

Nykredit's Constant Maturity Indices

This documentation provides a description of Nykredit's constant maturity indices and their definitions.

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Introduction

The Nykredit Markets index universe has been expanded to consist of twelve bond indices. In addition to the three existing bond indices the Nykredit Danish Mortgage Bond Index, the Nykredit Total Index, and the Nykredit Inflation Linked index, the index universe is extended with ten new constant maturity indices (CMI).

	CMI 1Y	CMI 3Y	CMI 5Y	CMI 7Y
Callable		X	X	X
Govt	X	X	X	X
BCB	X	X	X	

A CMI is a bond index that aims to replicate the market as closely as possible while simultaneously achieving a predetermined modified option adjusted duration (MOAD). This documentation provides an overview of how such an index is constructed and defined.

There are three new CMIs for callable mortgage bonds with MOAD 3, 5, and 7 years, respectively. There are four new CMIs for government bonds with MOAD 1, 3, 5, and 7, respectively. There are three new CMIs for bullet covered bonds with modified duration 1, 3, and 5, respectively.

The indices are defined from the general principle that the resulting index weights are solely determined by the predefined algorithm. This means that the resulting indices are determined entirely by the input data and without intervention. Additionally, the indices should be liquid and possible to replicate.

Index definition

More formally, the indices are defined as the solution to a minimisation problem. Having chosen a metric to measure how close any given set of index weights is to the market, the minimisation problem finds the set of index weights that are as close to the market as possible while obtaining the desired MOAD. In order to determine exactly which bonds that constitute the market some qualification requirements must be stated.

Bond universe

The bond universe comprises the bonds that are considered for the indices. Each index type have their own requirements for which bonds that qualify to enter the bond universe. Additionally, the bonds are coupled in groups when used in the algorithm. In general the bonds can be grouped by maturity, coupon and amortisation profile. The table below shows how bonds are grouped.

	Coupon	Maturity	Amort.
Callable	X	X	X
Govt		X	
BCB		X	

For instance, a group for the callable mortgage bonds could be annuity bonds with a 2% coupon that mature on 01/10/2050. Note that since only one Danish government bond exists for each maturity the groups are identical to the individual bonds.

Rebalancing

The index is rebalanced two business days before the first of each month. The index follows Danish business days. When the index is rebalanced the minimisation problem is simply solved anew.

Upcoming payments are excluded from the circulating amounts when rebalancing the index two business days before a coupon date.

Input data

The input bond prices used in the indices are the official last traded prices from Nasdaq Copenhagen. The circulating amounts used also provided by Nasdaq Copenhagen. Upcoming prepayments are provided by Nasdaq Copenhagen. Nykredit Markets' prepayment model is used order to calculate MOAD for the individual bonds. MOADs of the individual bonds are published along with the index weights.

Minimisation problem

The minimisation problem that defines the nominal index weights is performed on groups rather than individual bonds. For each group a group nominal market weight and group modified is calculated. The bonds within a group are weighted by their nominal market weight. We seek to minimise the relative squared deviations from the nominal market share of each group while still obtaining the desired MOAD target.

A formal description of the minimisation problem is given in the appendix.

In absence of a feasible solution

In case the minimisation problem is infeasible, the current implementation first expands the bond universe to include additional bonds if possible. If the problem is still infeasible then the MOAD target is adjusted in increments (decrements) of 0.25 in case the target is too low (high) compared to what is attainable in the market. Note, that this algorithm will only fail in case the difference between the lowest and highest MOAD of the entire bond universe is less than 0.25.

Requirements – CMI Callable

The CMI on callables intends to cover the entire callable Danish mortgage bond market. The bonds that can enter the CMI Callable universe adhere to the following requirements.

- Callable
- Fixed coupon rate
- Circulating amount greater than equivalent of EUR 250m.
- At least 1Y to maturity

- Issued in DKK
- Issued by
 - Nykredit
 - Nordea Kredit
 - Totalkredit
 - BRF Kredit / Jyske Realkredit
 - Realkredit Danmark
 - Danske Kredit
- Bond groups must cover 1% of market.
- BRF Kredit / Jyske Realkredit Forfinansierede explicitly excluded
- Amortization profile is either serial, annuity, or bullet.
 - IO possible

The bonds are grouped by coupon, maturity and amortization scheme.

In absence of a solution, the bond universe for the CMI Callable index is expanded. If the universe is expanded then the liquidity requirement for open bonds is reduced to DKK 100m for a single bond. Furthermore, the group need only cover 0.2% of the market.

Requirements – CMI Govt

The CMI Govt intends to cover the entire Danish government bond market. The bonds that can enter the CMI Govt universe adhere to the following requirements.

- Non-callable
- Fixed rate
- Circulating amount greater than equivalent of EUR 250m.
- Issued in DKK
- Issued by Danmarks Nationalbank
- Treasury bills are excluded
- Bullet bond
- At least 1Y to maturity for CMI3, CMI5, and CMI7
- At least 2M to maturity for CMI1

The bonds are grouped by maturity. Since there is only one bond per maturity for the Danish government bonds, the groups are identical to the individual bonds.

The CMI Govt bond universe cannot be expanded. In absence of a solution, the MOAD target is adjusted without including new bonds.

Requirements – CMI BCB

The CMI BCB intends to cover the entire Danish bullet covered bond market. The bonds that can enter the CMI BCB universe adhere to the following requirements.

- Non-callable
- Fixed Rate
- Circulating amount greater than equivalent of EUR 250m.
- Issued in DKK.
- Issued by
 - Nykredit
 - Nordea Kredit
 - Totalkredit
 - BRF Kredit / Jyske Realkredit
 - Realkredit Danmark
 - Danske Kredit
- Bullet
- At least 1Y to maturity for CMI3 and CMI5
- At least 2M to maturity for CMI1
- Government backed bonds are excluded
- BRF Kredit/Jyske Realkredit forfinansierede (English?) are excluded

The algorithm used to solve this problem is based on M.J.D. Powell's TOLMIN numerical optimization algorithm.

The bonds are grouped by maturity.

The CMI BCB bond universe cannot be expanded. In absence of a solution, the MOAD target is adjusted without including new bonds.

Content on sFTP-site

The indices are published on Nykredit's [website](#) and Nykredit Markets' sFTP site. The files are located under /common/ConstantMaturityIndex. The file CMI_weights_YYYYMMDD.csv contains the current nominal weights of the constant maturity indices and the MOAD used in the rebalancing. CMI_returns_YYYYMMDD.csv contains historical values of all constant maturity indices.

Appendix

Let N be the number of groups, $x_i \in [0,1], i = 1, \dots, N$ be the index weight of the i 'th group, $\bar{x}_i \in [0,1], i = 1, \dots, N$ be the corresponding market weight of the group, and $X = \{x_1, \dots, x_N\}$ be the set of weights. Formally, the objection function of the minimisation problem is then:

$$\min_{x_i \in X} \sum_{i=1}^N \left(\frac{x_i - \bar{x}_i}{\bar{x}_i} \right)^2$$

The objective function is subject to the constraints that index weights are non-negative, add-up to one, and achieve the constant maturity target, T_{MOAD} . Let $MOAD_i, i = 1, \dots, N$ be the MOAD of group i , the constraints can be formalized as the following four constraints.

1. $\sum_{i=1}^N x_i MOAD_i = T_{MOAD}$
2. $\sum_{i=1}^N x_i = 1$
3. $x_i \geq 0, \forall i$
4. $x_i \leq 1, \forall i$