ANALYZING CREDIT ALPHA IN AN INTEGRATED RISK AND PERFORMANCE ANALYSIS

Nick Sharp, Zsolt Simon, András Bohák

October 2015

Executive Summary

Portfolio managers and performance analysts need to be able to attribute the performance of their portfolio to distinct return drivers. At the same time risk analysts need to understand the portfolio's exposure to different sources of risk, identify unintended bets, and clearly communicate risk forecasts. Integrating these processes to achieve a coherent, side-by-side attribution of both risk and return creates a powerful analytical tool.

This Product Insight focuses on fixed income attribution and illustrates how an integrated risk and performance analysis can be carried out with BarraOne, which is part of MSCI's risk and performance platform, for a corporate bond portfolio invested using a credit value strategy.[1] The effectiveness of the analysis is illustrated through a "real world" use case, which shows how investors can analyze strategies that target credit alpha coming from exposure to spread risk. The theme of integrated fixed income attribution builds on a previous paper, Integrated Fixed Income Risk and Performance Analysis in BarraOne - A Case Study Built on QE Tapering Scenarios, where an integrated analysis was applied to a multi-currency government bond portfolio.

The next section presents the fixed income risk and performance attribution models, while the theme of integration is described in the subsequent section. The majority of the paper is then dedicated to the case study, and the final section summarizes the paper.

Risk and Performance Attribution Modeling

This section presents the modeling required for an integrated fixed income risk and performance analysis, and describes how the different sources of fixed income risk and the drivers of return can be captured and quantified. Their varied nature makes this particular asset class complex but rewarding to analyze.

Modeling Fixed Income Risk

The decision to purchase a bond exposes the investor to different sources of risk. The most fundamental of these is term structure risk, which comes from asset and portfolio exposure to changes in government interest rates. Next in importance is credit spread risk, which reflects the possibility that not all anticipated future cash flows from coupons and principal will be received; here the tightening and widening of credit spreads, related to changes in the credit worthiness of the bond's issuer, impact asset prices and create uncertainty about the likely return. In this context, spread refers to the risk premium over the government bond yield that results from this uncertainty. The case study later in this paper relates to corporate bonds, with a focus on term structure and spread risk. For assets such as mortgage-backed securities, prepayment risk and optionality risk are also relevant. Prepayment risk results from the possibility of principal being paid down prior to maturity, affecting bond values, while the impact of implied interest rate volatility on the value and return of any bond with embedded options produces optionality risk. Finally, for any multi-currency portfolio, exposure to the movement of foreign exchange rates is also a source of risk, as this impacts the present value of future cash flows from foreign investments.

[1] BarraOne, which is part of MSCI's multi-asset class, multi-currency, risk and performance platform, covers a multitude of use cases across all asset classes and multiple investment styles. This breadth and flexibility helps investment managers make more informed decisions, as our tool can be perfectly aligned with the way they invest.

Exhibit 1: Fixed Income Risk Model Diagram

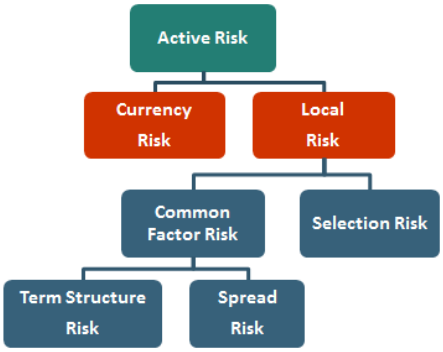


Exhibit 1 illustrates the attribution of risk in the fixed income risk model, where term structure risk and spread risk combine to produce common factor risk.

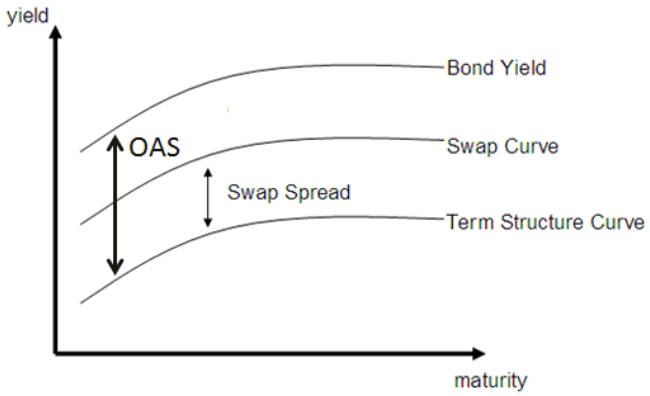
Decomposing Term Structure and Credit Spread Risk

A bond's term structure exposure is affected by any movement in the government bond curve. This movement can be decomposed into individual "key" rates, or viewed as a parallel shift in the curve, a twist in the curve by steepening/flattening, or a butterfly movement that changes the degree of "curvature" of the curve.

Exhibit 2 illustrates how the yield of a risky (non-government) bond of a particular maturity can be decomposed into a yield corresponding to the local government term structure, the local swap curve, and the spreads between these three curves.

The option adjusted spread (OAS) of a bond is the number of basis points the government curve needs to shift in order to match the present value of the sum of future cash flows to the bond's price. This can be split into the spread between the term structure of government interest rates and the swap curve, an additional spread due to the bond's systematic spread risk, and finally an amount of idiosyncratic spread, specific to the bond's issuer. The next section discusses the systematic spread risk of a bond.

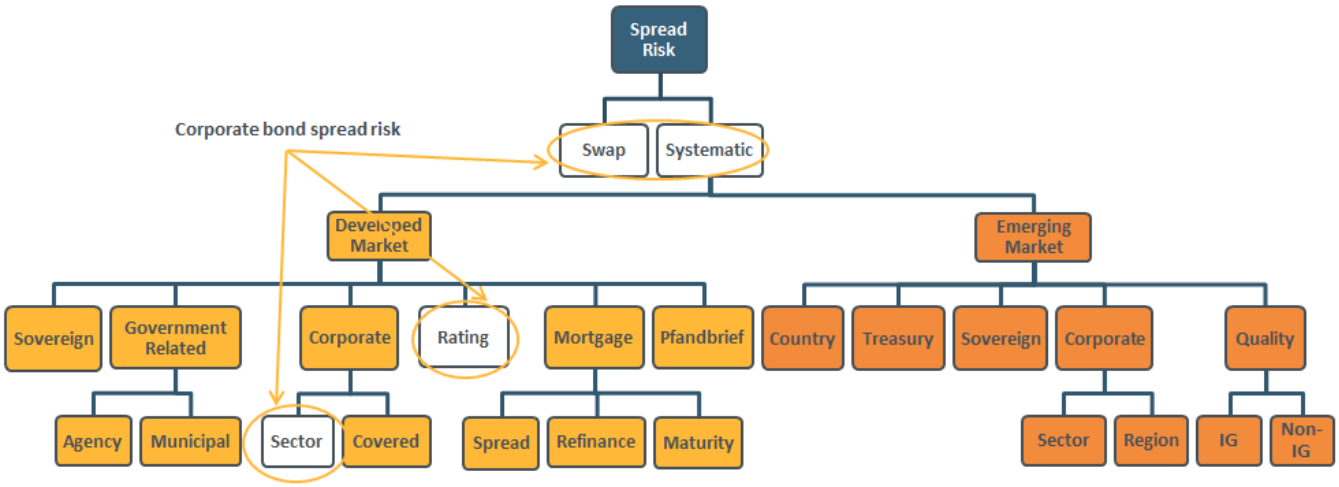
Exhibit 2: Decomposing Bond Yield



Granular Spread Risk Decomposition

Exhibit 3 illustrates how spread risk can be split between swap spread risk and systematic spread risk. Systematic spread risk, the risk that is common to bonds with similar characteristics, can be determined for over seven hundred sector-by-rating categories across developed market and emerging market bonds, over different countries, and for different types of risky bonds. Capturing sources of systematic spread risk in this way makes it possible to attribute risk with precision and insight.

Exhibit 3: Spread Risk Decomposition



For example, take a corporate bond issued by a particular firm. We can determine its spread risk and then attribute it according to the bond's exposure to the swap curve, the amount of spread risk resulting from the bond's sector, and the amount relating to its credit rating. Finally, there will be an amount of issuer-specific spread risk.

For further details on the fixed income risk model see Fixed Income Risk Model Details.

Fixed Income Performance Attribution

The fixed income performance attribution model uses an approach where each return driver is quantified by a return component. After separating the impact of currency, the following return components provide a detailed decomposition of return:

- Income return – due to the change in accrued interest and coupon payments. This is an absolutely essential return component as income in the form of interest is fundamental to fixed income investments.
- Paydown return – due to principal paid prior to maturity, and applicable to bonds with sinking funds, amortizing bonds, mortgage-backed securities, and callable bonds.
- Price return – due to the change in the clean price, and captured as a distinct component which allows the return from interest and principal payments to be separated from the return due to changes in the market. The market changes as interest rates move and credit spreads tighten or widen over time. The return due to each of these changes can be captured as follows:

- Rolldown return – due to the passage of time, caused by the pull-to-par effect and by assets rolling down their discount curve.
- Term structure return – due to exposure to fluctuations in government interest rates.
- Spread return – due to exposure to the tightening or widening of credit spreads.
- Unexplained return – price return not captured by rolldown, term structure or spread return.[2]

Term Structure Return

Intuitively, as interest rates decrease, this leads to higher asset prices and a positive term structure return. Conversely, as rates increase, this leads to lower asset prices and a negative term structure return. The magnitude of the term structure return depends on the asset's term structure exposure, meaning its sensitivity to changing interest rates. Key rate durations (KRDs), which measure the asset's sensitivity to a shift at each key rate, are multiplied by the observed shift in each rate to determine each key rate's term structure return. The sum of the key rate returns then gives us the term structure return for the asset. This is referred to as an exposure-based approach.

Credit Spread Return

The spread return is also calculated using an exposure based approach, but in this case applying the spread duration and the change in OAS. Tightening credit spreads lead to higher asset prices and a positive spread return, while widening credit spreads lead to lower asset prices and a negative spread return. The magnitude of the spread return depends on the asset's sensitivity to the changing spread, namely its spread duration.

For further details on the fixed income performance attribution model see Decomposing Fixed Income Performance — Part 1: Asset Analytics; and Decomposing Fixed Income Performance — Part 2: Case Study.

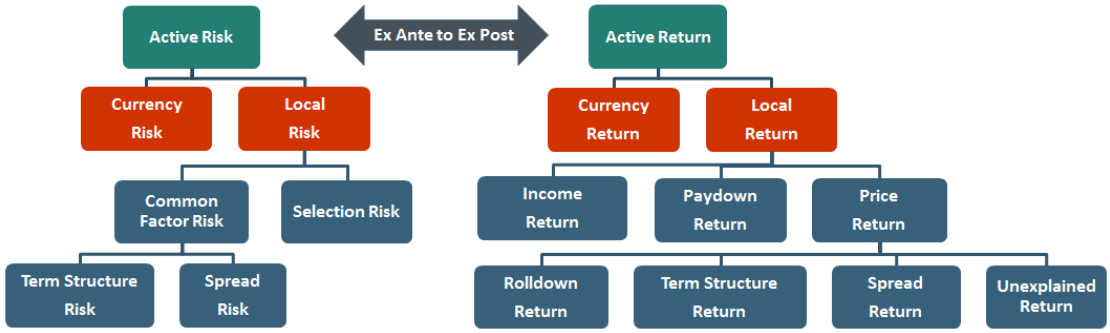
Correspondence between Risk and Performance

There is complete correspondence between the risk factors in the fixed income risk model and the return components in the performance attribution model. This is the foundation for the integrated analysis. The correspondence between the ex ante sources of risk and the ex post drivers of return is illustrated in Exhibit 4. The concept of 'carry' explains why correspondence is achieved, even though the two diagrams are not symmetrical.

Risk is defined in excess of carry, where carry is the deterministic or knowable portion of an asset's return. Carry can be approximated as the combination of income and rolldown return, and can be calculated ex ante using forward rates and accrued interest. Since risk is in excess of carry, it is not necessary to include attributes corresponding to income and rolldown in the risk model. This explains why there can be complete correspondence from ex ante to ex post even though the diagram in Exhibit 4 is not symmetrical.

[2] Unexplained return includes effects not captured by the model; such as from changes in implied interest rate volatility, or from non-yield driven changes in the mortgage prepayment speed.

Exhibit 4: Ex Ante to Ex Post – Risk Source and Return Driver Correspondence



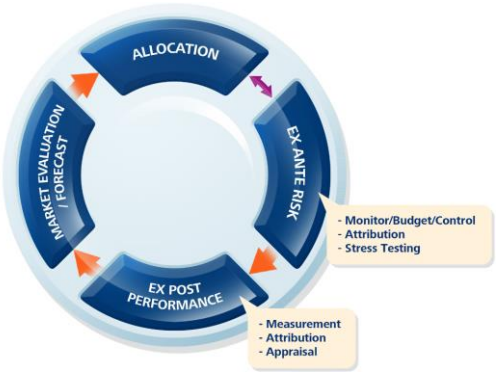
Integrated Risk and Performance Analysis

MSCI provides all the tools needed to carry out an integrated risk and performance analysis which complements the investment decision process.

Feedback Loop in the Investment Decision Process

Exhibit 5 illustrates the investment decision process, which begins with an evaluation of the market that may well take a quantitative approach and include some forecasting of likely market movements. The portfolio manager will then implement the investment strategy for the portfolio in the light of the approved asset allocation. This is the point when most can be gained from an ex ante or forward looking risk analysis, allowing the sources of risk to be understood and ensuring that the risk budget set in the investment mandate has been met. Risk attribution allows the identification of any unintended bets and the neutralizing of any unwanted exposures by adjusting portfolio allocations. Stress testing can also be helpful in risk analysis as it allows scenarios to be applied and the impact on the portfolio to be verified. At the end of the reporting period the ex post backward looking performance analysis should be carried out. Performance measurement provides the official record of performance upon which performance attribution can be undertaken to understand the drivers of return and to see which bets paid off. Finally, performance appraisal can be used to verify the manager's skill and to assess whether performance is likely to be sustained.

Exhibit 5: Feedback Loop in the Investment Decision Process

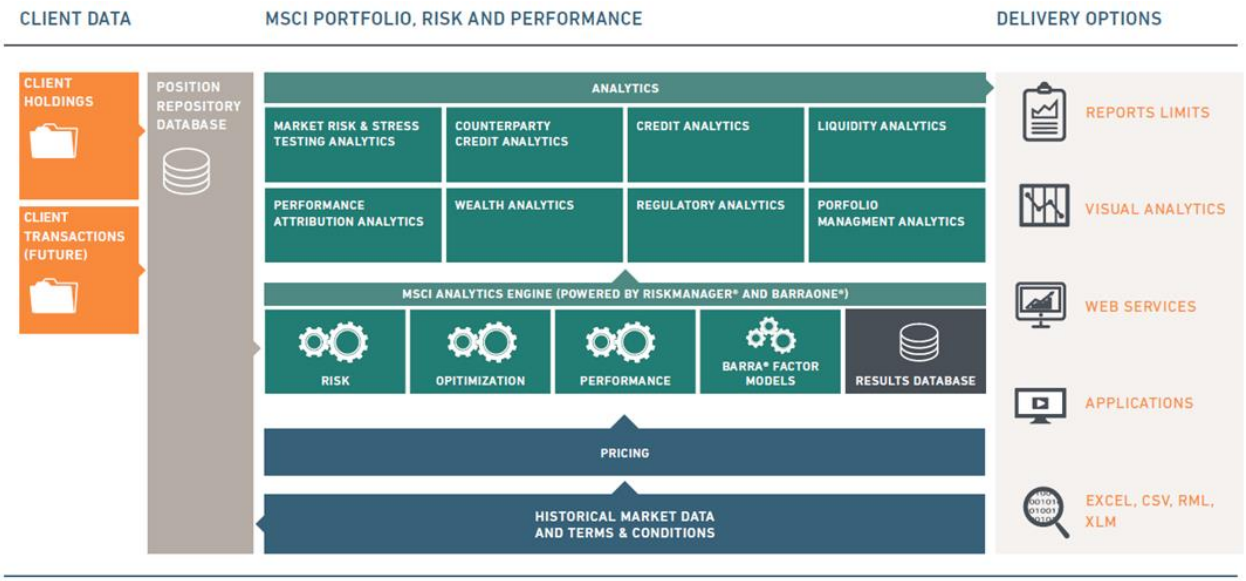


Carrying out these processes in an integrated fashion is extremely powerful as it introduces a feedback loop between forward looking expectations and backward looking realized performance.

Operational Requirements for Integrated Analysis

Carrying out integrated risk and performance attribution can be difficult if multiple platforms are used, and is almost impossible if those systems are from separate software vendors.

Exhibit 6: MSCI's Integrated Risk and Performance Platform



The following operational requirements must be met in order to carry out integrated risk and performance analysis in BarraOne, which is part of MSCI's risk and performance platform. Exhibit 6 illustrates that integrated analysis begins by consolidating portfolio data (shown in orange) and vendor data (shown in blue) into one

platform, including snapshots of client holdings as well as market data, index data and terms and conditions.[3] Since the analytics platform contains both risk and performance analytics engines, portfolio holdings only need to be loaded once for both ex ante risk and ex post performance analytics to be calculated. These can then be reported in an integrated fashion, leading to a reduction in total software costs, as multiple platforms and reconciliation processes are not required.

Integrated Risk and Performance Dashboard

Combining all portfolio data in a single platform enables risk and performance analytics to be reported in a coherent manner. This can be achieved through reporting dashboards which integrate risk and return analytics, allowing the user to quickly assess whether the portfolio's return drivers are aligned with its sources of risk.

The simple dashboard shown in Exhibit 7 is the template for the side-by-side attribution of risk and return which is applied in the case study in the next section.

Exhibit 7: Risk and Performance Dashboard

Portfolio Name, Benchmark Name, Timeframe

Allocation Groups	Dimension A			Dimension B			Total	
	Active Weight	Active Risk	Active Return	Active Weight	Active Risk	Active Return	Active Risk	Active Return
Match the								
Investment	Dimensions match sources of risk and drivers of return			Risk and Return reported in the same units (%, bps, £)				
Process								
Total								

To understand whether a portfolio's return drivers are aligned with its sources of risk, the columns of the dashboard which correspond to term structure, spread and currency, should show the portfolio's exposure, amount of risk and corresponding return. The rows should be aligned with the investment decisions made by the portfolio manager and should correspond to the allocation of capital to different markets, such as countries, term structures, spreads and ratings. Exposure can be measured by the weight or the duration of an investment in a given market or a combination of the two, or by spread duration, OAS times spread duration, and so on; perhaps most importantly, risk and return should be reported in the same units, whether percent, basis points or in terms of a particular currency. Ex post risk and risk-adjusted return measures can be added to the dashboard to allow manager and portfolio comparisons to be made.

Case Study: Corporate Bond Credit Value Strategy

The case study illustrates how an integrated risk and performance analysis can be carried out with BarraOne, for a corporate bond portfolio invested using a credit value strategy. The effectiveness of the analysis is illustrated by

[3] Market data includes foreign exchange rates, interest rates and corporate actions. Index data includes prices and returns from major equity and fixed income index providers such as MSCI, Russell, FTSE, Barclays, JP Morgan, iBoxx, etc.

this "real world" use case, which shows how investors can analyze strategies that target the credit alpha coming from exposure to spread risk.

Investment Mandate Applied in the Analysis

A hypothetical U.S. based investment grade corporate bond portfolio manager sets up a new fund in 2014 following a credit value strategy. The benchmark specified in the investment mandate is the BofA Merrill Lynch US Corporate Bond Index.[4] The portfolio is rebalanced monthly according to a credit value strategy, with the only limitation being an active risk budget of 200 basis points.

Opportunity Set

The investment opportunity set is the universe of investment choices available to the portfolio manager. This begins with all the assets from the benchmark and is then reduced according to the credit value strategy.

Since the case study contains only corporate bonds, the relevant sources of risk are term structure risk and credit spread risk. The two key characteristics of credit spread risk for this analysis are the sector each bond belongs to and the issuer's credit rating.

At the most granular level of classification, there are 70 corporate bond sectors defined by BofA Merrill Lynch, including banking, life insurance, auto loans, chemicals and aerospace/defense. To understand the size of the opportunity set, the matrix of the 70 BofA Merrill Lynch sectors and ten credit ratings levels for investment grade bonds, from AAA to BBB3, in theory gives a possible 700 sector-by-rating groups across which to allocate the 6,000 or so bonds in the benchmark. A rule-based approach is thus needed to help streamline the allocation process.

Credit Value Strategy: Seeking Credit Alpha

The portfolio manager's credit value strategy aims to earn credit alpha, which is the active return from exposure to credit risk alone. Credit value is a relative value strategy intended to exploit mispricing in different markets by identifying and investing in bonds that are undervalued compared to very similar bonds, according to their OAS. The strategy hinges on the expectation that a bond with a high spread in a category of otherwise similar bonds will see its spread decrease and mean revert towards the group average. If the spread tightens on the selected bonds, all else being equal, then a positive spread return will be achieved when their prices increase.[5] In practice the strategy aims to capitalize on credit risk exposure by selecting, month by month, the bond with the largest OAS from each duration-by-rating group in the benchmark, thus targeting a positive active spread return.

The focus is on the selection of individual bonds and not on allocation across different groups. An attempt is made to immunize against term structure risk by ensuring each group of similar bonds is duration neutral, with an active duration of zero. Allocation decisions are avoided by weighting the selected bond in line with its duration-by-rating group in the benchmark.

[4] Bank of America Merrill Lynch ("BofAML") index data used with permission. See Appendix for more details.

[5] The strategy used in the case study is only intended to illustrate a theoretical use case for MSCI's investment decision support tools. MSCI does not provide investment advice.

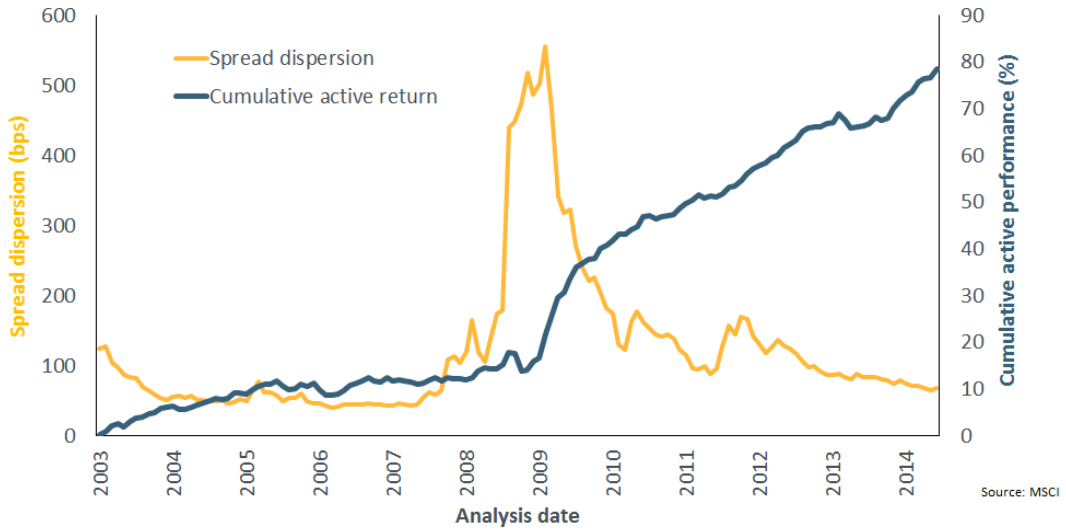
A price reliability constraint is applied to avoid selecting bonds where the price return is not well explained by the attribution model in the previous month. This avoids investing in bonds where the OAS is considered to be a noisy signal.

This type of credit value strategy is fairly common. For instance, PIMCO's Global Credit Opportunity Strategy aims to provide credit alpha, claiming that "while sector and industry decisions are important, bottom-up security selection will most likely be the main driver of long-term performance".

Backtest: Spread Dispersion vs. Performance

This section provides an assessment of the long term performance of the credit value strategy followed in the case study. Exhibit 8 shows the cumulative active performance of the portfolio over the last 11 years in blue, and the spread dispersion in yellow. Spread dispersion represents the "size" of the investment opportunity for the credit value strategy, being the maximum difference between spreads for bonds within a group of otherwise similar bonds. Through the global financial crisis late in 2008 and into 2009, when spread dispersion was at its largest for U.S. investment grade corporates, it was possible to select bonds with much larger spreads relative to their peers. This meant that some bonds were more likely to be undervalued, giving the opportunity to capture a positive spread return. It is clear that the credit value strategy would have outperformed greatly over the last 11 years and that there was a marked increase in performance when spread dispersion was greatest.[6] However, at this stage it is not possible to say that the active return derived from exposure to credit risk as a direct result of the strategy. For this purpose we need to use attribution models.

Exhibit 8: Spread Dispersion and Cumulative Active Return for the Credit Value Strategy



Note that investors following this strategy may have observed a lower realized performance, one reason being that bonds perceived to be under-valued may actually be illiquid, and their spread may not follow the expected trend.

[6] Future performance may differ materially.

Risk Attribution

Using ex ante risk attribution, we can assess the risk of the portfolio, first to establish if the risk budget was met, and then to understand if the portfolio was over exposed to a particular source of risk. We can also identify any unintended bets. All of this information can be fed back into the allocation process.

In Exhibit 9, the standalone risk of each source is reported, in terms of the ex ante standard deviation of returns, together with the risk contributions, which are additive and show how much a particular source of risk contributes to the overall risk of the portfolio. The overall active risk at the start of the analysis was 1.63 per cent, which was inside the risk budget of 200 basis points of tracking error. This was attributed to common factor sources of risk and an amount of selection risk. The common factor risk contribution of 92 basis points accounted for 56 per cent of the active risk, and the remaining 71 basis points could be attributed to selection risk, sometimes called specific or idiosyncratic risk. This large amount of selection risk was expected given that the credit value strategy led to the selection of bonds with relatively large spreads, which was partly due to idiosyncrasies that gave rise to large specific risks uncorrelated with other sources. Selecting bonds based on high OAS impacted common factor risk, with the systematic source of sector-by-rating spread risk contributing 46 basis points, which was close to 30 per cent of the active risk. The term structure risk was also significant, with 28 basis points equating to around one fifth of the overall active risk coming from term structure exposure. This was unintended given that the credit value strategy aimed to capitalize on credit risk exposure while remaining duration neutral. The unintended term structure exposure was actually caused by the duration of each bond selected in the portfolio differing from the average of each duration-by-rating group in the benchmark. If the duration-by-rating allocation groups had been more granular, the duration risk could have been immunized more effectively. The next section provides an attribution of term structure risk to understand why this was the case.

Exhibit 9: Attribution of Standalone Active Risk and Contribution to Active Risk

Risk Source	Active Risk (%)	Active Portfolio Correlation	Active Portfolio Risk Contribution (%)	% of Active Risk
Total Risk	1.63	1.00	1.63	100.0%
Local Market Risk	1.63	1.00	1.63	100.0%
Common Factor Risk	1.22	0.75	0.92	56.2%
Term Structure	0.67	0.42	0.28	17.0%
Spread	1.01	0.63	0.64	39.2%
Swap	0.37	0.48	0.18	11.0%
Sector-Rating	0.80	0.57	0.46	28.2%
Selection Risk	1.08	0.66	0.71	43.8%

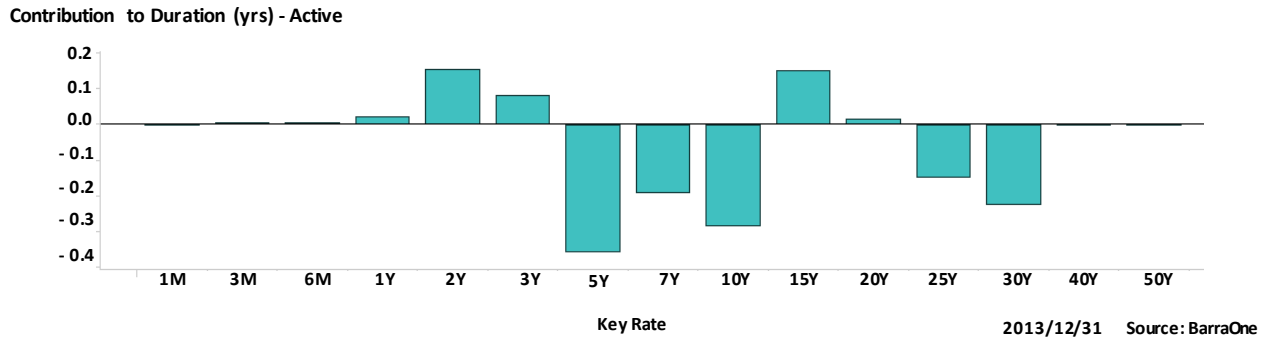
2013/12/31 Source: BarraOne

Term Structure Exposure and Risk

Exhibit 10 shows the portfolio's active contribution to duration for each key rate on the U.S. yield curve at the start of the analysis. This is the active term structure exposure at each rate. It is clear that the active portfolio was not

perfectly duration neutral as had been intended, being over- and under-exposed at various points on the curve. This led to a small active duration of minus 0.78 years (shown by the total active exposure in Exhibit 11).

Exhibit 10: Active Term Structure Exposure at the Start of the Analysis



In Exhibit 11, the impact of the unintended exposure appears as 28 basis points of term structure risk, which can be attributed to key rate duration factors or alternatively to shift, twist and butterfly factors. The main sources of risk were the 5, 10 and 30 year points on the curve, and the shift factor in the alternative view.

Exhibit 11: Multiple Views of Term Structure Risk

Factor	Active Exposure (yrs)	Active Portfolio Correlation	Active Portfolio Risk Contrib. (%)	% of Active Risk
Total	-0.78	0.67	0.28	17.0%
KRD 01y	0.03	0.01	0.00	0.0%
KRD 02y	0.14	-0.14	-0.01	-0.5%
KRD 03y	0.11	-0.21	-0.02	-0.9%
KRD 05y	-0.36	-0.29	0.08	5.1%
KRD 07y	-0.19	-0.36	0.05	3.3%
KRD10y	-0.29	-0.41	0.9	5.6%
KRD15y	0.15	-0.44	-0.05	-3.3%
KRD 20y	0.02	-0.44	-0.01	-0.5%
KRD 25y	-0.15	-0.44	0.05	3.3%
KRD 30y	-0.22	-0.44	0.8	5.1%
KRD 40y	-0.01	-0.44	0.00	0.0%
KRD 50y	-0.01	-0.44	0.00	0.0%

Factor	Active Exposure (yrs)	Active Risk (%)	Active Portfolio Correlation	Active Portfolio Risk Contrib. (%)	% of Active Risk
Total	N/A	0.67	0.42	0.28	17.0%
US Shift	-0.79	0.49	-0.38	0.19	11.4%
US Twist	-0.76	0.24	-0.37	0.09	5.5%
US Butterfly	0.43	0.09	0.02	0.002	0.1%

2013/12/31 Source: BarraOne

Spread Exposure and Risk

Exhibits 12 and 13 provide an attribution of spread risk through two alternative views, firstly from the systematic sources of sector-by-rating spread risk and then from selection risk, both of which are driven by lower rated bonds with larger spreads.

Exhibit 12 attributes the 46 basis points of sector-by-rating spread risk, which was just above 28 per cent of the overall active risk. The top five factors contributing to sector-by-rating spread risk are shown, with US Energy BBB being the top contributing factor.

Exhibit 12: Top 5 Systematic Sector-by-Rating Spread Risk Contributors

Factor	Active Exposure (yrs)	Active Risk (%)	Active Portfolio Correlation	Active Portfolio Risk Contribution (%)	% of Active Risk
Sector-Rating	N/A	0.80	0.57	0.46	28.2%
US Energy BBB	-0.39	0.28	-0.27	0.07	4.5%
US Energy A	-0.18	0.09	-0.36	0.03	2.1%
US Con. Disc. Media BBB	-0.21	0.15	-0.22	0.03	2.0%
US Telecom BBB	-0.24	0.23	-0.14	0.03	2.0%
US Con. Discretionary A	-0.18	0.09	-0.33	0.03	1.9%

2013/12/31 Source: BarraOne

Exhibit 13 attributes the 71 basis points of selection risk contribution, which was close to 44 per cent of the overall active risk. The top 5 contributors to the selection risk according to credit rating are shown.

Exhibit 13: Top 5 Selection Risk Contributors

Merrill Rating	OAS (bp)	Active OAS (bp)	Active Selection Risk (%)	Active Selection Contribution (%)	% of Active Risk
Total	293.0	151.8	1.08	0.71	43.8%
BBB1	314.7	164.9	4.73	0.37	22.9%
A3	264.8	145.5	2.49	0.12	7.5%
BBB2	380.4	187.6	2.14	0.10	5.9%
BBB3	463.1	233.0	3.07	0.07	4.3%
A2	233.9	132.2	1.47	0.03	2.0%

2013/12/31 Source: BarraOne

Triple B dominated the top sector-by-rating risk factors and selection risk contributors. This was expected given that the credit value strategy selected bonds with relatively large spreads, and that larger spreads are generally seen for lower rated bonds. These two characteristics led to a large amount of credit spread risk.

Performance Attribution

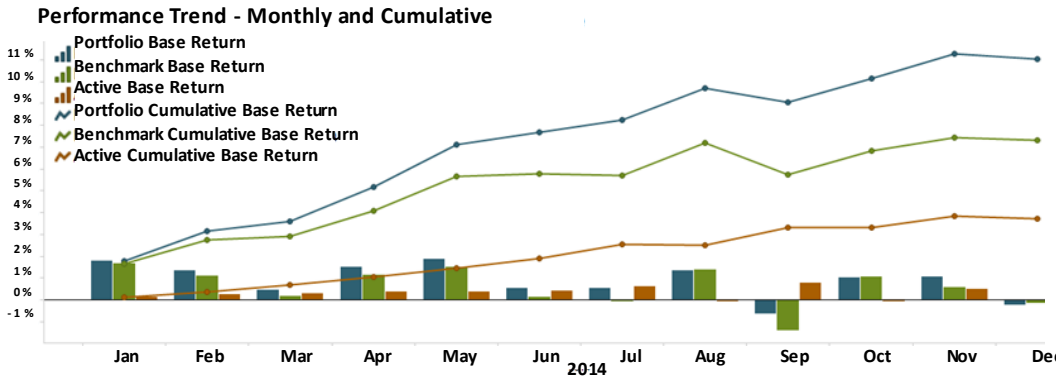
This section analyzes whether the exposure to different sources of risk was rewarded with a positive active return.

Exhibit 14 provides a summary of ex post performance over 2014. The active return was high at 373 basis points above the benchmark return of 7.31 per cent. The time series chart shows that active cumulative performance was steadily increased throughout the year. The ex post measures displayed can be used to give an indication of skill. Since the Sharpe ratio and information ratio were very high at over 4 and 2 respectively, active performance was high on a risk-adjusted basis.[7]

[7] A Sharpe ratio above 2 is considered to be very good and an information ratio above 0.5 is usually considered adequate.

Exhibit 14: Performance Attribution Summary

Portfolio Base Return	Benchmark Base Return	Active Base Return	Start Date	End Date
11.04 %	7.31 %	3.73 %	12/31/2013	12/31/2014



Ex Post Measures

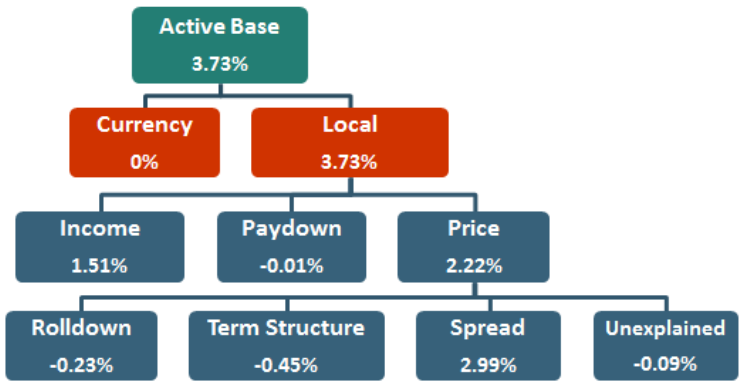
Statistic	Value
Variance	0.00
Portfolio Volatility (%)	2.36
Benchmark Volatility (%)	3.39
Covariance	0.00
Correlation	0.93
R-Squared	0.86
Beta	0.64
Sharpe Ratio	4.67
Sortino Ratio	11.17
Treynor Ratio	0.17
Alpha (%)	6.34
Jensen's Alpha (%)	6.33
M-Squared (%)	15.89
Tracking Error (%)	1.50
Information Ratio	2.48
T-Statistic	2.48
Upside Capture Ratio (%)	92.24
Downside Capture Ratio (%)	37.64
Maximum Drawdown (%)	-0.61

Source: BarraOne

Summary and return components

An examination of the return components shows whether the active performance of 373 basis points was achieved as a result of the credit value strategy, or simply the riskless carry return due to income and rolldown. Exhibit 15 indicates that the credit value strategy did indeed pay off since the majority of outperformance came from spread return. In fact, spread return contributed around 80 per cent of the 373 basis points of active return, whereas only 34 per cent came from carry return (income and rolldown return together). The high income return of 151 basis points was due to the portfolio having a larger average coupon than the benchmark, consistent with a credit value strategy tilted towards bonds with a larger OAS, which tend to have higher coupon rates. Also, it can be seen that 45 basis points were lost due to the unintended term structure return.

Exhibit 15: Active Return Components



[31 Dec, 2013 - 31 Dec, 2014] Source: BarraOne

Term Structure Performance Attribution

Despite the aim that the portfolio should be duration neutral compared to the benchmark, we can see from the first chart in Exhibit 16 that over 2014 the yield curve positioning of the portfolio and the benchmark did not match perfectly. The term structure performance attribution, shown in the third chart, decomposes the 45 basis points of underperformance from term structure return over each key rate on the U.S. government term structure. The longest duration group of the strategy was defined to be 10+ years, so while the sum of all active contributions for key rates in excess of 10 years was almost zero, positive active exposure to the 15 and 20 year nodes was offset by negative active exposure to the 25 and 30 year nodes. For example, at the 15 year key rate there was a small overweight in active term structure exposure (contribution to duration), which combined with a downward shift by over 100 basis points at this point on the U.S. government curve, leading to a positive term structure key rate return (KRD attribution) of around 45 basis points. Interest rates decreased by a similar amount at the 25 and 30 year key rates but the short exposure at those points on the curve resulted in a loss of around 70 basis points.

Cumulative Monthly Trend in Performance

It is valuable to look at trends in attribution effects over time, particularly if results for the full period appear to be counterintuitive. This occurs if a return component oscillates from positive to negative or vice versa within the reporting period. In Exhibit 17, the cumulative monthly attribution effects through 2014 are shown in a time series view for each return component. In this example, the full period and cumulative results follow the same pattern. Spread return (shown in grey) was consistently the top driver of active return, particularly during September, when the increase from one month to the next was largest. This is circled for ease of reference. Income return (shown in blue) was steady and positive, while term structure return (shown in orange) and rolldown return (shown in yellow) both detracted from the active return.

In the next section we focus on the spread return during September.

Exhibit 16: Term Structure Key Rate Performance Attribution

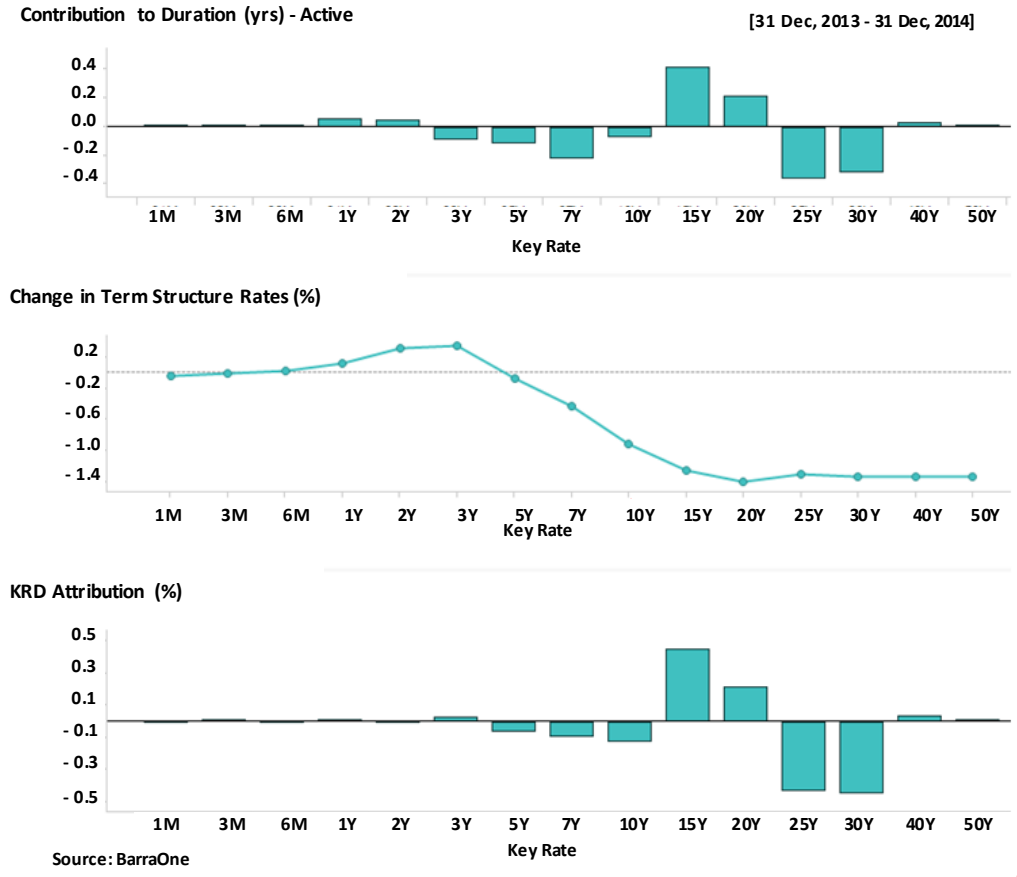
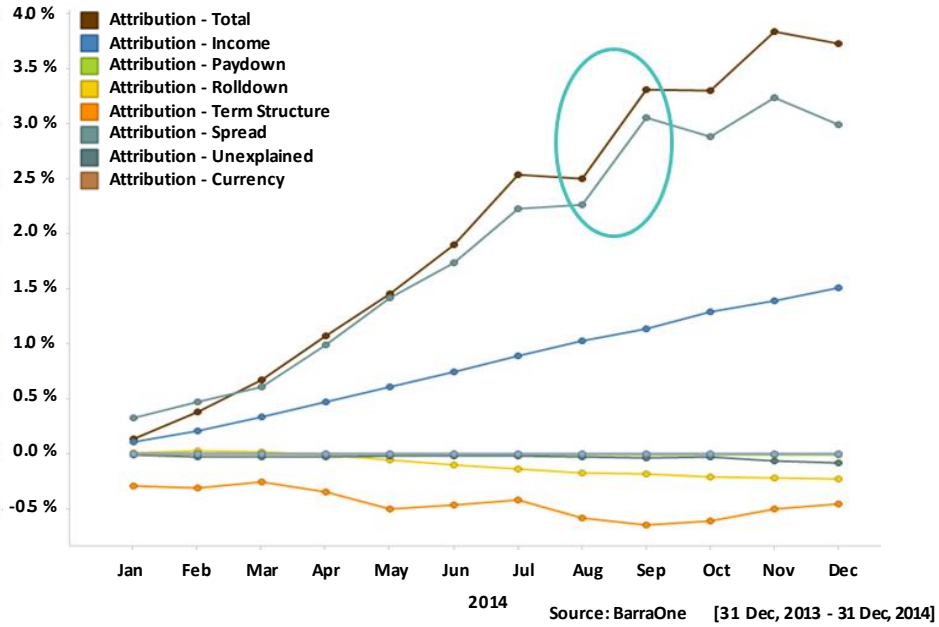


Exhibit 17: Trend in the Cumulative Monthly Attribution Effects

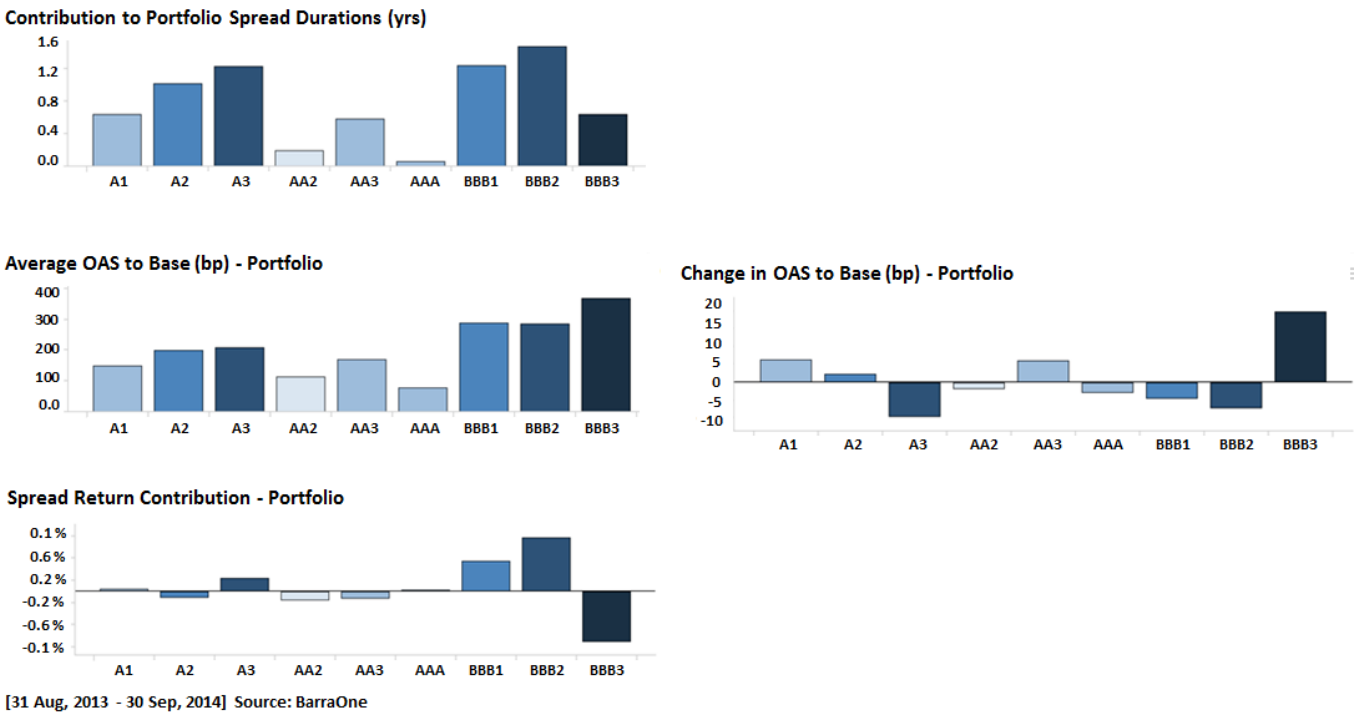


Portfolio Spread Return Over September 2014

The credit value strategy selects bonds with the largest OAS to profit from the expected mean reversion in spreads and thus the increases in bond values compared to the average of the respective rating-by-duration groups. If, for example, the average OAS in a group goes from 200 basis points to 230 basis points in a month while the OAS of the selected bond goes from 300 basis points to 310 basis points, the strategy makes money (in active terms) even though the price of the selected bond dropped. To show the difference between active and portfolio results, we pick a single month, September, when the active spread return was exceptionally large and analyze the spread return of the portfolio (and not the active portfolio) in detail.

In Exhibit 18, we show the spread exposure (measured by the contribution to spread duration) and the changes in spreads for the portfolio (again, these are absolute numbers, not relative to the benchmark). We also show the average OAS during September for each rating. The top chart shows the contribution of spread duration for each rating. These numbers are very close to that of the benchmark, since our strategy is rating-by-duration neutral and spread duration is very close to duration for the bonds in the benchmark. The second chart shows the change in OAS for each rating, while the bottom chart shows the resulting spread returns. In absolute terms, the portfolio made money on the BBB1 and BBB2 rated bonds, but lost on BBB3. Overall, the portfolio had a small positive spread return, but this was enough to substantially beat the benchmark. This was because although some selected bonds lost value during the month, the loss was less than the average of their peers and thus the resulting active spread return was still positive.

Exhibit 18: Spread Return Attribution Across Credit Ratings Over September 2014

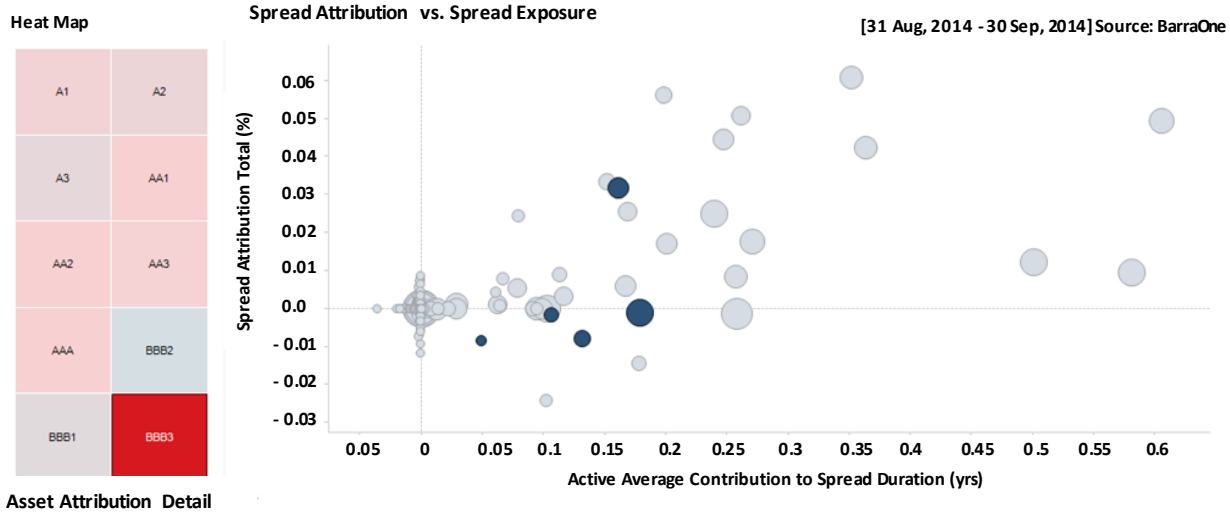


[31 Aug, 2013 - 30 Sep, 2014] Source: BarraOne

Attribution from Group Level to Asset Level

Exhibit 19 shows an asset-level spread return attribution over September in the context of the portfolio's exposure to BBB3 bonds. The dashboard links the performance of any groups of bonds in the portfolio using the heat map to illustrate a spread return attribution for the corresponding assets via the scatter plot and the tabular results.[8] For example, selecting BBB3 in the heat map causes the corresponding bonds for that rating to be highlighted in the scatter plot, with BBB3 shown in red in the heat map due to the poor performance of that group. The scatter plot shows spread exposure against spread performance. Selecting a category in the heat map also brings up further attribution results in the table for the corresponding bonds. The table is sorted by portfolio weight to focus on the bonds with the largest exposure in the portfolio. The five bonds in the BBB3 group can be highlighted in the scatter plot by selecting them from the table. Of the five bonds held in that group, only one recorded a positive spread return, with the other four showing flat or negative spread returns. From the table it can be seen that within BBB3, OAS only decreased for the positively performing Israel Electric bond, by 24 basis points, while spreads increased for the other four bonds, leading to poor overall spread performance for this group.

Exhibit 19: Asset-Level Spread Return Attribution Over September 2014



Asset Attribution Detail

Asset Name	Group 1	Group 2	Group 3	Portfolio Average Weight	Benchmark Average Weight	Active Average Weight	Portfolio Average Spread Duration	Active Av Cont. to Spread Duration	Portfolio Average OAS to Base (bp)	Portfolio Change in OAS to Base (bp)	Portfolio Spread Return	Spread Attribution Total
CANTOR FITZGERALD LP 7.875% 20191015	BBB3	3 to 5	Brokerage	2.65 %	0.01 %	2.64 %	4.05	0.11	454.79	32.21	-1.2964 %	-0.0018 %
FRANSHION DEVELOPMENT LTD 6.75% 20...	BBB3	5 to 7	RealEstate Dev ...	2.58 %	0.01 %	2.57 %	5.14	0.13	388.42	21.94	-1.1202 %	-0.0079 %
SOURCEGAS LLC 5.9% 20170401	BBB3	0 to 3	Gas Distribution	2.12 %	0.01 %	2.12 %	2.31	0.05	314.86	24.20	-0.5576 %	-0.0085 %
ISRAEL ELECTRIC CORP LTD 7.75% 20271...	BBB3	7 to 10	Electric-Integrated	1.92 %	0.01 %	1.91 %	8.42	0.16	302.23	-24.51	2.0622 %	0.0318 %
NEWCREST FINANCE PTY LTD 5.75% 2041...	BBB3	10 to +INF	Metals/Mining Ex...	1.50 %	0.01 %	1.49 %	12.01	0.18	372.26	30.17	-3.5722 %	-0.0011 %

The many exhibits in this section on performance attribution demonstrate how the visualization solution in BarraOne allows you to access results efficiently by using interactive dashboards - to gain deeper insights, understand trends and detect outliers.

[8] In this example, the groups categorize bonds according to credit rating, but it is possible to group by any attribute and over as many levels of drilldown as required.

Dashboard with Exposures, Risk and Performance

Exhibit 20 brings the risk and performance attribution results together in an integrated dashboard, showing the contributions to active risk and active return side-by-side. The results are shown for the sources of corporate bond risk in term structure risk, spread risk and selection risk, and for the return drivers of carry return, term structure return and spread return.[9] This provides a comprehensive and insightful analysis. The portfolio's average OAS for each rating is shown, giving an indication of the credit risk premium across each credit rating that the strategy had targeted. Term structure return was the only detractor, and this risk might have been counteracted more effectively, though this is difficult to achieve using a strategy that only selects one bond from each category. The overall risk reported at the start of the analysis was within the risk budget by 37 basis points. More risk could possibly have been taken by combining the credit value strategy with some yield curve positioning or sector rotation. Bonds were selected with the largest OAS, which resulted in a large common factor spread risk and issue-specific selection risk. The lower rated groups are highlighted in Exhibit 20. The bulk of the spread exposure was taken here, in line with the credit value strategy. The overriding theme is that exposure to these main sources of risk was strongly rewarded, with active spread return contributing almost 300 of the 373 basis points of active return.

Exhibit 20: Dashboard with Exposures, Risk and Performance

U.S. Corporate Bond Portfolio vs. BofA ML U.S. Corporate Bond Index, over 2014

Rating	Portfolio Average OAS (bp)		Term Structure		Spread		Selection	Total	
		Active Carry Return	Cont.to Active Risk (%)	Active Return Cont. (%)	Cont.to Active Risk (%)	Active Return Cont. (%)	Cont.to Active Risk (%)	Cont.to Active Risk (%)	Active Return Cont. (%)
Total	**259.1**	**1.28**	**0.28**	**-0.45**	**0.64**	**2.99**	**0.71**	**1.63**	**3.73**
AAA	85.5	0.00	0.00	-0.01	0.00	0.01	0.00	0.01	0.00
AA1	95.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AA2	112.0	0.01	0.00	-0.02	-0.01	0.03	0.00	-0.01	0.02
AA3	165.6	0.06	0.05	-0.08	0.15	0.17	0.01	0.21	0.15
A1	172.6	0.06	0.02	0.00	0.01	0.16	0.01	0.04	0.22
A2	209.2	0.15	0.08	-0.18	0.26	0.17	0.03	0.37	0.14
A3	226.2	0.17	0.06	-0.04	0.04	0.48	0.11	0.21	0.60
BBB1	295.8	0.28	0.01	-0.10	0.10	0.45	0.34	0.46	0.62
BBB2	336.6	0.32	0.03	0.02	0.08	0.77	0.09	0.21	1.06
BBB3	403.8	0.22	0.03	-0.04	-0.01	0.73	0.06	0.08	0.91

2013/12/31 Source: BarraOne

Comparing the performance over 2014 to the active risk at the start of the analysis is useful. However, risk analysis should be carried out on a regular basis, ideally, as regularly as investment decisions are implemented in the portfolio. This allows start of period risk exposures to be compared to return drivers at the end of the period in order to understand whether bets paid off. The one-year analysis in the case study involved rebalancing the portfolio each month according to the credit value strategy. To correctly align with this investment decision process, the dashboard should be produced monthly so that start-of-month risk exposures can be compared to end-of-month performance.

[9] Carry return was calculated as income return and rolldown return together, paydown return was negligible, and the unexplained return was zero, except for BBB3 bonds where it corresponded to -6 basis points.

Conclusion

In summary, this Product Insight illustrated how BarraOne, which is part of MSCI's risk and performance platform, can be used to provide an integrated fixed income attribution bringing together risk and performance. Reporting and analyzing risk and performance attribution on a single platform and along precisely the same dimensions provides a powerful complement to the investment decision process - for measuring risk, adjusting allocations and attributing portfolio performance.

The case study illustrated how this structure can be used to analyze strategies targeting credit alpha through exposure to spread risk for a corporate bond portfolio. However, this type of analysis can easily be extended to portfolios containing other types of fixed income instruments such as mortgage-backed securities and fixed income derivatives.

Most importantly, using a single platform which provides both risk and performance analytics means the time consuming task of reconciling portfolio holdings need only happen once, and allows the risk and the performance attribution models to be used together to provide a coherent side-by-side attribution of risk and return.

Learn More About the Analysis

To find out more and for a demonstration of how credit alpha can be analyzed using BarraOne, a recorded webinar corresponding to this paper can be found here:

Analyzing Credit Alpha in an Integrated Risk and Performance Analysis Webinar

Analyzing Credit Alpha in an Integrated Risk and Performance Analysis Webinar Slides

Derivatives

For derivatives the following steps are essential in providing an insightful performance attribution:

- Capture the appropriate exposure
- Calculate performance based on the actual return drivers
- Incorporate the impact of hedging in the analysis

We meet the above requirements by following a look through approach for futures, FX forwards, swaps (interest rate, zero coupon, OIS, total return swaps, and FX swaps), and composite assets (ETFs, index instruments). This allows us to work with the underlying legs, or constituent assets in the case of composites, which each have weights and returns that are straightforward to determine. We decompose the return of the underlying legs into return components as part of fixed income performance attribution. For example, for interest rate swaps, we use a look-through approach to determine the term structure exposure and return of the pay and receive leg. The hedging property of this instrument is thus easily incorporated in the analysis.

Apart from swaps, forwards, futures and composite assets, we support another eighty derivative instrument types, handling them on a market value basis. For example, a CDS is supported for valuation and return calculations, with its spread duration and weight used to determine the contribution to spread duration, the spread exposure. Hence, the targeted exposure to underlying spreads is captured and incorporated into the results. Also, its return is decomposed into components such as income return, based on the CDS premium (or deal spread), rolldown return and term structure return according to effective KRDs.

Other Attribution Models

Other attribution models are available in the Barra One Performance Analytics solution, each dedicated to a specific investment style, and can be tailored to the investment process. Separate models are available for:

- Classic Attribution, tying back return to top-down allocation and bottom-up selection decisions, for equity or multi-asset class portfolios.
- Factor Attribution, tying back return to Barra equity, equity implied volatility and commodity factors.
- Multi-Portfolio Attribution, tying back the return of hierarchical investment portfolios to tactical and strategic asset allocation decisions, manager selection decisions and benchmark mismatch.

Beyond Fixed Income Portfolios

Many credit portfolios also contain equities. For this type of balanced portfolio and also for any multi-asset class (MAC) portfolio, performance attribution can be carried out following one of these approaches:

1. Using the classic attribution model, modified for MAC portfolios. To align with a MAC investment decision process, this model has the ability to group by asset class and then allows independent asset-class specific groups to be set up for fixed income, equity, alternatives, etc. It is straightforward to apply allocation groups for fixed income like high yield/investment grade, rating, spread sector, duration, etc.; and for equity to apply allocation groups such as country, GICS sector, and industry; and so on for each asset class.
2. Using the fixed income performance attribution model. Instrument types from any asset class, including equity and alternatives as well as fixed income assets, may be present in the portfolio when carrying out fixed income performance attribution. The decomposition of asset return into fixed income return components is relevant for assets with "fixed income" characteristics. Practically, this means that assets with exposures to interest rates and credit spreads have their returns decomposed. The return of "non-fixed income" assets still contributes to the portfolio return, but is not decomposed into return components since they are not exposed to interest rates and credit spreads.

Appendix

BANK OF AMERICA MERRILL LYNCH INDEX USE

Source BofA Merrill Lynch, used with permission. BofA Merrill Lynch is licensing the BofA Merrill Lynch indices and related data "as is," makes no warranties regarding same, does not guarantee the suitability, quality, accuracy, timeliness, and/or completeness of the indices or any data included in, related to, or derived therefrom, assumes no liability in connection with their use, and does not sponsor, endorse, or recommend MSCI, or any of its products or services.

References

Analyzing Credit Alpha in an Integrated Risk and Performance Analysis Webinar; https://support.msci.com/videos/1596

Analyzing Credit Alpha in an Integrated Risk and Performance Analysis Webinar Slides; https://support.msci.com/docs/DOC-11253

BarraOne Performance Analytics Handbook; https://support.msci.com/docs/DOC-4040

Decomposing Fixed Income Performance — Part 1: Asset Analytics; https://support.msci.com/docs/DOC-3913

Decomposing Fixed Income Performance — Part 2: Case Study; https://support.msci.com/docs/DOC-4057

Fixed Income Risk Model Details; https://support.msci.com/docs/DOC-3077

Integrated Fixed Income Risk and Performance Analysis in BarraOne - A Case Study Built on QE Tapering Scenarios; https://support.msci.com/docs/DOC-9276

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

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 *
Sydney	+ 61 2 9033 9333
Taipei	008 0112 7513 *
Thailand	0018 0015 6207 7181*
Tokyo	+ 81 3 5290 1555

* = toll free

ABOUT MSCI

For more than 40 years, MSCI's research-based indexes and analytics have helped the world's leading investors build and manage better portfolios. Clients rely on our offerings for deeper insights into the drivers of performance and risk in their portfolios, broad asset class coverage and innovative research.

Our line of products and services includes indexes, analytical models, data, real estate benchmarks and ESG research.

MSCI serves 98 of the top 100 largest money managers, according to the most recent P&I ranking.

For more information, visit us at www.msci.com.

NOTICE AND DISCLAIMER

This document and all of the information contained in it, including without limitation all text, data, graphs, charts (collectively, the "Information") is the property of MSCI Inc. or its subsidiaries (collectively, "MSCI"), or MSCI's licensors, direct or indirect suppliers or any third party involved in making or compiling any Information (collectively, with MSCI, the "Information Providers") and is provided for informational purposes only. The Information may not be modified, reverse-engineered, reproduced or redisseminated in whole or in part without prior written permission from MSCI.

The Information may not be used to create derivative works or to verify or correct other data or information. For example (but without limitation), the Information may not be used to create indexes, databases, risk models, analytics, software, or in connection with the issuing, offering, sponsoring, managing or marketing of any securities, portfolios, financial products or other investment vehicles utilizing or based on, linked to, tracking or otherwise derived from the Information or any other MSCI data, information, products or services.

The user of the Information assumes the entire risk of any use it may make or permit to be made of the Information. NONE OF THE INFORMATION PROVIDERS MAKES ANY EXPRESS OR IMPLIED WARRANTIES OR REPRESENTATIONS WITH RESPECT TO THE INFORMATION (OR THE RESULTS TO BE OBTAINED BY THE USE THEREOF), AND TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, EACH INFORMATION PROVIDER EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES (INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTIES OF ORIGINALITY, ACCURACY, TIMELINESS, NON-INFRINGEMENT, COMPLETENESS, MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE) WITH RESPECT TO ANY OF THE INFORMATION.

Without limiting any of the foregoing and to the maximum extent permitted by applicable law, in no event shall any Information Provider have any liability regarding any of the Information for any direct, indirect, special, punitive, consequential (including lost profits) or any other damages even if notified of the possibility of such damages. The foregoing shall not exclude or limit any liability that may not by applicable law be excluded or limited, including without limitation (as applicable), any liability for death or personal injury to the extent that such injury results from the negligence or willful default of itself, its servants, agents or sub-contractors.

Information containing any historical information, data or analysis should not be taken as an indication or guarantee of any future performance, analysis, forecast or prediction. Past performance does not guarantee future results.

The Information should not be relied on and is not a substitute for the skill, judgment and experience of the user, its management, employees, advisors and/or clients when making investment and other business decisions. All Information is impersonal and not tailored to the needs of any person, entity or group of persons.

None of the Information constitutes an offer to sell (or a solicitation of an offer to buy), any security, financial product or other investment vehicle or any trading strategy.

It is not possible to invest directly in an index. Exposure to an asset class or trading strategy or other category represented by an index is only available through third party investable instruments (if any) based on that index. MSCI does not issue, sponsor, endorse, market, offer, review or otherwise express any opinion regarding any fund, ETF, derivative or other security, investment, financial product or trading strategy that is based on, linked to or seeks to provide an investment return related to the performance of any MSCI index (collectively, "Index Linked Investments"). MSCI makes no assurance that any Index Linked Investments will accurately track index performance or provide positive investment returns. MSCI Inc. is not an investment adviser or fiduciary and MSCI makes no representation regarding the advisability of investing in any Index Linked Investments.

Index returns do not represent the results of actual trading of investible assets/securities. MSCI maintains and calculates indexes, but does not manage actual assets. Index returns do not reflect payment of any sales charges or fees an investor may pay to purchase the securities underlying the index or Index Linked Investments. The imposition of these fees and charges would cause the performance of an Index Linked Investment to be different than the MSCI index performance.

The Information may contain back tested data. Back-tested performance is not actual performance, but is hypothetical. There are frequently material differences between back tested performance results and actual results subsequently achieved by any investment strategy.

Constituents of MSCI equity indexes are listed companies, which are included in or excluded from the indexes according to the application of the relevant index methodologies. Accordingly, constituents in MSCI equity indexes may include MSCI Inc., clients of MSCI or suppliers to MSCI. Inclusion of a security within an MSCI index is not a recommendation by MSCI to buy, sell, or hold such security, nor is it considered to be investment advice.

Data and information produced by various affiliates of MSCI Inc., including MSCI ESG Research Inc. and Barra LLC, may be used in calculating certain MSCI indexes. More information can be found in the relevant index methodologies on www.msci.com.

MSCI receives compensation in connection with licensing its indexes to third parties. MSCI Inc.'s revenue includes fees based on assets in Index Linked Investments. Information can be found in MSCI Inc.'s company filings on the Investor Relations section of www.msci.com.

MSCI ESG Research Inc. is a Registered Investment Adviser under the Investment Advisers Act of 1940 and a subsidiary of MSCI Inc. Except with respect to any applicable products or services from MSCI ESG Research, neither MSCI nor any of its products or services recommends, endorses, approves or otherwise expresses any opinion regarding any issuer, securities, financial products or instruments or trading strategies and MSCI's products or services are not intended to constitute investment advice or a recommendation to make (or refrain from making) any kind of investment decision and may not be relied on as such. Issuers mentioned or included in any MSCI ESG Research materials may include MSCI Inc., clients of MSCI or suppliers to MSCI, and may also purchase research or other products or services from MSCI ESG Research. MSCI ESG Research materials, including materials utilized in any MSCI ESG Indexes or other products, have not been submitted to, nor received approval from, the United States Securities and Exchange Commission or any other regulatory body.

Any use of or access to products, services or information of MSCI requires a license from MSCI. MSCI, Barra, RiskMetrics, IPD, FEA, InvestorForce, and other MSCI brands and product names are the trademarks, service marks, or registered trademarks of MSCI or its subsidiaries in the United States and other jurisdictions. The Global Industry Classification Standard (GICS) was developed by and is the exclusive property of MSCI and Standard & Poor's. "Global Industry Classification Standard (GICS)" is a service mark of MSCI and Standard & Poor's.