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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 consists of 30 bond indices of which 16 are of the Constant Maturity Index (CMI) type. They are divided into Callable, Callable EUR, Government Bonds and Bullet Covered Bonds.

CMI	1Y	2Y	3Y	4Y	5Y	7Y
Callable			X		X	X
Govt	X	X	X	X	X	X
BCB	X	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 CMIs for callable mortgage bonds with MOAD 3, 5, and 7 years, respectively. Additionally there are three more with the same specifications, but EUR hedged. There are six CMIs for government bonds with MOAD 1, 2, 3, 4, 5, and 7, respectively. There are four CMIs for bullet covered bonds with modified duration 1, 2, 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 the groups can consist of both green and non-green bonds.

Rebalancing

The index is rebalanced two business days before the first of each month. The index follows Danish business days. When

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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 at least 1% of market.
- BRF Kredit / Jyske Realkedit Forfinansierede not included
- 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 open group need only cover 0.2% of the market. The liquidity requirements for the closed bonds and groups are preserved from the initial attempt to find a feasible solution. This ensures the expanded index universe is a superset of the original index universe.

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 CMI2, CMI3, CMI4, 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 CMI2, CMI3 and CMI5
- At least 2M to maturity for CMI1
- Government backed bonds are excluded
- BRF Kredit/Jyske Realkredit forfinansierede (English?) are excluded
- The grouped bonds should represent at least 1% of the market.

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, $\overline{x_i} \in [0,1], i = 1, \dots, N$ 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:

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

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. $x_i \leq 1, \forall i$

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