White Paper

A Flexible Benchmark-Relative Method of Attributing Return for Fixed Income Portfolios

Stanley J. Kwasniewski, CFA

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Introduction

The primary purpose of an attribution analysis is to explain a portfolio's performance over a period of time using factors that correspond to a portfolio manager's investment strategy and decision making process. Fixed income performance attribution is the art of decomposing a fixed income portfolio's benchmark-relative performance into a series of attribution factors that sum to fully explain the variation in return over some period of time.

Attribution analysis can be used by investment management firms for both internal and external purposes. Internal consumers of attribution analysis are typically portfolio managers, performance analysts, risk analysts, and senior management. External consumers of attribution analysis are the clients of the investment management firm and consultants. The attribution model requirements for these audiences can vary.

Portfolio managers use attribution to validate investment strategy bets. As such, an important feature of an attribution model is that it uses factors consistent with a portfolio manager's primary investment decisions. The attribution analysis is most robust when it explains how much each individual investment decision contributed to benchmark-relative performance. If this criterion isn't met, the value of the attribution analysis can deteriorate and become less meaningful.

Performance, risk, and senior management teams use attribution to conduct portfolio performance reviews and risk audits. These individuals need to use attribution in the same way a portfolio manager does, but they may also require the flexibility to add additional attribution effects to reveal and quantify the impact of unintended bets. For example, is the portfolio consistently losing a few basis points (bps) relative to the benchmark because it is invested in securities that have a lower income return?

Consultants and clients of investment management firms have varying degrees of financial sophistication and therefore have different attribution requirements. Less is more for some, while others need to see an attribution analysis similar to what a portfolio manager would consume.

Given the requirements of the different consumers of attribution, in addition to the fact that the investment decision making process can vary for fixed income portfolios within the same firm, a "one size fits all" fixed income attribution model with an inflexible set of attribution factors is likely to fall short of satisfying every consumer. A customizable attribution model with factor flexibility built from a common framework is the preferred way to meet the needs of all internal and external consumers of attribution.

Attribution Model Considerations

Some important considerations when running a fixed income attribution:

- **Data Maintenance:** Who bears the responsibility for maintaining the portfolio and benchmark holdings and returns? How are the attribution model inputs calculated, uploaded, reconciled, and cleaned? Maintenance is an important consideration because errors at the individual security level can erode the integrity of an attribution analysis.
- **Pricing**: Does the attribution model allow the user to choose the pricing and analytics sources for the portfolio and benchmark? If different pricing sources can be used, is it possible to separate pricing source noise from portfolio management skill using a pricing effect?
- **Model Flexibility:** Does the attribution model allow the user to choose which attribution effects are included in the analysis? Does the attribution model allow the user to define the average change in interest rates? Does the attribution model allow the user to specify the type of durations used as inputs (modified, effective, coupon curve, partial, etc.) for purposes of calculating shift effect?
- **Cash:** How is cash handled in the attribution analysis? Can it be treated either as a part of the fixed income strategy or as a bet on a separate asset class?
- **Derivatives:** How are derivative securities handled in the attribution model? Is the impact of holding derivative securities properly captured in the attribution analysis?
- **Transactions:** Does the attribution model allow the user to provide transaction- level detail? If so, can the impact of transactions on benchmark- relative performance be quantified using a transaction effect?
- **Currency:** Does the attribution model allow the user to quantify the impact of currency management?
- **Security Bucketing:** Does the attribution model allow for user- defined bucketing of portfolio and benchmark securities so that the resulting report is reflective of the investment process?
- **Transparency:** Is the attribution model fully transparent? Can it expose data to the security level? Can its calculations be audited?

Attribution analysis has the potential to become noisy or irrelevant if ample consideration isn't given to these kinds of questions. FactSet's fixed income attribution model addresses all of these issues.

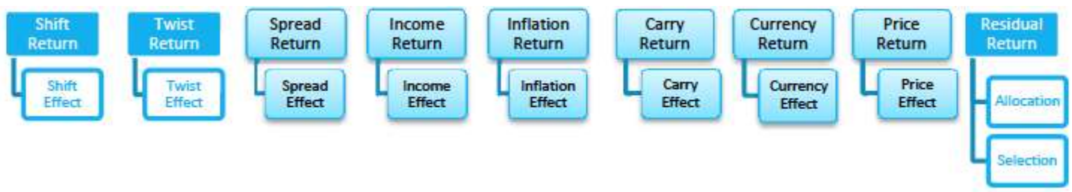
Model Background

FactSet's fixed income attribution model was designed to explain the arithmetic difference between the portfolio and benchmark total return using additive attribution effects. It was built on the framework outlined in *The Attribution of Portfolio and Index Returns in Fixed Income*, by Timothy J. Lord[1]. FactSet used this framework as the basis for its fixed income attribution model because it explained benchmark relative performance using factors that correspond to the most common investment decisions made by fixed income portfolio managers of investment grade portfolios: the portfolio's duration bet, the portfolio's curve positioning bets, the portfolio's sector bets, and the portfolio's individual security bets.

1 Timothy J. Lord, "The Attribution of Portfolio and Index Returns in Fixed Income", Journal of Performance Measurement, Fall 1997, pp. 45-57.

The Lord model could easily be extended to include additional attribution factors to meet the needs of investment managers with different investment processes. The model was also a logical extension of the Brinson Fachler[2] method of attributing the performance of equity portfolios, building on the fundamental attribution concept of asset allocation and security selection.

Model Overview



Basic Return Decomposition

The core concept in FactSet's fixed income attribution model is that a security's total return can be decomposed into additive subcomponent returns. Each subcomponent return corresponds to an investment decision and is subsequently used to calculate the attribution effect that quantifies the impact of that particular investment decision.

The "off the shelf" FactSet fixed income attribution model is designed to be parsimonious with respect to how it decomposes total return. It quantifies the impact of only the primary drivers of benchmark relative performance and delivers the most relevant attribution analysis to the portfolio manager based on his or her likely investment decisions.

The most basic form of this total return decomposition is as follows:

$$Total\ Return = Shift\ Return + Twist\ Return + Currency\ Return + Residual\ Return$$

Return Component	Formula	Investment Decision Measured
Shift Return	$-1 * E_{Duration} * \Delta_{ShiftPoint\ Yield} + {}^{1}/_{2} * E_{Convexity} * \left(\Delta_{ShiftPoint\ Yield}\right)^{2}$	Duration
Twist Return	$-1 * E_{Duration} * \left(\Delta_{Duration\ Matched\ Treasury\ Yield} - \Delta_{ShiftPoint\ Yield}\right)$	Curve Positioning
Currency Return	$Total\ Return - Total\ Return(local)$	Currency Management
Residual Return	$Total\ Return - (Shift\ Return + Twist\ Return + Currency\ Return)$	Group allocation & Security Selection

Effective duration is the default duration used to calculate shift and twist returns because it's the most commonly used measure of interest rate sensitivity for all security types, including those with embedded options. FactSet's fixed income attribution model also allows users to specify that modified, coupon curve, or partial durations be used instead of effective durations. The duration type selection has a direct impact on the shift and twist returns that the model produces. Users also have the ability to specify whether the durations are based on valuation versus a government, LIBOR, or municipal AAA GO curve. The curve choice is a subjective decision that reflects the practitioner's view of which curve most accurately captures the risk free rate that should be used to discount the security's cash flows.

2 Brinson, Gary P., and Nimrod Fachler, "Measuring Non-US Equity Portfolio Performance," Journal of Portfolio Management, Spring 1985, pp. 73-76.

Shift Return

$$-1 * E_{Duration} * \Delta_{ShiftPoint} + {}^{1}\!/_{2} * E_{Convexity} * \left(\Delta_{ShiftPoint}\right)^2$$

Shift return measures the portion of price return resulting from the average change in interest rates. The aggregate shift return of the securities in the portfolio and benchmark are subtracted to determine whether the portfolio manager's duration bet had a positive or negative effect on relative performance.

Defining the parallel shift, or average, change in interest rates is a subjective exercise. Most practitioners will set the shift point as the point on the yield curve closest to the overall effective duration of the benchmark. FactSet's fixed income attribution model allows the shift point to be defined in a variety of ways, enabling the user to specify what the average change in interest rates is based on: the portfolio or benchmark duration, a specific yield curve point, or the average change of multiple yield curve points. Shift yield changes are calculated for each security based on the observed movement of its respective local currency par yield curve.

Par yield curve movements are used in favor of spot yield curve movements for two reasons. First, portfolio managers generally observe par curve changes, not spot curve changes. Second, for coupon bearing securities, the par rate is a better approximation of the change in the yield curve relative to that security. In contrast, spot rate changes tend to be too volatile for coupon- bearing securities. A convexity adjustment is applied to the shift return to account for the fact that a security's price change is not a linear function of its duration.

Twist Return

$$-1 * E_{Duration} * \left(\Delta_{DurationMatchedTreasury} - \Delta_{ShiftPoint}\right)$$

or

$$\left(-1 * PartialDuration1 * \left(\Delta_{PartialPoint1} - \Delta_{ShiftPoint}\right)\right) +$$

$$\left(-1 * PartialDuration2 * \left(\Delta_{PartialPoint2} - \Delta_{ShiftPoint}\right)\right) +$$

$$\left(-1 * PartialDurationN * \left(\Delta_{PartialPointN} - \Delta_{ShiftPoint}\right)\right)$$

Twist return measures the portion of price return resulting from a non- parallel shift in the yield curve. The aggregate twist return of the securities in the portfolio and benchmark are subtracted to determine whether the portfolio manager's yield curve positioning bet had a positive or negative effect on relative performance.

The partial duration based method of calculating twist return is discussed in the "Attribution Model Advanced Options" section of this paper. A basic way to define the non- parallel change in interest rates is to observe the yield changes of duration- matched treasury securities (DMTs). Each security in both the portfolio and benchmark is assigned a DMT, which is a par- priced, synthetically created government security, denominated in the same currency as that of the security under observation. The DMT represents a risk- free investment with the same effective duration as each security in the portfolio and benchmark. The daily change in the yield of this DMT is used to approximate the impact of the non- parallel yield curve change on each security's price return. The change in yield at the shift point on the yield curve is subtracted from the change in yield of this DMT in order to determine twist return.

Currency Return

$$Total\ Return - Total\ Return(local)$$

Currency return measures the portion of total return resulting from changes in currency exchange rates. The aggregate currency return of the securities in the portfolio and benchmark are subtracted to determine whether the portfolio manager's ability to manage currency had a positive or negative effect on relative performance.

Residual Return

$$Total\ Return - (Shift\ Return + Twist\ Return + Currency\ Return)$$

Residual return quantifies the unexplained portion of the security's total return. Residual returns are used to determine the impact of the portfolio manager's ability to effectively allocate the portfolio's assets to different sectors (or countries) as well as the portfolio manager's ability to select superior performing securities within each sector (or country), adjusted for the already quantified impact of duration, curve, and currency.

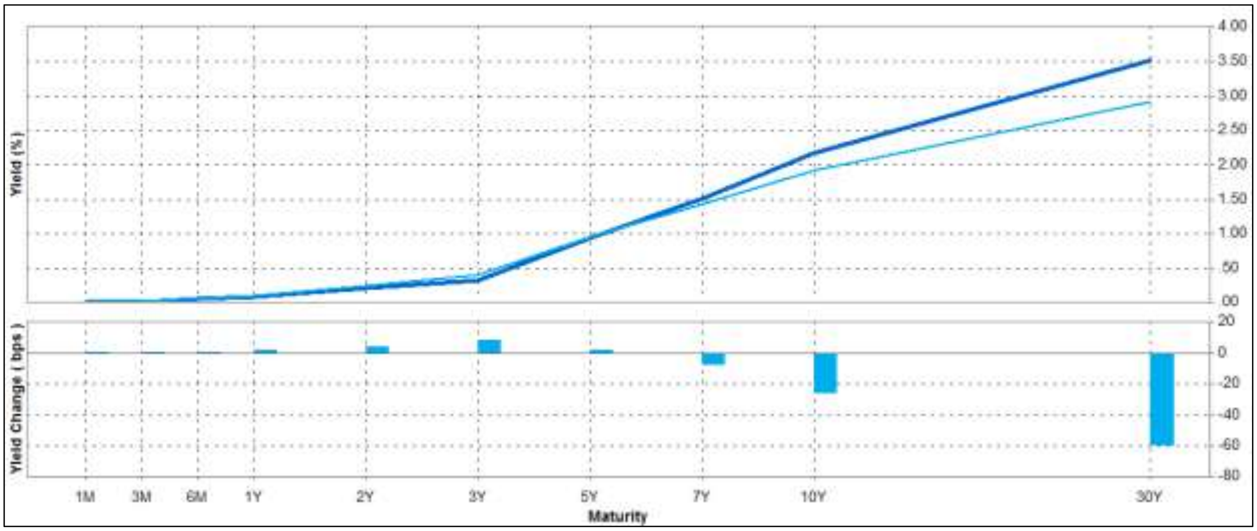
Shift, twist, currency, and residual returns are calculated daily for each security in the report. They are combined over time by multiplying prior period returns by subsequent period security- level total returns. Group- level returns are market value weighted averages.

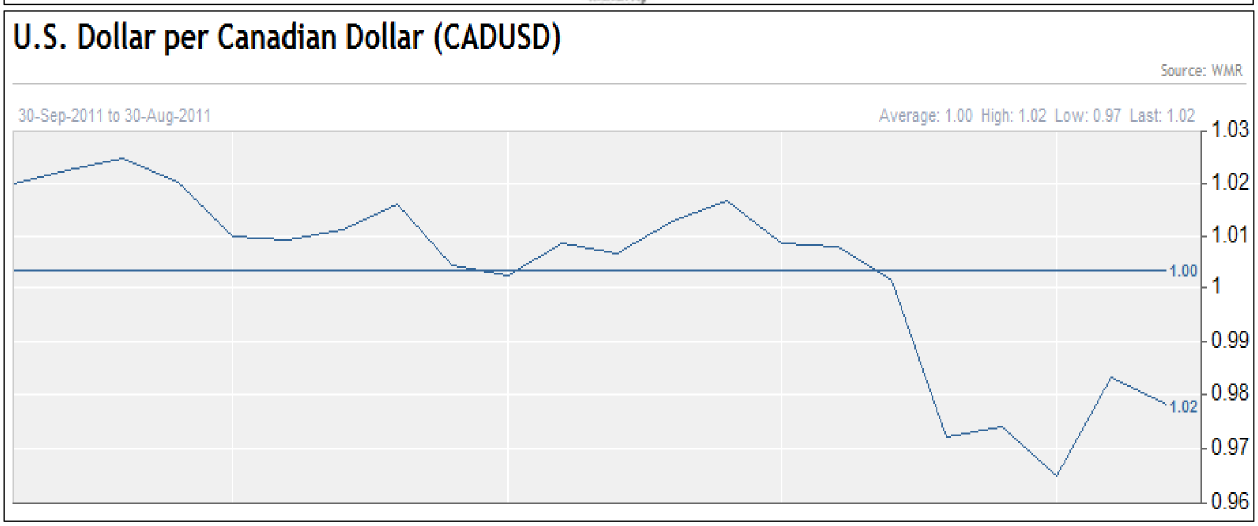
Example 1 illustrates a basic return decomposition for a demo portfolio over the course of a month:

Example 1:

Canadian Dollar

Class2	Avg. Effective Duration	Beg. Shift Point Yield	End Shift Point Yield	Shift Point Yield Change	DMT Yield Change	Port. Shift Return	Port. Twist Return	Port. Currency Return	Port. Residual Return	Total Return
Total	**4.55**	**.93**	**.96**	**.02**	**-.04**	**-.12**	**.75**	**6.30**	**-.06**	**6.87**
ABS	3.10	.93	.96	.02	.01	-.07	.16	6.30	.13	6.52
Agency	3.35	.93	.96	.02	-.01	-.08	.36	6.30	-.15	6.43
CMBS	3.40	.93	.96	.02	.03	-.07	-.01	6.30	.23	6.44
Financial Institutions	5.11	.93	.96	.02	-.05	-.12	.75	6.30	-1.80	5.13
Industrial	6.80	.93	.96	.02	-.12	-.18	1.58	6.30	-.58	7.12
MBS Passthrough	2.72	.93	.96	.02	.02	-.09	-.02	6.30	.24	6.43
Sovereign	6.83	.93	.96	.02	-.12	-.15	1.53	6.30	-3.67	4.01
Supranational	3.49	.93	.96	.02	.01	-.08	.16	6.30	-.06	6.32
Treasury	5.57	.93	.96	.02	-.07	-.14	1.28	6.30	.34	7.78
Utility	7.82	.93	.96	.02	-.15	-.21	2.09	6.30	-.60	7.59





The demo portfolio represents a U.S. strategy managed for a Canadian investor. The discount curve used for all of the securities in this portfolio was the U.S. government yield curve, and the shift point used was the five- year point. The portfolio reporting currency was Canadian dollars.

Because the shift point rose by 2bps, the average change in interest rates implied a decrease in security prices, resulting in an overall portfolio shift return decrease of 12bps. The short end of the yield curve remained flat over the course of this month, while the long end of the yield curve fell considerably. The demo portfolio had a greater exposure to movements in the long end of the yield curve and therefore produced 75bps in twist return. Canadian dollars depreciated relative to U.S. dollars causing the portfolio to gain a substantial 6.30% in currency return. Of the total return, 6bps remained unexplained by the return decomposition. This 6bps primarily includes the impact of carry return, spread return, income return, paydown return, and transactions.

Basic Attribution Model Calculations

FactSet's basic fixed income attribution model uses the following factors to quantify benchmark-relative performance:

$$Total\ Effect = Shift\ Effect + Twist\ Effect + Allocation\ Effect + Selection\ Effect + Currency\ Effect$$

Return Component	Formula	Investment Decision Measured
Shift Effect	$(P_{wt} * P_{Shftret}) - (B_{wt} * B_{Shftret})$	Duration
Twist Effect	$(P_{wt} * P_{Twstret}) - (B_{wt} * B_{Twstret})$	Curve Positioning
Allocation Effect	$(P_{wt} * B_{wt}) - (B_{resret} * B_{Totresret})$	Group Allocation
Selection Effect	$P_{wt} * (P_{resret} * B_{resret})$	Security Selection
Currency Effect	$Total\ Effect - Total\ Effect(Local)$	Currency Management
Total Effect		$Shift\ Effect + Twist\ Effect + Allocation\ Effect + Selection\ Effect + Currency\ Effect$

Shift Effect

Shift effect quantifies the impact of the portfolio manager's duration bet. It is calculated as follows:

$$(P_{wt} * P_{Shftret}) - (B_{wt} * B_{Shftret})$$

Where:

- P_{wt} = Portfolio Weight
- $P_{Shftret}$ = Portfolio Shift Return
- B_{wt} = Benchmark Weight
- $B_{Shftret}$ = Benchmark Shift Return

Twist Effect

Twist effect quantifies the impact of the portfolio manager's yield curve positioning bet. It is calculated as follows:

$$(P_{wt} * P_{Twstret}) - (B_{wt} * B_{Twstret})$$

Where:

- P_{wt} = Portfolio Weight
- $P_{Twstret}$ = Portfolio Twist Return
- B_{wt} = Benchmark Weight
- $B_{Twstret}$ = Benchmark Twist Return

Allocation Effect

Allocation effect quantifies the portion of benchmark-relative return that can be attributed to group allocation decisions after adjusting for duration, curve positioning, and currency. It is calculated as follows:

$$(P_{wt} * B_{wt}) - (B_{resret} * B_{Totresret})$$

Where:

- P_{wt} = Portfolio Weight
- B_{wt} = Benchmark Weight
- B_{resret} = Benchmark Residual Return
- $B_{Totresret}$ = Benchmark Residual Return

Selection Effect

Selection effect quantifies the portion of benchmark-relative return that can be attributed to security selection decisions after adjusting for duration, curve positioning, and currency. It is calculated as follows:

$$P_{wt} * (P_{resret} * B_{resret})$$

Where:

- P_{wt} = Portfolio Weight
- P_{resret} = Portfolio Residual Return
- B_{resret} = Benchmark Residual Return

Currency Effect

Currency effect quantifies the portion of benchmark-relative return that can be attributed to currency management. It is calculated as follows:

$$(TE_R - TE_L)$$

Where:

- TE_R = Total Effect in Reporting Currency
- TE_L = Total Effect in Local Currency

All attribution effects are calculated daily at the security level. Security-level shift and twist effects are summed to arrive at totals. Allocation, selection, and currency effects are calculated independently at each report level. The allocation, selection, and currency effects at the highest report grouping level are summed to arrive at totals. All daily attribution effects are combined over time using a compounding algorithm (see Appendix).

FACTSET

Example 2 illustrates a basic attribution for the demo portfolio relative to its benchmark over the course of a month:

Example 2:

Canadian Dollar

Class2	Portfolio: Average Effective Duration	Portfolio: Average Weight	Portfolio: Residual Return (Local)	Benchmark: Average Effective Duration	Benchmark: Average Weight	Benchmark: Residual Return (Local)	Variation: Shift Point Yield Change	Variation: Total Return	Fixed Income Performance Attribution: Shift Effect	Twist Effect	Allocation Effect	Selection Effect	Currency Effect	Total Effect
ABS	3.10	.26	.13	3.10	.23	.12	.02	.01	-.00	-.00	.00	-.00	.00	.00
Agency	3.35	7.51	-.15	3.53	8.59	-.59	.02	.43	.00	-.00	.00	.03	.00	.03
CMBS	3.40	2.15	.23	3.47	2.02	.44	.02	-.25	-.00	-.00	.00	-.01	.00	-.00
Covered	--	--	--	3.50	.33	-.85	.02	-5.29	.00	-.00	.00	--	.00	.00
Financial Institutions	5.11	6.97	-1.80	4.86	8.49	-2.08	.02	.39	.00	-.00	.03	.02	.00	.05
Industrial	6.80	10.83	-.58	5.96	14.97	-1.35	.02	1.29	.00	.00	.04	.08	.01	.14
MBS Passthrough	2.72	33.11	.24	2.72	28.72	.24	.02	--	-.00	-.00	.03	-.00	.00	.03
Sovereign	6.83	1.21	-3.67	6.12	2.69	-3.95	.02	.77	.00	-.01	.06	.00	.00	.05
Supranational	3.49	1.39	-.06	3.50	1.45	-.12	.02	.06	-.00	-.00	-.00	.00	.00	.00
Treasury	5.57	34.30	.34	5.57	29.76	.35	.02	-.01	-.01	.06	.03	-.00	.00	.09
Utility	7.82	2.27	-.60	7.18	2.77	-1.08	.02	.91	.00	-.00	.00	.01	.00	.02
Total	**4.55**	**100.00**	**-.06**	**4.55**	**100.00**	**-.39**	**.02**	**.40**	**-.00**	**.04**	**.19**	**.14**	**.02**	**.40**

The portfolio manager outperformed the benchmark by 40bps over the month. The portfolio had a neutral overall duration bet, which is reflected in the 0bp overall shift effect. The portfolio had a slightly higher exposure to the falling of the longer end of the curve, which is reflected in the overall positive 4bp of twist effect. The portfolio manager successfully allocated more of the portfolio's assets to sectors with a residual return greater than the benchmark total and fewer of the portfolio's assets to sectors with a residual return less than the benchmark total. The value added from these decisions is reflected in the positive 19bps of overall allocation effect.

For example, the portfolio manager over-weighted MBS passthroughs by approximately 5% and the 24bps residual return of MBS exceeded the overall -39bps residual return of the benchmark. The portfolio manager successfully selected securities with superior residual returns compared to the passive alternatives in the benchmark, which is reflected in the overall positive selection effect of 14bps. For example, the portfolio's residual return for the industrial sector was -58bps, which was superior to the benchmark's -135bps of residual return in the same sector. Finally, the overall currency return of the securities in the portfolio was 2bps higher compared to the overall currency return of the securities in the benchmark.

Attribution Model Advanced Options

Partial Duration Based Twist Return

It is possible to use partial durations to calculate twist returns instead of DMTs. This is accomplished by multiplying each partial duration by the difference in the change in yield at the partial duration point relative to the change in yield at the shift point:

$$\left(-1 * \ PartialDuration1 * \left(\Delta_{PartialPoint1} - \Delta_{ShiftPoint}\right)\right) +$$

$$\left(-1 * \ PartialDuration2 * \left(\Delta_{PartialPoint2} - \Delta_{ShiftPoint}\right)\right) +$$

$$\left(-1 * \ PartialDurationN * \left(\Delta_{PartialPointN} - \Delta_{ShiftPoint}\right)\right)$$

Using partial durations to calculate twist return produces more precise results for securities whose cash flow profiles are significantly different from government securities. For example, mortgage backed securities repay principal monthly and, therefore, can have different interest rate sensitivities compared to government securities with similar effective durations. Partial durations will account for this difference when calculating twist returns, while changes in DMT yields will not.

Example 3 compares differences in twist returns with the demo portfolio using the DMT and partial duration approaches over the course of one month:

Example 3:

	DMT		Partial Duration										
			Port. Beginning Partial Durations					Port. Ending Partial Durations					
Class2	Port. DMT Yield Change	Port Twist Return DMT	2 Year	5 Year	10 Year	30 Year	Total	2 Year	5 Year	10 Year	30 Year	Total	Port. Twist Return Partials
ABS	.01	.17	1.18	1.31	.42	.14	3.05	1.18	1.31	.43	.17	3.08	.20
Agency	-.01	.37	1.09	1.21	.70	.31	3.31	1.10	1.21	.72	.34	3.37	.39
CMBS	.03	-.02	1.00	2.25	.14	--	3.38	1.01	2.22	.12	--	3.35	.02
Financial Institutions	-.05	.78	.80	1.85	1.70	.68	5.03	.81	1.83	1.71	.71	5.07	.93
Industrial	-.12	1.64	.66	1.74	2.68	1.60	6.67	.65	1.72	2.73	1.76	6.86	1.84
MBS Passthrough	.02	-.02	-.26	1.20	1.57	.34	2.85	.11	1.13	1.10	.26	2.61	.63
Sovereign	-.12	1.59	.66	1.68	3.07	1.39	6.79	.67	1.65	3.03	1.45	6.80	1.79
Supranational	.01	.16	1.24	1.63	.51	.09	3.47	1.23	1.64	.51	.09	3.47	.18
Treasury	-.07	1.33	.91	1.68	1.67	1.13	5.39	.91	1.65	1.73	1.36	5.66	1.27
Utility	-.15	2.18	.51	1.76	3.06	2.29	7.61	.51	1.73	3.14	2.53	7.92	2.43
Total	**-.04**	**.78**	**.49**	**1.51**	**1.67**	**.81**	**4.49**	**.62**	**1.48**	**1.55**	**.90**	**4.55**	**1.02**

MBS passthroughs, because they pay down principal monthly, show the most significant differences in twist returns when comparing the DMT and partial duration approaches.

The most meaningful results are achieved when partial duration points corresponding to the yield curve points employed during the investment decision making process are used in the attribution analysis.

Price Effect

It is fairly common to have securities held in both the portfolio and benchmark that are valued differently by the investment management firm and the benchmark vendor. While pricing differences create noise in the attribution analysis, it is possible to eliminate this noise by introducing a price effect. The price effect quantifies the impact of using different pricing sources for securities that are held in common between the portfolio and benchmark. It is quantified by calculating the return of the portfolio using the portfolio's prices, then recalculating the return of the portfolio using the benchmark's prices, then taking the difference between the two returns. All subsequent attribution effects are calculated using the portfolio return calculated with the benchmark's prices, thereby ensuring that the remainder of the attribution effects are reflective of the manager's skill and are not influenced by differences in portfolio and benchmark valuations.

Example 4 illustrates a basic attribution for the demo portfolio over the course of a month that includes a price effect:

Example 4:

Canadian Dollar

Class2	Variation: Shift Point Yield Change	Variation: Total Return	Fixed Income Performance Attribution: Price Effect	Shift Effect	Twist Effect	Allocation Effect	Selection Effect	Currency Effect	Total Effect
ABS	.02	.01	-.00	-.00	-.00	.00	-.00	.00	.00
Agency	.02	.43	-.00	.00	-.00	.00	.04	.00	.03
CMBS	.02	-.25	-.01	-.00	-.00	.00	.00	.00	-.00
Covered	.02	-5.29	--	.00	-.00	.00	--	.00	.00
Financial Institutions	.02	.39	.00	.00	-.00	.03	.02	.00	.05
Industrial	.02	1.29	-.01	.00	.00	.04	.09	.00	.13
MBS Passthrough	.02	--	.00	-.00	-.00	.03	-.00	.00	.03
Sovereign	.02	.77	.00	.00	-.01	.06	.00	.00	.05
Supranational	.02	.06	-.00	-.00	-.00	-.00	.00	.00	.00
Treasury	.02	-.01	-.00	-.01	.06	.03	-.00	.00	.09
Utility	.02	.91	.00	.00	.00	.00	.01	.00	.02
Total	**.02**	**.40**	**-.02**	**-.00**	**.04**	**.19**	**.16**	**.02**	**.40**

The price effect removes 2bps of noise caused by pricing differences between the portfolio and benchmark from the attribution analysis. The impact of including the pricing effect is mostly seen in the allocation and selection effects.

Transaction Effect

A transaction effect results when a security is purchased or sold at a price that is different from the security's closing price on the day of the transaction. This can have a positive or negative effect on the portfolio's total return. Transaction effect shows the impact of trading at the security, group, and portfolio level. It is quantified by calculating the return of the portfolio using intraday transactions, recalculating the return of the portfolio without using intraday transactions, and then taking the difference between the two returns. FactSet offers four transaction-based return methodologies (see Appendix).

Example 5 illustrates a basic attribution for the demo portfolio over the course of one month that includes a transaction effect:

Example 5:

Canadian Dollar

Class2	Variation: Shift Point Yield Change	Variation: Total Return	Fixed Income Performance Attribution: Trans Effect	Shift Effect	Twist Effect	Allocation Effect	Selection Effect	Currency Effect	Total Effect
ABS	.02	.01	-.00	-.00	-.00	.00	-.00	.00	.00
Agency	.02	.43	-.00	.00	-.00	.00	.03	.00	.03
CMBS	.02	-.25	-.00	-.00	-.00	.00	-.00	.00	-.00
Covered	.02	-5.29	--	.00	-.00	.00	--	.00	.00
Financial Institutions	.02	.39	.00	.00	-.00	.03	.02	.00	.05
Industrial	.02	1.29	-.00	.00	.00	.04	.09	.00	.13
MBS Passthrough	.02	--	.00	-.00	-.00	.03	-.00	.00	.03
Sovereign	.02	.77	.00	.00	-.01	.06	.00	.00	.05
Supranational	.02	.06	-.00	-.00	-.00	-.00	.00	.00	.00
Treasury	.02	-.01	-.00	-.01	.06	.03	-.00	.00	.09
Utility	.02	.91	.00	.00	.00	.00	.01	.00	.02
Total	**.02**	**.40**	**-.01**	**-.00**	**.04**	**.19**	**.15**	**.02**	**.40**

The transaction effect indicates that 1bps of benchmark-relative performance was lost as a result of trading activity in the demo portfolio over the course of the month.

Advanced Return Decomposition

FactSet's fixed income attribution model also allows for a further decomposition of residual return into additional subcomponents for practitioners who require more granularity:

$$Total\ Return = Shift\ Return + Twist\ Return + Carry\ Return + Spread\ Return + Income\ Return + Inflation\ Return + Currency\ Return + Residual\ Return$$

Return Component	Formula	Investment Decision Measured
Shift Return	$-1 * E_{Duration} * \Delta_{ShiftPoint\ Yield} + {}^{1}/_{2} * E_{Convexity} * \left(\Delta_{ShiftPoint\ Yield}\right)^2$	Duration
Twist Return	$-1 * E_{Duration} * \Delta_{ShiftPoint\ Yield}\left(\Delta_{Duration\ Matched\ Treasury\ Yield} - \Delta_{Shiftpoint\ Yield}\right)$	Curve Positioning
Carry Return	$Accretion\ Return + Roll\ Down\ Return$	Time Management
Accretion Return	Calculated by holding the yield of the security constant, moving the settlement date forward to the ending date, then re- pricing the security	Passage of Time
Roll Down Return	Calculated by holding the spread of the security constant, moving the settlement date forward to the ending date, then re- pricing the security	Passage of Time
Spread Return	$-1 * S_{Duration} * \Delta_{OAS}$	Spread Management
Income Return	$\left((Accrued_E + Coupon_E) - Accured_B\right)/\left((Price_b + Accured_B) * 100\right)$	Income/Coupon Management
Inflation Return	Calculated by taking the difference in an inflation linked bond's total return with and without the inflation adjustment	Inflation Management
Currency Return	$Total\ Return - Total\ Return(Local)$	Currency Management
Residual Return	$Total\ Return - (Shift\ Return + Twist\ Return + Carry\ Return + Spread\ Return + Income\ Return + Inflation\ Return + Currency\ Return)$	Group Allocation & Security Selection

Carry return, spread return, income return, and inflation return are all embedded within residual return. It is possible to extract them from residual return and evaluate them as standalone return subcomponents. The more subcomponents used in the total return decomposition, the smaller the residual return, generally speaking. Some amount of residual return will always be present in FactSet's model. This is mostly because volatility, curve reshaping, and paydown returns are not captured as standalone factors.

Carry Return

$$\boldsymbol{Accretion\ Return + Roll\ Down\ Return}$$

Carry return measures the portion of price return resulting from the passage of time. It is the combined impact of accretion and roll down returns; both calculations require the use of a security calculation engine. Accretion return is calculated by holding the yield of a security constant, moving the settlement date forward to the ending date, then re-pricing the security. Roll down return is calculated by holding the spread of a security constant, moving the settlement date forward to the ending date, then repricing the security.

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Spread Return

$$-1 * \ S_{Duration} * \Delta_{OAS}$$

Spread return measures the portion of price return resulting from a change in the security's spread.

Income Return

$$\left((Accrued_E + Coupon_E) - Accured_B\right)/\left((Price_b + Accured_B) * 100\right)$$

Income return measures the portion of total return resulting from coupon payments and changes in the security's accrued interest.

Inflation Return

$$\boldsymbol{Total\ Return\ w/Inflation\ Adjustment - Total\ Return\ w/o\ Inflation\ Adjustment}$$

Inflation return measures the portion of an inflation linked bond's total return resulting from a principal adjustment due to rising or falling inflation.

Residual Return

$$Total\ Return - (Shift\ Return + Twist\ Return + Carry\ Return + Spread\ Return + Income\ Return + Inflation\ Return + Currency\ Return)$$

Residual return is calculated by subtracting both the basic and advanced model inputs from the security's total return.

Carry, spread, income, and inflation returns are calculated daily for each security in the report. They are combined over time by multiplying prior period returns by subsequent period security-level total returns. Group-level returns are market value-weighted averages.

Example 6 illustrates an advanced return decomposition for a demo portfolio over the course of one month:

Example 6:

Canadian Dollar

Class2	Ending Shift Point Yield	Shift Point Yield Change	Port. Shift Return	Port. Twist Return	Port. Carry Return	Port. Spread Return	Port. Income Return	Port. Inflation Return	Port. Currency Return	Port. Residual Return	Total Return
Total	**.96**	**.02**	**-.12**	**.75**	**-.21**	**-.71**	**.32**	**.00**	**6.30**	**.55**	**6.87**
ABS	.96	.02	-.07	.16	-.23	-.09	.31	.00	6.30	.13	6.52
Agency	.96	.02	-.08	.36	-.19	-.43	.23	.00	6.30	.25	6.43
CMBS	.96	.02	-.07	-.01	-.14	-.14	.44	.00	6.30	.07	6.44
Financial Institutions	.96	.02	-.12	.75	-.18	-2.66	.42	.00	6.30	.62	5.13
Industrial	.96	.02	-.18	1.58	-.26	-1.80	.40	.00	6.30	1.07	7.12
MBS Passthrough	.96	.02	-.09	-.02	-.19	-.38	.38	.00	6.30	.43	6.43
Sovereign	.96	.02	-.15	1.53	-.26	-4.90	.44	.00	6.30	1.05	4.01
Supranational	.96	.02	-.08	.16	-.19	-.20	.22	.00	6.30	.12	6.32
Treasury	.96	.02	-.14	1.28	-.21	-.17	.21	.00	6.30	.52	7.78
Utility	.96	.02	-.21	2.09	-.27	-2.23	.42	.00	6.30	1.49	7.59

Advanced Attribution Model Calculations

Carry Effect

Carry effect quantifies the impact of the portfolio manager's ability to manage the passage of time.
It is calculated as follows:

$$(P_{wt} * P_{Carret}) - (B_{wt} * B_{Carret})$$

Where:

- P_{wt} = Portfolio Weight
- P_{Carret} = Portfolio Carry Return
- B_{wt} = Benchmark Weight
- B_{Carret} = Benchmark Carry Return

Spread Effect

Spread effect quantifies the impact of the portfolio manager's ability to manage spreads.
It is calculated as follows:

$$\left(P_{wt} * P_{Sprdret}\right) - \left(B_{wt} * B_{Sprdret}\right)$$

Where:

- P_{wt}= Portfolio Weight
- $P_{Sprdret}$ = Portfolio Spread Return
- B_{wt}= Benchmark Weight
- $B_{Sprdret}$ = Benchmark Spread Return

Income Effect

Income effect quantifies the impact of the portfolio manager's ability to manage income.
It is calculated as follows:

$$(P_{wt} * P_{Incret}) - (B_{wt} * B_{Incret})$$

Where:

- P_{wt}= Portfolio Weight
- P_{Incret} = Portfolio Income Return
- B_{wt}= Benchmark Weight
- B_{Incret} = Benchmark Income Return

Inflation Effect

Inflation effect quantifies the impact of the portfolio manager's ability to manage inflation. It is calculated as follows:

$$(P_{wt} * P_{Infret}) - (B_{wt} * B_{Infret})$$

Where:

- P_{wt} = Portfolio Weight
- P_{Infret} = Portfolio Inflation Return
- B_{wt} = Benchmark Weight
- B_{Infret} = Benchmark Inflation Return

All attribution effects are calculated daily at the security level. Security-level carry, spread, income, and inflation effects are summed to arrive at totals. All daily attribution effects are combined over time using a compounding algorithm (see Appendix).

Example 7 illustrates an advanced attribution for the demo portfolio for a one-month time period:

Example 7:

Canadian Dollar

	Variation	Fixed Income Performance Attribution								
Class2	Variation in Total Return	Shift Effect	Twist Effect	Carry Effect	Spread Effect	Income Effect	Inflation Effect	Allocation Effect	Selection Effect	Total Effect
ABS	.01	.00	.00	.00	.00	.00	.00	-.00	.00	.00
Agency	.43	.00	.00	.00	.04	-.01	.00	.01	.00	.04
CMBS	-.25	.00	-.00	-.00	.00	.00	.00	-.00	-.00	.00
Covered	-5.29	.00	.00	.00	.00	-.00	.00	.00	.00	.01
Financial Institutions	.39	.00	.00	.00	.06	-.01	.00	.00	.01	.06
Industrial	1.29	.00	.00	.00	.18	-.03	.00	-.01	.03	.17
MBS Passthrough	.00	.00	.00	-.01	-.02	.02	.00	.00	.00	-.02
Sovereign	.77	.00	-.01	.00	.08	-.01	.00	-.01	.00	.06
Supranational	.06	.00	-.00	.00	.00	-.00	.00	.00	.00	.00
Treasury	-.01	-.01	.06	-.01	-.01	.01	.00	.00	.00	.04
Utility	.91	.00	.00	.00	.02	.00	.00	.00	.01	.02
Total	.40	.00	.04	-.01	.36	-.02	.00	-.02	.04	.40

Here, the portfolio manager outperformed the benchmark by 40bps over the month. The portfolio had a neutral duration bet, which is reflected in the 0bp overall shift effect. The portfolio had a slightly higher exposure to the falling of the longer end of the curve, which is reflected in the overall positive 4bp twist effect. The securities in the portfolio had a slightly lower carry return compared to the securities in the benchmark, which is reflected in the overall -1bp carry effect.

The securities in the portfolio had a higher spread return compared to the securities in the benchmark, which is reflected in the overall positive 36bp spread effect. The securities in the portfolio had a slightly lower coupon return compared to the securities in the benchmark, which is reflected in the overall -2bps income effect. The impact of inflation effect is negligible since neither the portfolio nor the benchmark held inflation linked bonds. The portfolio manager lost 2 bps of benchmark-relative return from sector allocation decisions. Selection effect delivered 4bps in benchmark-relative return, reflecting that factors such as the impact of trading, pricing source selection, and currency management added more value in the portfolio compared to the benchmark.

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Summary

FactSet’s fixed income attribution model explains the benchmark-relative total return of a fixed income portfolio in a manner that relates the primary investment decisions made by a portfolio manager to changes in the market environment over the measurement period. It acknowledges that a “one size fits all” model is not appropriate for all the consumers of fixed income attribution. The model overcomes this challenge by allowing a high degree of user-defined flexibility that can be leveraged to tailor an attribution analysis to the specific purpose and audience for which it is intended.

Appendix

Attribution effects are combined over time using one of four compounding algorithms:

- *Basic – Forward looking*
- *Basic – Backward looking*
- *Residual Free – Portfolio Cumulative*
- *Residual Free – Benchmark Cumulative*

The first two compounding algorithms also require the use of a residual smoothing algorithm to ensure that the attribution model’s total effect equals the difference between the portfolio and benchmark total return. The latter two compounding algorithms do not leave a residual and require no residual smoothing algorithm. The details of these compounding and smoothing algorithms are outside of the scope of this paper.

Transaction based returns can be calculated using one of four methodologies:

- Daily valuation
- Cash flows at start of day
- Purchase at start of day
- Cash flows at middle of day (resembles “Mid-Point Dietz”)

The details of these transaction based return methodologies are also outside of the scope of this paper.