How to Model Complex Derivatives On Your Lunch Hour

(even if you can't remember any math you learned after high school)

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Executive summary

Derivatives volumes are soaring, and at the same time instruments are becoming more and more complex. This has created a great demand for pricing models to handle these sophisticated structures, with a short supply of people capable of creating these models. The cost of building new models is high, and increased competition means firms need new models to be built in less time than ever.

This paper describes an internally developed tool called OmniPricer that Savvysoft has used for several years to keep up with the relentless demand for pricing new derivatives structures. OmniPricer has allowed Savvysoft to offer the widest breadth of derivatives models available anywhere in the world, and has helped the company earn Risk Magazine's ranking as the #1 Derivatives Analytics Vendor in the market.

OmniPricer simply requires the modeler to write the derivatives payoff function in an Excel spreadsheet, or a small C subroutine, and the OmniPricer engine prices the derivative that has that payoff function. This takes virtually no time, and doesn't require a PhD to write the model.

Introduction

The publication of the Black-Scholes option pricing model in 1973 is often considered a seminal event in financial history. While it occurred relatively recently, an unprecedented amount of research soon followed, as did an explosion in the market for options and other types of derivative securities. The combination of the newly-developed theory and computing power have led to a dizzying array of derivatives being offered on and off exchanges worldwide.

Sometimes, complex structures emerge simply because a financial artist conceived them, but the markets that prosper and grow always exist to fill a real need, and the breadth of options out there with liquid markets indicate there are a lot of needs waiting to be met.

Often, these structures are much more complex than the plain vanilla options Black, Scholes and Merton set out to value. And the pricing models required to manage them must therefore be much more complex, as well.

Why are pricing models important?

There are several reasons:

People need to know the right price to pay for things, and the right price to offer them for sale

OTC derivatives need to be marked-to-market on a regular basis for financial reporting purposes, which often means marking-to-model. This is important for FAS 133, IAS 39, and Sarbanes-Oxley

Models are required to do what-if analysis, to see where derivatives will trade after market moves

Models are essential to performing Value at Risk calculations, which measure the probability of excessive losses due to adverse market conditions

Models are vital for calculating hedges. Such calculations allow firms to accurately quantify and limit their exposure to the markets

How to create a pricing model

So how do you go about pricing complex derivatives? Black-Scholes is a good start, but it doesn't work for most of today's instruments. One solution is to hire a PhD with a thorough knowledge of partial differential equations, stochastic calculus, and finance. And then hire a top-notch programmer who understands all the math the PhD wrote down, and can turn it into a bug-free program ready to be integrated into the production system. And then wait for a solution, which may take a couple of weeks, or a couple of months. And then hope the opportunity to make money off the structure still exists…

Savvysoft has the quants and the programmers to do all this. But we don't waste their time on these sorts of problems. Instead, we found a better set of tools to get the job done faster, and more accurately, by people who don't have all the same advanced degrees it takes to do it the hard way. We use OmniPricer.

What is OmniPricer? A generic model that prices derivatives based on their payoff functions. You see, we've coded up a lot of derivatives models over the years; well over a hundred, in fact. We found we could handle almost any instrument using tree-based models, like binomial trees. Sure, closed-form solutions exist for some problems, but trees are much more flexible, and for the really hard problems, no known formulas exist. In fact, even plain vanilla American stock options require trees if there are dividends. Black-Scholes is fine for Europeans, but most options are not European. That's why the first thing Fischer Black did when he joined Goldman Sachs, after he was done gloating over the fact that his Black-Scholes model was being used for everything at Goldman, was to tell everyone to dump his model for binomial trees.

Binomial trees are discussed in another paper, "Basic Option Pricing." To summarize here, a tree is built that contains possible underlying asset prices as a function of time. In each "node" of the tree in which exercise is allowed, the option price is calculated as the maximum of the intrinsic value of the option, and the weighted average discounted value of the option in that node.

Here's the truly important thing: Building the tree is independent of what type of option you're pricing. And the weighted average discounted value calculation is also independent of the type of option you're pricing. The only thing that depends on the type of option is the intrinsic value in each node. Whether it's a call, or a put, or a straddle, or a strangle, whether it's got a strike of 80, 100 or 120, the tree is always built the same way, and the weighted average discounted value calculation is always done the same way. The only thing that ever changes is the intrinsic value payoff function.

So after coding the same trees about 100 times, and replacing lines in the source code with the proper intrinsic value calculation every single time we had to create a new option model, we had an insight: why not just write the tree code once, and pass into the tree function the name of the function that calculates the intrinsic value?

This makes all the difference in the world. The function to calculate the intrinsic value is short, often just 4 or 5 lines of C code. And what if you can't code in C? No problem: do it in a couple of cells of an Excel spreadsheet. So just enter this into a spreadsheet:

```
=If(put_call="C",max(price-strike,0),max(strike-price,0))
```

and you've got the ability to price plain vanilla options. Enter this:

```
=If(put_call="C",max(ln(price-strike)^2,0),max(ln(strike-price)^2,0))
```

and you can just as easily price square-log options (OK, these don't exist yet. But if they did, they'd be priced with this payoff function). This doesn't have to all be squeezed into one cell, so you're free to set up the spreadsheet any way you like, as simple or as complex as you like. Even call into other functions, so an option on an option can be priced just about as easily as a plain vanilla option:

```
=max(PlainVanillaOption(price,opstrike,expiration,vol,rate)-opopstrike,0)
```

OmniPricer Benefits

This method offers tremendous benefits over traditional modeling:

- It's FAST. Models can be created in minutes. Even the toughest models can be tackled in just a couple of hours (speaking of speed, OmniPricer models run just as fast as if they were hand-coded)

- It's easily maintained. The core of the coding has already been done for you in OmniPricer. It's written, it's tested, and it works. If your values don't look correct, you just have to look at a handful of lines of code, or a few spreadsheet cells, to debug it. Compare that to scouring 10,000 or even 100,000 lines to find the problem. And if something needs to be fixed in OmniPricer, your payoff function won't need to be changed

- It's easily audited, whether the auditor looks at C code or an Excel spreadsheet

- Anyone can create models. Well, anyone who can write a formula in Excel. Those people are easier to find and hire, cost a lot less money, and aren't nearly as likely to give you a heart attack when they tell you they were offered more money to go work for your competitor.

Conclusion

We've used OmniPricer for several years to create state-of-the-art derivatives models for our customers in record time, for less money than it would have cost to build them the old-fashioned way. And just how good are these models? World-class: we were recently named the world's top ranked derivatives analytics vendor by Risk Magazine, and rated #1 for Return on Investment by Euromoney Magazine, thanks largely to OmniPricer. Savvysoft is now making the OmniPricer technology available to our clients, so they, too, can stay ahead of the derivatives modeling curve.

If you'd like to try out our award-winning derivatives technology, please go to http://www.savvysoft.com/reqinfo_topstrial.cgi or call us at +1 212 742-8677.