TAILORING FIXED INCOME PERFORMANCE ATTRIBUTION TO YOUR INVESTMENT STRATEGY

Nick Sharp, Executive Director, MSCI

#MSCIconf
Overview

Fixed Income Performance Attribution Tailored to Your Investment Strategy:

• Delivering on Our Roadmap

• Case Studies on Recent Developments
  1. Granular, Flexible and Accurate Return Decomposition
  2. Understanding the impact of Spread Carry, DTS and OASD investment decisions

• Upcoming Developments
DELIVERING ON OUR ROADMAP: PRICING AND TRADING

PRICING IMPACT (June 2016)

- Specify portfolio price source separately from benchmarks
- More accurate portfolio return and impact due to pricing differences between the portfolio and the benchmark price source

Even More Precise Measurement of Return

TRANSACTIONS AND TRADING IMPACT (Aug 2016)

- Incorporate buy, sell, corporate action transactions, fees, taxes, & cash flows as well as positions
- Capture and attribute intra-day PnL and report gross or net portfolio return
Reporting and Data Management

- Batch reporting of results underlying visualization
  – Scheduled or on-demand generation of xlsx reports (April 2017)

- Import by notional amount (Feb 2017)

- Transactions – log files, perm ID, end date to processing (Feb 2017)

- Roll imported prices – follow max age for portfolio price source (April 2017)
DELIVERING ON OUR ROADMAP: NEW FI PA MODEL

FI PA 2.0  Feb 2017

- Base Return
  - Model Base Return
  - Trading Impact
  - Pricing Impact
  - Look Through Impact

- Currency Return
- Local Return
  - Paydown Return
  - Carry Return
  - Change Return
  - Unexplained Return

- Term Structure Carry
  - Term Structure Change Return
  - Spread Change Return

- Spread Carry
  - Term Structure KRD Return
  - Term Structure Convexity Return
  - Spread Duration Return
  - Spread Convexity Return

- Income Return
- Pull-to-Par Return
  - Rest of TS Return
  - Rest of Spread Return

- Rolldown Return
  - Term Structure Parallel Return
  - Term Structure Non Parallel Return

Extending the return drivers captured by the granular, flexible & accurate model

Providing the optionality to tie back to different types of investment strategy

Attribution Tailored to Your Investment Strategy

Hybrid DTS and Spread Carry FI PA  April 2017

Capture impact of DTS positioning, and DTS allocation & DTS decisions

Hybrid OASD mode also available
GRANULAR, FLEXIBLE AND ACCURATE RETURN DECOMPOSITION
FLEXIBLE RETURN DECOMPOSITION ACCORDING TO INVESTMENT STRATEGY & GRANULARITY REQUIRED

5 Decompositions in 1 Model

1. Overall Curve and Spread Return
   - Paydown Return
   - Carrying Return
   - Change Return
   - Unexplained Return

2. Or for portfolios positioned for level of spread
   - Paydown Return
   - Term Structure Carry Return
   - Spread Change Return

3. Capture rolldown for portfolios positioned according to curve shape
   - Paydown Return
   - Changes to Par
   - Spread Carry

4. Separate clean price change return from coupons & prepayment return
   - Local Return
   - Income Return
   - Paydown Return
   - Clean Price Return

5. Or capture broad curve bets
   - Paydown Return
   - Term Structure Parallel Return
   - Term Structure Non Parallel Return

Whitepaper:
Flexible, Granular, and Accurate Attribution — The New MSCI Fixed Income Performance Attribution Model (March 2017)
CASE STUDY 1: GRANULAR AND FLEXIBLE RETURN DECOMPOSITION

European investment grade corporate bond market & unprecedented central bank intervention

Mar 2016
• ECB announced IG corporate bond purchase program of “ECB-Eligible” non-bank, senior bonds issued by eurozone firms (a third of the market is eligible)
  • Euro corporate spreads tightened especially eligible bonds
  • Net bond issuance is up
    • Favorable borrowing costs
    • Race to profit from ECB eligibility
  • Headline inflation has increased

Nov 2016
• Prospect of program tapering in Nov 2016 and spreads widened

April 2017
• Looming sell off will provide liquidity problems combined with ongoing political risk

Program has had a major impact on the market

Case study with market defined as BoA Merrill Lynch Euro Corporate Index (MLER00)

• Goal: to demonstrate flexibility and granularity or the model and to evaluate market performance

Whitepaper: Navigating Central Bank Intervention in Corporate Bond Markets (May 2017)
**INSIGHTS FROM SPREAD CHARACTERISTICS**

**Understand return due to spread exposure**

<table>
<thead>
<tr>
<th>Index (MLER00) Return Decomposition</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark Base Return</td>
<td>3.86</td>
</tr>
<tr>
<td>Currency</td>
<td>0.00</td>
</tr>
<tr>
<td>Local Return</td>
<td>3.86</td>
</tr>
<tr>
<td>Paydown</td>
<td>0.00</td>
</tr>
<tr>
<td>Term Structure</td>
<td>1.72</td>
</tr>
<tr>
<td>Term Structure Carry</td>
<td>0.20</td>
</tr>
<tr>
<td>Term Structure Change</td>
<td>1.52</td>
</tr>
<tr>
<td>Term Structure KRD</td>
<td>1.43</td>
</tr>
<tr>
<td>Term Structure Convexity</td>
<td>0.03</td>
</tr>
<tr>
<td>Rest of Term Structure</td>
<td>0.06</td>
</tr>
<tr>
<td>Spread</td>
<td>2.16</td>
</tr>
<tr>
<td>Spread Carry</td>
<td>1.18</td>
</tr>
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<td>Spread Change</td>
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<tr>
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</tr>
<tr>
<td>Spread Convexity</td>
<td>-0.12</td>
</tr>
<tr>
<td>Rest of Spread</td>
<td>0.04</td>
</tr>
<tr>
<td>Unexplained</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

**BoA Merrill Lynch Euro Corporate Index: Characteristics**

<table>
<thead>
<tr>
<th></th>
<th>OAS (bp)</th>
<th>Spread Duration</th>
<th>Spread Convexity</th>
<th>DTS (yr*%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-Dec-15</td>
<td>153.93</td>
<td>5.32</td>
<td>16.16</td>
<td>8.19</td>
</tr>
<tr>
<td>31-Mar-17</td>
<td>126.35</td>
<td>5.55</td>
<td>18.04</td>
<td>7.02</td>
</tr>
<tr>
<td>Change</td>
<td>-27.58</td>
<td>0.23</td>
<td>1.88</td>
<td>-1.17</td>
</tr>
</tbody>
</table>

- **Spread Carry Return** is reasonably large and positive, determined from daily level of OAS and length of reporting period
- **Spread Change Return** is positive as tighter OAS causes higher bond prices
- **Negative Spread Convexity Return** due to a callable BBB financial contributing -9 bps due to its large negative spread convexity (-780)

[Euro Sovereign, EM, IG Corp, Securitized]

Spread Carry: From the daily level of OAS x change in time
Spread Duration Return: From daily spread duration exposure x minus change in OAS
Spread Convexity Return: From daily \((0.5) \times \text{spread convexity} \times (\text{change in OAS})^2\)

1 Analytics are from MSCI
BoA ML Euro Corporate Index source: BofA Merrill Lynch Global Research, used with permission
**INSIGHTS FROM THE TERM STRUCTURE**

*Understand return due to term structure exposure*

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**EUR Gov Term Structure**

- 31 Dec, 2015
- 31 March, 2017
- Average shift = -40 bps

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- Low level of rates means **Term Structure Carry** is small and positive
- Large **positive Term Structure KRD Return** as all rates dropped
- **Positive Rolldown Return** from upward sloping yield curve

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<table>
<thead>
<tr>
<th>Carry Return (%)</th>
<th>1.37</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>2.52</td>
</tr>
<tr>
<td>Pull to Par</td>
<td>-1.66</td>
</tr>
<tr>
<td>Rolldown</td>
<td>0.50</td>
</tr>
</tbody>
</table>

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**Term Structure Carry:** From the shape and level of the curve, approx. (YTM - OAS) x dt

**Term Structure KRD Return:** From daily KRD exposure x minus change in key rates

**Rolldown Return:** From the daily change in discount factors as we roll up or down the curve

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[Sovereign, EM, IG Corp, Securitized]
Non Eligible Non Bank bonds were the main contributor to index return (176 bps), where the main drivers of return were key rate change x KRD (62 bps), followed by OAS change x OASD (52), then spread carry (50 bps). Within, lower rated bonds were the main return drivers.
### Insights from Price and Coupon Characteristics

#### Understand carry return due to Income, Pull to Par and Rolldown

<table>
<thead>
<tr>
<th></th>
<th>Price</th>
<th>Coupon (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-Dec-15</td>
<td>105.74</td>
<td>3.24</td>
</tr>
<tr>
<td>31-Mar-17</td>
<td>106.29</td>
<td>2.61</td>
</tr>
<tr>
<td>Change</td>
<td>0.54</td>
<td>-0.63</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<tr>
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</tr>
<tr>
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<td>Currency</td>
<td>0.00</td>
</tr>
<tr>
<td>Local Return</td>
<td>3.86</td>
</tr>
<tr>
<td>Paydown</td>
<td>0.00</td>
</tr>
<tr>
<td>Income</td>
<td>2.52</td>
</tr>
<tr>
<td>Clean Price</td>
<td>1.33</td>
</tr>
<tr>
<td>Pull to Par</td>
<td>-1.66</td>
</tr>
<tr>
<td>Rolldown</td>
<td>0.50</td>
</tr>
<tr>
<td>Change</td>
<td>2.50</td>
</tr>
<tr>
<td>Term Structure Change</td>
<td>1.52</td>
</tr>
<tr>
<td>Term Structure - Parallel</td>
<td>1.60</td>
</tr>
<tr>
<td>Term Structure - Non-Parallel</td>
<td>-0.08</td>
</tr>
<tr>
<td>Spread Change</td>
<td>0.98</td>
</tr>
<tr>
<td>Spread Duration</td>
<td>1.06</td>
</tr>
<tr>
<td>Spread Convexity</td>
<td>-0.12</td>
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<tr>
<td>Rest of Spread</td>
<td>0.04</td>
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<tr>
<td>Unexplained</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

- **Income** is always positive
- **Pull-to-Par Return** negative as bonds pull towards their par value and average Clean Price of 106

**Income Return:** From the change in accrued interest

**Pull-to-Par Return:** From pull towards par value as maturity approaches

**Useful for higher yield bonds where return is driven by clean price changes and coupon payments**

**[HY, Core, Intermediate]**

**Capture impact of curve management according to curve shift and reshape**

Explain curve change return in 2 rather than 15 + 2 effects

**[HY, Mortgage]**
WILL YOUR PORTFOLIO’S CARRY RETURN COMPENSATE FOR RISING INTEREST RATES?

- Positive carry return can make bond positions profitable – if it outweighs negative curve change return as interest rates rise

<table>
<thead>
<tr>
<th>Index Return Decomposition</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benchmark Base Return</td>
<td>0.53</td>
</tr>
<tr>
<td>Currency</td>
<td>0.00</td>
</tr>
<tr>
<td>Local Return</td>
<td>0.53</td>
</tr>
<tr>
<td>Paydown</td>
<td>0.00</td>
</tr>
<tr>
<td>Carry</td>
<td>0.49</td>
</tr>
<tr>
<td>Income</td>
<td>0.76</td>
</tr>
<tr>
<td>Pull to Par</td>
<td>-0.50</td>
</tr>
<tr>
<td>Rolldown</td>
<td>0.23</td>
</tr>
<tr>
<td>Change</td>
<td>0.15</td>
</tr>
<tr>
<td>Term Structure Change</td>
<td>-0.73</td>
</tr>
<tr>
<td>Term Structure KRD</td>
<td>-0.75</td>
</tr>
<tr>
<td>Term Structure Convexity</td>
<td>0.01</td>
</tr>
<tr>
<td>Rest of Term Structure</td>
<td>0.01</td>
</tr>
<tr>
<td>Spread Change</td>
<td>0.88</td>
</tr>
<tr>
<td>Spread Duration</td>
<td>0.90</td>
</tr>
<tr>
<td>Spread Convexity</td>
<td>-0.04</td>
</tr>
<tr>
<td>Rest of Spread</td>
<td>0.02</td>
</tr>
<tr>
<td>Unexplained</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

**YTD up to April 26**

- YTD the EUR Gov Curve increased across all rates
- Resulting in a loss of -73 bps which was not compensated for by carry return 49 bps (only 11 bps from TS carry)
- Tightening of -21 bps in OAS helped offset the loss

**Carry**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Term Structure Carry</td>
<td>0.11</td>
</tr>
<tr>
<td>Spread Carry</td>
<td>0.38</td>
</tr>
</tbody>
</table>

**Benchmark Term Structure Exposure**

**Increase in EUR Gov Curve**

Parallel increase of +13 bps

**Loss Due to Exposure to Curve Change**

Loss of -75 bps

**Carry Return:** From the passage of time, approx. YTM x change in time
UNDERSTANDING THE IMPACT OF SPREAD INVESTMENT DECISIONS
## Case Study 2: Understanding the Impact of Spread Investment Decisions

### European Investment Grade Corporate Bond Market & Unprecedented Central Bank Intervention

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar 2016</td>
<td>ECB announced IG corporate bond purchase program of “ECB-Eligible” non-bank, senior bonds issued by eurozone firms (a third of the market is eligible)</td>
</tr>
<tr>
<td></td>
<td>• Euro corporate spreads tightened especially eligible bonds</td>
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<tr>
<td>Nov 2016</td>
<td>• Prospect of program tapering in Nov 2016 and spreads widened</td>
</tr>
<tr>
<td>April 2017</td>
<td></td>
</tr>
</tbody>
</table>

*Program has had a major impact on the market*

### Investment Strategy: Euro Corporate Bond Credit Value Strategy

- IG euro corporate PM targets credit alpha through issue selection of high spread bonds
  - OAS positioning for spread carry, and placing DTS market exposure, allocation and selection bets on changing spreads
    - Risk budget of 75 bps of active TEV
    - Maintain minimal interest-rate risk
    - Neutral on banks
    - Subject to constraints on bid-ask, issuer concentration and turnover
- **Benchmark**: BofA Merrill Lynch Euro Corporate Index

*Investment Grade Credit is an ideal use case for the Hybrid DTS FI PA model*
DURATION TIMES SPREAD APPROACH

DTS is standard approach in the industry for IG credit, used by POINT and now MSCI

- Higher spread & higher spread duration = higher spread risk exposure
- DTS is asset exposure to credit risk captured as *Spread Duration x Spread*

\[ X^{DTS} = D^s \times S \]

- Return driver in DTS approach is percentage change in spread

\[ f^{DTS} = \frac{\Delta s}{s} \]

**Responsive**
- Spread is a strong “forward-looking indicator” of bond risk
- Changing credit quality reflected immediately: no need to wait for ratings agencies

**Intuitive**
- Better measure of exposure to changes in spread than spread duration alone
- Relative spread change is easier to compare across assets/sectors

*OASD Approach*: suitable for IG Corporate, EM, and Euro Sovereign portfolios

*OASD Approach*: suitable for Money Market, Securitized incl. Mortgage related, and Aggregate (containing more than just corporates) portfolios
**SPREAD EXPOSURE AND RETURN DRIVERS**

<table>
<thead>
<tr>
<th>Asset Name</th>
<th>Asset ID</th>
<th>Weight (%)</th>
<th>Start OAS (bps)</th>
<th>End OAS (bps)</th>
<th>OAS Change (bps)</th>
<th>OASD (yrs)</th>
<th>OASD Contr. (yrs)</th>
<th>OASD Pct Contr. (%)</th>
<th>OAS % Change (%)</th>
<th>Start DTS (yrs*%)</th>
<th>DTS Contr. (yrs*%)</th>
<th>DTS Pct Contr. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLOVERIE PLC 7.5% 2039 07 24</td>
<td>XS0442190855</td>
<td>0.18</td>
<td>537</td>
<td>630</td>
<td>+93</td>
<td>11.00</td>
<td>0.02</td>
<td>0.36</td>
<td>+17.3</td>
<td>59.07</td>
<td>0.11</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Sensitivity**

\[ \text{DTS} = \text{OAS} \times \text{OASD} = \frac{537}{100} \times 11 = 59.07 \text{ yrs*%} \]

**Exposure**

\[ \text{DTS Contribution} = \text{Weight} \times \text{DTS} = \frac{0.18}{100} \times 59.07 = 0.11 \text{ yrs*%} \]

\[ \text{DTS Pct Contribution} = \frac{\text{Weight} \times \text{DTS}}{\text{Portfolio DTS}} = \frac{0.18}{100} \times \frac{59.07}{11.2} \times 100 = 0.95 \% \]

**Return Drivers**

\[ \text{OAS Change} = \text{OAS End} - \text{OAS Start} = 630 - 537 = +93 \text{ bps widening} \]

\[ \text{OAS % Change} = \frac{\text{OAS Change}}{\text{Start OAS}} = \frac{(630 - 537)}{537} \times 100 = 17.3 \% \text{ widening} \]
HYBRID DTS & SPREAD CARRY FIXED INCOME PERFORMANCE ATTRIBUTION

Hybrid FI PA: Ability to capture granular return drivers and capture the impact of investment decisions

Base Return

- Model Base Return
- Trading Impact
- Pricing Impact
- Look Through Impact

Currency Return

Local Return

Paydown Return

Term Structure Return

Term Structure Carry Return

Term Structure Change Return

Spread Return

Spread Carry Return

Spread Change Return*

Unexplained Return

Term Structure KRD Return

Term Structure Convexity Return

Rest of TS Return

Spread Carry Allocation

Spread Carry Selection

DTS Market Exposure

DTS Allocation

DTS Selection

Explain relative spread change return using allocation-selection modified with **contribution to DTS weights**

*Spread Change Return also decomposed as Spread Duration Return, Spread Convexity Return and Rest of Spread, and OASD mode also available

Return Contribution = Exposure x Return Driver

**DTS Market Exposure**: captures impact of directional DTS bet on benchmark’s spread change

**Allocation**: captures impact of active bet on benchmark group outperforming the benchmark

- **Spread Carry Allocation**:
  - Active OAS positioning on benchmark groups with higher OAS than the benchmark OAS
- **DTS Allocation**:
  - Active DTS bet on benchmark group spread tightening more than overall benchmark spread

**Selection**: captures impact of portfolio exposure to active performance of group

- **Spread Carry**:
  - Portfolio exposure to benefit from higher OAS groups in the portfolio than the benchmark
- **DTS Selection**:
  - Portfolio DTS exposure to benefit from portfolio group spread tightening more than benchmark group spread
Spread management decisions resulted in 213 bps of outperformance.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Av. OAS (bp)</th>
<th>OAS % Change (%)</th>
<th>Av. DTS (yrs*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio</td>
<td>206.06</td>
<td>-13.38</td>
<td>11.20</td>
</tr>
<tr>
<td>Benchmark</td>
<td>135.69</td>
<td>-13.87</td>
<td>7.49</td>
</tr>
<tr>
<td>Active</td>
<td>70.37</td>
<td>-12.43</td>
<td>3.70</td>
</tr>
</tbody>
</table>

Active Spread Return (%): 2.13
Spread Carry: 0.70
Spread Change: 1.43

Overweight DTS paid off as benchmark spread tightened.
Both spread allocation decisions were successful.
Selection of bonds where their spread tightened was the dominant return driver.

MSCI
IMPACT OF SPREAD INVESTMENT DECISIONS

<table>
<thead>
<tr>
<th>Active Spread Return (%)</th>
<th>DTS Market Exposure (%)</th>
<th>DTS Allocation (%)</th>
<th>DTS Selection (%)</th>
<th>Spread Carry Allocation (%)</th>
<th>Spread Carry Selection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.13</td>
<td>0.31</td>
<td>0.20</td>
<td>0.92</td>
<td>0.25</td>
<td>0.44</td>
</tr>
</tbody>
</table>

**Group Name** | **Active Av. DTS Contr. (yrs*%)** | **Spread Attribution (%)**
---|---|---
TOTAL | 3.70 | 2.13
Eligible | 0.12 | 0.56
Non Eligible Bank | 1.15 | 0.57
Non Eligible Non Bank | 2.43 | 1.00

- “Non Eligible Non Bank” bonds most important return driver contributing 100 bps
- Within “Non Eligible Non Bank” the lower rated (BBB and Below) bonds contributed 89 bps
- **DTS Selection** of “Non Eligible Non Bank” bonds was the main driver of spread outperformance (39 bps)
MONTHLY SPREAD MANAGEMENT PERFORMANCE

Performance of Spread Management Decisions (%)

- Spread performance largest in March (69 bp) when spreads tightened significantly
- DTS Market Exposure fluctuated according to market movement
- DTS Selection was a consistent contributor
- DTS Selection decision paid off even during tapering talk when spreads widened

Portfolio OAS vs. Index OAS

OAS analytics and determination of ECB eligibility are from MSCI
BoA ML Euro Corporate Index source: BoA Merrill Lynch Global Research, used with permission
Small negative active spread performance in November 2016
- Spread carry bets small positive payoff of 5bps
- Directional market exposure bet lost 48 bps
- DTS bets on change in spread paid off well with 37 bps

Necessary to consider exposure and return drivers to understand attribution results

**ATTRIBUTE SPREAD PERFORMANCE TO INVESTMENT DECISIONS – NOVEMBER 2016**

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Spread Carry Attribution Total (%)</th>
<th>Spread Carry Allocation (%)</th>
<th>Spread Carry Selection (%)</th>
<th>DTS Attribution Total (%)</th>
<th>DTS Market Exposure (%)</th>
<th>DTS Allocation (%)</th>
<th>DTS Selection (%)</th>
<th>Spread Attribution Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>0.05</td>
<td>0.02</td>
<td>0.03</td>
<td>-0.11</td>
<td>-0.48</td>
<td>0.14</td>
<td>0.23</td>
<td>-0.06</td>
</tr>
<tr>
<td>Eligible</td>
<td>0.01</td>
<td>0.00</td>
<td>0.01</td>
<td>0.08</td>
<td>0.02</td>
<td>-0.02</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>Non Eligible - Bank</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td>-0.06</td>
<td>-0.14</td>
<td>0.05</td>
<td>0.02</td>
<td>-0.05</td>
</tr>
<tr>
<td>Non Eligible - Non Bank</td>
<td>0.02</td>
<td>0.01</td>
<td>0.01</td>
<td>-0.13</td>
<td>-0.35</td>
<td>0.10</td>
<td>0.13</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

See Appendix for explanation of spread carry attribution results
## DTS ATTRIBUTION EXPLAINED

\[
\text{Return Contribution} = \text{Exposure} \times \text{Return Driver}
\]

\[
\text{DTS Market Exposure} \cong \text{Active DTS} \times (–\text{Benchmark % Spread Change})
\]

\[
\text{DTS Allocation} \cong \text{Active DTS Contribution} \times (–\text{Benchmark Relative Pct Spread Change})
\]

\[
\text{DTS Selection} \cong \text{Portfolio DTS Contribution} \times (–\text{Active Pct Spread Change})
\]

Benchmark Group % Spread Change – Overall Benchmark % Spread Change

Portfolio Group Pct Spread Change – Benchmark Group Pct Spread Change

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Active Average DTS Contr. (yrs*%)</th>
<th>Portfolio Average DTS Contr. (yrs*%)</th>
<th>Portfolio Average Pct Spread Change (%)</th>
<th>Benchmark Average Pct Spread Change (%)</th>
<th>Bmk Relative Pct Spread Change (%)</th>
<th>Active Average Pct Spread Change (%)</th>
<th>DTS Market Exposure (%)</th>
<th>DTS Allocation (%)</th>
<th>DTS Selection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>3.7</td>
<td>10.8</td>
<td>11.0</td>
<td>12.9</td>
<td>-</td>
<td>-1.9</td>
<td>-0.48</td>
<td>0.14</td>
<td>0.23</td>
</tr>
<tr>
<td>Eligible</td>
<td>-0.2</td>
<td>1.6</td>
<td>10.9</td>
<td>11.6</td>
<td>-1.3%</td>
<td>-0.7%</td>
<td>0.02</td>
<td>-0.02</td>
<td>0.08</td>
</tr>
<tr>
<td>Non Eligible - Bank</td>
<td>1.1</td>
<td>2.9</td>
<td>9.4</td>
<td>10.6</td>
<td>-2.3%</td>
<td>-1.2%</td>
<td>-0.14</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Non Eligible - Non Bank</td>
<td>2.8</td>
<td>6.2</td>
<td>7.7</td>
<td>9.8</td>
<td>-3.1%</td>
<td>-2.1%</td>
<td>-0.35</td>
<td>0.10</td>
<td>0.13</td>
</tr>
</tbody>
</table>

- **DTS Allocation Bet**
- **DTS Selection Bet**
- **Return Drivers**
- **Exposures**

All spreads widened but portfolio and bmk relative spreads widened less

Attribution results are determined daily and linked over the reporting period
ASSET CONTRIBUTION TO SELECTION EFFECT: November

DTS Selection vs. DTS Exposure

Top contributors to DTS Selection

Top/Bottom 5 Assets by DTS Selection (bp)

Interactive Visualization combined with tabular reporting enables rapid analysis

Similar analysis provided for OASD selection, spread carry selection decision and overall selection decision.
UPCOMING DEVELOPMENTS

Reporting and Data Management

- Batch reporting of results underlying visualization dashboards
  - Scheduled or on-demand generation
  - XML (June 2017), CSV (June 2017)
  - Extraction of reports via web API using BDT (August 2017)
  - Scheduled invalidation and repopulation of results after input data refresh (June 2017)
- Improved attribute search capability for grouping scheme setup (June 2017)
- Improved formatting in Excel output (Q3 2017)
- Reduce wait time to open FI PA 2.0 dashboards (Q3 2017)
- Dashboard timeout to be removed (Q3 2017)

Data Transparency

- Time-series view of positions with access to return calculation building blocks (August 2017)
- Disaggregated view of MV/Weight/Returns for Swaps and FX FWDS in the positions report (August 2017)
Attribution Evolution

• **Additional top-down allocated return modes in FI PA 2.0 (Local and Excess) (June 2017)**
  – Flexibility in allocated return for streamlined analysis, either Local or Excess of Term Structure Return

• **Alignment with fixed income risk**
  – **Adopting market standard curves and sensitivities in FI PA 2.0 as used in FI400 (August 2017)**
    • Gov curve other than for money market derivatives & mortgage related which use Swap
    • Eur Gov curve rather than Eur Country Curve as in our old risk model
    • Par shifted KRDs and convexity
  – Using RiskServer analytics where needed, e.g. MBS, “Intex” and other RiskServer valued assets (Q4)

• **Inflation carry and inflation change return in FI PA 2.0 (Q4 2017)**
  – Using break-even inflation curves (rather than Real) for return decomposition of inflation-linked assets

• **Geometric FI PA 2.0 (Q4 2017)**

• **Option to choose Gov or Swap reference curves** for different asset types (Roadmap)

• **Interest rate implied vol carry and implied vol change return** (Roadmap)

• **MAC factor PA model** (Roadmap)
  – Attributing return to MSCI Integrated Model equity and FI400 risk factors in PA Understand return
MSCI provides sophisticated analytical tools necessary to evaluate complex fixed income investment decisions.

MSCI’s Hybrid FI PA model is flexible to capture granular return drivers for a range of investment strategies and the impact of complex fixed income investment decisions:
- Introducing new carry decomposition, using repricing and adding convexity effects
- OASD or DTS approach to evaluate spread change investment decisions
- As well as spread carry investment decisions

Visualization dashboards enable financial insights to be gained rapidly:
- Facilitates very efficient investigation of major contributors, outliers, and trends

Find Out More:
- Performance Analytics Client Support Site
- Whitepaper: Navigating Central Bank Intervention in Corporate Bond Markets (May 2017)
APPENDIX
DEFINITION OF RETURN DRIVERS INCLUDED IN THE MODEL

- **Local Return**
  - **Paydown Return**: From principal prepayments made at a price differing from the clean price
  - **Carry Return**: Time return due to accrual, pull-to-par, the shape and level of the curve and the level of OAS
    - **Term Structure Carry**: From the shape and level of the curve
    - **Spread Carry**: From the level of OAS
  - **Income Return**: From the change in accrued interest
  - **Pull-to-Par Return**: From pull towards the par value as maturity approaches
  - **Rolldown Return**: From the change in discount factors as we roll up or down the curve

- **Change Return**: From exposure to the change in the curve and change in OAS using repricing
  - **Term Structure Change Return**: From exposure to the change in the curve using repricing
    - **Term Structure KRD Return**: From KRD exposure to the change in key rates
    - **Term Structure Convexity Return**: From convexity exposure to the average change in the curve
    - **Rest of Term Structure Return**: From repriced effect differing from 1st and 2nd order exposure effects
  - **Term Structure Parallel Return**: From duration and convexity exposure to the average change in the curve
  - **Term Structure Non-Parallel Return**: From repriced effect differing from the parallel effect
  - **Spread Change Return**: From exposure to the change in OAS using repricing
    - **Spread Duration Return**: From spread duration exposure to the change in OAS
    - **Spread Convexity Return**: From spread convexity exposure to the change in OAS
    - **Rest of Spread Return**: From repriced effect differing from 1st and 2nd order exposure effects

- **Clean Price Return**: From change in clean price, decomposed as pull-to-par, rolldown and change return
- **Unexplained Return**: From local return not explained by paydown, the passage of time, the curve or OAS
ACCURACY OF THE MODEL

Explanatory power of FI PA across common UK and Euro Gov, Corp and HY indexes

New model uses repricing to capture term structure change return and spread change return to reduce unexplained return

- **Older Model** explanatory power in general was high

- **New Model** explanatory power is very high

### Case study on explanatory power of FI PA

<table>
<thead>
<tr>
<th>Case</th>
<th>Case Description</th>
<th>Abs[Unexplained Return as a proportion of Base Return (%)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GB Government Agg Index – Across Brexit</td>
<td>2.48</td>
</tr>
<tr>
<td>2</td>
<td>GB Government Agg Index – 11m</td>
<td>6.49</td>
</tr>
<tr>
<td>3</td>
<td>Euro Corp Agg Index – Across Brexit</td>
<td>3.47</td>
</tr>
<tr>
<td>4</td>
<td>Euro Corp Agg Index – 11m</td>
<td>1.18</td>
</tr>
<tr>
<td>5</td>
<td>Euro HY Index – Across Brexit</td>
<td>2.30</td>
</tr>
<tr>
<td>6</td>
<td>Euro HY Index – 11m</td>
<td>6.35</td>
</tr>
</tbody>
</table>

- Unexplained return is return not explained by return drivers captured in the model
- “11m” = 31 Mar, 2016 – 28 Feb, 2017

---

**Term Structure Change Return**: From exposure to the change in the curve using repricing

**Spread Change Return**: From exposure to the change in OAS using repricing
Aligning the grouping scheme with the investment process

Ensure that the attribution effects reported are as insightful as possible

- **Index Data & Vendor classifications:** Bloomberg Barclays, BoA Merrill Lynch, JP Morgan, Citi, Markit iBoxx, S&P and Moodys, all natively covered
- **Analytics Attributes:** 25+ duration, OAS, and yield based attributes
- **User Attributes**
- **Custom Attributes:** using a formula builder
- **Multi-Level:** no limit on levels

**Top-Down Return Attribution Mode**

- Captures the impact of spread management investment decisions using either DTS or OASD exposures
  - **DTS Approach:** suitable for IG Corporate, EM, and Euro Sovereign portfolios
  - **OASD Approach:** suitable for Money Market, Securitized incl. Mortgage related, and Aggregate (containing more than just corporates) portfolios
Size & direction of attribution effects according to DTS/ OASD bets

- Market Exposure Bet – Result of directional credit bet has **opposite sign** and **different magnitude** between DTS and OASD approach

- Allocation and Selection Bets on Spread Changes – attribution effects differ as exposure and return drivers differ

- Spread Carry Bets – **not impacted** by DTS/OASD approach

**Allocation Decisions Included vs. No Allocation Decisions**

- “Allocation decisions Included”: groups correspond to allocation decisions

- “No allocation decisions”: assumes pure bottom-up selection. **Selection result includes allocation**

- Market exposure results are **the same**

**MSCI**

**DTS Approach**: IG Corp, EM, and Euro Sovereign portfolios

**OASD Approach**: Money Market, Securitized incl. Mortgage related, and Aggregate portfolios
Spread management worked very well.

Spread selection paid off consistently.

DTS Market Exposure payoff trends with the spread change of the benchmark.

DTS Selection success indicates issue selection strategy high spread bonds performed consistently well.

Consistent high OAS overweight drives success of Spread Carry Selection.
### Spread Carry Attribution Explained

Return Contribution = **Exposure** x **Return Driver**

Spread Carry Allocation = **Active Group Weight** x **Benchmark Relative Spread Carry Return**

\[(\text{Benchmark Group OAS} - \text{Benchmark OAS}) \times \text{Time Elapsed}\]

Spread Carry Selection = **Portfolio Group Weight** x **Active Spread Carry Return**

\[(\text{Portfolio Group OAS} - \text{Benchmark Group OAS}) \times \text{Time Elapsed}\]

<table>
<thead>
<tr>
<th>Group Name</th>
<th>Active Average Weight (%)</th>
<th>Portfolio Average Weight (%)</th>
<th>Portfolio Average OAS (bps)</th>
<th>Benchmark Average OAS (bps)</th>
<th>Time Elapsed (yrs)</th>
<th>Bmk Relative Average OAS (bps)</th>
<th>Active Average OAS (bps)</th>
<th>Spread Carry Allocation (%)</th>
<th>Spread Carry Selection (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>0.0</td>
<td>100.0</td>
<td>194.4</td>
<td>125.9</td>
<td>0.1</td>
<td>-18.4</td>
<td>68.6</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Eligible</td>
<td>-11.8</td>
<td>21.8</td>
<td>142.2</td>
<td>95.7</td>
<td>0.1</td>
<td>-30.2</td>
<td>46.5</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Non Eligible - Bank</td>
<td>-0.3</td>
<td>31.4</td>
<td>198.5</td>
<td>125.3</td>
<td>0.1</td>
<td>-0.5</td>
<td>73.2</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Non Eligible - Non Bank</td>
<td>12.2</td>
<td>46.9</td>
<td>212.8</td>
<td>151.0</td>
<td>0.1</td>
<td>25.1</td>
<td>61.8</td>
<td>0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Exposures**

- Spread Carry Allocation
- Spread Carry Selection

**Return Driver**

- Spread Carry Allocation Return Driver
- Spread Carry Selection Return Driver

Attribution results are determined daily and linked over the reporting period.
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