From Smart Beta to Enhanced Beta® in the fixed income world
Natixis Asset Management
Fixed income investment division

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The Fixed income investment division implements an active fundamental management, where risk is taken into account at every stage of the investment process. It offers a collegial approach with sector teams specialised by market segment.

The Fixed income investment division is supported by close to one hundred specialists, including asset managers, credit analysts, strategists, financial engineers and economists.

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². Seeyond is a brand of Natixis Asset Management.
³. Mirova is a subsidiary of Natixis Asset Management.
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INTRODUCTION

The proliferation of so-called ‘Smart Beta’ investment approaches has thus far been confined principally to the equity universe, and for good reason. While it seems logical, even intuitive, to test a range of Smart Beta approaches in a fixed income portfolio context, the nature of fixed income securities makes the exercise, by construction, far from straightforward.

For example, a "risk-based" investment approach such as minimum variance is not easily applicable to the fixed income world:

- A fixed income portfolio’s risk is directly linked to its duration. As such, the choice of interest rate sensitivity must be made prior to optimization, otherwise the optimization algorithm will build a low-duration and highly-concentrated portfolio by selecting only the instruments with the shortest maturities.
- Fixed income instrument pricing, based on numerous risk factors, is complex, making optimization processes more challenging and costly compared to that used for equities.
- Liquidity and fungibility issues are more complex for fixed income.

These are only a few of the technical and practical challenges to replicating Smart Beta strategies in the fixed income universe.

We offer an overview of the Smart Beta strategies that are currently or potentially applied to fixed income. Next, we introduce the solution developed by Natixis Asset Management, an approach founded on our convictions regarding the structure of the instruments in question.

We set out to demonstrate that by combining a Smart Beta optimization with an equally-transparent ‘skills quantification’, fixed income investors can receive Enhanced Beta® as an alternative solution to traditional fixed income portfolios. The objectives for an investor are therefore to have strong long-term returns for an appropriate level of risk by implementing a “best of both worlds” approach: active management and Smart Beta.
2 SMART BETA WITHIN THE FIXED INCOME UNIVERSE

2.1 WHY SMART BETA?

Most traditional indices are constructed based on their components’ market capitalization, for equities, and issue size, for bonds. Capitalization-weighted or size-weighted indices reflect market liquidity and so can be considered representative of the overall market. However, using them as a reference benchmark implies adhering to their long-term implicit biases, which may not be desired by the investor.

We define Smart Beta portfolios or indices as those constructed via alternative weighting methods that are not related to market capitalization or issue size. This point explains much of the popularity of the Smart Beta approach.

There is a large amount of literature on Smart Beta, especially in the Equity market. It appears that any weighting scheme not based on traditional “Market capitalization” weighting method, is called Smart Beta.

Natixis AM distinguishes Smart Beta approaches in two groups:

1. Indices whose weighting scheme is based on economic or financial variables.
2. Portfolios or indices whose weighting scheme is defined via an objective function, or algorithm.

Since the former category is based on ex-post data, we call it the ‘passive approach’. In contrast we term the second the ‘dynamic approach’ as it uses ex-ante data based on risk optimization.

Below, we describe the two approaches:

<table>
<thead>
<tr>
<th>WEIGHTING SCHEMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive approaches</td>
</tr>
<tr>
<td>Dynamic approaches</td>
</tr>
<tr>
<td>Market cap weighted</td>
</tr>
<tr>
<td>Efficient weighted</td>
</tr>
<tr>
<td>Arbitrary weighted</td>
</tr>
<tr>
<td>Risk-based weighted</td>
</tr>
<tr>
<td>Fundamental weighted</td>
</tr>
</tbody>
</table>

Both approaches assume that two underlying choices are made, whether implicit or explicit:

- Selecting an ‘optimal’ model portfolio framework which expresses implicit views on long-term allocation, to benefit from potential market inefficiencies.
- Explicit choice of risk exposure relative to the corresponding capitalization-weighted index.

The fact that the above positions must be established suggests that the resulting Smart Beta portfolio should continue to be compared to the reference capitalization-weighted index. As such, it is not an absolute return product.
From Smart Beta to Enhanced Beta® in the fixed income world

2.2. SMART BETA INDEX

In order to qualify as an ‘index’, a Smart Beta portfolio must be fully replicable, which implies:

- Transparency of the algorithms used, both in terms of data and methods (based on public data)
- Robustness and consistency of the weighting scheme

The following section discusses the limitations of traditional size-weighted fixed income indices.

2.2.1. How traditional market-weighted methods can lead to “inefficiencies”

Market value (ie, market capitalization) weighted indices are the standard used within the fixed income asset class. Their construction method, based on bond issuance size, is underpinned by the liquidity of the underlying asset because the weight of each bond is based on the amount outstanding of its debt and its price. At the same time, such indices highlight some shortcomings of the fixed income world. Amongst the most important, one can note the following drawbacks:

**Lack of diversification:**
As weights are based on prices, issuers (government or corporate) with a high level of debt are overweighted in the index and portfolios will thus suffer from a lack of diversification. For instance, in the Barclays Global Treasury index, 11 of the 37 countries represent 90% of the index (six countries for 80% and five for 70%).

Moreover, when certain countries’ debt is overvalued, investors can be exposed to potential bubbles in the fixed income markets. Investing in such an index can lead to a high concentration of risk. For example, during the financial crisis, the weight of the banking sector reached a peak, representing about 35% of the Barclays US Corporate Investment Grade index in the middle of 2008.

**Not representative of the real economy:**
Among global indices, emerging markets with higher growth perspectives are under-represented and indices do not reflect global economic dynamics. For example, emerging market bonds represent only 5.5% of the Barclays Global Treasury index.

--

1. The Barclays Global Treasury Index tracks fixed-rate local currency sovereign debt of investment grade countries. The index is a subset of the Global Aggregate Index in its entirety. Its inception date is 01/01/1987
Depend on issuance activity:
Market value weighted indices include newly issued securities; therefore, issuer weights pick up all issuance activity. This creates a conflict between the investor’s performance objective, and the treasurer’s objective, which is to minimize its cost of capital.

Return and risk are not correlated to indebtedness:
By construction, such indices may over-expose investors to very indebted countries. As illustrated below, there is no clear relationship between the level of long term bond yields and the level of debt for a specific country. Moreover, as measured by total debt outstanding, the link between total return on bonds or their historical volatility and the indebtedness of one country is not trivial.

2.2.2. Smart Beta Indices

2.2.2.1. Overview and examples
The following examples of alternative weighting schemes can be classified as passive methodologies; they are based only on predefined criteria applied to the traditional universe of market value weighted indices and their construction does not involve an explicit optimization.
We classify passive approaches into three groups - arbitrary, fundamental and risk-based:

<table>
<thead>
<tr>
<th>Arbitrary weighting</th>
<th>Fundamental weighting</th>
<th>Risk-based weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>a-priori weighted</td>
<td>GDP weighted</td>
<td>Duration Weighted:</td>
</tr>
<tr>
<td>Equal weighted</td>
<td>Pimco : Global Advantage Bond index (GLADI)</td>
<td>The Dow Jones CBOT Treasury Index</td>
</tr>
<tr>
<td>Cap weighted</td>
<td>Barclays GDP index</td>
<td>Ex post volatility weight</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

For each category, we provide examples of the existing index in the Fixed Income universe:

- **Arbitrary: straightforward weighting methodologies**
  - **Equal-weighted**: issuers have exactly the same weight, this means that for an index with N issuers, each issuer will have a weight of 1/N; the issues of each issuer are then weighted by their market value inside the issuer bucket. The Dow Jones Equal Weight U.S. Issued Corporate Bond Index is an example. The difficulty in replicating this index is a principal weaknesses. This is due to potentially high weights in issuer with low issue size.

- **Market value weighted by capitalization**: Issuers have a maximum weight of a chosen percent and the remaining is reinvested in the index in the same proportion. This methodology is useful in reducing concentration risk in traditional indices such as the Barclays EM Local Currency Government, in which countries have a 10% limit.

- **GDP² weighted**: issuers are weighted depending on the respective country’s economic performance. Current applications include EuroMTS Macro-Weighted Government Bond, Pimco : Global Advantage Bond index (GLADI), and Barclays GDP index. GDP-weighted indices are classified as arbitrary and not as a fundamental weighting scheme.

- **Fundamental: weighting methodologies based on issuer-specific characteristics.**
  - **Historically applied to equities only**, a fundamental weighting for fixed income indices can include quality rating. This is usually an agency credit rating but can also be an ESG rating (Environmental, Social and Governance)³.
  - **RAFI indices**: Research Affiliates Fundamental Index based on a transparent rules-based methodology that weights bonds using economic measures of company or country size. For example: the RAFI bond US High Yield 1-10 weights its issuer based on 4 factors: Sales, Cash flow, dividends and book value of assets. The RAFI Sovereign Developed Markets Bond Index weights each country based on four factors: Population, GDP, Energy consumption and Rescaled land area.

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2. GDP: Gross Domestic Product
3. Among others, one can identify: Barclays MSCI ESG Fixed Income Indices using MSCI ESG’s rating to create types of indices: Socially responsible (negative screening), Sustainability (positive screening) and ESG weighted (positive and negative tilts on the initial market value weighted index.
Barclays Capital Fiscal Strength index: issuer weight is a combination of its market value and a weighted average of the following factors: Debt/GDP, Deficit/GDP, CAB/GDP and, optionally, governance

Risk Weighted: passive approach (duration, volatility): for example, the Dow Jones CBOT Treasury Index is weighted by duration, so each component makes an equal contribution to the index total duration. In this case, contribution to duration is calculated as the weight multiplied by the component’s duration. We have not identified any volatility-weighted bond indices.

2.2.2.2. Focus on the most popular alternative indices: arbitrary weighting schemes

This scheme can be illustrated by using the Global Treasury universe (source Point™, 08/2014).

The diagram below shows the impact of a GDP weighting methodology as compared to a market value weighted index. The weights of Japan, France, UK and Germany are reduced whereas the emerging markets weight increases.

Historically, the market value weighting methodology underperforms both in return and volatility terms.
At the same time, the modified duration is reduced from 6.94 for the market value weighted to 6.35 for the GDP weighted index, and 6.18 for the equal-weighted index. This difference comes from the smaller weightings in countries with higher duration such as the United Kingdom and Japan.

The potential advantages and drawbacks of each major alternative index are summarized in the table below:

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equally-weighted index</strong></td>
<td>→ simple, intuitive, well diversified</td>
</tr>
<tr>
<td></td>
<td>→ high transactions costs when rebalancing,</td>
</tr>
<tr>
<td></td>
<td>→ not always replicable</td>
</tr>
<tr>
<td><strong>Capitalization-weighted</strong></td>
<td>→ limited concentration risk</td>
</tr>
<tr>
<td></td>
<td>→ does not change the relative composition of</td>
</tr>
<tr>
<td></td>
<td>the other issuers</td>
</tr>
<tr>
<td><strong>GDP-weighted</strong></td>
<td>→ based on economic performance</td>
</tr>
<tr>
<td></td>
<td>→ more representative of the actual</td>
</tr>
<tr>
<td></td>
<td>economies (eg more emerging countries)</td>
</tr>
<tr>
<td><strong>Quality or Agency Rating weights</strong></td>
<td>→ quarterly rebalancing may not be frequent</td>
</tr>
<tr>
<td></td>
<td>enough,</td>
</tr>
<tr>
<td></td>
<td>→ data can be subject to revision</td>
</tr>
<tr>
<td><strong>RAFI</strong></td>
<td>→ ratings include many factors determined by</td>
</tr>
<tr>
<td></td>
<td>the ratings agencies</td>
</tr>
<tr>
<td></td>
<td>→ potential lack of objectivity from the</td>
</tr>
<tr>
<td></td>
<td>rating agencies</td>
</tr>
<tr>
<td><strong>Risk-Based (passive approach)</strong></td>
<td>→ use of widely available data</td>
</tr>
<tr>
<td></td>
<td>→ subject to revision or change of methodology</td>
</tr>
<tr>
<td></td>
<td>→ majority of data is updated only annually</td>
</tr>
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<td></td>
<td>(source World bank)</td>
</tr>
</tbody>
</table>

2.3. SMART BETA STRATEGIES

2.3.1 Overview

Whereas Smart Beta indices are based using a passive (backward looking) methodology, Smart Beta strategies are built on dynamic quantitative approaches. From a very high level point of view, such approaches can be split into two families:

→ **Risk-weighted**: Construction frameworks focus on portfolio risk so as to decrease it. Some very well-known processes have been tested on the equity universe, such as minimum variance and beta-weighted strategies.
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**Efficiency-weighted:** Construction frameworks seek to define a portfolio close to an efficient frontier, whatever the definition of ‘efficient’ (Markowitz, modern portfolio theory, etc). The portfolio building process uses an optimization tool. Among others, mean variance, maximum Sharpe or maximum diversification algorithms belong to this category.

Whereas such methods are quite developed in the equity market, the definition of dynamic smart beta for fixed income encounters several difficulties, from both a technical and practical point of view. At least three of these should be carefully taken into account:

- **Carry** (defined here as the interest income) is one of the main, though not the only, performance drivers in the fixed income universe
- **Duration** is a key consideration in fixed income investing. The lowest-risk portfolio in the long-only fixed income universe is the money market portfolio.
- **Ex-ante risk calculations need efficient tools** and methods that take into account numerous risk factors. Modeling the risk of a bond involves modeling the entire yield curve whereas only one factor is needed for an equity security.

These elements, among others, begin to explain why Smart Beta approaches have not yet emerged on a large scale for fixed income portfolios.

We will focus on certain approaches and develop the pros and cons of the application of these algorithms in a fixed income context. We use ex-ante volatility as a risk measure for the portfolio.

### 2.3.2. Pure risk approaches and examples

Pure risk algorithms focus on the risk of the portfolio without any consideration of return. The most well-known are minimum variance and maximum diversification approaches.

#### 2.3.2.1. Minimum variance (MV)

The objective of the minimum variance approach is to define the lowest-risk portfolio within a specified universe. The weights of the minimum variance portfolio are determined by minimizing ex-ante portfolio risk, as measured by volatility:

\[
\mathbf{w}_{MV}^* = \arg \min_{\mathbf{w}} \{ \mathbf{w}^\top \Sigma \mathbf{w}, \mathbf{w} \in [0,1]^N \}
\]

Where \( \Sigma \) is the variance-covariance matrix and \( \mathbf{w} \) is the weight of each asset in the portfolio.

To apply this to a portfolio we transform the equation into a closed-form solution.

\[
\mathbf{w}_{MV} = \frac{\sum_{i=1}^{N-1} I_i}{\sum_{i=1}^{N-1} I_i N}
\]

One often advocated advantage of the use of the minimum variance approach is that it does not require projections of expected returns, and so is well-suited to situations where such projections are unreliable. A drawback is that it tends to overweight low-volatility constituents, generating highly-concentrated portfolios.

#### 2.3.2.2. Maximum diversification: focus on ‘Risk Parity’ (RP)

Minimum variance approaches often lead to poor diversification through high concentration of each block, such as asset or issuer. The idea behind the maximum diversification approach is to define a new portfolio construction method with the objective of maximizing diversification.
The most commonly used approach is rather logically referred to as max diversification. This uses an objective function introduced by Chouefaty, Y. Coignard, Y. [2008], which maximizes the ratio of the weighted average of the individual volatilities of each of the portfolio's assets to overall portfolio volatility:

$$w_{MD}^* = \arg \max w \in [0,1]^N \left\{ \frac{w^T \Sigma w}{\sqrt{w^T \Sigma w}} \right\}$$

Where $\Sigma$ is the variance-covariance matrix and $w$ is weight of each asset in the portfolio.

This approach aims to build well-diversified portfolios without any assumptions regarding expected returns or even on the total absolute level of risk of the portfolio.

We can obtain the corresponding weights by numerical computation similar to that used for maximum likelihood algorithms.

Another well-known related approach is called risk parity.

The idea behind risk parity is to equalize the contributions to overall risk. This method, formally analyzed in Maillard, S., Roncalli, T. Teiletche J. [2010], is based on the additive decomposition of the volatility of the total portfolio:

$$\sqrt{w^T \Sigma w} = \sum_{i=1}^{N} \frac{w_i (\sum w_i)}{\sqrt{w^T \Sigma w}}$$

The weights are then set so as to equalize the relative contributions of each constituent to total volatility of the portfolio:

$$w_{RP}^* = \arg \min w \in [0,1]^N \left\{ \frac{w (\sum w)}{\sqrt{w^T \Sigma w}} - \frac{1}{N} \right\}$$

The solution of this optimization, that is, determining the portfolio weights, does not have an analytical form (expected for the special case of 2 assets), because the weights are endogenously determined by the risk contribution itself of an asset in the portfolio. The weights must be computed by iteration.

An advantage of the risk parity approach is that it tends to emphasize (overweight) low volatility constituents relative to high volatility ones. It also tends to emphasize constituents with low correlation to the others. This property is also central to the minimum variance portfolio but unlike it, the risk parity approach allocates non-zero weights to all constituents. As a result it tends to be less concentrated than a minimum variance portfolio.

Here again, the goal is to build equally-risk-weighted blocks without any assumptions on the expected return or even on the total risk of the portfolio: The total risk of the portfolio is not defined prior to the determination of the weights.

2.3.3. Application of risk-based approaches to the fixed income universe.

- Pure risk-based strategies
In this section, we apply the pure risk-based methods to the Barclays Euro-Aggregate: Treasury index and we consider the risk at country level. The portfolio is rebalanced at the end of each month from March 2001 to January 2014. Then we compare the historical performance and diversification for the three risk-based indices created by the risk-based methods to each other and to the Barclays market-weighted portfolio (termed “Market”).
The main assumptions are:
- Short selling is not allowed: the resulting portfolio is long each asset or block.
- Ex ante data such as correlation, volatility, and returns are provided by Point™.
- Portfolios are rebalanced monthly.

The algorithms can lead to very different portfolios, as shown in Figure 7.

Figure 7. Asset weights of market value weighted, minimum variance, maximum diversification, and risk parity portfolios as of 31/07/2007.

The correlation among constituents in this example is high, between 0.95 and 1. The solutions of the risk parity portfolio and of the maximum diversification portfolio are therefore approximately proportional to the inverse of their volatility: as a result the higher (lower) the volatility of a component, the lower (higher) its weight in the portfolio.

By contrast, minimum variance weights are proportional to the inverse of variance. As a result, the portfolio based on this criteria is more concentrated in the low volatility components than the two other risk-based portfolios.

Figure 8. Risk based monthly ex ante volatility

Source Point™ and Natixis AM
Figure 8 shows the resulting monthly ex ante volatility of the risk-based portfolios. Unsurprisingly, the minimum variance portfolio exhibits the lowest volatility, whereas the market weighted portfolio typically has the highest volatility during the studied period.

Exhibit 9 displays the cumulative performance of the three risk-based portfolios, as well as the Barclays market value weighted index from 2002 to 2014.

The results are not surprising, as performance is not the explicit goal of risk-based portfolio construction. All three risk-based portfolios would have underperformed the market portfolio. Indeed, bond managers tend to focus on bond duration analysis rather than bond volatility when considering risk.

We consider the first-order approximation of a bond return relative to yield change:

\[
\frac{dP}{P} \approx -D \cdot dR
\]

Bond volatility can be viewed as a simple product of the duration and yield volatility. As the risk-based methods aim to produce lower portfolio volatility, the resulting portfolio durations are lower for the risk-based approaches than for the market weighted portfolio (see figure 10). For example, risk parity tends to overweight low-duration constituents relative to high-duration securities. Without duration constraints, duration of the portfolio is only an output of the risk-based algorithm. There is no a priori choice for overall duration.
This graph demonstrates the underperformance of risk-based versus market value-weighted indices. From 2001/2002 to 2014, the general decline in interest rates meant that lower duration implied lower return.

**What about diversification?**

The traditional view is that the inclusion of more securities in the portfolio implies better diversification and lower risk. However, the relatively low number of securities in maximum diversification and minimum variance portfolios illustrates that risk reduction can be best achieved by selecting fewer, less-correlated and less-risky securities, rather than just adding more securities.

Figure 10 shows that from January 2003 to end of 2008, the long-only minimum variance portfolio has nine of its ten assets weighted from zero and only 1%. The maximum diversification weights range from zero to 40%. This difference is due to the nature of their objective functions: minimum variance is proportional to variance and maximum diversification is proportional to the volatility.

A lower concentration for risk parity does not mean the portfolio exhibits less ex ante risk than the other two risk-based portfolios. Minimum-variance has the lowest ex ante-risk, but also the lowest diversification. Because asset blocks are closely correlated in the fixed income asset class, the minimum variance algorithm leads to a portfolio composed of only the less-risky assets. Lacking any constraints, the corresponding portfolio could be built with only one asset block.

Changes in volatility and correlation among country blocks have a high impact on the portfolio building methods, except for the market value-weighted method. Minimum variance and maximum diversification portfolios are the most sensitive to these market conditions.
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Figure 12 plots the correlation between the Italy block with respect to others blocks.

As we shall see, the risk parity portfolio seems close to the equal-weighted. It shows that the risk parity portfolio lies somewhere between the between equally-weighted portfolio and the minimum variance portfolio (Maillard, Roncalli, and Teiletche, 2010).

As a conclusion we can summarize the pro and cons for pure risk-based approaches applied to the fixed income universe.

<table>
<thead>
<tr>
<th>Risk based Approaches</th>
<th>Pro</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Variance</td>
<td>→ Analytical solution</td>
<td>→ Very sensitive to volatility estimation</td>
</tr>
<tr>
<td></td>
<td>→ Risk minimization</td>
<td>→ Low diversification</td>
</tr>
<tr>
<td></td>
<td></td>
<td>→ Does not control risk budget</td>
</tr>
<tr>
<td>Maximum Diversification</td>
<td>→ Analytical solution</td>
<td>→ Less sensitive to volatility estimate relative to market value weighted</td>
</tr>
<tr>
<td></td>
<td>→ Good risk diversification</td>
<td>→ Does not control risk budget</td>
</tr>
<tr>
<td>Risk Parity</td>
<td>→ Risk contribution control</td>
<td>→ No analytical solution</td>
</tr>
<tr>
<td></td>
<td>→ Best risk diversification</td>
<td>→ Less sensitive to volatility estimate relative to market value weighted</td>
</tr>
<tr>
<td></td>
<td>→ A good initial portfolio to apply leverage and to retain diversification advantage.</td>
<td></td>
</tr>
</tbody>
</table>

The fundamental and common property for all three risk-based portfolios is that they do not rely on the expected return assumption but only on variance/covariance estimates. Without any control on overall duration, the portfolios resulting from these algorithms are not duration-neutral relative to the market or to the portfolio manager’s projected changes in interest rates.

Adding active views to the risk parity approach: ‘Enhanced Risk Parity’

Standard risk-based portfolio construction methodologies do not integrate a risk target. To improve portfolio robustness, we introduce an enhanced risk parity portfolio in which we exploit volatility leverage to meet a double goal: to outperform the market value weighted portfolio and to take advantage of the diversification characteristics of the risk parity portfolio.

For illustration, we construct a portfolio that is as close as possible to the risk parity portfolio, while having a pre-defined volatility level as a constraint, or portfolio risk
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budget: the weights are obtained by constraining the volatility of the portfolio to that of the market value-weighted portfolio. For comparison purposes, we maintain a requirement, or constraint, that the portfolio be fully invested.

Figure 13 shows the enhanced risk parity asset weights and the cumulative performance for all portfolios.

Compared to the first three risk-based portfolios, the enhanced risk parity performance is much closer to the market value-weighted portfolio and outperforms the standard risk parity portfolio. This outperformance of the standard risk parity portfolio comes with additional risk, but as we have chosen the risk constraint, it is by definition an acceptable level of risk. A future improvement to this approach could be to update the risk budget on a regular basis depending, for example, on the risk appetite of the active portfolio manager or client under prevailing market conditions.

2.3.4. Mean-variance optimization: the special case of the Max Yield@Risk approach

Standard mean-variance optimization approaches exhibit well-known weaknesses, especially when applied to the fixed income universe. The most important ones are:

- Classical mean-variance portfolio approach aims to add ‘return’ to a pure risk-based methodology. The idea is to optimize the Sharpe ratio rather than the risk. The main and well-known difficulty, far removed from the technical ones, is to define the return used in the algorithm. For example, in a standard Markovitz portfolio algorithm, projections of returns are often estimated by using past performances of assets or blocks.

- The use of ex-ante risk measures in the fixed income universe, where modelling the market is more complex than for the equity market, requires costly methods and tools.

- In standard mean-variance portfolio construction methods, as for the pure risk-based approach, duration is a result produced by the algorithm and not an input: there is no control of the final duration of the portfolio.
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Our objective is not to explain the already well-known mean-variance approach, but to show how it can be adapted to fixed income by taking specific characteristics such as duration control or carry return into account.

As we have shown previously\(^5\), carry (ie, interest income) is a key consideration for fixed income returns. Carry represented about 80% of total returns over the ten-year period studied across all major fixed income asset classes and currencies.

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Total Return</td>
<td>5.09%</td>
<td>5.26%</td>
<td>4.85%</td>
<td>4.77%</td>
<td>4.82%</td>
<td>4.68%</td>
<td>4.71%</td>
<td>8.19%</td>
<td>1.96%</td>
</tr>
<tr>
<td>Annualized Price Return</td>
<td>0.98%</td>
<td>1.20%</td>
<td>0.99%</td>
<td>0.88%</td>
<td>0.15%</td>
<td>0.49%</td>
<td>0.67%</td>
<td>1.04%</td>
<td>0.56%</td>
</tr>
<tr>
<td>Annualized Carry effect (without Reinvestment)</td>
<td>4.02%</td>
<td>4.00%</td>
<td>3.82%</td>
<td>3.81%</td>
<td>4.37%</td>
<td>4.37%</td>
<td>3.78%</td>
<td>7.39%</td>
<td>1.39%</td>
</tr>
</tbody>
</table>

Source: Eulive.barclay.com

Using this well-known characteristic of the market, we define a Max Yield@Risk process under specific constraints.

This approach can be considered as maximum Sharpe-like, where the tradable universe is given by a selected market cap index.

- Expected return is represented by the yield-to-maturity of the portfolio in order to intelligently take into account the high contribution of carry to fixed income total return.
- Specific constraints are applied such as maximum ex ante tracking error, fixed duration, diversification, etc.

\[
\text{Max Expected Carry} \quad \text{Min Ex Ante volatility} \\
\text{Max Yield@Risk optimization parameters} \\
\text{Ex Ante TE constraint} \\
\text{Ex Ante volatility parameters} \\
\text{Max} \left( x^T \cdot (R - \lambda(q+x))^T \cdot V \cdot (q+x) \right) \\
\begin{align*}
& x^T \cdot 1 = 0 \\
& u.c. \quad x^T \cdot V \cdot x \leq \text{TE}_{\text{max}} \\
& x^T \cdot D = 0
\end{align*}
\]

There are numerous advantages to this approach:

- The approach is easy to understand and easy to implement using standard optimizers.
- The choice of duration is implicitly made by using a market cap index to define the tradable universe. The duration is then managed by setting a limit to the ‘relative to market cap index’ sensitivity.
- The deviation from the market cap benchmark is limited by the use of ex ante tracking error constraints. Risk is therefore a user-defined parameter.
- Other constraints can be added to ensure good diversification, such as constraints by country, liquidity score, issuer etc.

\(^5\) Please see “Managing Fixed Income portfolio in a rising rate environment” 04/2013, Natixis Asset Management
The robustness of the Max Yield@Risk process has been tested using the Point™ Optimizer on several Barclays market cap universes and with several sets of constraints. It exhibits good performance.

**Figure 14. Max Yield@Risk on Euro Treasury 500MM**

Source: NAM & Point™ - no transaction costs

Figure 14, max yield@risk approach has been tested on the Euro Treasury index with a 100 bps TE limit and an “a priori” liquidity filter where less liquid European countries such as Malta, Luxembourg or Slovenia have been removed.

**Figure 15**

Source: NAM & Point™ - no transaction costs

On a US corporate bond universe (Figure 15), we used LCS by issue (below 1.5) and turn over limits (below 37%) with a 100 bps maximum TE.

Finally, figure 14 shows the back test of a Max Yield@Risk process as tested on the Barclays Global Treasury Index.

**Figure 16. Example of Max yield@Risk process on a Global Treasury universe**

Source: Point™ & NAM
We define absolute risk by minimizing the portfolio variance and relative risk by setting a limit on tracking error. Controlling both the absolute and the relative risk decreases any potential drawdown compared to the benchmark without much change in the Sharpe ratio.

<table>
<thead>
<tr>
<th>01/01/2004 - 28/02/2014</th>
<th>Max Yield@Risk No ex ante TE max</th>
<th>Max Yield@Risk ex ante TE max=150 bps/year</th>
<th>Barclays Global Treasury</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return</td>
<td>6.33%</td>
<td>6.15%</td>
<td>4.40%</td>
</tr>
<tr>
<td>Ex post volatility</td>
<td>5.91%</td>
<td>6.07%</td>
<td>6.95%</td>
</tr>
<tr>
<td>Ret/vol</td>
<td>1.07</td>
<td>1.01</td>
<td>0.63</td>
</tr>
<tr>
<td>Ex post tracking error</td>
<td>1.93%</td>
<td>1.75%</td>
<td></td>
</tr>
<tr>
<td>Ex post Information Ratio</td>
<td>0.63</td>
<td>0.83</td>
<td></td>
</tr>
<tr>
<td>Max drawdown</td>
<td>-11.71%</td>
<td>-10.33%</td>
<td>-8.82%</td>
</tr>
</tbody>
</table>

Standard performance attribution shows security selection is the main source of performance. This is a direct consequence of applying Smart Beta in the fixed income world without explicit duration and allocation choices. (Duration is not here an alpha driver as it is predefined by using a the market capitalization index one).
3

3.1. ADDING ALPHA TO PURE-BETA STRATEGIES

As explained in the previous sections, pure Smart Beta strategies exhibit strengths and weaknesses and are more difficult to implement in fixed income than in equity portfolios. One of the main difficulties is the choice of duration, as duration management is a key consideration in fixed income active management but non-existent in equity models. Another important element in the fixed income universe is the low liquidity for some specific markets or during specific periods, for example European peripherical bonds during 2010 crisis.

At Natixis Asset Management, we choose to add alpha to our Max Yield@Risk Smart Beta strategies. The idea is to mix Smart Beta strengths and Natixis AM’s demonstrated fixed income skills.

We also propose to add active views into max yield@risk algorithm: we named this new portfolio construction framework ‘Enhanced Beta®’. From this approach we expect the following:

- To include liquidity criteria in portfolio construction to avoid liquidity squeezes in the implementation and management of actual portfolios
- To control global duration and/or volatility and consequently limit any potential drawdowns
- To smooth and increase the actual performance of the portfolios thanks to documented and recognized skills of active portfolio managers

3.2. FROM SMART BETA TO ENHANCED BETA®

3.2.1. Overview

Natixis Asset Management has tested the definition of a dynamic Smart Beta, which we have named ‘Enhanced Beta®’, based on two steps. The first assumption is that the investment universe (the beta) has already been defined in phase zero:

The choice of a traditional beta, such as either a standard or self-defined index, is the key for the process:

- This universe can be used as a comparison, or benchmark, for the Enhanced Beta® method
- Considering the duration of the universe is a good way to a priori define the target duration of the portfolio without any other subjective element
- The components of the chosen universe help to define the liquidity of the final portfolio
From Smart Beta to Enhanced Beta® in the fixed income world

When the reference universe has been identified, the central concept is to improve the Max Yield@Risk approach (phase one) by adding active views to the optimization algorithm (phase two).

By adding Natixis AM views to the Max Yield@Risk optimization, we expect to not only increase the effective excess return but to smooth realized performance and to limit the high turnover coming from the pure optimization framework. That is, increase performance while decreasing risk and decreasing trading and liquidity costs.

From a purely practical and general point of view, we ask the optimizer to identify the portfolio within the universe which:

- Presents a higher current yield and lower volatility
- Remains within a defined ex ante tracking error limit
- Respects the over/under exposures corresponding to Natixis AM’s active views

**Enhanced Beta® = Max Yield@Risk + Natixis AM views**

3.2.2. Back-test and numerical application

As an illustration, we apply the Enhanced Beta® process to the Barclays G4 universe hedged in Euro. The portfolio is rebalanced each month using an Enhanced Beta® algorithm to incorporate the updated monthly views of Natixis AM’s active portfolio management in G4 and European sovereign debt selection. Monthly views are translated into duration buckets or relative market weight translating G4 view into duration constraints.

<table>
<thead>
<tr>
<th>views</th>
<th>Min contributed duration</th>
<th>Max contributed duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-0.5</td>
<td>-0.25</td>
</tr>
<tr>
<td>-1</td>
<td>-0.25</td>
<td>-0.125</td>
</tr>
<tr>
<td>0</td>
<td>-0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>+1</td>
<td>0.125</td>
<td>0.25</td>
</tr>
<tr>
<td>1</td>
<td>0.25</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Translating sovereign debt views and selection into duration constraints

<table>
<thead>
<tr>
<th>views</th>
<th>Exposure range in % of the sensitivity of each country</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>-100%</td>
</tr>
<tr>
<td>-1</td>
<td>-50%</td>
</tr>
<tr>
<td>0</td>
<td>-10%</td>
</tr>
<tr>
<td>1</td>
<td>10%</td>
</tr>
<tr>
<td>2</td>
<td>25%</td>
</tr>
</tbody>
</table>

In this case, the duration of the resulting portfolio is only a consequence of the G4 views. For instance, if all the G4 views are negative, portfolio duration will be lower than the benchmark duration. At the same time, sovereign debt selection views are duration-neutral: The German bucket is used as the financing asset because of its size in the European sovereign market.

Figures have been computed using Point™.
From Smart Beta to Enhanced Beta® in the fixed income world

<table>
<thead>
<tr>
<th>From 01/01/2007 to 01/05/2014</th>
<th>Max yield@risk G4 (Hedged EUR) TE max = 150 bps</th>
<th>Enhanced Beta® G4 (Hedged EUR) TE max = 150 bps</th>
<th>Barclays Global G4 (Hedged EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualized Return</td>
<td>5.65%</td>
<td>5.16%</td>
<td>4.37%</td>
</tr>
<tr>
<td>Ex post volatility</td>
<td>3.15%</td>
<td>3.04%</td>
<td>3.00%</td>
</tr>
<tr>
<td>Ret/vol</td>
<td>1.79</td>
<td>1.7</td>
<td>1.46</td>
</tr>
<tr>
<td>Ex post Tracking Error</td>
<td>1.33%</td>
<td>0.71%</td>
<td></td>
</tr>
<tr>
<td>Ex post information ratio</td>
<td>0.96</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>Max DrawDown</td>
<td>4.20%</td>
<td>3.83%</td>
<td>3.71%</td>
</tr>
</tbody>
</table>

Overall, the objectives we were achieved:

- The ex post information ratio was improved compared to pure Max Yield@Risk approach.
- Return was increased without a significant decrease in return on volatility ratio compared to the Max Yield@Risk process.
- As shown in the previous diagrams, Enhanced Beta®’s excess returns are considerably smoother than those of the Max Yield@Risk one.
- The maximum draw-down was lower for the Enhanced Beta® construction than for the Max Yield@Risk portfolio: the portfolio manager’s skills are critical to this process in order not to destroy the value coming for the Max Yield@Risk. It decreases the overall risk and improves the liquidity.
CONCLUSION

ENHANCED BETA® – AN IMPROVED AND REPEATABLE PROCESS

We have argued in this document that even if the Smart Beta approach is quite developed in the equity world, its adaptation to the fixed income markets faces numerous difficulties, of which portfolio risk or duration control are the most significant. However, using simple approaches such as optimization under duration and tracking error constraints applied to traditional yield management provide interesting and stable results. We call this the Max Yield@Risk process.

We definitively conclude that adding our active management skills to this quantitative approach delivers an improved and more ‘intelligent’ asset management process: Enhanced Beta®.

As risk and stable reward are at the heart of the portfolio construction framework, Max Yield@Risk and Enhanced Beta® methodologies fall within the context of the Durable Portfolio Construction approach as defined by Natixis Global Asset Management.
REFERENCES

Towers Watson, July 2013. Understanding Smart Beta.
Research Affiliates, Memo 2014 on RAFI indices Citi, Dec 2012. RAFI Sovereign Developed Markets Bond Index Factsheet.
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