southwest corporate
INVESTMENT SERVICES

Special Report
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STOCHASTIC VALUATION IN INTEREST RATE RISK MANAGEMENT

This is the second of a three part series on Stochastic Valuation that will illustrate how the Southwest Corporate Investment Services (SCIS) A/LM Department utilizes this type of analysis technique. Part I defined the terms that are used in stochastic valuation and Part III will provide examples of the computation and the results of stochastic valuation.

Part II:
How Stochastic Valuation Is Used

Southwest Corporate Investment Services has chosen BancWare® A/LM 5, an advanced analytical tool to perform comprehensive A/LM analysis. The BancWare® A/LM 5 model has the ability to run stochastic simulation, a widely-used technique for valuing financial instruments with options.

The estimated market value (fair value) of any fixed income instrument is the present value of all expected cash flows. However, when an instrument has one or more options, its future cash flows become uncertain. If a callable security is called by the issuer or a mortgage loan is prepaid, its expected cash flow will be truncated. Other examples of instruments with optionality[1] are swaps[2], caps, floors, etc. To value such instruments, interest rate paths must be generated, a term structure of future interest rates must be chosen, and volatility of interest rates must be estimated.

BancWare® A/LM 5 stochastic simulation can generate hundreds of probabilistic scenarios that account for the uncertain variable, such as interest rates. In BancWare® A/LM 5, this simulation is implemented using a trinomial lattice. The structure of a trinomial lattice is similar to that of a tree. The variable begins from the root node, shifts onto three other branch nodes at time step one, each node then shifts onto three other branch nodes at time step two, and so on through the final maturity. Between nodes, the variable increases, decreases or stays the same. To further explain the trinomial lattice, let's introduce a phrase, random walk. "Random walk" means that in a free market, financial variables move in a random pattern while trending up or trending down or sideways. To capture this random nature, a coin-flip approach is often used because variables can go up or down and the outcome is as random as flipping a coin. Therefore, the binomial concept becomes very popular in developing financial models such as an option pricing model. But unlike the flip of a coin, financial variables have a third option, simply staying flat. Thus, a higher order method was developed for this three-sided coin, the trinomial lattice.

How is the path in the trinomial lattice determined? There are two sampling techniques that BancWare® A/LM 5 can utilize to accomplish this: Monte Carlo and Antithetic. Monte Carlo

[1] Optionality refers to risks arising from features embedded in assets, liabilities, or off-balance-sheet positions.
[2] A swap is an agreement to exchange cash flows in the future according to a prearranged formula.

generates sets of completely random numbers that are used to determine the path in the lattice. Antithetic sampling generates every other path in the lattice and creates an equal number of paths that are mirror images of the generated paths. Because the number of paths in a lattice grows exponentially with the size of the lattice, antithetic sampling saves compute time by reducing the number of paths generated. Also because the system generates paths in antithetic pairs, estimates of mean values converge more quickly to their true values than with pure Monte Carlo sampling[3].

The BancWare® A/LM 5 model provides the flexibility for one to choose either the Hull-White or Black-Karasinski single factor interest rate model when using the trinomial lattice to model future interest rates. The main difference between the Hull-White model and Black-Karasinski Model is that the Hull-White model assumes that the short term interest rate is a normal distribution while the Black-Karasinski model assumes lognormal distribution (interest rates cannot become negative). The decision of choosing one interest rate model over the other is driven by how one believes future interest rates will behave.

Finally, one must consider the volatility of interest rates, as volatility affects the possibility of the option being exercised. Therefore, a technique that can model the random evolution of future interest rates is critical. The volatility-dependent forward rates produced can then be used to discount the cash flows of any instrument in order to arrive at its fair value. In the BancWare® A/LM 5 Model, the volatility input can be constant or can vary over time.

There are two types of lattice-based valuations in BancWare® A/LM 5 that are used for advanced analytics:

Pathwise Lattice Simulation: This type of valuation is used to value instruments that have path-dependant options or have cash flows contingent on the path of future interest rates, for example loan prepayments. Mortgages, mortgage-backed securities, caps, and floors all depend on the path of future interest rates. Pathwise lattice simulation involves a process of simulating a pre-defined number of paths and computing the value as a probability-weighted average across all the paths.

Backward Induction (or Complete Lattice): This type of valuation is for valuing instruments with bond and swap options that have one or more exercise dates and are not path-dependant. Some examples of these types of instruments are: FHLB Advances, callable bonds, and the swaps used to hedge them. In backward induction, the payoff function at each node on the lattice is described, then pricing proceeds backwards, using the expected discounted payoff, until the root node is reached. At the root of the lattice, the price is the sum of the probability weighted payoff, discounted using the specified interest rate model (the Hull-White or Black-Karasinski). Theoretically, this price is a good approximation of the instrument's fair value.

With respect to the A/LM modeling practice utilized by Southwest Corporate Investment Services, we employ the Hull-White interest rate model and Monte Carlo sampling technique when running BancWare® A/LM 5 lattice-based valuation. Interest rate volatility is the swap option volatility from Lehman Brothers Inc., and the mean reversion is internally computed by the BancWare® A/LM system.

[3] BancWare® User's Guide.

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The BancWare® A/LM 5 model has a sophisticated functionality for valuing complex financial instruments. Southwest Corporate A/LM analysts have spent a great amount of time in testing and ensuring that the valuation results are reasonable and verifiable. These valuation methods are used within the analysis of all Southwest Corporate members who subscribe to the Comprehensive Asset/Liability Management Services. This advanced analysis provides an enhanced risk/reward opportunity because of this stochastic valuation.

Part III in this series will appear in September 2006 and will provide examples of Pathwise Lattice and Complete Lattice Valuations.

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Sources of information:

BancWare® A/LM User's Guide

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The Fundamentals of Risk Measurement, Chris Marrison, McGraw-Hill 2002

The Handbook of Fixed Income Securities (Second Edition), Frank J. Fabozzi and Irving M. Pollack., Dow Jones Irwin 1987