OSLO BØRS

OSLO STOCK EXCHANGE

JANUARY 2020

Oslo Børs - Specialized Bond Indices – Index Methodology

Issue 1.2

Content

1. Introduction

1.1 Background

This booklet describes how Oslo Børs calculates the specialized bond indices. It is aimed at users, investors and others interested in the construction and computation of such indices.

1.2 The index family

The indices in this methodology document can be divided into two groups;

- Government Bond Indices
- Treasury Bills Indices

The main objective of the Oslo Børs specialized bond indices is to supply investors in the Norwegian bond market with portfolio benchmarks where return can be replicated.

The main purpose of these indices is:

- To act as a benchmark for portfolio management at each point of the term structure
- To act as an indicator of market performance and development
- A comparator for different markets

If, for some reason, an index is to be discontinued, Oslo Børs will notify the market in due course. A notice will be published at least six months before an index is to be discontinued, unless continuous calculation is not possible due to force majeure or other events outside the control of Oslo Børs. The decision to discontinue an index will be made by the Index Management Committee.

1.3 Information Policy and Index Governance

Material changes to the index methodology are normally announced three months before they are put into effect. Examples of material changes to the methodology are changes to the price source, calculation formula and the index rebalancing requirements.

Oslo Børs may shorten the three months period for minor changes, or where the changes are the result of legislation, regulation, legal ruling, administrative decision or in other special cases.

The Index Management Committee (IMC) decides in each case whether an external consultation is necessary.

1.3.1 Daily Index Operations

Daily index operations, such as running constituency weights calculations, quality checks and general surveillance of the daily production is performed by the Products Department. The index specialists within the Products Department also prepare documentation and data for decisions to be made by the IMC, as well as proposing changes in index rules and methodology. Periodical reviews and rebalancing of the indices are prepared by the Products Department and presented to IMC which is the decision-making body for all significant decisions affecting the index production. The index production is overseen by the Benchmark Oversight Committee (BOC).[1]

1.3.2 Index Management Committee (IMC)

The Index Management Committee will ensure an orderly and objective index maintenance. The committee is overseen by the Benchmark Oversight Committee (BOC)[2] and has the following responsibilities:

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[1] Please see footnote 3 below.
[2] Please see footnote 3 below.

- Review and approve changes to the methodology
- Review and approve the semi-annual index rebalancing (only relevant for equity indices)
- Review and approve the handling of complex corporate actions, escalated by the Products Team
- Approve or propose external consultations and review consultation feedback
- Decide when and to which extent the Advisory Group should be consulted
- Handle formal index related complaints, according to the "Oslo Børs Index Queries and Complaints Policy"

The Index Management Committee is internal, consisting of experienced staff from various Oslo Børs departments:

- Head of the Information Services department (the committee chair)
- Head of the Surveillance and Operations department
- Head of the Derivatives department
- Senior representative from the Secondary Market department

The committee is scheduled to meet twice a year and on ad-hoc basis when needed. Resolutions require the attendance of at least two regular members.

1.3.3 Benchmark Oversight Committee (BOC)[3]

The Benchmark Oversight Committee is responsible for independent oversight of all aspects of the governance of index administration. The committee has the following responsibilities:

- Report to the relevant competent authorities any misconduct by Oslo Børs as a Benchmark Administrator of which the oversight function becomes aware.
- Review the benchmarks' methodology at least annually.
- Oversee any changes to the benchmark methodology.
- Oversee the Benchmark Administrator's control framework, the management and operation of the benchmark.
- Review the decisions of the Index Management Committee and Products Team.
- Complete documentation shall be maintained for at least five years of all aspects of the governance and decisions of the Committee in a manner that makes it accessible for future reference.

The Benchmark Oversight Committee consists of experienced staff from various Euronext departments:

- Group Head of Compliance Euronext Group
- Group Head of Risk & Compliance
- Group Head of Regulation
- Group Finance Director

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[3] Oslo Børs is currently in the process of filing for registration as an index administrator pursuant to the Regulation (EU) 2016/1011 ("**BMR**"). The Benchmark Oversight Committee's functions will be effective from the date Oslo Børs has been formally registered as a BMR administrator.

The Oversight Committee shall meet at least twice a year and whenever one or more of its members request a meeting. At least three members or deputy members ɑre required to be present for the meeting to be quorate.

1.3.4 Index Correction Policy

There are mainly three areas within Index Production that will require corrective measures; incidents concerning the real-time feed, incidents concerning the content of an index or incidents concerning the distribution of index weights.

More specifically, corrections may occur for instance due to wrong input prices or erroneous accrued interest, yield or duration. Incidents concerning the real-time market data feed is considered most critical.

Oslo Børs will correct any error as soon as possible and reissue index weight files and ensure correct closing and opening values. If the error is corrected during the market open, Oslo Børs will ensure correct real-time calculation.

The index correction policy requires reliable communication to market participants. Any corrections to index weight files or real-time dissemination will be communicated to the market participants directly or to the broader audience depending on scope of the incident and according to the overall contingency plans as a supervised entity. Communication will occur simultaneously to involved parties by e-mail and/ or the oslobors.no official webpage and distribution service.

2. Oslo Børs Specialized Government Bond Indices

2.1 Eligible securities

Index name	Index Ticker	Eligible securities	ISIN
OB Government Bonds All Index	OBGBA	All government bonds with maturity over 1 year	NO0010721475
OB Government Bonds < 5 year Index	OBGBU5Y	All government bonds within maturity range 1-5 year	NO0010721483
OB Government Bonds > 5 year Index	OBGBO5Y	All government bonds with maturity over 5 year	NO0010721491
OB Government Bonds Fixed Maturity 1 year Index	OBGBF1Y	Two bonds; with maturities closest under and over 1 year. Whenever the shortest bond has maturity over 1 year the treasury bill with the longest maturity is used.	NO0010721509
OB Government Bonds Fixed Maturity 2 year Index	OBGBF2Y	Two bonds; with maturities closest under and over 2 years	NO0010721517
OB Government Bonds Fixed Maturity 3 year Index	OBGBF3Y	Two bonds; with maturities closest under and over 3 years	NO0010721525
OB Government Bonds Fixed Maturity 4 year Index	OBGBF4Y	Two bonds; with maturities closest under and over 4 years	NO0010721533
OB Government Bonds Fixed Maturity 5 year Index	OBGBF5Y	Two bonds; with maturities closest under and over 5 years	NO0010721541
OB Government Bonds Fixed Maturity 6 year Index	OBGBF6Y	Two bonds; with maturities closest under and over 6 years	NO0010721558
OB Government Bonds Fixed Maturity 7 year Index	OBGBF7Y	Two bonds; with maturities closest under and over 7 years	NO0010721566

2.2 Index weights

The Oslo Børs Specialized Government Bond indices consist of two sets of categories:
- Benchmark (1 – 5 years, 5+ years and All)
- Fixed Maturities (1, 2, 3, 4, 5, 6 and 7 years)

The index weights are recalculated after the last trading day each month. The methods for calculating the index weights for the two categories differ, and a description of these calculations is found below.

2.2.1 Benchmark indices

The Benchmark indices (OBGBA, OBGBU5Y and OBGO5Y) consist of Norwegian government bonds within the maturity range of 1 – 5 years and 5 + years. The OB Government Bonds All index consists of all current Norwegian government Bonds with duration greater than 1 year.
Government Bonds that have less than one year to expiry are excluded from the index weight calculations from the month the duration become shorter than 1 year, i.e. a government bond with expiry 19th May 2017 will not be included in the index weights for May 2016. Hence, the last month this bond is included in the Benchmark indices will be April 2016.

2.2.1.1   Index weight calculation

The weights for the Benchmark indices are weighted by the size (nominal value) and market price (dirty price) of the individual bonds the last trading day in every month.
The Benchmark weights are calculated by using the following formula:

$$W_i = \frac{P_i V_i}{\sum P_i V_i}$$

Where P_i is dirty price of bond number i, and V_i is the nominal value.

2.2.2 Fixed Maturities

The Fixed Maturities indices are calculated including only two bonds. The two bonds included are the two bonds closest to the fixed maturity, i.e. for Fixed 1 year we take the bond closest under and the bond closest over one year, and then create a synthetic one-year bond.
As far as possible the index shall include at least one underlying bond on each side of the fixed duration. Hence, if the shortest bond is longer than one year, the government certificate with the longest maturity is used together with the shortest bond to make the Fixed 1 index.

2.2.1.2 Index weight calculation

In order to calculate the index weights for the Fixed Maturities indices we solve the two following equations:

1. $W_1 + W_2 = 1$
2. $M_1 W_1 + M_2 W_2 = F$

Where M denotes maturity, W is weight, and F is the fixed maturity in years.

2.3   Index calculation – Total Return Index

Although the methods for calculating the index weights are different for the Benchmark and Fixed Maturities the index values are calculated in the same manner for the two index categories.
All Oslo Børs Specialized Government Bond indices are total return indices which assume that all coupons are reinvested in the index.
Please note that only bid prices are used for calculating the value of the underlying bonds.

The bond's daily return is given by:
Dirty Price close/Dirty Price start – 1:

$$A_i = \frac{P_i}{P_0} - 1$$

where

Dirty Price close = Clean Price today + accrued interest today

$$Pi = Ki_t + ai_t$$

and

Dirty Price start = Clean Price t-1 + Accrued interest t-1

$$P_0 = Ki_{t-1} + ai_{t-1}$$

The index return is found by the following formula:

$$IA = \sum Wi \times Ai$$

where
Wi = index weights
Ai = the bond's return

Then the index value is given by:

$$I_t = I_{t-1} \times (1 + IA)$$

2.4 Duration

The duration for one single bond is given by first calculating the weighted average of the present value of each cash flow at time t by the following formula:

$$W_t = \frac{CF_t/(1+y)^t}{P}$$

where
Wt = weighted average of cash flow at time t
t = time in years
CFt = cash flow at time t
y = yield to maturity
P = bond price

The next step will then be to sum up these weighted averages by using the following formula (Macaulay Duration):

$$D = \sum_{t=1}^{T} t \times W_t$$

where
T = number of cash flow periods.

The weighted average duration for an index is given by:

$$D_a = \frac{\sum D_i P_i V_i}{\sum P_i V_i}$$

Where D_i is Duration of bond number i, P_i is dirty price, and V_i is the nominal value.

2.5 Yield

The bond yield is the single discount rate, that when applied to all cash flows, gives a bond price equal to dirty price.

The yield to maturity for a single bond can be found using an iterative process:

$$P = \frac{C_1}{(1+y)^{t_1}} + \frac{C_2}{(1+y)^{t_2}} + \cdots + \frac{C_n}{(1+y)^{t_n}} + \frac{Par}{(1+y)^{t_n}}$$

where
P = bond price
C = coupon
t = time in years t
y = yield to maturity
Par = par value of the bond

The formula for calculating the average yield to maturity (YTM) of an index needs some explanation, as it is not immediately obvious. For example, consider a portfolio of two bonds with the same coupon and the same size, but with different maturity and yield. Let the first bond have one week to maturity and a yield of 20%. Let the second bond have ten years to maturity and a yield of 10%. One might be tempted to say that the yield of the portfolio is 15%, but this would imply that the portfolio manager was expecting to reinvest the proceeds of the first bond to yield 20% in one week's time. Therefore the average index yield must be very close to 10%, as the second bond has a life which is more than 500 times longer than the first.

It is found that a good approximation to the yield can be obtained by weighting the individual bond yield by the size of the holding multiplied by its duration, since duration is the discounted life of all future cash flows of the bond. This gives the following formula for average yield for an index:

$$Y_a = \frac{\sum Y_i D_i P_i V_i}{\sum D_i P_i V_i}$$

Where Y_i is the yield of bond number i.

2.6 Convexity

The convexity works as a measure of the curvature in the relationship between the bond prices and bond yields.

Convexity for one single bond is given by:

$$Co = \frac{1}{(1+y)^2} \times \sum_{t-1}^{T} t \times (t+1) \times \frac{CF_t/(1+y)^t}{P}$$

where
P = bond price
y = yield to maturity
T = maturity in years
CFt = cash flow at time t

In a similar manner as for index duration, the average convexity of an index is calculated by averaging the convexities of the constituent bonds weighted by their market values.
The weighted average convexity is given by:

$$Co_a = \frac{\sum Co_i P_i V_i}{\sum P_i V_i}$$

3. Oslo Børs Specialized Treasury Bills Indices

3.1 Eligible securities

Index name	Index Ticker	Eligible securities	ISIN
OB Treasury Bills All Index	OBTBA	All treasury bills with maturity over 1 month	NO0010721574
OB Treasury Bills < 180 days Index	OBTBU180D	All treasury bills within maturity range 1 month and 180 days	NO0010721582
OB Treasury Bills > 180 days Index	OBTBO180D	All treasury bills with maturity over 180 days	NO0010721590

3.2 Index weights

The weights in the Oslo Børs Specialized Treasury Bills Indices are weighted by the size and market price of the individual certificated the last trading day each month by using the following formula:

$$W_i = \frac{P_i \cdot V_i}{\sum P_i V_i}$$

Where P_i = Price of certificate i
V_i = Nominal value of certificate i
W_i = Weight for certificate i

The certificates included are all current outstanding Norwegian Government Bills (which are all zero-coupon) unless they expire the coming month. Certificates are excluded from the index before the start of the month they expire, i.e. a certificate with expiry 17 December will not be included in the calculations for December.

3.3 Index calculation

The certificates daily return is given by using the same methods as for the Government Bonds, but the Treasury Bills does not consider accrued interest as they all are zero-coupon certificates. Please note that only bid prices are used for calculating the value of the underlying certificates

Single certificate return:

$$A_i = \frac{P_i}{P_0} - 1$$

where P_0 = Price at start
P_i = Price at close

This leads us to the index return, which is the sum of the weights multiplied with the return of each individual certificate:

$$IA = \sum Wi \times Ai$$

where
Wi = index weights
IA = Index return

The index value is given by:

$$I_t = I_{t-1} \times (1 + IA)$$

3.4 Duration

The duration of single certificate is calculated using the same technique as described in section 2.4 for duration of one single bond.

The duration of a Treasury Bills Index is given by:

$$D_a = \sum W_i \times D_i$$

Where Di = duration of certificate number i.

3.5 Yield

Please see section 2.5.