hp calculators

HP 30b Bonds and Bond Duration

Bonds

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Bonds

It is not unusual that either companies or governments themselves need extra funds to expand into new markets or raise funds to pay for programs. In these cases, they typically need large quantities of money that the average bank cannot provide. Raising money by issuing bonds to a public market is one solution.

By purchasing bonds, an investor becomes a creditor to the corporation or government. Many investors have at least part of their portfolio invested in bonds. The issuer of a bond must pay the investor a "fee" (interest payments) for the privilege of using his or her money. The interest rate is often referred to as the coupon, and the date on which the issuer has to repay the amount borrowed (face value) is called the maturity date. The total return an investor receives if the bond is held to maturity is equal to all the interest payments received plus any gain or loss. This is called the yield to maturity, or YTM.

Bond Duration

The basic definition of a bond's duration is the weighted average term to maturity of a bond's cash flows. This weighting is based upon the present value of each of the bond's cash flow divided by the price of the bond. There are two ways to calculate a bond's duration, Macaulay bond duration and Modified duration.

Macaulay bond duration is a measure of how long in years it takes before a bond returns, in present value terms, the price paid for the bond. By definition, the Macaulay duration of a zero-coupon bond is equal to the time to the bond's maturity. Other than zero-coupon bonds, a bond's duration will be shorter than its time to maturity. Macaulay duration may be computed using the following basic formula:

$$MacaulayDuration = \sum_{t=1}^{n} \frac{t \times CFPV_t}{p \times TCFPV}$$

where t is the period in which the cash flow is received, CFPV is the specific cash flow's present value, p is the number of bond cash flows per year, TCFPV is the present value of all the bond cash flows and n is the total number of periods remaining in the life of the bond.

Modified bond duration is a modification of Macaulay duration to take changes in interest rates into account. It is useful in assessing the sensitivity of a bond's price to changes in interest rates, or to interest rate shocks. It may be computed using the following formula:

$$ModifiedDuration = \frac{MacaulayDuration}{1 + \frac{YTM}{p}}$$

where Macaulay duration is as computed above, YTM is the bond's yield to maturity, and p is the number of bond cash flows per year.

Bonds on the HP 30b

The HP 30b solves these types of breakeven problems using the Bond menu. This menu is entered by pressing Bond and contains areas where you can enter or compute values related to bond problems. You can compute the price, yield to

maturity, yield to call, and accrued interest using this menu. You can solve problems related to bonds that pay interest semiannually or annually. You can also use an actual 365-day calendar or a 360-day, twelve 30-day month calendar. The map of this menu is presented below. To move from one item in the menu to the next, press the down arrow key [▼]. This key is abbreviated DWN in the map below. Below the menu map is a table explaining each of the entries in the bond menu in more detail.

Figure 1 The Menu Map for the Bond Menu

Table 5-1 Bond Menu

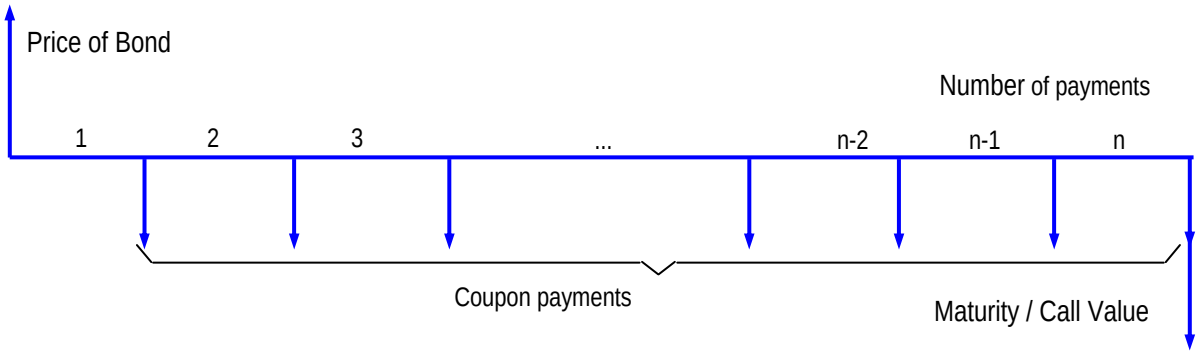
Variable	Description
Settlement Date	Settlement date. Displays the current settlement date in either *mm.ddyyyy* or *dd.mmyyyy* format. Note: Input only.
Maturity Date	Maturity date or call date. The call date must coincide with a coupon date. Displays the current maturity date in either *mm.ddyyyy* or *dd.mmyyyy* format. Note: Input only.
CPN%	Coupon rate stored as an annual %. Note: Input only.
Call	Call value. Default is set for a call price per $100.00 face value. A bond at maturity has a call value of 100% of its face value. Note: Input only.
Yield%	Yield% to maturity or yield% to call date for given price. Note: Input/Output.
Price	Price per $100.00 face value for a given yield. Note: Input/Output.
Accrued	Interest accrued from the last coupon or payment date until the settlement date for a given yield. Note: Output only.
Mod. Duration	Modified duration. Note: Output only.
Macaulay D.	Macaulay duration. Note: Output only.
Actual/Cal.360	Actual (365-day calendar) or Cal.360 (30-day month/360-day year calendar). Press [INPUT] to change modes.
Annual/Semiannual	Bond coupon (payment) frequency. Press [INPUT] to change modes.

The Yield% and Price menu items are considered a read/write menu item, because, when either are selected, both the *INPUT* and small (=) annunciators are lit in the top right corner of the HP 30b display. When lit, these annunciators indicate that entering a number and pressing [INPUT] will store the entered number in the displayed menu item. Pressing [=] (outside of a mathematical operation), on the other hand, would calculate the value for that item based on available data. The Accrued menu item is output only. This means it will show a computed value once enough other information has been entered, but is not changeable by the user.

The other menu items are input only. For these, only the *INPUT* annunciator is lit in the top order of the display. These menu items include the settlement date, maturity date, coupon rate and call value, in addition to the mode change selections.

To clear the bond menu while in the menu, press [▬] [Reset] [INPUT].

A cash flow diagram for a typical bond is shown below.



Practice solving bond problems

Example 1: What price should be paid on August 1, 2009 for a 6.75% US Treasury bond that matures on May 1, 2018, if the yield is 8.375%? The bond coupon payments are semiannual and under a 30/360 convention. This example assumes dates are entered in the MM.DDYYY format.

Solution:

[ON/CE] [ON/CE] [Bond] [▬] [Reset] [INPUT]	
8 · 0 1 2 0 0 9 [INPUT]	(Enters the settlement date)
[▼] 5 · 0 1 2 0 1 8 [INPUT]	(Enters the maturity date)
[▼] 6 · 7 5 [INPUT]	(Enters the coupon rate)
[▼] [▼] 8 · 3 7 5 [INPUT]	(Enters the yield)
[▼] [▼] [▼] [▼] [▼] [INPUT]	(Displays Actual / Cal.360 mode status. Press [INPUT] only if the screen shows Actual.)
[▼] [INPUT]	(Displays Annual / Semiannual mode status. Press [INPUT] only if the screen shows Annual.)
[▲] [▲] [▲] [▲] [▲] [=]	(Computes the price)

Figure 2

Answer: The price is $90.04 per $100 of face value plus accrued interest.

Example 2: For the previous problem, what is the accrued interest?

Solution: Assuming no other changes since the computing of the price, press: [▼]

Figure 3

Answer: The accrued interest is $1.69 per $100 of face value. The total amount owed to the seller is the price plus accrued interest.

Example 3: For the previous problem, what is the value of the bond's modified duration and Macaulay duration??

Solution: Assuming no other changes since the computing of the price, press: [▼]

Figure 4

[▼]

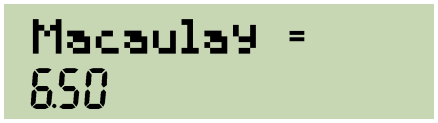


Figure 5

Answer: The modified duration is 6.24 years and the Macaulay duration is 6.5 years.

Example 4: For the bond as presented in problem 1, if the price is actually $88.25 per $100 of face value, what is the yield to maturity? Assume example 3 has just been computed.

Solution: [▲] [▲] [▲] 8 8 . 2 5 [INPUT] (Enters the new price)
[▲] [=]

Figure 6

Answer: The yield is now 8.69%.

Example 5: What price should be paid on December 1, 2009 for a 5.95% US Treasury bond that matures on July 20, 2010, if the yield is 5.5%? The bond coupon payments are semiannual and under a 30/360 convention. This example assumes dates are entered in the MM.DDYYY format.

Solution:

[ON/CE] [ON/CE] [Bond] [▬] [Reset] [INPUT]	
1 2 . 0 1 2 0 0 9 [INPUT]	(Enters the settlement date)
[▼] 7 . 2 0 2 0 1 0 [INPUT]	(Enters the maturity date)
[▼] 5 . 9 5 [INPUT]	(Enters the coupon rate)
[▼] [▼] 5 . 5 [INPUT]	(Enters the yield)
[▼] [▼] [▼] [▼] [▼] [INPUT]	(Displays Actual / Cal.360 mode status. Press [INPUT] only if the screen shows Actual.)

▼ INPUT	(Displays Annual / Semiannual mode status. Press INPUT only if the screen shows Annual.)
▲ ▲ ▲ ▲ ▲ =	(Computes the price)

Figure 7

Answer: The price is $100.27 per $100 of face value plus accrued interest.

Example 6: For the previous problem, what is the accrued interest?

Solution: Assuming no other changes since the computing of the price, press: ▼

Figure 8

Answer: The accrued interest is $2.17 per $100 of face value. The total amount owed to the seller is the price plus accrued interest.

Example 7: For the previous problem, what are the Macaulay duration and modified duration?

Solution: Assuming no other changes since the computing of the price, press: ▼

Figure 9

▼

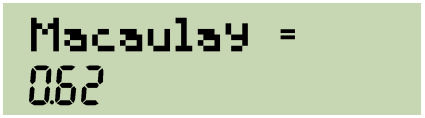


Figure 10

Answer: The modified duration is 0.61 years and the Macaulay duration is 0.62 years.

Example 8: A bond is callable until March 10, 2012 at 104% of face value, but has a maturity date of March 10, 2022. What is the yield to call for this bond on September 15, 2008, if the price of the bond is 98.5 and its coupon rate is 6.5% The bond coupon payments are semiannual and under a 30/360 convention. This example assumes dates are entered in the MM.DDYYY format.

Solution:

ON/CE ON/CE Bond ▬ Reset INPUT	
9 . 1 5 2 0 0 8 INPUT	(Enters the settlement date)
▼ 3 . 1 0 2 0 1 2 INPUT	(Enters the call date)
▼ 6 . 5 INPUT	(Enters the coupon rate)
▼ 1 0 4 INPUT	(Enters the call %)
▼ ▼ 9 8 . 5 INPUT	(Enters the price)

▼ ▼ INPUT	(Displays Actual / Cal.360 mode status. Press INPUT only if the screen shows Actual.)
▼ INPUT	(Displays Annual / Semiannual mode status. Press INPUT only if the screen shows Annual.)
▲ ▲ ▲ ▲ =	(Computes the yield to call)

Figure 11

Answer: The yield to call is 8.02%.

Example 9: Since the bond in example 6 is selling for a discount relative to the face value, it is relatively unlikely that it will be called, so it is improbable that the investor's return will really be 8.02%. Compute the yield to maturity after resetting the call value to 100 and compare it to the yield to call. Assume example 6 has just been completed and note that the non-call maturity date is March 10, 2022.

▲ 1 0 0 INPUT	(Resets the call% to 100)
▲ ▲ 3 . 1 0 2 0 2 2 INPUT	(Enters the non-call maturity date)
▼ ▼ ▼ =	(Computes the yield to maturity)

Figure 12

Answer: The yield to maturity is 6.67%, which is probably a better estimate of the investor's return.