Complex Bond Option Modeling with MATLAB Production Server

Computational Finance Conference 2015
Agenda

1. A Hard Problem
2. Our Approach
   • Real-world Market Model
   • Simulated Decisions
   • New Values and Yields
3. The Solution – Flexible/Scalable
A Hard Problem

- Total of 446,402 fixed-rate, callable, unfunded muni bonds outstanding
- $1.35 trillion\(^1\) par

\(^1\)SOURCE: Bloomberg data, 12Mar15
Refinancing (refunding) behavior drives risk – rate, credit and tax
Callable municipal bonds are actually complex; a model would capture all relevant markets; lots of moving parts.
The Approach
When is the right time to use real or “physical” world models versus no-arbitrage ones?

**Conditions**
- Markets are incomplete
- Markets are not free from arbitrage

**Purpose**
- Performance analysis
- Risk management / measurement
- Asset liability management
- Hedging performance
- End user (vs Dealer)
“The buy-side institution is interested in knowing whether the derivative is priced too cheaply or too expensively by a realistic model that can simulate the risk and return trade off under the physical measure.”

*What Rate Models to Use? Buy-Side versus Sell-Side*

Riccardo Rebonato and Sanjay Nawalkha, 2011

Rate Moves Lognormal (as % of Rate level)

Rate Moves Normal (bps up / down)

Nature of the Dependence of the Magnitude of Rate Moves to Rate Levels: a Universal Relationship

Nick Deguillaume, Riccardo Rebonato and Andrey Pogudin (2013)
Relationship holds across currencies and even centuries of yield data

Figure 11. Blue: Japanese yen; red: sterling; maroon: US$; orange: Swiss franc.

New research has led to vast improvements in risk modeling.
**MarketMaker Inputs**

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**MarketMaker Volatility Settings**

- **Number of Simulations**: => 5,000
- **Simulation Horizon**: => 30 Years
- **Simulation Tenor**: => 1 Month
- **Sampled Data Period**: => Mar64 thru Sep13
- **Window Length**: => 100 Days
- **Markets Created**: => Tax-exempt, Taxable, Treasury
- **Callable (10Y @100)**: => Tax-exempt, Taxable
DRP Model calibrates well to historic yield data, even at extremes

30Y UST Yield – Simulated vs Analytic Approximation over 30 Years
Allows for multiple simultaneous market simulations...
Description

Think you know municipal bonds? US Treasuries? LIBOR Swaps? Test yourself using this curiously addictive quiz to choose the fake yield curves from those created using our real-world simulator. It's yield curve history - fact or faux?!

For each question Curve Quiz provides two charts of yield data over a 4 year period - one of actual yield curves and one of simulated curves from one of these:

- Municipal bond market
- US Treasury market
- LIBOR swap market
- random combination

Simply touch the chart which you think is simulated and immediately see how well you did, including getting the starting year for the actual historical curves.

Answer ten questions and see if you're ready for any openings at PIMCO!
The Solution
SmartModels uses MATLAB production
<table>
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<th>Technology</th>
<th>Use</th>
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<td>Presentation layer, formatting</td>
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**Technology**

- VB.NET/VSTO
- C#.NET
- Custom XML
- Nhibernate

**Use**

- Presentation layer, formatting
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- Object Relational Mapping

**Technology**

- jtable
- GSON
- java.net.URL
- XSLT

**Use**

- Custom GUIs
- Web service com
- https connections
- Report generation
REQUIREMENTS - Installer

MATLAB Runtime v7.17, r2012a (32 or 64-bit)

Vista, Windows 7 or 8
Excel® 2007 SP2, Excel® 2010, Excel® 2013
Office Hotfix KB976477 (Excel® 2007)
.NET Framework 4.0
Visual Studio 2010 Tools for Office Runtime
MathWorks

MATLAB
Datafeed
Econometrics
Global Optimization
Optimization
Financial
Financial Instruments

Database
Compiler
Builder NE
Report Generator
Spreadsheet Link EX
Statistics

SmartModels
Stage I
Automatic data feeds
Cash flow calculations
Bond option values
Database integration

SmartModels
Capital
Cash flow calculations
Monte Carlo
NL Optimization
GUI (Viewers)

SmartModels
Structure
Bond structure optimization
Cash flows
GUIs (Viewer) Solutions
Custom Reports

SmartModels
Balance
Portfolio Optimization
Monte Carlo
Bond/Swap/Inv cash flows
Objectives for our box and how we build them

1. Fast, reliable development
2. Open/compatible
3. Interface easy to use and learn
4. Intellectual Property Protected
5. Shared results
I DON'T ALWAYS TEST MY CODE

BUT WHEN I DO I DO IT IN PRODUCTION