

## Valuation Commentary

### Valuation Q&As. Part 1: AD&Co Interest Rate Library

by Alex Levin

Two years ago we published [Inquiries & Interactions: We're Always Listening](#), an overview of commonly asked questions about some features of our valuation analytics. Since then, AD&Co's OAS system has made huge development strides and its customer base has more than doubled, along with the flow of inquiries seeking analytical advice, or integration help. Questions from users range widely – from simple ones that can be answered in a flash, to complex queries challenging our solutions.

Over the years I referred many clients who've asked, "How many paths is enough?" or "What is volatility index?" to this October '03 article. I decided to revisit this useful article and offer another round of Q&As. My goals are to (A) cover most questions, (B) not repeat or replace our research publications, and (C) fit it to a pair of short articles. Hence, I must resort to brief answers; if something remains unclear – give us a call. This is part 1 of 2, about the AD&Co interest rate library.

#### **Q. AD&Co has developed an "interest rate library." What does it do?**

**A.** It does two main things: (1) generate random or quasi-random rate paths for several user-defined maturity tenors; (2) it can price derivatives and path-independent instruments backwards. In either case, operations are performed on a lattice that is calibrated to market rates and volatilities.

While AD&Co's interest rate library underpins our OAS system, it can also be integrated into a client's application on its own. The library is built around the concept of risk-neutrality and is not intended for econometric rate forecasting.

#### **Q. In 2002, AD&Co recommended using the Hull-White model instead of the Black-Karasinski model. Is this recommendation still valid?**

**A.** Yes, it is. In 2004, the market evidence was revisited and confirmed. *The Journal of Portfolio Management* [Winter 2004 paper](#) was written based on the AD&Co 2002 Quantitative Perspectives, but with extended observations. I also included the dynamics of volatility indices as additional evidence.

AD&Co observes normality of rates and recommends using a normal model; such a model may have one or more factors.

#### **Q. Does an interest rate model selection matter for valuing MBS?**

**A.** Yes, it does. For example, lognormality extends interest rate sensitivity [hence, Option Adjusted Duration (OAD)] for most MBS owing to the proportional volatility specification. When rates rise, MBS loses twice – due to higher rates and due to inflated volatility. For TBA pass-throughs, one should expect a 0.3-0.5 yr OAD difference between normality and lognormality.

#### **Q. Isn't a two-factor model always better than a single-factor model for MBS pricing?**

**A.** Curiously enough, most MBS will be valued in a close range once a model is calibrated to the same

set of swap rates and swaption volatilities. This paradox is explained by the nature of our (and others') prepay model that simulates refinancing decisions as a series of European options.

We found that CMO tranches that are much shorter or much longer than their collateral will be valued differently. As a rule, two-factor rate modeling adds value for short tranches and subtracts it for long tranches. The same applies to inverse floaters. Some other instruments such as capped amortizing floaters are affected as well.

**Q. Why does AD&Co recommend using swaptions, not caps, for volatility calibration?**

**A.** Because jumps in short LIBOR rates are priced in caps. For the same variance, the jump process leads to smaller values of at-the-money (ATM) options than diffusion. That is why the short-dated caps look visibly cheaper on the Black-Scholes volatility scale than long-dated caps (cap hump) or even short-dated swaptions. Since all AD&Co rate models are diffusive ones, using caps will depress the short rate volatility and understate prepay option value. This comment applies to most existing MBS valuation models in general.

**Q. AD&Co's system uses ATM swaptions for volatility calibration. What about the skew?**

**A.** The skew is controlled solely by the model selection itself. For example, when selecting a lognormal model, a user produces no skew. A normal model leads to a pronounced volatility skew that is approximately described by the inverse square-root function. Hence, we don't load OTM or ITM volatilities when calibrating; we "measure" the skew first and then recommend a model.

**Q. How does AD&Co interpolate input rates? Does it produce a smooth forward curve?**

**A.** We accept up to 14 input yield-curve points. Then, we select more points and construct a cubic spline. After that, we derive a forward curve that matches the splined bond (or swap) rates and is linear between them.

Cubic spline is the smoothest theoretical function that passes through given points and is bound to zero second derivatives at each of the edges. Spline is continuous up to its second derivative. Hence, the short forward curve will be continuous up to its first derivative. In theory, AD&Co's linear interpolation of forward rate between spline nodes makes the forward curve "smooth, in general;" linear granulation segments are still somewhat noticeable.

Although a very smooth short forward curve is required only for special instruments (FRAs, for example) and not for MBS, AD&Co can compile its interest rate library with an arbitrary topology of input yield curve, interpolation grid, and pricing lattice. For example, we can "seed" interpolation points semiannually or even monthly; linear granulation becomes invisible and the forward curve lives up to expectation. By the same token, AD&Co can expand the input yield-curve points if it is absolutely necessary for a client. We have seen and met these requests.

**Q. AD&Co's lattice claims to be arbitrage-free. Why do we need to "fudge" rates?**

**A.** The lattice is constructed such that the rate nodes and transitional probabilities are computed to preclude arbitrage. That is, if we price a static bond (or swap) operating backward on this lattice, we recover the exact price. On the other hand, when running Monte-Carlo, a limited sample of paths is employed and they, collectively, just approximate the arbitrage-free law. AD&Co offers a simple and efficient option to "fudge" a limited set of short rate paths so that the averaged discount factors match bond prices exactly. We recommend using this option for most practical cases, especially when the selected number of paths is not large.

**Q. A firm is using a 3rd-party OAS system that has no volatility calibration tool. Can AD&Co help?**

**A.** Yes. Take a look at our [weekly Market Analysis](#) where we post calibration results for all single-factor rate models we support. Alternatively, consider licensing our Excel, Bloomberg-connected, tool called

IR\_GUI. It allows you to load market data and calibrate a model as often as needed. Calibration results can then be plugged into the vendor system that supports the same model (Black-Karasinski, Squared Gaussian, or Hull-White).

**Q. Can the AD&Co interest rate library price usual interest rate options?**

**A.** Yes, it can. We have developed a very powerful derivative pricing suite that is built around the concept of the “embedded option bond” model. This term refers to a variety of “bonds” that come with arbitrary call, put, coupon or amortization schedules. Calls and puts can be American, European, or Bermudan. An experienced reader can quickly figure out that this framework includes vanilla market swaptions and caps, cancelable and extendible swaps, callable corporate and agency debts, sinking funds, step-up and step-down bonds and so on. This system comes complimentary with the interest rate library license. In particular, a user can validate our volatility calibration by simply pricing swaptions.



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