Nordea's Danish Mortgage Bond Key Figures

Product Development

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Contents

This document describes the key figures Nordea offers on Danish mortgage bonds. Each key figure has a brief description and an informal mathematical definition. The subsections below contain the Nordea Analytics name of the key figure (and in parenthesis the name of the KeyfigureType enum in the raw Analytics code as of August 2016).

There are fundamentally two different kinds of key figures; deterministic and stochastic ones. The stochastic key figures are those that require Monte Carlo simulation of interest rate paths and resulting prepayment behavior. The deterministic ones are those that can be computed directly from the rate curves[1]. The deterministic key figures use a cash flow with no prepayments assumed, $CF_t^{PP=0}$, and the stochastic key figures use a cash flow resulting from prepayments as predicted by the prepayment model (from the simulated rates), CF_t.

1 Deterministic key figures

This section contains the key figures that can be computed without simulating the interest rates. I.e. key figures that can be computed directly from the rate curves.

1.1 Accrued interest (Accrued Interest)

This key figure shows how much interest a bond has accrued since the last coupon payment.

$$AI = c_{term} \frac{t_i}{t_p}, \tag{1}$$

where c_{term} is the coupon for the term in question (e.g. 3%/4), t_i the time in years since last coupon payment and t_p the time in years between the last payment and the next.

1.2 Clean price (Clean Price from Quote)

The dirty price minus the accrued interest a.k.a. the quote.

$$price_{clean} = price_{dirty} - AI = quote \tag{2}$$

1.3 PV from quote (PV from quote)

The quote plus the accrued interest a.k.a. the dirty price.

$$price_{dirty} = price_{clean} + AI = quote + AI \tag{3}$$

[1]Note however, that for the Capped Adjustable Rate Mortgage bonds (CARM bonds), simulations are always used to determine the average coupon and hence cash flow - even for deterministic key figures.

1.4 PV without prepayments (deterministic PV on time series)

The average discounted cash flow not accounting for prepayments (but including simulated coupons).

$$PV_{det}(z) = \sum_t E[CF_t^{PP=0}] \exp(-(r_t + z)t) \tag{4}$$

1.5 Spread without prepayments(deterministic spread)

The spread of the bond without accounting for prepayments (but including simulated coupons) is the $spread_{det}$ solving this equation:

$$PV_{det}(spread_{det}) = price_{dirty} \tag{5}$$

1.6 PV from yield without prepayments (PV from yield)

This key figure shows the PV of the cash flow discounted with a constant yield.

$$PV_{det}^{yield}(y) = \sum_t E[CF_t^{PP=0}] \exp(-yt) \tag{6}$$

1.7 Yield to Maturity without prepayments (Yield)

This key figure shows the yield to maturity without accounting for prepayments but including simulated coupons. It is the *yield* solving this equation:

$$PV_{det}^{yield}(yield) = price_{dirty} \tag{7}$$

1.8 BPV from yield without prepayments (BPV from yield)

This key figure shows how much the present value of a bond increases if the yield decreases, measured in currency unit per one percentage point (e.g. kroner per percentage point).

$$BPV_{det}^{yield}(y) = -\frac{PV_{det}^{yield}(y+\Delta) - PV_{det}^{yield}(y-\Delta)}{2\Delta} \frac{1}{100} \tag{8}$$

1.9 Convexity from yield without prepayments (CVX from yield)

This key figure shows how much the BPV_{det}^{yield} of a bond increases if the yield decreases, measured in currency unit per one percentage point squared (e.g. kroner per percentage point squared).

$$CVX_{det}^{yield}(y) = \frac{PV_{det}^{yield}(y+\Delta) - 2PV_{det}^{yield}(y) + PV_{det}^{yield}(y-\Delta)}{\Delta^2} \frac{1}{100^2} \tag{9}$$

1.10 Modified Duration from yield (deterministic Mod Dur Yield)

This key figure shows how much the present value of a bond changes - per invested currency unit - if the rates decrease, measured in currency unit per one percentage point (e.g. kroner per percentage point). The discounting curve is a z-curve with constat yield.

$$ModDur_{det} = \frac{BPV^{yield}_{det}}{\frac{price_{dirty}}{Par}}, \tag{10}$$

where par is the bond's notional (in most cases 100 DKK).

1.11 Fisher-Weil Duration (deterministic Fisher-Weil duration)

The discounted cash flow-weighted average of time of the payments (not accounting for prepayments but including simulated coupons).

$$FWD_{det} = \frac{1}{PV_{det}} \sum_t E[CF^{PP=0}_t] \exp(-(r_t + spread_{det})t)t \tag{11}$$

1.12 Macaulay Duration without prepayments (Macaulay Duration)

The discounted cash flow-weighted average of time of the payments, discounted with the yield to maturity (not accounting for prepayments but including simulated coupons).

$$MacD_{det} = \frac{1}{PV^{yield}_{det}} \sum_t E[CF^{PP=0}_t] \exp(-yieldt)t \tag{12}$$

1.13 Weighted Average Life (Deterministic WAL)

This key figure shows the cash flow-weighted average of time of the payments without accounting for prepayments or discounting.

$$WAL_{det} = \sum_t E[CF^{PP=0}_t]t / \sum_t E[CF^{PP=0}_t] \tag{13}$$

1.14 Spread risk without prepayments (deterministic spread risk)

This key figure shows how much the value of a bond will change if the spread changes (not accounting for prepayments but including simulated coupons).

$$SR = \frac{price_{dirty}}{par} FWD_{det}, \tag{14}$$

where FWD_{det} is the deterministic Fisher-Weil duration.

1.15 Theta without prepayments (Deterministic theta)

This key figure measures the drift of the bond price due to the passage of time.

$$\Theta_{det} = (r_{short} + spread_{det})price_{dirty} \tag{15}$$

1.16 NPV without spread and prepayment (Deterministic NPV)

This key figure shows the difference between the PV_{det} of a cash flow with no prepayments and discounted with a spread of zero, and the dirty price.

$$NPV_{det} = PV_{det}(0) - price_{dirty} \tag{16}$$

2 Stochastic key figures

This section contains the key figures that require Monte Carlo simulation of interest rate paths and resulting prepayment behavior

2.1 PV (PV on ts)

The present value of a bond, with a spread of z.

$$PV(z) = \sum_t E[CF_t \exp(-(r_t + z)t)] \tag{17}$$

2.2 Spread (spread)

The spread of the bond is the *spread* solving this equation:

$$PV(spread) = price_{dirty} \tag{18}$$

2.3 Quote from spread

The average discounted cash flow minus the accrued interest. The discounting occurs with the z-curve bumped with the spread.

$$quote = PV(spread) - AI, \tag{19}$$

2.4 Quote from PV (Quote from PV)

The PV minus the accrued interest.

$$quote = PV(spread) - AI \tag{20}$$

2.5 BPV / Basis Point Value (DVOneBP)

This key figure shows how much the present value of a bond changes if the rates decrease, measured in currency unit per one percentage point (e.g. kroner per percentage point).

$$BPV = -\frac{PV(r + spread + \Delta) - PV(r + spread - \Delta)}{2\Delta}\frac{1}{100} \tag{21}$$

2.6 Delta Ladder (DV / BPV)

Defined as BPV except that only part of the rate curve is bumped (see figure 1) and the results of different bumps are collected in a vector.

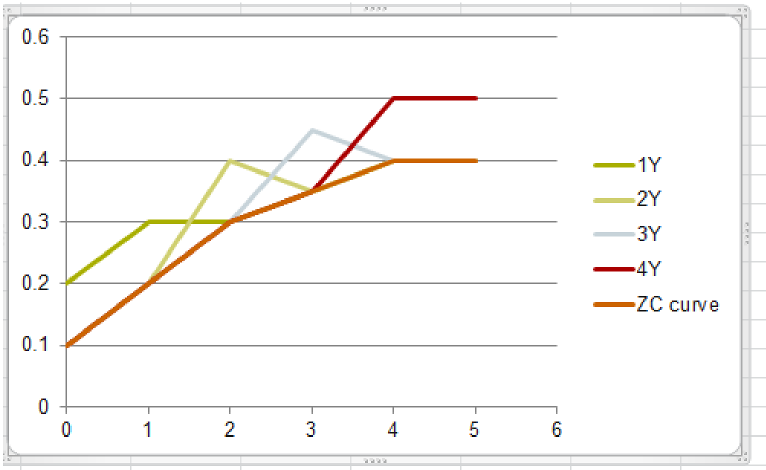

Figure 1: zero-curve and bumped curves used for calculating BPV. (Only up bumps are shown). Note in the case of automatic differentiation the curve isn't manually bumped

2.7 CVX / Convexity (DDVOneBP)

This key figure shows how much the BPV of a bond changes if the rates decrease, measured in currency unit per one percentage point squared (e.g. kroner per percentage point squared).

$$CVX = \frac{PV(r + spread + \Delta) - 2PV(r + spread) + PV(r + spread - \Delta)}{100^2\Delta^2} \tag{22}$$

2.8 Modified Duration (ModDur)

This key figure shows how much the present value of a bond changes - per invested currency unit - if the rates decrease measured in currency unit per one percentage point (e.g. kroner per invested krone per percentage point).

$$ModDur = \frac{BPV}{\frac{price_{dirty}}{Par}}, \tag{23}$$

where par is the bond's notional (in most cases 100 DKK).

2.9 Dur / Fisher-Weil duration (Fisher-Weil Duration)

The discounted cash flow-weighted average of time.

$$Dur = \frac{1}{PV(r + spread)} \sum_t E[CF_t \exp(-(r_t + spread)t)]t \tag{24}$$

2.10 Spread risk (spread risk)

This key figure shows how much the value of a bond will change if the spread changes.

$$SR = \frac{PV}{par} Dur, \tag{25}$$

where Dur is the "stochastic" Fisher-Weil duration.

2.11 Theta (Theta on ts)

This key figure measures the drift of the bond price due to the passage of time.

$$\Theta = (r_{short} + spread) price_{dirty} \tag{26}$$

2.12 NPV of cash flow (NPV)

This key figure shows the difference between the PV of the expected discounted cash flow (discounted with a spread of zero) and the dirty price.

$$NPV = PV(0) - price_{dirty} \tag{27}$$

2.13 Vega Risk (Vega on time series)

This key figure shows how much the present value of a bond changes if the volatility of the rates increase, measured per bond for a one percentage point volatility change (e.g. kroner per bond per percentage point).

$$\nu = \frac{PV_{+\Delta} - PV_{-\Delta}}{2\Delta} \frac{1}{100} \tag{28}$$