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SYSTEMS

The Perils of Monte Carlo

Derivatives Strategy interviews Andrew Kalotay on valuing callable debt and other challenges

Andrew Kalotay is President of Andrew Kalotay Associates, a debt-management advisory service for corporate treasury officials. The firm helps issuers develop cost effective funding structures, and advises them on refunding issues and the valuation of calls and repurchases.

Internal consistency -- in technical terms arbitrage freeness -- is a necessity for any transaction-oriented valuation system. A model should assign the same value to portfolios which have the same payoff.

Many of the commercially available risk management systems lack this internal consistency. A particular vendor may employ several different valuation methods. One approach may be a formula such as Black Scholes; another may be a Monte Carlo simulation; a third may be discounted cash flow analysis; and a fourth may be recursion, otherwise known as backward induction. The result: the same manager ends up valuing different securities using different models, leading to major internal inconsistencies.

Let's examine the limits of Monte Carlo models in more detail. These models work on the principle of averaging coin tosses. If you can toss a coin a few hundred times, you can estimate the probability of getting either a head or a tail by averaging the results of all the tosses. If the coin is unbiased, the result will be close to 50 percent but it won't be exactly 50. Monte Carlo models value securities with embedded options in a similar way. The models compute the value of the security under hundreds or thousands of interest rate scenarios, and give a value by averaging the results.

The average values that Monte Carlo models produce are imprecise, and the results they provide can differ significantly. If you let 20 people value the same instrument using twenty Monte Carlo models, they'll come up with 20 different results, which can be plotted on a bell curve.

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Monte Carlo models can do a reasonably good job of valuing instruments with predictable cash flows. They can be fairly satisfactory even for instruments embedded with European options, i.e. options that can be exercised at only one point in time. In these cases, the decision of whether or not to exercise is straightforward. Monte Carlo models are also reasonably good at valuing optionless floating rate instruments.

But the Monte Carlo method is unsatisfactory when it comes to valuing instruments with complex optionality, where cash flows are less predictable. These include callable bonds, cancelable swaps, path-dependent securities, and other instruments embedded with American options which can be exercised at the holder's discretion. The average values that the Monte Carlo models compute grow less precise as the number of potential outcomes increase and the cash flows become more unpredictable.

The source of the limitation of Monte Carlo models is that they can't tell you the best time to exercise an American option. This decision is one of the most critical of any option-based financial strategy. The models usually revert to heuristic or informal methods in making the decision. A corporate bond, for example, might be called when interest rates are 150 basis points less than the coupon on the bond or when the present value savings equals five percent of face value of the bond.

But if you don't know when to optimally exercise your call, you're likely to misvalue the option you hold. You may call the bond prematurely, and be only partially compensated for the value of the option you hold, or you may mistakenly fail to exercise the call because it doesn't satisfy your heuristic criteria. (See box on next page.) Last year $110 billion of the bonds in the $1.5 trillion corporate bond market were called, and a good portion of the decisions left money on the table.

Recursive models offer a precise way to determine the values of these complex instruments. Instead of starting at the bond's stated value at issue date and calculating an average value for each possible interest rate scenario, recursive models start evaluating the security at maturity and work backwards.

Recursive models are generally faster and more precise than Monte Carlo models. They are also consistent. 20 people using 20 different recursive models should come up with the same value.

This isn't to say that recursive methods are easy to develop. There are very real numerical difficulties in implementing the valuation. But recursive methods offer the most promising future valuation method for both dealers and end-users. □

Andrew Kalotay & Associates is offering readers of this reprint a free Windows-based program which serves as a primer on generating interest-rate trees and the recursive valuation of bonds with embedded options. To receive a copy, fax a request to: 212-475-6438