Caselet #48 – Party Boy’s Option Adjusted Spreads


“A chair? Ms. Gotzrox?”

“Yes, Sparky, a chair. Sit down.”

“But Ms. Gotrox, you’ve never invited me to sit before.”

“Sparky, I’m not inviting you now, either. Sit down. Good. Now, Sparky, you’re going to London.”

“London? Ms. Gotzrox?”

“Sparky, when you repeat someone’s final word of a declarative sentence as a question, it makes you look half-bright. Stop doing that.”

“Yes, Ms Gotzrox.”

“Good. Now, you’re going to London to see ‘Party Boy.’ He’s actually a Canadian bond salesman who’s ‘gone native’ in England but when all is said and done, he’s pretty good. Still, you must look him in the eye, speak slowly and repeat everything you say three times.”

“Three ti…? I mean, yes, Ms. Gotzrox, I will repeat myself three times.”

“Let me warn you, Sparky, ‘Party Boy’ has pub lunches, after work drinks and a very late dinner. If you try to keep up with him, they’ll send you home in an envelope.”

“An env…? I’ll be careful, Ms. Gotzrox.”

“Good, Sparky. Here’s what you need to do. ‘Party Boy’ wants to understand several aspects of fixed income better. He wants to know about option-adjusted spreads [OAS] on callables, as well as option-adjusted (or effective) duration, and option-adjusted (or effective) convexity. He also wants to know about cheapest-to-deliver issues into Treasury futures, he wants to know how to find the correct dv01 for Treasury futures contracts and he wants to know how to value over-the-counter options on Treasury bonds. All of those issues can be explored in a lognormal binomial forward rate tree framework.”

“The good news is that simple numerical examples that illustrate the point meet his preferences and they are something you can easily do. He has one other endearing characteristic. Let’s see how well you’ve been learning, Sparky. What could it be?”
“He has a large discretionary, consulting budget, Ms. Gotzrox?”

“Sparky, who’s better than you, eh? Yes, he has a large discretionary, consulting budget. That’s why you’re going to London. Oh, and Sparky, be sure to put that little Swiss army knife of yours in your packed luggage, eh? Mustn’t let the security troops put you face down on the tarmac and strip search you. Now, to prepare for ‘Party Boy’s’ lessons, you need to build some analytical tools in Excel. The first question about option-adjusted spread is the easiest to model. In the interest of saving time, I will lay out the steps for you.”

“First, you need a bootstrapping page. Because you only need simple examples, a par curve of annual pay bonds five years long will do the trick. In addition, all the calculations will be on a coupon payment date so that you can deal in whole number exponents and you won’t have to worry about day-count conventions. So, on the first sheet of the workbook, have a space to input par yields for each maturity, one through five years. Below that, bootstrap each of the five spot or zero coupon rates. If you show the discounting of the coupon payments on the sheet instead of putting them in a long formula, ‘Party Boy’ will get the point more easily; so do that. Also, calculate the price of each maturity zero-coupon bond. Do I need to slow down for your note taking, Sparky? Can we afford that? Your first sheet should also have a field for short-rate volatility; be sure to include it.”

“The page after the bootstrapper will be your lognormal binomial tree of one-year forward rates. Can you guess the first node, Sparky? Do you remember where par, spot and forward rates begin? We’ll see.”

“I don’t much care whether your tree goes from low yields up to high or from low yields down to high in the layout of the binomial tree. Some analysts invert their interest rate trees to have bond prices go upward from low to high. Suit yourself on this one. Having said that, I want you to use the lowest yield in each period to determine all of the nodes for that period. As you know, the node adjacent (above or below, your choice) to the lowest yield has a yield of $Y_{t, low}^*e^{2\sigma}$ and so on with each yield $e^{2\sigma}$ higher than the one adjacent. The $\sigma$ is the volatility; do you remember where to get it, Sparky? Stress to ‘Party Boy’ that he only needs to pick one yield for each period – and that only after the first period – and the rest of the yields follow according to the formula. No matter how big the tree gets, he only needs one yield per period in that tree.”

“Sparky, how many yields will you choose on your second sheet? Yes, that’s right, four. But now we face the challenge of how to find those four. We do it by matching the tree’s prices for zero coupon bonds with the bootstrapped value for zero coupon bond prices. That means that we need tree prices. They could go on the same sheet with the tree, but to keep the workbook easy to understand, I want you to put the STRIPS pricer on the third worksheet of the workbook. Because this is a small numerical example, price each STRIPS separately in its own little tree, using the forward rates from your lognormal binomial tree in the second sheet.”
“Once you have the tree prices, you can compare them with the bootstrapped prices. That is probably best done by copying both the first sheet prices and the third sheet prices onto the second sheet, where you are looking for the four lowest forward rates for periods two through five. The fastest path to the solution, now, is to use ‘solver’ in Excel. Make the objective to minimize the sum of squared pricing errors and make the search variables be the lowest forward rates for periods two through five. You’ll be amazed how quickly solver reaches its final solution.”

“Let’s ‘review the bidding’, eh, Sparky? You have a bootstrapping program, a lognormal binomial tree of one-year forward rates, a STRIPS pricer that uses those forward rates to price zero-coupon bonds of each maturity. You will use solver to find the lowest forward yields in the tree for periods two through five and the rest of the forwards for each period will follow from the formula. That tree is now ‘calibrated’ to the original yield curve.”

“Now, how shall we prove to ‘Party Boy’ that the curve really is calibrated to the original par yield curve? That’s right, we must show that the tree prices the cash flows of bonds with par coupon rates at par. To do that, build a fourth sheet. In that sheet, have the bond mature at a value of 100. At the end of each year, add the bond’s coupon payment to its value. Then, discount those cash flows using the calibrated tree interest rates. If you have done it correctly, it won’t matter which year you choose for the term to maturity. You’ll get an original price of 100 for the bond.”

“Sparky, you mustn’t let on that you’re getting tired just because my instructions are longer than a single page. Why do you think I told you to sit? Now, sharpen up, we’re almost done with ‘Party Boy’s’ first task. We finally have enough pieces to value a callable bond and to calculate its option-adjusted spread.”

“Copy your non-callable bond sheet to a new worksheet named ‘callable.’ All of the calculations will be the same, at least to start with. There are only two differences between the callable and non-callable valuation pages. The first is that I want this bond to be a European 5NC3. What that means is that within the tree pricing, for the third year only, you will include the Excel formula ‘min(100,…)’ where the … is the normal formula for pricing a coupon paying bond in the binomial tree. Can you guess anything about the price of a European 5NC3 with the same coupon as a 5-year bullet?”

“The second difference is that each of the forward rates in the tree will have the option adjusted spread (OAS) added to it. Somewhere on the page allot a space for OAS; start it at zero. While you’re at it, allot space to write down the market price of the bond and the squared difference between the model price and the market price.”

“To find OAS, use solver to minimize the squared pricing error by choosing OAS. Again the solution will be fast. That process should show ‘Party Boy’ exactly what he’s interested in with respect to calculating option-adjusted spread.”
“Sparky, you get started on this while I’m at lunch. This afternoon we can talk about effective duration and effective convexity. *Now get to it.*"