Choosing assumptions – deterministic and stochastic modeling

Peter Luk – July 2003

1. Introduction

1.1 What is happening?

Actuaries produce a great deal of numbers everyday. The quality of such numbers, on which the
totality of the profession depends so much, is a function of such factors as data
accuracy, methodology used, assumptions employed, clarity of presentation, etc. Most papers
in actuarial publications deal with methodologies even though choosing the right assumptions
is probably the single most important factor that affects the quality of the actuarial output.
One might surmise that it can be assumed that all actuaries have learnt to choose the right
assumptions on passing their examinations – an assumption probably not all will agree. In the
U.S., the Model Regulation XXX, now passed in most states, requires actuaries to justify the
mortality assumptions used.

The British actuarial profession did a survey on accounting worries and the results were
published in "The Actuary", July 2003. It showed that the No. 1 concern was "inadequate
provision for options and guarantees" and the No. 2 concern was inadequate disclosure of
assumptions. If one factors in the fact that inadequate provision for options and guarantees is
largely due to the lack of explicit assumptions for such provisions, one might say the No. 1
concern of British actuarial profession is inadequate disclosure of assumptions.

In the wake of Enron/Arthur Anderson debacle, professional accountability has become a
major issue. There is no doubt that one of the leading challenges for the actuarial profession
worldwide over the next decade will be disclosure and justifications of the assumptions.

1.2 Desirability or Necessity?

The use of inappropriate assumptions and its impact have been bothering the profession for a
long time. All of us have witnessed, or even personally experienced, reserves turning out
inadequate, products turning out underpriced, pension under-funded, etc.

We have also seen companies' share prices greatly different from the actuarial calculated
appraisal values. In theory, these two should be reasonably aligned. When they are far apart
for an extended period of time, two things may have happened: either the actuary is wrong or
the market is wrong (ignoring the third possibility that both are wrong). It is a relatively easy
task to rectify the situation if the actuary is wrong: just change the assumptions and/or
methodologies. It is a far more daunting task when the market is wrong. The implication is
that the investing community has no faith in the actuarial profession.

Successfully demonstrating to the world that actuaries know how to choose the right
assumptions will be an important step towards enhancing the reputation of the profession. In
actual fact, it is no longer merely desirable. It has become a necessity if the actuarial
profession is to survive the coming challenges.
1.3 Difficulties

'Making' assumptions is actuaries' euphemistic way of saying 'predicting'. Since actuaries do not have the crystal ball, it is not surprising that many assumptions turn out to be wrong.

The high-profile debate regarding the new accounting standards initiated by IASB (International Accounting Standards Board) adds a new dimension to the difficulties faced by actuaries in choosing their assumptions.

For instance, as IASB requires the use of stochastic modeling for calculating reserves, actuaries will be faced with the choice of a proper interest rate model: whether it should be a one-factor, two-factor model; whether it should use mean reversion or not, etc. On top of that, one has to decide what risk free rate to use and what risk premiums to use for anything except Treasury bonds.

The good thing (?) is that nobody will be able to tell for a long time if one has used wrong models or assumptions. The downside is that it will not enhance the reputation of the actuarial profession (as the investing public will understand far less than actuaries about stochastic modeling), at least in the shorter term. The certainty is that there will be a lot of volatility in the reported financial results in the near future.

1.4 Validity Check

Traditionally, actuaries justify their assumptions not by proving them right, but by showing them to be "not wrong". Since nobody has got the crystal ball, it becomes impossible to prove any assumption "wrong". One can only use such adjectives as conservative, liberal, aggressive, etc.

To find a better and generally accepted way to justify any assumption prospectively that satisfies all the stakeholders including regulators, investors, policyholders, etc. is a challenge the profession faces. It is a task that will probably take many decades to accomplish.

Meanwhile, the best way to justify any assumption is transparency. The profession should encourage actuaries (or even make it mandatory) to disclose their assumptions extensively. Proper disclosure should include not just what an actuary uses as input, it should also include the actual/expected over an extended period of time. A 5-year history, for instance, of wrong actual/expected should alert the actuary concerned that he or she may be overly conservative or aggressive.

In the history of actuarial profession, disclosure of assumptions is either non-existent or general and vague at best. This is going to change. There will be an increasing demand for disclosure and transparency, in pricing (such as in dividend illustration), appraisal value, reserving, etc.
2. Individual Components Of Actuarial Assumptions

2.1  Mortality and Morbidity

Mortality assumptions should be company-specific, as different companies do have different mortality experience. By the same token, different mortality assumptions should be used by the same company for different geographical areas.

It is generally considered reasonable to assume that, as medical science advances, overall mortality will be trending down over time, even though we cannot prove it. This has been true over the last couple of centuries and we simply extrapolate this into the future. Long-term guarantee of mortality rates has been standard practice and is generally considered safe.

Extensive mortality tables are available for actuaries to choose. As required by Model Regulation XXX, actuaries are to justify the use of any table. Several methods to do so are described in the references.

However, the same cannot be said for morbidity. Depending on the definition of morbidity in a particular context, it can actually increase over the time as people who would otherwise have died simply now become sick. Assumptions that are appropriate for a short-term product are not necessarily appropriate for a long-term product. Scenario testing is usually useful to gauge the financial impact of possible adverse changes.

2.2  Investment

Contrary to mortality assumptions, interest assumptions should NOT be company-specific (i.e., they should be market-based), particularly for intermediate to long-term products, even though such use has been widespread. Different actuaries may have different views about the future investment environment, but it is difficult to argue the case for the same actuary to use different assumptions for different companies, products, etc.

To start with, investment performance depends on the people who handle it. Barring very few exceptions such as Warren Buffet, there is little evidence that one particular investment team consistently outperforms the others. Even if there are such teams, there is no guarantee that such team or team members will stay with the same company forever.

Then there is this argument about asset allocation strategy. It might be true that a portfolio consisting of a mixture of risk-free bonds, risky bonds and equities will generally speaking outperform a portfolio consisting of Treasury bonds alone. But if there is such an optimum asset allocation strategy, then all companies can use the same strategy, which means no company will have an edge over the others. It is therefore unreasonable to accept the use of higher interest assumption for a company based on its current asset mix or its past performance.

It is believed that if companies are willing to disclose the asset allocation strategy in their interest assumptions, the discrepancy between companies will gradually narrow down. In other words, a situation could reach where there will be a central interest assumption with a fairly small variance.
For the choice of long-term risk-free rates, it is usual to use the government bond rate for the same duration as the duration of the product.

Where stochastic modeling of term structure is concerned, there are more than half a dozen models to choose from. Generally speaking, no-arbitrage models, which use the current term structure as input, are preferable to equilibrium models, which attempt to produce results as close as possible to the current term structure. Mean reversion is an intuitively appealing feature and a lognormal model may be more preferable in today's environment in order to avoid the appearance of negative short rates. Generally speaking, the more complex the model, the more computation time there will be and there is no consensus among the professionals which model is the best.

One is not even sure if any of these models will work in a highly regulated economy.

For determination of default rates of corporate bonds, the statistics published by rating agencies are often used. For example, one study shows that for an AA bond, the default fate is 4 basis point, for a BBB bond it becomes 50 basis point and for a CCC bond it increases to 2,800 basis point. These statistics are however compiled using North America experience and it is not clear whether they would be suitable for Asia or even European companies. It would be a worthwhile project to compile a default transition matrix using Asian experience.

The determination of risk premium (for calculating discount or hurdle rates) has long been a hot debate and many papers and books have been written about it. Capital Asset Pricing Model (CAPM) using data available from the market has been one of the oft-used methods for this purpose, even though empirical evidence does not necessarily support its use. Most empirical studies show that such premiums fall within the range of 3% to 6% depending on the period that was used in the study.

It is interesting to note that under the current low interest environment some actuaries are still using discount rates from 12% upwards in Asia. It is possible that a premium for country risk or currency risk has been incorporated in such cases. This is not a desirable approach. It is preferable to first use market-based discount rates (derived by using CAPM or some variations of it). One then calculates the company-specific hurdle rate by incorporating the company's preference regarding country risk, currency risk, etc. The resulting difference would give the actuary concerned a much better insight as to where he or she stands.

2.3 Persistency

In other industries, this is called customer loyalty.

Fortunately for the insurance industry, this is easily measurable. Unfortunately, it is extremely difficult to predict.

The oft-quoted LIMRA 13-month or 25-month formulas are certainly not appropriate for actuarial use.

Given the optimistic nature of human beings, it is not difficult to understand that people tend to overestimate the customer loyalty. For a reality check, it is suggested that actuaries perform periodical validation by calculating two actual/expected ratios using the present
values of income cash flow and outgo cash flow separately (offset permitting if it is incorporated in enforceable contracts).

Needless to say, the calculation of persistency should be company-specific.

2.4 Expense

Expense is another crucial element in the actuarial assumptions. Obviously any expense assumption should be company-specific.

With a wide variety of variable, semi-variable and fixed expenses, it is even more important to validate the expense assumptions by calculating actual/expected ratios periodically. One should be wary of excluding any one-off or extra-ordinary expenses, as most companies will have this kind of expenses from time to time such that their total exclusion will lead to understatement of long-term expenses.

While mortality (and to some extent persistency) may be difficult to manage once the business is written, expense is probably one of the easiest to manage among all the actuarial assumptions. In other words, if not properly managed, the future expenses can be way off those assumed. In this regard, the management's track record in managing expenses should be able to give a vital clue as to whether the assumed expenses are reasonable.

2.5 Regulations and tax regime

We are living in a rather imperfect world: On the one hand, actuaries are making assumptions about the long-term future. On the other hand, regulations are changing in a short term way. There is no better way to tackle this phenomenon other than to treat this as a country risk. In that sense, the country risk can be negative as tax and other regulations may become less onerous. Again, disclosure will serve a very useful purpose here.

2.6 Management

As most of the actuarial assumptions are about potential future experience, they are only as good as the management is willing to take measures to ensure their realization. In this regard, the management's track record is all-important.

There is no actuarial literature that includes the quality of the management as a component of actuarial assumptions, partly because it cannot be quantified and partly because the actuary concerned, whether a company actuary or a consulting actuary, is going to say that the company's management is less than perfect.

However, the investing public and the rating agencies will make their own adjustments incorporating their views regarding the quality of the management.
3. Special Cases For Actuarial Calculations

3.1 Reserving

For the old-fashioned statutory reserves, most of the actuarial assumptions are stipulated by regulations, which are solvency-oriented and intended to be conservative, and actuaries do not play a big role in their determination except at the very initial stage when the regulations are in its consultation stage.

In the more developed economy, there is a trend for the statutory and GAAP reserves to converge. Certainly, under the new IASB proposal there will be only one reserve that is based on realistic assumptions. Conservative margins may not be incorporated. However, some so-called market value margin has to be incorporated (God knows what it means in practical terms as far as liabilities are concerned).

In the introductory stage of the new IASB rules, there are bound to be people or companies that will use aggressive assumptions in order to boost their earnings or surplus. It won't surprises many people if auditors or other users of the financial statements are skeptical of such results.

It would be therefore very helpful for companies to start preparing validity checks as described above and build up a history of justifiable assumptions, thereby enhancing the creditworthiness of individual actuaries as well as that of the whole profession.

Some stochastic modeling methods have been published. Included in the reference are one for guaranteed unit-linked life insurance policies and one for claim reserves in general insurance. There is not yet any paper regarding traditional participating policies for several reasons: (a) the dividends/bonuses often depend on the surplus of a whole block of business; (b) they also depend on the management/board discretion taking into account the prospect of the future of the company and (c) the case of Equitable Society of UK shows how seriously wrong actuaries can be.

3.2 Pricing

This is an area where special care should be exercised. Some actuaries, particularly those relatively inexperienced ones, would easily convince themselves of the use of aggressive assumptions in order to meet the competition. Their inappropriateness would not be found until many years later, when the actuary concerned may have been promoted or moved elsewhere. Unrealistic illustrations in the selling process can sometimes be attributed to this mentality.

It is common practice in the selling of unit-linked business to use long-term return for all years of illustration. Very few companies, if any at all, illustrate a loss in the short term. This me-too mentality, while in its strictly technical sense is not actuarial in nature, does not endear us to the general public, nor does it enhance our image in the eyes of senior management or agency force.
Apart from full disclosure, which is very useful under this kind of circumstance, a system of historical comparisons of actual/expected should be implemented to detect the tendency, whether of a particular actuary or of the company management, to this kind of practice.

Another common me-too practice is to ignore the cost of options and guarantees, which is mentioned earlier in the British survey as the No. 1 concern of the profession. It is certainly not uncommon in Asia as well.

One thing that professional bodies like ASHK can do is to issue guidelines requiring members to explicitly consider their cost. It does not matter if the actuary concerned considers the cost of a particular option to be nil. The important thing is to face the issue rather than to ignore it.

3.3 AV/EV

AV/EV (i.e., appraisal value/embedded value) calculations are always a contentious issue, depending on whether one acts for the buyer, the seller or merely a neutral (and therefore independent) bystander. The major issue involved for the EV calculation is almost always the discount rate to be used. The AV calculation involves an additional dimension of uncertainty regarding future growth.

The determination of discount rate in the EV calculation is a relatively easy task if one acts for the buyer or the seller, in which case the buyer or seller determines the hurdle rate they prefer. For an 'independent' calculation, the discount rate should be determined with reference to the market data. A pitfall that often goes unnoticed is that the discount rates tend to remain unchanged from year to year, whereas a true reflection of the market would see the rates change from month to month. Another common mistake is the tendency to do the calculations from an international perspective, thereby implying the existence of an international buyer who wants to incorporate the country risk and currency risk in the calculations.

For IPO, an independent calculation is usually required. Country risk and currency risk specific to international buyers should not be incorporated. These are the job of the investment banker/sponsor, not that of the actuaries. On the other hand, regulatory risks (tightening or loosening or the regulations, higher or lower future taxes, etc.) should better be incorporated.

For calculation of the value of new business, it is the usual practice to calculate the value of one year's new business and apply a multiple to it. The multiple, just like the conventional P/E ratio, is calculated by assuming certain business growth (usually for say, ten years) and apply a discount rate (which is invariably higher than that for EV calculation to reflect the inherent uncertainty of such growth assumption) to it. This multiple is highly subjective in nature. Despite its theoretical plausibility, the investment community does not like it because of its subjectivity. The EVs are used far more frequently by the security analysts.

To lend credibility to the AV calculation, it is highly desirable to perform a consistent check. In this, one performs several long-term cash flow projections (more often, the projection is based on statutory earnings). The basic scenario uses the central assumptions developed by the actuary. Other scenarios, with both positive and negative variance, should be produced.
and a weighted average should come out reasonably close to the AV calculated by the method mentioned previously.

4. A Final Word

If the actuarial profession is to shrug off its reputation as a bean counter, it must be more proactive and assertive in incorporating the qualitative components in their work. Our accounting colleagues, whether in their roles as internal auditors, external auditors or management consultants, are certainly more assertive than us in this respect.

References:

2. The Aggregate Claims Distribution and Stop-Loss Reinsurance – TSA XXXII, 1982 by Harry Panjer
4. Options, Futures, and Other Derivatives – 2003, by John Hull