Bloomberg Fixed Income Optimization Methodology Supplement

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Introduction

This methodology supplement ("Methodology Supplement") for the Bloomberg Fixed Income indices (the "Indices" and each, an "Index") has been made available by Bloomberg Index Services Limited ("BISL") and supplements the index factsheet and base rules for the Bloomberg Fixed Income family of indices (together, the "Base Methodology") as may be updated from time to time and which can be found on the website here: https://www.bloomberg.com/professional/product/indices/

This Methodology Supplement provides the details of an alternative process by which customized indices may use an algorithmic optimization approach to calculate index composition.

Capitalized terms used in this Methodology Supplement but not otherwise defined have the meaning set forth in Appendix I (Glossary).

Section 1: Construction

With respect to each Determination Date, d, a set of Optimized Weights is determined by the Index Administrator by finding a solution to the Optimization Problem specified by the selected Objective Function, Weight Bounds and Constraints.

Should the optimizer fail to find a solution that satisifes the specified constraints on a given Determination Date, the optimization problem shall be iteratively modified following the specified constraint relaxation process and the optimization algorithm re-run until either a solution is found or the relaxation process is exhausted.

Objective Functions

The Objective Function defines the property of the Optimized Weights that should be either minimised or maximised, subject to the Weight Bounds and Constraints. An Index may specify one of the following Objective Functions.

Absolute Deviations from Target Universe

The Absolute Deviations from Target Universe objective function specifies that the optimiser seeks to minimise the total absolute differences between the Optimized Weights and the Benchmark Index Weights within the restrictions imposed by the Weight Bounds and the Constraints.

Minimize the result of the following function:

$$\sum_{i=1}^{n_d} \left| w_d^i - b_d^i \right|$$

Where:

n_d means the number of Constituents on Determination Date d;

w_d^i means the Optimized Weight of Constituent i on Determination Date d; and

b_d^i means the Benchmark Index Weight of Constituent i on Determination Date d.

Risk Factor Exposure

The Risk Factor Exposure objective function specifies that optimizer seeks to maximize the weighted Risk Exposure through the following expression.

Maximize the result of the following function:

$$\sum_{i=1}^{n_d} w_d^i \times re_d^i$$

Where:

n_d means the number of Constituents on Determination Date d;

w_d^i means the Optimized Weight of Constituent i on Determination Date d; and

re_d^i means the Risk Exposure of Constituent i on Determination Date d.

Weight Bounds

The Weight Bounds define the maximum and minimum weight that can be assigned to each Constituent. Unless otherwise specified for the Index, the Upper and Lower Weight Bounds are set with respect to Determination Date d for each Constituent i as follows:

If Constituent i is an Excluded Constituent:

$$ub_d^i = 0\%$$
$$lb_d^i = 0\%$$

Else:

$$ub_d^i = 100\%$$
$$lb_d^i = 0\%$$

Where:

ub_d^i and lb_d^i mean the Upper and Lower Weight Bounds respectively for Constituent i.

Constraints

Constraints define limitations on the simultaneous assignments of weights to subsets of the Constituents in order to enforce properties on the resultant Index. An Index may specify one or more of the following types of Constraints.

Group Risk Exposure

The Group Risk Exposure constraint ensures thar for each of the specified Groups that the sum of the weighted Risk Exposure of the Constituents belonging to that Group is within lower and upper bounds.

The lower and upper bounds can be specified either as absolute values or relative to the Benchmark Index.

$\forall g \in SelectedGroups_d$,

If ρ_{Type} is 'Absolute':

$$\rho(g)_{Lower} \leq \sum_{i=1}^{n_d} w_d^i \times re_d^i \times IsSec(i,g) \leq \rho(g)_{Upper}$$

The 'Absolute' type of lower and upper bounds may be used on constraints that require that the sum of the weighted Risk Exposure of the Constituents is within a specified set of absolute values independent of the Benchmark Index.

Else if ρ_{Type} is 'Group Scaling':

$\forall\, Constituent_j \in g$,

$$\rho(g)_{Lower} \leq \sum_{i=1}^{n_d} w_d^i \times \widehat{re}_d^i \times IsSec(i,g) \leq \rho(g)_{Upper}$$

Where:

$$\widehat{re}_d^i = \begin{cases} 1 - re_d^j, & Constituent_i = Constituent_j \\ -re_d^j, & Constituent_i \neq Constituent_j \end{cases}$$

'Group Scaling' may be used on constraints that require that the sum of the weighted Risk Exposure of the Constituents is within a specified set of absolute values while the ratio of each Optimized Weight w_d^i within group g relative to its corresponding Benchmark Index Weight b_d^i remains constant.

Else if ρ_{Type} is 'Relative Value':

$$\max\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) - \rho(g)_{Lower}, \rho_{Min}\right) \leq \sum_{i=1}^{n_d} w_d^i \times re_d^i \times IsSec(i,g) \leq \min\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) + \rho(g)_{Upper}, \rho_{Max}\right)$$

Else if ρ_{Type} is 'Relative Coefficient':

$$\max\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) \times \rho(g)_{Lower}, \rho_{Min}\right) \leq \sum_{i=1}^{n_d} w_d^i \times re_d^i \times IsSec(i,g) \leq \min\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) \times \rho(g)_{Upper}, \rho_{Max}\right)$$

Else if ρ_{Type} is 'Relative Coefficient-Value':

$$\max\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) \times \rho(g)_{Lower}, \rho_{Min}\right) \leq \sum_{i=1}^{n_d} w_d^i \times re_d^i \times IsSec(i,g) \leq \min\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) + \rho(g)_{Upper}, \rho_{Max}\right)$$

Else if ρ_{Type} is 'Relative Value-Coefficient':

$$\max\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) - \rho(g)_{Lower}, \rho_{Min}\right) \leq \sum_{i=1}^{n_d} w_d^i \times re_d^i \times IsSec(i,g) \leq \min\left(\left(\sum_{i=1}^{n_d} b_d^i \times re_d^i \times IsSec(i,g)\right) \times \rho(g)_{Upper}, \rho_{Max}\right)$$

The 'Relative Value', 'Relative Coefficient' and 'Relative Coefficient-Value' type of lower and upper bounds may be used on constraints that require that the sum of the weighted Risk Exposure of the Constituents is within a specified set of bounds relative to the Benchmark Index.

Where:

g means a Group;

$SelectedGroups_d$ means the Groups on which the constraints are applied determined by:

If $\rho_{Selection}$ is 'Excluding':

$$SelectedGroups_d = Groups_d \setminus \rho_{Exclude}$$

Else if $\rho_{Selection}$ is 'Specified':

$$SelectedGroups_d = Groups_d \cap \rho_{Include}$$

$Groups_d$ means the set of Groups in the Benchmark Index on Determination Date d;

n_d means the number of Constituents on Determination Date d;

b_d^i means the Benchmark Index Weight of Constituent i on Determination Date d;

re_d^i means the Risk Exposure of Constituent i on Determination Date d;

$IsSec(i,g)$ means 1 (one) if Constituent i is in Group g, otherwise means 0 (zero);

w_d^i means the Optimized Weight of Constituent i on Determination Date d; and

ρ_{Type}, $\rho_{Selection}$, $\rho_{Exclude}$, $\rho_{Include}$, $\rho(g)_{Lower}$, ρ_{Min}, $\rho(g)_{Upper}$ and ρ_{Max} mean the 'Type', 'Selection', 'Exclude', 'Include', 'Lower', 'Min', 'Upper', and 'Max' Constraint Parameter Values respectively.

Trajectory

On the Initial Determination Date, the Trajectory constraint ensures that a weighted Measure of the Index will be equal to or lower than a specified percentage of the weighted Measure of the Benchmark Index. On subsequent rebalances, the constraint ensures that the weighted Measure of the Index will be equal or lower than the lower of either the specified percentage of the weighted Measure of the Benchmark Index at the time, or the level determined by the specified geometric reduction relative the the weighted Measure of the Benchmark Index at the Initial Determination Date or Base Date.

The weighted Measures of the Index and the Benchmark Index exclude Constituents for which there is no reported or estimated value for the the Measure, and normalise the weightings to the remaining Constituents. For a Determination Date d, the weighted Measures are determined as follows:

$$IM_d = \frac{\sum_{i=1}^{n_d} w_d^i \times m_d^i}{\sum_{j=1}^{n_d} w_d^j \times nonZero\left(m_d^j\right)}$$

and

$$PM_d = \frac{\sum_{i=1}^{n_d} b_d^i \times m_d^i}{\sum_{j=1}^{n_d} b_d^j \times nonZero\left(m_d^j\right)}$$

Where:

IM_d and PM_d mean the weighted Measures of the Index and Benchmark Index respectively on Determination Date d;

n_d means the number of Constituents on Determination Date d;

w_d^i and w_d^j mean the Optimized Weight of Constituents i and j respectively on Determination Date d;

b_d^i and b_d^j mean the Benchmark Index Weight of Constituents i and j respectively on Determination Date d;

m_d^i means the Measure for Constituent i on Determination Date d, where the Measure is specified by the 'Measure' Constraint Parameter Value. For the avoidance of doubt, if there is no reported Measure for Constituent i on Determination Date d, then the value is 0 (zero); and $nonZero\left(m_d^j\right)$ means the value 1 (one) if there is a Measure m_d^j reported for Constituent j on Determination Date d, else the value 0 (zero).

The Trajectory Constraint is then:

$$Trajectory_{d_0}^{Upper} = \min\left(\rho_{Coefficient} \times PM_{d_0}, \frac{\rho_{Decay\ Coefficient} \times PM_{d_0} \times \rho_{Decay}^{\left(\frac{k_d}{\rho_{Periods}}\right)}}{IAF_{d_0}}\right) \times \rho_{Tolerance}$$

$$Trajectory_{d}^{Upper} = \min\left(\rho_{Coefficient} \times PM_{d}, \frac{\rho_{Decay\ Coefficient} \times PM_{d_0} \times \rho_{Decay}^{\left(\frac{k_d}{\rho_{Periods}}\right)}}{IAF_{d}}\right) \times \rho_{Tolerance}$$

From where:

$$0 \leq \sum_{i=1}^{n_{d_0}} \left(m_{d_0}^i - \rho_{Lower} \times Trajectory_{d_0}^{Upper} \times nonZero\left(m_d^i\right)\right) \times w_{d_0}^i$$

$$\sum_{i=1}^{n_{d_0}} \left(m_{d_0}^i - Trajectory_{d_0}^{Upper} \times nonZero\left(m_d^i\right)\right) \times w_{d_0}^i \leq 0$$

And:

$$\sum_{i=1}^{n_d} \left(m_d^i - Trajectory_d^{Upper} \times nonZero\left(m_d^i\right)\right) \times w_d^i \leq 0$$

Where:

d_0 means the Initial Determination Date or Base Date;

PM_d and PM_{d_0} mean the weighted Measures of the Benchmark Index on Determination Dates d and d_0 respectively;

k_d means, with respect to Determination Date d, the number of Determination Dates since the Initial Determination Date or Base Date;

$\rho_{Coefficient}$, ρ_{Decay}, $\rho_{Decay\ Coefficient}$, ρ_{Lower}, $\rho_{Periods}$, and $\rho_{Tolerance}$ mean the 'Coefficient', 'Decay', 'Decay Coefficient', 'Lower', 'Periods', and 'Tolerance' Constraint Parameter Values respectively;

IAF_d means the Inflation Adjustment Factor determined by:

If the Inflation Value is specified:

$$IAF_d = \frac{\sum_{i=1}^{n_d} iv_d^i \times nonZero\left(iv_d^i\right)}{\sum_{i=1}^{n_d} nonZero\left(iv_d^i\right)} \Bigg/ \frac{\sum_{i=1}^{n_{d_0}} iv_{d_0}^i \times nonZero\left(iv_{d_0}^i\right)}{\sum_{i=1}^{n_{d_0}} nonZero\left(iv_{d_0}^i\right)}$$

Else:

$$IAF_d = 1$$

Where:

iv_d^i and $iv_{d_0}^i$ mean the Inflation Values for Constituent i on Determination Dates d and d_0 respectively; and

n_{d_0} means the number of Constituents on Determination Date d_o.

If there is no reported Inflation Value for Constituent i on Determination Date d, then the value is 0 (zero); and $nonZero\left(iv_d^j\right)$ means the value 1 (one) if there is an Inflation Value iv_d^j reported and different from zero for Constituent j on Determination Date d, else the value 0 (zero).

For the avoidance of doubt, k_d has the value 0 (zero) and IAF_d has the value of 1 (one) on the Initial Determination Date, and so the constraint reduces to:

$$ICM_{d_0} \leq \rho_{Coefficient} \times PCM_{d_0} \times \rho_{Tolerance}$$

Turnover from Current

The Turnover from Current constraint ensures that the two-way turnover generated by moving from the current holdings to those of the Optimized Weights does not exceed the specified limit. This constraint does not apply on the Initial Determination Date.

If Determination Date d is not the Initial Determination Date:

If ρ_{Type} is 'Additional to Benchmark':

$$\sum_{i=1}^{n_{d,d-1}} \left|w_d^i - ew_d^i\right| \leq \sum_{i=1}^{n_{d,d-1}} \left|b_d^i - eb_d^i\right| + \rho_{Max}$$

Else (when ρ_{Type} is not specified):

$$\sum_{i=1}^{n_{d,d-1}} \left|w_d^i - ew_d^i\right| \leq \rho_{Max}$$

Where:

ρ_{Type} means the optional 'Type' Constraint Parameter Value;

$d-1$ means, with respect to Determination Date d, the immediately predecing Determination Date;

$n_{d,d-1}$ means the number of unique Constituents in the combined set of Constituents on Determination Dates d and $d-1$;

w_d^i means the Optimized Weight of Constituent i on Determination Date d. For the avoidance of doubt, if Constituent i is not a Constituent on Determination Date d, its Optimized Weight is 0 (zero);

ew_d^i means the current effective, or drifted, optimized weight of Constituent i on Determination Date d determined as follows:

If Constituent i is a Constituent on Determination Date $d-1$:

$$ew_d^i = \frac{w_{d-1}^i \times smv_d^i}{\sum_{j=1}^{n_{d-1}} w_{d-1}^j \times tmv_d^j}$$

Else:

$$ew_d^i = 0$$

Where:

n_{d-1} means the number of Constituents on Determination Date $d-1$;

w_{d-1}^i and w_{d-1}^j mean the Optimized Weights of Constituents i and j respectively on Determination Date $d-1$;

smv_d^i means the Returns Universe Security Market Value in the Index Currency of Constituent i on Determination Date d;

tmv_d^i means the Returns Universe Total Market Value in the Index Currency of Constituent i on Determination Date d;

b_d^i means the Benchmark Index Weight of Constituent i on Determination Date d. For the avoidance of doubt, if Constituent i is not a Constituent on Determination Date d, its Benchmark Index Weight is 0 (zero);

eb_d^i means the current effective, or drifted, Benchmark Index weight of Constituent i on Determination Date d determined as follows:

If Constituent i is a Constituent on Determination Date $d-1$:

$$eb_d^i = \frac{b_{d-1}^i \times smv_d^i}{\sum_{j=1}^{n_{d-1}} b_{d-1}^j \times tmv_d^j}$$

Else:

$$eb_d^i = 0$$

Where:

n_{d-1} means the number of Constituents on Determination Date $d-1$;

b_{d-1}^i and b_{d-1}^j mean the Benchmark Index Weights of Constituents i and j respectively on Determination Date $d-1$; and

ρ_{Max} means the 'Max' Constraint Parameter Value.

Appendix I: Glossary

Terms used in this Methodology Supplement that are either not already defined in, or extend those in, the Base Methodology.

Base Methodology	The Bloomberg Fixed Income Index Metholdogy. https://www.bloomberg.com/professional/product/indices/
Measure	The specified data to be used in the Trajectory constraint.
Constituent	The securities in the Benchmark Index, grouped by Ticker.
Constraint	A condition that solutions to the Optimization Problem must satisfy.
Constraint Parameter Value	With respect to a Constraint, the value specified for a named parameter.
Credit Cluster	A set of credit quality ratings.
Determination Date	A date on which the Optimized Weights are determined for a rebalance.
Excluded Constituent	A Constituent excluded from the Index due to the exclusion criteria.
Group	A partition of Constituents, chosen by a specific and common set of characteristic.
Index Base Date	The first date on which an Index has a value.
Initial Determination Date	The first date on which Optimized Weights are determined for the Index.

Objective Function	The property of the Optimized Weights that the Optimization Alorithm seeks to either minimize or maximize.
Optimization Problem	Together the Benchmark Index, Constituents, Objective Function, Weight Bounds and Constraints.
Optimized Weight	The weight of each Constituent, together the Index weights, determined by finding a solution to the Optimization Problem.
Benchmark Index Weight	The weights of the Constituents in the Benchmark Index.
Risk Exposure	A risk attribute of the Constituent.
Uplift Constituent	With respect to a Determination Date, the securities in the Uplift Index.
Weight Bounds	The upper and lower limits for the Optimized Weight of each Constituent.

Appendix II: Fields Description

Fields required in addition to those laid out in the Base Methodology for the application of optimization constraints.

Constraint	Field	Description
Green Revenue	CT_TOTAL_MAX_REV	This field represents the total of all revenues derived from any of the six environment impact themes including alternative energy, energy efficiency, green building, pollution prevention, sustainable water, or sustainable agriculture

Version Control

Version	Reviewer	Review Date	Comments
1			

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