DEUTSCHE BÖRSE

Guide to the Deutsche Börse EUROGOV® Indices

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General Information

In order to ensure the highest quality of each of its indices, Deutsche Börse AG exercises the greatest care when compiling and calculating fixed income indices on the basis of the rules set out in this guide.

However, Deutsche Börse AG cannot guarantee that the various indices, or the various ratios that are required for index compilation and computation purposes, as set out in this guide, are always calculated free of errors. Deutsche Börse AG accepts no liability for any direct or indirect losses arising from any incorrect calculation of such indices or key figures.

Decisions concerning the way its fixed income indices are calculated, as well as regarding their compilation, are always taken by Deutsche Börse AG to the best of its knowledge and belief. Deutsche Börse AG monitors the execution of the index calculation rules on an annual basis in order to ensure the validity of the index methodology. Deutsche Börse AG may decide to undertake a broad market consultation for this purpose. Once a decision on a significant index methodology change is made, a notification will be issued for public comment with a reasonable notice period. Deutsche Börse AG shall not be liable for any losses arising from such decisions.

The fixed income indices of Deutsche Börse AG do not represent a recommendation for investment of whatever nature. In particular, the compilation and calculation of the various indices shall not be construed as a recommendation of Deutsche Börse AG to buy or sell individual securities, or the basket of securities underlying a given index.

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January 2011	Introduction Deutsche Börse EUROGOV® France Indices
Novermber 2011	Modification of calculation rules for Deutsche Börse EUROGOV® Germany Money Market Index in order to cap the average residual life of the Index to 6 months
October 2013	Introduction cost factor
December 2014	Clarification relating to IOSCO principles
October 2017	Include liquidity requirements
October 2018	Change of cap level, minimum requirements for cash in the Money Market Index and cost factor formula

1 EUROGOV® Indices – Overview

The EUROGOV® indices family reflects the market for fixed income bonds denominated in Euro, by taking into account market data from Tradeweb®. Deutsche Börse is responsible for the calculation and distribution of the various indices. The indices are designed as selection indices and measure the investment performance in the market segment of highly liquid government bonds in the Eurozone.

In the field of German government bonds, the Deutsche Börse EUROGOV® Germany Money Market index measures the investment success for highly liquid government bonds of the Federal Republic of Germany in the money market segment.

The selection criteria for EUROGOV Germany indices guarantee high liquidity of the underlying bonds and easy replicability of the indices.

2 EUROGOV® Index Rules

2.1 Index concept

For the EUROGOV® indices (except for Germany EUROGOV® Money Market) bonds with a maturity of at least one year are considered. Therewith the medium- and long-term segments of the capital market are covered.

EUROGOV® Germany Money Market includes bonds with a remaining maturity of at least two months and a maximum of one year representing the money market segment.

For index admission, the minimum outstanding volume of bonds is €4bn. Zero bonds are excluded from the indices.

2.2 Calculated Indices

For all countries, the following maturity buckets[1] are calculated and distributed: 1-3, 3-5, 5-10, and over 10 years.

For German government bonds, the maturity range between two months and one year (Money Market) is calculated additionally.

2.3 Basis

The base date of EUROGOV® indices is 31 January 1999 with a base value of 100.

2.4 Review of index composition

The composition of the EUROGOV® indices is reviewed quarterly (end of January, April, July and October) except for the EUROGOV® Germany Money Market index which is adjusted monthly. The adjustment is carried out described as follows.

1. Selection of bonds

   All bonds that meet the index criteria at the rebalancing date (end of month) represent the universe of eligible bonds.

2. Adjustment of index composition

   Each bond is assigned to the corresponding indices according to the classification criteria. The eligibility for a selection index is determined on the basis of a ranking list. For each index, all eligible bonds are ranked according to outstanding nominal issue size. In case of equal outstanding issue sizes, priority is given to the newer

[1] Each inclusive maturity-minimum level and exclusive maturity-upper limit.

bond. The EUROGOV® indices contain maximum the first 15 bonds of this ranking list. In case there are less than 15 bonds satisfying the inclusion criteria, they all are included in the index.

3. Adjustment of the weighting of bonds

   A bond is weighted in the index based on its market capitalization. Changes of the outstanding nominal volume in the index are adjusted during the review of the index composition.

4. Cap Limit

   Capping is a procedure that restricts the weighting of index constituents and prevents single bonds from dominating the index. The weight of a bond in the index is capped to 25 percent at the rebalancing date. In case 4 or fewer bonds satisfy the admission criteria of an index, included bonds are weighted equally.
   For EUROGOV® Germany Money Market-Index special weighting rules apply. For details, see section 3.3.

5. Liquidity requirements

   For the bond indices, no explicit liquidity filter is applied. The applied selection criteria of the index constituents facilitate the selection of liquid constituents due to filtering by issuer, country as well as minimum nominal amount outstanding for a bond. Consequently, stricter constraints on the selection criteria favour the selection of the most liquid constituents for the index.

2.5 Index calculation

2.5.1 Calculation times and frequency

The indices are calculated and distributed every minute between 9 a.m. and 5 p.m. CET. Index calculation is based on the Xetra® trading calendar.

2.5.2 Settlement Convention

All EUROGOV® indices are calculated assuming t+0 settlement.

2.5.3 Publication

Deutsche Börse AG® publishes daily closing index levels and analytics on its web pages.

All data related to the new index composition is published online by Deutsche Börse AG in the evening of the index rebalancing.

2.5.4 Index correction policies

2.5.4.1 Internal errors

If Deutsche Börse AG becomes aware of internal index calculation errors within a trading day, intraday values of the respective index are corrected for that specific day, if technically feasible and economically reasonable. Intraday values, which are not detected within the same trading day are not corrected but will retroactively be flagged as invalid.

If there are deviations that are considered significant by Deutsche Börse AG, index close values also will be corrected retroactively, if technically feasible and economically reasonable.

2.5.4.2 External errors

Calculation errors based on incorrect external data are corrected as soon as possible, if technically feasible and economically reasonable. If there are deviations that are considered significant by Deutsche Börse AG, index close values will also be corrected retroactively, if technically feasible and economically reasonable. Intraday values that are not corrected will retroactively be flagged as invalid.

2.5.4.3 Correction of index parameter values

All index parameters that are published by Deutsche Börse AG in the context of the index review are only corrected or adjusted at the subsequent rebalancing date. This rule applies regardless of when Deutsche Börse AG became aware of facts that would have changed the index parameter values during the index review process.

2.5.5 Exceptional rules

2.5.5.1 Handling of unforeseeable events

In the case of an exceptional unforeseeable event that is not considered in this rulebook, Deutsche Börse AG will consider the respective facts and may apply procedures that differ from the aforementioned rules in this rulebook. This holds true especially in cases where i) there are no applicable rules, ii) the application of present rules does not lead to a clear result, iii) the rules contradict each other, and/or iv) the application of these rules lead to an inappropriate situation in the bond market. An example of an inappropriate situation is if the strict application of the rules heavily influences the liquidity of a bond emission in the government bond market. In the case that Deutsche Börse AG makes a decision that is outside the scope of the rulebook, this decision will be published within an appropriate notice period.

2.5.5.2 Consideration of extreme economic situations and market disruptions

In times of extreme economic situations and market disruptions, especially in cases where the price source is unavailable (e.g. market suspension or restriction), Deutsche Börse AG will generally use the last available price data.

Also in times of extreme economic cases, additional exceptions from this rulebook can be made, e.g. postponement of an ordinary index review.

All such changes will be published within an appropriate notice period.

2.5.6 Index Termination Policy

For the termination of an index or an index family for which outstanding products are present in the market, to the knowledge of Deutsche Börse AG, a market consultation will be initiated by Deutsche Börse AG to take into account the market participants' views and concerns related to the termination. A consultation period will be opened. Its duration depends on the specific issue. The length of the consultation period will vary based on the specific issues of each proposed termination. During the consultation period, clients are able to share their concern regarding the termination. Based on the collected feedback, Deutsche Börse AG may rethink its decision to terminate an index or an index family. At the end of the consultation period, Deutsche Börse AG will publicly announce its final decision about the termination. In case of termination a transition period will be granted.

For the termination of an index or index family for which, to the knowledge of Deutsche Börse AG, there are no listed financial products on the market, no market consultation will be conducted.

A decision to terminate an index will be communicated to the public within an appropriate notice period.

3 Index Formula

The EUROGOV® indices are calculated as so-called basket indices, implying that each index is based on real bonds. This makes it easy to track the index performance[2].

The indices are based on a volume weighted summation concept that analyzes relative changes in value compared to a reference date. The composition and volume of the index portfolio are adjusted at this date. Therefore, corresponding adjustments to index tracking portfolios are only required only at the respective reference date. The outstanding issue size of each bond is used for index weighting.

To ensure the continuous update of the indices, Deutsche Börse® calculates price and total return indices based on bid quotes. Newly issued bonds enter the indices with the last known binding ask quote from the previous month. These bid and ask quotes are binding, non-indicative quotes and provide high quality information about the current price level.

Bonds which are already in the index and whose weight increases as a result of rebalancing are valued at the bid price. In reality if a portfolio manager would track the index, those bonds will be purchased at the ask price, which implies tracking cost. In order to offset this effect and to reflect the costs accordingly, a cost factor is applied to the price and total return indices.

3.1 Price Index

Price indices are calculated as follows:

$$PI_t = PI_{t-m} \cdot \frac{\sum_{i=1}^{n} P_{i,t} \cdot N_{i,t-k}}{\sum_{i=1}^{n} P_{i,t-s} \cdot N_{i,t-k}} \cdot CF_{PI}$$

Whereby: $$CF_{PI} = \frac{\sum_{i=1}^{n} N_i^+ \cdot P_i^B}{\sum_{i=1}^{n} N_i^- \cdot P_i^B} \cdot \frac{\sum_{i=1}^{n} N_i^- \cdot P_i^{B/A}}{\sum_{i=1}^{n} N_i^+ \cdot P_i^{B/A}}$$

2 The calculation methodology applied for EUROGOV® indices is in line with the standards laid down by the "European Federation of Financial Analysts Societies" (EFFAS). For a detailed overview, cf. Patrick J. Brown (2002): "Constructing and Calculating Bond Indices – A Guide to the EFFAS European Bond Commission Standardized Rules", 2nd Edition, Cambridge, England, 2002.

$$P_i^{A/B} = \begin{cases} P_i^A, & \dfrac{N_i^+ \cdot P_i^B}{\sum_{i=1}^n N_i^+ \cdot P_i^B} > \dfrac{N_i^- \cdot P_i^B}{\sum_{i=1}^n N_i^- \cdot P_i^B} \Leftrightarrow w_i^+ > w_i^- \\ P_i^B, & \text{else} \end{cases}$$

3.2 Total Return Index

For total return indices, the monthly adjustment involves the reinvestment of coupon payments in the overall portfolio at the reference date fixed for any adjustment of the index composition. Consequently, total return indices are calculated as follows:

$$TR_t = TR_{t-m} \cdot \frac{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t} + G_{i,t}\right) \cdot N_{i,t-k}}{\sum_{i=1}^{n} \left(P_{i,t-s} + A_{i,t-s}\right) \cdot N_{i,t-k}} \cdot CF_{TR}$$

Whereby: $$CF_{TR} = \frac{\sum_{i=1}^{n} N_i^+ \cdot \left(P_i^B + A_i\right)}{\sum_{i=1}^{n} N_i^- \cdot \left(P_i^B + A_i\right)} \cdot \frac{\sum_{i=1}^{n} N_i^- \cdot \left(P_i^{B/A} + A_i\right)}{\sum_{i=1}^{n} N_i^+ \cdot \left(P_i^{B/A} + A_i\right)}$$

$$P_i^{A/B} = \begin{cases} P_i^A, & \dfrac{N_i^+ \cdot \left(P_i^B + A_i\right)}{\sum_{i=1}^n N_i^+ \cdot \left(P_i^B + A_i\right)} > \dfrac{N_i^- \cdot \left(P_i^B + A_i\right)}{\sum_{i=1}^n N_i^- \cdot \left(P_i^B + A_i\right)} \Leftrightarrow w_i^+ > w_i^- \\ P_i^B, & \text{else} \end{cases}$$

3.3 Special calculation EUROGOV® Germany Money Market index

3.3.1 Weighting of EUROGOV® Germany Money Market Index

The weighted average time to maturity of EUROGOV® Germany Money Market index should not exceed 6 months. Whenever this happens and under consideration of the capping level of 25% per bond, the index requires further adjustments.

At each rebalancing, the EUROGOV® Germany Money Market index consist of minimum 16% cash.

The following weighting mechanism is implemented to fulfil both the residual life and weight constraints:

1. Selection of the first 15 bonds by notional outstanding

a. The weight of the cash component is set to 16%, the rest 84% are redistributed to the bond constituents:

$w_{cash} = 16\%$

$w_i^{std} = \frac{N_{i,t-s} \cdot (P_{i,t-s} + A_{i,t-s})}{\sum_i^n N_{i,t-s} \cdot (P_{i,t-s} + A_{i,t-s})} \cdot (1 - w_{cash})$

b. The weight of each component is checked against the cap of 25%

$$w_i^{std} < 25\%$$

c. Check that the index YtM (Years to Maturity) does not exceed 0.5

$YtM_{Index}^{std} < 0.5$

$$YtM_{Index}^{std} = \sum_{i=1}^{n} w_i^{std} \cdot YtM_i$$

If both requirements are fulfilled the index weights are defined as $\boldsymbol{w_i^{std}}$; if **1.c.** is not fulfilled the mechanism continues with step **2.**; otherwise the mechanism continues with step **3,** where $w_i^* = w_i^{std}$.

2. The selection from point **1.** undergoes a bucketing process based on Years to Maturity (2 buckets, for YtM above or below 0.5)

a. YtM (YtM_B) for left and right bucket ($\boldsymbol{B} = \{\boldsymbol{L}, \boldsymbol{R}\}$) are calculated, as well as their share of the total market value of the index (w_B).

$$YtM_B = \frac{\sum_{i \in B} N_{i,t-s} \cdot \left(P_{i,t-s} + A_{i,t-s}\right) \cdot YtM_i}{\sum_{i \in B} N_{i,t-s} \cdot \left(P_{i,t-s} + A_{i,t-s}\right)} \cdot (1 - w_{cash})$$

$$w_B = \frac{\sum_{i \in B} N_{i,t-s} \cdot \left(P_{i,t-s} + A_{i,t-s}\right)}{\sum_{i}^{n} N_{i,t-s} \cdot \left(P_{i,t-s} + A_{i,t-s}\right)}$$

b. Scaling factors for the two buckets ($\boldsymbol{wgt_B}$) are calculated in order to cap the average YtM of the index to 0.5

$$wgt_L = \frac{0.5 - YtM_R}{YtM_L - YtM_R}$$

$$wgt_R = 1 - wgt_L$$

c. The selection is rescaled using the respective factors calculated in 2.b. and the adjusted weights, $\boldsymbol{w_i^*}$, are calculated. After that step **3.** is implemented.

$$w_i^* = \frac{w_i^{std} \cdot wgt_B}{w_B}$$

3. The rescaled selection undergoes the capping process if necessary:

a. Each bond's weight is checked and the need for capping is determined

($IsCappedBond_i$).

$$IsCappedBond_i = \begin{cases} 1, & if\ w_i^* > 25\% \text{ (cap to individual bond's weight)} \\ 0, & otherwise \end{cases}$$

b. For each bucket, the sum of weights of the bonds to be capped ($\boldsymbol{SumWeightExceedingBonds_B}$) and the number of bonds being capped is calculated ($\boldsymbol{NrCappedBonds_B}$).

$SumWeightExceedingBonds_B = \sum_{i \epsilon B} w_i^* \cdot IsCappedBond_i$

$$NrCappedBonds_B = \sum_{i \epsilon B} IsCappedBond_i$$

$i \in B$ bond i, element of bucket B

c. Within each bucket, the excess weight ($\boldsymbol{ExceedingWeight_B}$) is proportionally redistributed across the bonds not being capped ($\boldsymbol{w_i^{**}}$) through an $\boldsymbol{AdjFactor_B}$.

$$ExceedingWeight_B = wgt_B.(1 - w_{cash}) - SumWeightExceedingBonds_B$$

$$AdjFactor_B = 1 + \frac{SumWeightExceedingBonds_B - Cap \cdot NrCappedBonds_B}{ExceedingWeight_B}$$

$$w_i^{**} = \begin{cases} Cap, if\ IsCappedBond_i = 1 \\ w_i^* \cdot AdjFactor_B, otherwise \end{cases}$$

This step is iteratively repeated until all bonds in the bucket have a weight not exceeding the cap.

Any residual weight that cannot be allocated without breaching the cap, will be invested in EONIA: this operation is included in step **4**.

4. To ensure that index TtM does not exceed 6 months (could be a consequence of point **3.**), final weights ($\boldsymbol{w_i^{***}}$) are calculated and residual weight is allocated to EONIA ($\boldsymbol{w_{cash}^{***}}$)

$$YtM_{Index}^{**} = \sum_{i=1}^{n} w_i^{**} \cdot YtM_i$$

$$w_i^{***} = w_i^{**} \cdot min\left\{1, \frac{0.5}{YtM_{Index}^{**}}\right\}$$

$$w_{cash}^{***} = 1 - \sum_{i=1}^{n} w_i^{***}$$

$$cash_{t-s} = w_{cash}^{***} \cdot \sum_{i=1}^{n} N_{i,t-s} \cdot \left(P_{i,t-s} + A_{i,t-s}\right) \cdot 100$$

Where:

$i = 1, \ldots, n$

$B = \{L, R\}$ Set of bonds that belong to the bucket with residual YtM up to and including 6 months (L) or above 6 months (R)

$L = \{i: YtM_i \leq 0.5\}$

$R = \{i: YtM_i > 0.5\}$

3.3.2 Calculation of the EUROGOV® Germany Money Market Price Index

The Price Index is calculated taking into account the cash component ($\boldsymbol{cash_{t-s}}$) determined in section 3.3.1.

$$PI_t = PI_{t-m} \cdot \frac{\sum_{i=1}^{n} P_{i,t} \cdot N_{i,t-s} + cash_{t-s}}{\sum_{i=1}^{n} P_{i,t-s} \cdot N_{i,t-s} + cash_{t-s}} \cdot CF_{PI}$$

Whereby: $$CF_{PI} = \frac{\sum_{i=1}^{n} N_i^+ \cdot P_i^B + cash_{t-s}^+}{\sum_{i=1}^{n} N_i^- \cdot P_i^B + cash_{t-s}^-} \cdot \frac{\sum_{i=1}^{n} N_i^- \cdot P_i^{B/A} + cash_{t-s}^-}{\sum_{i=1}^{n} N_i^+ \cdot P_i^{B/A} + cash_{t-s}^+}$$

$$P_i^{A/B} = \begin{cases} P_i^A, & \frac{N_i^+ \cdot P_i^B}{\sum_{i=1}^{n} N_i^+ \cdot P_i^B + cash_{t-s}^+} > \frac{N_i^- \cdot P_i^B}{\sum_{i=1}^{n} N_i^- \cdot P_i^B + cash_{t-s}^-} \\ & \Leftrightarrow w_i^+ > w_i^- \\ P_i^B, & \text{else} \end{cases}$$

3.3.3 Calculation of the EUROGOV® Germany Money Market Total Return Index

For total return index, the monthly adjustment involves the reinvestment of coupon payments in the overall portfolio at the reference date fixed for any adjustment of the index composition. Although the cash component in the index is invested for a period of 1 month until the next rebalancing date (EONIA rate), the change in its value is partially reflected in the daily index performance. Consequently, the Total Return Index is calculated as follows:

$$TR_t = TR_{t-m} \cdot \frac{\sum_{i=1}^{n}\left(P_{i,t}+A_{i,t}+G_{i,t}\right)\cdot N_{i,t-s}+cash_{t-s}\cdot\left(1+r_{t-s}^{1d}\cdot\frac{days_{t-m,t}}{360}\right)}{\sum_{i=1}^{n}\left(P_{i,t-s}+A_{i,t-s}\right)\cdot N_{i,t-s}+cash_{t-s}} \cdot CF_{TR}$$

Whereby:

$$CF_{TR} = \frac{\sum_{i=1}^{n} N_i^+ \cdot (P_i^B + A_i) + cash_{t-s}^+}{\sum_{i=1}^{n} N_i^- \cdot (P_i^B + A_i) + cash_{t-s}^- \cdot \left(1 + r_{t-s}^{1d} \cdot \frac{days_{t-m,t}}{360}\right)} \cdot \frac{\sum_{i=1}^{n} N_i^- \cdot \left(P_i^{B/A} + A_i\right) + cash_{t-s}^- \cdot \left(1 + r_{t-s}^{1d} \cdot \frac{days_{t-m,t}}{360}\right)}{\sum_{i=1}^{n} N_i^+ \cdot \left(P_i^{B/A} + A_i\right) + cash_{t-s}^+}$$

$$P_i^{A/B} = \begin{cases} P_i^A, & \frac{N_i^+ \cdot \left(P_i^B + A_i\right)}{\sum_{i=1}^{n} N_i^+ \cdot \left(P_i^B + A_i\right) + cash_{t-s}^+} > \frac{N_i^- \cdot \left(P_i^B + A_i\right)}{\sum_{i=1}^{n} N_i^- \cdot \left(P_i^B + A_i\right) + cash_{t-s}^- \cdot \left(1 + r_{t-s}^{1d} \cdot \frac{days_{t-m,t}}{360}\right)} \\ & \Leftrightarrow w_i^+ > w_i^- \\ P_i^B, & \text{else} \end{cases}$$

4 Index Analytics

There are several analytics that are calculated in addition to the index values. The following analytics are calculated and distributed for each index separately:

4.1 Average Yield

The average yield is calculated, weighting the yield of each bond by the corresponding market capitalization and duration of the respective bond.

$$RY_t = \frac{\sum_{i=1}^{n} Y_{i,t} \cdot \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}}{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}}$$

4.2 Average Duration

The average duration is calculated, weighting the duration of each bond by the corresponding market capitalization of the respective bond.

$$DU_t = \frac{\sum_{i=1}^{n} D_{i,t} \cdot \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s}}{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s}}$$

4.3 Average Modified Duration

Calculation of the average modified duration is in line with the previously-described calculation process for the average duration.

$$MDU_t = \frac{\sum_{i=1}^{n} MD_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}$$

4.4 Average Convexity

Calculation of the average convexity is in line with the previously described calculation process for the average duration and average modified duration.

$$CX_t = \frac{\sum_{i=1}^{n} X_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}$$

4.5 Average Coupon

The average coupon is calculated, weighting the coupon of each bond by its outstanding issue size.

$$CO_t = \frac{\sum_{i=1}^{n} C_{i,t} \cdot N_{i,t-s}}{\sum_{i=1}^{n} N_{i,t-s}}$$

4.6 Average Remaining Years to Maturity

Calculation of the average remaining years to maturity is in line with the previously-described calculation process for the average coupon (i.e. weighting on the basis of outstanding issue size).

$$LF_t = \frac{\sum_{i=1}^{n} L_{i,t} \cdot N_{i,t-s}}{\sum_{i=1}^{n} N_{i,t-s}}$$

4.7 Nominal Value

The cumulated nominal value of all bonds at time t is calculated as follows:

$$NV_t = \sum_{i=1}^{n} N_{i,t-s}$$

4.8 Market Value

The cumulated market value of all bonds at time t is calculated as follows:

$$MV_t = \sum_{i=1}^{n} \left(P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot CP_{i,t}\right) \cdot N_{i,t-s}$$

4.9 Base Market Value

The cumulated base market value (i.e. market value as at the base date) of all bonds is calculated as follows:

$$MV_0 = \sum_{i=1}^{n} \left(P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}\right) \cdot N_{i,t-s}$$

5 Bond Analytics

There are several bond analytics that are calculated in addition to the index values and index analytics.

5.1 Yield

The yield of a bond at time t is calculated as follows:

$$P_{i,t} + A_{i,t} = \sum_{j=1}^{k} CF_{i,j} \cdot (1+Y_{i,t})^{-L_{i,t,j}}$$

The Newton iteration method is used to solve the equation for $Y_{i,t}$.

5.2 Duration

The duration of a bond at time t is calculated as follows:

$$D_{i,t} = \frac{\sum_{j=1}^{n} CF_{i,j} \cdot L_{i,t,j} \cdot \left(1 + Y_{i,t}\right)^{-L_{i,t,j}}}{\sum_{j=1}^{n} CF_{i,j} \cdot \left(1 + Y_{i,t}\right)^{-L_{i,t,j}}} = \frac{1}{P_{i,t} + A_{i,t}} \cdot \sum_{j=1}^{n} CF_{i,j} \cdot L_{i,t,j} \cdot \left(1 + Y_{i,t}\right)^{-L_{i,t,j}}$$

5.3 Modified Duration

The modified duration of a bond at time t is calculated as follows:

$$MD_{i,t} = D_{i,t} \cdot \frac{1}{1 + Y_{i,t}}$$

5.4 Convexity

The convexity of a bond at time t is calculated as follows:

$$X_{i,t} = \frac{1}{P_{i,t} + A_{i,t}} \cdot \sum_{j=1}^{n} L_{i,t,j} \cdot \left(L_{i,t,j} + 1\right) \cdot CF_{i,j} \cdot \left(1 + Y_{i,t}\right)^{-\left(L_{i,t,j}+2\right)}$$

6 Appendix

6.1 Index Overview

Overview of the EUROGOV® indices

	Index	Alpha (TR)[3]	ISIN (TR)Error! Bookmark not defined.Error! Reference source not found.	Alpha (PR)Error! Bookmark not defined.	ISIN (PR)Error! Bookmark not defined.
Germany	Deutsche Börse EUROGOV® Germany Money Market	3LE2	DE000A0S3QB2	3LEV	DE000A0S3P50
	Deutsche Börse EUROGOV® Germany 1-10	3LE1	DE000A0S3QA4	3LEU	DE000A0S3P43
	Deutsche Börse EUROGOV® Germany 1-3	3LEW	DE000A0S3P68	3LEQ	DE000A0S3P01
	Deutsche Börse EUROGOV® Germany 3-5	3LEX	DE000A0S3P76	3LER	DE000A0S3P19
	Deutsche Börse EUROGOV® Germany 5-10	3LEY	DE000A0S3P84	3LES	DE000A0S3P27
	Deutsche Börse EUROGOV® Germany 10+	3LEZ	DE000A0S3P92	3LET	DE000A0S3P35
France	Deutsche Börse EUROGOV® France 1-10	7D5J	DE000A0YK025	4D0U	DE000A0YKZA4
	Deutsche Börse EUROGOV® France 1-3	7D5I	DE000A0YK017	4D0T	DE000A0YKY95
	Deutsche Börse EUROGOV® France 3-5	7D5K	DE000A0YK033	4D0V	DE000A0YKZB2
	Deutsche Börse EUROGOV® France 5-10	7D5L	DE000A0YK041	4D0W	DE000A0YKZC0
	Deutsche Börse EUROGOV® France 10+	7D5M	DE000A0YK058	4D0X	DE000A0YKZD8

6.2

6.2 List of formula notations and abbreviations

A_i = Accrued interest of bond i on the rebalancing day

$A_{i,t}$ = Accrued interest of bond i at time t

$A_{i,t-s}$ = Accrued interest of bond i on the last trading day of previous month

$C_{i,t}$ = Coupon of bond i at time t

$cash_{t-s}$ = Cash at rebalancing (at the end of last month)

$cash_{t-s}^{+}$ = Cash at rebalancing with the new composition

$cash_{t-s}^{-}$ = Cash at rebalancing with the old composition

$CF_{i,j}$ = Cash flow of bond i within period j

CF_{PI} = Cost factor price index, valid since last rebalancing date

[3] TR = Total Return Index, PR = Price Index

CF_{TR}	=	Cost factor total return index, valid since last rebalancing date
CO_t	=	Average coupon at time t
CX_t	=	Average convexity at time t
$days_{t-m,t}$	=	Calendar days between last calendar day of previous month and t
$D_{i,t}$	=	Duration of bond i at time t
DU_t	=	Average duration at time t
$G_{i,t}$	=	Value of a coupon payment on bond i at time t, made at the coupon date or within the period s. If there has been no payment within the respective month, the value equals zero
i	=	bond i = 1,...,n
k	=	number of future cash flows
$L_{i,t}$	=	Remaining years to maturity of bond i at time t
$L_{i,t,j}$	=	Time (in years) between time t and the cash flow of bond i within period j
LF_t	=	Average remaining years to maturity at time t
$MD_{i,t}$	=	Modified duration of bond i at time t
MDU_t	=	Average modified duration at time t
MV_t	=	Cumulated market value of all bonds at time t
MV_0	=	Cumulated base market value of all bonds
n	=	Number of bonds in the index
N_i^+	=	Outstanding issue size of bond i after rebalancing
N_i^-	=	Outstanding issue size of bond i before rebalancing
$N_{i,t-k}$	=	Notional amount (after capping procedure) of bond i at the time of last rebalancing
NV_t	=	Cumulated nominal value of all bonds at time t
$P_i^{A/B}$	=	Either closing ask or bid quote of bond i depending on the change in the weight resulting from the re-composition
P_i^A	=	Closing ask quote of bond i on the rebalancing day
P_i^B	=	Closing bid quote of bond i on the rebalancing day
$P_{i,t}$	=	Price or quotation of bond i at time t

$P_{i,t-s}$	=	Closing price or closing quotation of bond i on the last trading day of previous month
PI_t	=	Price index value at time t
PI_{t-m}	=	Price index value on the last calendar day of the previous month
r_{t-s}^{1d}	=	EONIA rate at the time of last rebalancing
RY_t	=	Average yield at time t
t	=	Calculation date
t-k	=	Time of the last index rebalancing
t-m	=	Last calendar day of previous month
t-s	=	Last trading day of previous month
TR_t	=	Total return index value at time t
TR_{t-m}	=	Total return index value on the last calendar day of the previous month
w_i^+	=	Weight of bond i after rebalancing
w_i^-	=	Weight of bond i before rebalancing
w_i^{std}	=	indicates the uncapped weight of bond *i*
wgt_B	=	weighting factor of bucket *B*
$X_{i,t}$	=	Convexity of bond i at time t
$Y_{i,t}$	=	Yield of bond i at time t

6.3 our direct Line to Deutsche Börse

- Information on prices, index concepts and index licensing

  STOXX Limited – Customer Support

  Phone: +41 43-430-7272

  Fax: +41 43-430-7272

  Email: customersupport@stoxx.com

- Internet

  www.dax-indices.com

- Mailing Address

  Deutsche Börse AG

  60485 Frankfurt/Main

  Germany