Modeling the post-crisis world: sovereign debt and other credit risk issues
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Conning Risk and Capital Management Solutions

Modeling the post-crisis world: sovereign debt and other credit risk issues
What has changed? What are the challenges? How far have we come? What can we learn?
Agenda

• Credit in the Pre and Post Crisis World
• Problems in credit modeling
• Corporate Credit vs Sovereign Credit
• Solving the Problem: What can cutting edge models achieve?
• Quantitative comparison of Sovereign debt modeling approaches
• Summary

The Pre and Post Crisis World
The Pre Crisis World

Pre 2007 life seemed so simple:

- Government Bonds
- Municipal Bonds
- Insured MBS (GNMA)
- Other...
- Corporate Credit
- Counter Party Risk

This view of the world was based on localised experience:

Source: Conning/Bloomberg
The Post Crisis World

Put this in perspective:

![Graph showing Spreads on Instruments (1998-2007)]

Source: Conning/Bloomberg

Models which were once well specified are no longer so

![Graph showing Green Tax Rate Model Fit to Market Data (1991-2011)]

Source: Conning/Bloomberg
The Post Crisis World

And everyone is now concerned about credit risk being everywhere

Which of the following issues pose the GREATEST RISK TO YOUR INVESTMENT PORTFOLIO over the next 12 months?

<table>
<thead>
<tr>
<th>Issue</th>
<th>% Total Ranked (1-3)</th>
<th>% Ranked First Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Debt Crisis</td>
<td>75</td>
<td>45</td>
</tr>
<tr>
<td>Credit and Equity Market Volatility</td>
<td>58</td>
<td>17</td>
</tr>
<tr>
<td>Slow US Economic Growth</td>
<td>47</td>
<td>13</td>
</tr>
<tr>
<td>Accommodative Monetary Policies</td>
<td>28</td>
<td>10</td>
</tr>
<tr>
<td>Deflation</td>
<td>23</td>
<td>5</td>
</tr>
<tr>
<td>Inflation</td>
<td>21</td>
<td>3</td>
</tr>
<tr>
<td>European Financial Market Regulatory Change</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td>Economic Slowdown in China</td>
<td>16</td>
<td>1</td>
</tr>
<tr>
<td>US Financial Market Regulatory Change</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td>Volatile Oil Prices and Supplies</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: Goldman Sachs

The Post Crisis World

People are asking;

- are my credit risks adequately modeled?
- is my definition of a credit risky instrument broad enough?
Capital Market Modeling Perspective

Most of the models developed for Capital Modeling focused on corporate credit

- Driven partly by the academic literature
- Cost of developing new models
- Fear of the sophisticated models

Corporate Credit

Government Bonds
Municipal Bonds
Insured MBS (GNMA)
Other…

3 Problems in Credit Modeling
Credit Modeling Problem 1
Mainstream corporate credit models are too simple

Deterministic Risk Premia
+ Static Loss Given Default

<table>
<thead>
<tr>
<th>Transition Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
</tr>
<tr>
<td>AAA</td>
</tr>
<tr>
<td>AA</td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>BBB</td>
</tr>
<tr>
<td>HY</td>
</tr>
</tbody>
</table>

Credit Modeling Problem 2
The credit risk component does not explain the spreads of credit risky instruments

- High spreads imply high default probabilities

Table 7
Results from the regression of credit spread changes on financial and macroeconomic variables. This table reports the parameter estimates and their Newey-West t-statistics from the regression of annual credit spread changes on contemporaneous values in the indicated variables. Change in default rate represents the change in the annual percentage default rate of U.S. nonfinancial corporate bonds for the 1866–2008 period, and the variables represent the corresponding changes in the explanatory variables described in Table 4.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>t-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.00008</td>
<td>0.27</td>
</tr>
<tr>
<td>Change in default rate</td>
<td>-0.00161</td>
<td>-0.17</td>
</tr>
<tr>
<td>Stock return</td>
<td>-0.00292</td>
<td>-2.22</td>
</tr>
<tr>
<td>Change in volatility</td>
<td>0.00723</td>
<td>2.04</td>
</tr>
<tr>
<td>Change in return</td>
<td>-0.14089</td>
<td>-2.22</td>
</tr>
<tr>
<td>Consumption growth</td>
<td>-0.00189</td>
<td>-0.17</td>
</tr>
<tr>
<td>IP growth</td>
<td>0.00079</td>
<td>0.37</td>
</tr>
<tr>
<td>Inflation rate</td>
<td>-0.00002</td>
<td>-0.01</td>
</tr>
<tr>
<td>GDP growth</td>
<td>0.00483</td>
<td>0.83</td>
</tr>
</tbody>
</table>

Adj R^2: 0.386

Source: Giesecke, Longstaff, Schaefer, Streubalev, Corporate bond default risk: A 150-year perspective,
Credit Modeling Problem 3

There are significant differences in the behaviour of different credit instruments

- Default rates
- Spread behaviour
- Bond Return Distributions
- Mechanics of default and restructuring

We will now look at some of these aspects

- Concentrate on corporate credit and Eurozone Sovereign credit
- Why do we need separate modeling approaches?
- What is possible using state of the art modeling approaches?
- Does it matter?

Default Rates Sovereign vs. Corporate

Credit risk is likely to be a significant component of spread

- The Greek situation is nothing new
- In fact the current global situation is timid on a long historical basis
- Corporate default rates have spiked at various points in history too
- Free lunches can become expensive quickly

Source: Reinhart and Rogoff “This Time is Different: A Panoramic View of Eight Centuries of Financial Crises” (top), Giesecke, Langstaff, Schaefer, Strebulaev, Corporate bond default risk: A 150-year perspective, (Bottom)
Sovereign Debt Spread Behaviour

Source: Conning/Bloomberg

Corporate Bond Spread Behaviour

GB AA and BBB Corporate Bond Spread (1992-2013)

- Time varying stochastic dynamics
- Systematic “Shocks” which decay away
- Positive Spreads (so Far)

Source: Conning/Bloomberg

Sovereign Debt – Bond Return Distributions

“High Risk” Sovereign Debt exhibits a marked “default hump” in the tail of the return distribution

- More pronounced than High Yield Corporates
- Might imagine given longer histories secondary and tertiary humps due to multiple credit events

Source: Conning/Bloomberg
Sovereign Debt – Default Mechanics

Most corporate defaults are “absorbing” states

- The bonds don’t transition out of default
- A recovery rate (RMV) is paid
- This RMV is time dependent and may depend on the prevailing default environment

Source: E. Altman, A. Resti, A. Sironi, Analyzing and Explaining Default Recovery Rates
New Credit Modeling Approaches

GEMS® Defaultable Sovereign Debt Model

**Model of yields and spreads**

- Output is a stochastic term structure
- Stochastic credit events
- Reproduces wide range of observed dynamics
- Correlation (incl. tail correlation) with equity, interest rates, corporate bonds and other asset classes
- CLR and RMV
- Relatively Parsimonious (ca. 12 parameters govern the stochastic processes)

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Source: Conning/Bloomberg
The GEMS Corporate Yield Model

In 2010 Conning developed a new corporate bond model based on the latest published research.

The model is a multi factor arbitrage free model of the corporate credit market:

- Stochastic spreads
- Codependency with government yields
- Time varying transition and default dynamics
- Time varying recovery rates
- Real World and Risk Neutral versions
- Ability to produce the jump like behaviour in spreads observed during the 2008 crisis
- Accurate fits to initial market spread curves
- Correlation between spreads of different rating < 1
- Pricing of bonds within an arbitrage free framework

Defaultable Sovereign Spread Sample Paths

Inter Crises Lull and No Return to Pre Crisis Levels

Return to Pre Crises level for Extended Periods of Time

Source: Conning GEMS ESG
Defaultable Sovereign Spread Sample Paths

Periodic Crises Followed by Return to Pre Crisis Levels

Record Crisis Spreads and High Default Rates

Source: Conning GEMS ESG

GEMS Corporate Credit Spread Evolution

2008 was characterised by a rapidly increasing spreads

- The model incorporates a process for capturing such events
- Jumps decay away smoothly over time
Model Corporate Credit Spread Correlations

Source: Conning GEMS ESG

Modeling Sovereign Debt - A Short Case Study
Sovereign Debt – Common Approaches

Institutional investors investing in this asset class have come under regulatory pressure to adopt a more realistic approach.

Several approaches are commonly seen:

• Ignore it and treat them as non-defaultable
• Modelling a return index
• Modelling using a corporate bond model (e.g. Merton, JLT, JLT+, other)

None of these approaches is particularly satisfying because Sovereign credit is not like other credit

Does Modeling Approach Matter?

Look at Several Portfolios:

• Start from universe of active bonds from UK, DE, Eurozone (at 31/03/2013)
• Consider portfolios with modified durations from 3 to 10 years, initial value GBP 1bn
• Hold duration and asset allocation constant
• Model the Sovereign Debt 3 ways
  - Non Defaultable
  - AA or BBB Corporate
  - Defaultable Sovereign Model

Study Asset Allocation

- UK Gilt: 55%
- DE Bund: 22%
- Eurozone Medium Risk: 9%
- Eurozone High Risk: 4%
- Eurozone Equity: 10%

15 October 2013
Result

Differences in cost of capital over 1, 3 and 5 year horizons:

- Low duration portfolios show the smallest differences (ca. GBP 750k)
- As duration increases model selection is increasingly important (ca. GBP 1m)
- Corporate bond models generally overestimate the risk
- Non defaultable models underestimate it
- For longer time horizons the differences are generally larger

Summary

Our view of credit risk has changed

- Our definition is broader
- The need for robust modeling approaches greater

But there are challenges for both researchers and users

- Markets are complex

Sovereign credit differs from corporate credit in a number of important ways

- Spread behaviour – dormant/active “cycles”
- Return distributions – “loss tail hump”
- The precise details of future cash flows post credit events
Summary
Some aspects of two models built specifically to address limitations in corporate and sovereign credit modeling were presented

How important is model selection?

- Comparisons with other modeling approaches showed significant differences -> differences become larger with increasing duration

Work still to be done

- Stochastic recovery rates where appropriate
- Liquidity effects

*Inspite of this improved approaches to credit risk modeling have been developed in the last 6 years. Ultimately we should always aim to use the most realistic granular models, because the effect of model choice is not simple to estimate.*

Questions

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.
The Post Crisis World

And as interest rates fell allocations to credit risky asset classes increased

• This is likely to continue

• Credit risks must be properly managed

Are you planning to increase, decrease or maintain YOUR ALLOCATION to the following asset classes in the next 12 months? (%)

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Increase</th>
<th>Maintain</th>
<th>Decrease</th>
<th>Do not invest</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Yield Debt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US Investment Grade Corporates</td>
<td></td>
<td>26</td>
<td>66</td>
<td>8</td>
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<tr>
<td>Real Estate</td>
<td>28</td>
<td>74</td>
<td>8</td>
<td>0</td>
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<tr>
<td>Emerging Market Debt</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Equity</td>
<td></td>
<td>0</td>
<td></td>
<td>100</td>
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<tr>
<td>Bank Loans</td>
<td>42</td>
<td>58</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Mezzanine Debt</td>
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</tr>
<tr>
<td>US Equities</td>
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<tr>
<td>European Investment Grade Corporates</td>
<td>40</td>
<td>60</td>
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<td>Mortgage-Backed Securities</td>
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<td>Local Government Debt</td>
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<td>Emerging Market Equities</td>
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<td>Hedge Funds</td>
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<tr>
<td>Commodity</td>
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<tr>
<td>Euroyen Master Limited Partnerships/MLPs</td>
<td>14</td>
<td>86</td>
<td>0</td>
<td>0</td>
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<tr>
<td>European Financial Credit</td>
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<tr>
<td>Cash/Short-Term Instruments</td>
<td></td>
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</tr>
</tbody>
</table>

Source: Goldman Sachs