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Bond Calculator

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

The software interface allows viewing key bond parameters and saving calculation results as PDF and Excel files. It is also possible not only to analyze traded issues, but also create user models.

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Using the calculator

Calculating yield by price **Calculating the price by yield** Issue model

Please choose issue from Cbonds database 02/17/2017

Price: % of face value in currency of issue

Calculate Reset

To continue working with the calculator, you need to load the issue from Cbonds database or create a bond model.

Loading issues from Cbonds Database

1. Enter either ISIN, or the issue registration number, or the issuer in the search bar.
2. Select a bond issue from the opened list.

Calculating Bond Parameters

Calculating yield by price **Calculating the price by yield** Issue model

Russia, 26209 04/21/2017

Price: % of face value in currency of issue

Calculate Reset

The calculator allows computing analytical parameters either based on the known bond price, or based on the given yield. "Calculating yield by price" is the active tab by default. To calculate bond parameters based on the given yield, choose the tab "Calculate Price from Yield".

Bond price can be shown as a percentage of face value, or directly in units of face value. You can make your calculations based on the known net price of the bond (price excluding ACI), or dirty price (including ACI). By default, calculations are made from the net price shown as percentage of face value.

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

Issue parameters

Face value	1000	Day count fraction	Actual/365 (Actual/365F)
Interest accrual date	01.08.2012	Coupon frequency	2
Maturity date	20.07.2022		

Calculation results (for T+0 date)			
Date	21.04.2017	Current coupon sum	37.9
YTM (eff.), %	7.9863	The current coupon period, days	182
YTM (nom.), %	7.8329	Number of days elapsed in the current coupon period	86
YTM (simple), %	7.7302	Number of days left till the next coupon payment	96
CY, %	7.6768	D (to maturity), days	1585.7548
ACY, %	7.8673	D (to maturity), years	4.3445
P (excl. ACI), %	99	MD (to maturity)	4.0232
P (incl. ACI), %	100.791	PVBP (to maturity), in currency of issue	0.0406
P (excl. ACI), in currency of issue	990	Conv (to maturity)	22.0047
P (incl. ACI), in currency of issue	1007.91	G-spread (to GCurve), bp	18.5285
Outstanding principal amount at par	1000	Z-spread (to SwapCurve), bp (beta-version)	-42.4888
ACI	17.91	Z-spread (to GCurve), bp (beta-version)	20.4122

Calculation results can be downloaded as PDF and Excel files.

Using the "Issue model"

There is the function to model simple coupon-bearing and discount bonds, which allows you to quickly assess the price or yield of bonds according to the input parameters.

Calculating yield by price	Calculating the price by yield	Issue model	
Coupons and long-term zero-coupon bonds		Short-term zero-coupon bonds	
Coupon rate	<input type="text" value="10"/>	Maturity (days)	<input type="text" value="200"/>
Maturity (years)	<input type="text" value="5"/>	Current price	<input type="text" value="95"/>
The freq. of coupon payments (per year)	<input type="text" value="2"/>	Yield to maturity (effective)	<input type="text" value="9.8132"/>
Current price	<input type="text" value="102"/>	Yield to maturity (nominal)	<input type="text" value="9.6053"/>
Yield to maturity (effective)	<input type="text" value="9.7135"/>	<input type="button" value="Calculate"/>	<input type="button" value="Clean"/>
Yield to maturity (nominal)	<input type="text" value="9.4884"/>		
<input type="button" value="Calculate"/>	<input type="button" value="Clean"/>		

To model the issue, enter the "Maturity", "Coupon rate", "The frequency of coupon payments (per year)". At least one of the fields "Current price" or "Yield to maturity" is also required for calculation.

Press the button "Calculate" to view all other calculating parameters.

In the example we create the model of short-term zero-coupon bond with current price 95% and maturity 200 days. Also we create the model of 5-year coupon bond with current price 102% and coupon rate 10%. We use bond basis 365 days per year to calculate all parameters.

Terms and Definitions

Face Value

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

The notion of **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

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

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

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

Calculating the Number of Days between Dates

Days calculation method determines the formula used to calculate the notional number of days between the starting and ending dates of the ACI period, and the notional number of days in a year (calculation basis). The choice of method affects the discount value when calculating analytical parameters of the bond.

For Russian bonds, the generally used method is Actual/365F; for Ukrainian bonds, we usually use methods 30/360 or Actual/365F; 30E/360 is the most commonly used method for international bonds.

30/360 Methods

Starting date: D1.M1.Y1 (day.month.year)

Ending date D2.M2.Y2 (day.month.year)

Difference between the dates (Day count) = $(Y2 - Y1) * 360 + (M2 - M1) * 30 + (D2 - D1)$

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, then D2=30

The last day of February: February 29 in any leap year, February 28 in any non-leap year.

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, then D2=30

30/360 US (other names: **30U/360, 30US/360**)¹

D1 and D2 adjustment rules:

- if D1=31, then D1=30
 - if D2=31 and D1=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
- Last day of February: February 29 in any leap year, February 28 in any non-leap year.

30E+/360¹

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: **30/360 Eurobond, 30/360 ISMA, 30/360 European, 30S/360 Special German, Eurobond Basis**)

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))

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 \(c\)\)](#)

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 on the period, otherwise calculation basis = 365.

Actual/365F (other names: **Actual/365 Fixed, English**)

Source: 2006 ISDA Definitions (Section 4.16(d))

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**)¹

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 (other names: **Act/Act, Actual/Actual (ISDA)**)

Sources: 2006 ISDA Definitions (Section 4.16(b), [The Actual-Actual Day Count Fraction \(1999\)\(Section 2 \(a\)\)](#))

Number of days in the period (per share per annum) = (Number of days in the period, which falls on a leap year) / 366 + (number of days in the period, which falls on a non-leap year) / 365.

Actual/Actual (ISMA) (other names: **Actual/Actual (ICMA)**)

Источники: 2006 ISDA Definitions (Section 4.16(c), ISMA Rule Book (Rule 251.1 (iii)), [The Actual-Actual Day Count Fraction \(1999\)\(Section 2 \(b\)\)](#))

Number of days in the period is calculated as the difference between the dates without any date adjustments.

¹ – we used prospectuses, expert opinions and site deltaquants.com to describe the method

Number of days in the period (per share per annum) = Number of days in the period / ((number of days in the current coupon period) · (number of payments 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**)²

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 on 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 Brazil calendar between dates is used. Calculation basis = 252.

Source: [«PUBLIC DEBT: the Brazilian experience»](#)

² – we used prospectuses, expert opinions and site deltaquants.com to describe the method

Designations

Parameter	Definition
Y	effective yield, % p.a.
Y_n	nominal yield, % p.a.
Y_s	simple yield, % p.a.
CY	current yield, % p.a.
ACY	adjusted current yield, % p.a.
A	accrued coupon interest, ACI, 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
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.
t₀	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
T_m	years to maturity
PVBP	price value of a basis point
Conv	convexity
G-spread	G-spread, bp
T-spread	T-spread, bp
Z-spread_{toGCurve}	Z-spread to zero-coupon yield curve, bp
Z-spread_{toSwap}	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 zero-coupon yield curve as at the coupon payment date (redemption at the face value), bp

Calculated Values

Accrued Coupon Interest

Accrued coupon interest (ACI, 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 ACI 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 ACI (there are exceptions, however: for example, in the bond market of Ukraine bonds are quoted at full price). 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 ACI to the net price.

In practice, there are different methods of ACI 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, ACI is not calculated.

Calculation example

Issue – [Russia, 26209](#) (26209RMFS, RU000A0JSMA2)

Date: 21.04.2017

Face value = 1 000 RUB

Coupon, % = 7.6% p.a.

Coupon size = 37.9 RUB

The current coupon period = 182 days

Day count fraction – Actual/365 (Actual/365F)

Price (net), % of face value = 99%

Days from the beginning of the coupon period until the calculation date = 21.04.2017 – 25.01.2017 = 86

ACI calculation based on the coupon rate:

$$A = 7.6\% \cdot 1000 \cdot \frac{86}{365} = 17.91$$

ACI calculation based on the coupon amount:

$$A = 37.9 \frac{86}{182} = 17.91$$

[Calculation results in the Cbonds calculator](#)

Bond Yield

Yield is an indicator characterizing the rate of return on investment in bonds; it is usually indicated in percentages per annum. The bond calculator calculates several different types of yield.

Effective Yield

Effective yield represents a discount rate, with which the amount of indicated cash flows coming until the expected redemption (offer) date, as well as the price as of this date, is equal to the dirty bond price. Effective yield is calculated based on reinvestment of coupon payments during the year at the rate of the initial investment. Effective yield is calculated with the equation:

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

Effective yield of zero-coupon bonds is calculated with the equation (a special case of the equation to calculate the effective yield when $A = 0$ and $C_i = 0$):

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

The calculator computes the effective yield using Newton's method (also known as the tangent method).

Effective yield is only an ESTIMATE of the return investors will get from the bond, as calculation of the yield to maturity takes into account reinvestment of coupons at the same interest rate. In reality, this assumption cannot be true, which is why the actual yield will differ from the estimated yield to maturity. However, yield to maturity is the most frequently used method of assessing bonds.

With respect to the issues with the cash flow fully determined until the redemption date, effective yield to maturity (YTM_{eff}) is calculated with respect to issues with non-executed offer and partially determined cash flow – effective yield to put/call option (YTP_{eff}).³

Calculation example (continuation)

Gross price of bonds = $99\% \cdot 1000 + 17.91 = 1007.91$ RUB

Calculation of the year share: $\frac{t_1 - t_0}{B} = \frac{(26.07.2017 - 21.04.2017)}{365} = \frac{96}{365} = 0.26$

$$1007.91 = \frac{37.9}{(1+Y)^{0.26}} + \frac{37.9}{(1+Y)^{0.76}} + \dots + \frac{37.9}{(1+Y)^{4.75}} + \frac{1037.9}{(1+Y)^{5.25}}$$

$Y = 7.9863\%$

[Calculation results in the Cbonds calculator](#)

Nominal Yield

Nominal yield is the yield, which does not include reinvestment of coupon payments during the year. If the paper is being placed at par, at the time of placement nominal yield will be equal to the coupon rate. For example, a bond with semiannual coupons of 10% would have a nominal yield to maturity of 10%, while the effective yield would be 10.25%. Nominal yield is calculated using effective yield and based on the following equation:

$$1 + Y = \left(1 + \frac{Y_n}{m}\right)^m$$

For a zero-coupon bond, nominal yield to maturity is calculated from the ratio:

$$Y_n = \left(\frac{N}{P} - 1\right) \frac{B}{t_i - t_0}$$

Methodologically, the effective yield is a measure that is more correct than nominal yield. However, traditionally in many developed bond markets, nominal yield is more applicable. In Russia, the effective yield is more commonly used, while nominal and effective yield is used in Ukraine.

With respect to the issues with the cash flow fully determined until the redemption date, nominal yield to maturity (YTM_{nom}) is calculated with respect to issues with non-executed offer and partially determined cash flow – nominal yield to put/call option (YTP_{nom}).³

³ – When calculating indicators to the offer, the non-executed put/call option nearest to the calculation date, the occurrence of which will take place at least 14 calendar days later, is selected. Only those payments (including denomination redemption) are taken into account that will be made until the put/call option date. Calculations are performed with respect to the date of the coupon last known until the expected offer.

Calculation example (continuation)

Number of coupon payments per year = 2

$$1 + 0.079863 = \left(1 + \frac{Y_n}{2}\right)$$

$$Y_n = 7.8329\%$$

[Calculation results in the Cbonds calculator](#)

Simple Yield

Simple yield to maturity is the yield to maturity, which does not take into account reinvestment of coupon payments during the year. It is calculated from the ratio:

$$Y_s = \left(\frac{\sum (C_i + N_i) - P_{d(\text{purchase})}}{P_{d(\text{purchase})}} \right) \frac{B}{t_i - t_0}$$

With respect to the issues with the cash flow fully determined until the redemption date, simple yield to maturity (YTM_{simple}) is calculated with respect to issues with non-executed offer and partially determined cash flow – simple yield to put/call option (YTP_{simple}).⁴

Current Yield

Current Yield (CY) is the bond yield based on the current coupon period only. It is assumed that the net price of the bond will remain unchanged during this period. The calculator uses the following formula to determine the current yield:

$$CY = \frac{C_{\%}}{P_{\%}}$$

For bonds trading above par the current yield will be higher than the yield to maturity, as potential reduction in prices will not be taken into account. With this in view, current yield is not the best indicator of the bond's investment appeal. Thanks to its simplicity, however, this value is often calculated as an additional parameter.

Calculation example (continuation)

$$CY = \frac{7.6\%}{99\%} = 7.6768\%$$

[Calculation results in the Cbonds calculator](#)

⁴ – When calculating indicators to the offer, the non-executed put/call option nearest to the calculation date, the occurrence of which will take place at least 14 calendar days later, is selected. Only those payments (including denomination redemption) are taken into account that will be made until the put/call option date. Calculations are performed with respect to the date of the coupon last known until the expected offer.

Adjusted Current Yield

Adjusted current yield is the yield on a bond that takes into account possible purchase of bonds at a premium or a discount. The calculator uses the following formula to determine the adjusted current yield:

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

Calculation example (continuation)

$$ACY = 7.6768\% + \frac{100\% - 99\%}{1916/365} = 7.8673\%$$

[Calculation results in the Cbonds calculator](#)

Volatility, Duration, Convexity

The bond yield includes i.a. the risk premium (credit, market and liquidity risks etc.) taken by the investor at the issue purchase. In order to estimate the market risks, such parameters as

- duration,
- cost of one bp., and
- convexity index should be taken in consideration.

Years to Maturity (Put/Call option)

This parameter represents the time (in years) remaining until maturity of the bond.

With respect to issues with the cash flow fully determined until the redemption date, the number of years until redemption is calculated based on issues with the non-executed offer and partially determined cash flow - year until the offer⁵.

Macaulay duration

Macaulay duration (D) is an estimate of the average tenor of payment flows on the bond, taking into account discounting the cost of certain payments. The formula for calculating of duration is as follows:

$$D = \frac{\sum_{i=1}^m (t_i - t_0) \frac{C_i + N_i}{(1 + Y)^{(t_i - t_0)/B}}}{P + A} \quad (\text{days})$$

⁵ – When calculating indicators to the offer, the non-executed put/call option nearest to the calculation date, the occurrence of which will take place at least 14 calendar days later, is selected. Only those payments (including denomination redemption) are taken into account that will be made until the put/call option date. Calculations are performed with respect to the date of the coupon last known until the expected offer.

Duration is usually measured in years, but in the Russian and Ukrainian markets, it is often specified in days.

Duration not only shows the average tenor of payment flows on the bond, but is a good measure of price sensitivity to changing interest rates. The higher the duration, the greater the volatility of interest rates in relation to price changes. The phrase "bond duration is three years" means that the bond in question has the same price sensitivity to interest rates changes as a three-year zero-coupon bond.

Duration is a measure of the bond price elasticity to the interest rate, and characterizes the risk of changes in bond prices following a change in interest rates. From this view point, duration can be conceived of as:

$$D = -\frac{dP_d}{P_d} : \frac{d(1+Y)}{1+Y}, \text{ where}$$

dP_d - minor change in bond gross price,

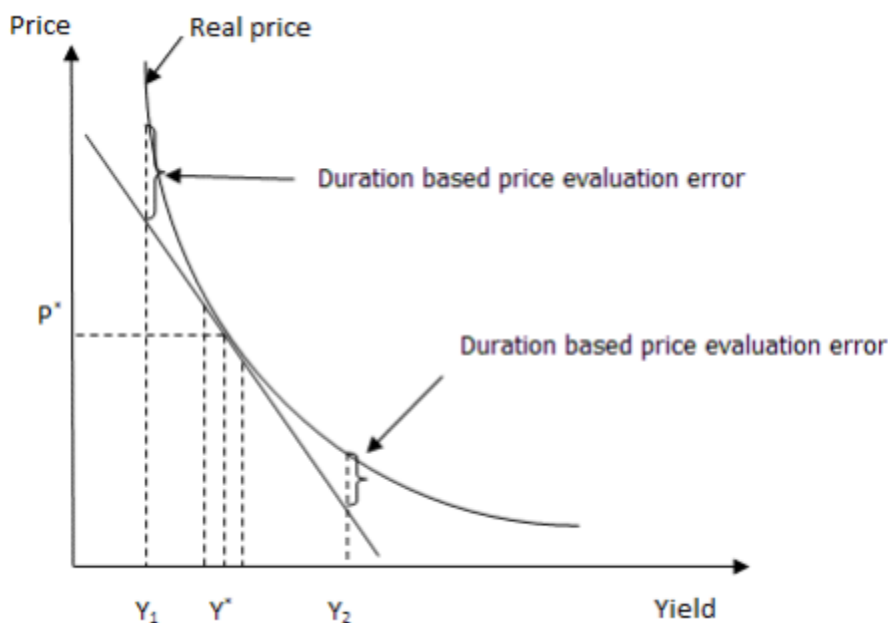
dY - minor change in bond yield,

$\frac{dP_d}{P_d}$ - percentage change in bond gross price,

$\frac{d(1+Y)}{1+Y}$ - percentage change in bond yield.

From the formula it follows that: $\frac{dP_d}{P_d} = -D \frac{dY}{1+Y}$.

This formula is used for approximate calculation of the relative price change based on given change in yield and given duration.



Using only duration when calculating the relative price change does not give a very accurate estimate of the percentage change in the bond price. The more the yield to maturity changes, the less accurate the estimate will be. The error of result occurs because the duration is a linear estimate of the percentage change in bond price.

Duration properties:

1. The duration is less or equal to the period until the bond redemption. The duration of the zero-coupon bond is equal to its period until redemption and does not depend on yield change.
2. Under otherwise equal conditions, the higher the coupon rate, the lower the cost of later payments compared to the short-term ones, and the smaller the duration; and vice versa.
3. Under otherwise equal conditions, when yield to maturity grows, duration decreases, and vice versa.
4. Under otherwise equal conditions, the longer the time to maturity, the greater the duration. However, longer tenor of the bond does not automatically mean an increase in duration.
5. Under otherwise equal conditions, the higher the coupon frequency, the shorter the duration, as more payments are scheduled closer to the starting point, and vice versa.
6. Regardless of the coupon size, duration of a coupon bond, increasing the time until maturity tends to a

limit equal to $1 + \frac{1}{Y}$.

*With respect to the issues with the cash flow fully determined until the redemption date, duration to maturity is calculated with respect to issues with non-executed offer and partially determined cash flow – duration to put/call option.*⁶

Calculation example (continuation)

$$D = \frac{96 \frac{37.9}{(1+0.0799)^{0.26}} + 278 \frac{37.9}{(1+0.0799)^{0.76}} + \dots + 1916 \frac{1037.9}{(1+0.0799)^{5.25}}}{1007.91} = 1586 \text{ days (4.3445 years)}$$

[Calculation results in the Cbonds calculator](#)

Modified duration

Modified Duration (MD) is the indicator that represents the relative change of the bond price in case of yield change for 1%, provided that the amounts of expected cash flows based on the bond in the event of yield change remain constant. It is important to note that modified duration shows volatility of the dirty price. It is the value, by which the dirty price changes when the yield changes by 100 bp.

Modified duration is connected to the duration value through the following formula:

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

In terms of derivatives modified duration is the first derived function of price from yield:

$$MD = - \frac{(P_d)'_y}{P_d}$$

$$\frac{\Delta P_d}{P_d} \approx -MD \cdot \Delta Y$$

In case of small values, the following equality applies:

⁶ – When calculating indicators to the offer, the non-executed put/call option nearest to the calculation date, the occurrence of which will take place at least 14 calendar days later, is selected. Only those payments (including denomination redemption) are taken into account that will be made until the put/call option date. Calculations are performed with respect to the date of the coupon last known until the expected offer.

Modified Duration properties:

1. Modified duration of a zero-coupon bond is less than the time before its maturity. In this case, the modified duration equals $\frac{T_m}{1+Y}$.
2. Modified duration decreases as the yield to maturity grows, and vice versa.

With respect to the issues with the cash flow fully determined until the redemption date, modified duration to maturity is calculated with respect to issues with non-executed offer and partially determined cash flow – modified duration to put/call option.⁷

Calculation example (continuation)

$$MD = \frac{4.3445}{1+0.079863} = 4.0232$$

In the event of yield change for 1%, the dirty bond price will change for 4.0232%

Let us suppose that yield increased to 0.5%. Let us calculate the change of the bond price:

$$\frac{\Delta P_d}{P_d} \approx -4.0232 \cdot 0.005 = -2.0166\%$$

$$\Delta P_d \approx -2.0166\% \cdot 1007.91 = -20.33RUB$$

In the event of yield growth by 0.5%, the dirty bond price decreased by 2.0166% to 987.56 rubles.

[Calculation results in the Cbonds calculator](#)

Price Value of Basis Point

In contrast to the modified duration, which is a relative value, Price Value of Basis Point (PVBP) indicates the absolute value of a dirty price change following the change in the yield by one basis point.

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

With respect to the issues with the cash flow fully determined until the redemption date, PVBP to maturity is calculated with respect to issues with non-executed offer and partially determined cash flow – PVBP to put/call option.⁷

Calculation example (continuation)

$$PVBP = \frac{4.0232}{100} \cdot \frac{100.791}{100} = 0.0406$$

In the event of yield change by 1 bp, the bond cost will increase (or decrease) by 40.6 kopecks per each 1,000 rubles of the face value.

[Calculation results in the Cbonds calculator](#)

⁷ – When calculating indicators to the offer, the non-executed put/call option nearest to the calculation date, the occurrence of which will take place at least 14 calendar days later, is selected. Only those payments (including denomination redemption) are taken into account that will be made until the put/call option date. Calculations are performed with respect to the date of the coupon last known until the expected offer.

Convexity

Convexity (Conv) is an indicator of the curve-shape relationship between the bond price and yield, which shows how the modified duration changes when the yield shifts by 100 bp. It gives a much better approximation of price change due to yield change.

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

In terms of derivatives modified duration is the first derived function of price from yield:

$$Conv = \frac{(P_d)''}{P_d}$$

Approximation of the price change at the expense of yield change can be calculated based on the ratio:

$$\frac{\Delta P_d}{P_d} \approx -MD \cdot \Delta Y + \frac{1}{2} Conv \cdot (\Delta Y)^2.$$

Use of modified duration and convexity allow a rather accurate estimation of the percentage change in the bond price due to a significant change in the yield to maturity.

Convexity properties:

1. Value of convexity grows along with decreasing yield to maturity, and vice versa.
2. With duration grows, convexity grows faster than duration. This is a consequence of the quadratic dependence of convexity on duration.
3. At a given value of yield to maturity and time of redemption, the value of convexity is greater for bonds with lower coupon.
4. For the given level of yield to maturity and coupon, convexity increases along with the tenor.
5. For zero-coupon bonds convexity is calculated from the ratio $\frac{t \cdot (t+1)}{(1+Y)^2}$.
6. Convexity of a perpetual bond is equivalent to $\frac{2}{Y^2}$.

*With respect to the issues with the cash flow fully determined until the redemption date, convexity to maturity is calculated with respect to issues with non-executed offer and partially determined cash flow – convexity to put/call option.*⁸

⁸ – When calculating indicators to the offer, the non-executed put/call option nearest to the calculation date, the occurrence of which will take place at least 14 calendar days later, is selected. Only those payments (including denomination redemption) are taken into account that will be made until the put/call option date. Calculations are performed with respect to the date of the coupon last known until the expected offer.

Calculation example (continuation)

$$Conv = \frac{0.26 \cdot 1.26 \cdot \frac{37.9}{(1 + 0.079863)^{2.26}} + 0.76 \cdot 1.76 \cdot \frac{37.9}{(1 + 0.079863)^{2.76}} + \dots + 5.25 \cdot 6.25 \cdot \frac{1037.9}{(1 + 0.079863)^{7.25}}}{1007.91} = 22$$

Let us suppose that yield increased by 0.5%. Let us calculate the change of the bond price:

$$\frac{\Delta P_d}{P_d} \approx -4.0232 \cdot 0.005 + \frac{1}{2} \cdot 22 \cdot (0.005)^2 = -1.9841\%$$

$$\Delta P_d \approx -1.9841\% \cdot 1007.91 = -20 RUB$$

In case of yield growth by 0.5%, the dirty bond price decreased by 1.9841% to 987.91 rubles.

[Calculation results in the Cbonds calculator](#)

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

G-spread is calculated as the difference between the issue yield and the yield for the point on G-curve with the same duration. G-spread can only be calculated for Russian rouble-denominated bonds. Results of G-spreads computation are published daily in the ruble bond trading results of the Trading Floor Quotes section. The archive of spreads is calculated starting from 2003.

G-spread estimation is available only for Russian rouble-denominated bonds (is calculated to G-curve, estimated in accordance with the [method](#)). The G-spread calculation results are available also in the Trading Floor Quotes section (archive - since 2003)

T-spread is calculated as the difference between the issue yield and the yield on government securities of the USA, Great Britain and Germany in the corresponding issue currency and with comparable modified duration (the calculations are based on the effective yields only). The value is computed only for issues in USD, EUR, GBP. "Benchmark T-spread" field displays the issue, against which the T-spread is computed on the day of calculation. Issues with floating coupon rate and kinds of issues like STRIPS are excluded from the total amount of benchmarks. In the search for a benchmark for T-spread calculation, data from Cbonds Estimation floor is used.

Results of T-spreads computation are published daily in the USD bond trading results of the Trading Floor Quotes section. The archive of spreads for issues in USD is calculated starting from 2013, for issues in EUR, GBP – from September 2013.

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 zero-coupon curve estimation is available only for Russian rouble-denominated bonds (is calculated to G-curve, estimated in accordance with the [method](#)).

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

$$P + A = \sum_{i=1}^m \frac{C_i + N_i}{(1 + \text{SwapYield}_i + \text{Zspread}_{\text{SwapCurve}})^{\frac{t_i - t_0}{B}}}$$

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

Z-spread to swaps estimation is available only for Russian ruble-denominated bonds (calculated to swaps curve, which is calculated using average swaps values to interest rates (IRS), short end of the curve (up to 6 months), represent the money market instruments (in current realization MosPrime rates).

References

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