

Economic scenario generators

John Hibbert discusses Barrie & Hibbert's economic scenario generators for economic capital and long-term financial risk management

A revolution is under way. The past five years have seen a transformation in the framework used by stakeholders in life insurance firms to understand economic value and capital. Over the past 20 years, the inadequacies of traditional valuation and risk management practices have been exposed by an environment of lower inflation, declining nominal rates of return and increasing longevity. As a consequence, regulators, accountants, rating agencies and forward-thinking insurance firm managers have moved to change practice.

The new methods generate real insights into the forces that drive change in the balance sheet of long-term financial institutions, but create considerable implementation challenges. It should be no surprise, given the complexity of the questions faced, that judgement continues to play a central role in valuation and risk management practice.

Stochastic asset-liability models

The internal stochastic asset-liability model (ALM) is the primary implementation tool for estimating market-consistent (economic) values and risk capital. These tools use two fundamental building blocks: firstly, a description of an entity's liabilities and a set of rules, which describe how final cash flows are generated in an uncertain world; secondly, an economic scenario generator (ESG), which allows the modeller to estimate future cash flows in a large number of possible future states of the world. Much of this uncertainty is caused by the future behaviour of capital markets, but the models may also aim to capture risk in longevity and general insurance risks.

The models are used to perform four key tasks:

- Valuation – the calculation of market-consistent liability values can inform the pricing (and design) of new product lines, ensuring that business is written at, or above, economic (market) 'manufacturing cost'. Further, it can provide a 'base line' measure of economic capital requirements for in-force business by answering the question: does the entity have enough capital to transfer its market risk to a third party immediately?
- Capital assessment – the measurement of the potential future mismatch between assets and liabilities and the quantity of capital required to meet liabilities with a high level of confidence.
- Strategy evaluation – the model can be used to evaluate strategies to change the risk profile and capital demands of the business. This might involve changing product design, modifying asset strategy or implementing a hedging strategy.
- Communication – the models hold out the promise of a coherent economic approach, which creates consistency and transparency and aids communication between business managers and all other stakeholders.

It should be no surprise that implementation turns out to be very difficult. Building internal stochastic ALMs presents some big challenges for actuaries, economists, financial modellers and financial mathematicians. We will touch briefly on a couple of issues (out of many). The stakes are high – the benefits to firms that are able to master these new technologies are significant since performance of the four tasks listed above are fundamental to the successful operation of an insurance or pensions entity.

ESGs

The task of building mathematically consistent ESGs suitable for both mark-to-market valuation and more traditional 'real-world' projection requires strong quantitative economic skills. You might expect that market-consistent work would be free of analytical judgement, which

must play a part in setting real-world assumptions. You would be wrong. Let us explain why and illustrate this with a basic – but fundamental – example.

Valuation

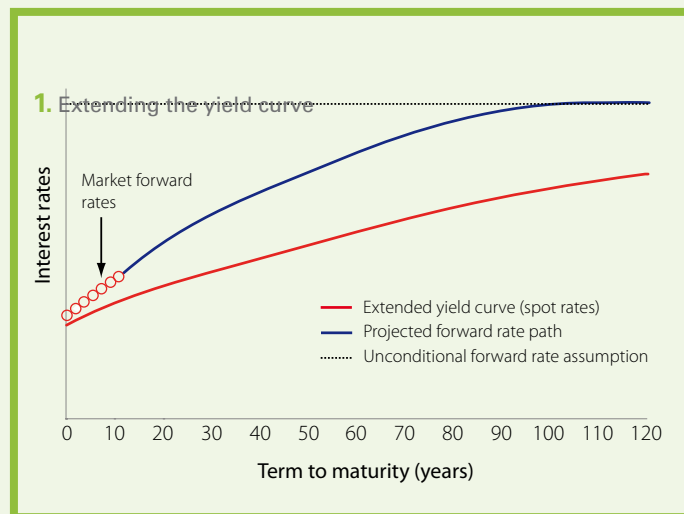
Our aim is to value liabilities in a way that is consistent with ‘similar’ market-traded instruments. Of course, if a liquid market existed in instruments with features exactly matching insurance liabilities, our task would be simple. Just like the asset side of the balance sheet we would simply use those prices to mark liabilities to market. However, liabilities are typically very long-term, path-dependent and determined by multiple risk drivers. Dealing with this complexity requires the flexibility of a stochastic ‘Monte Carlo’ model, which is designed to value cash flows generated along many possible paths for asset prices.

A first step in market-consistent valuation is the collection of market prices. This is simple in theory, however, in practice it turns out that there are many missing relevant market prices. For example, we cannot observe a liquid market in the volatility of real estate and index-linked bonds. Long-term correlations do not trade in any meaningful way. More fundamentally, yield curves and the maturities of traded options will fall short of the term of insurance and pensions liabilities. So, a basic task of the modeller is filling in some of the pricing gaps. Let us look briefly at one example.

Extending the yield curve

One basic example of the need to generate prices where no actual market exists is for the yield curve itself. If the longest traded bond has a maturity of 10 years, how do we set a price for a risk-free cash flow at 50 years? In this case our aim is to create ‘pseudo’ interest rates at long terms, which are consistent with observable short rates and rational assumptions about key drivers of long-term rates. But what actually determines long-term interest-rates? Financial economists argue that there are two underlying drivers: firstly, investors’ expectations of the future path of short-term interest-rates; secondly, uncertainty about the future path of rates. Uncertainty will affect the yield curve in two ways: via any required risk premium which causes some bond maturities to offer different expected returns and also through a technical ‘convexity adjustment’ which will cause forward rates to fall below expected short rates given the non-linear relationship between bond prices and yields. Extension of the yield curve requires a set of assumptions for expected short rates (typically based on assumptions for long-term inflation and real short rates) and assumptions for risk premium and convexity based on very long-term market behaviour.

Figure 1 gives a sense of how this extrapolation exercise might work when market yields extend to 10 years, but we need to extrapolate to value ultra long-term insurance cash flows. While objective and transparent processes can be put in place to estimate the unconditional forward rate and how the yield curve is extrapolated towards it, this process is inherently subjective and difficult.



Policy review

Given the importance of assumptions and methods adopted in model calibration, it is critical that those assumptions are coherent and consistent over time. To that end we have established a technical advisory panel of external experts with the aim of ensuring that our standard calibration methods are viewed as reasonable, objective (as far as is possible) and transparent by users of financial information prepared using Barrie & Hibbert ESG services.

Long live the revolution

The new generation of internal stochastic models requires sophisticated, mathematically-robust models of capital markets, as well as assumptions for the value of non-traded assets, which are economically coherent and consistent with the prices that really can be observed. In order to meet these challenges, today’s modellers must use know-how that spans investment banking ‘rocket science’, the economics of capital markets and actuarial judgement. However, the internal modelling framework offers a huge advance in understanding the economic value of complex long-term liabilities and their consumption of economic capital, and in informing robust risk management strategy.

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