Using MATLAB to Develop a Fixed-Income Model for Risk Management and Performance Analysis
Computational Finance Conference 2017
Who are you?

- Portfolio Manager?
- Risk Manager?
- Trader?
- Analyst?
- Sales?
Are you most on...

A. Sell-side

B. Buy-side
1. What Model and Why
2. A Real-World Model in MATLAB®
3. Deploy to the World
The *reason* we use a model is as important as the market itself in determining the right type

<table>
<thead>
<tr>
<th></th>
<th>Risk-Neutral</th>
<th>Real-World</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricing (for hedged portfolio)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pricing (speculation)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Pricing (incomplete market)</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Performance/scenario analysis</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Risk management/measurement</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Asset-liability management</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Hedging performance</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Buy-side needs robust Real World Models

“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 [real-world] measure.”

What Rate Models to Use? Buy-Side versus Sell-Side
Riccardo Rebonato and Sanjay Nawalkha, 2011
I wish we could create good, history consistent, real-world yield curves...

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.

Relationship holds across currencies and even centuries of yield data

“The volatility structure implied by cap prices is similar to that observed in the real world...the best we can say is that these results are consistent with Girsanov’s theorem.”

John Hull and Alan White, September 2016
How it works

MarketMaker Volatility Settings
Number of Simulations => 10,000
Simulation Horizon => 10 Years
Simulation Tenor => 1 Month
Window Length => 100 Days
Markets simulated – the Magnificent 7

1. US Treasuries
2. US$ LIBOR Swap
3. Municipal Bond
4. US Corporate Bond
5. JPY Govt Bond
6. Canadian Govt Bond
7. UK Govt Bond

65 Total Tenors
Steps to a Demonstration

1. Load data
2. Prep data for simulation
3. Set model parameters
4. Simulate markets
5. Visualize results
DRP Model calibrates well to historic yield data, even at extremes
Samples look like real-world yield curves

“Grandma’s Sweater”
20,000 Simulations of IS Municipal Curves
Rolling down the Muni Yield Curve

Yield of 5% Coupon, 10 Year Maturity Muni Bond – Simulated Through Maturity

95th Percentile

±1 Std Dev

5th Percentile
Rolling down the Muni Yield Curve

Price of 5% Coupon, 10 Year Bond – Pricing Yield Through Maturity
Samples look like real-world yield curves

Sampling of Municipal Curves, 7/1/2025
Distribution of 30Y Muni Tenor

Muni 30Y Tenor Simulation from 7Jul20 to 4Jan27

95th Percentile

±1 Std Dev
Mean Reversion to Long Term Curve

Average Curve of UK Govt Bond Yields at Years 1 to 10 in Simulation
The model employed is a flexible, multi-market yield curve model that has the following key features

• Positive simulated rates
• Perfect recovery of the distributions of rate changes
• Perfect replication of correlations across markets
• Control over the curve shape while still allowing adequate variation of slope, humps, and twists
• Long high end and fat low end distribution tails for the rates themselves
• Accurate analytic approximations to rate distributions
• Computationally inexpensive simulations
• Can be extended to a wide range of markets and asset classes
Test real vs simulated yield curves yourself, free – CurveQuiz (ios and Android)

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 fiction?!

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 those:

- Municipal bond market
- US Treasury market
- LIBOR swap market or
- 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 FIMCO!
For further information

646.202.9446 or info@intuitive-analytics.com