iBoxx EUR Benchmark Index Family

Index Guide

March 2007

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09.08.2002	**Launch** of iBoxx EUR Non-Financials Rating indices
10.07.2002	**Launch** of iBoxx EUR Financials Rating indices
from 01.07.2002	**Exclusion** of sinking funds and amortizing bonds
from 01.07.2002	**Assignment** of iBoxx EUR Other Sovereigns index into the iBoxx EUR Sub-Sovereigns sector

from 01.07.2002	**Investment grade rating** obligatory for all iBoxx EUR Non-Sovereigns bonds (including Jumbo Pfandbriefe)
from 01.07.2002	**Amount outstanding unification** for the iBoxx EUR Sub-Sovereigns index to EUR 1 bn.
from 01.06.2002	**Expansion of iBoxx EUR bond analytics for periodic and annualized key data analogous to the iBoxx GBP index family**
22.11.2001	**Launch of iBoxx EUR Non-Sovereigns, iBoxx EUR Greece and iBoxx EUR Other Sovereigns indices**
18.04.2001	**Launch of iBoxx EUR Corporates and Overall indices**
14.03.2001	**Launch of iBoxx EUR Sub-Sovereigns indices**
14.02.2001	**Launch of iBoxx EUR Collateralized indices**
13.12.2000	**Launch of iBoxx EUR Sovereigns indices**

1. iBoxx EUR Indices

The iBoxx EUR index family[1] is published by International Index Company Limited (IIC) and represents the investment grade fixed-income market for Euro and Eurozone-currency denominated bonds.[2] Prices for all bonds in the indices are provided by ten major financial institutions: ABN AMRO, Barclays Capital, BNP Paribas, Deutsche Bank, Dresdner Kleinwort,Goldman Sachs, HSBC, JP Morgan, Morgan Stanley, Royal Bank of Scotland and UBS Investment Bank. Deutsche Börse calculates and disseminates the indices.

Table 1: iBoxx EUR Benchmark Indices

<table>
<tr><td colspan="4">iBoxx € Index Family
overall and maturity indices (1-3, 3-5, 5-7, 7-10 and 10+ years)</td></tr>
<tr><td colspan="4">iBoxx € Overall
overall and maturity indices</td></tr>
<tr><td>iBoxx € Sovereigns
overall and maturity indices</td><td colspan="3">iBoxx € Non-Sovereigns
overall and maturity indices

iBoxx € Non-Sovereigns Rating Indices
each with overall indices</td></tr>
<tr><td rowspan="2">iBoxx € Eurozone
iBoxx € Germany
iBoxx € France
iBoxx € Italy
each with overall and maturity indices

iBoxx € Austria
iBoxx € Belgium
iBoxx € Finland
iBoxx € Greece
iBoxx € Ireland
iBoxx € Netherlands
iBoxx € Portugal
iBoxx € Spain
each with overall indices</td><td>iBoxx € Sub-Sovereigns
overall and maturity indices</td><td>iBoxx € Collateralized
overall and maturity indices</td><td>iBoxx € Corporates
overall and maturity indices</td></tr>
<tr><td>iBoxx € Sub-Sovereigns Rating Indices
each with overall indices

iBoxx € Supranationals
each with overall and maturity indices

iBoxx € Agencies
iBoxx € Public Banks
iBoxx € Regions
iBoxx € Other Sovereigns
iBoxx € Other Sub-Sovereigns
each with overall indices</td><td>iBoxx € Collateralized Rating Indices
each with overall indices

iBoxx € Covered
each with overall and maturity indices

iBoxx € Covered Sub-Indices
iBoxx € Germany Covered Sub-Indices
iBoxx € Securitized
iBoxx € Other Collateralized
each with overall indices</td><td>iBoxx € Corporates Rating Indices
iBoxx € Corporates Sector Indices
each with overall and maturity indices

iBoxx € Financials Rating Indices
iBoxx € Non-Financials Rating Indices
iBoxx € Financials Sub-Indices
iBoxx € Corporates Market Sector Indices
each with overall indices</td></tr>
</table>

1.1. Structure of the iBoxx EUR Benchmark Indices

The iBoxx EUR benchmark indices comprise an overall index and four major index sub-groups. The sovereigns index group is made up of Euro-denominated and Eurozone-currency sovereign debt isuued by Eurozone-governments. It includes an overall index and maturity indices. An overall index is published for each of the Eurozone countries (with the exception of Luxembourg), i.e. Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. The iBoxx sovereigns group is detailed further, with maturity indices for Germany, France and Italy.

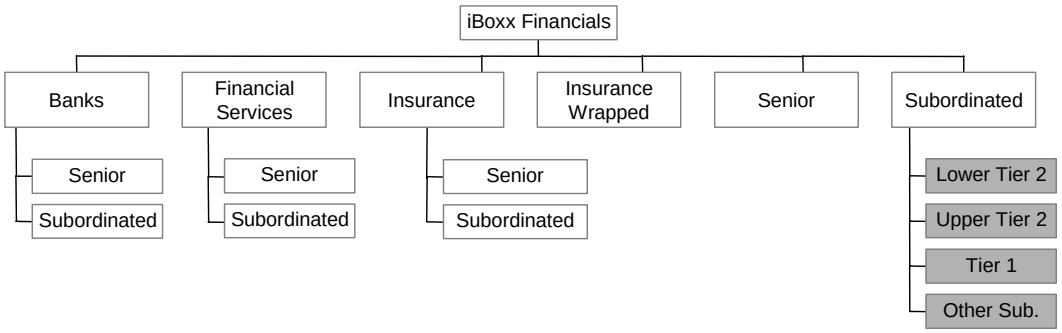
The iBoxx EUR Non-Sovereigns index comprises all bonds that do not qualify for the iBoxx EUR Sovereigns index. These bonds are further classified into the Sub-sovereigns, Collateralized and Corporates index sub-groups. Sovereign bonds from countries outside the Eurozone are included in the iBoxx EUR Other Sovereigns index within the Sub-sovereigns index subgroup. The

[1] iBoxx is a registered trademark of International Index Company Limited

[2] Bonds denominated in a Eurozone legacy currency are included in the iBoxx indices with their amounts outstanding redenominated into Euro.

Corporates indices[3] include overall, rating and maturity indices, with a split into financial and non-financial bonds, and rating and maturity sub-indices for each. A further breakdown is made into market sectors. Senior and subordinated debt indices are published for the financial and non-financial sectors. Sub-indices for financial debt according to the debt status are also calculated. The financial sub-indices are shown in Table 2.

Table 2: Financial Sub-Indices



1.2. Publication of the iBoxx EUR Benchmark Indices

All top-level indices (iBoxx EUR Overall, iBoxx EUR Sovereigns, iBoxx EUR Eurozone, iBoxx EUR Germany, iBoxx EUR Non-Sovereigns, iBoxx EUR Sub-Sovereigns, iBoxx EUR Collateralized, iBoxx EUR Corporates, iBoxx EUR Financials, iBoxx EUR Non-Financials and the iBoxx EUR Corporates Market Sector Indices) are computed and disseminated once per minute between 9.00 a.m. and 5.15 p.m. CET. End-of-day closing values are calculated and disseminated for all indices after 5.15 p.m. CET.

Bond and index analytical values are calculated each trading day using the daily closing prices. Closing index values and key statistics are published at the end of each business day by IIC on www.indexco.com, which also has information and news about the iBoxx indices. In addition, midday fixing levels for bond prices and indices are published. Real time indices and bond prices are published by Deutsche Börse.

Index calculation is based on the Xetra trading calendar. In addition, the indices are calculated with the previous trading day's closes on the last calendar day of each month if that day is not a trading day. IIC publishes an index calculation calendar on www.indexco.com. The base date of the indices is 31 December 1998. Index data and bond price information is also available from the main information vendors.

[3] See Table 4 in the Appendix for an overview of the iBoxx EUR Corporates Sectors.

2. iBoxx EUR Index Rules

2.1. Criteria for iBoxx EUR Bonds

The selection criteria for the inclusion of bonds in the iBoxx EUR indices are:

- Bond type
- Rating
- Time to maturity
- Outstanding amount.

2.1.1. Bond Type

General inclusion criteria: Only fixed rate bonds whose cash flow can be determined in advance are eligible for the indices. The indices are comprised solely of bonds. T-Bills and other money market instruments are not eligible. The iBoxx EUR indices include only Euro and legacy currency denominated bonds. The issuer's domicile is not relevant.

In particular, bonds with the following characteristics are included:

- Fixed coupon bonds ("plain vanilla bonds")
- Zero coupon bonds
- Step-ups
- Event-driven bonds, such as rating- or tax-driven bonds with a maximum of one coupon change per period
- Dated and undated callable subordinated corporate bonds, including fixed-to-floater bonds that change to a floating rate note at or after the first call date. Undated bonds must be callable. In the index calculation, these bonds are always assumed to redeem at the first call date
- Soft bullets only for the iBoxx EUR Collateralized indices. These are bonds with an initial fixed-coupon period and a variable or step-up coupon period thereafter that are structured so that they are expected to redeem at the end of the initial period. In the index calculation soft bullets are always assumed to redeem at the end of the initial period

The following bonds are specifically excluded:

- Sinking funds and amortizing bonds
- Other callable and undated bonds
- Floating rate notes and other fixed-to-floater bonds
- CDOs (Collateralized Debt Obligations) and bonds collateralized by CDOs
- German Kommunalanleihen, - obligationen or Kommunalschatzanweisungen secured by public loans are excluded from the indices unless they qualify as Jumbo Pfandbriefe
- Retail bonds. Retail bonds as identified by the iBoxx Technical Committee are excluded from the indices. The list of retail bonds is published on the website www.indexco.com

2.1.2. Bond classification

Each bond is classified into one of the four categories: Sovereigns, Sub-Sovereigns, Collateralized and Corporates as well as a number of category-specific subsectors.

Sovereigns – are bonds issued by central governments in their domestic currencies.

Sub-sovereigns – are bonds issued by local governments (e.g. German Bundeslaender) and bonds guaranteed or issued by entities guaranteed by the governments such as government agencies (e.g. Cades, KfW), public banks (e.g. German Landesbank debt issued before 31 July 2005) or supranational entities (e.g. EIB, World Bank). Bonds issued by central governments in foreign currencies are included as Other Sovereigns under Sub-sovereigns.

Collateralized bonds - are bonds secured against specific assets or pools of assets. Bonds with simple credit enhancements such as a first mortgage are included in the corporate indices as are bonds whose only security is a financial insurance guarantee.

- **Covered bonds:** A covered bond is a bond that fulfils the criteria specified in UCITS 22.4 or similar directives, e.g. CAD III. In addition, other bonds with a structure affording an equivalent risk and credit profile, and considered by the market as covered bonds, will be included in the iBoxx covered bond indices. The criteria taken into account by the iBoxx Technical Committee in evaluating the status of a bond will be structure, trading patterns, issuance process, liquidity and spread-levels.. Currently, the following bond types are included in the iBoxx EUR Covered indices:

  - Austrian Pfandbriefe
  - French Obligations Foncières
  - German Jumbo Pfandbriefe
  - Irish Asset Covered Securities
  - Luxembourg Lettres de Gage
  - Spanish Cedulas Hipotecarias and Cedulas Territoreales
  - UK covered bonds

- **Securitised bonds:** Are bonds secured against specific assets or receivables (ABS), mortgages (MBS) or cash flows from a whole business segment (Whole Business Securitizations) in each case via a special purpose vehicle.

Corporate bonds – Bonds issued by public or private corporations. The bonds are further classified into Financial and Non-Financial bonds and into the sectors. The category insurance-wrapped is added under Financials for corporate bonds whose timely coupon and/or principal payments are guaranteed by a special monoline insurer such as AMBAC or MBIA.
Corporate debt is classified into senior and subordinated debt. Hybrid bank capital is further detailed into the respective tiers of subordination:

- Tier I
- Upper Tier 2
- Lower Tier 2
- Other. This category includes not only all remaining subordinated bank debt but also all other subordinated debt

2.1.3. Rating

All bonds in the iBoxx EUR index family must be rated investment grade by at least one of the following rating agencies: Standard & Poor's, Moody's or Fitch. If a bond is rated by several agencies, then the lowest available rating is attached to the bond. This rating determines whether the bond is eligible for the iBoxx EUR indices and to which rating index it belongs.

The minimum rating to qualify a bond as investment grade is BBB- for Fitch or S&P and Baa3 from Moody's. Ratings are consolidated (e.g. BBB+, BBB and BBB- are consolidated to BBB; A+, A and A- are consolidated to A etc.).

Eurozone sovereign debt does not require a rating.

2.1.4. Time to Maturity

All bonds must have a minimum remaining time to maturity of at least one year at the re-balancing date.

2.1.5. Amount Outstanding

All bonds require a specific minimum amount outstanding in order to be eligible for the indices, as shown below. The figures indicate minimum issue sizes. Figures in parentheses apply only to legacy bonds, i.e. bonds issued in a pre-Euro currency.

- Sovereigns: Euro 2 billion
- Sub-sovereigns: Euro 1 billion
- Covered: Euro 1 billion
- Collateralized: Euro 500 million (1 billion) (except covered bonds)
- Corporates: Euro 500 million (1 billion)

The amount outstanding of each bond is used to calculate its index weight. The indices are capitalization-weighted.

2.1.6. Monthly Rebalancing of the Indices

Once a month the indices are reviewed and re-balanced. This includes:

1. Bond selection

The universe of bonds is reviewed monthly; those issues meeting the criteria described above at the end of the month are included in the indices. The cut-off date for meeting the amount outstanding criteria is three business days prior to month-end. The rating information includes all rating actions published three trading days before the end of the month. Intra-month rating changes are reflected at the beginning of the following month. The time to maturity is measured from the last calendar day of the current month to the final specified maturity date of the bond.

Newly issued bonds that have not settled three trading days before the end of the month are only included in the iBoxx indices, if (a) they settle before the end of the month and (b) their rating and outstanding amount are known with certainty three trading days before the end of the month.

2. Index composition

All bonds are assigned to the indices according to their classification. The assignment of a bond to a certain maturity bucket is based on its expected remaining life. The expected remaining life is expressed in years and calculated as follows:

- For plain vanilla bonds, the expected remaining life of the bond is its time to maturity, calculated as the number of days between the last calendar day of the current month and its maturity.

- For dated and undated callable hybrid capital bonds, the first call date is always assumed to be the expected redemption date. The expected remaining life is calculated as the number of days between the last calendar day of the month and the expected redemption date.

- For soft bullets, the expected redemption date at the end of the initial period is assumed to be the expected redemption date.

All bonds remain in their maturity bucket for the entire month.

3. Weighting adjustments

Within an index, each bond is weighted according to its amount outstanding. Intra-month changes of the amount outstanding for each bond are reflected in the index through the rebalancing procedure at the beginning of each new month.

4. Coupon Adjustments

Coupon changes to corporate bonds are taken into account in the calculation of the indices from the exact date on which the coupon was altered.

5. Re-balancing timeframe

Six business days before the end of each month, Deutsche Börse compiles a list of all bonds that meet the inclusion criteria.

Four business days before the end of each month, a preliminary membership list is published on the websites of International Index Company and Deutsche Börse. This list contains preliminary information on rating and amount outstanding of all bonds.

Three business days before the end of each month, a membership list ("Constituents Super List") with final amount outstanding for each bond is published. This Constituents Super List contains the maximum number of constituents for the next month.

Two business days before the end of the month, the rating information for the bonds on the Constituents Super List is updated and the list is adjusted for all rating changes occurring three business days prior to month-end after first publication. The resulting list is the final membership list for the following month and is published as soon as all rating changes are confirmed [Note: bonds that are upgraded to investment grade are not included unless they had previously been on the Constituents Super List].

On the last business day of each month, International Index Company and Deutsche Börse publish the membership list with closing prices of all bonds at the close of business.

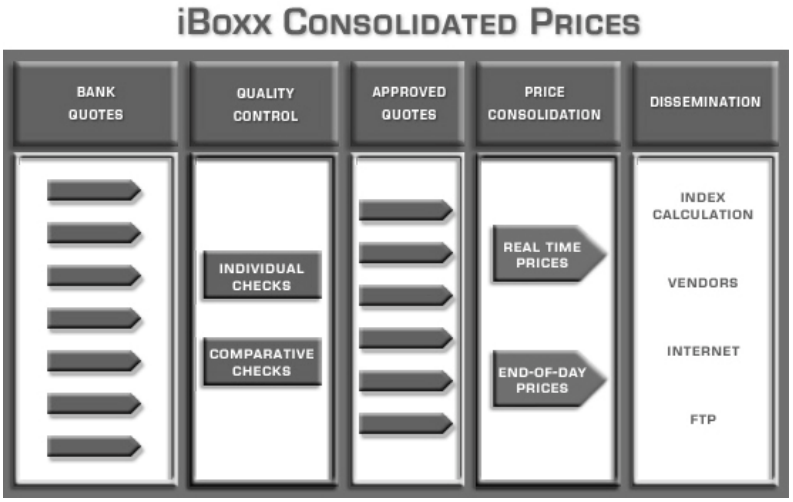
2.2. Consolidation of Contributed Quotes

Index calculation is based on bid and ask quotes provided by the contributing banks. As at July 2006 the following supply bond prices:

ABN AMRO, Barclays Capital, BNP Paribas, Deutsche Bank, Dresdner Kleinwort, Goldman Sachs, HSBC Bank, JP Morgan, Morgan Stanley, Royal Bank of Scotland, UBS.

The quotes pass through a two-step consolidation process:

Table 3: iBoxx Consolidation Process



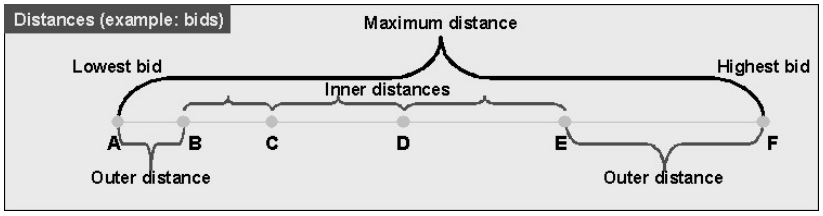
The first filter tests the technical validity of the quotes. The following parameters are tested:

- Whether bid and ask quotes are non-negative
- Whether the bid quote is lower than the ask quote
- Whether the bid-ask spread is within 500 basis points
- Whether the quote has been updated within the last 60 minutes

A quote is only accepted if both bid and ask pass the test.

Subsequently, in the second filter the bid and the ask sides of all surviving quotes are ordered from highest to lowest. In a first test the difference between the maximum and the minimum quote must not be greater than a specified limit (the limit depends on the bond). If the test is passed, all quotes enter the consolidation process. If the distance between maximum and minimum quote is too wide, two more tests are carried out. First, the distance between the maximum / minimum quote and its neighbor is checked. If this distance is too wide then the maximum and/or minimum quote is excluded. Second, the distances between the other neighboring quotes are tested and all quotes are dismissed if one of the distances is greater than a predefined limit.

Table 4: iBoxx Consolidation Process (example)



The consolidated bid and ask prices are calculated from the remaining quotes:

- If less than two quotes are valid, no consolidated price can be generated.
- If two or three quotes are received, the consolidated price is determined as the arithmetical mean of these quotes.
- If four or more quotes are received, the highest and lowest quotes are eliminated. Thereafter the mean value of the remaining quotes is calculated to determine the consolidated price.

2.3. Index Calculation

2.3.1. Calculating the Indices

The quotes from the contributing banks are consolidated and enter the index calculation in real time as consolidated prices. In the event that no new quotes for a particular bond are received, the index will continue to be calculated based on the last available consolidated prices. The indices are calculated based on bid prices. Bonds that are not in the iBoxx universe for the current month, but become eligible for at the next re-balancing, enter the indices at their ask price.

2.3.2. Minimum Number of Bonds

An index is calculated if at least one available bond matches all index criteria. If no more bonds qualify for an index, that index is no longer calculated and the index level remains at the last level. Should at least one bond qualify again, calculation of the index is resumed.

2.3.3. Maturity Buckets

All bonds are categorized into maturity buckets, which are then used to calculate maturity indices. As a principle, the bands are defined as 1-3, 1-5, 1-10, 1-20, 3-5, 5+, 5-7, 5-10, 5-15, 7+, 7-10 and 10+ years. Some specific indices may have one or more custom maturity bands in addition to the above.

2.3.4. Accrued Interest

The following day count conventions are taken into account when calculating the indices:

- ACT/ACT
- ACT/360
- ACT/365
- ISMA 30/360

2.3.5. Reinvestment of Cash

Payments from coupons and scheduled partial and unscheduled full redemptions are held as cash until the next rebalancing, when the cash is reinvested in the index.

2.3.6. Settlement Conventions

The settlement convention for all iBoxx indices is t+0.

2.4. Determination of Benchmarks

Benchmark spreads are calculated for every bond in the iBoxx EUR Non-Sovereign indices as the difference between the annual or semi-annual yield of the bond, and the annual or semi-annual yield of its benchmark.

The benchmark for a bond is assigned monthly by the following procedure:

- A bond is eligible as benchmark if

- the bond is part of the iBoxx EUR Eurozone index,

- the issuer country is among the three largest AAA issuer countries in the iBoxx EUR Eurozone index (by market value at (t-4)).

- Every eligible bond is assigned to one of the following maturity bands:

1 year:	Maturity < 1.5 years
2 years:	Maturity 1.5 to < 2.5 years
3 years:	Maturity 2.5 to < 3.5 years
4 years:	Maturity 3.5 to < 4.5 years
5 years:	Maturity 4.5 to < 5.5 years
6 years:	Maturity 5.5 to < 6.5 years
7 years:	Maturity 6.5 to < 7.5 years
8 years:	Maturity 7.5 to < 8.5 years
9 years:	Maturity 8.5 to < 9.5 years
10 years:	Maturity 9.5 to < 12.5 years
15 years:	Maturity 12.5 to < 17.5 years
20 years:	Maturity 17.5 to < 25 years
Long:	Maturity 25 years and greater

- Eligible bonds are assigned to Sets A or B depending on their age. An eligible bond is assigned to Set A within a maturity band if it is not older than two years. Otherwise, it is assigned to Set B. The age of a bond is calculated from the first settlement date to the current re-balancing date.

The benchmark bond for each maturity band is selected in two steps:

- Step One – Selecting the best benchmark for the issuer country: The largest bond (by amount outstanding) of all bonds in Set A is selected. If Set A is empty, then the most recently issued bond of Set B is chosen as the best benchmark for the respective issuer country.

- Step Two: The largest benchmark bond selected in Step One (for each maturity band) is selected as the respective benchmark bond for a maturity band.

- For every bond in the iBoxx EUR Non-Sovereigns index, the benchmark bond with the closest maturity is selected as benchmark. Therefore, the chosen benchmark is not necessarily the same as the benchmark for the maturity band of the bond. If the time to maturity distance of a bond to its two neighboring benchmarks is exactly the same, then the benchmark bond with the longer time to maturity is chosen.

3. Index Formulae

The iBoxx EUR indices are calculated as basket indices based on real bonds. All indices are published as price and total return indices.

The iBoxx EUR benchmark indices are calculated on a capitalization-weighted basis that recognizes the relative changes in value compared to the beginning of each month. The composition and weightings of the index are adjusted at the beginning of each month.

The annotations used throughout the index formulae are attached in Appendix 5.2.

3.1. Price Index

The price index is calculated as follows:

$$(1) \qquad PI_t = PI_{t-s} \frac{\sum_{i=1}^{n} P_{i,t} \cdot N_{i,t-s}}{\sum_{i=1}^{n} P_{i,t-s} \cdot N_{i,t-s}}$$

3.2. Total Return Index

For total return indices the monthly adjustment involves the reinvestment of coupon payments at the beginning of the month. Consequently, total return indices are calculated as follows:

$$(2) \qquad TR_t = TR_{t-s} \frac{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})\right) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}) \cdot N_{i,t-s}}$$

4. Analytics

In addition to the price and total return indices, a range of analytical values is calculated for the indices[4] as described below. The annotations used in the formulae are attached in Appendix 5.2.

4.1. Bond Analytics

4.1.1. Yield

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

$$(3)\ P_{i,t} + A_{i,t} = \sum_{j=1}^{n} CF_{i,j} \cdot (1 + Y_{i,t})^{-L_{i,t,j}}$$

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

The true yield is calculated as follows:

$$(4)\ Y_{i,t}^{t} = Y_{i,t} \cdot m$$

The periodic yield can be transformed into the annual yield:

$$(5)\ Y_{i,t}^{a} = (1 + Y_{i,t})^{m} - 1$$

The semi-annualized yield is calculated as follows:

$$(6)\ Y_{i,t}^{s} = 2 \cdot \left(\sqrt{1 + Y_{i,t}^{a}} - 1\right)$$

4.1.2. Duration

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

$$(7)\ D_{i,t} = \frac{\sum_{j=1}^{n} CF_{i,j} \cdot L_{i,t,j} \cdot (1 + Y_{i,t})^{-L_{i,t,j}}}{\sum_{j=1}^{n} CF_{i,j} \cdot (1 + Y_{i,t})^{-L_{i,t,j}}} = \frac{1}{(P_{i,t} + A_{i,t})} \cdot \sum_{j=1}^{n} CF_{i,j} \cdot L_{i,t,j} \cdot (1 + Y_{i,t})^{-L_{i,t,j}}$$

4.1.3. Modified Duration

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

$$(8)\ MD_{i,t} = D_{i,t} \cdot \frac{1}{1 + Y_{i,t}}$$

[4] The calculation method used for the iBoxx indices is based on the EFFAS-Standards. For further reading see Patrick J. Brown (2002): “Constructing & Calculating Bond Indices – A Guide to the EFFAS European Bond Commission Standardized Rules”, 2nd edition, Cambridge, England, 2002.

In the same way, the annual modified duration can be expressed as:

$$(9)\ MDA_{i,t} = D_{i,t} \cdot \frac{1}{1 + Y^{a}_{i,t}}$$

The semi-annualized modified duration is calculated as follows:

$$(10)\ MDS_{i,t} = D_{i,t} \cdot \frac{1}{1 + \frac{Y^{s}_{i,t}}{2}}$$

4.1.4. Convexity

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

$$(11)\ CX_{i,t} = \frac{1}{P_{i,t} + A_{i,t}} \cdot \sum_{j=1}^{n} L_{i,t,j} \cdot \left(L_{i,t,j} + 1\right) \cdot CF_{i,j} \cdot \left(1 + Y_{i,t}\right)^{-\left(L_{i,t,j} + 2\right)}$$

Using the annualized yield, the annualized convexity of a bond can be calculated as:

$$(12)\ CXA_{i,t} = \frac{1}{P_{i,t} + A_{i,t}} \cdot \sum_{j=1}^{n} L^{a}_{i,t,j} \cdot \left(L^{a}_{i,t,j} + 1\right) \cdot CF_{i,j} \cdot \left(1 + Y^{a}_{i,t}\right)^{-\left(L^{a}_{i,t,j} + 2\right)}$$

Similarly, using the semi-annualized yield, the semi-annualized convexity of a bond can be calculated as:

$$(13)\ CXS_{i,t} = \frac{1}{P_{i,t} + A_{i,t}} \cdot \sum_{j=1}^{n} L^{s}_{i,t,j} \cdot \left(L^{s}_{i,t,j} + 1\right) \cdot CF_{i,j} \cdot \left(1 + \frac{Y^{s}_{i,t}}{2}\right)^{-\left(L^{s}_{i,t,j} + 2\right)}$$

4.1.5. Benchmark Spread

The benchmark spread is calculated for bonds in the Non-Sovereigns indices. For Sovereign bonds a “*” is shown.

The annualized benchmark spread of bond i at time t is:

$$(14)\ BMS_{i,t} = \begin{cases} * & \text{for Sovereign bonds} \\ Y^{a}_{i,t} - Y^{a}_{BM(i),t} & \text{else} \end{cases}$$

The semi-annualized benchmark spread of bond i at time t is:

$$(15)\ BMSS_{i,t} = \begin{cases} * & \text{for Sovereign bonds} \\ Y^{s}_{i,t} - Y^{s}_{BM(i),t} & \text{else} \end{cases}$$

4.1.6. Daily and Month-to-Date Bond Returns

Daily bond returns are calculated for all iBoxx EUR benchmark indices according to the following formula:

$$(16)\ LCR_{t-1,t} = \frac{P_{i,t} + A_{i,t} + XD_{i,t-s}\left(G_{i,t} + CP_{i,t}\right) - \left(P_{i,t-1} + A_{i,t-1} + XD_{i,t-s}\left(G_{i,t-1} + CP_{i,t-1}\right)\right)}{P_{i,t-1} + A_{i,t-1} + XD_{i,t-s} \cdot CP_{i,t-1}}$$

Month-to-date bond returns are calculated as follows:

$$(17)\ LCR_{t-s,t} = \frac{P_{i,t} + A_{i,t} + XD_{i,t-s}\left(G_{i,t} + CP_{i,t}\right) - \left(P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}\right)}{P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}}$$

4.2. Index Analytics

The index analytics are based on annual and semi-annual bond analytics

4.2.1. Gross Price Index

The gross price index represents the portion of the total return that is due to movements of the dirty price of the constituent bonds.

The gross price index is calculated as follows:

$$(18)\qquad GI_t = GI_{t-s} \frac{\sum_{i=1}^{n}\left(P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot CP_{i,t}\right) \cdot N_{i,t-s}}{\sum_{i=1}^{n}\left(P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}\right) \cdot N_{i,t-s}}$$

4.2.2. Income Indices

The income indices measure the portion of the index return that is due to actual cash payments. Interest payments are represented in the coupon income index, redemptions in the redemption income index and the total of these in the income index.

The coupon income index is calculated as follows:

$$(19)\qquad IC_t = IC_{t-s} + GI_{t-s} \frac{\sum_{i=1}^{n} XD_{i,t-s} \cdot G_{i,t} \cdot N_{i,t-s}}{\sum_{i=1}^{n}\left(P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}\right) \cdot N_{i,t-s}}$$

The redemption income index is calculated as follows:

$$(20)\qquad IR_t = IR_{t-s} + GI_{t-s} \frac{\sum_{i=1}^{n} PR_{i,t-s,t} \cdot N_{i,t-s}}{\sum_{i=1}^{n}\left(P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}\right) \cdot N_{i,t-s}}$$

The income index is calculated as follows:

$$(21) \qquad IN_t = IN_{t-s} + GI_{t-s} \frac{\sum_{i=1}^{n} \left(XD_{i,t-s} \cdot G_{i,t} + PR_{i,t-s,t}\right) \cdot N_{i,t-s}}{\sum_{i=1}^{n} \left(P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}\right) \cdot N_{i,t-s}}$$

Or simplified:

$$(22) \qquad IN_t = IC_t + IR_t$$

Income indices are reset to zero at the beginning of each year.

4.2.3. Average Yield

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

$$(23) \qquad RY_t = \frac{\sum_{i=1}^{n} Y_{i,t}^{a} \cdot \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}}{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}}$$

The average semi-annualized yield is calculated as follows:

$$(24) \qquad RYS_t = \frac{\sum_{i=1}^{n} Y_{i,t}^{s} \cdot \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}}{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}}$$

The average portfolio yield is calculated as follows:

$$(25) \qquad RYP_t = \frac{\sum_{i=1}^{n} Y_{i,t}^{a} \cdot \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}}{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s} \cdot D_{i,t}} \cdot \frac{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t}\right) \cdot N_{i,t-s}}{\sum_{i=1}^{n} \left(P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})\right) \cdot N_{i,t-s}}$$

The average semi-annualized portfolio yield is calculated as follows:

$$(26)\quad RYPS_t = \frac{\sum_{i=1}^{n} Y_{i,t}^{S} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s} \cdot D_{i,t}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s} \cdot D_{i,t}} \cdot \frac{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})) \cdot N_{i,t-s}}$$

4.2.4. Average Duration

The average duration is weighted by the market capitalization of the respective bonds, where market capitalization is defined as the result of the dirty price of a bond multiplied by its amount outstanding.

$$(27)\quad DU_t = \frac{\sum_{i=1}^{n} D_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}$$

The average portfolio duration is calculated as follows:

$$(28)\quad DUP_t = \frac{\sum_{i=1}^{n} D_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})) \cdot N_{i,t-s}}$$

4.2.5. Average Modified Duration

The calculation method for average modified duration is similar to that previously described for average duration, except that duration is replaced by modified duration.

$$(29)\quad MDU_t = \frac{\sum_{i=1}^{n} MDA_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}$$

The average semi-annualized modified duration is calculated as follows:

$$(30)\quad MDUS_t = \frac{\sum_{i=1}^{n} MDS_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}$$

The average modified portfolio duration is calculated as follows:

$$(31)\ MDUP_t = \frac{\sum_{i=1}^{n} MDA_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})) \cdot N_{i,t-s}}$$

The average semi-annualized modified portfolio duration is calculated as follows:

$$(32)\ MDUPS_t = \frac{\sum_{i=1}^{n} MDS_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})) \cdot N_{i,t-s}}$$

4.2.6. Average Convexity

The calculation method for average convexity is similar to that previously described for average duration and average modified duration, except that duration/modified duration is replaced by convexity.

$$(33)\ CXU_t = \frac{\sum_{i=1}^{n} CXA_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}$$

The average semi-annualized convexity is calculated as follows:

$$(34)\ CXUS_t = \frac{\sum_{i=1}^{n} CXS_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}$$

The average portfolio convexity is calculated as follows:

$$(35)\ CXUP_t = \frac{\sum_{i=1}^{n} CXA_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})) \cdot N_{i,t-s}}$$

The average semi-annualized portfolio convexity is calculated as follows:

$$(36)\ CXUPS_t = \frac{\sum_{i=1}^{n} CXS_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot (CP_{i,t} + G_{i,t})) \cdot N_{i,t-s}}$$

4.2.7. Average Coupon

The average coupon is calculated by weighting the coupon of each bond with the amount outstanding of the respective bond:

$$(37)\ CO_t = \frac{\sum_{i=1}^{n} C_{i,t} \cdot N_{i,t-s}}{\sum_{i=1}^{n} N_{i,t-s}}$$

4.2.8. Average Time to Maturity

The calculation method for average time to maturity is similar to the previously described calculation. A weighting is carried out in accordance with the amount outstanding:

$$(38)\ LFU_t = \frac{\sum_{i=1}^{n} LF_{i,t} \cdot N_{i,t-s}}{\sum_{i=1}^{n} N_{i,t-s}}$$

4.2.9. Nominal Value

The nominal value of all bonds is calculated as follows:

$$(39)\ NV = \sum_{i=1}^{n} N_{i,t-s}$$

4.2.10. Market Value

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

$$(40)\ MV_t = \sum_{i=1}^{n} \left(P_{i,t} + A_{i,t} + XD_{i,t-s} \cdot CP_{i,t}\right) \cdot N_{i,t-s}$$

4.2.11. Base Market Value

The base market value of all bonds is calculated as follows:

$$(41)\ MV_0 = \sum_{i=1}^{n} \left(P_{i,t-s} + A_{i,t-s} + XD_{i,t-s} \cdot CP_{i,t-s}\right) \cdot N_{i,t-s}$$

4.2.12. Cash Payment

The cash payment of all bonds is calculated as follows:

$$(42)\ CV_t = \sum_{i=1}^{n} XD_{i,t-s} \cdot G_{i,t} \cdot N_{i,t-s}$$

4.2.13. Index Benchmark Spread

The index benchmark spread is calculated for all Non-Sovereign indices. For Sovereign and overall indices a "*" is shown.

The annualized index benchmark spread at time t is:

$$(43)\ BMSA_t = \begin{cases} * & \text{for Sovereign, overall indices} \\ \dfrac{\sum_{i=1}^{n} BMS_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s} \cdot D_{i,t}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s} \cdot D_{i,t}} & \text{else} \end{cases}$$

The semi-annualized index benchmark spread at time t is:

$$(44)\ BMSAS_t = \begin{cases} * & \text{for Sovereign, overall indices} \\ \dfrac{\sum_{i=1}^{n} BMSS_{i,t} \cdot (P_{i,t} + A_{i,t}) \cdot N_{i,t-s} \cdot D_{i,t}}{\sum_{i=1}^{n} (P_{i,t} + A_{i,t}) \cdot N_{i,t-s} \cdot D_{i,t}} & \text{else} \end{cases}$$

4.2.14. Daily and Month-to-Date Index Returns

Daily index returns are calculated for all iBoxx EUR benchmark indices according to the following formula:

$$(45)\ R_{t-1,t} = \frac{TR_t - TR_{t-1}}{TR_{t-1}}$$

Month-to-date index returns are calculated as follows:

$$(46)\ R_{t-s,t} = \frac{TR_t - TR_{t-s}}{TR_{t-s}}$$

5. Appendix

5.1. Overview: iBoxx Corporates Sectors

Table 5: Overview: iBoxx Corporates Sectors

	Economic Sector	Market Sector
Financials	Financials	Banks
		Insurance
		Financial Services
		Insurance-wrapped
Non-Financials	Oil & Gas	Oil & Gas
	Basic Materials	Chemicals
		Basic Resources
	Industrials	Construction & Materials
		Industrial Goods & Services
	Consumer Goods	Automobiles & Parts
		Food & Beverage
		Personal & Household Goods
	Health Care	Health Care
	Consumer Services	Retail
		Media
		Travel & Leisure
	Telecommunications [6000]	Telecommunications
	Utilities	Utilities
	Technology	Technology

5.2. Annotations

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

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

$BMS_{i,t}$ = Annualized benchmark spread of bond i at time t

$BMSA_t$ = Annualized index benchmark spread at time t

$BMSS_{i,t}$ = Semi-annualized benchmark spread of bond i at time t

$BMSAS_t$ = Semi-annualized index benchmark spread at time t

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

$CF_{i,j}$ = Cash flow of bond i in the jth period

CO_t = Average coupon at time t

$CP_{i,t}$ = Value of the next coupon payment of bond i during an ex-dividend period (because the next coupon is separated from the bond during the ex-dividend period). Outside the ex-dividend period, the value is 0

$CP_{i,t-s}$ = Value of the next coupon payment of bond i (at the last re-balancing) during an ex-dividend period (because the next coupon is separated from the bond during the ex-dividend period). Outside the ex-dividend period, the value is 0

CV_t = Cash payment of all bonds at time t

$CX_{i,t}$ = Convexity of bond i at time t

$CXA_{i,t}$ = Annual convexity of bond i at the settlement date

$CXS_{i,t}$ = Semi-annualized convexity of bond i at time t

CXU_t = Average convexity at time t

$CXUP_t$ = Average portfolio convexity at time t

$CXUPS_t$ = Average semi-annualized portfolio convexity at time t

$CXUS_t$ = Average semi-annualized convexity at time t

$D_{i,t}$ = Duration of bond i at time t

DU_t = Average duration at time t

DUP_t = Average portfolio duration at time t

$G_{i,t}$ = Coupon payment received from bond i between the day of the payment and month-end. If none the value is set to 0

$GI_{i,\ t}$ = Gross price index at date t

$GI_{i,t-s}$ = Gross price index at at the last re-balancing before t

$IC_{i,\ t}$ = Coupon income index at date t

$IC_{i,t-s}$ = Coupon income index at the last re-balancing before t

$IN_{i,\ t}$ = Income index at date t

$IN_{i,t-s}$ = Income index at the last re-balancing before t

$IR_{i,t}$ = Redemption income index at date t

$IR_{i,t-s}$ = Redemption income index at the last re-balancing before t

$L_{i,t,j}$ = Time in coupon periods of the jth cash flow of bond i at time t

$L^{a}_{i,t,j}$ = Time in years between the settlement date and the jth cash flow of bond i at time t

$L^{s}_{i,t,j}$ = Time in half-years between the settlement date and the jth cash flow of bond i at time t

$LCR_{t-1,t}$ = Daily bond return

$LCR_{t-s,t}$ = Month-to-date bond return

$LF_{i,t}$ = Expected remaining life of bond i at time t; average life for amortizing bonds and sinking funds

LFU_t = Average time to maturity at time t

M = Number of coupon payments per year

$MD_{i,t}$ = Modified duration of bond i at time t

$MDA_{i,t}$ = Annualized modified duration of bond i at time t

$MDS_{i,t}$ = Semi-annualized modified duration of bond i at time t

MDU_t = Average modified duration at time t

$MDUS_t$ = Average semi-annualized modified duration at time t

$MDUP_t$ = Average semi-annualized modified portfolio duration at time t

$MDUPS_t$ = Average semi-annualized modified portfolio duration at time t

MV_0 = Base market value of all bonds in the index at the last trading day at the end of last month

MV_t = Market value of all bonds in the index at time t

n = Number of bonds resp. number of future cash flows in the index

$N_{i,t-s}$ = Notional of bond i at the last rebalancing

NV = Nominal value of all bonds in the index on the third trading day prior to month-end

$P_{i,t}$ = Price of bond i at time t

$P_{i,t-s}$ = Closing price of bond i on the last trading day of the previous month

$P_{i,t}+A_{i,t}$ = Dirty price of bond i at time t

PI_t = Price index level at time t

PI_{t-s} = Closing price index level on the last calendar day of the previous month

$PR_{i,t-s,t}$ = Redemption price of a portion redeemed between the last re-balancing and time t (default value is 100)

$R_{t-1,t}$ = Daily index return

$R_{t-s,t}$ = Month-to-date index return

RY_t = Average annual yield at time t

RYS_t = Average semi-annual yield at time t

RYP_t = Average annual portfolio yield at time t

$RYPS_t$ = Average semi-annual portfolio yield at time t

s = Time since last rebalancing

t = Time of calculation

TR_t = Total return index level at time t

TR_{t-s} = Closing total return index level on the last calendar day of the previous month

$XD_{i,t-s}$ = 0, if the bond enters the index during its current ex-dividend period (to ensure that the next coupon payment is not included in the total return calculation)

= 1, if (a) the bond does to have ex-dividend conventions, (b) has not entered the index during an ex-idivdend period, or (c) entered the index during a previous ex-dividend period

$Y_{i,t}$ = Yield of bond i at time t

$Y^a_{BM(i),t}$ = Annualized yield of the benchmark of bond i BM(i) at time t

$Y^s_{BM(i),t}$ = Semi-annualized yield of the benchmark of bond i BM(i) at time t

$Y^t_{i,t}$ = True yield at the settlement date

$Y^a_{i,t}$ = Annual yield of bond i at time t

$Y^s_{i,t}$ = Semi-annual yield of bond i at time t

6. Further information

- International Index Company

Goetheplatz 5
60313 Frankfurt
Germany

Phone: +49-69-299 868 140
Fax: +49-69-299 868 149
E-mail: info@indexco.com
Internet: www.indexco.com

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