult as blocks of code have to be moved around.

The use of linked suites of spreadsheets exacerbates these problems. Despite these drawbacks, spreadsheets can be very useful for valuing simple products where detailed individual policy projections are not required. They are also useful for providing quick answers (e.g. what-if scenarios), for doing audit checks on other models, for summarising results and for presenting results in the form of tables and graphs.

Proprietary projection models are designed specifically for actuarial valuations and overcome the problems of spreadsheets by imposing a much more structured design on the model. Assumption files, data input files and output files are clearly separated. Formulae refer to variable names, rather than cell addresses. A description of each formula and variable is included within the model. Version control is much stronger, allowing changes since the previous version to be readily identified. Unauthorised model changes can more easily be avoided. Proprietary models also have much faster processing speeds than spreadsheets. The main drawbacks of these models are the extra costs of purchasing and maintaining the software and the need to train staff in the use of the model.

Asset Share Models

Asset share models are sometimes used in the management of participating business. An asset share model calculates liabilities on a retrospective (rather than prospective) basis by accumulating past cash flows up until the reporting date for the policies that are currently in force.

The methodology used for calculating the Value of Supporting Assets under APRA Prudential Standard LPS 340 is an example of a retrospective method, although the calculation is performed on a group basis rather than for individual policies. The calculation is rolled-forward every year so that at any particular reporting date it only has to look back over the previous 12 months' experience.

Asset share calculations for individual policies can be useful as a guide for determining bonus rates. Bonus rates can vary between policies with different starting dates in order to reflect differences in historical experience. They can also vary between policies with different scales of premium rates. Asset shares are also useful in assessing whether the current surrender value basis remains appropriate.

Asset shares allow for the actual amounts of premiums, expenses (expressed as unit costs), rates of investment return and tax rates. There will also be an allowance for the cost of death claims (and other rider benefits) and shareholder profits. Sometimes a "cost of capital" will be deducted instead of shareholder profits. There may be an allowance for profits or losses on terminated policies, depending on whether the company's bonus philosophy is to distribute these profits to continuing participating policies.

The asset share for a policy is, in effect, equal to the value of an investment-linked policy with the same premiums, rider benefits and backing assets, but with expenses and shareholder profits being deducted from the policy value instead of fees.

An asset share model needs historical data going back as far as the commencement date of the oldest policies still in force. Obtaining this data can be a challenging exercise if asset shares have not previously been calculated.

The liability calculated using an asset share approach can be compared with the best estimate liability and value of future bonuses calculated using a projection approach. Supportable future bonus rates can then be found by equating the projected liabilities to the asset shares.

Historic Valuation Methods

Under the Life Insurance Act of 1945 (which was superceded in 1995), liabilities were published on a solvency basis, which used conservative assumptions to ensure that there was a sufficient buffer to absorb adverse changes in experience or circumstances. The main purpose of a valuation of policy liabilities was to assess the solvency of the life company. The policy liabilities were not on a realistic basis and did not provide useful information about the profitability of life companies. An allocation of surplus assets between participating policy owners and shareholders was not required. This meant that the ownership of the surplus assets (also known as the "estate") was often unclear.

In order to address these problems, the Life Insurance Act 1995 established distinct and separate methods for valuing policies for the purpose of determining profit and for establishing whether a statutory fund had sufficient capital to ensure solvency. The ownership of surplus assets was also made clear by establishing separate pools for shareholders' capital, shareholders' retained profits and policy owners' retained profits within each statutory fund.

Net Premium Method

The most common historical method for valuing policy liabilities for traditional business was the net premium method. This method is still used in some overseas countries.

The net premium method was developed long before computers were invented and is much more simple and crude than modern valuation methods. Policy liabilities calculated using this method err on the side of conservatism (i.e. they tend to have a bias towards being too high) since the alternative would be to risk having the policy liabilities being inadequate. A conservative bias is appropriate if the policy liabilities are used as a measure of solvency. However it also means that the net premium method is not all that useful as a means of calculating policy liabilities for the purpose of profit reporting.

The net premium method uses commutation functions combined with conservative assumptions. Commutation functions avoid the need for a projection of future cash flows. A low future interest rate is assumed and there is no explicit allowance for future bonuses, maintenance expenses, surrenders or shareholders' profits.

An artificial net premium is calculated using the valuation assumptions for interest and mortality and an approximate allowance for acquisition expenses. The net premium is used to calculate the policy liability instead of the actual premium so that the policy liability at commencement of a new policy (before any cash flows occur) is zero. Note that the Margin on Services method achieves the same outcome by including a reserve for future best estimate shareholder profits and bonuses in the policy liability. Under the net premium method there is no explicit reserve for these items.

The net premium method can be used for immediate term and lifetime annuities and for level premium risk business. It cannot be applied to stepped premium risk business because the net premium method assumes that premiums are level.

Strict Net Premium Method

There are several variants of the net premium valuation method - the simplest being the strict net premium method. Using this method, the liability under a whole of life policy is:

$$(SI + RB)\, A_{x+t} - PNP \times \ddot{a}_{x+t}$$

where

SI is sum insured

RB is attached reversionary bonuses

A_{x+t} is a reversion, at the valuation rate of interest, for age x+t where x is entry age and t is duration in force

PNP is the pure net premium which is calculated as SI * $A_x/\ddot{a}_x$

$\ddot{a}_{x+t}$ is an annuity at the valuation rate of interest for age x+t

Modified Net Premium Method

Although simple to use, the strict net premium valuation method can be criticised on the grounds that it is entirely artificial, as it makes no explicit allowance for expenses or for future bonuses.

Various modifications can be made to the strict net premium valuation method. The main modifications are discussed below.

Sprague adjustment

A Sprague adjustment allows the net premium to be calculated at a higher entry age and for a shorter term than the actual age/term status at issue. The intention is to offset the first premiums against the acquisition expenses for the policy. For example if the acquisition expenses equal the first year premium, the Sprague adjustment could be set at one year. The valuation liability with a d-year Sprague adjustment is:

$$(SI + RB)\, A_{x+t} - SNP \times \ddot{a}_{x+t}$$

where the Sprague net premium, SNP, is calculated as:

$$SNP = \frac{A_{x+d}}{\ddot{a}_{x+d}} \times SI$$

The Sprague adjustment to the strict net premium method, while more realistic in relation to actual circumstances than the strict net premium method, can still be criticised. The main problem is that although acquisition expenses are now allowed for as a percentage of sum insured, the Sprague adjustment is only a rough approximation to the actual acquisition expenses. Initial commission can vary significantly between whole of life policies and endowments of different terms. Other acquisition costs can also vary from policy to policy as a proportion of premium.

Sprague's method can lead to negative liabilities, which may not be appropriate for solvency valuations. These negative values can be difficult to eliminate when grouped data are used.

Zillmer adjustment

The Zillmer Adjustment adds to the pure net premium an amount which has a fixed capitalised value per unit sum insured regardless of the age/term status at the inception of a policy. The formula is:

$$(SI + RB)\, A_{x+t} - \left(PNP + \frac{I}{\ddot{a}_x} \right) \ddot{a}_{x+t}$$

where I is the Zillmer adjustment and PNP is the pure net premium

This again moves in the direction of realism but like the Sprague adjustment it will produce negative liabilities, which can persist for several years at young ages. In fact the valuation liability at the outset of the contract is -I per unit of sum insured.

Other adjustments

Another modification that has been used is to specify that the premium to be valued by net premium methods shall not exceed K% of the office premium that is actually being paid. This modification is aimed at making at least a minimum allowance for renewal expenses.

Example

The example in the spreadsheet is the same as Example 1 from Chapter 21 but includes a projection of net premium liabilities on three different bases: strict, Sprague and Zillmer. The Sprague adjustment is 6 months and the Zillmer adjustment is the actual acquisition costs. In practice the Sprague and Zillmer adjustments would not provide such a close match to actual acquisition expenses as they have to be averaged across a range of policies issued at different times.

Bonus Reserve Valuation Method

The bonus reserve valuation method is also sometimes called the gross premium valuation method. It too uses commutation factors. However, unlike the net premium method it makes explicit allowance for the actual premium and future expenses and bonuses.

When a compound reversionary bonus is being declared and the only expenses are premium-related expenses and per policy expenses, the valuation formula is:

$$(SI + RB)\; A^{i-b}_{x+t} \; - (1 - E)P \; \ddot{a}^{i}_{x+t} \; + R\ddot{a}^{i-r}_{x+t}$$

where:

A^{i-b}_{x+t} is the reversion at the valuation date, at a rate of interest i-b, where i is the valuation rate of interest and b is the reserved rate of bonus

SI is the sum insured

RB is the attached reversionary bonuses

P is the actual annual premium being received

E is the proportion of premium reserved for future expenses

$\ddot{a}^{i}_{x+t}$ is an annuity at rate i

R is the per policy expense

$\ddot{a}^{i-r}_{x+t}$ is an annuity at rate i-r, where r is the assumed rate of inflation of per policy renewal expenses

Other Valuation Methods

A number of different profit reporting methods have been used at various times in different countries around the world. The differences between methods generally revolve around the following key issues:

- timing of profit recognition;
- degree of conservatism;
- deferral of acquisition costs;
- treatment of assumption changes; and
- treatment of participating business

As noted in Chapter 21, under Margin on Services future profits are not recognised at point of sale but future losses must be provided for. This means that, while sales of new business are one of the main activities of a life company, providing the business is expected to be profitable, new business commencing during the reporting period has little impact on the reported profit.

A Margin on Services policy liability comprises a best estimate liability together with reserves for future bonuses and profits. Other reporting methods sometimes use a more conservative estimate of the liabilities. For example, Australian general insurers are required to hold a liability that is higher than the best estimate. An additional risk margin allows for the possibility that claims will be higher than expected and results in a deferral of profit emergence. Another type of margin that can be required to be included in the liabilities is a margin for the cost to shareholders of providing capital support to the liabilities. The aim of this type of margin is to increase the liabilities to their fair value. The fair value is the amount of compensation another insurer would require if it was to take over the liabilities. The fair value must exceed the best estimate of the liabilities as the acquiring insurer will want some reward for providing capital and taking on the risk that future experience will be worse than expected.

In Chapter 21 it was noted that different rules currently apply in Australia to the deferral of acquisition costs for life insurance contracts and life investment contracts. The amount of acquisition costs that can be deferred varies under different reporting methods. If some of the acquisition costs are recognised immediately a loss might have to be reported for new business, even though the business is expected to produce profits in future reporting periods.

Under Margin on Services, all valuation assumptions are regularly reviewed, but changes in assumptions do not result in changes to the policy liabilities unless future losses are expected. Some reporting methods used in other countries (e.g. US GAAP) lock in some or all of the assumptions at point of sale. This results in larger and more

persistent experience profits than would typically be observed under Margin on Services. It also makes the valuation process much more complicated as policies must be grouped by year of commencement, with different assumptions being used to value each group.

The Life Insurance Act 1995 distinguishes between the allocation and the distribution of profits to participating policy owners. Retained profits are identified as belonging to either shareholders or participating policy owners. These features did not exist under the previous Act and do not exist in many overseas countries. One method of determining shareholder profits for participating business in overseas countries is as a fixed proportion (e.g. 10%) of the cost of declared bonuses. An undesirable outcome of this approach is that it gives management an incentive to inflate profits by declaring higher bonuses than can actually be supported. In theory, a company could report higher and higher profits whilst heading towards insolvency. Under the Australian system, shareholder profits are a fixed proportion of the cost of the best estimate bonus. The best estimate bonus must be supportable by the Value of Supporting Assets. If the declared bonus exceeds the supportable bonus, policy owners' retained profits will reduce. Under the accounting standards, policy owners' retained profits cannot become negative. If they fall to zero any further distributions to policy owners must come out of shareholders' retained profits. Under APRA standards, policy owners' retained profits can become negative, but a write-off may become necessary if they are not expected to eventually return to zero.

Appraisal values are an example of an alternative reporting method that is often used to provide supplementary information in the financial statements for publicly-listed life companies (or their parents). Appraisal value methods can also be used for internal management reporting. These methods are widely used in both Australia and overseas. This topic is covered in detail in Chapter 27.

Future Changes to Valuation Methods

The method used to value life investment contracts in Australia changed in 2005 as a result of Australia's adoption of International Accounting Standards. Prior to 2005, life investment contracts had been valued using the Margin on Services method.

Methods for valuing life insurance contracts currently vary around the world as there is no international standard for valuing these types of contracts. The Margin on Services method is not an international standard. It will be replaced by a method that conforms to International Accounting Standards once agreement on an international standard is reached. At the time of writing, a method for valuing life insurance contracts has been under development and discussion by the International Accounting Standards Board for a number of years.