Materiality

An actuary generally will not have the time to quantify all the assumptions in a model. An important aspect of modeling is to distinguish between the material (important) assumptions that need to be accurately quantified, and the assumptions that are immaterial and can be quickly estimated. The knowledge of which assumptions are material can often be obtained through sensitivity testing. In short, sensitivity testing involves changing an assumption and measuring the effect of the change on the model’s result. If a small change in the assumption causes a large change in the result, then the assumption is likely material.

Incorrect Assumptions and GMDBs

An example of incorrect assumptions leading to problems occurred in the late 1990s when variable annuities (VA) were being developed. At that time, the stock market was in a long bull run. The VA took the mutual fund concept a step further by offering guarantees, such as a guaranteed minimum death benefit (GMDB).

Regardless of how the VA funds performed, the policyholder was certain of having a death benefit greater than some formula. For example, a GMDB might guarantee the death benefit to be at least the premiums paid in, accumulated at five percent interest. When these guarantees were initially priced, very little was charged for them, because it was assumed that the stock market (and thus the VA value) would continue rising.

With the collapse of the bull market in 2001, insurance companies finally learned that this product feature does in fact have a cost. Many companies lost significant amounts of money because the initial equity return assumption was inappropriate.

Actuaries had tended to price and model products using one deterministic scenario. What this means is that actuaries use a single value for each assumption, and the model provides a single result. When GMDBs were priced using a single assumed equity return (say seven percent which was lower than historic averages at the time), in a product that returned premiums accumulated at five percent interest, the result was that the GMDB appeared to cost the insurance companies little or nothing.

This type of policy has an embedded put option—in this case the right to “sell” the equity returns at a price determined by the five percent guarantee. This option has a real cost that can and should be evaluated. If the baseline scenario shows no cost, additional modeling must be done to elicit the true cost.

By including a wide range of values when testing key assumptions, the variability of the results is shown by the model. Such sensitivity testing can be either deterministic or stochastic.

In deterministic scenarios, specific values are stipulated for the assumptions. For example, testing the cost of a GMDB may involve a scenario where a ten percent equity return is assumed for the first five years, and then a drop of 50 percent in equity value is assumed in the fifth year. This type of testing was used by regulators to determine reserve requirements for GMDBs.
Dynamic Scenarios

Stochastic testing is a form of scenario testing in which some key assumptions are randomly generated. Stochastic scenarios are used in determining the amount of capital companies must hold for GMDBs. The testing involves developing random values for the assumed equity returns in each year of a projection. By running many stochastic scenarios, the actuary can determine a distribution of results from the model. This shows the risk involved much better than a single deterministic scenario.

Economic assumptions are becoming increasingly important as more complex and asset-intensive products are developed. Predicting the path of the economy is quite difficult, so actuaries tend to focus instead on developing internally consistent economic scenarios to test using stochastic analysis. This process avoids trying to predict economic variables by choosing hundreds or thousands of scenarios to test, and using the results to show the risk/return profile for the product or company.

If stochastic scenarios are used, it is important that all values for the variables could happen, and that within a given scenario, they are not mutually contradictory. For example, if the assumed long-term inflation rate is ten percent, having an assumed long duration bond yield of five percent is not internally consistent because investors in the bond would not accept a five percent return when the value of their money depreciates ten percent annually. Another example is the connection between inflation and foreign exchange rates. The theory of Relative Purchasing Power Parity states that foreign exchange rates will adjust to offset inflation so that the people in different countries maintain relatively constant levels of purchasing power. Any scenario that includes foreign exchange rates should be internally consistent with relative inflation and also interest rates (as inflation affects interest rates).