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What Else Makes an Economic Scenario Generator "Realistic"?

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In his article in the August 2014 issue of Risk and Rewards, Bahram Mirzai covered two risk factors modeled in economic scenario generation that are intended to produce realistic (real-world) distributions: specifically equity returns and risk-free interest rates. This article expands on Mirzai's comments around non-normal distributions as well as factors to consider when modeling credit spreads, inflation and exchange rate risks.

In his discussion of equity modelling, Mirzai states, "the choice of stochastic residual distribution must account for the observed tails of returns for both market booms and market crashes." While it is true that the non-normal distribution of equity returns can be captured by using non-normal residuals, there are other methods that could also be used. A well-known regime switching log-normal model developed by Dr. Mary Hardy at the University of Waterloo is available for research purposes on the Society of Actuaries website. More complex models that use a combination of log-normal residuals plus discrete, asymmetric jumps have been developed as well. These models are also able to capture the fat-tails of equity return distributions.

Credit ratings communicate the level of credit risk inherent in a debt security and are issued by several credit rating agencies. Credit spreads correspond closely with these credit ratings and measure the additional yield an investor receives for the additional risk of purchasing a fixed income security from an issuer who is not risk-free. Similar to risk-free rates, spreads have a term structure that varies by maturity. A realistic economic scenario generator (ESG) should capture different levels of credit risk as well as the term structure of the spreads. Using a simplified distribution of credit ratings, an ESG might rank different securities, from AAA, AA, A, continuing to CCC, with seven distinct credit ratings, where AAA is the best rated (least risky) and has the lowest spread and CCC has much more credit risk and very high credit spreads. The model might capture the entire term structure of spreads or should at least reflect the risk difference between short and long maturities which can be very significant.

Because companies evolve over time, corporate bond ratings can and do change which has a significant impact on the price of the bond. The probabilities of securities being upgraded or downgraded or even defaulting can be measured over time and summarized in a "transition matrix." A realistic ESG should also capture this possibility of upgrade, downgrade and default and reflect these transitions on the bond's return. An even more sophisticated model would coherently incorporate both stochastic credit spreads and stochastic transition and default probabilities, with the spreads and the probabilities reflecting the inherent level of risk of each scenario at each point in time. For example, in a complex model, a scenario where credit spreads are well above their historical average would also have higher than average probabilities of downgrade and default. Finally, consideration should be given to the relationship between credit markets and equity markets; a negative jump in equity returns (a market correction) as described above would realistically translate into a spike in credit spreads.

When modelling realized price inflation in an ESG, it is important to capture real-world dynamics. It is particularly important for asset-liability modelling where liabilities are linked to inflation, as in the case of auto insurance claims or pension benefits with cost of living adjustments. Price inflation and short-term interest rates are highly dependent because in most developed economies, the central bank will use short-term rates as a lever to target price inflation or keep it within a desired range. This interdependence could be modelled using a correlation factor, or a stricter relationship could be captured by directly linking these two series within the model in a cascade approach (where the output from one model becomes input, or cascades into a second model). In addition to this relationship, other key factors need to be considered in a real world inflation model. For instance, experienced inflation can be negative even if this does not happen frequently and typically it does not remain negative for an extended period of time. Also, since inflation can historically be observed as having different regimes, for example a normal regime and a hyperinflation regime, these variations could be captured using a regime shifting model where the probability of switching between regimes is a model input. Finally, because central banks tend to have an inflation target, it makes sense to use an inflation model that reverts over time, on average, to this target, known as a mean reverting model.

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It should be noted that the above is referring to experienced inflation, such as CPI or the increases observed on a basket of goods. This contrasts with the forward looking "break-even" inflation defined as the market observable difference between the yield on nominal bond and the yield on an inflation linked bond of the same maturity. Break-even inflation would have a different set of dynamics.

As for the modelling of exchange rate risk, there are two important economic theories that need to be considered. Purchasing Power Parity (PPP) states that have an identical good in two countries should have the same price when expressed in the same currency. While reflecting perfect PPP in an ESG would not be considered realistic, historical exchange rates display weak to moderate PPP and an ESG should capture this. As discussed above, a realistic projection of nation-specific inflation should revert to the central bank's inflation target for each country being modelled. Since each country's central bank will likely have a different inflation target, exchange rate projections would exhibit a trend due to the difference in inflation targets and the effect these different levels of inflation will have on relative prices for goods between the two countries. The second economic theory to consider in exchange rate modelling is Interest Rate Parity which states that the differential in the risk-free rate between two countries will be equal to the difference in the forward exchange rate and the spot exchange rate. Interest Rate Parity is more important in short term exchange rate projections because if it does not hold, an immediate arbitrage opportunity exists. Of course the assumption must be made that the countries for which the exchange rates are being modelled actually have risk-free rates.

The goal of a real-world economic scenario generator is to capture realistic distributions of various risk factors as well as interrelationships between these factors. While no model can perfectly capture all risk factors and dependencies, most asset-liability models will need to reflect credit spreads and inflation and may also need to capture exchange rate risks. This paper was intended to outline some considerations when developing or reviewing an economic scenario generator that will provide input into an asset-liability model. ■

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