



## The Danish mortgage bond market

**Nykredit**

# Contents

The Danish bond market	4
Investment in mortgage bonds	10
Nykredit's mortgage bond indices	14
Issuance: tap and auctions	16
The repo market	17
Refinancing and prepayment	19
Available market information	21
Cash flows	23
Pricing of fixed-rate callable bonds	26
Pricing of capped floaters	29
Other sources of information	31

## DANISH MORTGAGE BONDS

The Danish mortgage bond market is Europe's second largest covered bond market after the German Pfandbrief market and more than twice the size of both the French and the Spanish covered bond markets.

The size of the Danish mortgage bond market can be ascribed to the fact that real property financing in Denmark is mainly based on mortgage loans raised through mortgage banks whose lending is funded exclusively through the issuance of mortgage bonds - covered bonds.

As the Danish market is not part of the euro zone and the main part of issues are DKK-denominated, Danish mortgage bonds offer:

- A Aaa-rated market, high carry and liquidity
- Solid historical performance
- Portfolio diversification
- Ultra-long duration through the new 30-year capped floaters
- A vehicle for volatility selling off the OTC derivatives market
- A spread market vs Euroland with extremely low currency risk

This paper contains the essentials of the Danish mortgage bond market and has been prepared for investors and others who are interested in learning more about Danish mortgage bonds.

The Danish mortgage finance system contains several special features designed to support and enhance the credit strength of Danish mortgage bonds. In many ways, the legal and institutional framework has been the basis for the efficiency and success of Danish mortgage finance and is probably the foremost reason for the notably long and unblemished history of specialised lending in Denmark.

The statutory balance principle, the backbone of Danish mortgage finance, which de facto eliminates mortgage banks' liquidity, interest rate and currency risks, has basically not been changed since 1850. Another fundamental trait of the system is the inherent preferential status which mortgage bondholders enjoy through their claims on a mortgage bank in case of its insolvency, of which there has been none in the 200-year long history of Danish mortgage bonds.

According to Moody's, "the MCA of Denmark is one of the, if not the strongest mortgage bond frameworks in the world".

A specialised lender principle provides mortgage banks with an exclusive right to grant mortgage loans and issue mortgage bonds.

The mortgage banks are subject to supervision by the Danish Financial Supervisory Authority (DFSA).

The Danish market is characterised by a high degree of concentration – at present, four major issuers account for 95% of the bond debt outstanding. The liquidity of Danish mortgage bonds is further supported by the fact that all mortgage banks issue bonds with almost identical characteristics resulting in a unity-like market. In practice, bonds from different issuers are therefore traded on equal terms.

Nykredit aims to provide its investors and other interested parties with relevant, reliable and accurate information.

For more information, visit our website at [www.nykredit.com/ir](http://www.nykredit.com/ir) and [www.nykreditmarkets.com](http://www.nykreditmarkets.com), or contact us directly.

Nykredit, March 2006.

### Nykredit contacts

#### Investor Relations:

Michael Ager Carlsen, Head of Investor Relations,  
[mca@nykredit.dk](mailto:mca@nykredit.dk), +45 33 42 11 40

#### Research:

Martin Hagelskjær Nielsen,  
Head of Fixed Income and Derivatives Research,  
[marn@nykredit.dk](mailto:marn@nykredit.dk), +45 33 42 11 56

#### Sales:

Kim Lynggaard Madsen, Head of International Sales,  
Fixed Income and Derivatives,  
[klm@nykredit.dk](mailto:klm@nykredit.dk), +45 33 42 13 54

Internet: [www.nykredit.com/ir](http://www.nykredit.com/ir)  
[www.nykreditmarkets.com](http://www.nykreditmarkets.com)

## THE DANISH MORTGAGE BOND MARKET AND THE BONDS

### The Danish bond market

The Danish bond market is among the largest in the world with a nominal outstanding amount of bonds of DKK 2,427bn (EUR 325bn) at end-2005 of which Danish mortgage bonds accounted for DKK 1,740bn (EUR 233bn) equal to approx 72% of the total Danish bond market.

**Table 1: Outstanding amount of bonds, December 2005, EURm**

Bond type	Market value	Nominal value
Government bonds, etc	77,909	71,334
Treasury bills	7,981	8,055
<b>Total government bonds</b>	<b>85,890</b>	<b>79,389</b>
Fixed-rate callables	96,633	97,883
Non-callable bullets, DKK	76,933	77,286
Non-callable bullets, EUR	10,990	10,851
Floating-rate bonds	31,617	31,709
Index-linked	17,532	15,538
<b>Total mortgage bonds</b>	<b>233,706</b>	<b>233,267</b>
Other Danish bonds	11,836	11,898
<b>Total Danish bonds</b>	<b>331,432</b>	<b>324,554</b>
Foreign bonds	896	781
<b>Total</b>	<b>332,327</b>	<b>325,335</b>

Source: Nykredit Markets

The Danish mortgage bond market is highly concentrated not only in terms of the number of mortgage banks (currently seven), but particularly with respect to volume and liquidity within the different benchmark bonds.

The outstanding amount of mortgage bonds, as well as liquidity, is concentrated within a limited number of bonds from each issuer. The large bonds are typically bonds that are or have been open for issuance for the past couple of years, cf Table 4.

The reason for the concentration within a limited number of bonds is the historically low interest rates and Danish borrowers taking advantage of these to refinance loans.

The high level of liquidity within a limited number of bonds contributes to ensuring an effective pricing, which is further underpinned through market making agreements between some members of the OMX, the Copenhagen Stock Exchange (CSE).

**Table 2: Daily turnover 2005 (excl repos), nom value, EURm**

Month/year	Mortgage bonds	Government bonds
January 2005	2,502	1,444
February 2005	2,262	890
March 2005	1,843	635
April 2005	2,528	854
May 2005	2,127	690
June 2005	3,081	1,104
July 2005	1,941	494
August 2005	2,082	638
September 2005	2,305	770
October 2005	2,475	770
November 2005	2,735	913
December 2005	8,665	977

Source: CSE

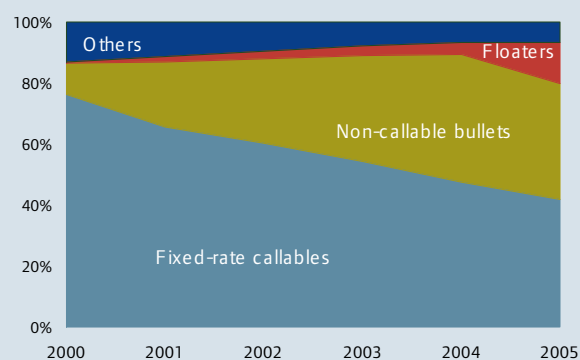
### Mortgage bonds

Danish mortgage bonds are listed on the CSE. The bonds that have been issued in accordance with UCITS 22.4 and Danish mortgage credit legislation meet the criteria for covered bonds. Danish mortgage banks are supervised by the DFSA.

### Bond types

In recent years, the Danish mortgage bond market has undergone large structural changes on the product side - a development expected to continue. Figure 1 shows the distribution of the outstanding amount of bonds by bond type.

**Figure 1: Outstanding amounts by bond type, end-2005**



Source: Nykredit Markets

**Figure 2: Outline of main bond types (open for issuance)**

**Fixed-rate callables:**

- Fixed-rate callable annuity bonds
- With or without interest-only options (interest-only period of a maximum of 10 years)
- Maturities: 10, 20 and 30 years
- Daily tap issuance depending on the lending activity
- Used to fund fixed-rate callable annuity loans until expiry of loan term with or without interest-only options
- Opening periods of typically three years
- DKK- (mainly) and EUR-denominated

**Non-callable bullets:**

- Fixed-rate non-callable bullet bonds
- Maturities: 1 to 11 years
- Daily tap issuance combined with...
- ... auctions in March (from 2006), September (from 2006) and December
- Used to fund adjustable-rate annuity loans up to interest reset day
- Open for issuance until maturity
- DKK- and EUR-denominated

**Floater:**

- Floating-rate annuity bonds
- Coupon typically based on 6M Cibur plus fixed spread subject to semi-annual coupon fixing (Cibur-linked)
- Capped or non-capped
- With or without interest-only options (interest-only period of a maximum of 10 years)
- Maturities: 5, 10, 20 and 30 years
- 20- and 30-year bonds typically with a prepayment option at a price of 105 just as a few of the shorter-term bond types are callable either at par (100) or at a price of 105
- Daily tap issuance combined with auctions in December
- Fund floating-rate mortgage loans with or without interest-only options and capped or non-capped
- DKK- (mainly) and EUR-denominated

Danish mortgage bonds can basically be grouped into three types: Callables, non-callables and floaters.

Long-term fixed-rate callable annuity bonds have traditionally dominated the Danish mortgage bond market. However, the introduction of fixed-rate non-callable bullet bonds and related adjustable-rate mortgage loans (ARMs) in the second half of the 1990s and, most recently, the successful introduction at end-2004<sup>1</sup> of capped long-term floating-rate Cibur<sup>2</sup>-linked bonds and related floating-rate mortgage loans with interest rate caps have diversified the Danish mortgage bond market, providing investors as well as borrowers with far more investment opportunities.

The main part of all new issuance takes place within three bond types: fixed-rate callable annuity bonds (fixed-rate callables), fixed-rate non-callable bullet bonds (non-callable bullets) and long-term capped floating-rate annuity bonds (capped

floaters). Figure 2 provides an outline of the three main bond types.

**Floating-rate mortgage bonds**

Among floating-rate mortgage bonds, capped long-term Cibur-linked bonds, ie the capped floaters, constitute the largest and most homogeneous subgroup.

In 2000 borrowers were offered the opportunity to raise 30-year floating-rate mortgage loans with interest rate caps. The bonds behind these loans are capped floaters with maturities of up to 5 years. After five years borrowers have to refinance their loan through new capped floaters, and the interest rate cap is therefore only effective for five years. In 2004 it became possible to raise loans funded by capped floaters with maturities of up to 30 years, whereby borrowers can obtain a fixed interest rate cap throughout the loan term. Since then, the product development and the introduction of new floating-rate loan and bond types

<sup>1</sup> Capped short-term (5-year maturity) floating-rate bonds were introduced by Totalkredit in 2000.

<sup>2</sup> Copenhagen Interbank Offered Rate.

have accelerated. As a result, a large number of floating-rate bonds with different individual features are now being offered.

Other Danish mortgage banks such as RD, Nordea and BRF have also launched floating-rate Cibor-linked bonds but with more exotic features. The so-called floating-to-fixed-rate bonds are characterised by converting into an ordinary fixed-rate callable bond in case 6M Cibor rates reach a certain level (knock-in). Issuance in this type of bond is declining heavily as borrowers prefer capped floating-rate mortgage loans and consequently capped floating-rate bonds. Other floating-rate bonds in the Danish market have mainly been issued by Nykredit and Totalkredit, and a detailed description of their features is available at [www.nykredit.com/ir](http://www.nykredit.com/ir).

### Non-callable bullets

Since the introduction of ARMs and up to 2004, many borrowers opted to take advantage of the steep yield curve by raising ARMs funded by short-term fixed-rate non-callable bullets. This led to the creation of a substantial market for non-callable bullet mortgage bonds representing almost 40% of the mortgage bond market in 2004.

Non-callable bullets with maturities of up to 10 years are offered, but the market is dominated by short-term 1-year bonds. Until 2005 all bonds matured on 1 January, at which time all mortgage loans behind the bonds consequently had to be refinanced. The loans were refinanced through large auctions every December where considerable amounts of new short-term non-callable bonds were issued, cf Table 3. From 2006 Nykredit will furthermore hold refinancing auctions in March and September for which reason bond series maturing on 1 April and 1 October are now offered.

**Table 3: Non-callable mortgage bond auctions**

Auction	Total issuance, DKKbn	Of which 1-year bonds	Of which 2-year bonds
2005	312.3	72.5%	1.2%
2004	247.3	77.5%	1.7%
2003	129.1	66.3%	1.7%
2002	103.6	70.0%	2.4%

Source: Nykredit Markets

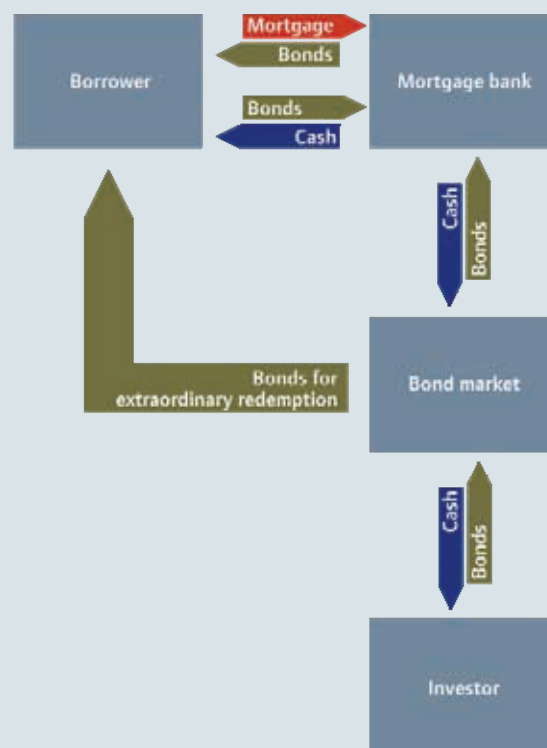
### Details

Bond prospectuses and fact sheets providing detailed descriptions of the individual bond types are available for download at [www.nykredit.com/ir](http://www.nykredit.com/ir), just as the features of the individual bonds may be downloaded from Nykredit's Bond Data pages. These pages also contain supplementary market information on debtor distribution, cash flows, drawings and prepayments.

### The delivery option

Danish mortgage borrowers may terminate their loans by buying back the mortgage bonds in the bond market and delivering them to the mortgage bank. This option is referred to as the delivery option or the buyback option. The buyback option applies to all mortgage bonds whether callable or non-callable. The buyback option is a special feature of the Danish mortgage finance system, and borrowers therefore always know the ISIN code(s) of the bonds behind their mortgage loans. The buyback option constitutes a significant difference between the US and the Danish mortgage finance system. The US system only allows mortgage loan prepayment at par (100).

**Figure 3: The delivery option**



A unique feature of the Danish mortgage finance system is borrowers' possibility of prepaying loans by delivering the bonds behind the loan to the mortgage bank.

The buyback option does not affect the nominal value of investors' mortgage bond positions which will remain unchanged in case of buybacks. However, it may have an indirect effect on investors' positions as buybacks will typically have a positive effect on prices as a result of increasing demand in the bond market. If no investors are prepared to sell, borrowers may be forced to pay a high price for buying back their bonds, and small illiquid bonds are therefore often expensively priced in the Danish mortgage bond market.

The buyback option is an advantage to borrowers in situations with rising interest rates. As bond prices fall, the market value of borrowers' debt is reduced along with borrowers' exposure to increasing rates as a result of decreasing property prices. For borrowers with 30-year fixed-rate loans, such effect may be significant.

The consequences of borrowers' prepayment option in connection with funding through callable bonds are described in detail under "Refinancing and prepayment" below.

### Issuance

Danish mortgage bonds are issued on a current basis through daily tap issuance directly in the market combined with regular auctions held in connection with the refinancing of ARMs and floating-rate loans with fixed-term interest rate caps.

### Tap issuance

Tap issuance funds the current funding need arising out of Nykredit's lending activities and, in combination with the long opening period, secures the build-up of large liquid bond series.

The tap issuance is a consequence of the Danish statutory balance principle. The balance principle requires a match between the cash flows relating to mortgage lending and bond issuance.

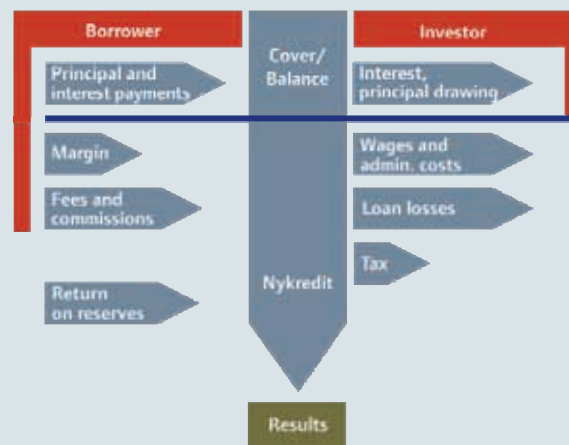
Callables and long-term capped floaters are issued in bond series with opening periods typically of three years. Short-term bullets and floaters are open for issuance throughout their maturity.

In 2005 the new floaters accounted for 18% of total new issuance, while fixed-rate callables and non-callable bullets accounted for 36% and 46%, respectively, of total new mortgage bond issuance.

### Volume and liquidity

The balance principle and the strict rules for maturities and repayment profiles of Danish mortgage finance legislation form the basis of the large number of bond series.

**Figure 4: The Danish balance principle**



Balance between cash flows relating to mortgage bank lending and bond issuance.

Although there were almost 1,900 bond series in the Danish market at end-2005, the outstanding bond amount is concentrated within a limited number of bond series which are very large, even by international standards. The very large series are the outcome of the interest rate development, loan refinancing and growing mortgage lending from the 1990s and ahead. Of the total number of bond series, 119 and 67 have outstanding nominal amounts exceeding EUR 500m and EUR 1bn, respectively, equal to a market share of 75% and 64%, respectively, and a share of market turnover of 99% and 84%, respectively, at end-2005. Table 4 shows the outstanding amount of the largest bonds within each of the three main bond types.

The depth and liquidity in the Danish market are further supported by the unity-like market. This means that issuers of Danish mortgage bonds issue bond series with identical coupons, maturities and coupon dates with respect to fixed-rate callables and non-callable bullets. Bonds from different issuers therefore practically trade as one. Where floaters are concerned, however, the issues differ significantly from issuer to issuer, although certain similarities exist as regards the features of long-term capped floaters.

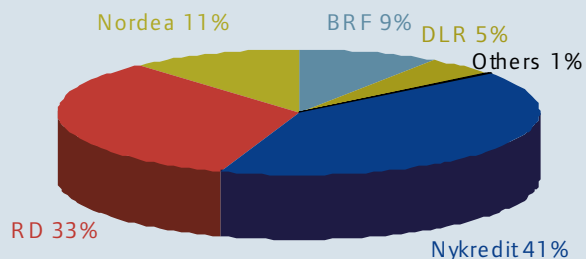
Danish mortgage bonds are mainly issued in DKK. However, some fixed-rate non-callable bullets denominated in EUR have large outstanding amounts.

### Issuers

Danish mortgage banks issue mortgage bonds to fund their mortgage lending activities. In consequence of the strict Danish mortgage finance legislation, mortgage loans may exclusively be

granted against registered mortgages on real property, just as the balance principle requires balanced lending and bond issuance.

**Figure 5: Danish mortgage bond market, December 2005**



Nykredit includes Totalkredit.

Source: Association of Danish Mortgage Banks

Seven Danish mortgage banks currently issue new mortgage bonds: Nykredit Realkredit A/S (NYK), Totalkredit A/S (TOT), Realkredit Danmark A/S (RD), BRFkredit A/S (BRF), LR Realkredit A/S (LR), Nordea Kredit Realkreditaktieselskab (NDA) and DLR Kredit A/S (DLR). Figure 5 shows market shares in terms of bond debt outstanding.

Among the mortgage banks above, Nykredit Realkredit, Realkredit Danmark and Nordea Kredit offer mortgages for all property types, while the remaining mortgage banks focus on a limited property segment. Totalkredit, which exclusively grants private residential mortgage loans, is a Nykredit subsidiary. New issuance in Totalkredit will cease once the joint funding activities with Nykredit have been fully implemented.

**Table 4: Outstanding amounts of selected mortgage bonds, end-2005, EURm**

	Fixed-rate callables, DKK	Non-callable bullets, DKK	Non-callable bullets, EUR	Floaters,	DKK
Nykredit	4% 2038 1,946	2% 2007 15,048	4% 2007 549	CF 5% 2038	1,558
Totalkredit	-	4% 2007 694	-	CF 6% 2038	1,245
RD	4% 2038 1,634	2% 2007 15,128	4% 2007 334	CF 5% 2038	1,497
BRF	4% 2038 486	2% 2007 4,669	4% 2007 12	CF 5% 2038	455
NDA	4% 2038 5,136	2% 2007 6,126	4% 2007 110	CF 5% 2038	171
LRF	4% 2038 25	4% 2007 357	-	CF 5% 2038	14
DLR	4% 2038 196	2% 2007 3,101	4% 2007 208	CF 5% 2038	279

Source: CSE

## Rating

The majority of Danish mortgage bonds are Aaa-rated, just as new issuance mainly takes place in Aaa-rated bond series.

Nykredit and a few of the other mortgage banks issue their mortgage bonds through capital centres. These are characterised by constituting independent liability entities separate from other bonds and mortgages. The capital centres have segregated reserve funds which are subject to special investment rules.

**Table 5: Rating of Danish mortgage bonds**

	Moody's	S&P's
Nykredit	Aaa	-
Totalkredit	Aaa	-
RD	Aaa	AAA
NDA	Aaa	AAA
BRF	Aa1	-
DLR	Aa1	-
LRF	-	-

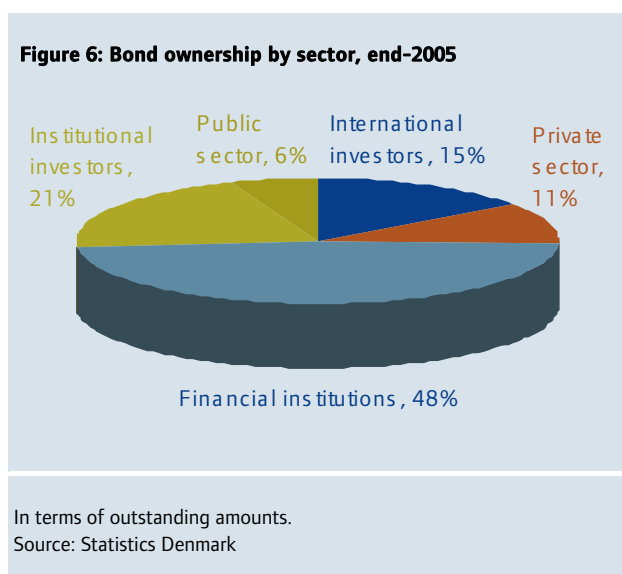
Bond series open for issuance.



## Investors

Danish mortgage bonds are purchased by all types of Danish and foreign investors. The bank and mortgage bank ownership share continues to increase and was 47% at end-2005. The increase has mainly taken place at the expense of insurance companies' and pension funds' ownership shares, while foreign investors' ownership share (15% at end-2005) as well as private and public sector ownership shares have been stable in recent years.

Foreign investors' interest in Danish mortgage bonds was simulated by the inclusion of selected Danish non-callable bond series at 1 July 2004 in the Lehman Brothers bond index.



The diversified ownership of Danish mortgage bonds and the market maker agreements contribute to securing an effective pricing of benchmark mortgage bonds.

On a quarterly basis, Statistics Denmark publishes a detailed survey of investors owning the bonds listed on the CSE.

## INVESTMENT IN MORTGAGE BONDS

This section outlines a number of investment strategies for each of the three main bond segments and ends with a review of Nykredit's Danish Mortgage Bond Index and Lehman's index containing Danish mortgage bonds.

The main activity in Danish mortgage bonds takes place in the open bond series where mortgage banks currently issue new bonds, just as the outstanding amount is concentrated in these bonds. A line of the closed bonds, eg 5% MTG 2035, are still relatively liquid. Older bond series are typically relatively illiquid, but nonetheless still attract the attention of quite a few investors.

### Research and quotes

Both foreign and domestic investors demand in-depth research on the Danish mortgage bond market. Nykredit Markets meets this demand by further developing pricing models and offering a number of IT solutions. Nykredit Markets updates and distributes a number of central key figures on benchmark bonds via Reuters, Bloomberg and the internet on a daily basis. Reuters and Bloomberg also contain updated prices on Danish benchmark government and mortgage bonds as well as comments and key indicators on the Danish economy.

Furthermore, it is possible for Nykredit Markets customers to make calculations and examine historical market movements by means of our web-based research tool, Bond focus.

Investors seeking an overview of the development in returns on Danish mortgage bonds may avail themselves of the Nykredit Danish Mortgage Bond Index which gives a good impression of the development in the return on Danish mortgage bonds. The index is published daily on Nykredit Markets's

website, [www.nykreditmarkets.com](http://www.nykreditmarkets.com), as well as Bloomberg (NYKR) and Reuters (NYKI).

**Table 6: Quotes and key figures**

Reuters:	Bloomberg:
Nykred12	NYKR
Nykred17	

Nykredit Markets quotes prices on benchmark mortgage bonds through Reuters and Bloomberg. Key figures and indices are available at [www.nykreditmarkets.com](http://www.nykreditmarkets.com) and [www.bondfocus.com](http://www.bondfocus.com). At Bloomberg you can also view information about the Nykredit Danish Mortgage Bond Index as well as historical performance data.

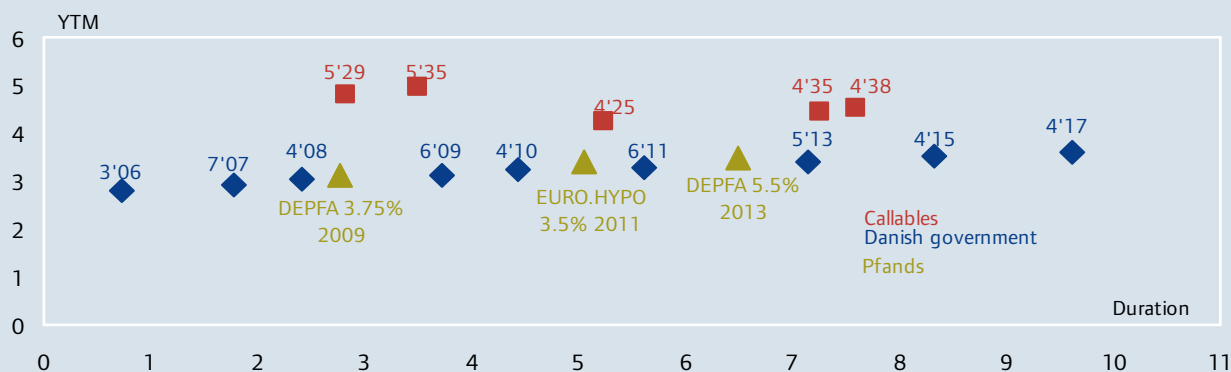
"The market set-up" below contains a review of the market set-up and trading conventions in the Danish market.

### Investment in fixed-rate callable bonds

Historically, fixed-rate callable mortgage bonds have been the mainstay of the Danish mortgage bond market and still represent the largest market segment, cf Figure 1.

Fixed-rate callable bonds typically have an annuity profile with times-to-maturity of 20 or 30 years and four annual coupon dates. The fact that the bonds are callable means that borrowers may prepay the underlying loans at par (100) in connection with any future coupon date.

**Figure 7: YTM relative to the duration of callable Danish MTGs, government bonds and German Pfandbriefs**



Source: Nykredit Markets

The prepayment option means that investors obtain only limited upside potential on yield decreases, but nonetheless typically a significantly higher YTM relative to non-callable bonds involving the same interest rate risk as illustrated in Figure 7.

The prepayment option makes the pricing of the bonds relatively complex and places demands on investors' risk management. Successful investment in callable mortgage bonds requires an understanding of how prepayment risk affects the pricing. Figure 8 shows typical trends in market prices given changes in yields as well as the significant variation in the characteristics depending on whether prices are far below or close to 100. The prepayment option makes these bonds very different from other similar bonds without embedded prepayment options. This means that certain bond key figures commonly used such as YTM and YCS are of limited usefulness. Instead, you should apply a theoretical pricing model to assess risk as well as investment potential in callable bonds. The pricing model applied is reviewed in the section "Pricing of Danish mortgage bonds". The key figure most commonly applied in the assessment of the investment potential of callable mortgage bonds is option-adjusted spread (OAS). OAS reflects the yield pick-up investors obtain when adjusting for the prepayment option. The OAS key figure provides investors with a basis for comparing the value of callable mortgage bonds with other investment alternatives. OAS is typically estimated relative to the Danish swap yield curve, but may also be estimated relative to the government bond yield curve. Current OAS levels play an important role, but trading strategies are often established as a result of OAS changes. Relative value strategies where you sell a mortgage bond and buy another are therefore often established as a result of changes in the OAS between the bonds.

### Callables – out of the money

Callable bonds trading far below 100 (low-coupon bonds) have characteristics that are similar to non-callable bonds because of the limited value of their prepayment option. The risk management of these bonds is therefore relatively simple. These bonds are often the first choice of new or non-Danish investors. Liquidity is typically highest in this segment as it usually involves open benchmark bonds. A very common trading strategy for this group of callable mortgage bonds is to buy mortgage bonds and sell government bonds with the same risk profile. The calculation of hedge ratios will typically be based on option-adjusted basis point value (OABPV). Such strategy also provides investors with:

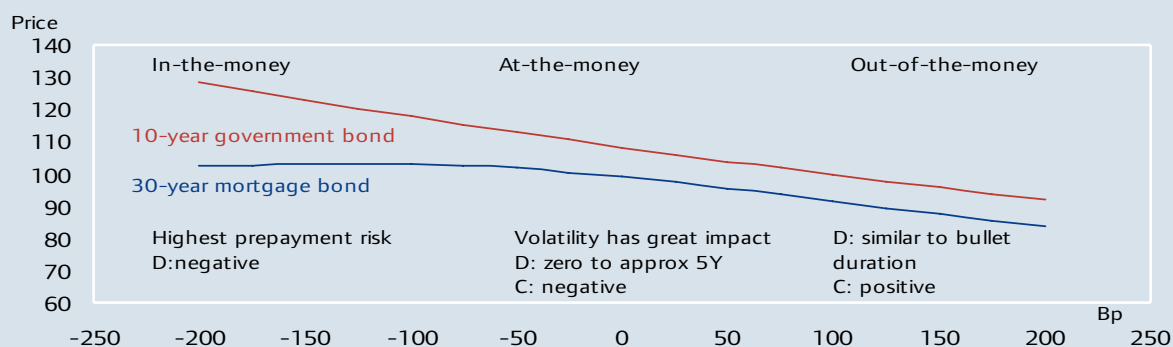
- High positive carry
- Neutral or limited negative convexity
- Exposure to rising volatility

Foreign covered bond investors may establish corresponding investment strategies eg by selling German Pfandbriefs and buying callable mortgage bonds.

### Callable MTGs – at the money

Callable mortgage bonds trading close to 100 will have an at-the-money prepayment option. The risk management of these bonds is complex because of their high negative convexity. The bonds are characterised by limited upside and significant downside. The downside is attributable to rising yields increasing the duration significantly (extension). The high complexity means that investors typically demand a higher risk premium (OAS) for buying these bonds. The hedging of callable bonds trading close to par requires interest rate derivatives to hedge both the extension and the volatility risk or regular adjustment of hedges with non-callable bonds (delta hedging). Investors often establish strategies involving swaptions to hedge risk.

**Figure 8: Theoretical price of a 30-year mortgage bond vs the YTM of a 10-year government bond**



Difference between the theoretical price of a 30Y callable bond and a 10Y government bond on shifts in yield levels.

### Callables - in the money

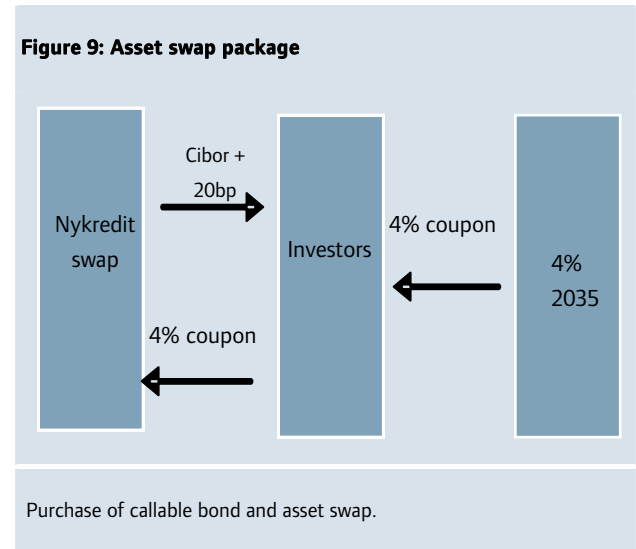
Callable bonds trading far above par (high-coupon bonds) have typically been subject to high prepayment rates on a number of past coupon dates. As a result, the current outstanding amount only constitutes a small fraction of the original outstanding amount (pool factor below 10%). At present, bonds with a coupon from 6% and above fall into this category. On account of the low pool factor, prepayments have become less dependent on yield levels as most rational borrowers have already prepaid their loans. Furthermore, it will take significant yield rises before extension risk starts being a problem. This type of bond has a duration close to zero and is traded as an alternative to the money market. Because of the small outstanding amount, liquidity is low and large purchases/sales difficult to execute.

Investors who prefer investments in high-coupon mortgage bonds to money market investments are therefore willing to assume the interest rate and prepayment risks which do not exist in the money market. These investors are also willing to risk a prepayment rate higher than discounted by the market as well as a volatility increase.

### Asset swap of callable bonds

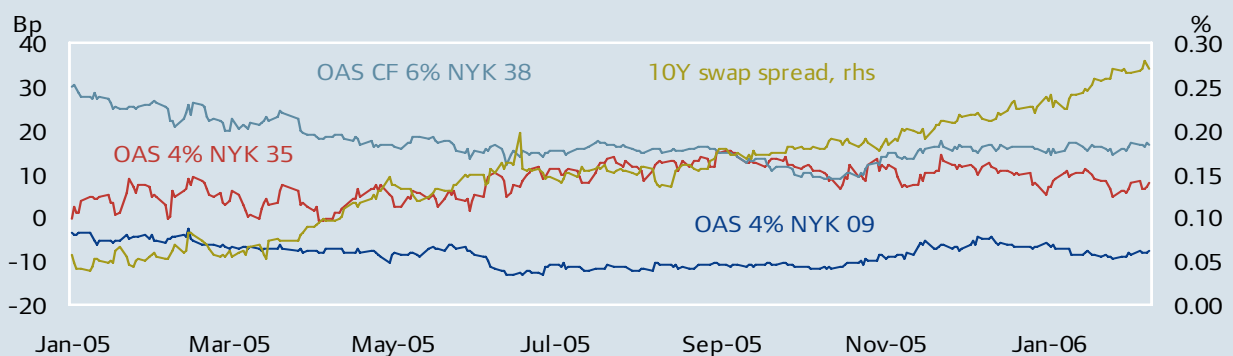
Interest rate derivatives may be applied to establish asset swap packages based on callable mortgage bonds. The bonds are asset swapped so that investors receive a variable rate plus a spread, while eliminating prepayment, interest rate and volatility risks. It is typically only relevant to establish asset swap packages in periods in which Danish mortgage bonds are relatively cheap. As a rule of thumb, the OAS against the swap curve should be over 30bp before it would be relevant to

establish asset swap packages. In situations with spread widening, the establishment of asset swap packages will underpin prices in callable bonds. Figure 9 illustrates the structure of asset swap packages.



Investors are buying the mortgage bond funded at 3M Cibor, while entering into a payer interest rate swap where investors pay the bond's fixed coupon rate and receive a floating rate plus a spread. The interest rate swap should have the same amortisation profile as the mortgage bond. Furthermore, you will be buying the right to cancel the interest rate swap on all future coupon dates in step with borrowers' loan prepayment. This can be done by purchasing a Bermuda swaption. Such a construction is often referred to as a cancellable asset swap package. The price of the overall package will be 100.

**Figure 10: OAS and swap spread**



Source: Nykredit Markets

The asset swap package can only be established with bonds trading below par. The spread which investors receive is often referred to as the Cibar spread. This spread will be lower than the OAS. The reason is that an asset swap package protects investors from a 100% prepayment rate on a subsequent coupon date. By contrast, the OAS is estimated on the basis of statistical assumptions of borrowers' historical prepayment behaviour which only rarely results in prepayment rates over 40% on any coupon date. Moreover, some borrowers will never prepay their loans whatever the incentive. The OAS therefore factors in that borrower behaviour is not necessarily rational.

### Investment in fixed-rate non-callable bullets

The market for Danish fixed-rate non-callable bullet bonds is dominated by short-term 1Y bonds. Up to and including 2005, all non-callables have been maturing on 1 January on which date the underlying loans were up for refinancing by auction in December. From 2006, Nykredit started supplementing the December refinancing auctions of 1Y bonds with auctions in March and September.

In contrast to callable mortgage bonds, the pricing of non-callable mortgage bonds is very simple. The bonds from most issuers are Aaa-rated and typically quite aggressively priced at negative spreads against the swap curve.

The very low complexity makes these bonds attractive to a string of investor segments that wish to avoid or is unable to handle the risk related to callable bonds. Foreign investors familiar with investments in eg German Pfandbriefs could just as well buy Danish fixed-rate non-callable bonds. The only risk factor compared with German Pfandbriefs is the FX exposure to DKK. Danish mortgage banks also offer EUR-denominated non-callable bonds. These have lower outstanding amounts than the DKK-denominated equivalents.

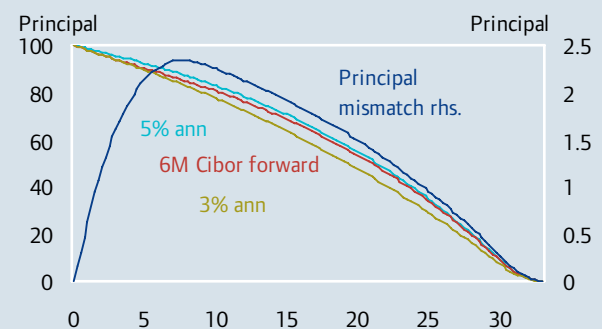
### Investment in long-term capped floaters

Despite the variable nature of long-term Danish capped mortgage floaters, they cannot be compared with other ordinary floaters as their embedded caps involve both interest rate and volatility risk. 30Y capped floaters with 5% caps have a higher sensitivity to changes in 30Y yields than 30Y fixed-rate callable bonds.

The Danish capped mortgage floaters typically have an annuity cash flow. On each coupon fixing date, the annuity profile-to-maturity is recalculated, and this means that the bond's repayment profile becomes dependent on 6M Cibar, thereby gaining a stochastic element. As a result of the special characteristics of capped floaters, ordinary mortgage/government bond strategies where you buy a capped floater and sell a government bond are problematic. In terms of BPV alone, it

will offhand be most natural to hedge the CF bond by selling a 5Y government bond. The problem with this strategy is that the capped floater has negative interest rate sensitivity in the 5Y spot making investors very vulnerable to curve steepening. A more "appropriate" strategy would be to buy a 5Y government bond along with the capped floater, while selling a 20Y government bond. Table 7 shows how investors can hedge the curve risk of the capped floater with two government bonds.

**Figure 11: Cash flow of 30Y capped floater**



Repayment profile depends on the development in 6M Cibar rates.

### Asset swaps of Cibar-linked bonds

Asset swaps of Cibar-linked capped floaters are in principle very simple as investors only have to buy a cap equal to the embedded cap of the bond. This provides investors with 6M Cibar plus a spread. Example:

CF 5% 2038 has a bond coupon cap of 5% and pays 6M Cibar plus 80bp. The embedded cap of the bond therefore has a strike rate of  $4.1315\% (4.1315+80bp) \cdot (365/360) = 5\%$ . However, there are certain challenges involved in buying 30Y amortising caps:

- 30Y amortising DKK-denominated caps are illiquid
- The EUR cap market is a good alternative but entails country spread risk
- The stochastic amortisation a priori implies some degree of uncertainty about the choice of cash flow.

In practice, many investors have opted to hedge the vega risk of capped floaters by buying plain vanilla EUR caps. The use of plain vanilla EUR caps makes it possible to hedge delta, gamma and vega risks

**Table 7: Buying long-term Cibor-linked bonds – CF 5% 2038 – curve hedge with government bonds**

Bond	Nom	Price	OAD	OAC	Vega	BPV2Y	BPV5Y	BPV10Y	BPV30Y
CF 5% 2038	100.00	98.82	4.60	-1.40	-0.51	-0.08	-0.10	2.14	2.49
6% DGB 09	90.00	110.18	3.73	0.17	0.00	1.42	1.76	0.00	0.00
7% DGB 24	-47.00	144.56	17.03	2.72	0.00	0.35	0.99	5.75	2.72
Money market	-131.39		0.25	0.00	0.00	0.24	0.00	0.00	0.00
Total		0.00	-0.38	-2.52	-0.51	0.70	1.01	-0.56	1.22

Source: Nykredit Markets

### Nykredit's mortgage bond indices

Due to the size of the Danish mortgage bond market benchmarks are an important element. There are several Danish mortgage bond indices that enable investors to follow the developments in the market. Nykredit is the oldest index provider and has two major indices that cover Danish mortgage bonds – the Nykredit Danish Mortgage Bond Index and the Nykredit Total Index.

The index value of the Nykredit Danish Mortgage Bond Index is estimated based on a portfolio consisting of the most liquid mortgage bond series listed on the CSE. The Nykredit Danish Mortgage Bond Index is a negotiable, liquid benchmark index covering the Danish mortgage bond market.

The Nykredit Total Index expands the index portfolio from the absolutely most liquid series to include all actively traded Danish mortgage bonds. The index forms the basis of four subindices. The subindices represent a breakdown of the mortgage bond market according to four typical investment strategies within fixed-rate callable mortgage bonds, see more below.

Both Nykredit's mortgage bond indices are rebalanced quarterly. The selection is made on the basis of a minimum requirement for the number of days the bonds have traded since the last rebalancing.

The index value and the option-adjusted duration, which reflect the element of prepayment risk in the mortgage bond market, are published on a daily basis. Furthermore, the composition of the two indices can be viewed at [www.nykredit-markets.com](http://www.nykredit-markets.com) along with historical index values and duration levels.

On the website, a detailed description of the indices, including specific selection criteria, is available.

The trend in the index may be seen daily at Reuters (NYKI) and Bloomberg (NYKM5).

### The Nykredit Danish Mortgage Bond Index

The first index Nykredit launched was the Danish Mortgage Bond Index which is a standard Bellwether index containing the ten most liquid mortgage bonds listed on the CSE.

From October 2005 Nykredit's Danish Mortgage Bond Index contains both fixed-rate callable, fixed-rate non-callable and Cibor-linked floating-rate mortgage bonds. The index basis is 5 January 1993. The minimum requirement for the individual bond series to qualify for the index is an outstanding amount of DKK 5bn. As the index is always rebalanced on the second trading Tuesday of a quarter (January, April, July and October), the rebalancing takes place based on outstanding amounts calculated excl prepayments and issuance related to the preceding borrower notification period.

Figure 13 shows the historical return on Nykredit's Danish Mortgage Bond Index compared with duration-equivalent government bond and covered bond indices. Since January 1999, the Danish Mortgage Bond Index has produced an annual pick-up relative to German Pfandbriefs of approx 1%.

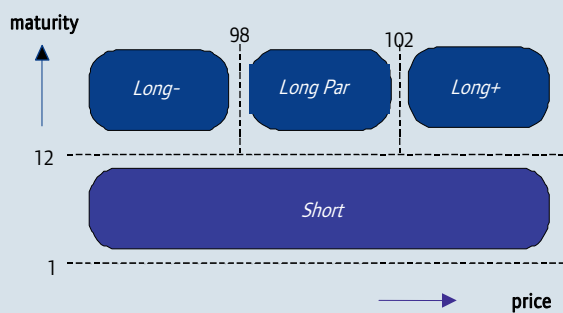
### Nykredit Total Index

The Total Index is a standard Tracker index of the most liquid callable mortgage bond series broken down into four groups: short-term bonds with times-to-maturity of between 1 and 12 years and long-term bonds (over 12 years) grouped in three according to price: Long-: price <= 98, Long Par: 98 < price <= 102 and Long+: price > 102. The index basis is 13 January 1998.

Figure 12 shows the breakdown into the four subindices and illustrates the subdivision according to the price and remaining maturity of the bonds.

In line with Nykredit's Danish Mortgage Bond Index, the Nykredit Total Index is rebalanced on the second trading Tuesday of January, April, July and October. The subindices of the Total Index are rebalanced on a monthly basis.

**Figure 12: Breakdown of Nykredit's Total Index**



Source: Nykredit Markets

A breakdown into subindices according to the date of maturity does not make sense when it comes to callable bonds. In consequence, the subdivision is made according to price as the price of callable bonds can be used as an indicator of duration. This also makes the breakdown into subindices independent of prepayment models as mortgage bonds trading far below par do not risk prepayment which generally means a long duration. Similarly, when the price of these bonds is close to 100, prepayment risk will be high and the duration of these bonds will be short. Consequently, the four subindices reflect common investment strategies for different investors.

### Foreign index providers

On 1 December 2002 Lehman Brothers Inc., as the first foreign investment bank, introduced an index based on Danish mortgage bonds. The introduction should be seen in the light of

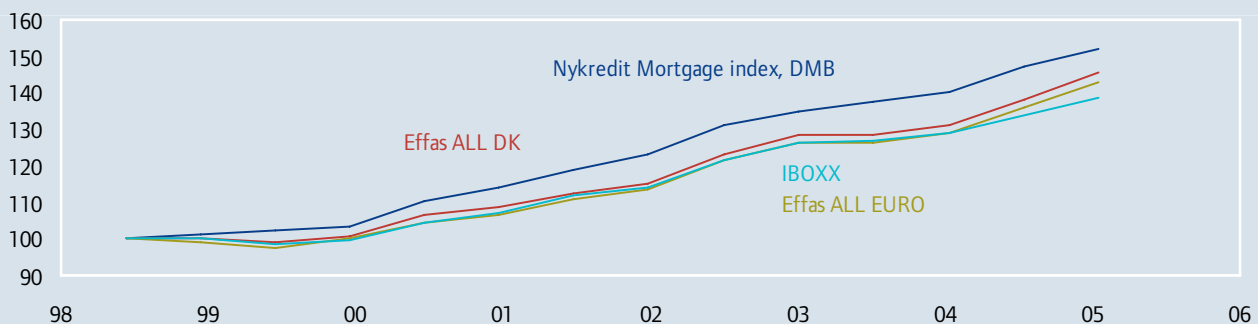
the growing share of foreign ownership in Danish mortgage bonds.

On 1 July 2004 Lehman Brothers included Danish non-callable bullet bonds, without embedded options, in its Pan-European and Global Aggregate indices. Euro-denominated bonds of this type were also added to the Euro Aggregate Index.

To be included in Lehman's indices, mortgage bonds must have an outstanding amount of at least EUR 300m, an investment grade rating from either Moody's or Standard & Poor's and a maturity longer than one year. On 1 July 2004 29 Danish mortgage bond issues were included in the indices representing a market value of EUR 27.6bn.

If Denmark joins Euroland, more foreign index providers are expected to start taking an interest in the Danish mortgage bond market. This trend will increase the exposure of and focus on the Danish mortgage bond market in general. The size of the Danish mortgage bond market would have a weighting of approx 2.5% in an overall European index similar to Lehman's if Denmark were to join the euro.

**Figure 13: Nykredit's Danish Mortgage Bond Index compared with the Effas Bond Index**



The indices used as basis of comparison have been adjusted for money market deposits to obtain identical durations. Source: Nykredit Markets.

## MARKET SET-UP

### Market participants and their roles

The Danish market for mortgage bonds has been organised as an integrated system consisting of bond issuing mortgage banks, investors, investment banks and other members of the OMX, the Copenhagen Stock Exchange (CSE) and VP Securities Services (VP).

Mortgage banks arrange their own issues and sales in the primary market through the CSE and the unofficial telephone market.

All Danish mortgage bonds are listed on the CSE and registered with VP.

The CSE is the market place for transactions in Danish securities, while VP serves as central securities depository and clearing organisation.

The CSE and VP are electronically interconnected and also subject to supervision by the DFSA.

The CSE is part of NOREX, a strategic alliance between Nordic stock exchanges with joint trading systems (SAXESS) and harmonised rules for trading and membership.

A list of CSE members is available at the CSE's website, [www.cse.dk](http://www.cse.dk).

VP is responsible for the electronic issuance, registration including registration of ownership and rights, settlement and clearing of all securities transactions, settlement of periodic payments (interest and principal payments) as well as custody and administration services in relation to securities. Figure 14 provides a graphic presentation of the relationships between market participants.

### Issuance: tap and auctions

Danish mortgage bonds are usually issued on tap as required on a day-to-day basis in combination with recurring auctions in connection with the refinancing of ARMs and floating-rate loans with a fixed-term interest rate cap.

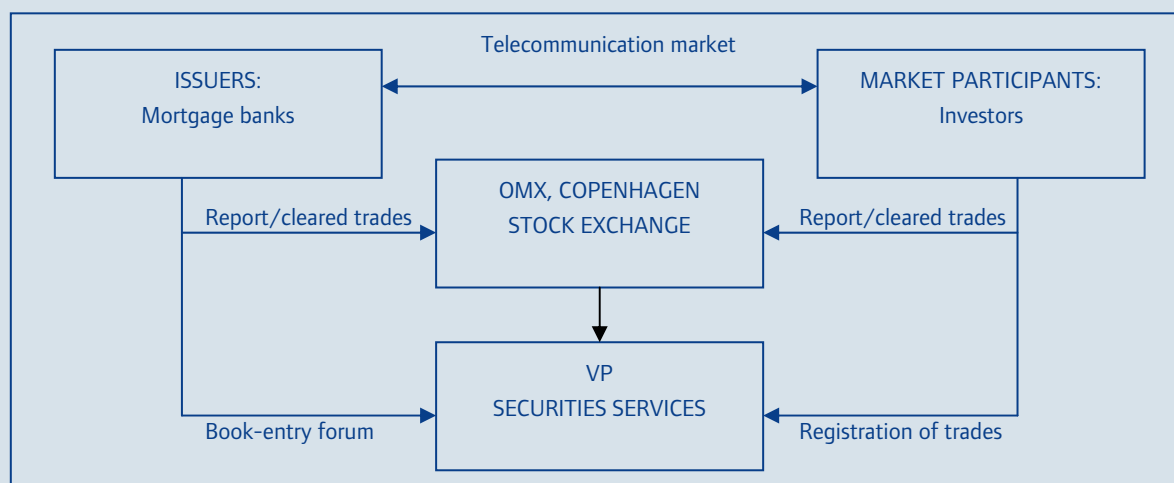
Tap issuance funds Nykredit's continuous lending activities.

At the refinancing auctions, fixed-rate non-callable bullet bonds related to the interest rate adjustment of ARMs are offered as well as floating-rate capped non-callable annuity bonds related to the adjustment of the cap on floating-rate loans with fixed-term interest rate caps.

### Trading and settlement of trades

Danish mortgage bonds are traded either directly as on-exchange trading or indirectly through the telephone market (OTC) between members of the CSE. CSE members are under a duty to report all trades over a certain minimum size within five minutes from execution. Only a limited share of all trades takes are executed through the CSE. The remaining transactions are executed through the telephone market.

**Figure 14: The Danish bond market and its participants**



The Danish bond market and its participants. Mortgage bond issuers and investors.



All trades are subsequently settled and cleared through VP. The Danish market was the first in the world to introduce electronic ownership registration of securities which is now exclusively established by VP registration.

After a transaction has been executed, VP also ensures the simultaneous delivery of the security and the payment necessary to settle the transaction (Delivery versus Payment, DvP). The DvP principle eliminates the principal risk related to the settlement of securities transactions. To enhance efficiency and liquidity in connection with settlement, VP offers settlement of cross-border securities trading through links to international securities markets. VP is linked to Euroclear and Clearstream Banking. On top come bilateral Free of Payment (FoP) links to the Swedish and Icelandic clearing centres. The direct links through Euroclear Bank to international securities markets enable customers of Euroclear to trade in Danish securities settled through Euroclear without the risk of losses due to late settlement.

### Market making – pricing

Liquidity in the Danish mortgage bond market is secured through a market making agreement between a number of members of the Danish Securities Dealers Association.

The agreements involve quote-on-request arrangements and vary in size according to liquidity levels in the bonds involved.

On top comes that the Nykredit Realkredit Group lets Nykredit Bank quote prices in the retail market for Nykredit Realkredit and Totalkredit's liquid bonds.

### The repo market

The Danish bond market is backed by a large and liquid repo market for both government and mortgage bonds. The market is a telephone market where all trades must be reported to the CSE.

The repo market is extremely efficient with a large number of commercial bank and mortgage bank participants. Repo transactions account for some 75% of the overall turnover in the Danish bond market.

### Central bank repo

Since the summer of 1999, the Danish Central Bank (Danmarks Nationalbank) has accepted all Danish mortgage bonds as collateral in lending transactions with banks and mortgage banks. This step has increased the flexibility of the financial sector's repo financing of investors' positions in mortgage securities.

Contrary to repo trades in the money market, Danmarks Nationalbank offers lending alone on the basis of the market value of the bonds, not accrued interest. Apart from this limitation, the following haircuts apply to borrowing using mortgage bonds as collateral with the Nationalbank.

**Table 8: Haircuts on borrowing in Danmarks Nationalbank**

Remaining maturity	Haircut
0-1 years	1.0%
1-3 years	2.5%
3-5 years	3.5%
5-7 years	4.5%
7-0 years	5.5%
Over 10 years	7.5%

Source: Nykredit Markets

Danish mortgage bonds meet the requirements of highly secure bonds in the UCITS directive, article 22.4. In line with eg German Pfandbriefs – Danish mortgage bonds would be eligible for inclusion on the ECB's Tier 1 list of collateral if Denmark should enter into the EMU.

**Table 9: Trading Danish mortgage bonds – significant factors and market conventions**

Issuance	Danish mortgage bonds are issued on tap and, where fixed-rate bullets are concerned, by auction. The bonds are issued in book-entry form and registered with VP.
Accrued interest	Accrued interest is calculated from the last coupon date (including) to the settlement date (excluding) using the Actual/Actual day count.
Bids/Offers	Bid/offer spreads are typically 0.10 point for the most liquid bonds and higher for less liquid bonds.
Drawings	<p>When bonds are drawn for redemption, investors and/or any rights holders will immediately thereafter receive notification, and on the due date amounts payable will be transferred to the receivers in the manner agreed.</p> <p>The drawing procedure is a straight forward mathematical model which determines the exact amount to be drawn in any given series. The drawing fraction is defined as:</p> $\text{Drawing fraction} = (\text{amount for drawing}) / (\text{outstanding amount})$ <p>The fraction is multiplied by the share of the relevant series in each deposit, and the amount is rounded off to DKK øre/EUR cent.</p>
Ex-coupon	Ex-coupon periods no longer apply to Danish mortgage bonds.
Ex-prepayments	Bonds are traded ex-prepayments in the period between the day after the publication of drawing rates (published in the Official Stock Exchange List and uploaded under "Bond data" at <a href="http://www.nykredit.com/ir">www.nykredit.com/ir</a> for Nykredit and Totalkredit bond series) and the payment date.
Settlement	The usual settlement period is three days if settlement takes place through VP. If other settlement centres are used, eg Cedel or Euroclear, the normal settlement period will be three days. However, this may vary.
Taxation	In Denmark foreign investors are not liable to taxation on investments in Danish bonds. As a general principle, resident investors pay tax on coupon payments and capital gains on Danish bonds. Private investors do not pay tax on capital gains if the relevant security meets the requirements of the Danish minimum interest rate rules at the time of issuance.
Trade	The CSE is the central market place for trading in Danish bonds and is open daily between 9:00 am and 5:00 pm. There is, however, also a considerable unofficial market. All authorised traders on the CSE are obligated to report all trades in listed bonds even if a trade does not take place through the CSE. The authorised traders comprise stockbroker houses, Danmarks Nationalbank, banks, savings banks and mortgage banks.
Trading	Trading takes place in clean prices.
Trade lot	The minimum trade lot is DKK 0.01 and EUR 0.01 for bonds denominated in DKK and EUR. CSE members are not obliged to trade through the CSE systems, but all trades exceeding a minimum amount of typically DKK 100,000/1,000,000 (depending on the liquidity in the bond) and EUR 10,000 must be reported.
Yield-To-Maturity	The YTM is determined by rediscounting the value of the cash flow to the actual amount invested – ie price including accrued interest. The cash flow is rediscounted to the settlement date when the trade is settled.
Risk weighting	In Denmark and other European countries the risk weighting of Danish mortgage bonds is 10% because of their eligibility as particularly secure securities as defined in Article 22.4 in the EU's UCITS directive.

Trading Danish mortgage bonds – significant factors and market conventions.

## REFINANCING AND PREPAYMENT

Refinancing and prepayment are important concepts when considering investment in callable Danish mortgage bonds.

Below we will only use the term "prepayment" for the refinancing of loans funded by callable bonds trading above par. In relation to bondholders, prepayments will have a direct effect on their positions, while all other refinancing methods only have an indirect effect on bondholders. Prepayments will be registered as drawings, whereas refinancing through the purchase of bonds at market prices (the delivery option) will only result in a market demand for the bonds. This market demand may have an indirect effect on the prices of the bonds concerned.

Note that refinancing in this section does not include the interest rate adjustment of ARMs and cap adjustment of floating-rate mortgage loans.

### Prepayment

As a consequence of the callability of callable fixed-rate and callable floating-rate loans, borrowers may prepay their loans by repaying the bond debt outstanding at par<sup>3</sup>. The required notice of prepayment is two months before the next coupon date (five months for some older mortgage bonds). For the investor, this implies a prepayment risk throughout the maturity of the bond, cf the section on investment in Danish mortgage bonds and the pricing of callable mortgage bonds.

There may be several reasons for prepaying a mortgage loan. In order for the investor to assess the risk inherent in callable bonds, an understanding of the underlying motivation is useful. In Denmark, the predominant motive is to obtain a positive prepayment gain in the form of a reduced NPV of the loan and consequently a reduction in post-tax payments. This can be done by prepaying high-coupon loans and switching to loans carrying lower rates which are either fixed, adjustable or floating.

The introduction of adjustable-rate mortgages (ARMs) in 1996 based on the short-term rates, the very low interest rates in recent years and, most recently, the introduction of floating-rate mortgage loans with embedded interest rate cap at the end of 2004 have led to historically high prepayments in connection with remortgaging into fixed-rate loans with lower coupons and in part to new loans based on short-term rates. Also the liberalisation of the financial system and the increased competition between mortgage banks have underpinned the development.

<sup>3</sup> Note that callable floating-rate loans will often be callable at a price of 105 and not at par.

When trying to determine the correlation between prepayment rates and economic variables such as interest rate levels, it is important to note that legislation has in many cases had a major impact on prepayment activities.

### Costs related to prepayment

Apart from the prospects of lower rates, prepayment costs also play a role.

Prepayment costs relate to both the existing and the new loan. When the new bonds are sold, a commission must be paid to cover the trading costs on the CSE as well as related transaction costs. In addition, there is a small loan fee. In connection with the registration of the mortgage, also a stamp duty and a registration fee will be payable to the public authorities.

The table below shows an example of the costs incurred by a typical homeowner when prepaying a Nykredit mortgage loan of DKK 1m. The costs of prepaying a mortgage are generally the same across mortgage banks.

**Table 10: Typical costs of prepaying a loan of DKK 1m**

Cost elements	Amount, DKK
Loan fee	2,000
Registration fee	1,400
Registration handling costs	2,200
Office copy of Danish Land Registry entries	175
Commission (0.15%)	1,500
Price spread (0.10)	1,000
Interest difference *	8,333
Total cost	16,608

\* The difference between the coupon rate of the prepaid loan from the date of prepayment to the coupon date and the interest rate received by the mortgage bank for depositing the prepayment amount in a bank. The interest difference is deductible for tax purposes.

### Refinancing determinants

There are several factors that influence the refinancing gains of individual borrowers. It used to make a difference whether the borrower was a private individual or a company as there were different rules governing the amounts of interest deductible for tax purposes. However, amendments to tax laws have in practice harmonised these rules.

Due to the fixed costs related to loan prepayment, the size of the debt outstanding and the remaining term of the loan make a big difference to borrowers' potential refinancing gains. In bond series with a relatively large number of large loans, current drawings will, other things being equal, be larger than those of equivalent series with small loans.

Lastly, it also plays a role whether the loan is a bond or a cash loan as the after-tax payments on cash loans are lower than on corresponding bond loans. The lower repayments are a result of the fact that the capital loss arising from the disbursement of the loan (as a result of the underlying bonds being issued below par (100)) is factored into the loan rate after which the borrower obtains a deduction for tax purposes on the current interest payments. This advantage lapses in case of the prepayment of a cash loan, and the potential prepayment gain of a cash loan is therefore smaller than that of a bond loan. On top comes the fact that private borrowers with cash loans are subject to tax on any capital gains. Furthermore, the taxation of capital gains is the reason why only a limited share of private borrowers have fixed-rate callable cash loans today.

#### **Tabel 11: Bond versus cash loans**

Bond loan: The principal of a bond loan equals the nominal value of the bonds issued to fund the loan, and the interest payments will correspond to the coupon payments on the bond.

Cash loan: The principal of a cash loan equals the market value of the bonds issued, and interest payments will correspond to the yields-to-maturity of the bonds adjusted for compound interest

Difference between bond loans and cash loans.

#### **Refinancing not constituting prepayment**

After a period with rising yield levels, borrowers have been seen to refinance from a callable fixed-rate loan based on a low coupon bond to a callable fixed-rate loan based on a bond with a higher coupon. This provides borrowers with an opportunity to prepay if interest rates decrease again. Refinancing and extension are situations where borrowers wish to change the characteristics of their loans. They may for example want to extend the term of their loan from 20 to 30 years or extend the interest rate period for adjustable-rate loans, etc.

Although it is possible in Denmark for homebuyers to assume existing mortgage debt, the sale of a property will usually result in the refinancing of the loan (or prepayment if bond prices are above par).

## AVAILABLE MARKET INFORMATION

In order to maintain a high level of transparency in the Danish mortgage bond market, Nykredit and other Danish mortgage banks publish a line of data for bond investors, the purpose being to obtain a more effective pricing of callable mortgage bonds with focus on debtors' prepayment behaviour in callable bonds.

Data are published on:

- Debtor distribution
- Preliminary prepayments
- Notice of drawings, ie final prepayments and ordinary repayments
- Cash flows
- Basic bond information

The data are in general useful and necessary in the pricing of Danish mortgage bonds.

Danish mortgage banks submit the relevant data to the OMX, the Copenhagen Stock Exchange (CSE) which redistributes them through a number of data distributors along with information on prices, daily turnover, outstanding amounts, etc.

Data on Nykredit and Totalkredit mortgage bonds together with basic bond information and prevailing outstanding amounts are available for download under Nykredit's Bond Data pages at [www.nykredit.com/ir](http://www.nykredit.com/ir). The data is available by ISIN code as Excel files.

Figure 15 below contains a time schedule for the release of mortgage bond data.

### Debtor distribution

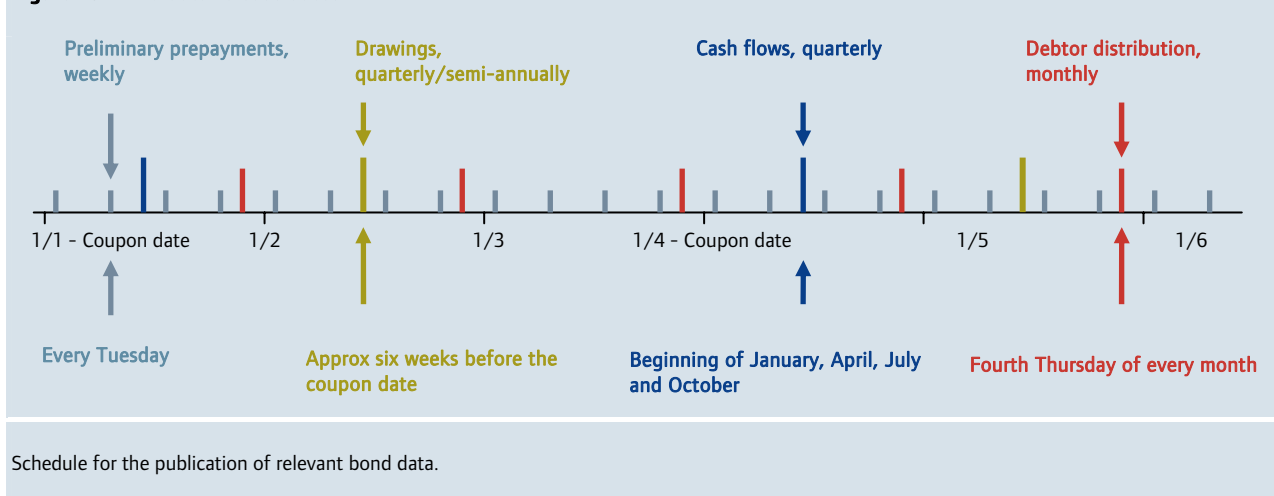
Debtor distribution data are published for all callable bond series. The data grouped in bond series cover all loans broken down into five loan groups. These loan groups represent five debt intervals as listed in Table 12. Furthermore, the data include the distribution of private and non-private debtors among these loan groups. Finally, the ten loan groups are broken down into cash and bond loans which are each subject to different debtor tax regimes. Furthermore, the data are supplemented with the average cash loan rates of each loan group. Average cash loan rates determine the size of the post-tax proceeds from prepaying a loan and consequently debtors' incentive to do so.

Debtor distribution data are published monthly and submitted to the CSE on the fourth Thursday of each month. The data are compiled four trading days before.

### Preliminary prepayments

Prepayments for the coming payment date are compiled every Friday and published around noon on the following Tuesday. Although the data are preliminary, they provide investors with insight into debtors' prepayment behaviour and make continuous assessments about the impact hereof on the individual bond series. Preliminary prepayments accelerate in the weeks before the notification date as the cost of prepaying a loan decreases in step with the expiry of the notification period.

**Figure 15: Bond data release dates**



Schedule for the publication of relevant bond data.

**Table 12: Debtor distribution supplied by mortgage banks (DKK 1,000 and number)**

Name of series	Debtor distribution		Notice
Remaining bond debt	Private <sup>1</sup>	Other <sup>2</sup>	By payment date <sup>3</sup>
<200	Bond debt outst. (bond loans)	Bond debt outst. (bond loans)	Total loans
	Cash debt outst. (cash loans)	Cash debt outst. (cash loans)	Total debt outstanding
	Avg. cash loan rate	Avg. cash loan rate	
	Bond loans	Bond loans	
	Cash loans	Cash loans	
	Tax-deductible capital loss accounts	Tax-deductible capital loss accounts	
200-499	-same-	-same-	-same-
500-999	-same-	-same-	-same-
1,000-2,999	-same-	-same-	-same-
>3,000	-same-	-same-	-same-

1) "Private" reflects loans for owner-occupied dwellings and recreational property.

2) "Other" reflects all other types of property, ie commercial and agricultural.

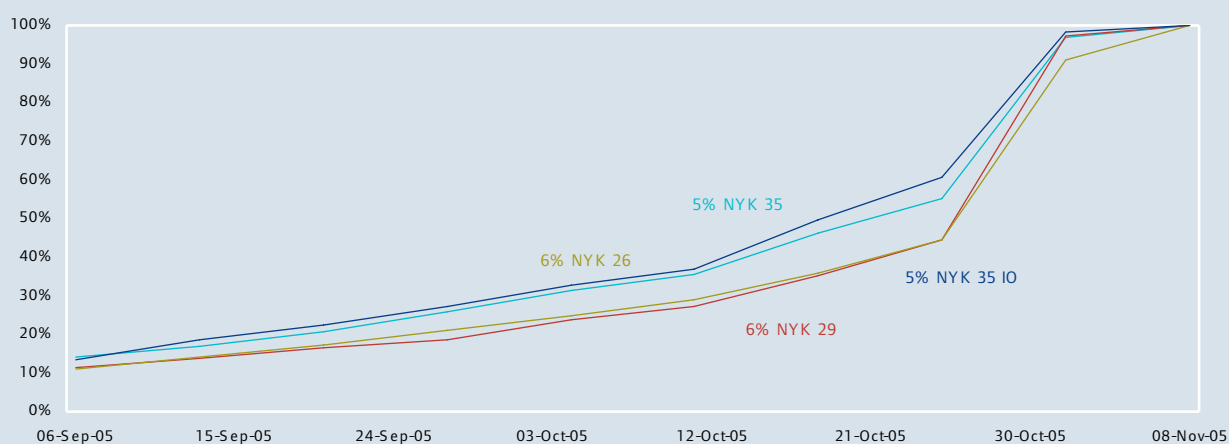
3) The data are supplied with information about the number and the bond debt outstanding of loans for which notice of prepayment has been given for any future payment date regardless of whether drawings have been published or not.

## Drawing of bonds

Total drawing rates and the distribution between ordinary and extraordinary (prepayments) drawings of a specific payment date are published approx six weeks before the payment date. The drawing date is always a Friday known beforehand. Bonds are drawn on a Friday between 18 and 24 February, May, August and November, respectively. Information on the drawings of all callable bond series is published quarterly/semi-annually.

The drawings are published on the day of drawing. On the next trading date and until the payment date, callable bonds will be traded exclusive of prepayments and ordinary repayments for the coming payment date. This means that a callable bond will be traded as two different bonds for a while – one in which no prepayments will be made on the coming payment date, and one that will be prepaid 100%. The two bonds will of course trade at different prices.

**Figure 16: Preliminary prepayments**



Source: Nykredit Markets

## Cash flows

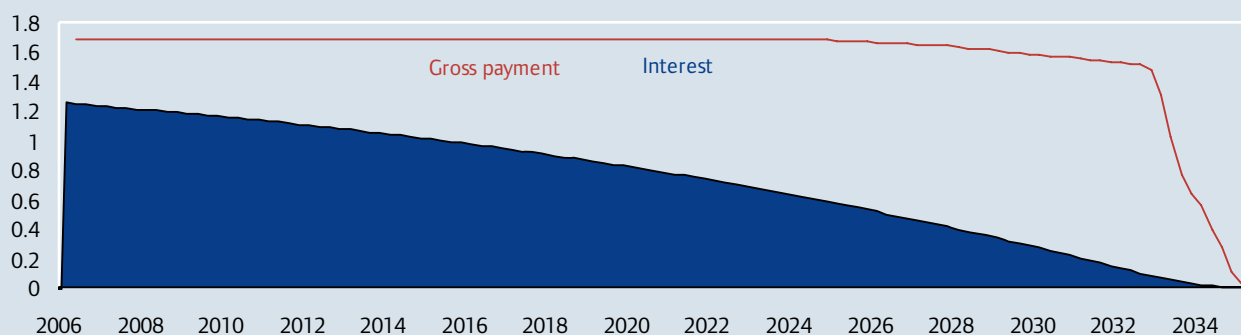
Cash flows are published for all open and closed annuity series with and without deferred amortisation as well as serial bonds and index-linked series four times a year.

Cash flows have been broken down into principal repayments and interest on the debtor side exclusive of administration margins. The calculations are based on all loans, including loans for which notice of prepayment has been given for future payment dates, but excluding loans prepaid immediately and loans prepaid by way of a delivery of bonds. The data are compiled as of 31 March, 30 June, 30 September and 30 December and submitted to the CSE not later than 12 trading days after and published not later than at the beginning of the next trading day.

Most mortgage loans are annuity loans, in some cases combined with an interest-only period, but even though the cash flow of a given Danish callable mortgage bond reflects the underlying loans, the bonds are not perfect annuities. The reason for this is that all loans behind a 30-year bond are 30-year annuity loans. The opening period of the bonds is three years, and therefore, when a bond closes for issuance and the last debtors take out loans in the bond series, the first debtors will already have made three years' worth of repayments on their loans. In consequence, there is a three-year maturity difference between the shortest and the longest loans.

5% MTG 35 was open from 1 September 2002 to 31 August 2005. With respect to 5% NYK 2035, this means that the bond will be an annuity bond until 2032 when the first debtors have repaid their loans in full. As depicted in Figure 17 below, the repayments scheduled for the last three years decrease. The decrease will be a more or less exact replication of the timing of debtors' entry into the mortgage pool in the opening period depending on the scope of prepayments made in the intermediate period. As the Danish mortgage system only offers 10Y, 15Y, 20Y and 30Y fixed- and floating-rate bonds, a debtor requiring a 26Y fixed-rate callable mortgage loan or a 26Y floating-rate mortgage loan will have no choice but to take out the loan in 30Y bonds. If a bond is still open and the final cash flows therefore unknown, there are two ways of estimating them. The first and most commonly used method is the generic cash flow method which is based on the assumption that lending in the opening period is evenly distributed over the period. The other (and less applied) method is to estimate the cash flow based alone on debtors who have already taken out loans and to assume that no other debtors will be taking out loans in the bond for the rest of the opening period. This assumption is of course unrealistic which is why the generic cash flow is the most used method as long as the bond is open. The difference between the two methods is illustrated in Figure 18.

**Figure 17: Cash flow of 5% MTG 2035**



Source: Nykredit Markets. Gross payments equal interest and principal payments.

## Other mortgage bond-specific information

Other bond data available at [www.nykredit.com/investors](http://www.nykredit.com/investors):

- Basic bond information available together with the market information under the Nykredit Bond Data pages
- A list of all Nykredit mortgage bonds, including specification of bond category, rating, capital centre and series as

well as a reference to the relevant bond prospectus and final bond terms

- Fact sheets on each primary bond type
- Bond prospectuses and other statutory documents with respect to Nykredit mortgage bonds
- Rating overview of Nykredit bonds.

**Figure 18: Temporary and generic cash flow of 4% MTG 2038**



Source: Nykredit Markets. Gross payments equal interest and principal payments.



**Table 13: Overview of bond information provided by Danish mortgage banks**

Info type covered	Bond series covered	Contents/calculations	Time of compilation and publication	Frequency of publication
Basic bond information*	All Nykredit and Totalkredit mortgage bonds	Bond ID/ISIN code, short name, series, rating, coupon, type of interest rate, maturity, etc.	First trading day after the bond has been listed on the OMX, the Copenhagen Stock Exchange (CSE).	Daily
Debtor distribution	All callable bonds excluding index-linked and pre-1970 series	Breakdown of debtors' existing loans at the time of compilation, ie including loans to be prepaid on a specific payment date but excluding immediate and bond delivery prepayments. Debtors are categorised into "private" and "other". Furthermore, the loans are divided into five loan size intervals.	Publication on the fourth Thursday of every month. If the fourth Thursday is not a trading day, publication will take place on the next trading day. The data are compiled four banking days before publication.	Monthly
Preliminary prepayments	All callable series	Prepayments (immediate and on future payment dates) by series up to the Friday before the day of publication excluding cancelled bonds.	Compiled every Friday. If the Friday concerned is not a trading day, compilation will take place on the trading day before. Weekly publication two trading days after compilation, usually on Tuesdays.	Weekly
Drawings	All callable series	All ordinary and extraordinary (prepayments) bond drawings. Outstanding amount compiled two days before drawing.	Compiled and published on a Friday approximately six/eighteen weeks before the payment date or the trading day before.	Quarterly/semi-annually. Drawings in February, May, August and November.
Cash flows	All open and closed series except series based on adjustable-rate mortgages and bullet loans, but including floating rate bonds.	Cash flows divided into prepayments and interest on the debtor side excluding administration margins. Based on all loans including loans terminated for repayment on future payment dates, but excluding loans prepaid immediately and loans prepaid by way of bonds.	Compiled on 31 March, 30 June, 30 September and 31 December. Submitted to the CSE, not later than 12 trading days after compilation and published not later than at the beginning of the next trading day.	Quarterly
Bond terms and conditions	All series	Terms and conditions	When new bond series are opened.	Continuously

Note: \* Additional information available through download from Nykredit's website.

## PRICING OF DANISH MORTGAGE BONDS

This section reviews the pricing models applied to fixed-rate callable mortgage bonds as well as Cibor-linked floating-rate callable mortgage bonds – capped floaters. Conceptually, the pricing of non-callable bullet mortgage bonds is straightforward. The payments of a bullet bond are discounted with eg the swap curve plus a constant yield curve spread (which generally increases with the maturity of the bond). The pricing of fixed-rate callable mortgage bonds<sup>4</sup> and Cibor-linked floating-rate callable mortgage bonds<sup>5</sup> is, however, more complex due to the embedded options.

The models described in this section are applied to the pricing in Nykredit Markets’s online research tool Bond focus.

### Pricing of fixed-rate callable bonds

#### The prepayment option

In principle, a fixed-rate callable bond constitutes a portfolio of a non-callable bond and a short position in an American call option on that bond (with a strike price of 100) reflecting the embedded prepayment option. However, for pricing purposes, the prepayment option cannot be treated as a standard American call option since borrowers do not pursue rational exercise strategies. There are no prepayments when a mortgage bond trades below par (consistent with the rational exercise rule), but for bonds trading above par, there is usually substantial variation in observed prepayment rates over time and across different coupons and maturities.

#### Prepayment models

Instead, an empirical prepayment model estimated based on historical data is needed to price fixed-rate callable mortgage bonds. This model predicts the prepayment rate for a given payment date as a function of the yield curve (through the refinancing rate) and other factors affecting the level of prepayments such as the size of the loans.

The most important factors in the prepayment model developed by Nykredit Markets are discussed below. In order to calculate theoretical (model) bond prices and key figures such as option-adjusted duration, the prepayment model is combined with a stochastic term structure model which is calibrated to the Danish yield curve (swap or government) and to implied volatilities for Danish caps and swaptions. The stochastic term structure model provides a range of possible yield levels on a number of future dates and attached probabilities at such yield levels. The technicalities of the calculations are outlined below.

#### Refinancing rates and prepayment gain

The most important factor affecting the prepayment rate is the gain from refinancing to a lower rate. The gain is defined as the percentage reduction in the mortgage payments on the new loan, taking taxation and prepayment costs into account. When prepaying a loan, borrowers face both fixed and loan-size variable costs. The gain calculation is based on the total payment for the next year or the present value of all remaining payments using the after-tax refinancing rate on the new loan as the discount rate. The Nykredit Markets prepayment model uses the present value criterion, but in most cases, the difference between the two gain definitions is quite small.

**Table 14: Subpool prepayment rates for 5% NYK 2035**

Payment date	Aggregate Prepayment rate	Loan size (DKK 1,000)				
		0-200	200-500	500-1,000	1,000-3,000	3,000-
1 Jan 06	18.90	16.31	12.12	18.11	20.03	23.95
1 Oct 05	24.39	13.52	9.87	14.79	24.13	43.57
1 Jul 05	16.64	9.19	7.13	9.72	14.35	30.30
1 Apr 05	15.05	11.34	6.41	8.77	12.39	25.91
1 Jan 05	0.10	0.63	0.45	0.42	0.57	0.46
1 Oct 04	0.04	0.43	0.43	0.43	0.43	0.43

Source: Nykredit Markets

<sup>4</sup> Fixed-rate callable bonds are callable at par (100).

<sup>5</sup> Cibor-linked floating-rate bonds are callable at a price of 105.

The refinancing rate assumes that the new loan is a fixed-rate mortgage with the same maturity as the existing loan. In order to address the growing importance of floating-rate and adjustable-rate mortgages (to refinancing), the model prepayment rate also depends on the slope of the yield curve as discussed below.

### Size of the loan

On average, borrowers prepay large loans more actively than smaller loans. This effect is illustrated in Table 14 which contains subgroup prepayment rates for five loan size intervals of the bond 5% NYK 2035 (the subgroup prepayment data are described below). For realistic parameter values, the bulk of the difference between the prepayment rates of large and small loans reflects the borrowers' prepayment strategies and not the effect of fixed prepayment costs. For the investor, however, this distinction is largely irrelevant, and the prepayment model must simply take into account that large loans prepay faster than small ones.

### Cash loans vs bond loans

The after-tax payments on cash loans are smaller than on corresponding bond loans. This implies that the prepayment gain is smaller for a cash loan than for a bond loan since the tax advantage is lost on prepayment. Therefore, the prepayment rate of a given mortgage bond should be inversely related to the average cash rate of the underlying loans. The Nykredit Markets prepayment model uses the average cash rate when calculating the gain from prepayment (in this connection, bond loans can be regarded as cash loans with a cash rate equal to the coupon rate).

### Time-to-maturity of the loan

The required gain needed to trigger prepayment increases with the time-to-maturity of the loan. This is to be expected if borrowers take the time value of the prepayment option into

account when formulating prepayment strategies. Furthermore, with respect to loans with short maturities, the liquidity effect of refinancing on a loan with a long maturity becomes more important (as discussed above, the gain used in the prepayment function assumes that the new loan has the same maturity as the existing loan).

### Spread between long- and short-term rates

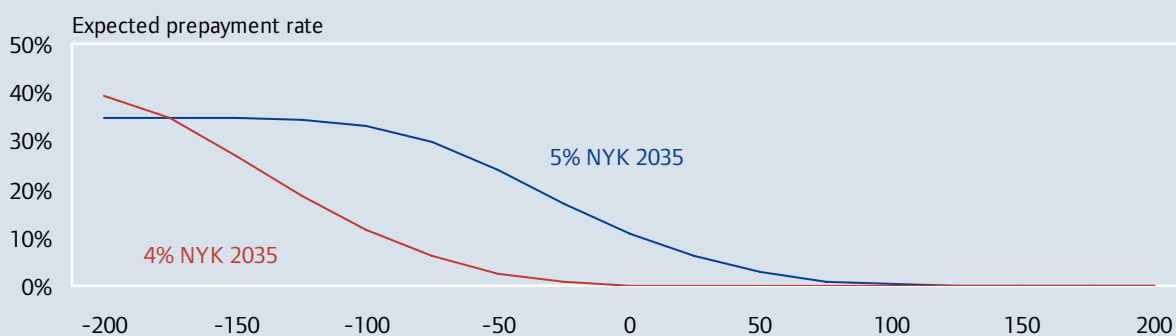
In the Nykredit Markets prepayment model, there is a positive relationship between the slope of the yield curve (the spread between long- and short-term rates) and prepayment rates. Presumably, when the yield curve is steep, borrowers are more likely to refinance their existing fixed-rate mortgage into a floating-rate or adjustable-rate mortgage, where the prepayment gain is higher. Judging by the empirical estimates, this effect is quite small, and fixed refinancing rates are the main driver behind prepayment behaviour.

### Modelling the heterogeneity of prepayment rates

As mentioned above, there is substantial variation in prepayment rates observed over time and across different bonds. The main systematic difference is related to the gain from prepayment, but there is also a tendency for prepayments to slow down over time (other things being equal). The reason for this effect, called burnout, is that the most aggressive borrowers leave the mortgage pool first, and the remaining borrowers on average prepay less aggressively. There are two ways of capturing this effect in the prepayment model.

Firstly, the prepayment function may depend on the pool factor which is the ratio of the current debt outstanding to the debt amount before the prepayments started. The main problem with the pool factor approach is that the pricing problem becomes path dependent, and this makes the numerical procedures used for valuation (pricing) more time consuming.

**Figure 19: Prepayment function**



Source: Nykredit Markets

Secondly, the burnout behaviour can be modelled using mortgage subgroups, for example based on the size of the loan. If there are different prepayment functions for each subgroup, and if the relative composition changes over time towards the slowly prepaying subgroups, the aggregate prepayment rate will slow down. The main advantage of the subgroup approach is that there are no path dependencies within each subgroup. This means, for example, that one-factor PDE methods can be used for pricing. Apart from the different prepayment functions, the subgroup approach only requires the initial weights of each subgroup in order to calculate the theoretical price of a mortgage bond. This approach is most effective when the subgroup heterogeneity is observable primarily because the parameters of the prepayment function must be estimated for each subgroup.

The Nykredit Markets prepayment model uses borrower subgroups based on the five loan size intervals shown in Table 14. Subgroup prepayment rates are not directly available since Danish mortgage banks only supply information about the total prepayment rate of each bond. However, mortgage banks do provide a breakdown of the total debt outstanding grouped in the five loan size intervals, cf "Market information supplied by mortgage banks", and Nykredit Markets calculates the subgroup prepayment rates based on changes in the debt outstanding of each subgroup. This type of calculation must include corrections for new issuance activity in the open series and buybacks when a bond trades below par. The internal subgroup prepayment data are used to estimate the parameters of the prepayment function.

### The prepayment function

The prepayment function of subgroup  $k$  is specified as  $\lambda_k = s(L_k)\Phi(G_k)$  where  $G_k$  is the actual prepayment gain,

$\Phi(x)$  is a cumulative probability distribution function (truncated normal in Nykredit Markets's model), and  $s(L_k)$  is a linear spline function of the loan size  $L_k$ . The multiplication by the spline function  $s(L)$  serves two purposes. Firstly, the upper bound of the expected prepayment rate of a given payment date is below 100%.

Secondly, the function determines the heterogeneity between the different subgroups in a simple way (the parameters in  $\Phi(x)$  are constant across subgroups). The mean of the distribution  $\Phi(x)$  depends on two explanatory variables, the time-to-maturity of the underlying loans (positive coefficient) and the spread between long- and short-term yields (negative coefficient). Figure 19 contains the prepayment function of the bonds 4% NYK 2035 and 5% NYK 2035 on 3 October 2005. Note that the upper bound of the expected prepayment rate is higher with respect to 4% NYK 2035. This reflects a difference in the borrower distribution. Since there have already been some prepayments in the 5% bond, the remaining borrowers have smaller loans on average.

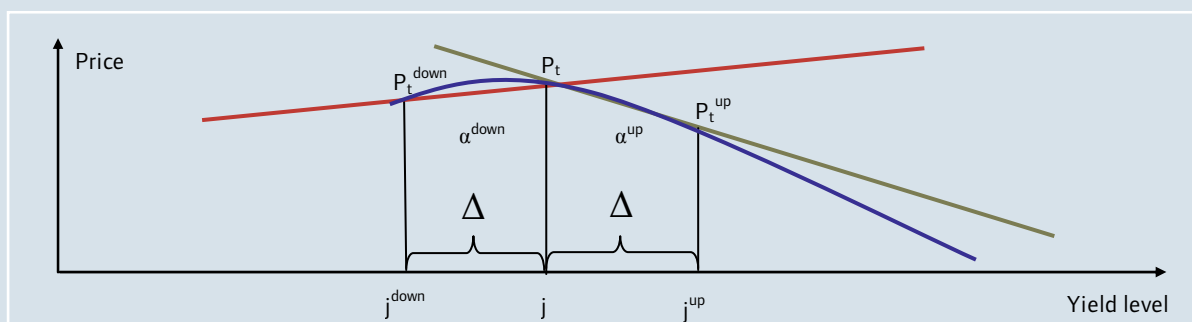
### Numerical pricing procedures

The stochastic term structure model is the extended Vasicek model:

$$dr(t) = \{\theta(t) - \kappa(t)r(t)\}dt + \sigma(t)dW(t)$$

where the time-dependent functions  $\sigma(t)$  and  $\kappa(t)$  are calibrated to implied volatilities for DKK-denominated caps and swaptions. The time dependent function  $\theta(t)$  is used to calibrate to the initial yield curve. The extended Vasicek model has closed-form expressions for European bond options (including caps and swaptions), and this facilitates an efficient calibration method.

Figure 20: Calculation of adjusted convexity



Source: Nykredit Markets

More complex options must be priced using numerical methods. Here, Nykredit Markets uses an implicit finite-difference PDE implementation of the extended Vasicek model. The backward recursion is a tridiagonal system of equations  $L_m V_m = R_m V_{m+1}$  where  $V_m$  is the value of the claim at time  $t_m$  in the  $N$  states of the PDE discretisation. Since the matrix  $L_m$  is tridiagonal, this system of equations can be solved very fast. The main advantage of the PDE approach compared with for example trinomial trees is that the time and state discretisations can be chosen independently. For the prepayment model, the PDE grid must be solved for each mortgage subgroup, so that the current price can be calculated as

$$V_0 = \sum_{h=1}^H w_h V_{0,h}$$

where  $w_h$  is the initial weight of subgroup  $h$ , and  $V_{0,h}$  is the theoretical bond price at time 0 ("today") when using the prepayment function for subgroup  $h$ . The backward recursion for the value of each mortgage subgroup consists of three equations:

$$L_m V_{m,h}^{NC} = R_m (V_{m+1,h} + c)$$

$$L_m V_{m,h}^E = R_m (100 + c)$$

$$V_{m,h} = V_{m,h}^{NC} - \lambda_h(t_m)(V_{m,h}^{NC} - V_{m,h}^E)$$

where  $c$  is the quarterly coupon rate and  $\lambda_h(t_m)$  is the prepayment rate for subgroup  $h$  at the decision date  $t_m$  (two months before the coupon date, corresponding to the notice period for prepayment). Note that the value of the bond is split into two parts at the decision date:  $V^E$  is the value of the prepaid (exercised) part, and  $V^{NC}$  is the value of the non-prepaid part. Between the decision date and the previous coupon date, there are no payments and/or prepayment events, and the normal backward recursion is used. The option-adjusted dollar

duration is calculated using the central finite-difference formula:

$$D^{OA} = \frac{V(-\Delta) - V(\Delta)}{2\Delta}$$

where  $V(\Delta)$  is the theoretical mortgage price after a parallel shift of the yield curve of  $\Delta$ . In practice,  $\Delta = 10bp$  is used. This calculation is completely analogous to the one used for non-callable bonds except that the theoretical mortgage pricing model is used to obtain  $V(\Delta)$ .

Option-adjusted convexity, which can be interpreted as the change in the dollar duration when the yield curve changes, is given by the formula:

$$C^{OA} = \frac{V(\Delta) + V(-\Delta) - 2V(0)}{\Delta^2}$$

The option-adjusted convexity is also the average of the one-sided durations when the yield curve changes by  $\Delta$  and  $-\Delta$  basis points, respectively. Figure 20 illustrates this interpretation of  $C^{OA}$ .

Table 15 contains key figures on benchmark 30-year mortgage bonds. Note that all bonds have negative convexity because of the prepayment option.

### Pricing of capped floaters

Capped floaters carry a floating rate, are callable<sup>6</sup> and have an embedded option in the form of an interest rate cap. The cap has a fixed strike throughout the maturity of the bond, typically up to 30 years. The repayment profile will be of the annuity type where amortisation may be deferred for the first 10 years. A characteristic of Danish capped floaters is that the

**Table 15: Key figures on trading date**

ID code	Bond	Price	Yield	Swap OAS	OA bpv	OAC
975729	4% NYK 2035 A	96.28	4.40	7.99	7.09	-1.80
976164	4% NYK 2038 A	95.33	4.47	13.01	7.44	-1.63
975362	5% NYK 2025 A	102.73	4.72	9.38	1.26	-3.40
974587	5% NYK 2029 A	102.83	4.78	14.98	2.57	-4.23
975346	5% NYK 2035 A	101.50	4.95	24.53	3.16	-4.46
972363	6% NYK 2026 A	105.40	5.40	26.57	-0.63	-1.89
974072	6% NYK 2029 A	104.68	5.60	-11.91	-0.88	0.48

Source: Nykredit Markets

annuity rate tracks 6M Cibur. This means that the repayment profile of the bonds is stochastic as the annuity rate is fixed on the basis of the development in 6M Cibur. As the bonds have embedded options, a stochastic yield curve model is required for the pricing. This model must be calibrated to basis options (such as caps and swaptions) matching the implied options embedded in the capped floaters. We apply the same yield curve model as to callable bonds, ie the extended Vasicek model. In order to allow for the volatility smile, the extended Vasicek model is calibrated to caps with the same strike rate as the capped floaters. Consequently, a volatility calibration specific to the individual capped floaters is applied.

### Calibration – capped floaters

The yield curve is naturally calibrated to the Danish swap curve. It makes no sense to calculate key figures relative to the Danish government bond curve as the yield curve is also applied to determine future coupon fixings. In the ordinary mortgage bond model, the Vasicek model's volatility parameters are calibrated to at-the-money (ATM) swaptions and caps. However, this method cannot be applied to capped floaters.

One of the limitations of the extended Vasicek model is the lacking possibility of matching the option prices at all strike rates. The Vasicek model has constant basis point volatility which means that Black-76 (relative) volatilities decline monotonously with the strike rate. This correlation is a good match with strike rates that are moderately lower than ATM strikes where the Vasicek model is able to match the volatility skew seen in the market (that lower strikes are trading at higher Black-76 volatilities than ATM strikes). The prepayment option in the traditional fixed-rate mortgage bond is typically slightly out-of-the-money which is well in line with what an extended Vasicek model calibrated to ATM strikes is able to handle.

Where capped floaters are concerned, quite the opposite is the case as the option element has higher strike rates than ATM. Where these caps are concerned, the Vasicek model calculates Black-76 volatilities that are somewhat lower than ATM caps. This is not in line with what can be observed in the market. In other words, a Vasicek model calibrated to ATM options would underestimate the option element of capped floaters and therefore calculate a theoretical price that was too high.

There are several possible solutions to this problem. The best would clearly be to develop a stochastic yield curve model whose theoretical option prices match the actual ones at all strike rates. Such models have stochastic volatility as a minimum and many other complications. Another solution would be to calibrate the extended Vasicek model to caps with the

same strike as the capped floaters. As long as the option element in capped floaters is not particularly dependent on the current ATM options, this approach would be an acceptable solution. Note that a two-factor Gaussian model would have the same problem with volatility calibration as a one-factor Vasicek model.

Table 16 below shows the Black-76 volatilities of caps with strike rates at 5.5 at which the Vasicek model will be calibrated. Note that the table shows mid prices, and that the calculations are based on EUR volatilities from the Reuters page VCAP3 (interpolation between 5% and 6% strikes) plus an appropriate spread for the difference between DKK and EUR volatility (between 0.9 and 1.25 percentage points).

**Table 16: Black-76 volatilities**

Maturity	Black vol	Cap price	Vasicek model	ATM Vasicek
1Y	27.85%	0.00	0.00	0.00
2Y	27.30%	0.01	0.01	0.00
3Y	25.30%	0.08	0.08	0.01
4Y	22.85%	0.22	0.22	0.06
5Y	20.85%	0.46	0.46	0.20
6Y	19.40%	0.77	0.77	0.41
7Y	18.15%	1.14	1.14	0.71
8Y	17.20%	1.57	1.57	1.07
9Y	16.55%	2.04	2.04	1.47
10Y	16.10%	2.54	2.54	1.89
12Y	15.40%	3.56	3.55	2.75
15Y	14.35%	4.93	4.94	4.05
20Y	13.15%	6.95	6.95	6.07

The last two columns show the theoretical cap prices with the Vasicek model calibrated to a strike of 5.5% (matching the actual prices in the third column per construction) and the Vasicek model calibrated to ATM caps and swaptions, respectively.

The embedded interest rate caps of capped floaters can be implemented in the extended Vasicek model without further problems.

<sup>6</sup> At a price of 105.

**Table 17: Theoretical prices and key figures – capped floaters**

ID code	Bond	Price	Swap OAS	OA bpv	OAC
471712	CF 5.6778% TOT 2015	100.94	4.08	1.41	-0.63
976148	CF 5% NYK 2038 A	98.82	20.29	4.60	-1.40
976156	CF 5% NYK 2038 DA	97.87	22.64	5.31	-1.51
975966	CF 6% NYK 2038 A	99.73	16.82	2.95	-0.80
975974	CF 6% NYK 2038 DA	99.23	18.74	3.43	-0.84
927279	FF 6% RD 2038 A	100.42	6.87	2.53	-0.68

Source: Nykredit Markets

The prepayment option at a price of 105 causes slightly more problems as the utilisation of the option depends on the borrower behaviour in principle in the same way as fixed-rate callable mortgage bonds. However, there is no need to develop a completely new state-of-the-art model as the option is relatively insignificant in the overall picture. We opt for the

pragmatic solution where 25% of borrowers utilise the option if it is in the money on a given coupon date. This share is in no way critical to the subsequent conclusions. The pricing is based on a constant option-adjusted spread (OAS) - the normal procedure when it comes to all other bonds with or without embedded options.

### Other sources of information

#### Nykredit notes:

[Nykredit – the short version](#)

[The Danish mortgage finance system: set-up, legislation and security](#)

[Funding in Nykredit: strategy, bond issuance and risk management](#)

#### Fact sheets:

[Fixed-rate callable annuity bonds](#)

[Fixed-rate non-callable bullet bonds](#)

[Floating-rate annuity bonds](#)

[Interest-only hybrid bond series](#)

[Nykredit Bond Data: Download market information and basic bond information per ISIN code as Excel files](#)

[Prospectuses and final bond terms](#)

[Nykredit Markets's latest research](#)

[More on Nykredit's Danish Mortgage Bond Index](#)

[Nykredit Markets's research tool, Bond focus](#)

All information is available at [www.nykredit.com/ir](http://www.nykredit.com/ir)

## DISCLAIMER

This material has been produced by Nykredit for the private information of the investors to whom Nykredit has distributed the material. The material is solely based on information accessible to the public.

Nykredit does not accept any liability for the fairness, correctness, accuracy or completeness of the information or opinions contained in the material.

This material does not constitute an offer to sell or the solicitation of an offer to buy any securities mentioned in the material.

Nykredit makes no representation and gives no advice concerning the appropriate legal treatment, regulatory treatment, accounting treatment or possible tax consequences in connection with an investment in securities mentioned in the material. Before proceeding with any such investment investors should determine, without reliance upon Nykredit, the economic risk and merits, as well as the legal, tax, regulatory and accounting characteristics and consequences, of such an investment and that investors are able to assume these risks. Investors should conduct their own analysis, using such assumptions as they deem appropriate in making an investment decision. Nykredit does not accept any liability for any loss, howsoever arising, directly or indirectly from the issue of this material or its contents including transactions made based on information in this material.

This material contains certain tables and other statistical analyses (the "Statistical Information") which have been prepared in reliance upon information accessible to the public. Numerous assumptions were used in preparing the Statistical Information, which may not be reflected herein. As such, no assurance can be given as to the Statistical Information's accuracy, appropriateness or completeness in any particular context, nor as to whether the Statistical Information and or the assumptions upon which they are based reflect present market conditions or future market performance. The Statistical Information should not be construed as either projections or predictions or as legal, tax, financial or accounting advice. Calculations and presentations are based on ordinary econometric and financial tools and methods as well as publicly available sources. Danish mortgage bonds are modelled by means of an in-house developed mortgage bond model. The mortgage bond model consists of a stochastic yield curve model and a stochastic refinancing model calibrated to borrowers' historical refinancing behaviour. The yield curve model is calibrated with liquid European interest rate derivatives.

Assessments and recommendations, if any, made in this publication may involve substantial risks. Such risks, including a sensitivity analysis based on relevant assumptions, have been described in the publication.

Nykredit Realkredit A/S and/or other companies of the Nykredit Group may buy, sell or hold positions in the securities mentioned in the material, just as these companies may be involved in activities involving companies mentioned in the material.

This material is being directed at you solely in your capacity as a relevant person for your information and may not be reproduced or redistributed or passed on to any other person or published in whole or in part, for any purpose, without the prior written consent of Nykredit. Relevant persons are persons who have professional experience in matters relating to investments in securities mentioned in the material and to whom the material may be lawfully communicated. This material may not be acted on or relied on by persons who are not relevant persons.

Editor responsible under press law: Nels Petersen



**Nykredit**

Kalvebod Brygge 1-3

DK-1780 Copenhagen V

Tel +45 33 42 10 00