Swisscanto Asset Management AG

Presentation of the FIPA Project

"Fixed Income Performance Attribution" Project

Bond team

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1. Introduction
What is FIPA?

- Performance attribution purpose
  - Understand the sources of realized excess returns
  - Identify the active decisions that have generated excess returns
  - Communicate the results to clients and not least to portfolio managers
- Fixed Income Performance Attribution (FIPA)
  - Model to decompose **bond** performance into factors
  - No well-established standard in the bond industry yet
  - Much more difficult than an Equity Performance Attribution

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1. Introduction
What is FIPA?

- Equity Performance Attribution factors:
  - Asset allocation (AA)
  - Stock selection (SS)

  But the decomposition for Fixed Income is much more difficult…

- Fixed Income Performance Attribution (FIPA) factors:
  - Coupons and roll-down effect (carry)
  - Yield curve shifts (change in the interest rate term structure)
  - Credit spread (captured by yield curves of different ratings)
  - Stock selection

  Furthermore, the effect of yield curve shifts and spread changes on bond value is non-trivial.

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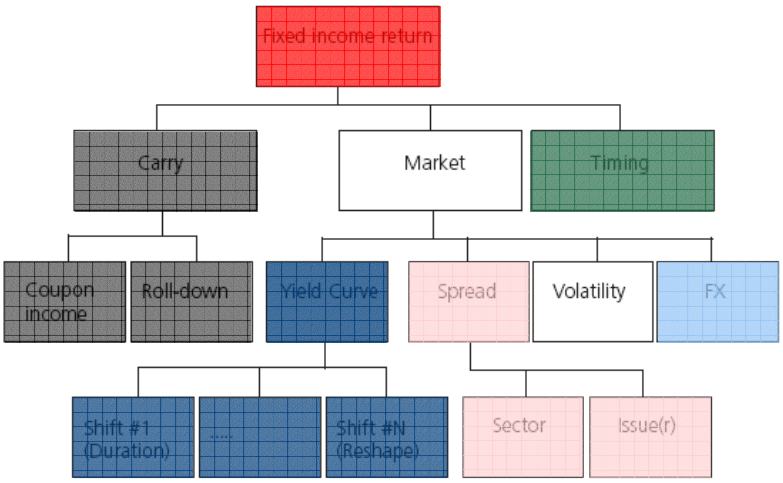
2. Theoretical framework
FIPA factors

- Usual decomposition of a Fixed Income return:



Source: SimCorp A/S

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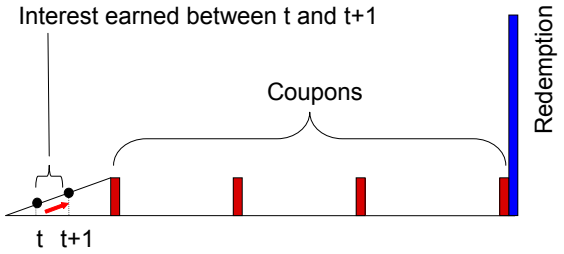
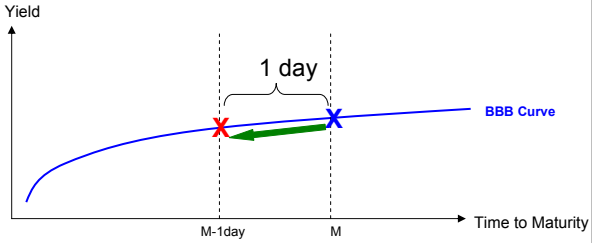
2. Theoretical framework FIPA factors

Carry return

- Direct return
  - Returns generated by the coupons



- Roll-down return
  - Returns generated by time (convergence to par at maturity)
  - negative effect for premium bonds
  - Positive effect for discount bonds



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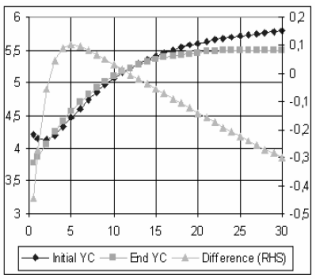
2. Theoretical framework FIPA factors

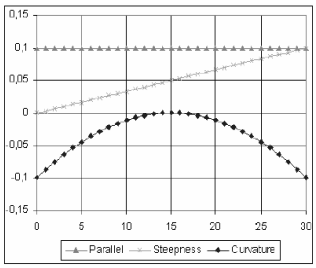
Market return – Interest component

- Yield curve Shift 1
  - Returns generated by parallel shift of the YC (can be approximated by the duration)

$$r_{\text{Parallel}} \cong -D \cdot \Delta yc_{\text{Parallel}}$$



- Yield curve Shift 2
  - Returns generated by a twist (steepness) of the YC
  - Short term and long term rates move in opposite direction but proportionately in relation to the distance from some “pivot point” maturity



Source: SimCorp A/S

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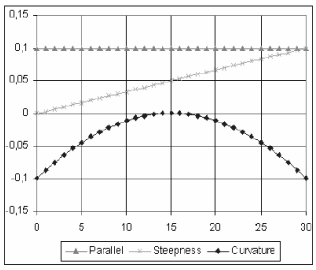
2. Theoretical framework FIPA factors

Market return – Interest component

- Yield curve Shift 3
  - Returns generated by "butterfly" shift of the YC
  - Short term and long term rates move in same direction while medium term rates move in an opposite direction, still proportionately
- Yield curve Reshape
  - Returns generated by a shift of the YC other than Shift 1,2 and 3
  - The unexplained shift left is normally statistically small
- $r_{\text{YieldCurve}} = r_{\text{Parallel}} + r_{\text{Twist}} + r_{\text{Curvature}} + r_{\text{Reshape}}$



Source: SimCorp A/S

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2. Theoretical framework FIPA factors

Market return – Credit component

- In addition to the general yield levels, **non-sovereign debt** is also sensitive to credit risk. The market measure of credit risk is the *spread*.
- Typically decomposed in two subcategories
  - **Sector spread** (industry specifics and rating specifics) which reflects aspects common across bonds issued by corporations with similar ratings and similar industries
  - **Issue spread** (issuer specifics) which reflects issue/issuer specific considerations
- $r_{\text{Spread}} = r_{\text{Sector}} + r_{\text{Issue}}$

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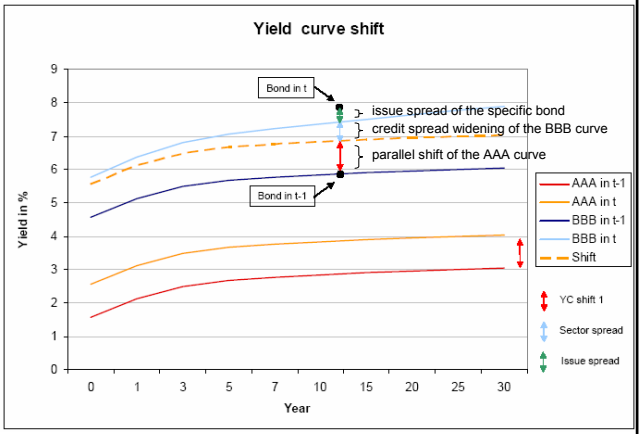
2. Theoretical framework
FIPA factors

Decomposition of the spread (sector spread and issue spread)

Example with a BBB bond

- **The yield curve shift** is fully explained by the move of the base curve (generally a AAA curve or a government curve)
- **The sector spread effect** is due to the credit spread of the bond. The moves of a BBB curve are typically of higher intensity than the ones of a AAA curve
- **An issue spread effect** which is specific to the bond. This effect is closely related to the picking effect.



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2. Theoretical framework
FIPA factors

Market return – Volatility

- Returns generated by change in implied volatility
- Play an important role for portfolios with **embedded options** like:
  - asset-backed
  - mortgage-backed
  - corporate bonds which have built-in options in the form of put, call or prepayment options

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2. Theoretical framework
FIPA factors

Market return – FX

- Returns generated by FX changes
- Very important factor for multi-currency bond portfolios

Timing return

- Returns generated by trading activities in the portfolio (trading price vs. close price)
- Performance measurement is based on end of day prices (close). Discrepancies occur between trading and close price

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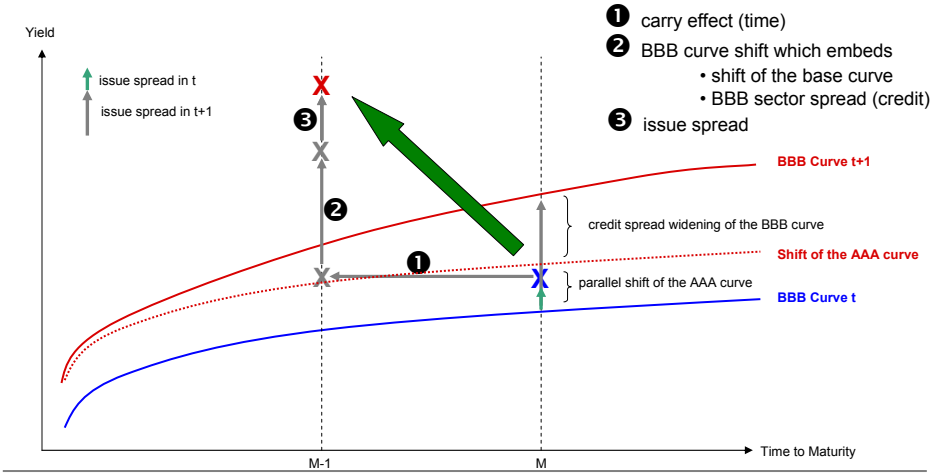
2. Theoretical framework
FIPA factors – Recapitulation

- And to finish this section a small graphical example…



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2. Theoretical framework Yield curve construction

- The yield curves are extracted from bonds available on the markets. Basically there are two main types of yield curves - the yield to maturity curve and the zero coupon yield curve.

YTM curve

- The YTM curve is computed with the yield to maturity, which is a security's internal rate of return, or the anticipated yield of the bond if held to maturity

Zero-coupon curve

- The zero coupon yield curve is computed with zero coupon yield, which is the return it would show if all coupons were stripped out.

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2. Theoretical framework
Yield curve construction

Zero-coupon curve

- Thanks to its simplicity a lot of evaluation methods have been developed for the zero coupon yield curve. The following list is not exhaustive:
  - Bootstrapping → bootstrapping method
  - **Cubic spline**
  - Natural spline
  - Nelson Siegel
  - Maximum smoothness

  } mathematical models
  - Cox Ingersoll Ross
  - Cox Ingersoll Ross (inflation)
  - Vasicek
  - Longstaff Schwartz

  } term structure models

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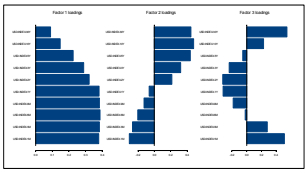
2. Theoretical framework
Yield curve decomposition

- As we showed before the yield curve shift can be decomposed in 3 main factors (parallel shift, twist, butterfly, plus a residual). What are the methods to decompose the YC global shift?



Principal component analysis (PCA)

- PCA method is a pure statistical decomposition
- Advantages:
  - does not require that functional form of the parallel, twist and butterfly are defined a priori
- Drawbacks:
  - one has to make assumptions on the horizon length. There is a fine line between statistical data relevance and explanatory relevance.

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2. Theoretical framework
Yield curve decomposition

Empirical method

- Very similar to the PCA method BUT shifts of the curve are computed empirically. (see for example the model developed by Lehman brothers where the pivot point is arbitrarily set at 5 years)
- Advantages:
  - flexibility which allows the portfolio manager to customize the attribution relatively to his bets.
- Drawbacks:
  - dependent on the accuracy of the model. Note that a PCA analysis may be used together with the Empirical method to calibrate the pivot point.

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2. Theoretical framework
Yield curve decomposition

Polynomial method

- The polynomial method does not involve a multi-dimensional statistical analysis, but rather uses a more intuitive of **extracting the zero**, first and second order changes from polynomials that fit the yield curve at the beginning and end of period and model the yield changes as the difference between each polynomial of the same degree.

$$\begin{matrix}\left(\alpha_0^{\text{Begin}},\alpha_0^{\text{End}}\right)\\ \left(\beta_0^{\text{Begin}},\beta_0^{\text{End}}\right),\left(\beta_1^{\text{Begin}},\beta_1^{\text{End}}\right)\\ \left(\gamma_0^{\text{Begin}},\gamma_0^{\text{End}}\right),\left(\gamma_1^{\text{Begin}},\gamma_1^{\text{End}}\right),\left(\gamma_2^{\text{Begin}},\gamma_2^{\text{End}}\right)\end{matrix}$$

parallel shift	$p=\alpha_0^{\text{End}}-\alpha_0^{\text{Begin}}$
twist	$s(t)=\left(\beta_0^{\text{End}}-\beta_0^{\text{Begin}}\right)+\left(\beta_1^{\text{End}}-\beta_1^{\text{Begin}}\right)\cdot t$
butterfly	$b(t)=\left(\gamma_0^{\text{End}}-\gamma_0^{\text{Begin}}\right)+\left(\gamma_1^{\text{End}}-\gamma_1^{\text{Begin}}\right)\cdot t+\left(\gamma_2^{\text{End}}-\gamma_2^{\text{Begin}}\right)\cdot t^2$

- Remark:
  - In practice, polynomial method leads to a poor outcome and a minuscule attribution of the return to the parallel component because each factors explains as much of the variance as possible in a non-orthogonal space → colinearity

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2. Theoretical framework
Yield curve decomposition

Duration method

- The duration approach decomposes returns of the portfolio based on its yield, duration and convexity. This method is very intuitive
  - Parallel shift $\Delta_{\text{Parallel}}=-D\cdot\Delta R$
  - Twist $\Delta_{\text{Twist}}=\frac{1}{2}C_i\cdot\Delta R^2$

- Advantages:
  - does not require the definition of terms and conditions of securities.
  - does not need a daily full revaluation of the portfolio

- Drawbacks:
  - impossibility to analyze the butterfly effect
  - key assumption that the distributed cash flows of a fixed income instrument are approximated by a concentrated cash flow at the duration of the security.

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2. Theoretical framework
Linking multiple periods

- FIPA decomposition is done on a daily basis. Then two broadly used methods are available to link returns over multiple time period: the geometric model and the arithmetic model

Arithmetic model

- Within a day the *I* factors are simply arithmetically added: $r_{t-1,t} = \sum_{i=1}^{I} r_{t-1,t}^{i}$
- The return *r* for *N* days is then: $1 + r = \prod_{t=1}^{N} \left(1 + r_{t-1,t}\right) = \prod_{t=1}^{N} \left(1 + \sum_{i=1}^{I} r_{t-1,t}^{i}\right)$
- Advantages:
  - Simple and intuitive
- Drawbacks:
  - Generation of cross products residuals difficult to attribute and interpret. (Note that methods have been developed like the optimized logarithmic linking approach to solve the problem)

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2. Theoretical framework
Linking multiple periods

Geometric model

- Within a day the *I* factors are multiplied: $1+r_{t-1,t}=\prod_{i=1}^{I}\left(1+r_{t-1,t}^{i}\right)$
- The return *r* of *N* days is then: $1+r=\prod_{t=1}^{N}\left(1+r_{t-1,t}\right)=\prod_{t=1}^{N}\prod_{i=1}^{I}\left(1+r_{t-1,t}^{i}\right)$
- Advantages:
  - No problem with the multi-period linking
  - Keep the proportionality and convertibility (same return for all currencies) properties
- Drawbacks:
  - Not intuitive

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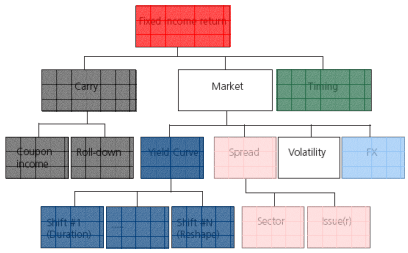
3. Characteristics of the portfolio analyzed
Constraints on the portfolio

- Multi-currency bond portfolio with reporting currency in CHF
- Size: over 1 bn CHF
- The portfolio has a customized credit benchmark with fixed weights which are rebalanced every month.
- The portfolio invests in investment grade credits (from AAA to BBB) and government bonds
- They are no derivatives in the portfolio as well as in the benchmark
- A special emphasis is put on spread



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3. Characteristics of the portfolio analyzed Setup used

- The setup used to analyze this portfolio was chosen after having reviewed carefully the theoretical documentation and white papers available on the FIPA topic. Some setups had to be chosen for technical reasons. Some others were strongly recommended by market standards:
  - Yield curve construction: **cubic spline** interpolation
  - Yield curve decomposition: mix of the **empirical and PCA method**
    - parallel shift represent more than 95% of the global shift
    - reshape that contains twist, butterfly and residual (5% left)
  - Linking method: **geometric linking**

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4. Characteristics of the portfolio analyzed Issues in practice

- Implementing a FIPA analysis implies a multitude of technical and practical issues. Data cleaning and data improvement is costly and very time consuming. Here is a non-exhaustive list of problems we had to solve before running a FIPA analysis:
  - **Replication of the benchmark index by a security-level benchmark portfolio**
    - A FIPA analysis can only be run with 2 portfolios
    - Having a portfolio and a benchmark index is not sufficient (because an index **does not** provide enough information like coupon payments, maturities, etc.)
  - But the replication is complex because:
    - each market provider has a different methodology for the coupon reinvestment, monthly rebalancing of the benchmark, etc.
    - A benchmark might have more than 5'000 securities

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4. Characteristics of the portfolio analyzed Issues in practice

– Improve data quality
  - price sources
  - booking of non-standard features like callable or multi-step bonds,
  - synchronization of changes in ratings, changes of maturity buckets,…

– Booking of reclaimable withholding taxes that differ across countries and bond owner

– Gross and net basis in accordance with the SPPS standards (Swiss version of GIPS)

– etc…

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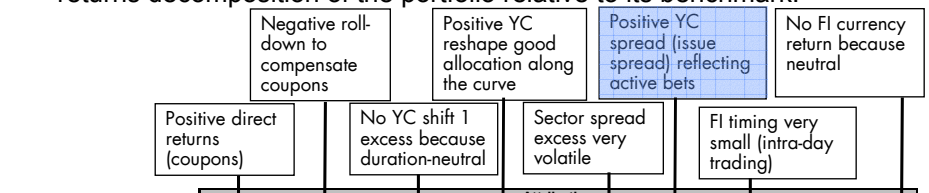
5. The results

- The results of the FIPA decomposition allow a clear and simple analysis of the origin of the returns. The following table presents the excess returns decomposition of the portfolio relative to its benchmark:



		Attribution							
Date	**Excess return RC (Bps.)**	Direct return excess (Bps.)	Roll down excess (Bps.)	YC shift 1 excess (Bps.)	YC reshape excess (Bps.)	Sector spread return excess (Bps.)	YC spread return excess (Bps.)	Fixed income timing excess (Bps.)	Fixed income currency return excess (Bps.)
01/2005									
02/2005									
03/2005									
04/2005									
05/2005									
06/2005									
07/2005									
08/2005									

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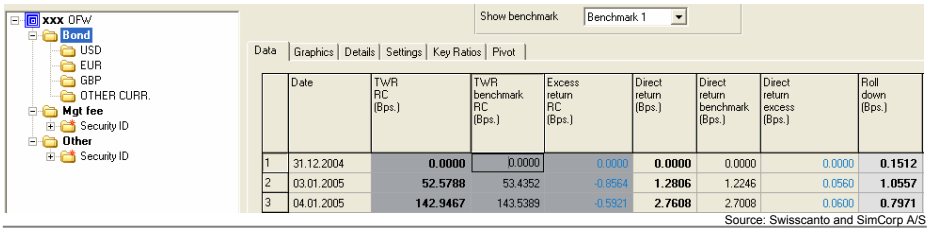
6. Some screen shots

- Interface totally customizable
  - – You can define the tree complexity and can do a FIPA analysis for each node
    - currencies
    - ratings
    - maturities
    - business classes
    - countries, etc.
  - – Allows a direct overview in one window (period return or accumulated return / by day, months, quarter, years / can add the factors you want to see / graphic interface)



	Date	TWR RC (Bps.)	TWR benchmark RC (Bps.)	Excess return RC (Bps.)	Direct return (Bps.)	Direct return benchmark (Bps.)	Direct return excess (Bps.)	Roll down (Bps.)
1	31.12.2004	**0.0000**	0.0000	0.0000	**0.0000**	0.0000	0.0000	**0.1512**
2	03.01.2005	**52.5788**	53.4352	-0.8564	**1.2806**	1.2246	0.0560	**1.0557**
3	04.01.2005	**142.9467**	143.5389	-0.5921	**2.7608**	2.7008	0.0600	**0.7971**

Source: Swisscanto and SimCorp A/S

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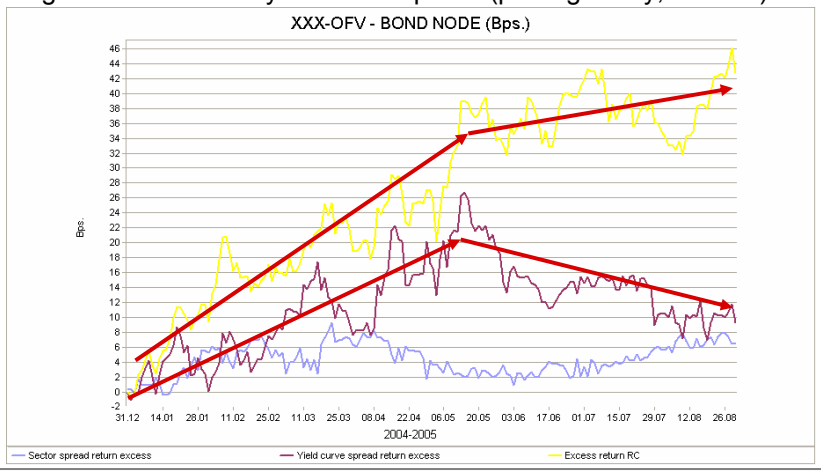
6. Some screen shots
Excesses

- Excess return of 43bps till 31.08.2005 (yellow line)
- High correlation with yield curve spread (picking ability, red line)



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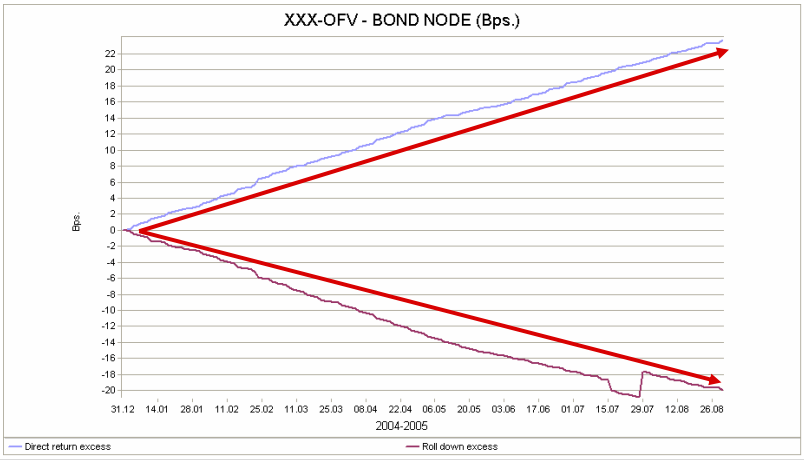
6. Some screen shots
Carry (direct return excess and roll down excess)

- Direct return excess linear, 24bps till 31.08.2005
- Roll down excess linear, compensates direct return, -20bps till 31.08.2005



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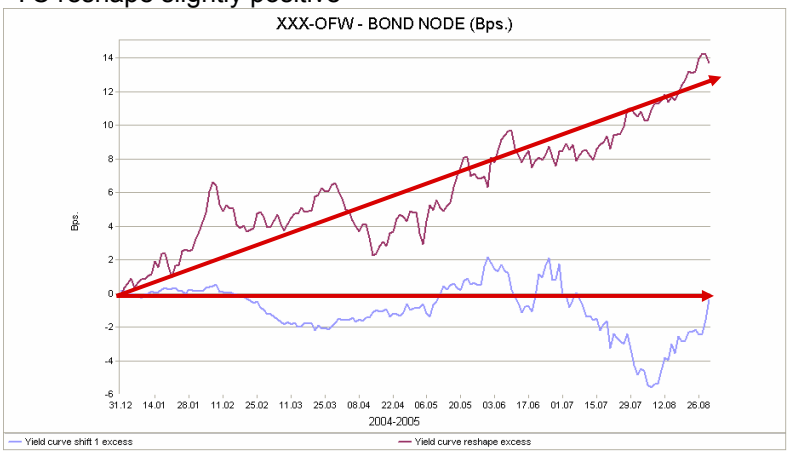
6. Some screen shots
Yield curve moves (parallel shift and reshape)

- YC shift 1 (parallel) almost zero
- YC reshape slightly positive



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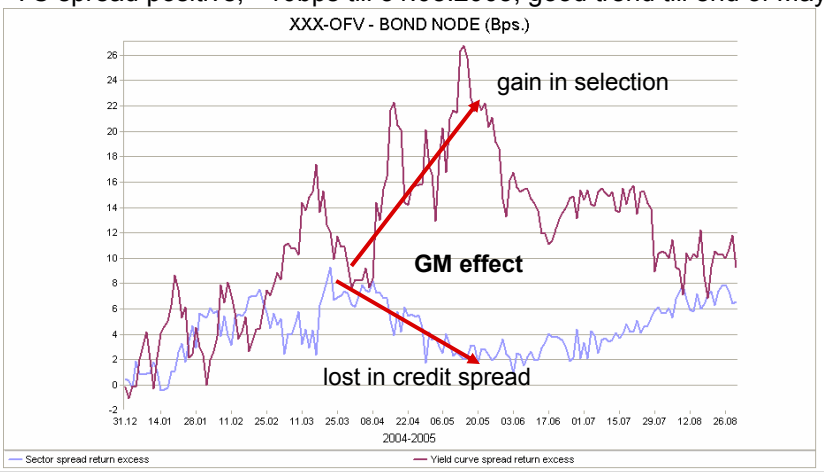
6. Some screen shots
Credit spread (sector) and selection (YC spread)

- Sector spread slightly positive but close to the benchmark
- YC spread positive, +10bps till 31.08.2005, good trend till end of May



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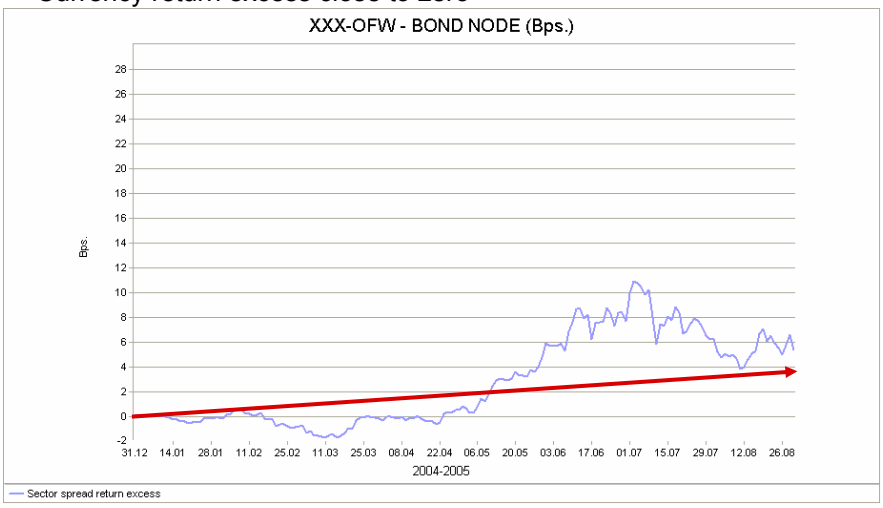
6. Some screen shots
Currency

- Currency return excess close to zero



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7. Conclusion

- Fixed Income Performance Attribution (FIPA) is an unbelievable powerful tool to decompose the performance of a bond portfolio.
- The data quality (yield curve generation, yield curve construction, replication of the benchmark, price quality, static data of the bonds) is essential. FIPA is very sensitive to any mistakes. You have to keep in mind that for a bond portfolio a yearly excess return of 40bps against the benchmark is already a huge one. And FIPA decomposes these 40bps in about 10 factors!
- Thanks to the FIPA analysis, we have shown that the active decisions of the portfolio manager
  - have generated an average excess return of 5 to 6bps per month.
  - a good part of it comes from the issue spread (the area where the portfolio manager took his credit bets), especially for the first part of the year

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7. Conclusion

- We believe that FIPA analysis will become a necessary tool for bond management because it is a powerful tool for analyzing the portfolio manager's decisions.

- This tool could also be used with ex-ante scenarios (yield curve shift scenario, FX change scenario,…) to become an active management tool in bond selection. Basically you can test the impact of future changes of the market variables on your portfolio.

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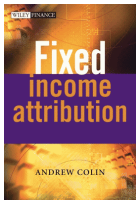
7. Conclusion



A few good books on Fixed Income Performance Attribution:

- **Colin A.,** "Fixed Income Attribution", Wiley Finance Series, 2005
- **Spaulding D.,** "Investment Performance Attribution", McGraw-Hill, 2003
- **Dynkin L., Hyman J. & Konstantinovsky V.,** "A return Attribution Model for Fixed Income Securities", Handbook of Portfolio Management, 1998
- **Esseghaier Z., Lal T., Cai P. & Hannay P.,** "Yield Curve Decomposition and Fixed Income Attribution", DST international, 2003
- **Fong G., Yoo D., & Zelaya Z.M.,** "Global Performance Attribution, Perspectives on International Fixed Income Investing", 1998
- **Hughston L.,** "Vasicek and Beyond: Approaches to Building and Applying Interest Rate Models", Risk Books, 1997
- **James J. & Webber N.,** "Interest Rate Modelling", Ed. J. Wiley, 2001
- **Knott G.D.,** "Interpolating cubic splines", Birkhäuser, 2000
- **Søgaard-Andersen P.,** "Fixed Income Performance Attribution, a flexible approach", SimCorp Dimension, Knowledge-sharing, 2005
- **Sørensen O.,** "FIPA calculations in SimCorp Dimension", SimCorp Dimension, 2005

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Thank you for your attention

Any questions?

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