MSCI SEMINAR SERIES: FIXED INCOME INSIGHTS

Navigate the ECB’s Corporate Sector Purchase Program with MSCI Fixed Income Analytics
MSCI = FIXED INCOME EXPERTISE

- **1 bp** tolerance level for MSCI-reconciled bottom up, daily index returns vs. vendor reported returns
- **15** years of providing data management, reconciliation, and reporting managed services to large organizations
- **40+** fixed income researchers focusing on fixed income modeling/single security pricing
- **100+** fixed income pricing models available through MSCI
- **125+** people devoted to providing exceptional data quality & management
- **1989** is the year when MSCI introduced its first fixed income factor model
- **6,000** issuer curves built by MSCI and used in our models
- **19,000** fixed income benchmark indexes available through MSCI, including Barclays Capital, Bloomberg, JPMorgan, iBoxx, and BofA Merrill Lynch
- **40,000** global structured fixed income deals covered through INTEX cashflow models
- **3.3 million** instruments for which MSCI delivers terms & conditions data
MSCI IS A LEADER IN FIXED INCOME ANALYTICS

- Over 100 pricing models
- Over 6,000 issuer curves

- Global, including EM
- Integrated with equity & private asset classes

- Data management
- Quality control
- Reporting

- Curve & Spread attribution
- Visualization dashboards

Single Security Analytics

Factor Models

Services

Performance Attribution
MSCI FIXED INCOME ANALYTICS INFRASTRUCTURE

Data
- 125+ staff dedicated to data services
- Significant QA processes
- 50+ vendors
- Reference data for over 3.3 million assets

Benchmark Indexes
- All major indexes: Bloomberg / Barclays, iBoxx, BofA / Merrill, JPMorgan, Citigroup
- Over 19,000 benchmark indexes
- Indexes reconciled daily to 1 bp of reported returns

Reporting
- Multiple data output capabilities: batch reports, APIs, XMLs, Web Based Platform
- Market-leading partitioning: slice & dice, user data, user-defined groupings
- On-demand report creation

Research
- Over 40 research staff on FI
- Majority of client consultants have advanced degrees and experience as market practitioners
WHY MSCI FOR FIXED INCOME?

• **Expertise**
  – Three decades of expertise in fixed income
  – Four decades building factor models

• **Services**
  – Data collection, reconciliation, implementation, & custom workflow integration
  – Built around your process

• **Scalability**
  – On-demand infrastructure for asset growth and new strategies
  – Links to other asset classes

• **Reporting**
  – Flexible, open
  – Batch, user interface, web services, Excel interface

• **Investment**
  – Significant product development investments in FI analytics in 2016
MSCI Fixed Income Analytics is built to meet a series of client requirements.
FIXED INCOME RESEARCH INITIATIVES
Current and Future Successes

• New Fixed Income Factor Model (phase 2: Nov 2016)
• Integration of Barra and RiskMetrics Models (ongoing effort)
• Bank Loan Model (Nov 2016, Q2 2017)
• Systematic Strategy Factors (e.g. carry, value, trend) (2017)
• Advanced Modeling for High Yield and Distressed (2017)
MSCI INTEGRATED ANALYTICS

- Risk Reporting
- Macroeconomic models
- GDP GROWTH
- INFLATION
- EQUITY
- RATES
- CREDIT
- REAL ASSETS
- PURE ALTS
- INFLATION
- GLOBAL COUNTRY FACTORS
- GLOBAL RATES
- GLOBAL VALUE
- GLOBAL BANKS
- GLOBAL SPREADS
- PRIVATE ASSETS
- EQUITY STYLES
- EQUITY INDUSTRIES
- KEY RATES
- CREDIT SPREADS
- PRIVATE ASSETS
- EQUITY TIME SERIES
- ISSUER CURVES
- MUNICIPAL CURVES
- KEY RATE DURATIONS
- IMPLIED VOLATILITY SURFACES
- COMMODITY PRICES

- Asset Allocation and Total Plan Risk Budgeting
- Integrated Factor models
- Horizon
- 3 YEARS +
- 1 YEAR
- 1 MONTH
- 1 DAY

- Risk Management
- Portfolio Management
- Board Reporting

- Equity
- Fixed Income
- Derivatives
- Private Assets
INTEGRATING FIXED INCOME ANALYTICS

Link RiskMetrics with Barra factor analytics

- Asset coverage, pricing models, curves, data ...
- Connect layers of the investment “pyramid”
- Deliver RiskManager positions into BarraOne
- Allow BarraOne access to pricing models in RiskManager

Benefits to Clients

- Improved single security analytics and portfolio risk models
- Integrated solution to address needs of both risk managers and front office decision makers
- Industry standard fixed income models
NEW MODEL FOR BANK LOANS

Data
• Partnership with Markit
• Unequaled access to best-in-class leveraged loan data

Pricing
• Joint treatment of call and default risk
• Better modeling of amortization, floors, revolving credit and prepayments

Curves and factors
• Improved curves structure with region/lien/credit quality/sector differentiation

New statistics
• Probability of default, probability of prepayment, spread to maturity

Current Bank Loan Market

<table>
<thead>
<tr>
<th>Currency</th>
<th>Par Amount (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>1,370</td>
</tr>
<tr>
<td>EUR</td>
<td>107</td>
</tr>
<tr>
<td>GBP</td>
<td>20</td>
</tr>
<tr>
<td>HKD</td>
<td>20</td>
</tr>
<tr>
<td>NOK</td>
<td>7</td>
</tr>
<tr>
<td>JPY</td>
<td>5</td>
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<tr>
<td>CAD</td>
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</tr>
<tr>
<td>DKK</td>
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</tr>
<tr>
<td>SEK</td>
<td>1</td>
</tr>
<tr>
<td>PLN</td>
<td>0.3</td>
</tr>
<tr>
<td>AUD</td>
<td>0.3</td>
</tr>
<tr>
<td>CHF</td>
<td>0.1</td>
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</table>

Source: Markit
NEW FIXED INCOME FACTOR MODEL
NEW FIXED INCOME FACTOR MODEL: BRIDGING THE NEEDS OF PORTFOLIO & RISK MANAGERS

Intuitive Factors (examples)

- Key Rate Durations
- OAS as forward indicator of spread risk
- Breakeven-Inflation
- Basis risk (CDS & Bond, OTR & OFTR Tsy)
- EUR spreads calculated to the German government curve

Designed to assist in portfolio construction, hedging and rebalancing

Based on deep experience in modeling factors combined with rigorous validation process
NEW FIXED INCOME FACTOR MODEL

Fixed Income Risk

- Rates (KRDs)
- Break-even Inflation
- Spread
- Volatility
- Basis

Swap
Corporate*
Emerging Market*
Euro Sovereign*
MBS ABS* CMBS*

* Duration x Spread (DTS) models
**WHAT IS DTS?**

Asset exposure to credit risk is “Duration Times Spread” (DTS)

\[ X = D \times s \]

- Higher-spread = higher risk exposure
- Factors reflect *relative* changes in spread
- Rigorous empirical validation of model

**Absolute Spread Based Risk**

Forecast \( \sigma(\Delta OAS) \approx \text{Historical } \sigma(\Delta OAS) \) \( \leftarrow \) Backward Looking

**Relative Spread Based Risk (DTS)**

Forecast \( \sigma(\Delta OAS) \approx \text{Current OAS} \times \text{Historical } \sigma \left( \frac{\Delta OAS}{OAS} \right) \) \( \leftarrow \) Forward Looking
OAS as forward-looking risk indicator
- Reflects changing quality immediately
- Reduces dependence on rating agencies
- Recognizes return to market calm after crises
# EXAMPLE: EURO FACTORS

**Yield Curve**

<table>
<thead>
<tr>
<th>Rates</th>
<th>Swap</th>
<th>Inflation¹</th>
</tr>
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<tbody>
<tr>
<td>1M</td>
<td>1M</td>
<td>1Y</td>
</tr>
<tr>
<td>6M</td>
<td>6M</td>
<td>2Y</td>
</tr>
<tr>
<td>1Y</td>
<td>1Y</td>
<td>5Y</td>
</tr>
<tr>
<td>2Y</td>
<td>2Y</td>
<td>10Y</td>
</tr>
<tr>
<td>5Y</td>
<td>5Y</td>
<td>20Y</td>
</tr>
<tr>
<td>10Y</td>
<td>10Y</td>
<td>30Y</td>
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<tr>
<td>20Y</td>
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<td>30Y</td>
<td>30Y</td>
<td></td>
</tr>
<tr>
<td>50Y</td>
<td>50Y</td>
<td></td>
</tr>
</tbody>
</table>

**Sovereign Spread**

- Austria
- Belgium
- Finland
- France
- Ireland
- Italy
- Netherlands
- Portugal
- Spain
- EU Other

¹/We have additional inflation factors for Germany, France and Italy

**Credit**

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Country</th>
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<tbody>
<tr>
<td>EU Financials IG</td>
<td>Austria</td>
</tr>
<tr>
<td>EU Banking IG</td>
<td>Belgium</td>
</tr>
<tr>
<td>EU Capital Markets IG</td>
<td>Finland</td>
</tr>
<tr>
<td>EU Diversified Financials IG</td>
<td>France</td>
</tr>
<tr>
<td>EU Insurance IG</td>
<td>Germany</td>
</tr>
<tr>
<td>EU Real Estate IG</td>
<td>Ireland</td>
</tr>
<tr>
<td>EU Financials HY</td>
<td>Italy</td>
</tr>
<tr>
<td>EU Industrials</td>
<td>Luxembourg</td>
</tr>
<tr>
<td>EU Capital Goods IG</td>
<td>Netherlands</td>
</tr>
<tr>
<td>EU Services IG</td>
<td>Portugal</td>
</tr>
<tr>
<td>EU Consumer Discretionary</td>
<td>Spain</td>
</tr>
<tr>
<td>EU Auto IG</td>
<td></td>
</tr>
<tr>
<td>EU Consumer Staples</td>
<td></td>
</tr>
<tr>
<td>EU Food IG</td>
<td></td>
</tr>
<tr>
<td>EU Energy</td>
<td></td>
</tr>
<tr>
<td>EU Oil &amp; Gas IG</td>
<td></td>
</tr>
<tr>
<td>EU Telecoms</td>
<td></td>
</tr>
<tr>
<td>EU Diversified Telecoms IG</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU Utilities</td>
<td></td>
</tr>
<tr>
<td>EU Electric Utility IG</td>
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</tr>
<tr>
<td>EU Materials</td>
<td></td>
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<tr>
<td>EU Health Care</td>
<td></td>
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<tr>
<td>EU Information Technology</td>
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<tr>
<td>EU Transportation</td>
<td></td>
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<tr>
<td>EU Agency</td>
<td></td>
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<tr>
<td>EU Supranational</td>
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<tr>
<td>EU Pfandbrief</td>
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<tr>
<td>EU Covered France</td>
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<tr>
<td>EU Covered Spain</td>
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<tr>
<td>EU Other Covered</td>
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<tr>
<td>EU Local &amp; Provincial</td>
<td></td>
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<tr>
<td>EU Corporate IG</td>
<td></td>
</tr>
<tr>
<td>EU Corporate HY</td>
<td></td>
</tr>
</tbody>
</table>

**Credit Basis**

- CDS Basis IG
- CDS Basis HY

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*Example: French Bank → EU Banks IG + EU France Corporate*
• Major fixed income market models available for testing starting July 18\textsuperscript{th}

• Model has been locked down after receiving substantial client feedback and is scheduled for release on November 19th

Markets: \textit{USD, Euro, Sterling, Yen, EM models} \hspace{1cm} \textit{All FI Markets} \hspace{1cm} \textit{MSCI Integrated Model}

Select Enhancements Planned for 2017
• Bank Loans
• Basis Factors for Inflation Swaps, Tsy & FX Futures
• Nordics Credit (evaluating data)
• Integration with Equities, Private Assets & Commodities
• Systematic Strategy Factors (e.g. carry, value, trend)
• Improvements for high yield & distressed
ANALYZING A STRATEGY FOR EUROPEAN CORPORATES:

Background

Portfolio Construction

Performance Analysis
Key MSCI Tools Used to Analyze Euro Corporate Strategy

• New Fixed Income Factor Model
• Performance Attribution
• Portfolio Optimizer
• BLM Model Bid/Ask Spreads
OVERVIEW OF ECB’S CORPORATE BOND PROGRAM (CSPP)

- Corporate Sector Purchase Program announced on March 10th, 2016
- Part of the ECB’s quantitative easing program
- Purchases began on June 8th
- Purchases have been averaging approximately €2b per week
- €40b has been purchased through November 4th
- At current rate, CSPP purchases will total €77b by March 2017, or approximately 11% of the eurozone corporate bond market eligible for purchases

### Eligibility Criteria

<table>
<thead>
<tr>
<th>ECB Corporate Program</th>
<th>Investment Grade</th>
<th>Credit Institutions</th>
<th>Issuing Entity in Eurozone</th>
<th>Minimum Amount Outstanding</th>
<th>Fixed and Floaters</th>
<th>Senior Debt and Subordinates</th>
<th>Minimum Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>BofAML Euro Corporate Index*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>€250,000,000</td>
<td>Fixed Only</td>
<td>Yes</td>
<td>1-Year</td>
</tr>
</tbody>
</table>

*At time of ECB purchase

1 Source: BofA Merrill Lynch Global Research, used with permission
See Appendix for BofA Merrill Lynch Global Research disclaimer
SIGNIFICANT SPREAD TIGHTENING...

- Strong Euro corporate spread tightening following announcement of CSPP
- Non-ECB eligible bonds have also benefitted but not as much as ECB eligible sector
- In contrast to other sectors, bank spreads have not tightened
- ECB eligible sector is now the richest part of Euro investment grade corporate market

### OAS Trends: BofAML Euro Corporate Index

<table>
<thead>
<tr>
<th></th>
<th>Weight</th>
<th>OAS (bps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECB Eligible</td>
<td>33.5%</td>
<td>84</td>
</tr>
<tr>
<td>Banks</td>
<td>31.7%</td>
<td>118</td>
</tr>
<tr>
<td>Other</td>
<td>34.8%</td>
<td>139</td>
</tr>
</tbody>
</table>

*as of Oct 31, 2016

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1 OAS analytics and determination of ECB eligibility are from MSCI. Index source: BofA Merrill Lynch Global Research, used with permission.
AND SURGING CORPORATE BOND ISSUANCE

Net issuance of CSPP eligible issuers

SINCE ANNOUNCEMENT OF PROGRAM

MONTHLY IN € BILLIONS

Source: MSCI
AND WHAT HAS BEEN THE IMPACT ON LIQUIDITY?

- Early concerns that ECB corporate bond buying would dry-up liquidity
- As measured by bid/ask spreads, liquidity conditions have not noticeably deteriorated since launch of program

**MSCI BLM Model**
- Estimates bond bid/ask spreads
- Important variables impacting bid/ask:
  - spread duration
  - OAS
  - bond age
  - size of bond (e.g. $1 billion)
- Model being updated with coverage extended to include 460,000 bonds

*Liquidity Trends: MSCI BLM Model for Bid/Ask*

*Bid/Ask on securities underlying the BofAML Euro Corporate Index*
• ECB quantitative easing efforts scheduled to end by March 2017, but considerable market speculation that it will be extended through September 2017

• Peter Praet (Member of ECB Executive Board) 26 October 2016: “We remain committed to preserving...monetary accommodation...to secure convergence of inflation towards levels below, but close to, 2% over the medium term.”

What Should a Credit PM Do?
• The ECB eligible sector has richened this year

• But inflation is still substantially below ECB target and QE may continue past end date

• What has been the risk/reward profile of a credit spread strategy in the presence of QE?
ANALYZING A STRATEGY FOR EUROPEAN CORPORATES:

- Background
- Portfolio Construction
- Performance Analysis
Investor Persona: European Credit PM

Type of Institution
• Long Only Asset Manager

Benchmark
• BoA Merrill Lynch Euro Corporate Index

Investment Principles/Guidelines
• Focus on credit strategies
• Minimal interest rate risk
• Avoid excessive issuer concentration
• Approximate risk budget of 125 bps of annual tracking error
• Portfolio turnover not to exceed 60% per annum (5% per month)

Investment Perspective
• Risk premia exists in the corporate bond market. High spread bonds will outperform low spread bonds over longer periods of time.
• Banks, the largest sector in the index, are a tough investment call given lack of balance sheet transparency and the potential for government intervention
• Starting at the beginning of 2016, PM has a moderately positive view on the market
Portfolio Construction: Setup

- Maximize \(\{\text{Return Forecast} - \text{Risk Aversion} \times \text{Active Risk}\}\)

Subject to:
- Tracking Error: 90 bp – 150 bp
- No more than 5% turnover per month
- Term structure risk to be no greater than 10% of active risk
- Banking weight limited to 37% (1.15 x Benchmark’s Banking Weight)
- No single issuer should have more than 2% weight in portfolio
- Minimize trade size is less than the minimum in the portfolio
- No more than 600 bonds in portfolio (index has 2100+ bonds)

- Return forecast is derived from [OAS – BLM model bid/ask spread]

- Risk Aversion parameter moves between 0 to 1
  - The higher the value, the less risk you are willing to take

- Monthly rebalancing at month-end

- Portfolio securities must belong to BofAML Euro Corporate Index
BARRA OPTIMIZER

- Developed in-house resulting from over two decades of dedicated research
- Takes advantage of the special structure of multi-factor risk models employed by many portfolio managers
- Incorporates proprietary solvers with innovative, high-quality heuristic techniques to certain ill-behaved, complex portfolio optimization problems

Types of Optimization supported:
- Standard Mean-Variance Optimization
- Maximizing the Sharpe Ratio or Information Ratio
- Threshold and Cardinality Optimization
- Risk Parity Portfolio Construction
- Risk Constrained Optimization
- Portfolio Construction with Diversification Control
- Long/Short (Hedge) Optimization
- After-Tax Optimization
EXAMPLE OF OPTIMIZATION PARAMETERS

Optimization Types

- **Standard**
- **Risk Target**
- **Long/Short**
- **Efficient Frontier**

Types of Constraints

- **Include Benchmark in Universe**
- **Allow Short**
- **Transaction Costs**

**Optimization Parameters**

- Asset Returns
- Cash In/Out: 0.00
- Selection Risk Multiplier: 1.00

**Basic Constraints**

- Max # Assets
- Min Holding(%)
- Min Trade(%)
- Max Trade(%)
- Max Turnover(%)
- Max Transaction Cost(%)

**Holdings Bounds**

- Asset Bounds
- Cash Position(%): 0.00
- Non-Cash Assets(%)

**Conditional Holding Rule**

- Portfolio Return(%)

- Risk Budgeting Constraints
PORTFOLIO CONSTRUCTION WORKFLOW

Initial Implementation

- Cash (10 Million Euros)
- Optimization
- Initial Portfolio (Jan 1 2016)

Rebalance Process

- Starting Portfolio
- Risk / Compliance Check
- Risk Monitoring
- Month-end Optimization
- Starting Portfolio

MSCI
• Portfolio OAS in excess of index OAS by 70-100 bps
• Total Assets in portfolio ranges from 501 - 600

1 OAS analytics from MSCI
Index Source: BofA Merrill Lynch Global Research, used with permission
Ex-ante tracking error ranges between 91 bp to 135 bps
• Non-bank, ECB ineligible bonds (non-eurozone issuers and subordinates) are significantly over-weighted in the portfolio.

• Weight on ECB eligible bonds has fallen over the year as their OAS has tightened sharply.
• Tracking error driven by spread risk (Average Contribution from spread = 90%)
• Term Structure risk limited to a max of 10% of active risk, as per constraint
DRIVERS OF SPREAD RISK: BET ON INSURANCE
We are significantly overweighted in the subordinated debt segment and are making bond selection bets in this segment.
### EXAMPLE OF OUTPUT: SPREAD EXPOSURE AND RISK

<table>
<thead>
<tr>
<th>Factor</th>
<th>Volatility</th>
<th>Active Exposure</th>
<th>Active Risk</th>
<th>Cont. to AR (Residual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU Insurance IG</td>
<td>23.03</td>
<td>0.01826</td>
<td>0.42042</td>
<td>0.35321</td>
</tr>
<tr>
<td>EU Materials</td>
<td>26.67</td>
<td>0.00514</td>
<td>0.13709</td>
<td>0.11341</td>
</tr>
<tr>
<td>EM Spread</td>
<td>22.05</td>
<td>0.00835</td>
<td>0.18423</td>
<td>0.11176</td>
</tr>
<tr>
<td>EU Financials HY</td>
<td>25.30</td>
<td>0.00434</td>
<td>0.10973</td>
<td>0.08948</td>
</tr>
<tr>
<td>EU Banks IG</td>
<td>24.61</td>
<td>0.00389</td>
<td>0.09580</td>
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</tr>
<tr>
<td>EU Other Financials IG</td>
<td>24.92</td>
<td>0.00331</td>
<td>0.08243</td>
<td>0.06796</td>
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<tr>
<td>GB Materials</td>
<td>22.18</td>
<td>0.00609</td>
<td>0.13501</td>
<td>0.06505</td>
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<tr>
<td>EU Agency</td>
<td>26.48</td>
<td>0.00190</td>
<td>0.05034</td>
<td>0.03365</td>
</tr>
<tr>
<td>GB Banks IG</td>
<td>24.21</td>
<td>0.00169</td>
<td>0.04103</td>
<td>0.02676</td>
</tr>
<tr>
<td>EU Consumer Staples</td>
<td>22.71</td>
<td>0.00145</td>
<td>0.03282</td>
<td>0.02391</td>
</tr>
</tbody>
</table>

- EU Insurance IG is the biggest contributor to spread risk (35 bps)
• Tracking error drops substantially in September – why?
**AUGUST RISK DELTA – WHY DID RISK CHANGE?**

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Total Risk</td>
<td>0.95</td>
<td>1.23</td>
<td>-0.26</td>
<td>-0.01</td>
<td>-0.01</td>
</tr>
<tr>
<td>Local Market Risk</td>
<td>0.95</td>
<td>1.23</td>
<td>-0.26</td>
<td>-0.01</td>
<td>-0.01</td>
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<tr>
<td>Market Timing</td>
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<td>Common Factor</td>
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<td>1.18</td>
<td>-0.26</td>
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<tr>
<td>Term Structure</td>
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<td>0.00</td>
<td>0.09</td>
<td>0.00</td>
<td>-0.04</td>
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<tr>
<td>Implied Volatility</td>
<td>0.03</td>
<td>0.03</td>
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<tr>
<td>Spread</td>
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<td>1.15</td>
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<td>EU Insurance IG</td>
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<td>Selection Risk</td>
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<td>0.05</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.01</td>
</tr>
</tbody>
</table>

- Insurance factor exposure drives 15 bps of the change in risk
- OAS for Insurance sector went down starting 8/31 and consequently the optimizer decreased its weight – OAS increased the next month and we loaded back up on it
PORTFOLIO EXPOSURE SNAPSHOT (AUG 31)

<table>
<thead>
<tr>
<th>Group</th>
<th>Active Weight(%)</th>
<th>Total Contribution</th>
<th>Allocation Risk Contribution</th>
<th>Selection Risk Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial</td>
<td>13.65%</td>
<td>0.62</td>
<td>0.07</td>
<td>0.56</td>
</tr>
<tr>
<td>Securitized</td>
<td>-0.04%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Utility</td>
<td>-3.88%</td>
<td>0.08</td>
<td>0.01</td>
<td>0.07</td>
</tr>
<tr>
<td>Industrials</td>
<td>-10.11%</td>
<td>0.24</td>
<td>0.03</td>
<td>0.21</td>
</tr>
<tr>
<td><strong>Active Total Risk</strong></td>
<td><strong>0.00%</strong></td>
<td><strong>0.95</strong></td>
<td><strong>0.13</strong></td>
<td><strong>0.82</strong></td>
</tr>
</tbody>
</table>

Zooming to Financial Merrill sector¹

<table>
<thead>
<tr>
<th></th>
<th>Active Weight(%)</th>
<th>Total Contribution</th>
<th>Allocation Risk Contribution</th>
<th>Selection Risk Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insurance</td>
<td>6.77%</td>
<td>0.37</td>
<td>0.19</td>
<td>0.18</td>
</tr>
<tr>
<td>Banking</td>
<td>4.94%</td>
<td>0.24</td>
<td>0.01</td>
<td>0.24</td>
</tr>
</tbody>
</table>

- Big over-weight in Financial Sector and more specifically in Insurance and Banking
- Different bets in both sectors – Insurance equally split between sector allocation and bond selection
- Banking purely sector allocation

¹ Sector source: BofA Merrill Lynch Global Research, used with permission
### DRIVERS OF SPREAD RISK: BET ON INSURANCE

<table>
<thead>
<tr>
<th>Date</th>
<th>Sector</th>
<th>Active Weight(%)</th>
<th>Total Contribution</th>
<th>Allocation Risk Contribution</th>
<th>Selection Risk Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/1/16</td>
<td>Insurance</td>
<td>9.11%</td>
<td>0.49</td>
<td>0.25</td>
<td>0.24</td>
</tr>
<tr>
<td>10/1/16</td>
<td>Insurance</td>
<td>9.15%</td>
<td>0.54</td>
<td>0.27</td>
<td>0.27</td>
</tr>
<tr>
<td>9/1/16</td>
<td>Insurance</td>
<td>6.75%</td>
<td>0.36</td>
<td>0.19</td>
<td>0.18</td>
</tr>
<tr>
<td>8/1/16</td>
<td>Insurance</td>
<td>8.60%</td>
<td>0.55</td>
<td>0.28</td>
<td>0.27</td>
</tr>
<tr>
<td>7/1/16</td>
<td>Insurance</td>
<td>8.12%</td>
<td>0.53</td>
<td>0.27</td>
<td>0.25</td>
</tr>
<tr>
<td>6/1/16</td>
<td>Insurance</td>
<td>7.86%</td>
<td>0.47</td>
<td>0.20</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Insurance sector has the highest overweight in the portfolio
Equal bet on sector allocation and bond selection
• The high OAS spread strategy subject to constraints has been consistently applied for each month in 2016 YTD

• Over the course of the year, the optimizer increased the weight on ECB ineligible, non-bank bonds (particularly subordinates from the Insurance sector) and reduced the weight on ECB eligible bonds

• As of the end of October:
  – The portfolio was overweighting the ECB ineligible, non-bank sector by 19 percentage points and was underweighting the ECB eligible sector by 25 percentage points
  – Insurance and Banking comprised almost two-thirds of the portfolio’s active risk
ANALYZING A STRATEGY FOR EUROPEAN CORPORATES:

Background
Portfolio Construction
Performance Analysis
QUESTIONS ON OUR CLIENTS’ MINDS

How can I attribute the performance of a credit spread strategy?

How did the ECB’s Corporate Sector Purchase Program (CSPP) impact the market?

How does MSCI’s solution allow us to smoothly transition from our current system and what is your roadmap?

Answering these questions requires a **Fixed Income Performance Attribution** solution that is accurate, granular, and flexible.
INTEGRATED ANALYSIS ON ONE SYSTEM

- Holdings & transactions loaded into one system only
- Multiple Analytics Solutions
- Increased efficiency and reduced total cost of software

- Impossible to carry out risk and performance attribution in an integrated fashion if multiple systems are used from separate vendors
CORRESPONDENCE BETWEEN RISK AND PERFORMANCE

- Sources of risk correspond to drivers of return

- Carry corresponds to the “knowable” portion of return
- Risk is in excess of carry
HYBRID FI PA MODEL WITH FLEXIBLE SPREAD ATTRIBUTION

Active Base Return

Model Base Return
Trading Impact
Pricing Impact
Look Through Impact
Benchmark Residual

Currency Return
Local Return

Income Return
Paydown Return
Clean Price Return

Rolldown
Term Structure Change
Spread Change
Unexplained

Capture impact of term structure allocation decisions
- Made through precise yield curve positioning
- Parallel / Non Parallel bets

Capture impact of credit spread investment decisions
- Spread duration positioning
- Sector management
- Issue selection
Contribution to OASD exposures

• Tie back return to distinct drivers of fixed income return
• Return components provide a granular decomposition of local return
Flexible multi-level partitioning to tie back attribution results to the investment process

- Native vendor sector classifications
  - Bloomberg Barclays, BoA ML, JPM, Citi, Markit iBoxx, S&P, Moodys,
  - Country, Coupon, Currency, ID, Inst. Type, Issuer

- Analytics
  - Dollar Duration, Duration to Worst, Effective Duration (OAD), KRDs, Macaulay Duration, Modified Duration, Spread Duration (OASD), Spread Dollar Duration, SKRDs, Weighted Average Life, Convexity (OAC), Spread Convexity (OASC), Theta, Vega, Inflation DV01/KRDs
  - OAS (bp), OAS to Swap (bp)
  - Current Yield, Yield to Best (%), Yield to Maturity (%), Yield to Next (%), Yield to Worst (%), Yield to 1-year prior/18m,3y,4y
  - Time to Maturity and Time to Coupon

- Using the Formula Builder with user tags and system attributes
  - IF([ECB Eligible Bond]='ECB Eligible Bond','Eligible','Non Eligible')
  - IF([AssetAttribute::Merrill Sector Class 3]='Banking','Banking','Others')

- Flexible reporting horizon
  - MTD, QTD, YTD, trailing 1 month, 3 month, 6 month, 1 year, 3 year, 5 year
  - Based on any custom reporting period from 1 day up to 5 years
• Active performance was high at 1.39% YTD
  – Outperformance after the announcement of the CSPP
  – Performance was also high on a risk-adjusted basis
IMPACT OF SPREAD MANAGEMENT DECISIONS

Spread Duration Positioning, Sector Management and Issue selection outperformance

- Issue selection was the dominant driver of outperformance
- Then spread duration market exposure
- Sector management provide only a small contribution
### DASHBOARD WITH EXPOSURES, RISK AND PERFORMANCE

#### EURO Corporate Bond Portfolio vs. BofAML Euro Corporate Bond Index

<table>
<thead>
<tr>
<th>Rating</th>
<th>Active Average OAS (bp)</th>
<th>Active Average Cont. to OASD (yr)</th>
<th>ACTIVE TERM STRUCTURE</th>
<th>ACTIVE SPREAD</th>
<th>SELECTION</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>96.03</td>
<td>-0.06</td>
<td>18.9</td>
<td>-6.8</td>
<td>-18.6</td>
<td>83.1</td>
</tr>
<tr>
<td>Eligible</td>
<td>65.13</td>
<td>-1.25</td>
<td>-</td>
<td>-2.5</td>
<td>-53.7</td>
<td>-</td>
</tr>
<tr>
<td>Banks</td>
<td>66.16</td>
<td>0.03</td>
<td>3.3</td>
<td>-5.0</td>
<td>-2.4</td>
<td>9.1</td>
</tr>
<tr>
<td>Others</td>
<td>91.95</td>
<td>1.15</td>
<td>15.6</td>
<td>1.3</td>
<td>37.5</td>
<td>74.0</td>
</tr>
<tr>
<td>BBB3</td>
<td>34.95</td>
<td>0.65</td>
<td>0.0</td>
<td>1.7</td>
<td>30.9</td>
<td>32.9</td>
</tr>
<tr>
<td>BBB2</td>
<td>81.42</td>
<td>0.43</td>
<td>5.0</td>
<td>-1.4</td>
<td>18.8</td>
<td>12.5</td>
</tr>
<tr>
<td>BBB1</td>
<td>82.7</td>
<td>0.14</td>
<td>1.0</td>
<td>0</td>
<td>6.2</td>
<td>8.9</td>
</tr>
<tr>
<td>BB2</td>
<td>65.53</td>
<td>0.01</td>
<td>-1.1</td>
<td>0</td>
<td>0</td>
<td>3.3</td>
</tr>
<tr>
<td>A2</td>
<td>60.74</td>
<td>0.02</td>
<td>2.4</td>
<td>0</td>
<td>0</td>
<td>5.8</td>
</tr>
</tbody>
</table>

- **Risk** as of start of analysis and **Performance** for Dec 31 to Oct 31
- Exposure tilted toward lower rated bonds within “Others” Non-ECB, Non-Bank → Top Performing Sector
  - Top contributors shown this top performing sector
  - Risk mainly from common factor spread risk
  - Performance was driven by main source of risk

---

1 Performance and risk analytics from MSCI

Index source: BofA Merrill Lynch Global Research, used with permission
**Pricing Impact** from different price sources for common assets in the portfolio & benchmark, attribution in summary and for drilldown at asset, and group level

**Trading Impact** from differences in traded prices and closing prices – also available down to position-level attribution
HYBRID FI PA MODEL WITH FLEXIBLE SPREAD ATTRIBUTION

Year to Date  [31 Dec, 2015 - 31 Oct, 2016]

Active Base Return 139 bps

Model Base Return 140.5 bps

Trading Impact

Pricing Impact -1.5 bps

Look Through Impact

Benchmark Residual

Currency Return

Local Return 140.5 bps

Income Return 42.8 bps

Paydown Return 0.1 bps

Clean Price Return 97.6 bps

Rolldown 30.4 bps

Term Structure Change -18.6 bps

Spread Change 77.2 bps

Unexplained 8.6 bps

Spread Market Exposure 23.1 bps

Spread Allocation -4.5 bps

Spread Selection 58.6 bps

• Have we captured return from spreads mean reverting?

Spread change contributes 79% of clean price change return

Issue selection the No.1 driver

Carry return decomposed into income and rolldown
HYBRID FI PA MODEL WITH FLEXIBLE SPREAD ATTRIBUTION

Year to Date [31 Dec, 2015 - 31 Oct, 2016]

Active Base Return 139 bps

Model Base Return 140.5 bps

Currency Return

Local Return 140.5 bps

Trading Impact

Pricing Impact -1.5 bps

Look Through Impact

Benchmark Residual

Paydown Return 0.1 bps

Term Structure -25.4 bps

Term Structure Carry -6.8 bps

Term Structure Change -18.6 bps

Spread 157.2 bps

Spread Carry 80 bps

Spread Change 77.2 bps

Spread Market Exposure 23.1 bps

Spread Allocation -4.5 bps

Spread Selection 58.6 bps

Unexplained 8.6 bps

Carry return decomposed into term structure and spread carry

Spread carry and spread change return together is the major contributor to outperformance
TERM STRUCTURE CHANGE RETURN

• Term Structure Change Return
  – Captured using an exposure-based approach
  – Return due to term structure exposure and observed shift at each rate in the relevant curve

\[ R_{j,t}^{\text{term structure}} = - \sum_{k=1}^{K} KRD_{k,j,t} \Delta y_{k,j,t} \]

- Key-Rate Duration at key rate \( k \)
- Change in key rate \( k \)

- Decomposed into term structure key rate returns

\[ R_{k,j,t}^{\text{key rate}} = -KRD_{k,j,t} \Delta y_{k,j,t} \]

• Insight into term structure key rate returns
  – Positive if key rates decrease
  – Negative if key rates increase
  – Magnitude depends on the sensitivity
Yield curve positioning

- Active EUR Gov. yield curve exposure
- Initial curve negative below 5y rate
- Flattening at long end
- Attribution of the -19 bps of active term structure change return
• Spread Change Return
  – Captured using an exposure-based approach
  – Driven by spread exposure and shift in asset option adjusted spread (OAS)

\[ R_{j,t}^{spread} = -D_{j,t}^s \Delta S_{j,t} \]

- Spread Duration of asset \( j \)
- Change in OAS to Base of asset \( j \)

- Tightening credit spreads lead to higher asset prices and positive spread return
- Widening credit spreads lead to lower asset prices and negative spread return
- Magnitude depends on sensitivity, i.e. the spread duration
MONTHLY TREND IN PERFORMANCE ATTRIBUTION

Where spreads tightened significantly

(Spread Change) outperformance was largest during March

OAS Trends: BofAML Euro Corporate Index

1 Performance and risk analytics from MSCI
Index source: BofA Merrill Lynch Global Research, used with permission
**HOW DID THE ECB’S CSPP PROGRAM IMPACT THE MARKET (INDEX)?**

- **March: all spreads tightened, all sectors gained**
  - 135 bps benchmark return
  - 155 bps from changes in spreads

- **Largest exposure to Non-Eligible Non-Bank bonds (Others)**
  - Spreads decreased by 41 bps from 180 bps
  - Gained 70 bps in spread contribution

- **ECB bonds gained 54 bps, and Banks 31 bps**
HOW DID THE ECB’S CSPP PROGRAM IMPACT THE MARKET (INDEX)?

- **June:** spreads widened but ECB spread widened less than Non-ECB
  - 103 bps benchmark return
  - -58 bps from changes in spreads

- Largest exposure to Non-Eligible Non-Bank bonds (Others)
  - **Spreads increased** by 7bps from 169 bps
  - Lost 33 bps in spread contribution

- ECB bonds gained 1 bp, and Banks lost 26 bps
ISOLATE TOP PERFORMING BONDS IN MARCH

Use the heat map to drill into the bonds within each bucket...

...and the table shows more results for bonds selected

BBB3 bond saw a marked decrease in OAS
AND LARGEST DETRACTORS IN JUNE

- Extremely easy to identify contributors and investigate bond level results

BBB1 bond with large OAS saw its spread increase further
• Investment strategy to select high OAS bonds outperformed the benchmark
  – Issue selection was the dominant driver of outperformance
  – Overweighting high OAS, non-ECB non-bank paid off in the long run
  – Performance was driven by main source of risk
  – Could have neutralized term structure risk better

• The ECB’s CSPP program impacted the whole market
  – All spreads tightened initially particularly ECB eligible bonds
  – March: Non-ECB bonds largest contributor to market performance
  – June: Non-ECB bonds largest detractor to market performance
PERFORMANCE ANALYTICS ROADMAP
MODEL EVOLUTION:
CONSISTENT INVESTMENT IN FI ANALYTICS

- **2008**
  - Initial FI PA model released, term structure KRD effects & allocated spread return from residual
- **2011**
  - Returns Calculator introduced for limited instrument types
- **2013**
  - Income, Paydown, and Rolldown Return
  - **Index data integrity ensured for 20,000+ indexes across 30+ vendors**
  - **Returns Calculator coverage expanded to 100+ instrument types**
  - Look through for futures, composite, swaps & forwards
- **2014**
  - Visualization dashboards and returns/attribution results storage
  - Spread change return captured explicitly using change in OAS and spread duration
  - Multi-level portfolio partitioning, & 60+ FI-specific system grouping schemes
- **2016**
  - **Transaction-based and trading impact**
  - **Price source flexibility and Pricing Impact**
  - Precomputed analytics for common FI indexes
  - Currency hedging, Spread return for credit derivatives, Callable bonds valued to next call date
- **2017**
  - Term Structure Carry, Spread Carry, Convexity, Spread Convexity, repriced TS and OAS effects
  - DTS mismatch, DTS common factors, alignment with FI400 risk model, BEI, Implied Vol, Basis
**4th Generation Fixed Income Performance Attribution**

- **Existing FI PA model** is used extensively by many BarraOne clients
- **Strategic model enhancements** to help ensure a smooth transition for POINT clients*
- **Add flexibility, extend granularity and accuracy** with reduction in unexplained return
- **More enhancements to be added in 2017**
  - DTS Attribution
  - Further consistency with FI400 risk model
  - RiskServer valuations in PA

---

*Enhancements also benefit existing clients and clients switching from any vendor*
- **Add flexibility**, extend **granularity** and **accuracy** with reduction in unexplained return.

- Introducing:
  - Carry Return Decomposition
    - Term Structure Carry, Spread Carry Return
    - Income, Pull-to-Par, Rolldown Return
  - Term Structure Change Return & Spread Change Return
    - More accurate using repricing
    - More granular with convexity, duration and “rest of”
  - Unexplained Return reduced

- **Highlighted results** will be different from the 3rd generation FI PA model

---

### Carry Return Decomposition & Enhanced Curve Change and Spread Change Decomposition: UAT Q4 2016

<table>
<thead>
<tr>
<th>Return Decomposition</th>
<th>Current FI PA</th>
<th>FI PA 2.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Return</td>
<td>50 bp</td>
<td>50 bp</td>
</tr>
<tr>
<td>Trading Impact</td>
<td>2 bp</td>
<td>2 bp</td>
</tr>
<tr>
<td>Pricing Impact</td>
<td>1 bp</td>
<td>1 bp</td>
</tr>
<tr>
<td>Look Through Impact</td>
<td>0 bp</td>
<td>0 bp</td>
</tr>
<tr>
<td>Model Base Return</td>
<td>47 bp</td>
<td>47 bp</td>
</tr>
<tr>
<td>Currency Return</td>
<td>4 bp</td>
<td>4 bp</td>
</tr>
<tr>
<td>Local Return</td>
<td>43 bp</td>
<td>43 bp</td>
</tr>
<tr>
<td>Paydown Return</td>
<td>3 bp</td>
<td>3 bp</td>
</tr>
<tr>
<td>Carry Return</td>
<td>NA</td>
<td>12 bp</td>
</tr>
<tr>
<td>Term Structure Carry Return</td>
<td>NA</td>
<td>3 bp</td>
</tr>
<tr>
<td>Spread Carry Return</td>
<td>NA</td>
<td>3 bp</td>
</tr>
<tr>
<td>Income Return</td>
<td>8 bp</td>
<td>8 bp</td>
</tr>
<tr>
<td>Pull-to-Par Return</td>
<td>NA</td>
<td>2 bp</td>
</tr>
<tr>
<td>Rolldown Return</td>
<td>4 bp</td>
<td>2 bp</td>
</tr>
<tr>
<td>Market Change Return</td>
<td>28 bp</td>
<td>28 bp</td>
</tr>
<tr>
<td>Term Structure Change Return</td>
<td>4 bp</td>
<td>5 bp</td>
</tr>
<tr>
<td>Term Structure KFRD Return</td>
<td>4 bp</td>
<td>4 bp</td>
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<tr>
<td>01M Return</td>
<td>0 bp</td>
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<td>03M Return</td>
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<td>06M Return</td>
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<td>01Y Return</td>
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<td>02Y Return</td>
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<td>20Y Return</td>
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<td>30Y Return</td>
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<td>40Y Return</td>
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<tr>
<td>50Y Return</td>
<td>0 bp</td>
<td>0 bp</td>
</tr>
<tr>
<td>Term Structure Convexity Return</td>
<td>NA</td>
<td>1 bp</td>
</tr>
<tr>
<td>Rest of Term Structure Return</td>
<td>NA</td>
<td>1 bp</td>
</tr>
<tr>
<td>Spread Change Return</td>
<td>13 bp</td>
<td>19 bp</td>
</tr>
<tr>
<td>Spread Duration Return</td>
<td>13 bp</td>
<td>13 bp</td>
</tr>
<tr>
<td>Spread Convexity Return</td>
<td>NA</td>
<td>4 bp</td>
</tr>
<tr>
<td>Rest of Spread Return</td>
<td>NA</td>
<td>2 bp</td>
</tr>
<tr>
<td>Unexplained Return</td>
<td>11 bps</td>
<td>3 bps</td>
</tr>
</tbody>
</table>

Illustrative results for a corporate bond
CARRY RETURN DECOMPOSITION & ENHANCED CURVE CHANGE AND SPREAD CHANGE DECOMPOSITION: UAT Q4 2016

• Alternative decompositions according to investment process & granularity required
  – Carry return distinct from market change return or within overall term structure and spread return
  • View impact of time and market change within curve and spread return
  • Or separate out carry and market change impact & view income, rolldown and pull-to-par

• Highlighted results will be different from the 3rd generation FI PA model

Illustrative results for a corporate bond
HYBRID FI PA MODEL WITH TOP-DOWN SPREAD CARRY AND DTS ATTRIBUTION: ROADMAP Q2 2017

Capture impact of sector management, issue selection and DTS investment decisions

Using top-down Spread Carry & DTS Attribution

Explain spread carry return using allocation-selection with MV weights

*Spread Change Return also decomposed as Spread Duration Return, Spread Convexity Return and Rest of Spread
HYBRID FI PA MODEL WITH COMMON FACTOR-BASED DTS ATTRIBUTION: ROADMAP H2 2017

Capture impact of FI400 common factor exposure

Using **common factor-based DTS Attribution**

**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**
  - **DTS Common Factor Return**
  - **Idiosyncratic Return**

**Unexplained Return**

Explain spread change return **DTS common factor returns** precisely aligned with FI400 risk model

BEI, Implied Vol, and Basis Return also on the roadmap for H2 2017
INCORPORATING FIXED INCOME FI400 FACTORS AND MIM FACTORS IN PERFORMANCE ATTRIBUTION

- Research in Progress
  - Plan to support all sources of MIM common factor risk in Performance Attribution
  - Equity factors already supported
  - Support FI400 common factors
  - Support private and HF common factors once data availability improves

Aligned with FI400 risk model

Prerequisite: Valuation and Returns data

Feasible to begin support for “Core” factors once FI400 common factors are incorporated
SUMMARY

• Performance Attribution for Credit Portfolios
  – Best-of-breed solution, integrated with risk, with ongoing investment enables a smooth transition from current systems
  – Flexible FI PA model captures drivers of return with reporting aligned with your investment process
  – Built on strong foundations: benchmark data integrity, market data, asset coverage, valuation engine, price source flexibility, pricing impact, trading impact

Blog: What is the future of the ECB’s corporate bond program?
Whitepaper: Analyzing Credit Alpha in an Integrated Risk and Performance Analysis
# PERFORMANCE ANALYTICS SOLUTIONS

## Best-of-Breed Solution for Fixed Income & Multi-Asset Class Integrated Risk and Performance Analytics

- **MEASUREMENT** – Portfolio gross/net return and attribution of intra-day P&L using asset-level transactions
- **ATTRIBUTION** – Granular attribution models covering all asset classes
- **APPRAISAL** – Ex post risk and risk-adjusted return measures

### MODELS

- **Fixed Income Attribution**
  Income, paydown, carry, pull-to-par, rolloff, term structure, spread return drivers captured

- **Classic Attribution**
  Allocation, selection, interaction and currency explanation, equity & MAC

- **Equity Factor Attribution**
  Align sources of equity risk and return using Barra factor models

- **Multi-Portfolio Attribution**
  Strategic and tactical allocation, manager selection, benchmark & currency mismatch

### DATA

- **Data Availability**
  - Reconciled benchmark data for 20,000+ fixed income, equity & commodity indexes
  - Daily market data
  - Fixed income terms and conditions
  - Calculated returns and analytics for 100+ instrument types

- **Data Management**
  - Portfolio administration capability
  - Management of user data and terms and conditions
  - Full user control of data import and export

### DELIVERY

- **Reporting**
  - Automated batch reporting
  - Flexible to align with any investment process
  - Trading impact & Pricing Impact
  - Contribution/attribution from portfolio to asset level
  - Look through into swaps, forwards, futures and composites
  - Currency hedging

- **Visualization**
  - Deep insight through interactive dashboards
  - View, analyze, and communicate results
  - Processed automatically based on latest market, vendor and portfolio data
CLOSING REMARKS
AN INTEGRATED VIEW OF RISK AND PERFORMANCE

The essential tools for ex-ante portfolio construction and ex-post performance evaluation

Single Security Analytics
- 100+ Pricing models
- Flexible analytics
- Granular risk drivers

Factor-Based Analytics
- Best-in-class
- Integrated MAC factors
- Flexible partitioning

Performance Analytics
- Accurate
- Granular Attribution
- Aligned to Client’s Investment Process

Portfolio Optimizer
- Mean/Variance Based
- Developed In-House
- Built from two decades of experience
APPENDIX

- Additional Performance Attribution Capabilities
- MSCI
- Disclaimers and Rights of Use
ADDITIONAL PERFORMANCE ATTRIBUTION CAPABILITIES
Daily reconciled index and constituent returns for +20,000 indexes from +30 vendors

**Fixed Income**
- Bloomberg Barclays, BoA ML, JP Morgan, Markit iBoxx, Citigroup, Nomura, FTSE, Nikko, SIX Swiss, Thompson Reuters, Bloomberg Aus Bond, China Bond, HSBC, UBS

**Equity**
- MSCI, S&P, FTSE, Russell, Australia-ASX, NASDAQ, Russell Nomura, STOXX, TOPIX

**Commodity**
- Bloomberg, Deutsche Borse, S&P

Reconciliation from at least January 1, 2009, in general and more recently for newly added indexes
BUILT-IN ASSET RETURNS CALCULATOR
Provides daily valuations, asset returns & return decomposition for fixed income

Equity
• Contract for Difference
• Equity Basket Future/Option, Equity Claim/Future/Index Future
• Equity Index Future Option, Equity Option, Warrant

Fixed Income
• ABS, CDO, CMBS, RMBS, CMO (using Intex cashflows)
• Adjustable Rate Mortgage (ARM)
• Agency Bond (U.S.)
• Bond Future, Bond Future Option, Bond Option
• Cash Flow Asset, Cash Flow Bond
• Commercial Deposit, Commercial Paper
• Convertible Bond, Convertible Preferred, Coco
• Corporate Bond (U.S. and Global)
• Credit Default Swap, Credit Default Swap Basket
• Credit Linked Note
• Duration Proxy, Eurobond (Global)
• Floating Rate Note
• Government Note/Bond, Inflation-Protected Bond
• Mortgage-Backed Security (U.S./Denmark)
• Municipal Bond (U.S.)
• Repo, Syndicated Loan
• TBA Mortgage-Backed Security

• Term Deposit
• Variable Rate Note
• Zero Coupon Swap

Interest Rate
• Cap/Floor, Eurodollar Future, Eurodollar Future Option
• Forward Rate Agreement
• Interest Rate Swap, Inflation Swap, Overnight Index Swap
• Swaption

Currency
• FX Forward, FX Future, FX Future Option, FX Option, FX Swap

Volatility
• Forward Volatility Agreement
• Variance Future, Variance Swap
• Volatility Option, Volatility Swap

Commodity
• Commodity Future, Commodity Future Option
• Commodity Index Future, Commodity Option/Spot/Swap

Other
• Certificate/Tracker
• Custom Exposure Asset
• Composite
• Link Proxy
• Total Return Swap

Equities, bonds, currencies, futures, ETFs, MFs – Returns are delivered by our data team
Alternatives such as HFs, property, PE, RE – users must supply returns
## Attribution of Trading and Pricing Impact

For Classic Brinson, Fixed Income and Equity Factor Attribution

### Transactional Return vs. End-of-Day Return
*Impact of official performance differing from end-of-day holding-based performance*
- Reported at portfolio-level and attributed to the asset-level since asset-level transactions are incorporated.

### End-of-Day Return vs. Portfolio Return using benchmark return source for common assets
*Impact of portfolio and benchmark having different price sources*
- For assets with a distinct price source for the portfolio and benchmark
- Reported at portfolio, group and asset level

### Portfolio Return using BMK source for common assets vs. Look Through for Composites and Futures
*Impact of holding composites/futures rather than their constituents/underlyings*
- For futures and composites
- Reported at portfolio, group and asset level

### Further Attribution Dependent on the Model

End-of-Day Return uses the portfolio price source for all assets – common and off-benchmark.
IMPORTANT FLEXIBILITY FOR PORTFOLIO-SPECIFIC PRICE SOURCE

Important flexibility for price sources resulting in accurate returns and capture of pricing impact

- **Flexibility** to define portfolio-specific price and FX source
- **Accurate** portfolio return uses portfolio price source for all assets – common and off-benchmark

- **Pricing Impact** from different price sources for common assets in the portfolio & benchmark

Positions report and risk analysis also benefit from flexible portfolio-specific price source driven analytics.
### Transactions Combined with Holdings

<table>
<thead>
<tr>
<th>Accurate capture of <strong>portfolio return</strong></th>
<th>Supplement asset-level attribution with <strong>transactions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time weighted rate of return following GIPS recommended calculations</td>
<td>Incorporate asset-level transactions, i.e. buys, sells, revenue, coupon, paydown, dividend, margin, etc., in PA analytics</td>
</tr>
<tr>
<td>Incorporating daily valuations, external cash flows, portfolio-level transactions, fees, taxes, commission payments, expenses</td>
<td></td>
</tr>
</tbody>
</table>

- Results in official portfolio return
- Capture impact from differences in traded prices and closing prices
- Data management tools helps clients manage and reconcile calculations
Trading Impact from differences in traded prices and closing prices
Attribution provided in the summary and for drilldown at asset, and group level
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### Americas

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<tr>
<td>Americas</td>
<td>1 888 588 4567 *</td>
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<tr>
<td>Atlanta</td>
<td>+ 1 404 551 3212</td>
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<tr>
<td>Boston</td>
<td>+ 1 617 532 0920</td>
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<tr>
<td>Chicago</td>
<td>+ 1 312 675 0545</td>
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<tr>
<td>Monterrey</td>
<td>+ 52 81 1253 4020</td>
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<td>New York</td>
<td>+ 1 212 804 3901</td>
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<td>San Francisco</td>
<td>+ 1 415 836 8800</td>
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<tr>
<td>Sao Paulo</td>
<td>+ 55 11 3706 1360</td>
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<td>Toronto</td>
<td>+ 1 416 628 1007</td>
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### Europe, Middle East & Africa

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<td>Cape Town</td>
<td>+ 27 21 673 0100</td>
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<tr>
<td>Frankfurt</td>
<td>+ 49 69 133 859 00</td>
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<td>Geneva</td>
<td>+ 41 22 817 9777</td>
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<tr>
<td>London</td>
<td>+ 44 20 7618 2222</td>
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<td>Milan</td>
<td>+ 39 02 5849 0415</td>
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<td>Paris</td>
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### Asia Pacific

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<td>China South</td>
<td>10800 152 1032 *</td>
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<tr>
<td>Hong Kong</td>
<td>+ 852 2844 9333</td>
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<tr>
<td>Mumbai</td>
<td>+ 91 22 6784 9160</td>
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<tr>
<td>Seoul</td>
<td>00798 8521 3392 *</td>
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<tr>
<td>Singapore</td>
<td>800 852 3749 *</td>
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<tr>
<td>Sydney</td>
<td>+ 61 2 9033 9333</td>
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<tr>
<td>Taipei</td>
<td>008 0112 7513 *</td>
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<td>Tokyo</td>
<td>81 3 5290 1555</td>
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* = toll free

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