

MSCI SEMINAR SERIES: FIXED INCOME INSIGHTS

Navigate the ECB's Corporate Sector Purchase Program with MSCI Fixed Income Analytics

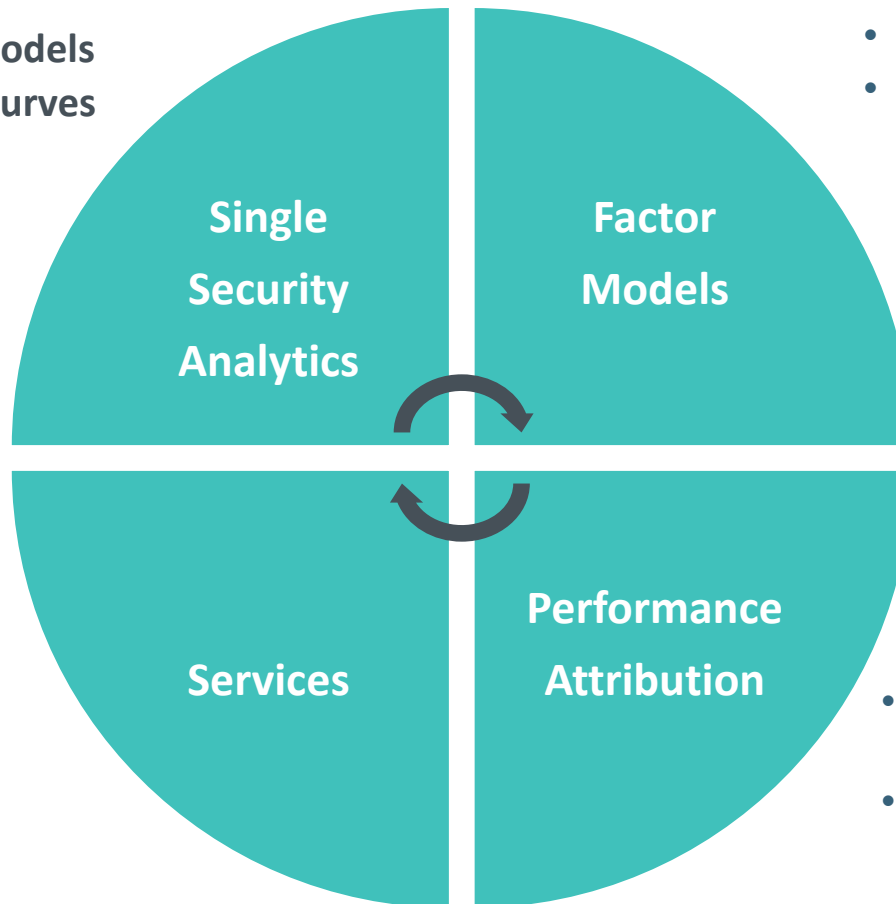


MSCI = FIXED INCOME EXPERTISE

- **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

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

Research

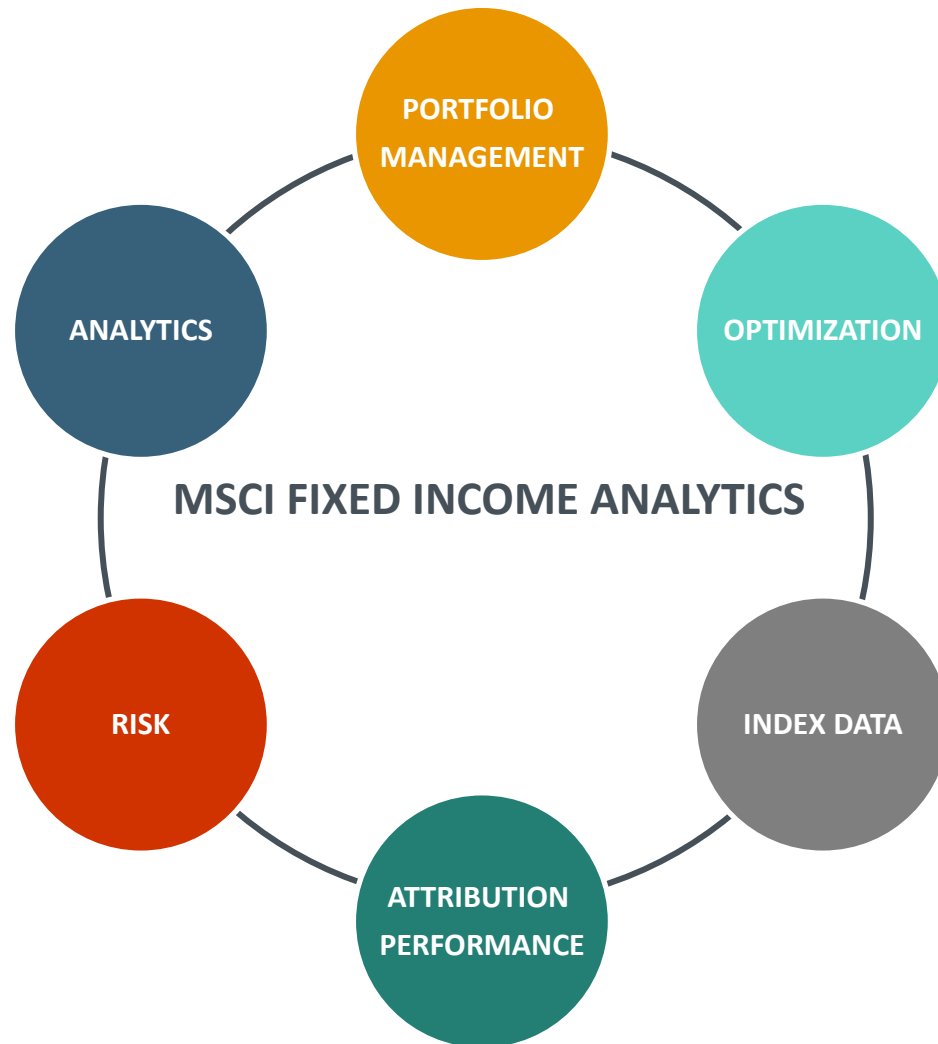
- Over 40 research staff on FI
- Majority of client consultants have advanced degrees and experience as market practitioners

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

MSCI Fixed Income Analytics is built to meet a series of client requirements



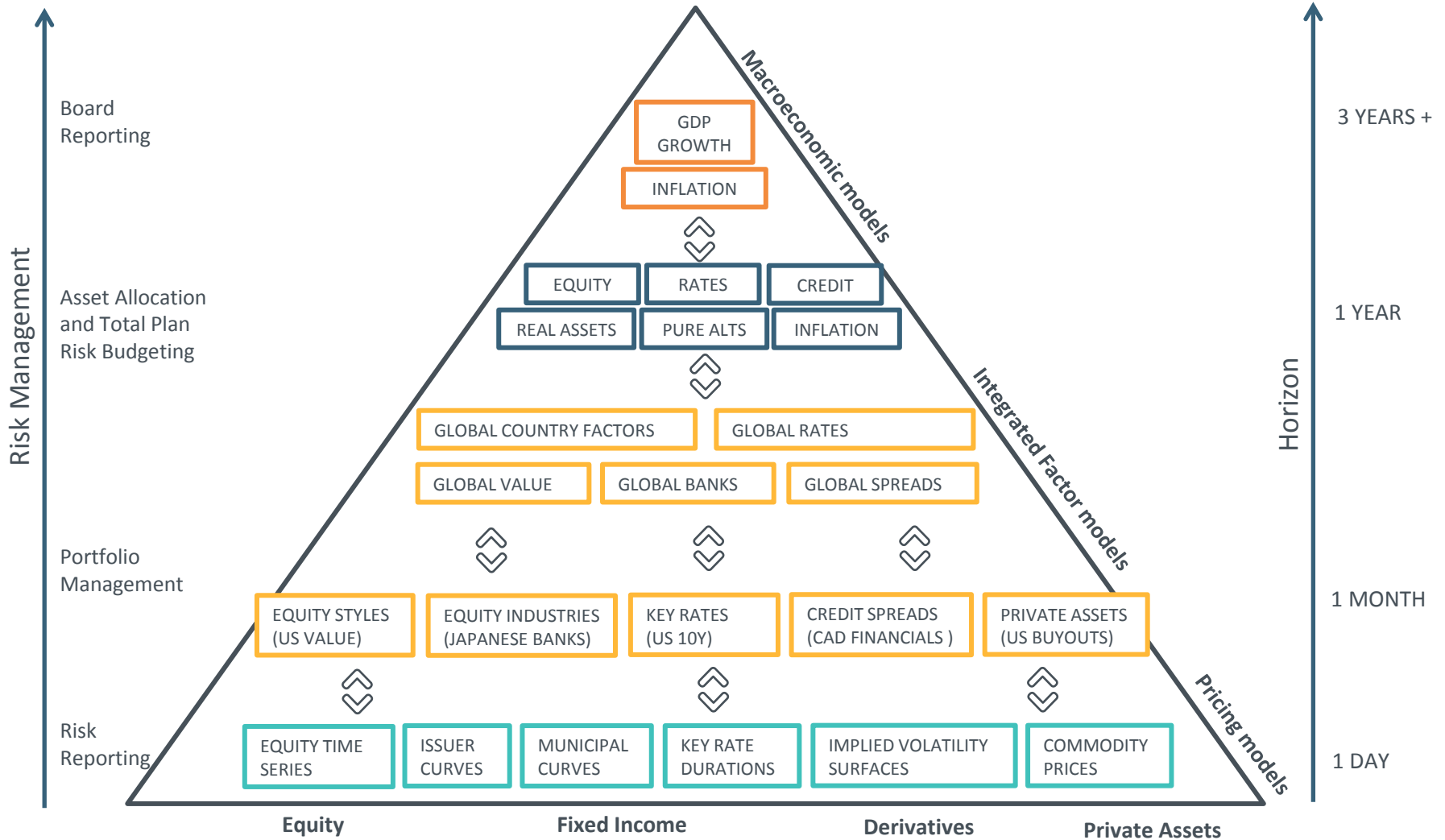
FIXED INCOME RESEARCH INITIATIVES

FIXED INCOME RESEARCH HEADLINES

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



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

| Currency | Par Amount (B) |
|----------|----------------|
| USD | 1,370 |
| EUR | 107 |
| GBP | 20 |
| HKD | 20 |
| NOK | 7 |
| JPY | 5 |
| CAD | 2 |
| DKK | 1 |
| SEK | 1 |
| PLN | 0.3 |
| AUD | 0.3 |
| CHF | 0.1 |

Source: Markit

NEW FIXED INCOME FACTOR MODEL

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



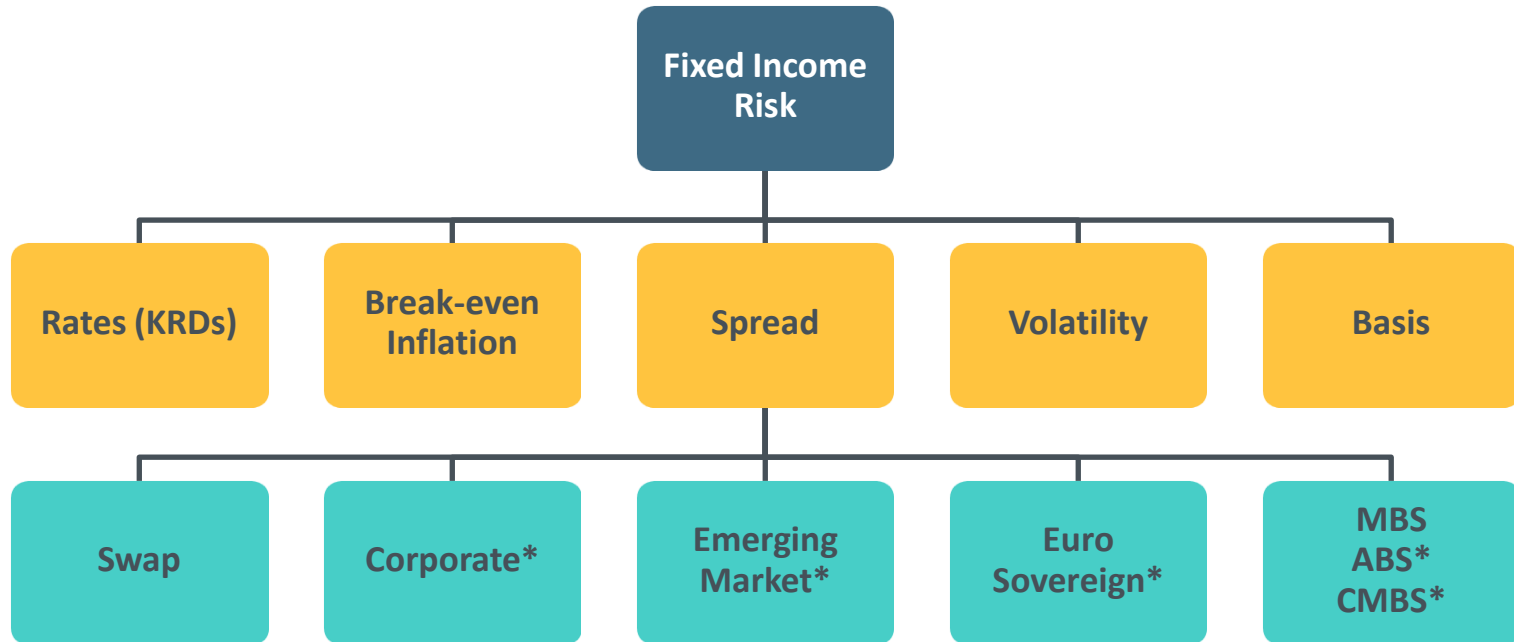
Intuitive Factors (examples)

Designed to assist
in portfolio
construction,
hedging and
rebalancing

- 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

Based on deep
experience in
modeling factors
combined with
rigorous
validation process

NEW FIXED INCOME FACTOR MODEL



* Duration x Spread (DTS) models

WHAT IS DTS?

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

$$X = D \times s$$

Asset exposure — X — Asset Spread

Spread — D — “Times”

Duration — s —

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

Absolute Spread Based Risk

Forecast $\sigma(\Delta OAS) \approx$ *Historical* $\sigma(\Delta OAS)$ ← Backward Looking

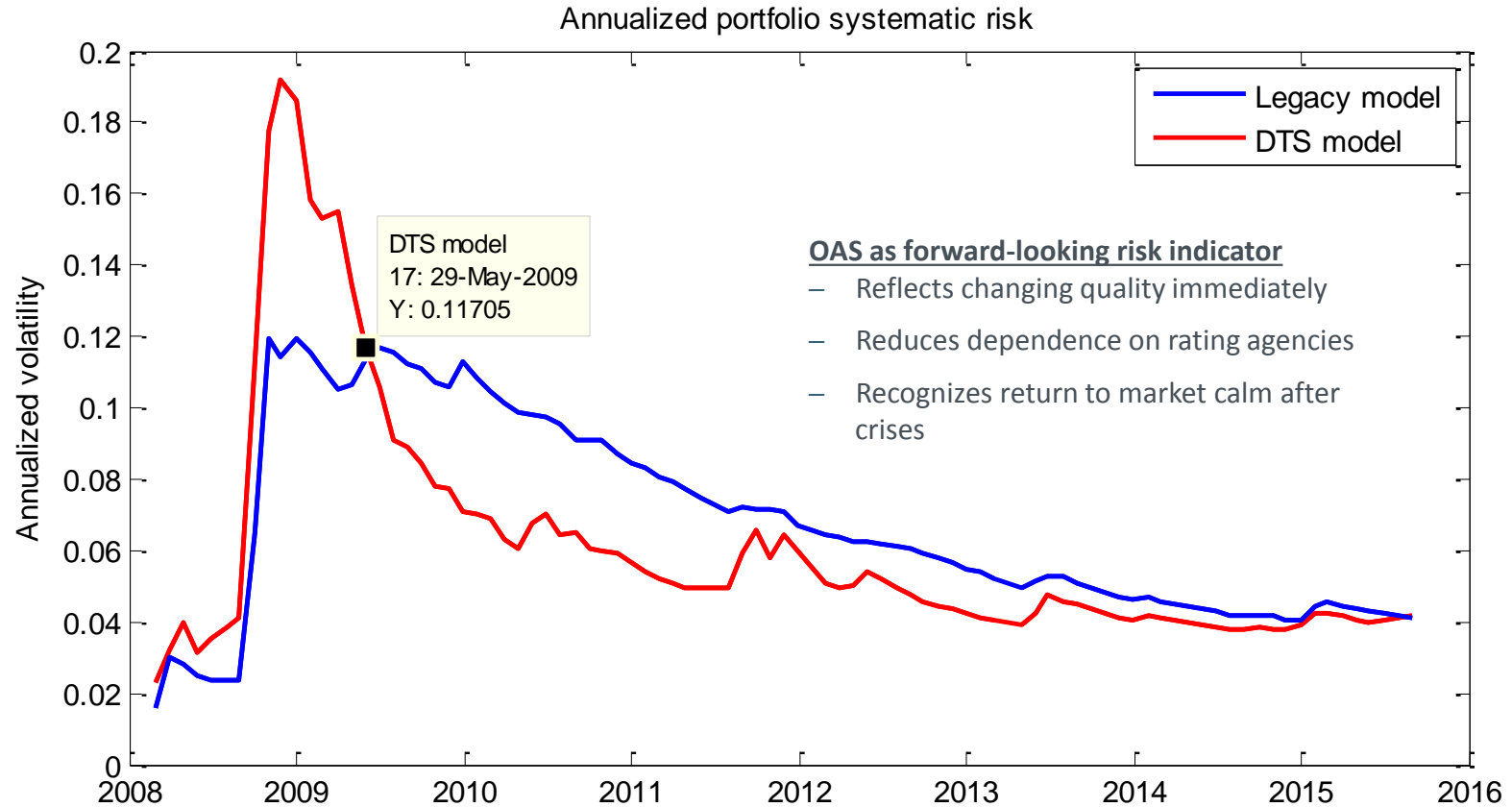
Relative Spread Based Risk (DTS)

Forecast $\sigma(\Delta OAS) \approx$ *Current OAS* \times *Historical* $\sigma\left(\frac{\Delta OAS}{OAS}\right)$ ← Forward Looking

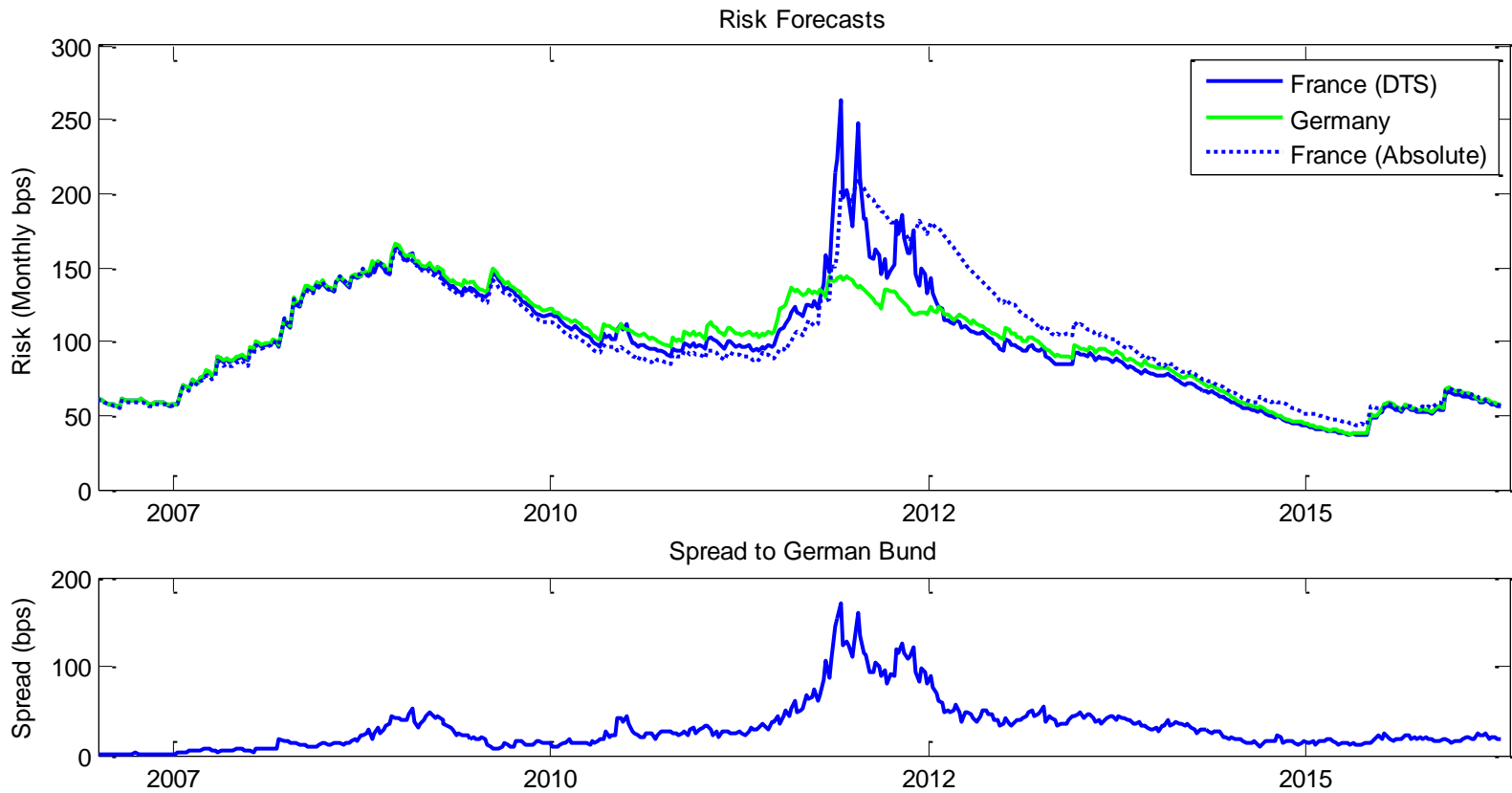
WHY DTS?



RESPONSIVENESS



DTS FOR SOVEREIGN EUROPE: FRANCE



EXAMPLE: EURO FACTORS

Yield Curve

| Rates | Swap | Inflation ¹ |
|-------|------|------------------------|
| 1M | 1M | 1Y |
| 6M | 6M | 2Y |
| 1Y | 1Y | 5Y |
| 2Y | 2Y | 10Y |
| 5Y | 5Y | 20Y |
| 10Y | 10Y | 30Y |
| 20Y | 20Y | 50Y |
| 30Y | 30Y | |
| 50Y | 50Y | |

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

| Sectors | | Country |
|------------------------------|---------------------------|-------------|
| EU Financials IG | EU Utilities | Austria |
| EU Banking IG | EU Electric Utility IG | Belgium |
| EU Capital Markets IG | EU Materials | Finland |
| EU Diversified Financials IG | EU Health Care | France |
| EU Insurance IG | EU Information Technology | Germany |
| EU Real Estate IG | EU Transportation | Ireland |
| EU Financials HY | EU Agency | Italy |
| EU Industrials | EU Supranational | Luxembourg |
| EU Capital Goods IG | EU Pfandbrief | Netherlands |
| EU Services IG | EU Covered France | Portugal |
| EU Consumer Discretionary | EU Covered Spain | Spain |
| EU Auto IG | EU Other Covered | |
| EU Consumer Staples | EU Local & Provincial | |
| EU Food IG | EU Corporate IG | |
| EU Energy | EU Corporate HY | |
| EU Oil & Gas IG | | |
| EU Telecoms | | |
| EU Diversified Telecoms IG | | |

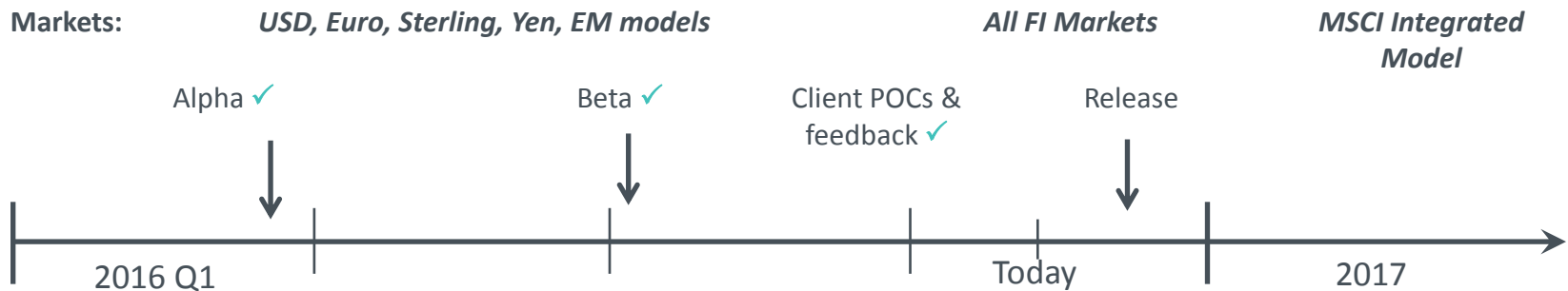
Basis

CDS Basis IG
CDS Basis HY

e.g. French Bank → EU Banks IG + EU France Corporate

NEW FIXED INCOME FACTOR MODEL: DELIVERY TIMELINE

- Major fixed income market models available for testing starting July 18th
- Model has been locked down after receiving substantial client feedback and is scheduled for release on November 19th



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

STARTING POINT

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

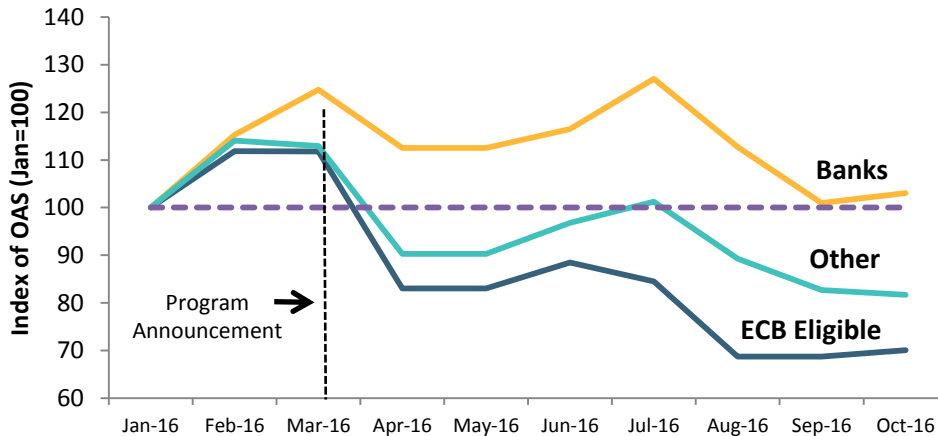
| | Eligibility Criteria | | | | | | |
|--|----------------------|---------------------|----------------------------|----------------------------|--------------------|------------------------------|------------------|
| | Investment Grade | Credit Institutions | Issuing Entity in Eurozone | Minimum Amount Outstanding | Fixed and Floaters | Senior Debt and Subordinates | Minimum Maturity |
| ECB Corporate Program | Yes | No | Yes | None | Yes | Senior Only | 6-months* |
| BofAML Euro Corporate Index ¹ | Yes | Yes | Not Necessary | € 250,000,000 | Fixed Only | Yes | 1-Year |
| *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 Index¹



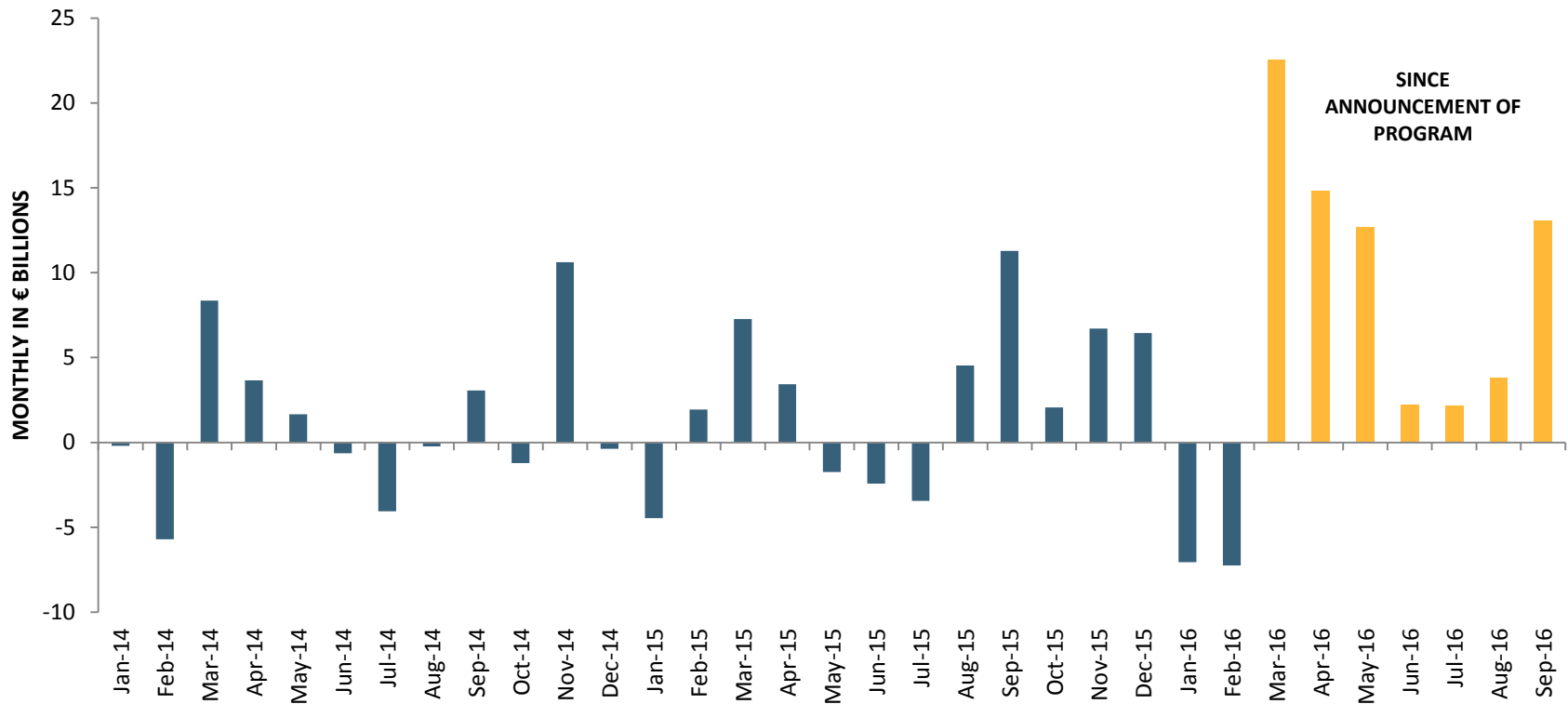
| BoAML Euro Corporate Index ¹ | | |
|---|--------|-----------|
| | Weight | OAS (bps) |
| ECB Eligible | 33.5% | 84 |
| Banks | 31.7% | 118 |
| Other | 34.8% | 139 |

*as of Oct 31, 2016

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

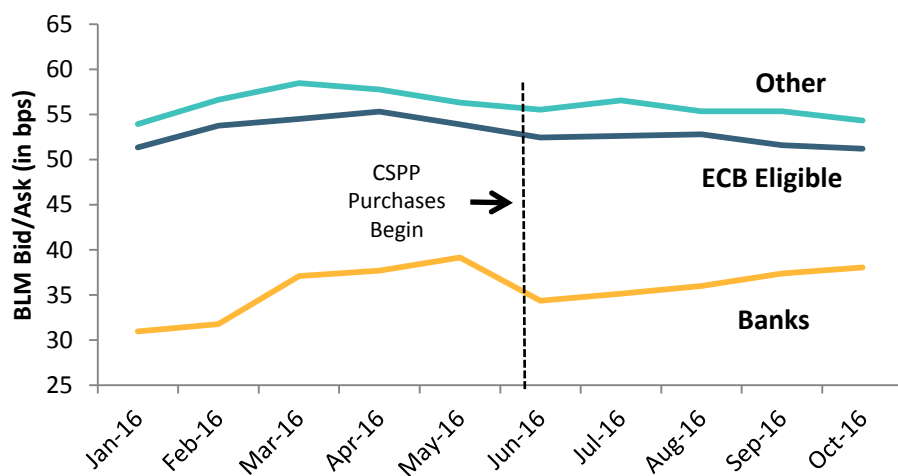


Source: MSCI

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

Liquidity Trends: MSCI BLM Model for Bid/Ask



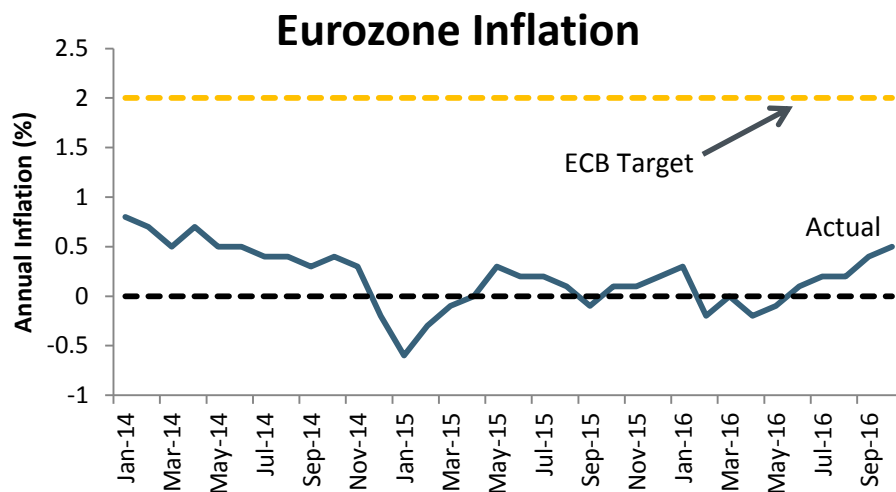
*Bid/Ask on securities underlying the BofAML Euro Corporate Index

MSCI BLM Model

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

PORTFOLIO POSITIONING

- 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 {Return Forecast – Risk Aversion * 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

Optimization Type

Standard

Risk Target

Long/Short

Efficient Frontier

Ok

Types of Constraints

Optimization Parameters

Include Benchmark in Universe Asset Returns ... Risk Aversion

Allow Short Cash In/Out Selection Risk Multiplier

Transaction Type ▾

Transaction Costs:

Basic Constraints

| Max # Assets | Min Holding(%) | Min Trade(%) | Max Trade (%) | Max Turnover(%) | Max Transaction Cost(%) |
|----------------------|----------------------|----------------------|----------------------|----------------------|-------------------------|
| <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> | <input type="text"/> |

Holdings Bounds

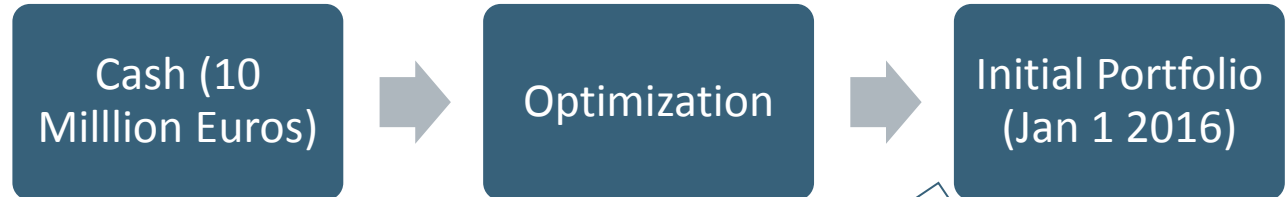
| | Min | Max |
|---------------------|---|---|
| Asset Bounds | <input type="text"/> ... <input type="button" value="Clr"/> | <input type="text"/> ... <input type="button" value="Clr"/> |
| Cash Position(%) | <input type="text" value="0.00"/> | <input type="text" value="0.00"/> |
| Non-Cash Assets(%) | <input type="text"/> | <input type="text"/> |
| Portfolio Return(%) | <input type="text"/> | <input type="text"/> |

Conditional Holding Rule

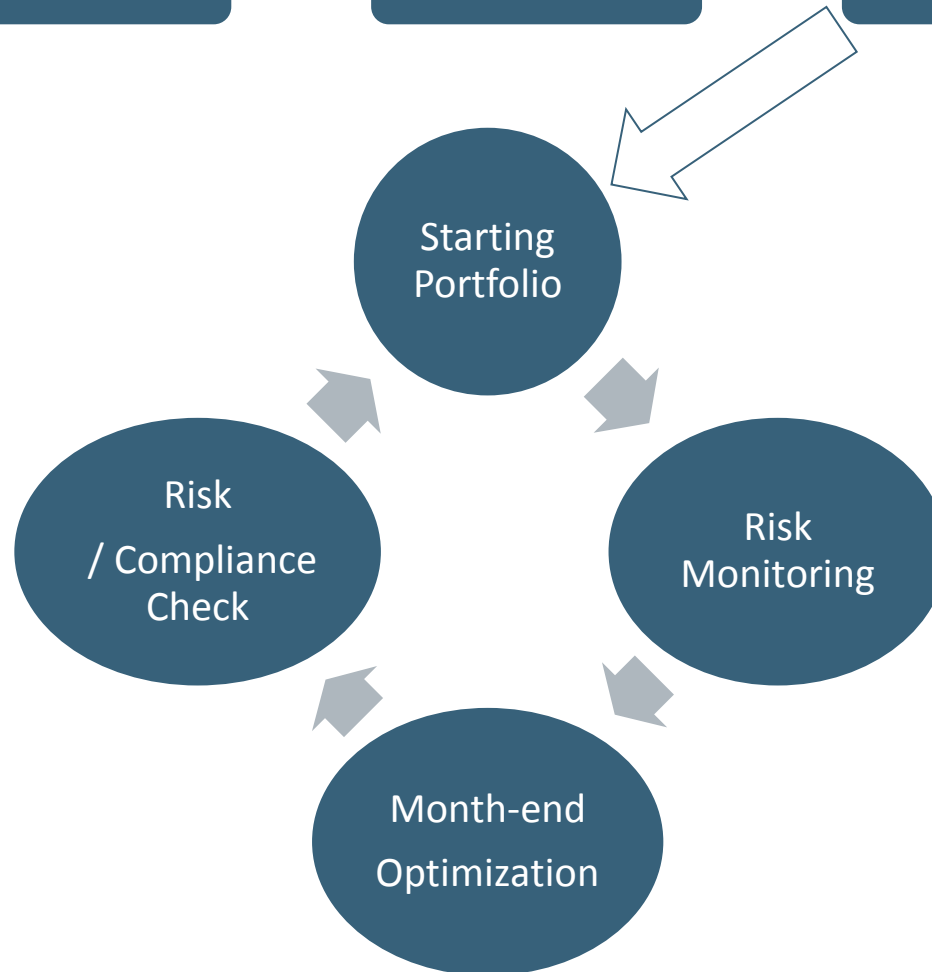
Risk Budgeting Constraints

PORTFOLIO CONSTRUCTION WORKFLOW

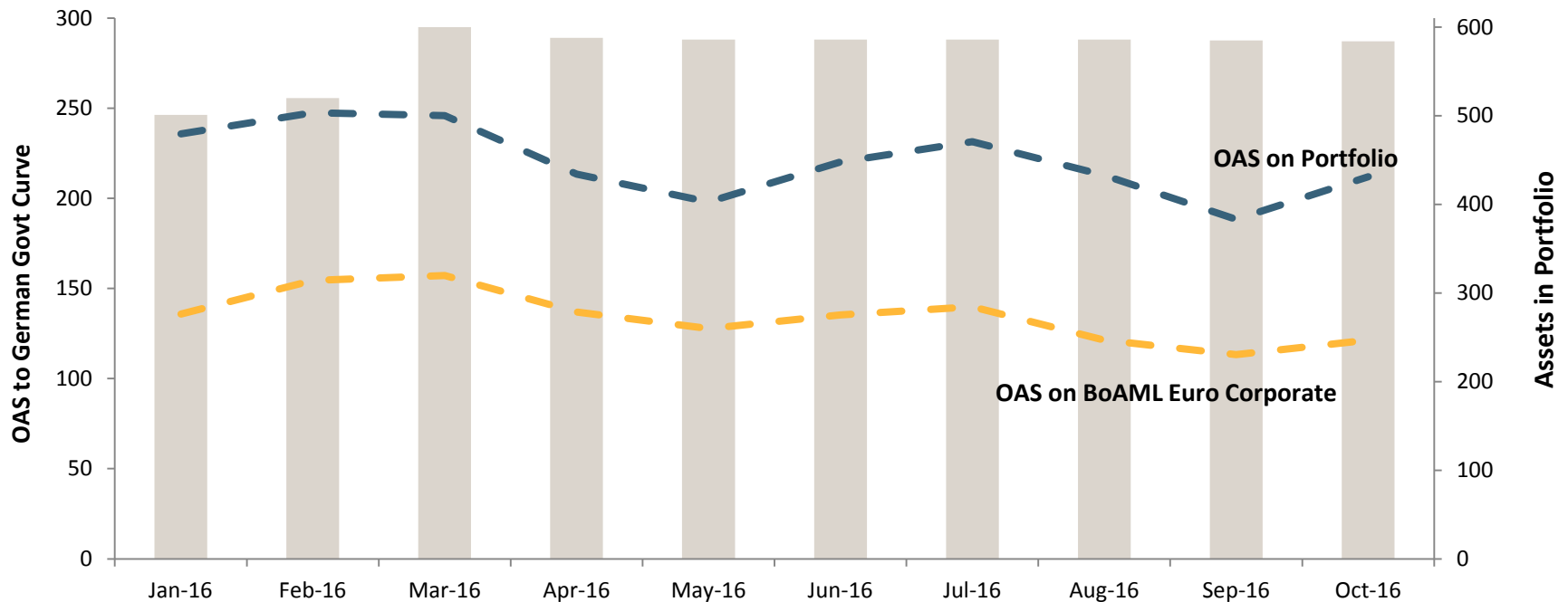
Initial Implementation



Rebalance Process



PORTFOLIO CONSTRUCTION: OAS AND # OF ASSETS

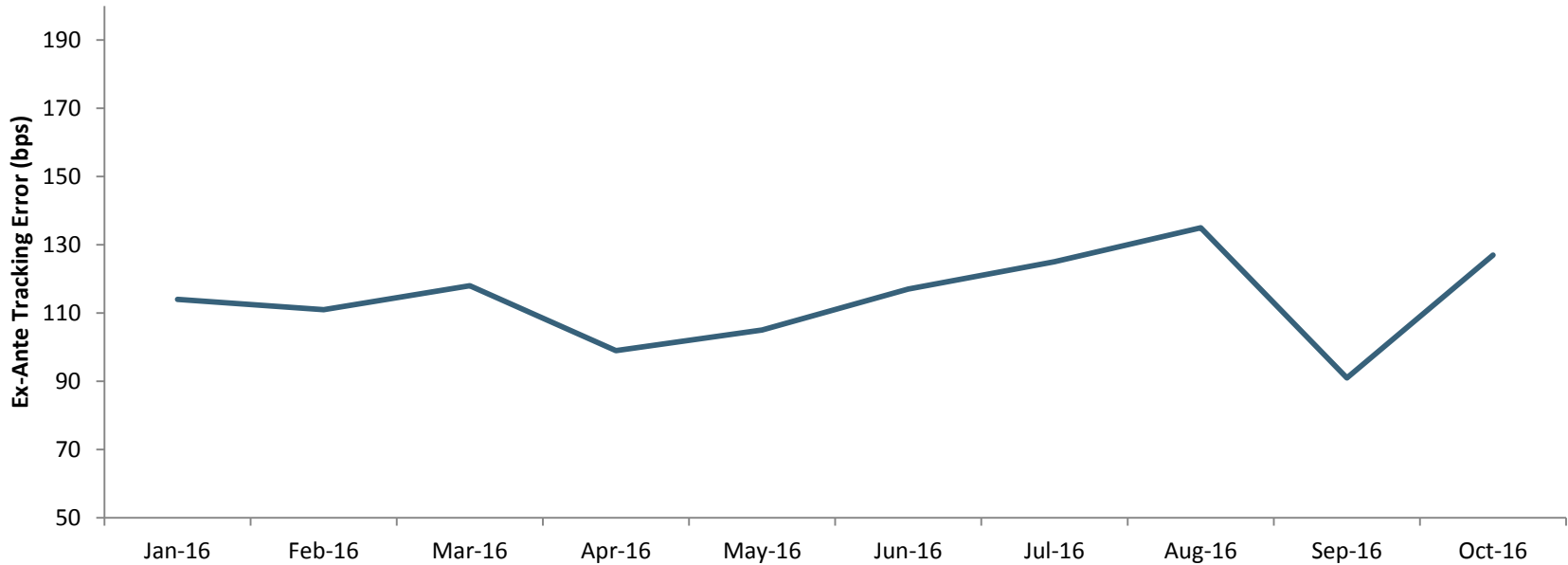


- Portfolio OAS in excess of index OAS by 70-100 bps
- Total Assets in portfolio ranges from 501 - 600

¹ OAS analytics from MSCI
Index Source: BofA Merrill Lynch Global Research, used with permission

PORTFOLIO CONSTRUCTION: TRACKING ERROR

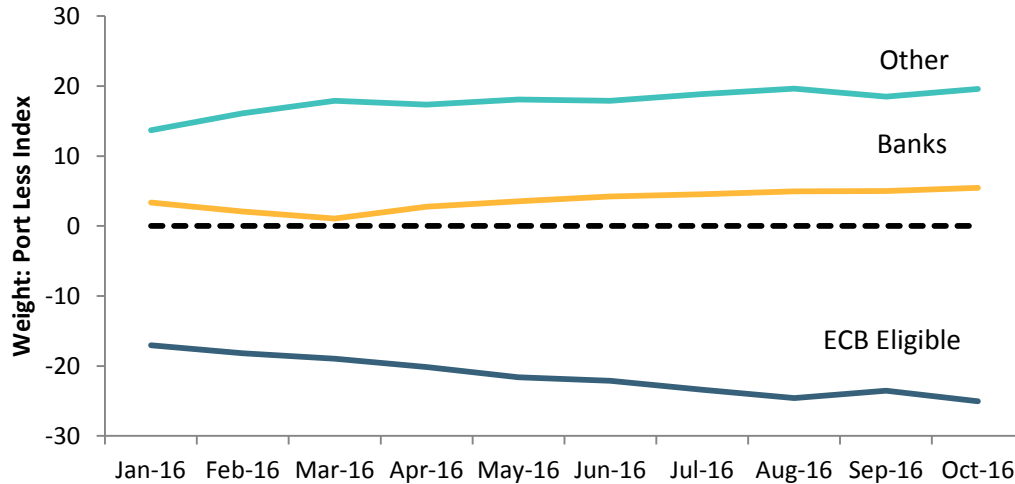
Ex-Ante TE vs BofAML Euro Corporate Index



- Ex-ante tracking error ranges between 91 bp to 135 bps

PORTFOLIO CONSTRUCTION: OVER/UNDER WEIGHTS

Active Weight vs BofAML Euro Corporate Index

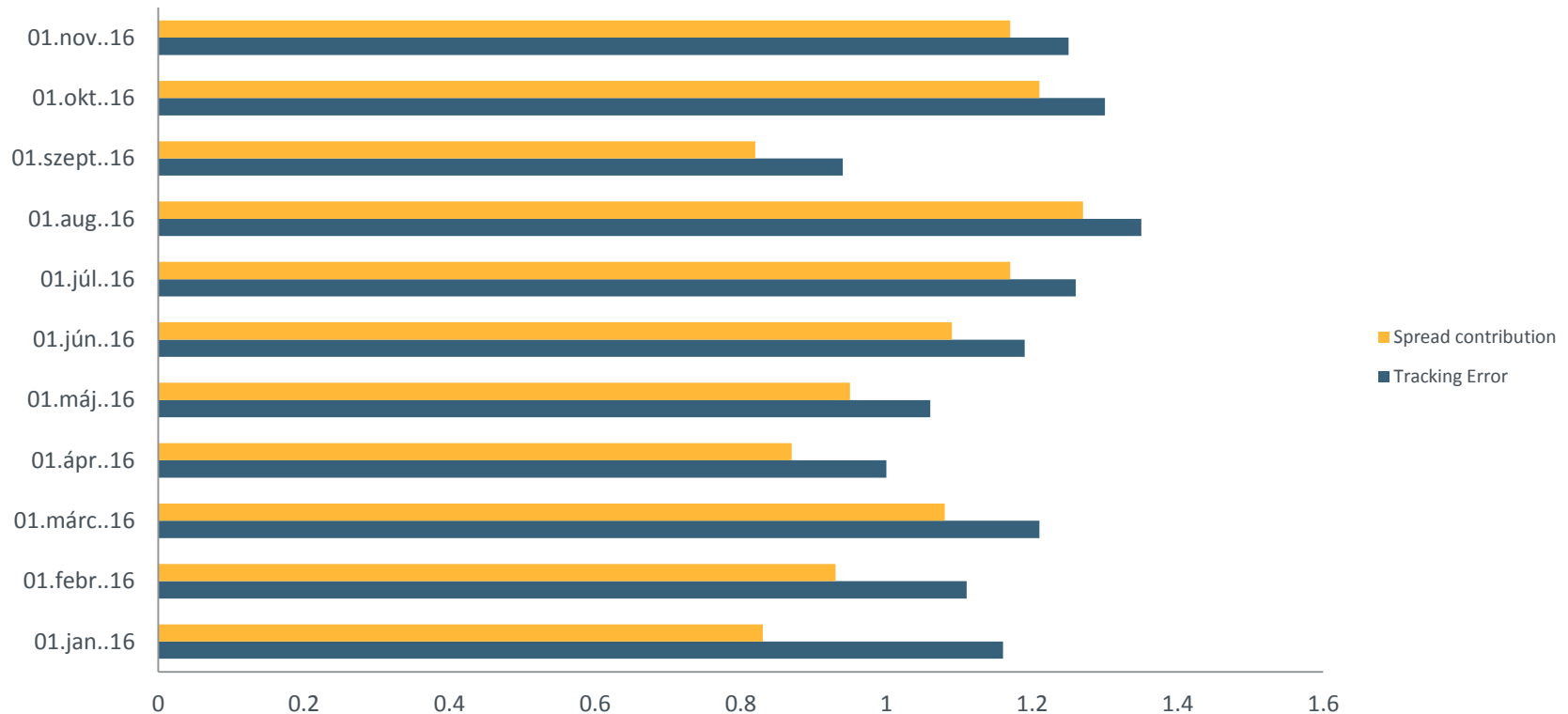


| | Portfolio Weights | |
|--------------|-------------------|---------|
| | Jan 4th | Oct 3rd |
| ECB Eligible | 14% | 9% |
| Banks | 37% | 37% |
| Other | 49% | 54% |

- 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

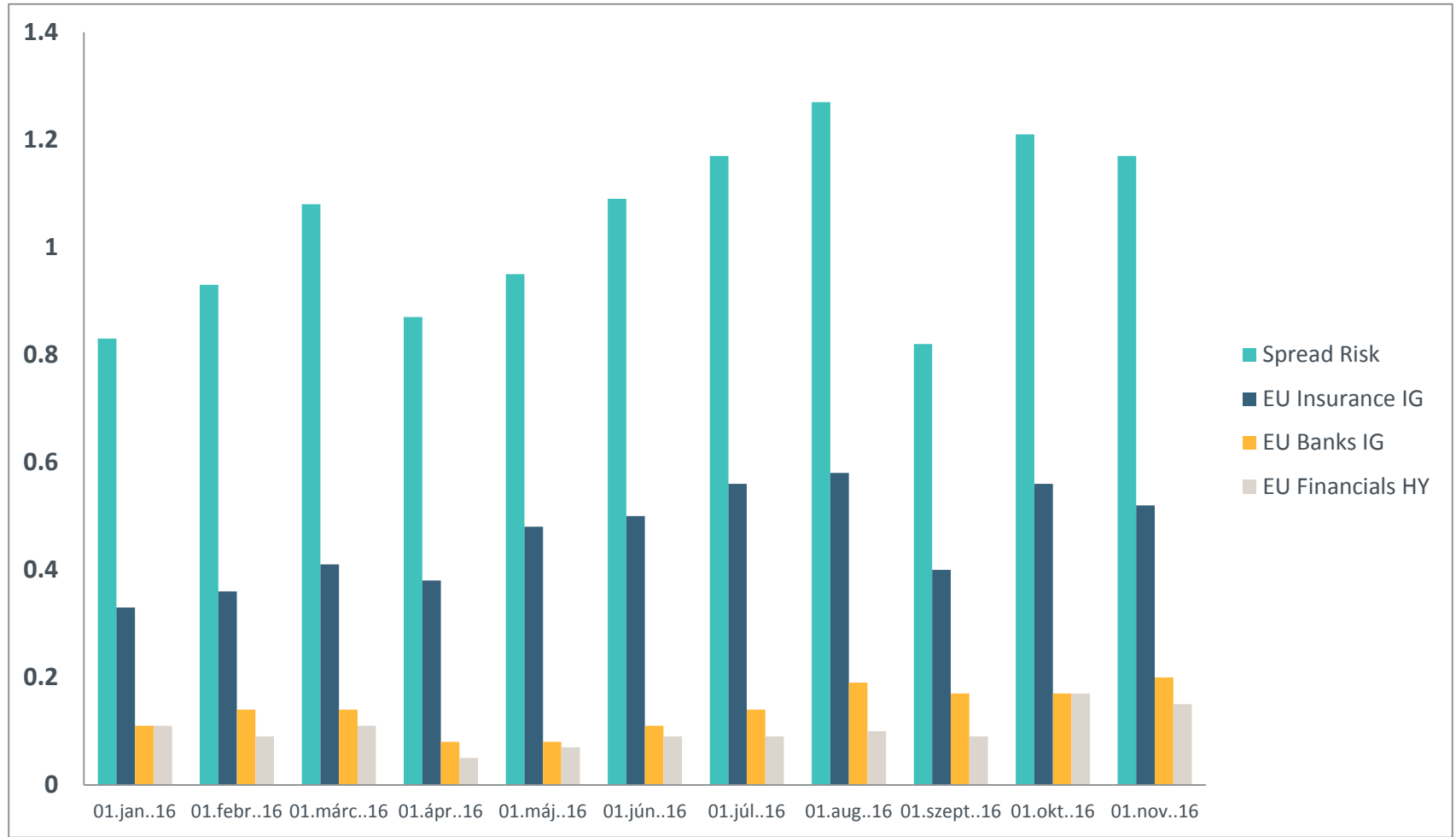
TIME SERIES OF SPREAD % OF ACTIVE RISK

Spread Risk contribution to Tracking Error Volatility



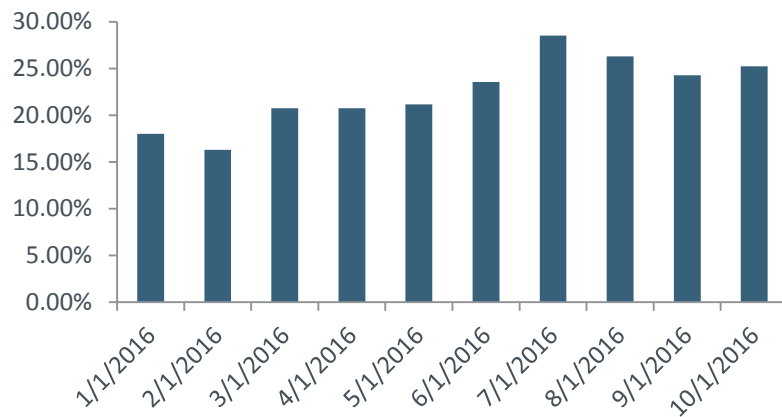
- Tracking error driven by spread risk (Average Contribution from spread = 90%)
- Term Structure risk limited to a max of 10% of active risk, as per constraint

DRIVERS OF SPREAD RISK: BET ON INSURANCE

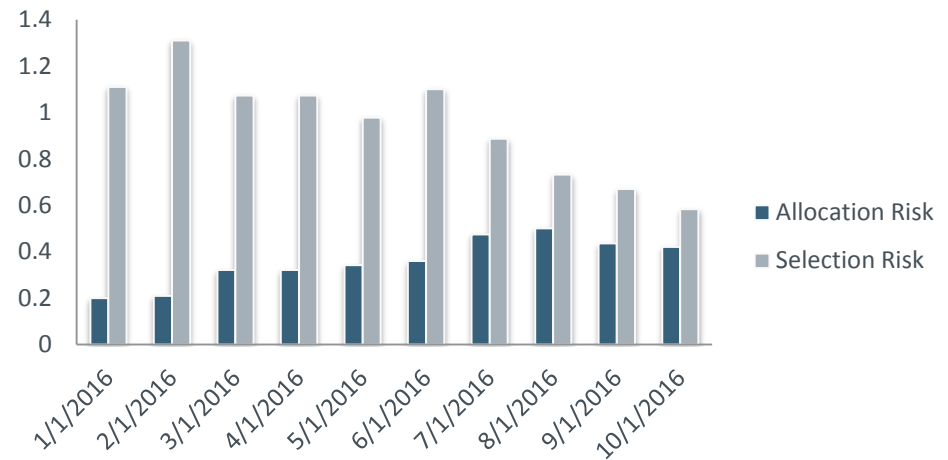


WHICH SEGMENT OF THE INSURANCE MARKET

Subordinated Debt Allocation (Overweight/Underweight)



Subordinated Debt: Risk Contribution



We are significantly overweighted in the subordinated debt segment and are making bond selection bets in this segment.

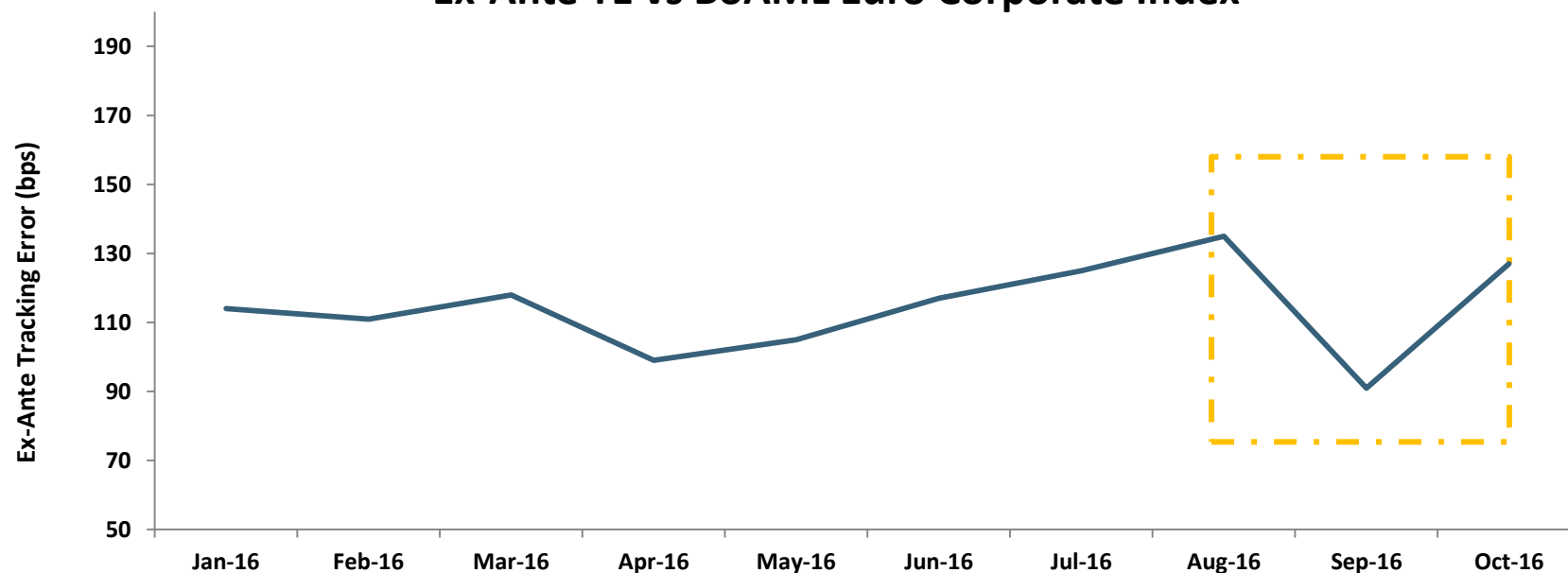
EXAMPLE OF OUTPUT: SPREAD EXPOSURE AND RISK

| Factor | Volatility | Active Exposure | Active Risk | Cont. to AR (Residual) |
|------------------------|------------|-----------------|-------------|------------------------|
| EU Insurance IG | 23.03 | 0.01826 | 0.42042 | 0.35321 |
| EU Materials | 26.67 | 0.00514 | 0.13709 | 0.11341 |
| EM Spread | 22.05 | 0.00835 | 0.18423 | 0.11176 |
| EU Financials HY | 25.30 | 0.00434 | 0.10973 | 0.08948 |
| EU Banks IG | 24.61 | 0.00389 | 0.09580 | 0.07950 |
| EU Other Financials IG | 24.92 | 0.00331 | 0.08243 | 0.06796 |
| GB Materials | 22.18 | 0.00609 | 0.13501 | 0.06505 |
| EU Agency | 26.48 | 0.00190 | 0.05034 | 0.03365 |
| GB Banks IG | 24.21 | 0.00169 | 0.04103 | 0.02676 |
| EU Consumer Staples | 22.71 | 0.00145 | 0.03282 | 0.02391 |

- EU Insurance IG is the biggest contributor to spread risk (35 bps)

ANALYZING TRACKING ERROR

Ex-Ante TE vs BoAML Euro Corporate Index



- Tracking error drops substantially in September – why?

AUGUST RISK DELTA – WHY DID RISK CHANGE?

| Risk Source | Active Risk Contribution (2016-08-31) | Active Risk Contribution (2016-08-30) | Active Exposure Change Contribution | Active Volatility Change Contribution | Active Correlation Change Contribution |
|---------------------------|---------------------------------------|---------------------------------------|-------------------------------------|---------------------------------------|--|
| Total Risk | 0.95 | 1.23 | -0.26 | -0.01 | -0.01 |
| Local Market Risk | 0.95 | 1.23 | -0.26 | -0.01 | -0.01 |
| Market Timing | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Common Factor | 0.90 | 1.18 | -0.26 | 0.00 | -0.01 |
| Term Structure | 0.04 | 0.00 | 0.09 | 0.00 | -0.04 |
| Implied Volatility | 0.03 | 0.03 | 0.00 | 0.00 | 0.00 |
| Spread | 0.84 | 1.15 | -0.35 | 0.00 | 0.04 |
| EU Banks IG | 0.18 | 0.18 | 0.00 | 0.00 | 0.01 |
| EU Financials HY | 0.10 | 0.10 | -0.01 | 0.00 | 0.01 |
| EU Insurance IG | 0.40 | 0.54 | -0.15 | 0.00 | 0.01 |
| Selection Risk | 0.05 | 0.05 | 0.00 | -0.01 | 0.01 |

- 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)

| Group | Active Weight(%) | Total Contribution | Allocation Risk Contribution | Selection Risk Contribution |
|--------------------------|------------------|--------------------|------------------------------|-----------------------------|
| Financial | 13.65% | 0.62 | 0.07 | 0.56 |
| Securitized | -0.04% | 0.00 | 0.00 | 0.00 |
| Utility | -3.88% | 0.08 | 0.01 | 0.07 |
| Industrials | -10.11% | 0.24 | 0.03 | 0.21 |
| Active Total Risk | 0.00% | 0.95 | 0.13 | 0.82 |

Zooming to Financial Merrill sector¹

| | | | | |
|-----------|-------|------|------|------|
| Insurance | 6.77% | 0.37 | 0.19 | 0.18 |
| Banking | 4.94% | 0.24 | 0.01 | 0.24 |

- 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

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

Insurance sector has the highest overweight in the portfolio
Equal bet on sector allocation and bond selection

SUMMARY OF KEY TAKEAWAYS

- 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?

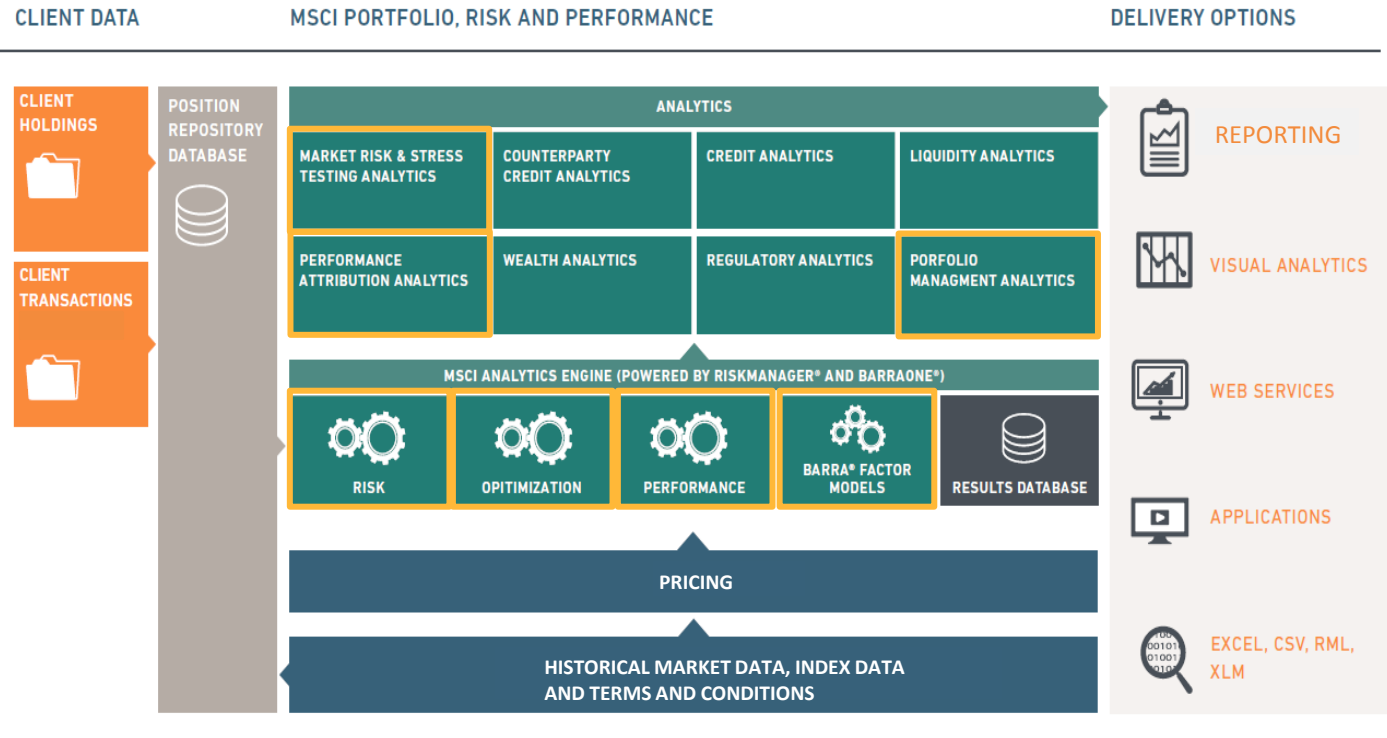
How did the ECB's Corporate Sector Purchase Program (CSPP) impact the market?

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

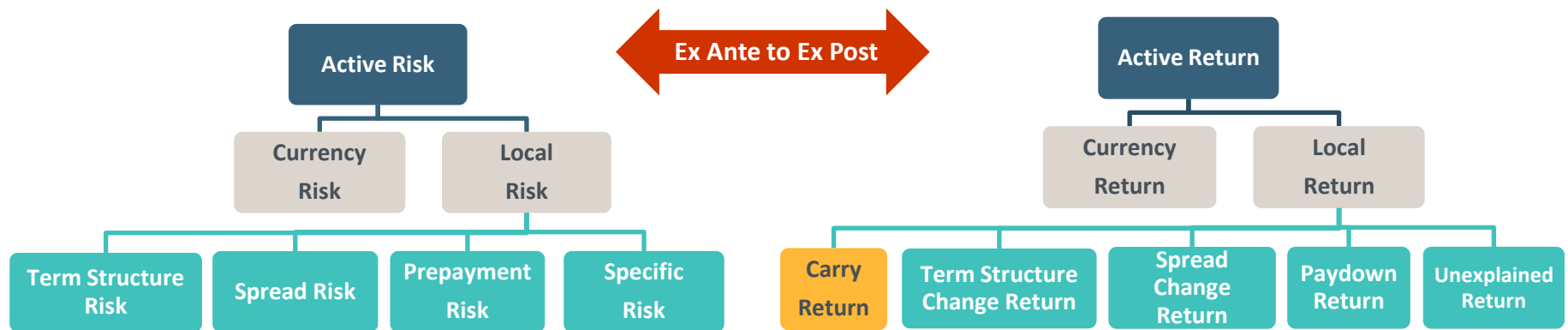
- Holdings & transactions loaded into one system only
- Multiple Analytics Solutions
- **Increased efficiency and reduced total cost of software**



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

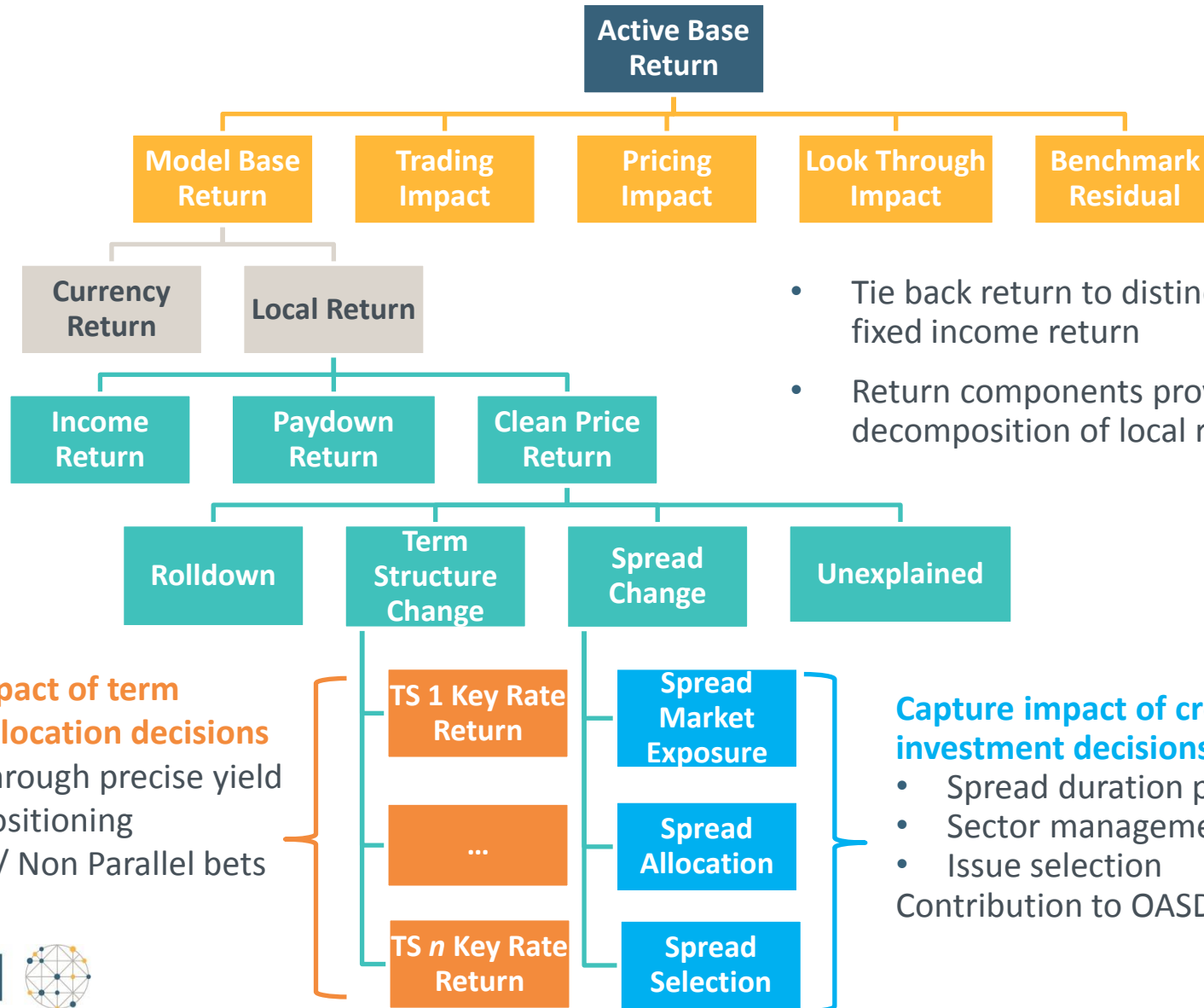
CORRESPONDENCE BETWEEN RISK AND PERFORMANCE

- 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



- Tie back return to distinct drivers of fixed income return
- Return components provide a granular decomposition of local return

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

REPORTING ALIGNED WITH THE INVESTMENT PROCESS

- **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')

| | Attribute | Grouping Scheme |
|---|-----------------|------------------------|
| 1 | ECB Eligible | distinct |
| 2 | Merrill Banking | distinct |
| 3 | Merrill Rating | distinct |
| 4 | Spread Duration | Spread Duration_SYSTEM |

Buttons: + Add, Edit, ↑ Up, ↓ Down, ✕ Delete

Orange arrows point from the formulas in the previous block to the 'ECB Eligible' and 'Merrill Banking' rows in this table.

- **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

PERFORMANCE ATTRIBUTION SUMMARY

| Portfolio Base Return | Benchmark Base Return | Active Base Return |
|-----------------------|-----------------------|--------------------|
| 6.59 % | 5.20 % | 1.39 % |

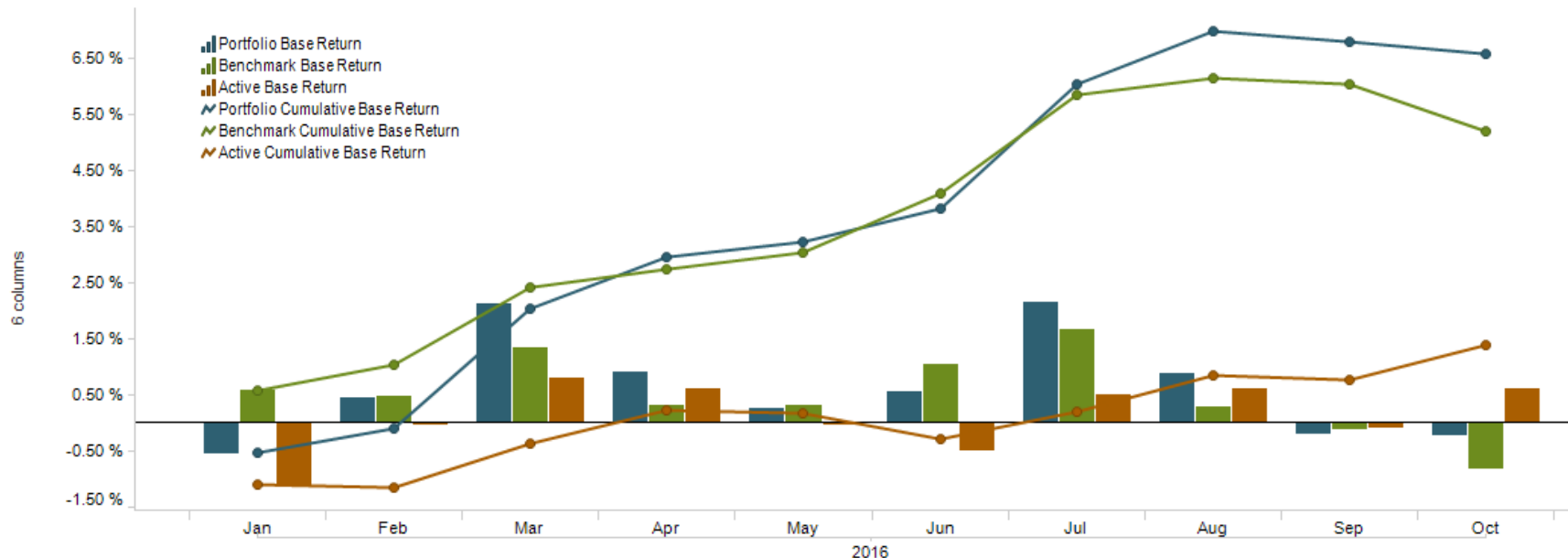
Year to Date [31 Dec, 2015 - 31 Oct, 2016]

Ex Post Measures

| Statistic | Value | Statistic | Value |
|--------------------------|-------|----------------------------|-------|
| Variance | 0.00 | Alpha (%) | 1.09 |
| Portfolio Volatility (%) | 2.24 | Jensen's Alpha (%) | 1.09 |
| Benchmark Volatility (%) | 1.76 | M-Squared (%) | 5.20 |
| Covariance | 0.00 | Tracking Error (%) | 1.24 |
| Correlation | 0.83 | Information Ratio | 1.12 |
| R-Squared | 0.70 | T-Statistic | 1.12 |
| Beta | 1.06 | Upside Capture Ratio (%) | 95.65 |
| Sharpe Ratio | 2.95 | Downside Capture Ratio (%) | 76.04 |
| Sortino Ratio | 4.88 | Maximum Drawdown (%) | -1.86 |
| Treynor Ratio | 0.06 | | |

- Active performance was high at 1.39% YTD
 - Outperformance after the announcement of the CSPP
 - Performance was also high on a risk-adjusted basis

Performance Trend - Monthly and Cumulative

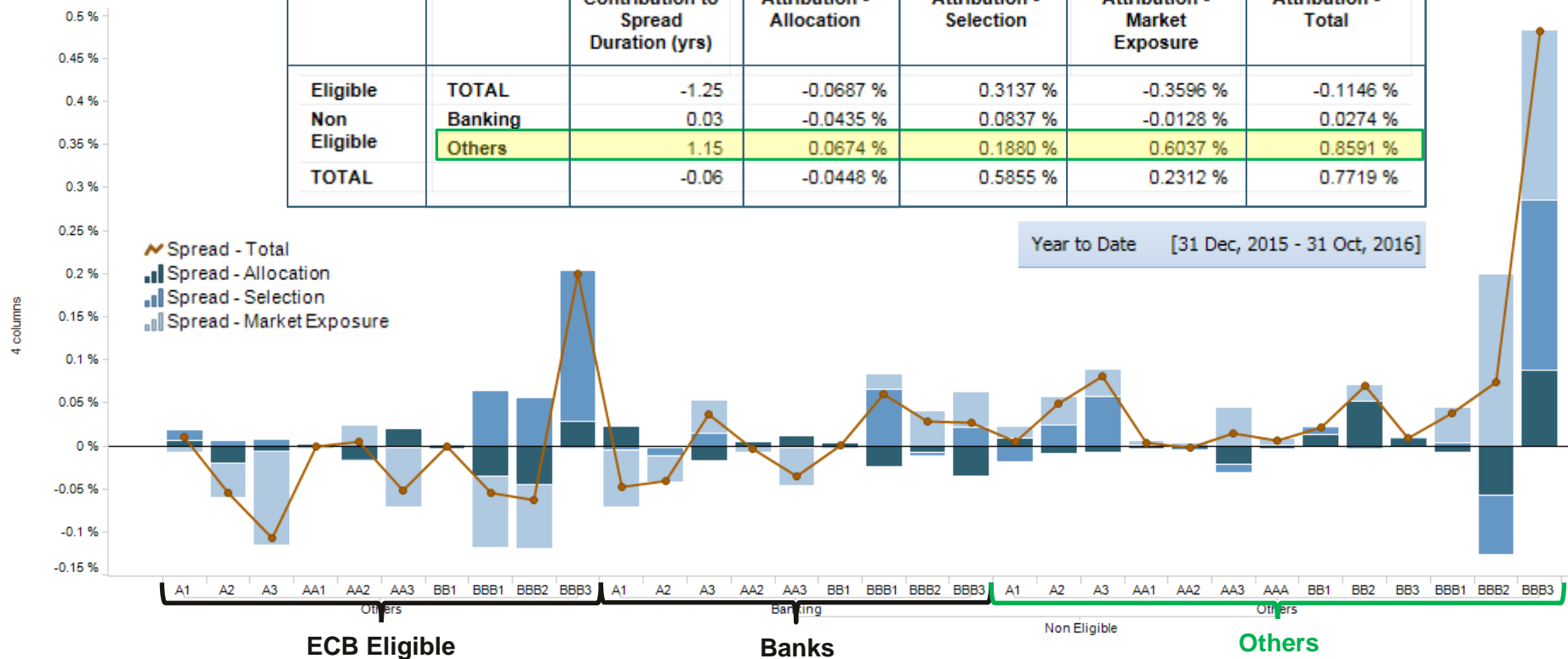


IMPACT OF SPREAD MANAGEMENT DECISIONS

Spread Duration Positioning, Sector Management and Issue selection outperformance

Spread Attribution

| Group 1 | Group 2 | Active Average Contribution to Spread Duration (yrs) | Spread Attribution - Allocation | Spread Attribution - Selection | Spread Attribution - Market Exposure | Spread Attribution - Total |
|--------------|---------|--|---------------------------------|--------------------------------|--------------------------------------|----------------------------|
| Eligible | TOTAL | -1.25 | -0.0687 % | 0.3137 % | -0.3596 % | -0.1146 % |
| Non Eligible | Banking | 0.03 | -0.0435 % | 0.0837 % | -0.0128 % | 0.0274 % |
| Eligible | Others | 1.15 | 0.0674 % | 0.1880 % | 0.6037 % | 0.8591 % |
| TOTAL | | -0.06 | -0.0448 % | 0.5855 % | 0.2312 % | 0.7719 % |



- 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 Index¹

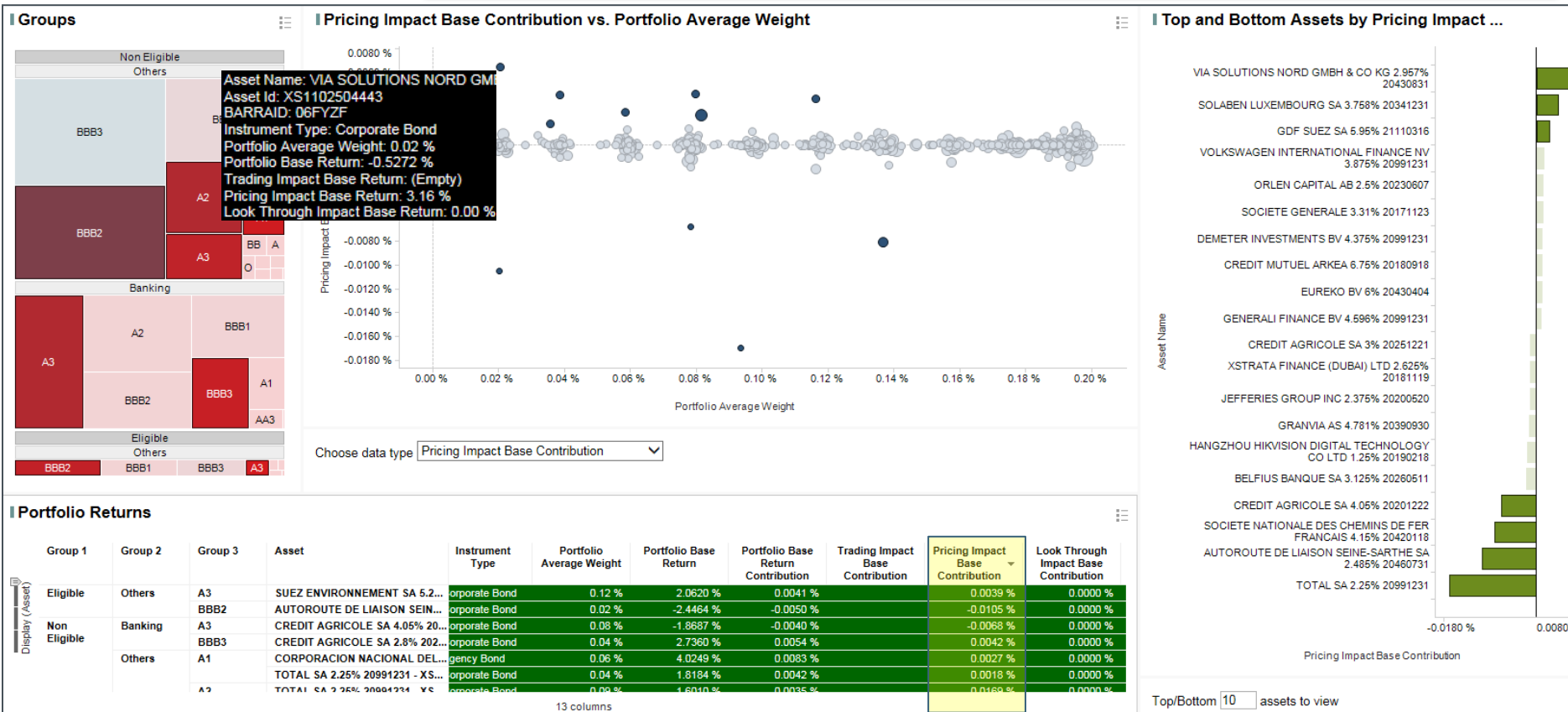
| Rating | Active Average OAS (bp) | Active Average Cont. to OASD (yr) | ACTIVE TERM STRUCTURE | | | ACTIVE SPREAD | | | SELECTION | TOTAL | |
|-----------------|-------------------------|-----------------------------------|-----------------------|-------------------------|--------------------------|-----------------|-------------------------|--------------------------|-----------------|------------------------|--------------------------|
| | | | Risk Cont. (bp) | Carry Return Cont. (bp) | Change Return Cont. (bp) | Risk Cont. (bp) | Carry Return Cont. (bp) | Change Return Cont. (bp) | Risk Cont. (bp) | Active Risk Cont. (bp) | Active Return Cont. (bp) |
| Total | 96.03 | -0.06 | 18.9 | -6.8 | -18.6 | 83.1 | 80.0 | 77.2 | 10.0 | 111.9 | 140.5 |
| Eligible | 65.13 | -1.25 | - | -2.5 | -53.7 | - | -12.5 | -11.5 | - | - | -78.8 |
| Banks | 66.16 | 0.03 | 3.3 | -5.0 | -2.4 | 9.1 | 24.1 | 2.7 | 0.5 | 12.9 | 21.7 |
| Others | 91.95 | 1.15 | 15.6 | 1.3 | 37.5 | 74.0 | 68.7 | 85.9 | 9.5 | 99.0 | 197.6 |
| BBB3 | 34.95 | 0.65 | 0.0 | 1.7 | 30.9 | 32.9 | 30.8 | 48.2 | 5.1 | 38.0 | 120.3 |
| BBB2 | 81.42 | 0.43 | 5.0 | -1.4 | 18.8 | 12.5 | 20.2 | 7.4 | 0.7 | 18.2 | 47.7 |
| BBB1 | 82.7 | 0.14 | 1.0 | 0 | 6.2 | 8.9 | 9.6 | 3.8 | 1.7 | 11.6 | 21.3 |
| BB2 | 65.53 | 0.01 | -1.1 | 0 | 0 | 3.3 | 0.0 | 7.0 | 0.3 | 2.5 | 8.1 |
| A2 | 60.74 | 0.02 | 2.4 | 0 | 0 | 5.8 | 2.6 | 4.9 | 0.5 | 8.7 | 6.9 |

- **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

PRICING IMPACT & TRADING IMPACT DASHBOARD

| Attribute | Full Period |
|-----------------------|-------------|
| Portfolio Base Return | 6.5856 % |
| Trading Impact | 0.0000 % |
| Pricing Impact | -0.0150 % |
| Look Through Impact | 0.0000 % |

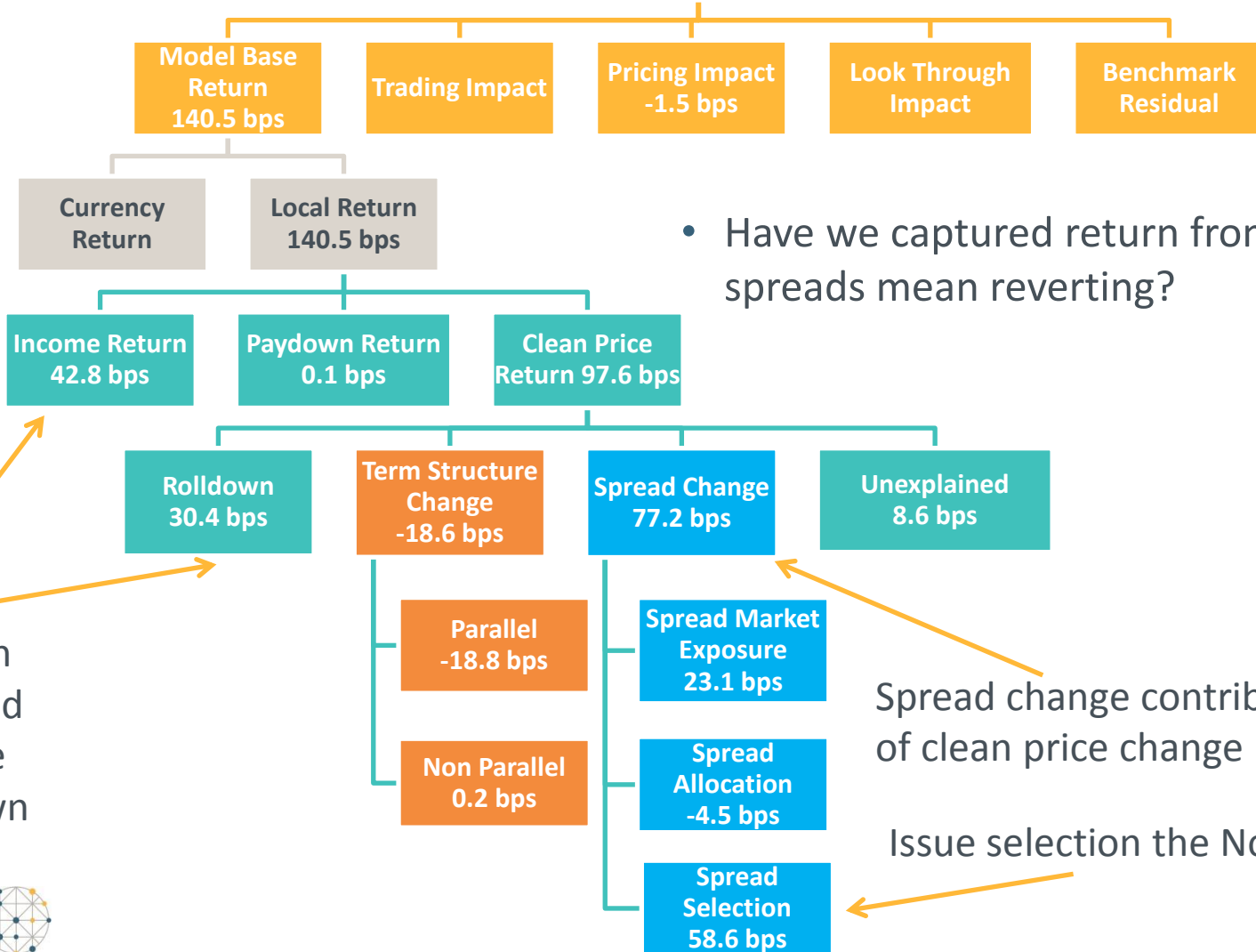
Pricing Impact from different price sources for common assets in the portfolio & benchmark, attribution in summary and for drilldown at asset, and group level



HYBRID FI PA MODEL WITH FLEXIBLE SPREAD ATTRIBUTION

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

Active Base Return 139 bps



- Have we captured return from spreads mean reverting?

Carry return decomposed into income and rolldown

Spread change contributes 79% of clean price change return

Issue selection the No.1 driver

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

Paydown
Return 0.1 bps

Term Structure
-25.4 bps

Spread
157.2 bps

Unexplained
8.6 bps

Term Structure
Carry -6.8 bps

Term Structure
Change
-18.6 bps

Spread Carry
80 bps

Spread Change
77.2 bps

Carry return
decomposed
into term
structure and
spread carry

Parallel
-18.8 bps

Non Parallel
0.2 bps

Spread Market
Exposure
23.1 bps

Spread
Allocation
-4.5 bps

Spread
Selection
58.6 bps

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

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

Key-Rate Duration at key rate k

Change in key rate k

- Decomposed into term structure key rate returns

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

- Insight into term structure key rate returns
 - Positive if key rates decrease
 - Negative if key rates increase
 - Magnitude depends on the sensitivity

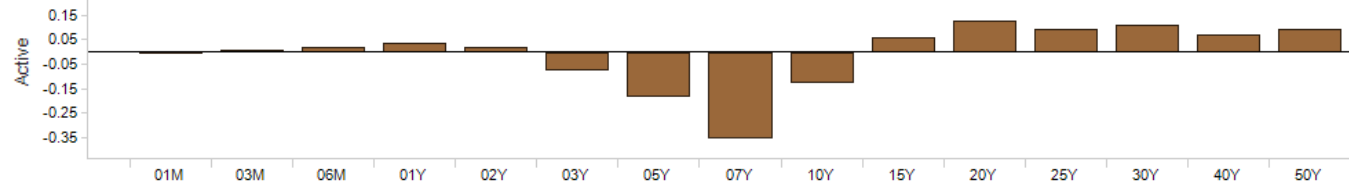
TERM STRUCTURE CHANGE PERFORMANCE ATTRIBUTION

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

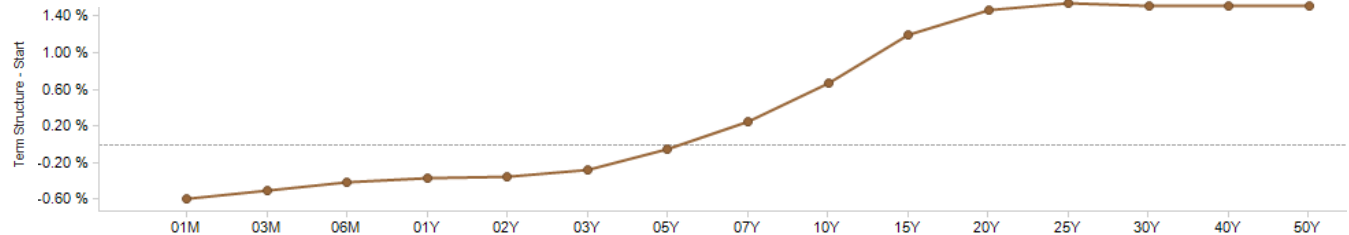
Yield curve positioning

- 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

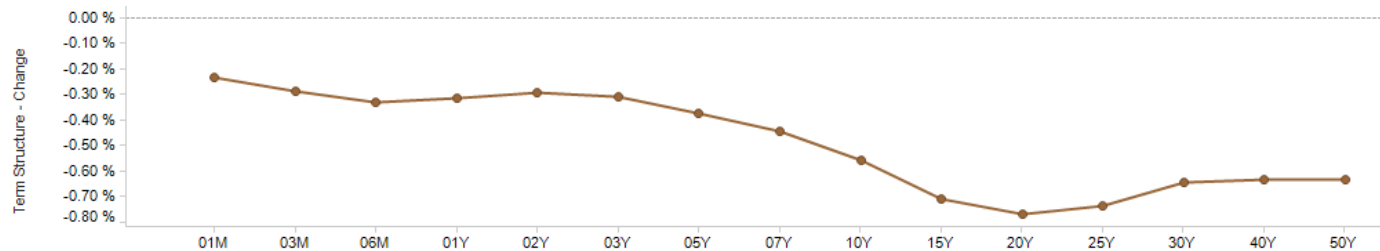
Active Contribution to Duration (yrs)



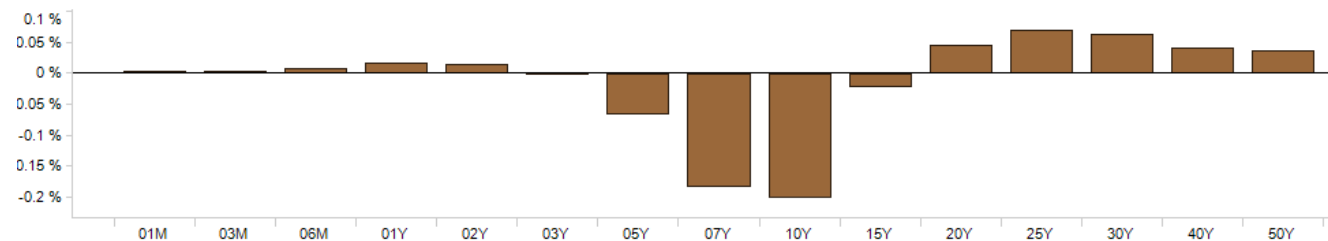
Initial Term Structure



Term Structure Change



Key Rate Change Attribution



SPREAD CHANGE RETURN

- **Spread Change Return**

- Captured using an exposure-based approach
- Driven by spread exposure and shift in asset option adjusted spread (OAS)

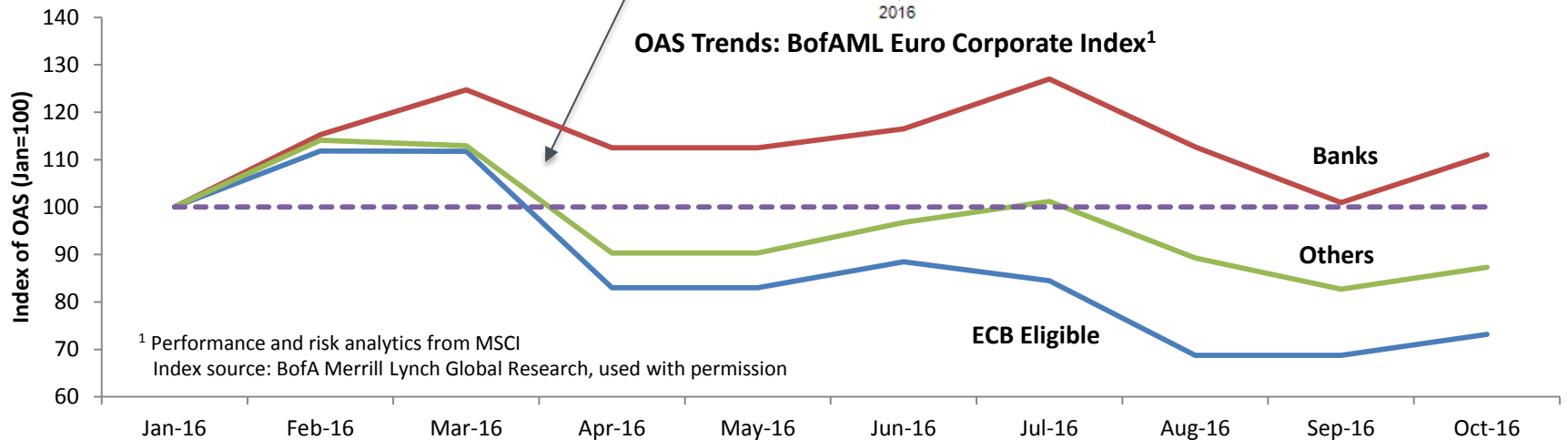
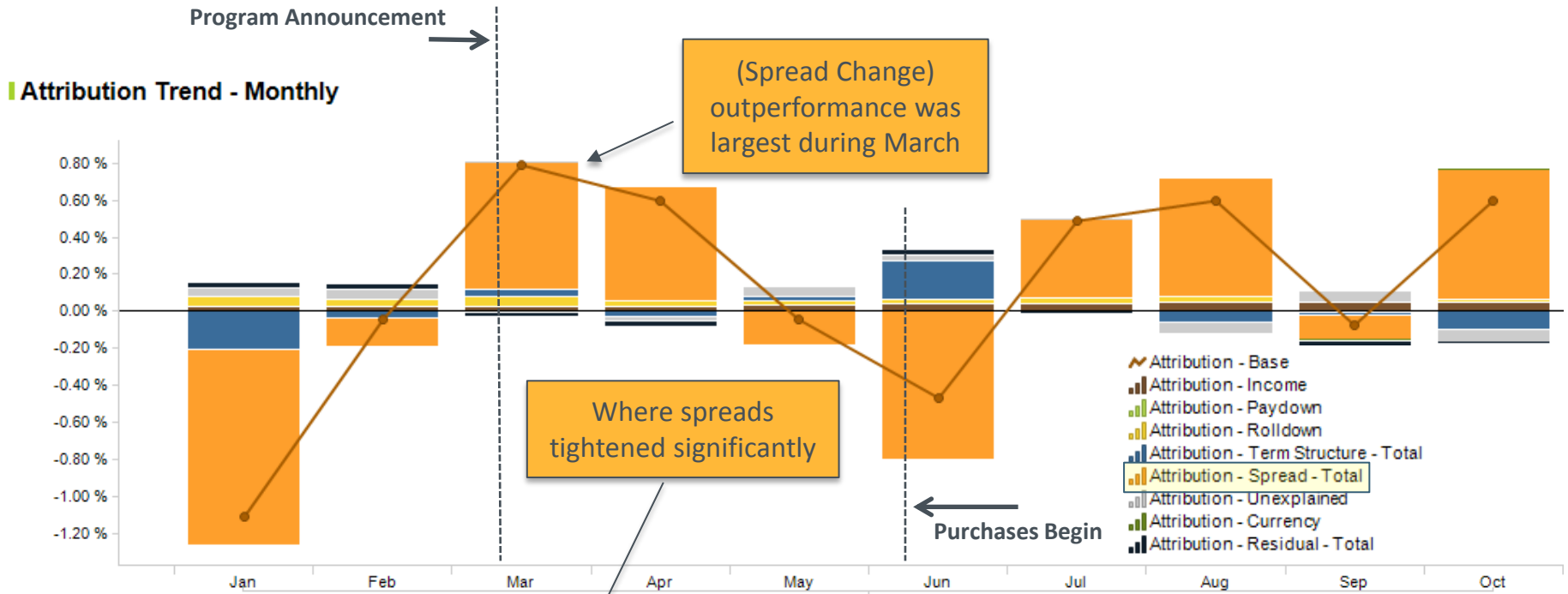
$$R_{j,t}^{spread} = -D_{j,t}^s \Delta S_{j,t}$$

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



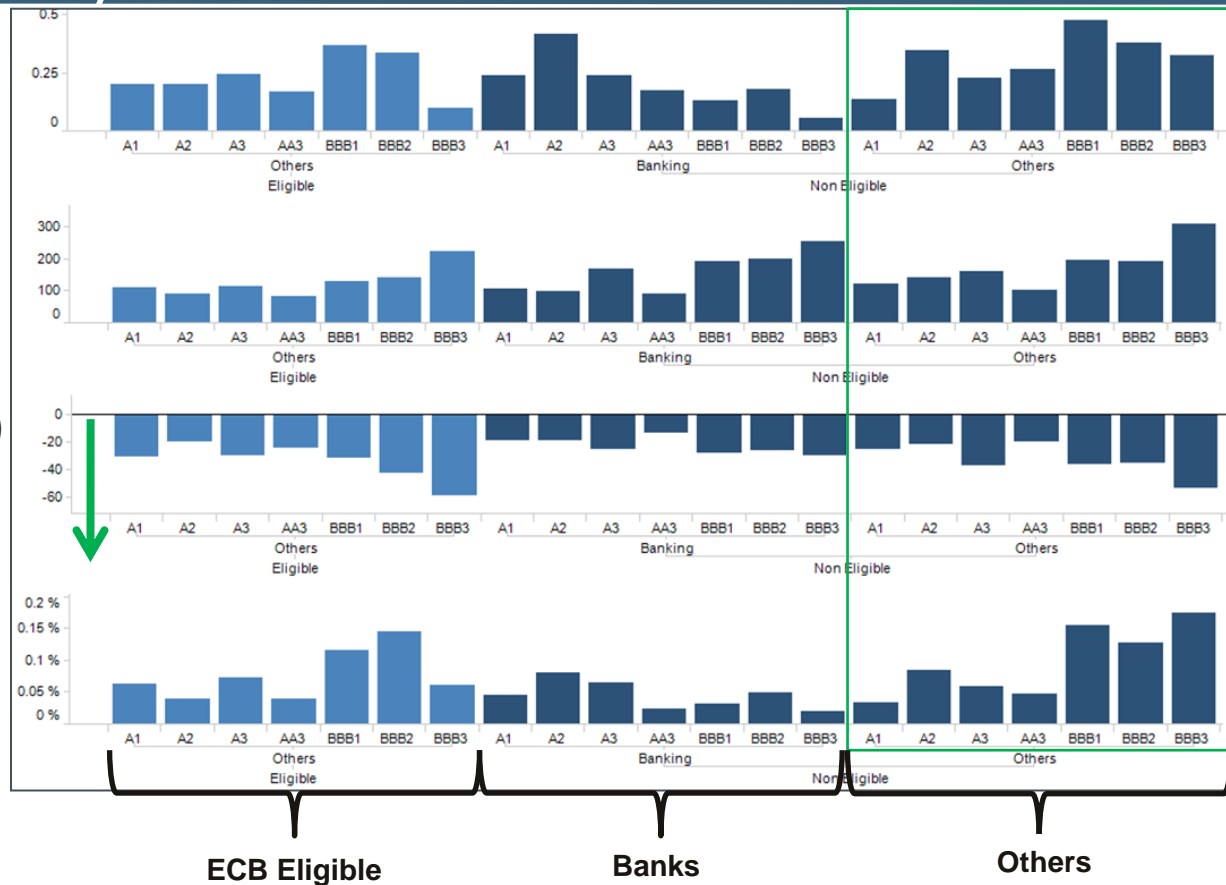
HOW DID THE ECB'S CSPP PROGRAM IMPACT THE MARKET (INDEX)?

Benchmark Contribution to OASD (yrs)

Average OAS (bp)

Change in OAS (bp)

Benchmark Spread Change Contribution



- **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 41bps from 180 bps
 - Gained 70 bps in spread contribution
- ECB bonds gained 54 bps, and Banks 31 bps

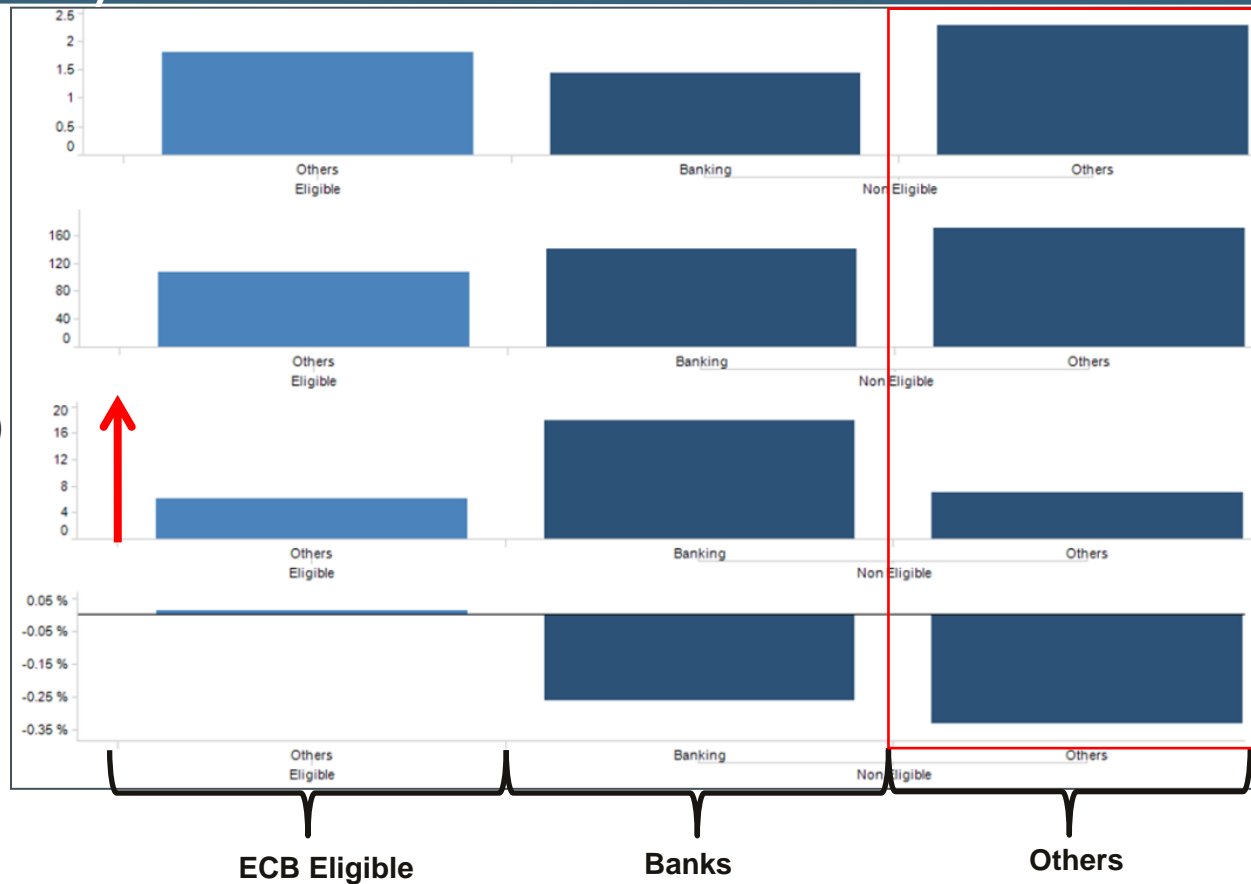
HOW DID THE ECB'S CSPP PROGRAM IMPACT THE MARKET (INDEX)?

Benchmark Contribution to OASD (yrs)

Average OAS (bp)

Change in OAS (bp)

Benchmark Spread Change Contribution

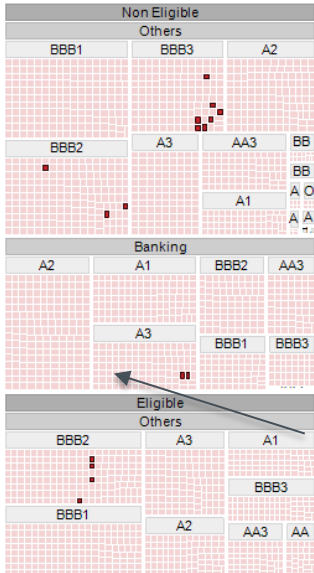


- **June: spreads widened but ECB spread widened less than Non-ECB**
 - 103 bps benchmark return
 - -58 bps from changes in spreads
 - Largest exposure to Non-Eligible Non-Bank bonds (Others)
 - Spreads increased by 7bps from 169 bps
 - Lost 33 bps in spread contribution
 - ECB bonds gained 1 bp, and Banks lost 26 bps

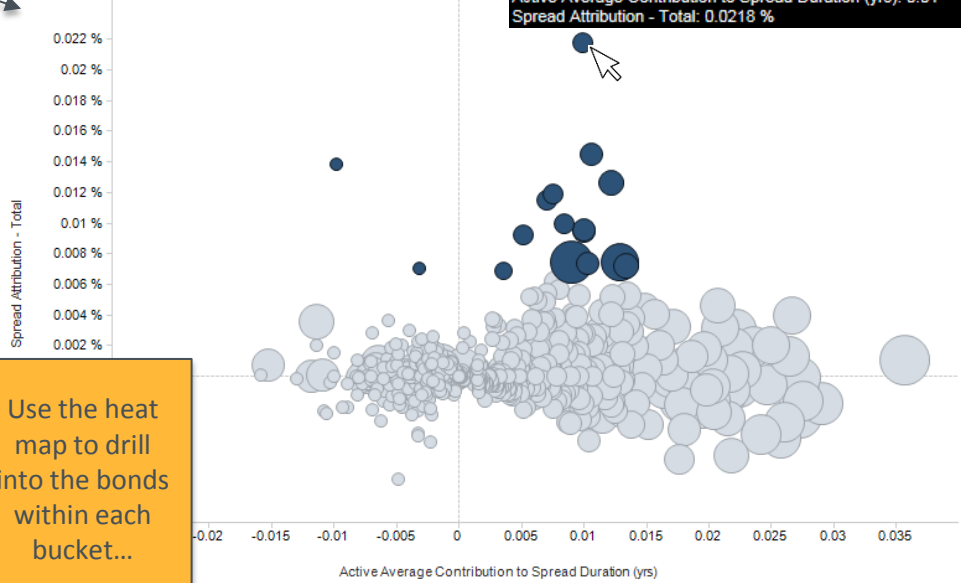
ISOLATE TOP PERFORMING BONDS IN MARCH

...the scatter plot shows active spread exposure against spread change attribution

Spread Attribution

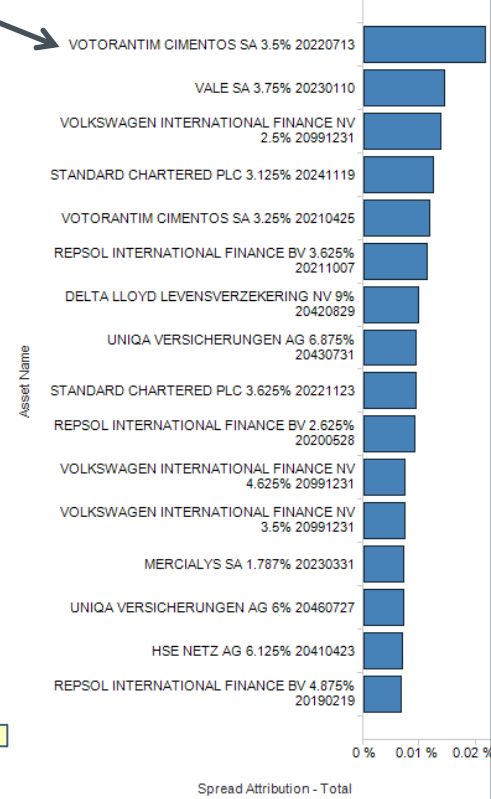


Spread Attribution vs. Spread Exposure



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

Asset Detail - Spread Attribution



Asset Attribution Detail

| Asset Name | Asset Id | Group 3 | Benchmark Average Spread Duration (yrs) | Benchmark Average OAS to Base (bp) | Benchmark Change in OAS to Base (bp) | Spread Attribution - Total | Spread Attribution - Selection | Benchmark Spread Return |
|--|--------------|---------|---|------------------------------------|--------------------------------------|----------------------------|--------------------------------|-------------------------|
| VOTORANTIM CIMENTOS SA 3.5% 20220713 | XS1232126810 | BBB3 | 5.05 | 995.30 | -325.66 | 0.0218 % | 0.0218 % | 18.1448 % |
| VALE SA 3.75% 20230110 | XS0802953165 | BBB3 | 5.58 | 768.61 | -272.50 | 0.0145 % | 0.0145 % | 16.7328 % |
| VOLKSWAGEN INTERNATIONAL FINANCE NV 2.5% ... | XS1206540806 | BBB3 | 18.22 | 122.09 | -9.07 | 0.0139 % | 0.0139 % | 1.4332 % |
| STANDARD CHARTERED PLC 3.125% 20241119 | XS1140857316 | A3 | 7.43 | 429.75 | -147.50 | 0.0126 % | 0.0126 % | 11.3367 % |
| VOTORANTIM CIMENTOS SA 3.25% 20210425 | XS1061029614 | BBB3 | 4.20 | 980.40 | -285.42 | 0.0119 % | 0.0119 % | 12.8932 % |
| REPSOL INTERNATIONAL FINANCE BV 3.625% 2021... | XS0975256685 | BBB2 | 5.02 | 266.88 | -179.21 | 0.0115 % | 0.0115 % | 9.3097 % |
| DELTA LLOYD LEVENSVERZEKERING NV 9% 20420829 | XS0824168423 | BBB2 | 4.85 | 745.69 | -184.48 | 0.0099 % | 0.0099 % | 8.9657 % |

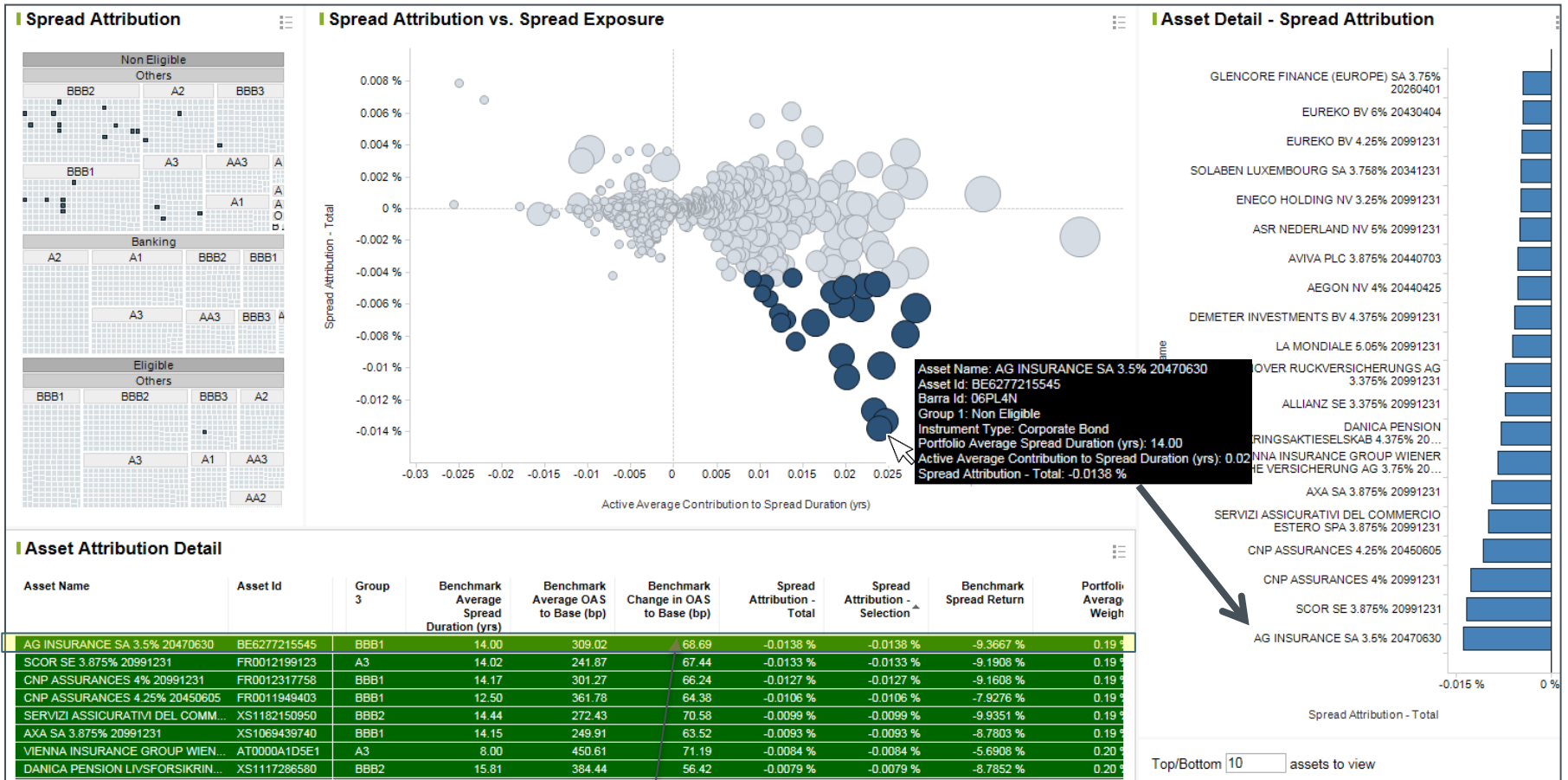
Top/Bottom 10 assets to view

BBB3 bond saw a marked decrease in OAS

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

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

SUMMARY OF RESULTS

- 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

1st

- 2008
 - Initial FI PA model released, term structure KRD effects & allocated spread return from residual
- 2011
 - Returns Calculator introduced for limited instrument types

2nd

- 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

3rd

- 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

4th

- 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

FI PA PRODUCT DEVELOPMENT STRATEGY

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

2016

2017

*Enhancements also benefit existing clients and clients switching from any vendor

CARRY RETURN DECOMPOSITION & ENHANCED CURVE CHANGE AND SPREAD CHANGE DECOMPOSITION: UAT Q4 2016

- 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

| Return Decomposition | Current FI PA | FI PA 2.0 |
|---------------------------------|---------------|-----------|
| Base Return | 50 bp | 50 bp |
| Trading Impact | 2 bp | 2 bp |
| Pricing Impact | 1 bp | 1 bp |
| Look Through Impact | 0 bp | 0 bp |
| Model Base Return | 47 bp | 47 bp |
| Currency Return | 4 bp | 4 bp |
| Local Return | 43 bp | 43 bp |
| Paydown Return | 3 bp | 3 bp |
| Carry Return | NA | 12 bp |
| Term Structure Carry Return | NA | 3 bp |
| Spread Carry Return | NA | 9 bp |
| Or | | |
| Income Return | 8 bp | 8 bp |
| Pull-to-Par Return | NA | 2 bp |
| Rolldown Return | 4 bp | 2 bp |
| Market Change Return | 28 bp | 28 bp |
| Term Structure Change Return | 4 bp | 6 bp |
| Term Structure KRD Return | 4 bp | 4 bp |
| 01M Return | 0 bp | 0 bp |
| 03M Return | 0 bp | 0 bp |
| 06M Return | 0 bp | 0 bp |
| 01Y Return | 1 bp | 1 bp |
| 02Y Return | 2 bp | 2 bp |
| 03Y Return | 3 bp | 3 bp |
| 05Y Return | 4 bp | 4 bp |
| 07Y Return | 0 bp | 0 bp |
| 10Y Return | 0 bp | 0 bp |
| 15Y Return | -3 bp | -3 bp |
| 20Y Return | -3 bp | -3 bp |
| 25Y Return | 0 bp | 0 bp |
| 30Y Return | 0 bp | 0 bp |
| 40Y Return | 0 bp | 0 bp |
| 50Y Return | 0 bp | 0 bp |
| Term Structure Convexity Return | NA | 1 bps |
| Rest of Term Structure Return | NA | 1 bps |
| Spread Change Return | 13 bp | 19 bp |
| Spread Duration Return | 13 bp | 13 bp |
| Spread Convexity Return | NA | 4 bp |
| Rest of Spread Return | NA | 2 bp |
| Unexplained Return | 11 bps | 3 bps |

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

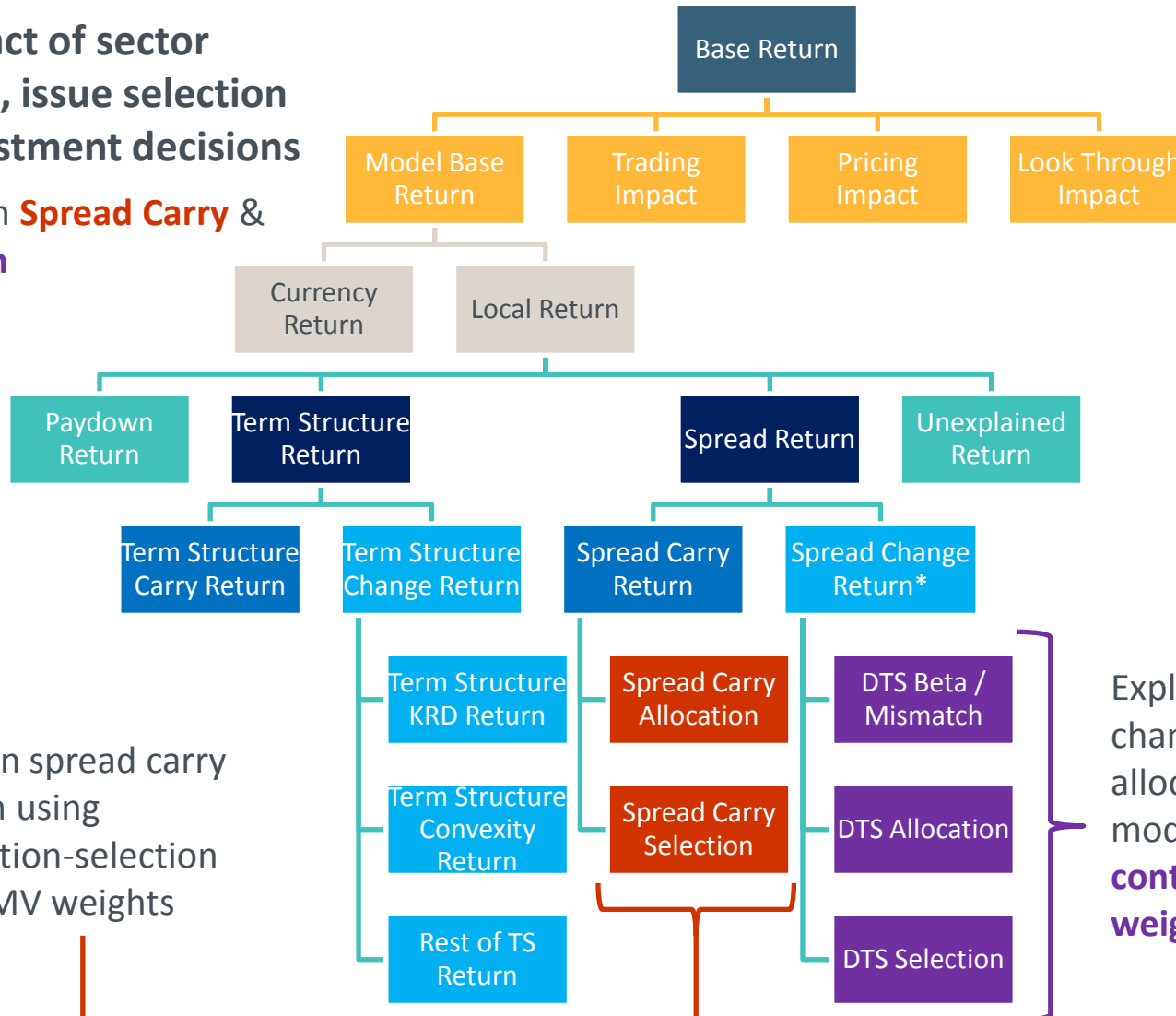
| Return Decomposition | Current FI PA | FI PA 2.0 |
|---------------------------------|---------------|-----------|
| Base Return | 50 bp | 50 bp |
| Trading Impact | 2 bp | 2 bp |
| Pricing Impact | 1 bp | 1 bp |
| Look Through Impact | 0 bp | 0 bp |
| Model Base Return | 47 bp | 47 bp |
| Currency Return | 4 bp | 4 bp |
| Local Return | 43 bp | 43 bp |
| Paydown Return | 3 bp | 3 bp |
| Term Structure Return | NA | 9 bp |
| Term Structure Carry Return | NA | 3 bp |
| Term Structure Change Return | 4 bp | 6 bp |
| Term Structure KRD Return | 4 bp | 4 bp |
| 01M Return | 0 bp | 0 bp |
| 03M Return | 0 bp | 0 bp |
| 06M Return | 0 bp | 0 bp |
| 01Y Return | 1 bp | 1 bp |
| 02Y Return | 2 bp | 2 bp |
| 03Y Return | 3 bp | 3 bp |
| 05Y Return | 4 bp | 4 bp |
| 07Y Return | 0 bp | 0 bp |
| 10Y Return | 0 bp | 0 bp |
| 15Y Return | -3 bp | -3 bp |
| 20Y Return | -3 bp | -3 bp |
| 25Y Return | 0 bp | 0 bp |
| 30Y Return | 0 bp | 0 bp |
| 40Y Return | 0 bp | 0 bp |
| 50Y Return | 0 bp | 0 bp |
| Term Structure Convexity Return | NA | 1 bps |
| Rest of Term Structure Return | NA | 1 bps |
| Spread Return | NA | 28 bp |
| Spread Carry Return | NA | 9 bp |
| Spread Change Return | 13 bp | 19 bp |
| Spread Duration Return | 13 bp | 13 bp |
| Spread Convexity Return | NA | 4 bp |
| Rest of Spread Return | NA | 2 bp |
| Unexplained Return | 11 bps | 3 bps |

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**



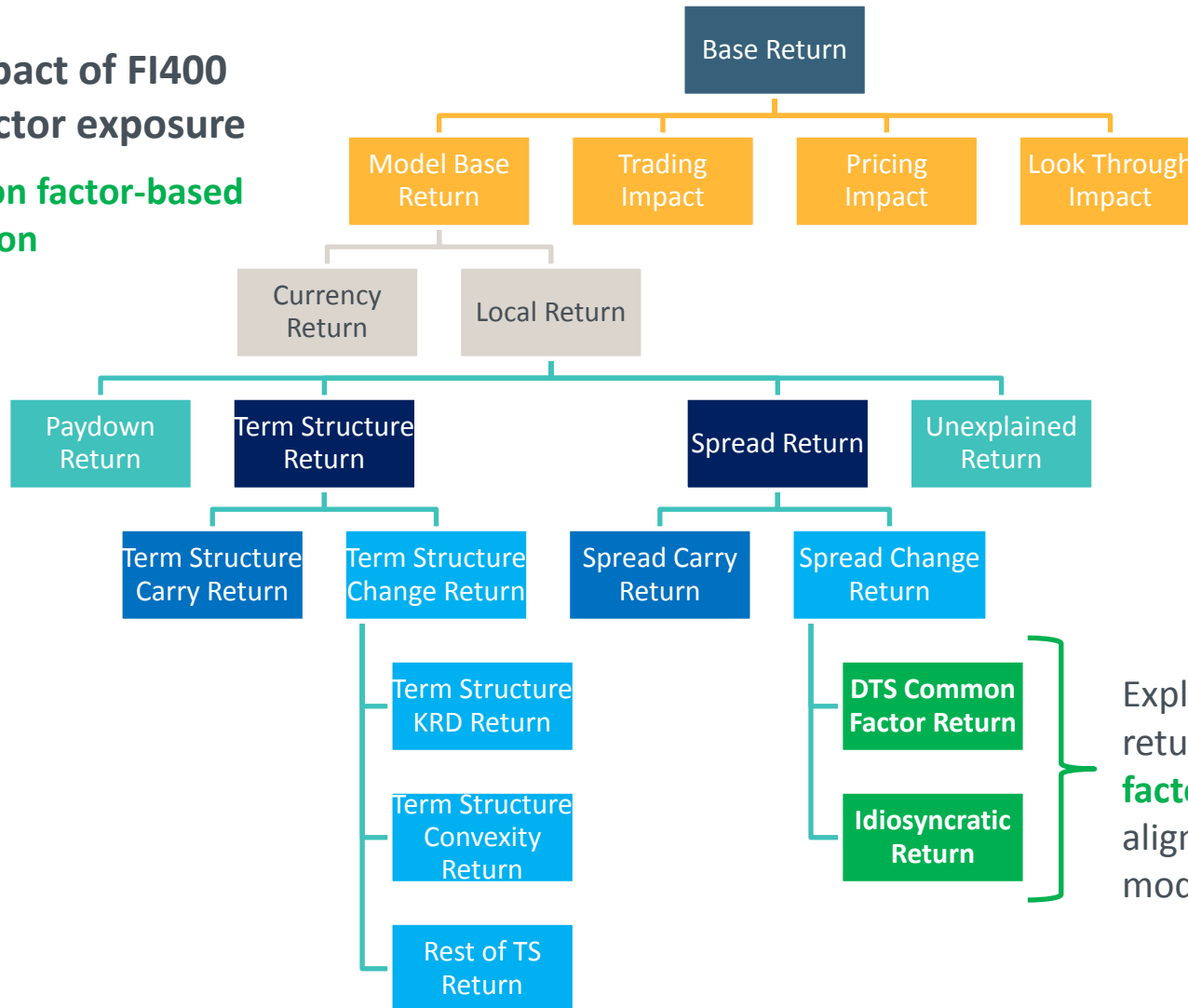
Explain spread carry return using allocation-selection with MV weights

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

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**



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

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, rolldown, 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

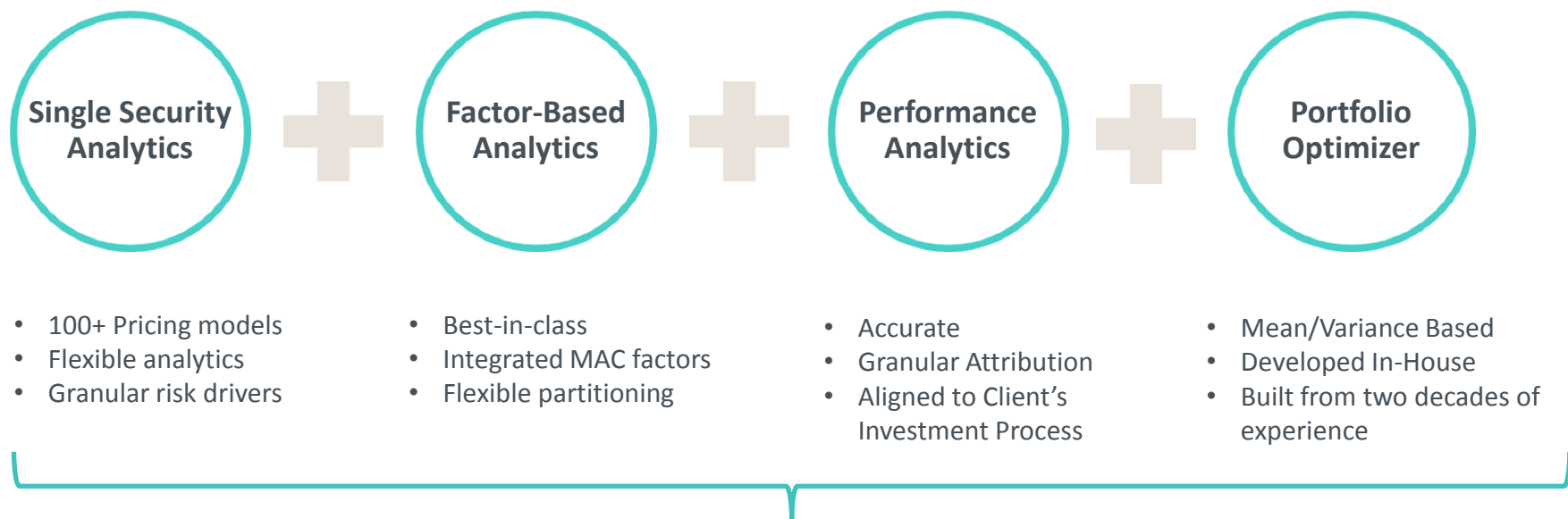
- Automated batch reporting
- Flexible to align with any investment process
- Trading impact & Pricing Impact
- Contribution/attribution from portfolio to asset level
- Look through into swaps, forwards, futures and composites
- Currency hedging

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

APPENDIX

- Additional Performance Attribution Capabilities
- MSCI
- Disclaimers and Rights of Use

ADDITIONAL PERFORMANCE ATTRIBUTION CAPABILITIES

BENCHMARK DATA INTEGRITY AND INDEX COVERAGE

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

ATTRIBUTION OF TRADING AND PRICING IMPACT

For Classic Brinson, Fixed Income and Equity Factor Attribution

Transactional Return vs. End-of-Day Return

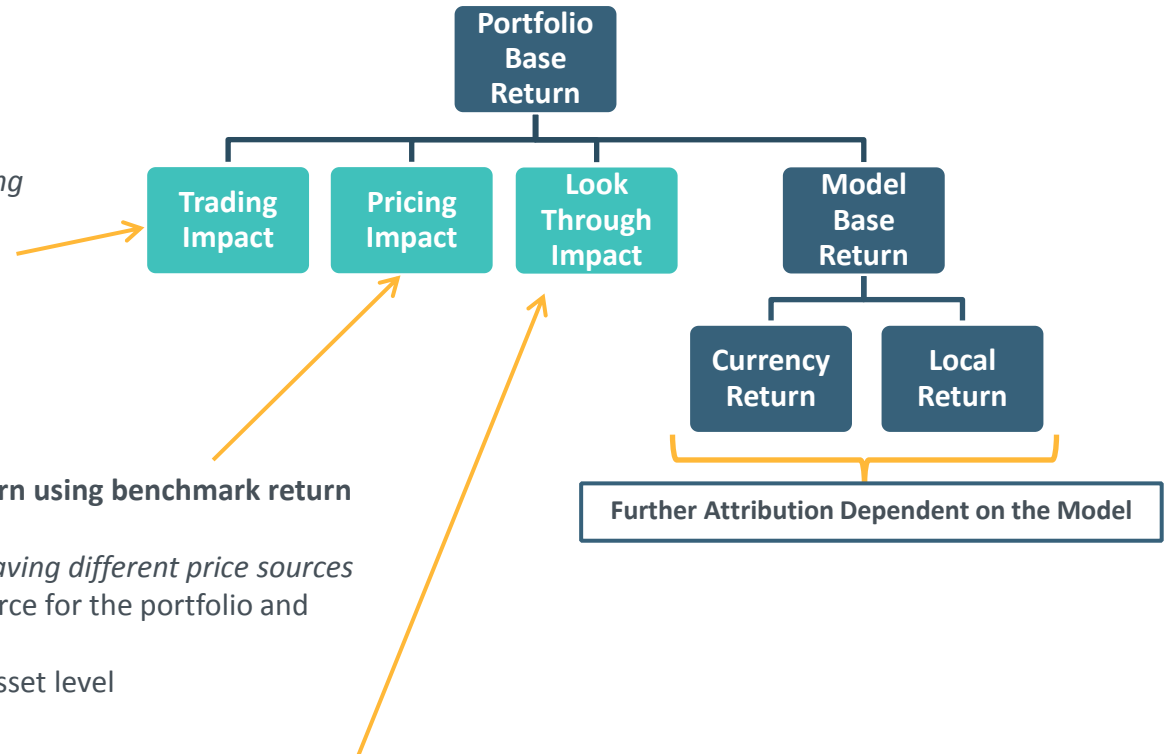
Impact of official performance differing from end-of-day holding-based performance

- 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

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

MSCI | BARRAONE

Analysis | Simulation | Performance | **Portfolio Admin** | Data Admin | Import | Export | Accounts

Credit Portfolio | BIM303

Location : rmademo » HOME » Credit Portfolio

General Info | Positions | **Settings** | History | VaR Info | Transactions | Transaction-Based Returns

Base Strategy: Barra Default [Go]

Portfolio Price Source: PRICE\rmademo\Custom Price

Benchmark: The BofA Merrill Lynch Euro Corporate Index [None]

Benchmark Price Source: PRICE\Barra\BofA Merrill

FX Rate Source: Follow FX Rate Priority

Priorities for: Price

| Priority | Name | Source | Type |
|----------|---------|-----------------|-------|
| 1 | Barra | BofA Merrill | PRICE |
| 2 | Barra | Barclays EU | PRICE |
| 3 | Barra | Barclays Global | PRICE |
| 4 | Barra | Barclays Muni | PRICE |
| 5 | rmademo | Custom Price | PRICE |
| 6 | Barra | Barra | PRICE |
| 7 | Barra | JPM GBIEM | PRICE |
| 8 | Barra | EJV | PRICE |
| 9 | Barra | FTSE Gilts | PRICE |
| 10 | Barra | ANDIMA | PRICE |
| 11 | Barra | Citigroup | PRICE |
| 12 | Barra | JPM CBT | PRICE |

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

Security Returns

Run returns calculator

Exclude Link Proxy assets

Use User Price in case of Calibration Failure

Asset Return Source: Default

Composite/Future Base Return: Top-level only

Use user FX rate

Use return from the underlying asset for Link Proxy

Capture Pricing Impact

Use the specified portfolio price and FX source to capture the Pricing Impact due to differing asset returns for common assets in the portfolio and benchmark. Checking this automatically runs the return calculator. Ensure the specified price and FX sources are populated with data prior to running the analysis.

Positions report and risk analysis also benefit from flexible portfolio-specific price source driven analytics

TRANSACTIONS AND HOLDINGS

BarraOne Performance Analytics Solution

Transactions Combined with Holdings

Accurate capture of **portfolio return**

Time weighted rate of return following GIPS recommended calculations

Incorporating daily valuations, external cash flows, portfolio-level transactions, fees, taxes, commission payments, expenses

Supplement asset-level attribution with **transactions**

Incorporate asset-level transactions, i.e. buys, sells, revenue, coupon, paydown, dividend, margin, etc., in PA analytics

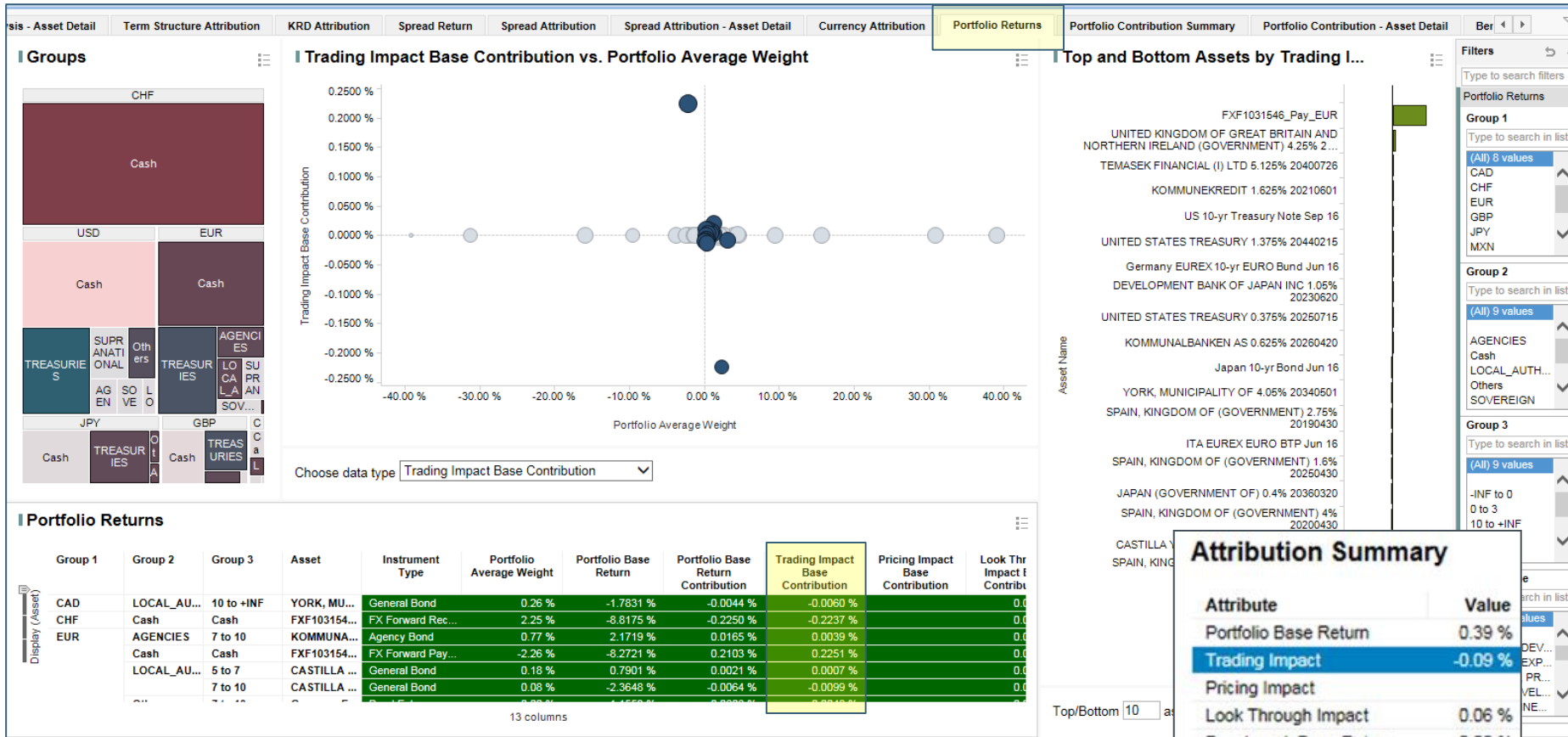
Results in official portfolio return

Capture impact from differences in traded prices and closing prices

Data management tools helps clients manage and reconcile calculations

ASSET-LEVEL TRADING IMPACT DASHBOARD

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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CONTACT US

AMERICAS

| | |
|---------------|-------------------|
| Americas | 1 888 588 4567 * |
| Atlanta | + 1 404 551 3212 |
| Boston | + 1 617 532 0920 |
| Chicago | + 1 312 675 0545 |
| Monterrey | + 52 81 1253 4020 |
| New York | + 1 212 804 3901 |
| San Francisco | + 1 415 836 8800 |
| Sao Paulo | + 55 11 3706 1360 |
| Toronto | + 1 416 628 1007 |

* = toll free

msci.com

clientservice@msci.com

EUROPE, MIDDLE EAST & AFRICA

| | |
|-----------|--------------------|
| Cape Town | + 27 21 673 0100 |
| Frankfurt | + 49 69 133 859 00 |
| Geneva | + 41 22 817 9777 |
| London | + 44 20 7618 2222 |
| Milan | + 39 02 5849 0415 |
| Paris | 0800 91 59 17 * |

ASIA PACIFIC

| | |
|-------------|-------------------|
| China North | 10800 852 1032 * |
| China South | 10800 152 1032 * |
| Hong Kong | + 852 2844 9333 |
| Mumbai | + 91 22 6784 9160 |
| Seoul | 00798 8521 3392 * |
| Singapore | 800 852 3749 * |
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