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Bond Calculator

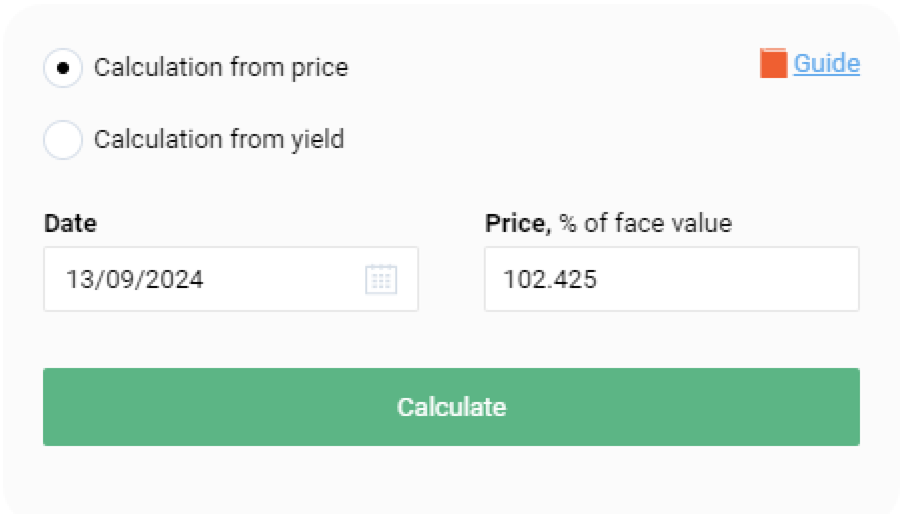
The bond calculator is designed to calculate analytical parameters used in the assessment of bonds. The tool allows the calculation of prices, accrued coupon interest, various types of bond yields, duration, as well as modified duration, curve and PVBP, making it possible to analyze the volatility of debt market instruments and assess how bond prices changes with yield.

Using the calculator

The Calculator is available on the Bond page by clicking on the "Calculator" button under the main parameters block:

As in the case of the [Pemex, 10% 7feb2033, USD (US71654QDP46)] issue.

Calculating Bond Parameters



The calculator allows for the computing of analytical parameters either based on the known bond price or based on a given yield. "Calculation from price" is active by default. To calculate bond parameters based on the given yield, choose the tab "Calculation from yield".

The Calculate button will be active when you have filled in the input data. You will see the calculation results in the table below.

Downloading calculation results in XLS formats is possible by clicking «Export to Excel».

Calculation results (for T+0 date)

YTM, %	**9.7991**	CY, %	**9.7632**
D to maturity, years	**5.8533**	ACI	**10**
NY, %	**9.5701**	SY, %	**9.3897**
ACY, %	**9.4746**	P excl. ACI, %	**102.425**
P incl. ACI, %	**103.425**	P excl. ACI, in currency of issue	**1,024.25**
P incl. ACI, in currency of issue	**1,034.25**	Outstanding face value	**1,000**
Current coupon sum	**50**	The current coupon period, days	**180**
Number of days elapsed in the current coupon period	**36**	Number of days left till the next coupon payment	**144**
Years to maturity	**8.4**	D to maturity, days	**2,107.1852**
MD to maturity	**5.3309**	PVBP to maturity, in currency of issue	**0.0551**
Conv to maturity	**40.2128**	G-spread to the zero-coupon curve, bps	**627.3279**

Export to Excel

Terms and Definitions

Face Value

The face value of a bond is a par value set by the issuer and is usually indicated directly on the security itself.

The notion of an **outstanding face value** applies to bonds structured with amortization. It is a part of the face value remaining after partial repayments of par over the life of the bond. Analytical indicators on such bonds are calculated based on the outstanding face value.

Lot of Multiplicity

The lot of multiplicity (denomination increment, trading lot increment) is the minimum number of securities at face value with which settlement and depository operations are performed.

Minimum Denomination

The minimum denomination (minimum trading lot, minimum trading volume) is a parameter of a certificated bearer international bond. The borrower determines the total size of the issue at face value, the lowest denomination and denomination increment. **All payments on international bonds will be made from the minimum trading lot.**

Coupon

A coupon is a periodic interest payment made throughout the life of the bond. The coupon is calculated as a percentage (per annum) of the face value and/or an amount payable to bondholders.

Methods for Calculating the Number of Days (Day Count Conventions)

Methods for calculating the number of days between dates determine the notional number of days in a year (calculation basis), the rules for calculating the notional number of days between the start and end dates, and the length of the period on an annual basis. The choice of method affects the calculation of accrued interest, coupons, and discount rates when calculating analytical parameters.

The method is specified by an expression formatted as XX/YYY. The numerator defines the rule for calculating the number of days in a month, and the denominator is the length of the year in days. An up-to-date list of applied methods is available in the prospectuses on a Eurobond issue.

30/360 Methods

Start day: D1.M1.Y1 (day.month.year)
End date: D2.M2.Y2 (day.month.year)
Day count fraction = $((Y2-Y1)\cdot 360 + (M2-M1)\cdot 30 + (D2-D1))/360$

30/360 German (other names: **30E/360 ISDA**)
Source: 2006 ISDA Definitions (Section 4.16(h))
D1 and D2 adjustment rules:

- if D1=31, then D1=30
- if D2=31, then D2=30
- if D1 is the last day of February, then D1=30
- if D2 is the last day of February, and not maturity date, then D2=30

30/360 ISDA (30/360) (other names: **Bond Basis, 30-360 U.S. Municipal**)
Source: 2006 ISDA Definitions (Section 4.16(f))
D1 and D2 adjustment rules:
- if D1=31, then D1=30
- if D2=31 and D1=30 or 31, then D2=30

30/360 US (other names: **30U/360, 30US/360, 30/360SIA**)
D1 and D2 adjustment rules:
- if D1=31, then D1=30
- if D2=31 and D1=30 or 31, then D2=30
- if D1 is the last day of February, then D1=30
- if D1 is the last day of February and D2 is the last day of February, then D2=30

30E+/360 [1]
D1 and D2 adjustment rules:
- if D1=31, then D1=30
- if D2=31, then D2.M2.Y2 is the first day of the following month ((D2=1; Y2=Y2+integral part((M2+1)/12); M2 = ((M2 +1) mod 12) – remainder of dividing (M2+1) by 12)

30E/360 (other names: **Eurobond Basis, 30/360 Eurobond, 30/360 ISMA, 30/360 European, 30S/360 Special German**)
Source: 2006 ISDA Definitions (Section 4.16(g))
D1 and D2 adjustment rules:
- if D1=31, then D1=30
- if D2=31, then D2=30

Actual Methods

Actual/360 (other names: **Act/360, French**)
Source: 2006 ISDA Definitions (Section 4.16(e))
The number of days in the period is calculated as the difference between the dates without any adjustments, based on 360-day year. Calculation basis = 360.

Actual/365A (other names: **Actual/365 Actual**)
Source: The Actual-Actual Day Count Fraction (1999)(Section 2 (c))
The number of days in the period is calculated as the difference between the dates without any date adjustments. Calculation basis = 366, if the leap day (February 29) falls during the period, otherwise calculation basis = 365.

Actual/365F (other names: **Actual/365 (Fixed), English**)
Source: 2006 ISDA Definitions (Section 4.16(d))
The number of days in the period is calculated as the difference between the dates without any date adjustments. Calculation basis = 365.

Actual/365L (other names: **Actual/365 Leap year, Actual/365 (Sterling)**)
The number of days in the period is calculated as the difference between the dates without any date adjustments. Calculation basis = 366, if the end date of the period falls on a leap year, otherwise calculation basis = 365.

Actual/Actual (ISDA) (other names:**Act/Act, Actual/Actual, Act/ISDA**)
Sources: 2006 ISDA Definitions (Section 4.16(b)), The Actual-Actual Day Count Fraction (1999)(Section 2 (a))
The length of a period on an annual basis is the number of days in the period summarized and divided by 366 for a leap year or divided by 365 for a non-leap year leap year or divided by 365 for a non-leap year.

Actual/Actual (ISMA) (other names: **Actual/Actual (ICMA**))
Sources: 2006 ISDA Definitions (Section 4.16(c), ISMA Rule Book (Rule 251.1 (iii)),The Actual-Actual Day Count Fraction (1999)(Section 2 (b))
The number of days in a period is the difference between two dates without any date adjustments.
The length of the period on an annual basis is the number of days of the period divided by the product of multiplying the duration of the coupon period in days by the number of coupons per year.

Actual/364 - instance Actual/Actual (ISMA), when the coupon period is 91 or 182 days. Used for some short-term securities. Calculation basis = 364.

NL/365 (other names: **Actual/365 No Leap year, NL 365**)
The number of days in the period is calculated as the difference between the dates without any date adjustments.
1 is deducted from the number of days in the period, if the leap day (February 29) falls during this period. Calculation basis = 365.

BD/252 (other names: **ACT/252, ACTW/252, BU/252, BD/252, BUS/252**)
Number of working days for the Brazilian calendar between dates is used. Calculation basis = 252.

Actual/366
The year is assumed to be 366 days. The actual number of days between dates is used.
Day count basis = 366.

Designations

Parameter	Definition
YTM	annually compounded yield to maturity, % p. a.
YTC/YTP	annually compounded yield to call/put, % p. a.
NY	quarterly/semi-annually compounded nominal yield, % p. a.
NYC/NYP	quarterly/semi-annually compounded nominal yield to call/put, % p. a.
SY	simple yield (including A), % p. a.
SYC/SYP	simple yield to call/put (including A), % p. a.
CY	current yield, % p. a.
ACY	adjusted current yield (to maturity/offer), % p. a.
A	accrued coupon interest, A, units of face value
P	net price, units of face value
$P_{\%}$	net price, % of face value
P+A, P_d	gross price, units of face value
$C_{\%}$	coupon rate, % p. a.
C_i	size of i-th coupon payment, units of face value
N	face value of the bond, units of currency
$N_{\%}$	face value of the bond, %
N_i	the i-th payment of the debt face value (including redemption of principal under offer, amortization payments, full repayment), units of face value
NN	outstanding face value, units of face value
n	coupon frequency (per year)
m	number of coupon payments
k	number of calendar days from the date of beginning of the coupon period until the calculation date
t_i	redemption date of the i-th coupon, face value etc.
t_0	calculation date
t_m	maturity date
B	number of days in a year taken for calculation purposes, calculation basis
D	Macaulay duration, days/years
MD	modified duration
Tm	years to maturity
PVBP	price value of a basis point
Conv	convexity
G-spread	G-spread, bp
T-spread	T-spread, bp
$Z\text{-spread}_{GCurve}$	Z-spread to zero-coupon yield curve, bp
$Z\text{-spread}_{Swap}$	Z-spread to swaps yield curve, bp
$GCurveYield_i$	yield value on zero-coupon yield curve as at the coupon payment date (redemption at the face value), bp
$SwapYield_i$	yield value on swap curve as at the coupon payment date (redemption at the face value), bp

Calculated Values

Accrued Coupon Interest

Accrued coupon interest (A, Accrued Interest) is a value measured in monetary units, and characterizing the part of coupon income, which has "accrued" from the beginning of the coupon period.

Coupon on the bonds is paid periodically, usually once every quarter, six months or a year. Accordingly, when one coupon is paid and the next coupon period begins, the coupon begins to "accrue". On the coupon due date, investors receive a coupon payment for the respective coupon period, and Accrued Interest is zero.

Calculating this indicator is important due to the fact that in most markets, bonds are traded at so-called net price excluding the Accrued Interest. Thus, in order to get the full price payable by the bond buyer to the seller (also known as gross price), one needs to add A to the net price.

In practice, there are different methods of A calculation:

1) **based on the coupon rate:**

$$A = C_{\%} NN \frac{t_0 - t_{i-1}}{B}$$

2) **based on the coupon amount:**

$$A = C_i \frac{t_0 - t_{i-1}}{t_i - t_{i-1}}$$

3) **based on the coupon amount applicable on each date within the coupon period** *(for papers with changeable coupon rate within the coupon period):*

$$A = NN \sum_{i=1}^{k} \frac{C_{\%_i}}{B_i}$$

For zero-coupon bonds, A is not calculated.

Calculation example

Issue – *Pemex, 10% 7feb2033, USD (US71654QDP46)*

Date: 06.09.2024
Face Value = 1 000 USD
Coupon, % = 10% p.a.
Coupon size = 50 USD
The current coupon period = 180 days
Day count fraction – 30E/360
Price (net), % of face value = 102,425

Days from the beginning of the coupon period until the calculation date = 36

A calculation based on the coupon size:

$$A=50 \cdot \frac{36}{180}=10$$

See page 3 for calculation results in the Cbonds calculator.

Yield

The Yield is the main indicator characterizing bonds. Several of the calculation approaches currently used in practice can be divided into two groups - simple yield rates and compound rates, or compound yield rates.

Simple Yield

Current yield, flat yield

Current Yield (CY) is a simple yield rate calculated as the coupon rate divided by the bond's clean price. Unlike coupon yield, it takes into account the current clean price of the bond. Also, it does not take into account the bond yield curve and measures the yield as a percentage of the current clean price.

$$CY = \frac{C\%}{P\%} \cdot 100\%$$

Calculation example (continued)

$$\text{CY} = \frac{10\%}{102{,}425\%} \cdot 100\% = 9{,}7632\ \%$$

See page 3 for calculation results in the Cbonds calculator.

Adjusted current yield

Adjusted current yield (ACY) is a simple yield rate that considers the coupon yield and the capital gains yield (the purchase price excl. accrued). The calculation formula for the indicator is as follows:

$$ACY = CY + \frac{100\% - P\%}{T_m}$$

Calculation example (continued)

$$\text{ACY} = 9{,}7632\% + \frac{100\%\text{-}102{,}425\%}{8{,}4} = 9{,}475\ \%$$

See page 3 for calculation results in the Cbonds calculator.

Simple Yield to Maturity, including A, SY (SYC/SYP)

Simple Yield including A (SY (SYC/SYP)) is a yield, for the calculation of which the "dirty" price is used instead of the net price (including A costs when buying bonds):

$$SY = \frac{\sum(C_i + N_i) - Pd}{Pd} \cdot 100\%/T_m$$

Calculation example (continued)

Dirty price (Pd) = 102,425% · 1000 + 10 = 1 034,25 USD

$SY = \frac{(850+1000)\text{-}1034{,}25}{1034{,}25} \cdot 100\%/8{,}4 = 9{,}3897\%$

For calculation results in the Cbonds calculator, see page 3

SY is calculated for issues with the cash flow fully determined until the redemption date. SYP/SYC is calculated for issues with the non-executed offer and partially determined cash flow.

Compound Yield

Compound yield is also called the internal rate of return.

Compound yield to maturity (YTM)

- is the compound interest rate over a certain compounding period calculated on the initial investment (clean price + A).

- is the discount rate that equates the present value of all future cash flows until the maturity date with the dirty price of the bond.

Based on the definition of YTM, this concept does not involve reinvestment of any future coupon payments and links the initial investment (dirty price) with future payment flows before maturity without taking into account any additional investment.

The common conception from financial literature stating that the yield to maturity (effective yield) is calculated based on the assumption of reinvesting coupon payments at the same rate does not apply to the concept of YTM.

Annually compounded yield to maturity, YTM (YTP/YTC)

Yield to maturity (YTM (YTC/YTP)) is the annually compounded rate of return regardless of a bond's coupon period. This approach is used to calculate yields in Japanese, Norwegian, Italian, Danish, Swedish, and Spanish markets as well as a number of other countries.

Yield to maturity (YTM) is calculated using the following equation:

$$P + A = \sum_{i=1}^{m} \frac{C_i + N_i}{(1 + YTM)^{\frac{t_i - t_0}{B}}}$$

When a bond is at par price and A = 0, the YTM value will be marginally higher than the coupon rate (for coupon bonds with a coupon period of less than a year).

For zero-coupon bonds, the value of YTM is calculated using the following equation (a special case for the equation when A = 0 and Ci = 0):

$$P = \frac{N}{(1 + YTM)^{\frac{t_m - t_0}{B}}}$$

or

$$YTM = \left[\left(\frac{N}{P}\right)^{\frac{B}{t_m - t_0}} - 1\right] \cdot 100\%$$

The calculator computes YTM for coupon bonds using Newton's method (also known as the tangent method).

Calculation example (continued)

Dirty Price = 102,425% · 1000 + 10 = 1 034,25 USD

$$1034{,}25 = \frac{50}{(1+YTM)^{0{,}4}} + \frac{50}{(1+YTM)^{0{,}9}} + \cdots + \frac{1050}{(1+YTM)^{8{,}4}}$$

$$YTM = 9{,}7991\%$$

For calculation results in the Cbonds calculator, see page 3.

YTM is calculated for issues with the cash flow fully determined until the redemption date. YTP/YTC is calculated for issues with the non-executed offer and partially determined cash flow.

Monthly/quarterly/semi-annually compounded nominal yield, NY (NYP/NYC)

Nominal yield (NY (NYC/NYP)) is the rate of return with monthly/quarterly/semi-annual compounding. This approach is used in US, UK, Canadian, German, Australian, Indian, French, Swiss, Portuguese, South African, Finnish, and Polish markets as well as in some other countries. Because yields that are calculated on a compounded basis on the same frequency as the coupon frequency, it seems to be following the most coherent logic out of all compound rates.

NY is calculated using the following equation:

$$(P + A) \cdot \left(1 + \frac{NY}{100h}\right)^{\frac{t_1 - t_0}{\frac{B}{h}}} = (C_1 + N_1) + \sum_{i=2}^{m} \frac{C_i + N_i}{(1 + \frac{NY}{100h})^{i-1}}$$

Nominal yield can also be calculated through yield to maturity (YTM):

$$NY = n \cdot \left((1 + YTM)^{\frac{1}{n}} - 1\right) \cdot 100\%$$

When the bond’s at par price and A = 0, = 0, nominal yield will be equivalent to the coupon rate.

The NY will be lower than the corresponding YTM - a shorter compounding period (more frequent) leads to a lower internal rate of return required for bond payments.

For zero-coupon bonds, NY and YTM are equivalent.

Calculation example (continued)

Number of coupon payments per year = 2

$$\text{NY} = 2 \cdot ((1 + 0{,}097991)^{\frac{1}{2}} - 1) \cdot 100\%$$

$$\text{NY} = 9{,}5701\%$$

For calculation results in the Cbonds calculator, see page 3

NY is calculated for issues with the cash flow fully determined until the redemption date. NYP/NYC is calculated for issues with the non-executed offer and partially determined cash flow.

Duration, convexity

Among other things, the bond yield takes into account the risk premium (credit, market, liquidity risk, etc.) to compensate for the risks that the investor accepts upon purchase. Below are parameters used to assess market risk:

- duration
- price value of basis point
- convexity

Years to maturity

This indicator shows the bond's term to maturity in years.

Years to maturity are calculated for issues with the cash flow fully determined until the redemption date. Years until the offer is calculated for issues with a non-executed offer and partially determined cash flow [1].

Macaulay Duration (D)

Macaulay's duration (D) is the average tenor of payment flow, and the estimate depends on the compounding period used in calculations. For the standardization of duration values for different bonds, the duration calculator uses the annual compounding period. The formula for calculating the duration is as follows:

$$D = \frac{\sum_{i=1}^{m}(t_i - t_0)\dfrac{C_i + N_i}{(1+YTM)^{\frac{t_i - t_0}{B}}}}{P + A} \ \textit{(days)}$$

Duration is a finite value also for perpetual bonds (only the coupon is paid) and coupon bonds that are equivalent to them at Tm → ∞, and it is expressed by the formula:

$$D = 1 + \frac{1}{YTM} \ \textit{(years)}$$

Duration is usually measured in years on international markets (Bloomberg).

Duration not only shows the average tenor of payment flow on bonds, but it is also a good measure of price sensitivity to interest rate fluctuations.

Duration to maturity is calculated for issues with the cash flow fully determined until the redemption date. Duration to Put/Call option is calculated for issues with a non-executed offer and partially determined cash flow [1].

Calculation example (continued)

$$D = \frac{\left[144 \cdot \frac{50}{(1+0{,}097991)^{0{,}4}} + 324 \cdot \frac{50}{(1+0{,}097991)^{0{,}9}} + \cdots + 3024 \cdot \frac{1050}{(1+0{,}097991)^{8{,}4}}\right]}{1034{,}25}$$

[1] – When calculating indicators to the offer, the selection falls on the non-executed put/call option that is nearest to the calculation date, which takes place in at least 14 calendar days, and only those payments made until the put/call option date are taken into account.

$D = 2107$ days (5,8533 years)

For calculation results in the Cbonds calculator, see page 3.

Modified duration (MD)

The first derivative of the price with respect to the yield, normalized by the price of a bond, can serve as a measure of price sensitivity to changing yield:

$$MD = -\frac{1}{P}\frac{\partial P}{\partial YTM}$$

Differentiating the dirty price function from the yield:

$$\frac{\partial Pd}{dYTM} = \frac{d\left(\sum_{i=1}^{m}\frac{(C_i+N_i)}{(1+YTM)^t}\right)}{dYTM} = -\sum_{i=1}^{m}\frac{t\cdot(C_i+N_i)}{(1+YTM)^t\cdot Pd}\cdot\frac{Pd}{1+YTM}, \text{ where } t = \frac{t_i-t_0}{B}$$

The first multiplier is the Macaulay duration. Thus,

$$MD = \frac{D}{1+YTM}$$

This value is technically called the modified duration, although it has its own calculation basis.

Modified Duration (MD) is an indicator that represents the relative change in the bond's dirty price when the yield changes by 1%, provided that the expected cash flow values based on the bond remain constant through the yield change. It is important to note that the modified duration does not characterize the volatility of the bond's clean price. It does so for the dirty price and shows how the dirty price will change when the yield changes by 1%.

International practice (Bloomberg) also implies calculating the Risk indicator, which is the relative price change of a bond when the yield changes by 1 bp (see below Price value of basis point).

The approximate value of the relative price change in case of a yield change and a given duration/modified duration is calculated using the following formula:

$$\frac{\Delta Pd}{Pd} = -D\frac{\Delta YTM}{1+YTM} = -MD\cdot\Delta YTM$$

Duration to maturity is calculated for issues with the cash flow fully determined until the redemption date. Duration to Put/Call option is calculated for issues with the non-executed offer and partially determined cash flow[2].

Calculation example (continued)

$$MD = \frac{5{,}8533}{1+0{,}097991} = 5{,}3309$$

If the yield changes by 1%, the dirty price of the bond will change by 5.3309%

[2] – When calculating indicators to the offer, the selection falls on the non-executed put/call option that is nearest to the calculation date, which takes place in at least 14 calendar days, and only those payments made until the put/call option date are taken into account.

Let's assume the yield is up 0.5%. The change in the bond price is calculated as follows:

$$\frac{\Delta Pd}{Pd} \approx -5{,}3309 \cdot 0{,}005 = -2{,}665\%$$

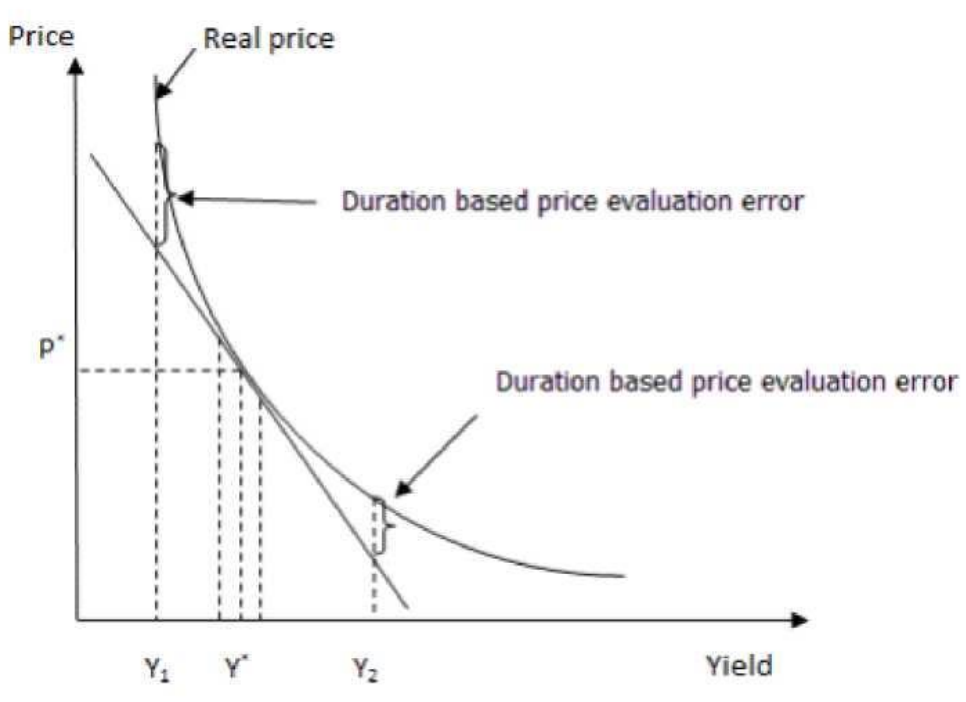
$$\Delta Pd = -2{,}665\% \cdot 1034{,}25 = -27{,}56\ \text{U}SD$$

With a 0.5% increase in yield, the bond's dirty price decreases by 2.665%, down to 1,006.69 USD.

For calculation results in the Cbonds calculator, see page 3.

Properties of duration and modified duration

1. The longer the duration, the more sensitive the price becomes to interest rate fluctuations. A three-year bond means that the given bond has the same price sensitivity to interest rate fluctuations as a three-year zero-coupon bond.
2. Duration is always less than or equal to the period until bond redemption. The duration of a zero-coupon bond is equal to its period until redemption and does not depend on yield change.
3. Under otherwise equal conditions, the higher the coupon rate, the shorter the duration, and vice versa.
4. Under otherwise equal conditions, if yield to maturity grows, duration decreases, and vice versa.
5. Under otherwise equal conditions, the longer until maturity, the longer the duration. However, an increase in the tenor of a bond does not always correlate with an increase in its duration.
6. Under otherwise equal conditions, the higher the coupon payment frequency, the shorter the duration, and vice versa.
7. The duration of a perpetual bond (without redemption of the par value), as well as the duration of the equivalent coupon bond at Tm → ∞, is $\frac{1}{YTM}$ years, regardless of the coupon rate.
8. The modified duration of a zero-coupon bond is less than its term to maturity and is equivalent to $\frac{T_m}{1+YTM}$.
9. Under otherwise equal conditions, the modified duration decreases with an increase in bond yields and vice versa.



Only using duration (modified duration) to calculate a relative price change does not produce an accurate estimate of the percentage change in a bond's price. And the more the yield changes, the less accurate the estimate will be. This inaccuracy is caused by the duration being represented as a linear estimate of the percentage change in a bond's price, while the price/yield function is a non-linear function. Subsequently, the estimate of the relative price change, which only takes into account the duration, produces a less accurate result.

Price value of a basis point, basis point value (PVBP, BPV, DV01)

Unlike modified duration, which is a relative value, the price value of a basis point (basis point value) shows the absolute value of a dirty price change when its yield changes by one basis point. PVBP is calculated with this formula:

$$PVBP = \frac{MD}{100} \cdot \frac{(P+A)_{\%}}{100}$$

The Bloomberg terminal features this indicator as Risk (BRV, Bloomberg Risk Value), and it is calculated for a par value of 10,000.

PVBP is calculated for issues with the cash flow fully determined until the redemption date. PVBP to put/call option is calculated for issues with a non-executed offer and a partially determined cash flow[3].

Calculation example (continued)

$$PVBP = \frac{5{,}3309}{100} \cdot \frac{103{,}425}{100} = 0{,}0551\%$$

If the yield changes by 1 bp, the bond price will increase (or decrease) by 55 cents per 1000 dollars of the par value.

Convexity (CONV)

Convexity (CONV) is equivalent to the second derived function of price from yield, normalized by the price of a bond. This indicator characterizes asymmetry in the connection between bond prices and changes in yield. The bond price increase resulting from an increase in yield will typically be more than the price decrease resulting from an increase in yield of the same magnitude. This indicator shows the change in modified duration when the yield changes by 1%.

$$CONV = \frac{1}{P+A} \cdot \frac{d^2 Pd}{dYTM^2}$$

$$CONV = \frac{\sum_{i=1}^{m} \frac{(C_i+N_i) \cdot t \cdot (t+1)}{(1+YTM)^{t+2}}}{P+A}, \text{ where } t = \frac{t_i - t_0}{B}$$

[3] – When calculating indicators to the offer, the selection falls on the non-executed put/call option that is nearest to the calculation date, which takes place in at least 14 calendar days, and only those payments made until the put/call option date are taken into account.

Convexity can also be expressed as the sum of the modified duration and its derivative with respect to yield:

$$CONV = MD^2 - \frac{dMD}{dYTM}$$

Considering that the derivative of the modified duration with respect to yield is negative, convexity for coupon bonds (without options) is always positive.

The indicator delivers a better approximation of the price change due to yield change. It can be calculated from the ratio:

$$\frac{\Delta Pd}{Pd} \approx -MD \cdot \Delta YTM + \frac{1}{2} CONV \cdot (\Delta YTM)^2$$

The use of modified duration and convexity allows for estimation of the bond price percentage change with a significant change in yield to maturity.

Convexity properties:

1. Convexity is always positive for conventional coupon bonds (without options).
2. Under otherwise equal conditions, convexity grows with an increase in the time of redemption and decreases with an increase in yield.
3. For zero-coupon bonds, convexity is calculated from the ratio:

$$CONV = \frac{N}{P+A} \cdot \frac{t \cdot (t+1)}{(1+YTM)^{t+2}}, \text{ where } t = \frac{t_m - t_0}{B}$$

4. Convexity of a perpetual bond and a coupon bond with Tm → ∞ is equivalent to $\frac{2}{YTM^2}$

Convexity to maturity is calculated for issues with the cash flow fully determined until the redemption date. Convexity to a Put/Call option is calculated for issues with a non-executed offer and partially determined cash flow[4].

Calculation example (continued)

$$CONV = \frac{\left[0{,}4 \cdot 1{,}4 \frac{50}{(1+0{,}097991)^{2{,}4}} + 0{,}9 \cdot 1{,}9 \frac{50}{(1+0{,}097991)^{2{,}9}} + \cdots + 8{,}4 \cdot 9{,}4 \frac{50}{(1+0{,}097991)^{10{,}4}}\right]}{1034{,}25} = 40{,}2128$$

Let's assume the yield is up 0.5%. The change in the bond price is calculated as follows:

$$\frac{\Delta Pd}{Pd} \approx -5{,}3309 \cdot 0{,}005 + \frac{1}{2} \cdot 40{,}2128 \cdot (0{,}005)^2 = -2{,}62\%$$

$$\Delta Pd = -2{,}62\% \cdot 1034{,}25 = -27{,}1\ USD$$

With a 0.5% increase in yield, the bond's dirty price has decreased by 2.62%, down to 1,007.15

For calculation results in the Cbonds calculator, see page 3.

[4] – When calculating indicators to the offer, the selection falls on the non-executed put/call option that is nearest to the calculation date, which takes place in at least 14 calendar days, and only those payments made until the put/call option date are taken into account.

Spreads (G-spread, T-spread, Z-spread)

The **G-spread** for issues in USD, EUR, CHF, KZT, RUB currencies is calculated as the arithmetic difference between the bond yield on the calculation (trading) date and the yield on the zero-coupon yield curve for government bonds with the same duration on the maximum date in the Cbonds database (at the time of calculation), which is less than or equal to the calculation (trading) date. For USD, CHF, KZT the curves calculated in accordance with the methodologies of national banks are used, for EUR the curve calculated in accordance with the methodology of the European Central Bank, for RUB - G-curve.

For USD, EUR, GBP issues, **T-spread** is calculated as the difference between the yield at issue and the US, UK, or German government securities yield in the corresponding issue currency and with comparable modified duration (the calculations take into account yield to maturity). The “Benchmark T-spread” field indicates the issue that the T-spread on the maturity date was calculated for. Issues with a floating coupon rate and STRIPS-type issues are excluded from the benchmarks. The data from the Cbonds Estimation platform is used to search for a benchmark for calculating T-spread.

Z-spread to zero-coupon curve brings the sum of the cash flows on the bond, discounted at zero-coupon yield curve for government securities (G-curve) plus spread, to the dirty price of the bond. Z-spread to zero-coupon curve is calculated with the equation

$$P + A = \sum_{i=1}^{m} \frac{C_i + N_i}{(1 + GCurveYield_i + Zspread_{Gcurve})^{\frac{t_i - t_0}{B}}}$$

The calculator computes the spread using Newton’s method (also known as the tangent method).

Z-spread to swaps, Zero-volatility spread to swaps brings the sum of the cash flows on the bond, discounted at zero-coupon swap curve plus spread, to the “dirty” price of the bond**.**

$$P + A = \sum_{i=1}^{m} \frac{C_i + N_i}{\left(1 + SwapYield_i + Zspread_{SwapCurve}\right)^{\frac{t_i - t_0}{B}}}$$

The calculator computes the spread using Newton’s method (also known as the tangent method).