

## **OMXI Bond Indices**

22 February 2011

### **Introduction**

NASDAQ OMX Iceland (OMXI) began calculating its current bond indices in the beginning of 2005. They were a response to recent changes in Treasury bond issuance as well as restructuring by the Housing Financing Fund (HFF) in the summer of 2004. These changes resulted in many of the largest and most active bond series being excluded from OMXI's previous indices, which were designed for zero-coupon bonds.

### **Summary**

Like their predecessors, the bond indices have a fixed duration, while the most significant changes from the previous method are principally the following:

- (i) The indices cover a larger portion of the bond market than did the earlier indices. In addition to zero-coupon bonds, bonds with equal instalments, annuities and coupon bonds are also eligible for inclusion in the indices. Both bonds listed at clean price and dirty price will be admissible. The changes mean that HFF bonds and all benchmark Treasury bond classes can be considered for inclusion in the OMXI indices.
- (ii) There can now be more than two bonds in each index at any point in time, while this was previously limited to two bonds at a time. As a result of these changes, the bond indices will reflect a larger portion of the market, reducing the likelihood of "extraordinary" price movements in one bond class substantially affecting the indices.
- (iii) The definition of the new indices is broader than that of the previous ones. The former indices were limited to individual bond classes, such as T-bonds and Housing Bonds, whereas the current indices contain government-guaranteed, indexed and non-indexed bonds of varying maturities. The indices will therefore not be as sensitive as the previous indices to the issuers' choice of the type of bonds they issue, i.e. their choice between the types of payment (such as zero-coupon, annuity

or coupon bonds), on the one hand, and between indexed and non-indexed classes, on the other.

## **Indices**

The following indices are calculated for government-guaranteed bonds and bills:

<u>Name</u>	<u>Code</u>	<u>Duration</u>	<u>ISIN</u>
OMXI 10-year indexed	OMXI10YI	10years	IS0000010031
OMXI 10-year non-indexed	OMXI10YNI	10 years	IS0000020436
OMXI 5-year indexed	OMXI5YI	5 years	IS0000011864
OMXI 5-year non-indexed	OMXI5YNI	5 years	IS0000010023
OMXI 1-year non-indexed	OMXI1YNI	1 year	IS0000010007
OMXI 3-month non-indexed	OMXI3MNI	3 months	IS0000010015

The indices have been calculated since in the beginning of 2005 apart from OMXI5YI, which was introduced in December 2005, and OMXI10YNI, which was introduced in February 2011. Historical series have been constructed extending back to the beginning of 1998 except the series for the OMXI10YNI index which only extends back to the beginning of 2011. The 1-year index will include both bonds and bills to attain the one-year duration.

Due to shortage of government-guaranteed short-term securities, OMXI decided to use three-month REIBOR interest rates on the interbank market in ISK for interpolation of OMXI3MNI from and including March 1 until and including June 1 2006.

In February 2011, following the National Debt Management's first ever issuance of a 20-year nominal treasury bond, OMXI started calculating a new 10-year non-indexed bond index (OMXI10YNI). Values for OMXI10YNI were calculated back to the beginning of 2011 but the index had variable duration until the new 20-year bond became eligible in the index on February 1<sup>st</sup>.

## **Eligible securities**

The general rule for the earlier indices, of considering benchmark government-guaranteed bonds, will generally continue to apply. Benchmark bond classes and bills are generally eligible for inclusion in the indices on the fourth day of trading. In constructing historical index series, pre-dating the time of formal benchmark classes of the Treasury and HFF, the marketability of bonds, mainly as reflected by trading volume, is taken into consideration. If the benchmark system is eliminated in the future, OMXI will announce its response specifically; such a response will aim at having "benchmark-equivalent" classes in the indices and reflect the (probable) trading volume.

OMXI also reserves the right to respond to other special circumstances and will give specific notice of any actions in such cases. The first step in this direction was implicit in the calculation of historical index values at the indices introduction, since Housing Authority Bonds and Housing Bonds were excluded after 1 July 2004. This action was justified on the grounds that these were bonds which were in the process of disappearing from the market, and their price formation was not nearly as efficient as previously. Trading in these bonds had fallen sharply and agreements with market makers provided only for bids and not offers.

Apart from this, the indices are reviewed monthly in accordance with the following rules, which include a number of aspects borrowed from the rules of Oslo Børs.

1. Bonds can be considered for inclusion in an index if their duration falls within the period<sup>1</sup>:

[duration of the index - 0.5 \* (1 + duration of the index), duration of the index + 0.5 \* (1 + duration of the index)]

### For example:

For the 1Y index, bonds with a duration of 0 to 2 years are eligible

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<sup>1</sup> When determining the eligibility of a bond, its duration is rounded to one decimal place.

For the 5Y index, bonds with a duration of 2 to 8 years are eligible,

For the 10Y index, bonds with a duration of 4.5 to 15.5 years are eligible.

The 3-month index deviates slightly from this rule. From the beginning of 1998 until 28th of February 2006 only government guaranteed bills with a duration under 1 year were eligible (instead of 0.9 years had the rule above applied). As of June 1, 2006, this rule continues to apply but with the addition that non-indexed Treasury bonds with a duration of 1 year or lower are also eligible. Furthermore, at the same time the rules were changed in order to increase the probability that the index will have a fixed duration. The rules were changed in such a manner that if the situation arises that no eligible security with duration above three months and less than or equal to one year exists, then the government-guaranteed security with the shortest duration among those with duration above one year will be selected. Still, securities with a duration of more than two years do not qualify.

2. Wherever possible, bonds of both longer and shorter duration than that of the index should be chosen. Thus bonds outside of the duration intervals indicated above can be considered if necessary to ensure that the index includes durations both longer and shorter than the designated index duration.
3. If bonds with durations on both sides of the index duration are not available, only one bond shall be chosen for the index, i.e. the bond with a duration closest to the index duration. Only under such circumstances is the index duration variable and will differ from its reference duration.
4. Eligibility for indices based on the duration rules described in steps 1 and 2 above is determined on the 20th of each month (or the first trading day following if the 20th is not a trading day).<sup>2</sup> The duration of the bonds as of that date (based on closing yield that day) is used as reference. Changes under these rules take effect as of the 1<sup>st</sup> of the following month. Please note that this rule, however, does not prevent new benchmark

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<sup>2</sup> The rule described in step 3 has an immediate effect on the day all eligible bonds are on one side of the index target duration.

classes from becoming eligible earlier for the indices, as it applies to classes which had already been issued on the last date of review. As previously mentioned, new benchmark classes become eligible on the fourth day of trading.

### Calculation of index weights

Calculation of the weight of each bond in the index is done in two steps:

- (i) All bonds in the index with a duration less than the index duration are placed in one group (portfolio 1) and all bonds exceeding the index duration in another (portfolio 2). The weights of bonds in each group is determined using a normal distribution, with the mean equal to the index duration and standard deviation equal to  $0.25 * (1 + \text{index duration})$ . In particular, weights of a bond  $i$  in portfolio  $k$  ( $k = 1$  or  $2$ ) is:

$$\alpha_i = \frac{F(-z_i)}{\sum_{i=1}^{n_k} F(-z_i)} \quad (1)$$

where

$\alpha_i$  is the weight of bond  $i$

$F(\cdot)$  is the cumulative probability function for the afore-mentioned normal distribution,

$z_i$  is the number of standard deviations (absolute value) the duration of a bond is from the duration of the index, and

$n_k$  is the number of bonds in group  $k$ .

- (ii) The weights of the portfolios on each side of the index duration are determined in the following manner:

If  $d_{p1}$  is the duration of portfolio 1,  $d_{p2}$  is the duration of portfolio 2 and  $d_{\text{index}}$  is the duration of the index, the weight of portfolio 1 is:

$$\gamma_{p1} = \frac{d_{\text{index}} - d_{p2}}{d_{p1} - d_{p2}} \quad (2)$$

and the weight of portfolio 2 is

$$\gamma_{p2} = 1 - \gamma_{p1} \quad (3)$$

The weight of bond  $i$  in the index is thus

$$w_i = \alpha_i * \gamma_{pk} \quad (4)$$

if the bond is in portfolio  $k$  ( $k = 1$  or  $2$ )

The duration of portfolio  $k$  is found using the following formula:

$$d_{pk} = \sum_{i=1}^n \alpha_i d_i \quad (5)$$

where  $d_i$  is the duration of bond  $i$ .

### **Index calculation**

The index value is calculated using the following formula:

$$I_t = I_{t-1} \sum_{i=1}^n w_{it} \frac{P_{it} + H_{it}}{P_{it-1} - J_{it-1}} \quad (6)$$

where

$I_t$  = the index value on day  $t$ ,

$w_{it}$  = the weight of bond  $i$  in the index on day  $t$ ,

$P_{it}$  = the dirty price, or settlement price, of bond  $i$  on day  $t$ ,

$j_{it-1}$  = an adjustment factor for interest payments and instalments. This is the amount of the cash flow (the sum of instalments and interest) on day  $t$ ,

$H_{it}$  = an adjustment factor reflecting the reinvestment of called bonds (Housing Bonds). This is 0 except on the redemption date of called bonds, when the adjustment factor is given a different value if the yield on date  $t$  differs from the bond's nominal yield. This value depends upon the proportion of bonds called and the yield on the call date (see below for more details).

All bonds are thus placed in the index formula on a comparable price basis, i.e. using the dirty price for all of them, which makes the price in the formula differ from the quoted market price for both HFF bonds and some classes of Treasury bonds, where the quoted market price is the clean price.

The adjustment factor  $j$  in the equation denominator results from the fact that on a cash flow "ex-date", and holding other things constant, the dirty price (settlement price) falls by the amount of this cash flow.

### Adjustment for Housing Bonds

A special adjustment is made to the calculation of indices including Housing Bonds on the redemption date for called Housing Bonds. The reason for this is that the redemption price differs from the market price of the bonds if their nominal interest rate differs from the yield on the date of redemption. Without this adjustment the index including such bonds would underestimate (overestimate) the change in value of the underlying asset portfolio when the redemption price is higher (lower) than the market price of the bond in question.

We can take an example where  $a\%$  of the class concerned is redeemed on date  $t$ . Since the nominal interest rate differs from the bond's market yield, the value of the called bonds is  $a\% * (P_t + b)$  and not  $P_t$  ( $b > 0$  if the nominal interest rate is lower than the market yield and  $b < 0$  if the nominal interest rate is higher than the yield). This makes the adjustment co-efficient

$$H_{it} = a\% * b \quad (7)$$

### Index yield calculation

The indices' yield is calculated by considering the weighted cash flow of the underlying bonds. The calculated yield is only meant to indicate the yield level of the relevant segment of the fixed-income market and is therefore for informational purposes only. The index values are not based on the calculated yield.

The weighted average price of the index is given by:

$$\Omega_{ht} = \sum_{i=1}^n w_{it} \cdot P_{it}, \quad (8)$$

where

- $P_{it}$  : the price of bond  $i$  at time  $t$ ,
- $w_{it}$  : the weight of bond  $i$  at time  $t$ ,
- $\Omega_{ht}$  : the weighted average price of the constituents of index  $h$  at time  $t$ .

The index's yield is obtained through the following formula:

$$\Omega_{ht} = \sum_{s=t}^T \left[ \frac{\sum_{i=1}^n w_{it} \cdot CF_{is}}{(1 + y_{ht})^{(s-t)/360}} \right], \quad (9)$$

where

- $CF_{is}$  : the cash flow from bond  $i$  at time  $s$ ,
- $y_{ht}$  : the yield of index  $h$  at time  $t$ .

The quantity “ $s-t$ ” is calculated according to the 30/360 day count rule.