Institute for International Research

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Risk and Attribution Analysis Conference

Fixed Income Attribution Analysis

Andrew Frongello
frongello@yahoo.com
Sydney, Australia
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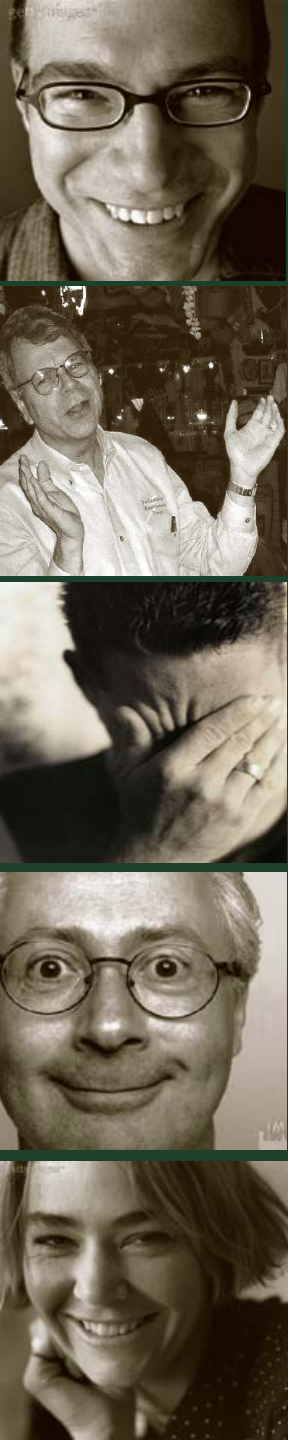
Purpose of Performance Attribution

Internal

- Explain portfolio total return relative to a benchmark
- Analyze effects of key predetermined factors on return
- Relate performance results to investment strategies and changes in market conditions
  - Provides evidence regarding investment strategy bets
  - Shows how changes in market conditions impact total returns
  - Reveals unintended bets and their contribution to relative performance

External

- Client support & RFPs



Desirable Characteristics of an Attribution Model

Simple and Consistent

- Consistent methodology applied to portfolio and index

Flexible

- Accommodates new products/asset types

Dynamic

- Captures all trades and revisions

Multi-dimensional

- Computations occur from the bottom up; interpretation from the top down

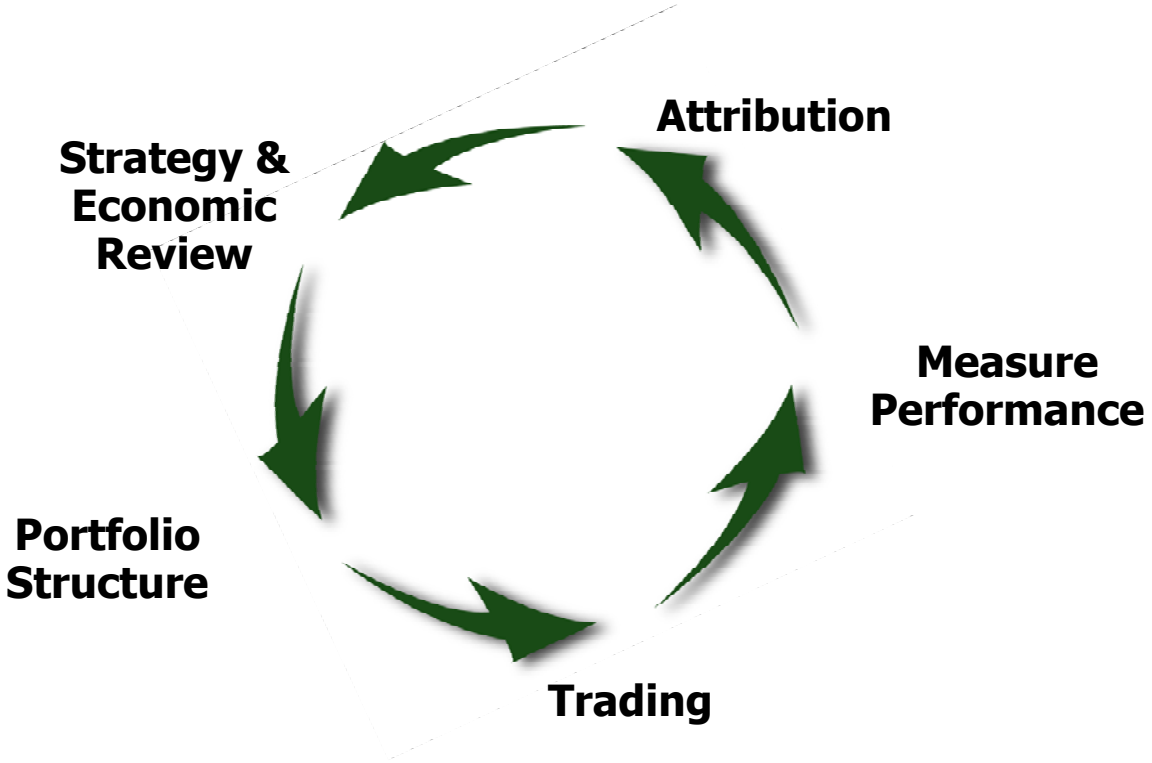
Accurate

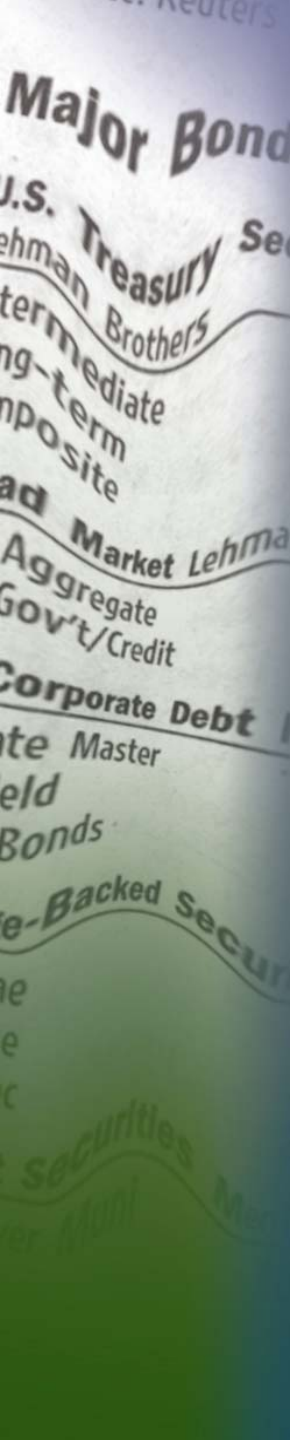
- Explains relative performance, consistent with market conditions, key risk factors, and investment strategy

Role of Attribution in the Investment Process

Performance Summary of Strategy, Trading & Markets:

Provides feedback on management decisions & portfolio risk





Attribution Factors used in Equity & Fixed Income

Yield Curve & Duration Effect

- Measures impact of duration and yield curve posture over measurement period
- Duration return broken out into shift and twist components

Allocation Effect

- Measures pay-off due to over-weights / under-weights
- Bucketed by sector, industry, quality, coupon & maturity or other dimensions

Selection Effect

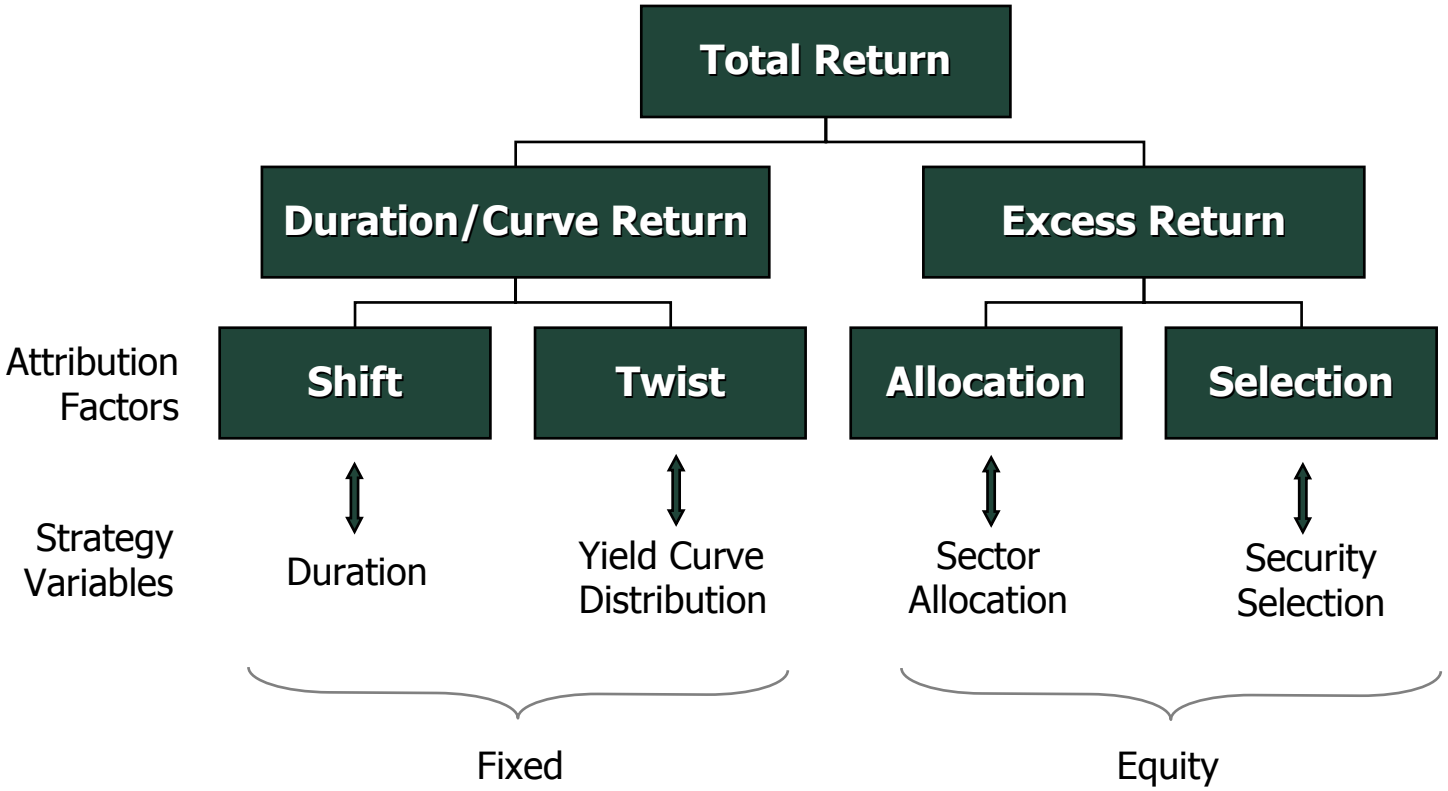
- Measures ability to choose desirable securities and avoid blow-ups
- Defined relative to chosen buckets

Currency Effect

Management style determines relevance and priority of each factor

Fixed Income Attribution Model

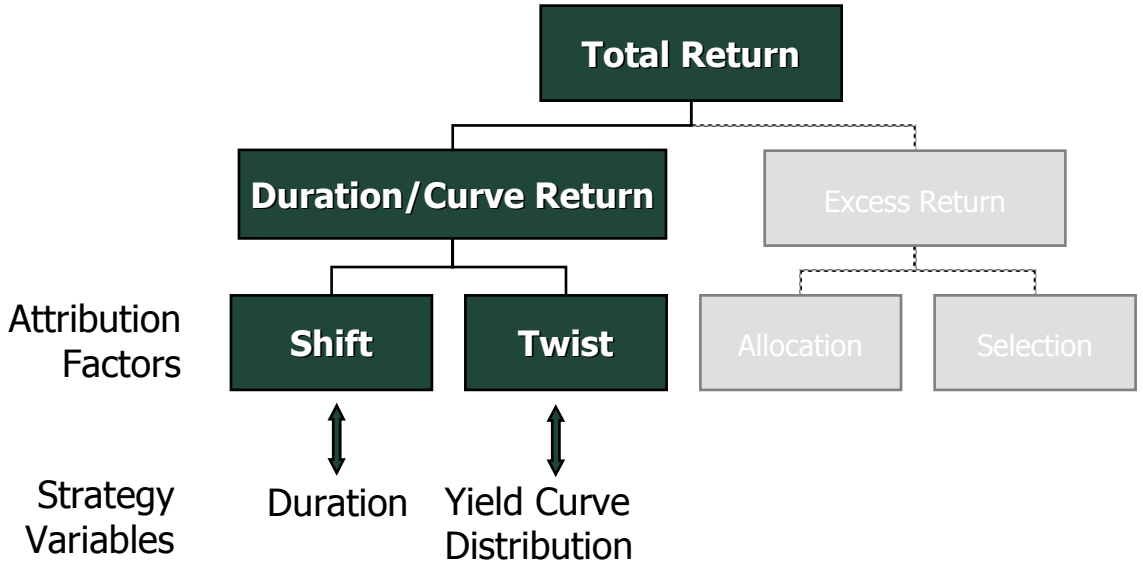
- Each security's total return consists of a duration return and an excess return
- Portfolio and index returns are a weighted average of constituent issue returns



Duration Return

Portion of Total Return due to duration and curve

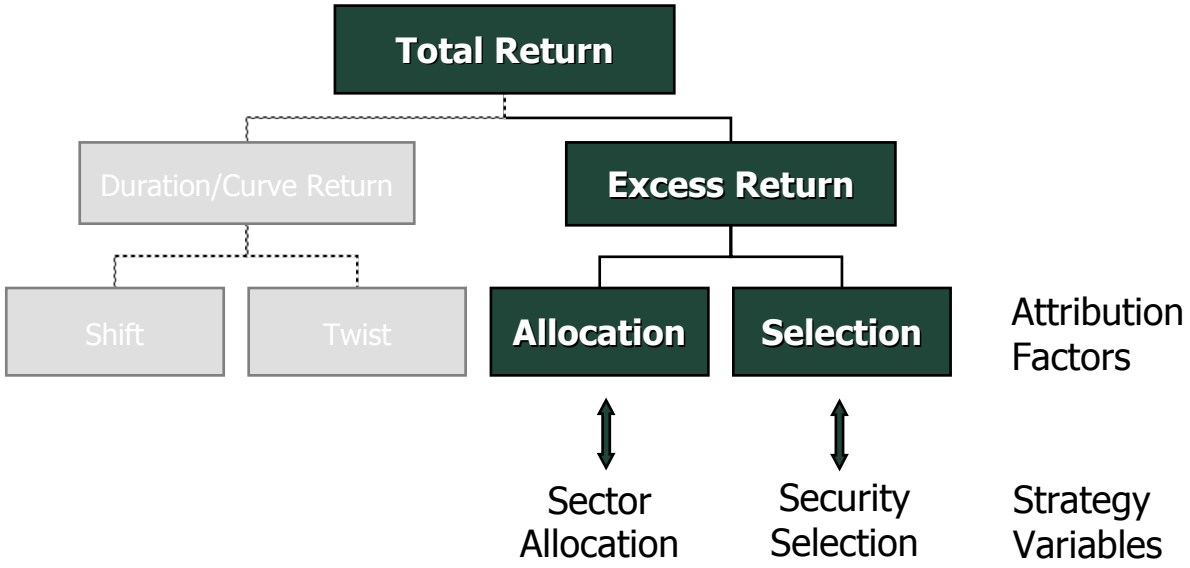
- Create synthetic Duration-Matched-Treasury (**DMT**) from yield curve
- All portfolio holdings are assigned equivalent DMTs
- DMT measures price return due to changes in the yield curve



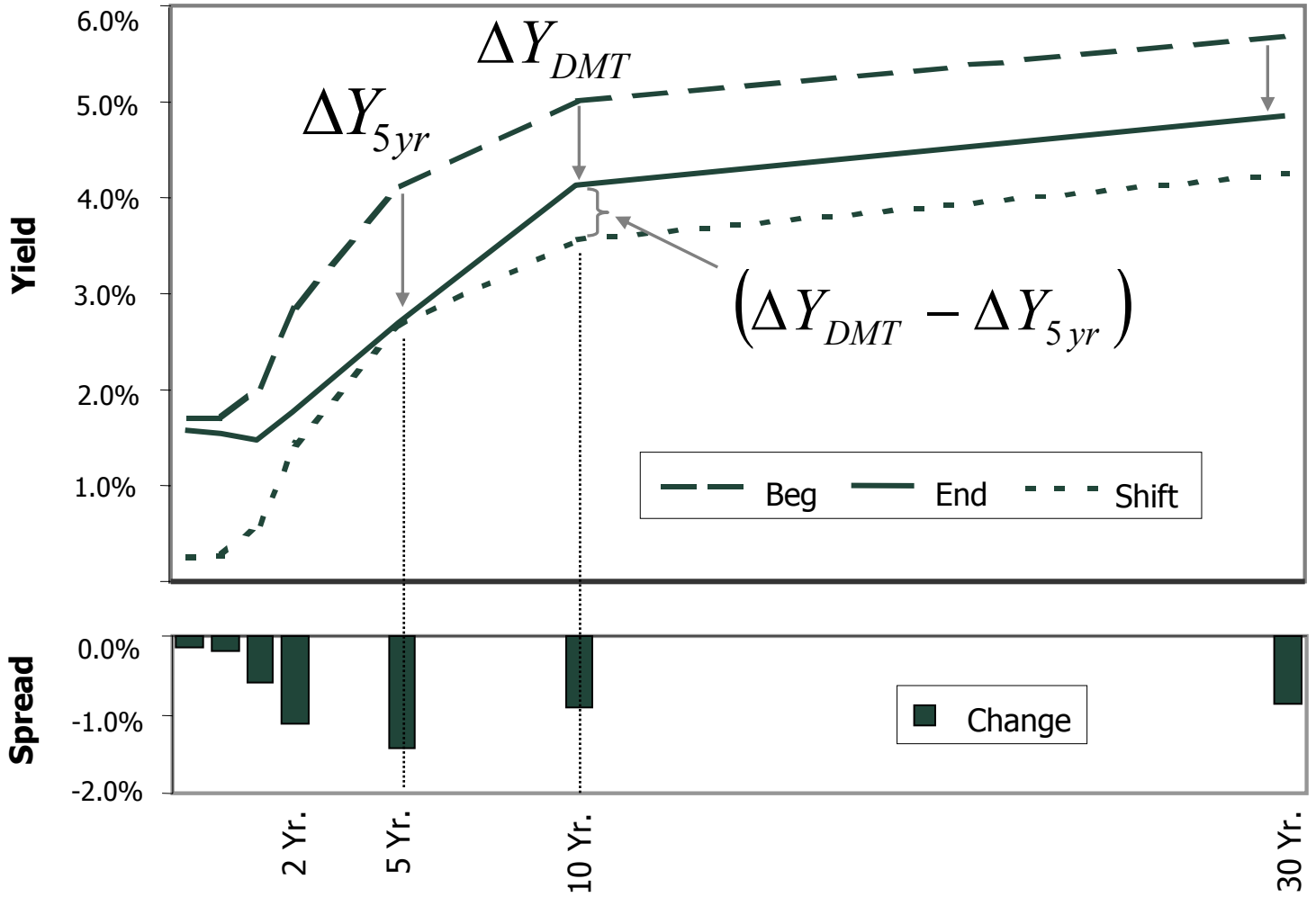
Excess Return

Portion of Total Return due to OAS and other "Spread Factors"

- Compute ***excess return*** over DMT
  - Excess Return = total return - duration return
- Difference between portfolio and benchmark total excess returns is explained by allocation and selection



Yield Curve Shifts (referenced to 5yr Treasury)



Attribution Equations: Shift and Twist

Total Return = **Duration Return** + Excess Return

$$-D \times \Delta Y_{DMT}$$

Shift

$$-D \times \Delta Y_{5yr}$$

Twist

$$-D \times \left(\Delta Y_{DMT} - \Delta Y_{5yr} \right)$$

Duration Return Example (December 2002)

Issue Name = First Energy 6.45% 11/15/11

Duration = 6.87

Total return = 3.79%

Change 5yr = -0.513%

Change 6.87yr = -0.408%

Duration Return = $-D \times \Delta Y_{DMT}$ = -6.87 x -.408% = 2.80%

Shift Return = $-D \times \Delta Y_{5yr}$ = -6.87 x -.513% = 3.52%

Twist Return = $-D \times \left(\Delta Y_{DMT} - \Delta Y_{5yr}\right)$ = -6.87 x .105% = -0.72%

Excess Return = Total Ret – Duration Ret = 3.79% - 2.80% = 0.99%

Aggregate to Higher Dimensions (Sector Example)

By computing duration and excess return at the cusip level, the data can be aggregated to any higher dimension-sector, quality, coupon, etc.

Sector	Weight	Duration	Total Return	Shift Return	Twist Return	Excess Return
Total	**100.00%**	**3.90**	**2.23%**	**2.00%**	**-0.28%**	**0.50%**
	20.00%	**5.05**	**2.37%**	**2.59%**	**-0.50%**	**0.27%**
GOV	10.00%	6.05	2.70%	3.10%	-0.71%	0.31%
GOV	10.00%	4.05	2.03%	2.08%	-0.28%	0.24%
	40.00%	**1.60**	**1.04%**	**0.82%**	**-0.07%**	**0.30%**
MBS	15.00%	1.58	1.04%	0.81%	-0.08%	0.31%
MBS	15.00%	1.76	1.10%	0.90%	-0.04%	0.24%
MBS	10.00%	1.40	0.97%	0.72%	-0.12%	0.37%
	30.00%	**6.02**	**3.64%**	**3.09%**	**-0.47%**	**1.03%**
CORP	10.00%	6.87	3.79%	3.53%	-0.72%	0.99%
CORP	10.00%	5.65	3.24%	2.90%	-0.48%	0.82%
CORP	10.00%	5.54	3.89%	2.84%	-0.22%	1.27%
	10.00%	**4.45**	**2.46%**	**2.28%**	**-0.05%**	**0.22%**
HY	5.00%	4.61	3.41%	2.37%	-0.12%	1.16%
HY	5.00%	4.29	1.50%	2.20%	0.02%	-0.72%

Attribution Equations: Allocation & Selection

$$R - \overline{R} = S + A$$

$$A = \sum_{i} [(W_i - \overline{W}_i)(\overline{R}_i - \overline{R})]$$

$$S = \sum_{i} [W_i(R_i - \overline{R}_i)]$$

R = Return of portfolio

$\overline{R}$ = Return of benchmark

A = Allocation effect of all sectors i

S = Selection effect of all sectors i

R_i = Return of sector i in portfolio

$\overline{R}_i$ = Return of sector i in benchmark

W_i = Weight of sector i in portfolio

$\overline{W}_i$ = Weight of sector i in benchmark

Equity Inputs

Weights

R = Total Returns

Fixed Income Inputs

Weights

R = Excess Returns

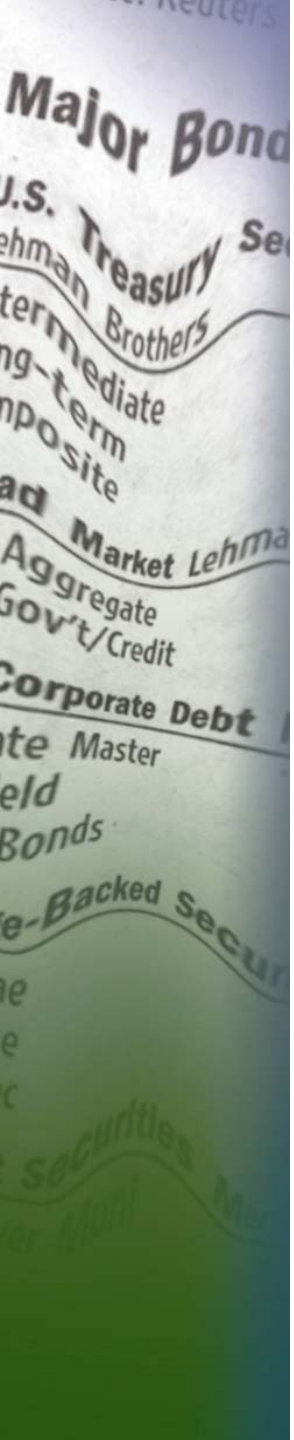
Portfolio vs. Benchmark: Consolidated Attribution

Which bets paid off: Shift, Twist, Allocation, Security Selection?

Portfolio	Index	Difference	Shift	Twist	Allocation	Selection
2.23%	**2.07%**	**0.16%**	**-0.05%**	**0.05%**	**-0.12%**	**0.28%**
				GOV:	0.01%	0.00%
				MBS:	0.00%	0.02%
				CORP:	0.01%	0.16%
				HY:	-0.13%	0.11%

Portfolio	Weight	Duration	Total Return	Shift Return	Twist Return	Excess Return
	100.00%	**3.90**	**2.23%**	**2.00%**	**-0.28%**	**0.50%**
GOV	20.00%	5.05	2.37%	2.59%	-0.50%	0.27%
MBS	40.00%	1.60	1.04%	0.82%	-0.07%	0.30%
CORP	30.00%	6.02	3.64%	3.09%	-0.47%	1.03%
HY	10.00%	4.45	2.46%	2.28%	-0.05%	0.22%

Index	Weight	Duration	Total Return	Shift Return	Twist Return	Excess Return
	100.00%	**4.00**	**2.07%**	**2.05%**	**-0.32%**	**0.34%**
GOV	38.25%	5.12	2.41%	2.63%	-0.51%	0.30%
MBS	35.58%	1.63	1.04%	0.84%	-0.04%	0.25%
CORP	26.17%	5.60	2.95%	2.87%	-0.43%	0.51%
HY	0.00%	4.70	1.40%	2.41%	-0.09%	-0.92%



Variations/Enhancements Around this Simple Model

- **Time Effects on DMT Income**
- **Time Effects on DMT Price**
- **Key Rate Durations**
- **Cash Flow Decomposition**
- **Principle Components**
- **Daily Calculations**

Time Effects on DMT Income

The simple method only captures the dirty price return of the DMT and does not capture physical cash flows.

$$-D \times \Delta Y_{DMT}$$

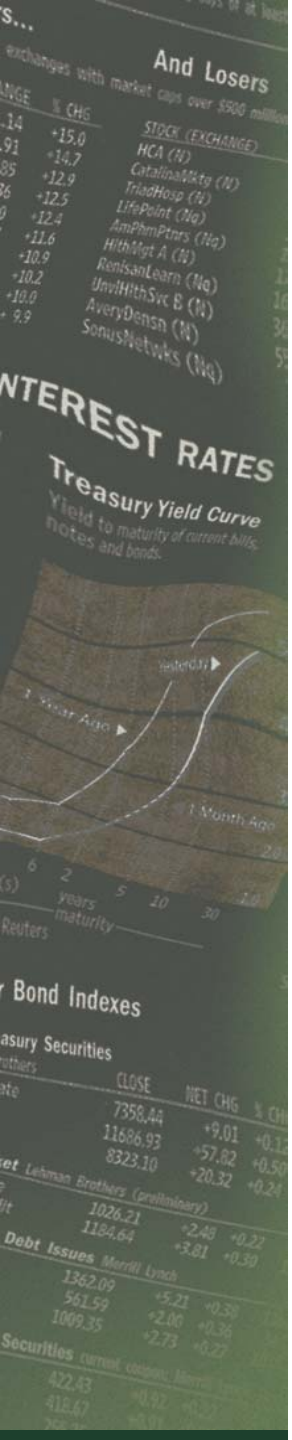
Some incorporate an income approximation for the DMT by adding the product of:

the portion of the year elapsed during the measurement period

and

the yield of the DMT.

$$-D \times \Delta Y_{DMT} + \Delta T \times Y_{DMT}$$



Time Effects on DMT Price

Rolldown Effect

As a bond matures, its DMT reference point on the yield curve will rolldown to the left.

In a steep yield curve environment, bond prices will increase as the bonds age and fall into portion of the yield curve with lower yields.

Accretion Effect (often though of as income)

As a bond reaches maturity, its price will move towards par.

This results in accretion for discount bonds or amortization for premium bonds.

Key Rate Durations

The simple method does not capture the issue's cash flow distribution along the yield curve. It treats every security as a bullet cash flow security.

Why is this a limitation?

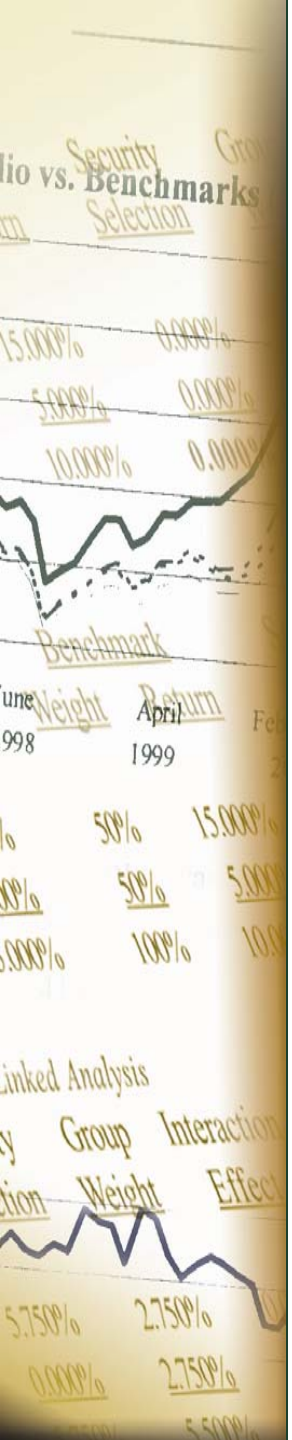
Even with identical durations, a barbell cash flow distribution will outperform a laddered or bullet distribution in a flattening environment. Vice versa for steepening.

Key rate durations capture the issue's sensitivity to movements at key rates.

DMT	Duration	Shift	Duration Return
Total	5	-0.30	**1.50**
KRD	Duration	Shift	Duration Return
1 YR.	0.6	-0.25	0.15
5 YR.	3.2	-0.30	0.96
10 YR.	0.9	-0.35	0.32
30 YR.	0.3	-0.40	0.12
Total	5		**1.55**

Compute duration return at each key rate with shift at corresponding point on curve. Total duration return is simply the sum at each point.

Shift can be defined as in the simple method with twist backed out from the total.



Cash Flow Decomposition

Identical to the simple method except

all cash flows are broken out of each issue and treated as bullet bonds!

Pros	Ideal. Most accurate measure of duration return attainable.
Cons	Data intensive. Doesn't add much value over KRD approach.

Principal Components

In the simple model the yield curve is described by shift & twist.

Popular principal components include

- Shift - The parallel component of the yield curve movement
- Twist – The movement of the ends defined around a static pivot.
- Butterfly – The movement of the ends relative to the center movement.

Other principal components include

- Snake – Large sine curve to model other curve movement
- Worm – Smaller sine curve and/or other residual to explain rest of curve.

Be careful not to model things you can't actively manage or manage against.

Daily Calculations

Equity and Fixed Income attribution both benefit from daily calculations.

However, this benefit is greater in the fixed income world!

Why?

Duration statistics change everyday.

A fresh measure of duration will lead to accurate duration returns.

A stale measure of duration will lead to erroneous duration returns.

Capture a fresh duration every day to avoid this problem.

Questions?