Lecture 6. Valuing Bonds

Olga Uzhegova, DBA

2015

BOND: HOW IT WORKS

BONDS
Interest and principal amount in the future

BORROWER

- Issues bonds
- Receives funds today
- Agrees to payback the funds (the principal / face value) with interest (Coupons) on specific dates in the future

LENDER (Bondholder)

- Buys bonds
- Gives funds today
- Agrees to give funds right now in return for future cash flows (interest and principal amount at the maturity date)

Principal amount TODAY

BONDS are debt instruments

Two features that set bonds apart from equity investments:

- **The promised cash flows on a bond** (i.e., coupon payments and the face value of the bond) **are usually set at issue and do not change during the life of the bond**.
- Bonds usually have **fixed life times**, unlike stocks, since most bonds specify a maturity date.
- Bonds with such standard features are **straight bonds.**
- Bonds are also called "fixed-income" securities

Classification of bonds based on an issuer:

- Government bonds
- Corporate bonds
- Financial institutions bonds

Classification of bonds based on the currency and origin

- Bond (conventional one) is issued in a domestic market by a domestic entity, in the domestic market's currency.
- Foreign bond is issued in a domestic market by a foreign entity, in the domestic market's currency.
- A Eurobond is an international bond that is denominated in a currency not native to the country where it is issued.

CLASSES OF BONDS

- **Conventional or Straight bonds** have a fixed coupon (usually paid on an semi-annual basis) and maturity date when all the principal is repaid.
- **Floating rate bonds** have coupon interest rate that "floats," i.e. goes up or down in relation to a benchmark rate plus some additional "spread" of basis points (each basis point being one hundredth of one percent). The reference benchmark rate is usually LIBOR (London interbank offered rate) or EURIBOR (Euro interbank offered rate). The "spread" added to that reference rate is a function of the credit quality of the issuer.

CLASSES OF BONDS

- **Zero-coupon bonds** do not have interest payments, are sold at a significant discount from their eventual value or return at redemption.
- **Convertible bonds** can be exchanged for another instrument, usually ordinary shares (fixed ahead of time with a predetermined price) of the issuing organization. The bondholder has an option whether to convert the bond or not.

CLASSES OF BONDS

- **Perpetual Bond (consol)** is a bond in which the issuer does not repay the principal. Rather, a perpetual bond pays the bondholder a coupon as long as investor holds it (coupon could be fixed or floating).

CLASSES OF BONDS

- **Callable bonds:** the issuer has the right, but not the obligation, to buy back the bonds from the bond holders at a defined call price and cease all interest payments before the bond matures. If interest rates in the market have gone down by the time of the call date, the issuer will be able to refinance its debt at a cheaper level and so will be incentivized to call the bonds it originally issued.

CLASSES OF BONDS

- **Puttable bonds** (put bond, putable or retractable bond) are bonds with an embedded put option. The holder of the puttable bond has the right, but not the obligation, to demand early repayment of the principal on one or more specified dates. This type of bond protects investors: if interest rates rise after bond purchase, the future value of coupon payments will become less valuable. Therefore, investors sell bonds back to the issuer and may lend proceeds elsewhere at a higher rate.

CLASSES OF BONDS

- **High-yield bonds** are those that are rated to be "below investment grade" by credit rating agencies (i.e. issuer has a credit rating below BBB).

BOND RATINGS

- Ratings are produced by Moody's, Standard and Poor's, and Fitch
- Range from AAA *(top-rated)* to C (*lowest-rated*) or D *(default)*.
- **Help investors gauge likelihood of default by issuer.**
- Help issuing companies establish a yield on newly issued bonds.
  - ***Junk bonds (***High-yield bonds): the label given to bonds that are rated below BBB. These bonds are considered to be speculative in nature and carry higher yields than those rated BBB or above (investment grade).

BOND RATINGS

Credit Description	Rating Company		
	Fitch	Moody's	Standard & Poor's
Investment Grade Bonds			
Highest Credit Rating	AAA	Aaa	AAA
	AA+	Aa1	AA+
High Credit	AA	Aa2	AA
	AA−	Aa3	AA−
	A+	A1	A+
Upper Medium Credit	A	A2	A
	A−	A3	A−
	BBB+	Baa1	BBB+
Lower Medium Credit	BBB	Baa2	BBB
	BBB−	Baa3	BBB−

BOND RATINGS

Credit Description	Rating Company		
	Fitch	Moody's	Standard & Poor's
Speculative Grade Bonds (Junk Bonds)			
Low Credit	BB+	Ba1	BB+
	BB	Ba2	BB
	BB–	Ba3	BB–
Very Low Credit	B+	B1	B+
	B	B2	B
	B–	B3	B–
Extremely Speculative Bonds			
Extremely Low Credit	CCC+	Caa	CCC+
	CCC		CCC
	CCC–		CCC–
Extremely Speculative	CC	Ca	CC
	C	C	C
Bonds in Default			D

KEY COMPONENTS OF A BOND

- ***Par or face value:*** the value of a bond at a maturity (typically $100, $ 1000 or KZT 1000)
- ***Coupon rate:*** Annual payout as a percentage of the bond's par value (set by an issuer of bonds)
- ***Coupon:*** Regular interest payment received by bondholder (annually or semiannually).
- ***Maturity date:*** Expiration date of bond when par value is paid back.
- ***Yield to maturity:*** Expected rate of return, based on price of bond.

COUPON

- **Annual coupon** - regular interest payment received by bondholder per year: **Par Value × Coupon Rate**
- **Semiannual coupon** - regular interest payment received by bondholder per half a year:

Par Value × Periodic Coupon Rate

Example: if you purchased a bond with a par value of $1000 and it pays a coupon rate of 7% →

→ its **annual coupon** will be: $1000 × 0.07 = **$70**

→ Its $\$1000 \times \frac{0.07}{2} = \$1000 \times 0.035 = \$35$

Periodic Coupon Rate

In decimal points

PRICING THE BONDS

Key determinants of bonds' prices:

- Risk of default of an issuer (based on the ratings)
- Demand and supply of bonds with specific terms and overall situation in the bond market (For instance high coupon rate of bonds to be traded and decrease in the yield-to-maturity of other bonds will lead to increase in the price of the bonds to be traded /if it will coincide with an increased stability of the issuer of such bonds, prices will go even higher/. This leads to a situation when bonds are traded at premium / above face value).
- The longer the time period till maturity, the lower will be a price (the higher will be a discount rate)
- Expected inflation

VALUING BONDS

Value of the bond can be estimated by using present value techniques, i.e., discounting of future cash flows (combination of present value of an annuity and of a lump sum)

Bond value = Present value of all coupon payments

+ Present value of par/face value of the bond

$$V_B = \sum PV_{\text{ of all coupon payments}} + PV_{\text{ of par value of the bond}}$$

Note: coupon payments constitute an annuity stream

VALUING BONDS

$$V_B = \sum_{t=1}^{n} \frac{CF_{(Coupon\_Payments)}}{(1+r)^t} + \frac{FV}{(1+r)^n}$$

$$V_B = \sum_{t=1}^{n} \frac{CF_{(Coupon\_Payments)}}{(1+YTM)^t} + \frac{FV}{(1+YTM)^n}$$

$$V_B = Coupon \times \boxed{\frac{1-\frac{1}{(1+r)^n}}{r}} + Par/Face\_Value \times \boxed{\frac{1}{(1+r)^n}}$$

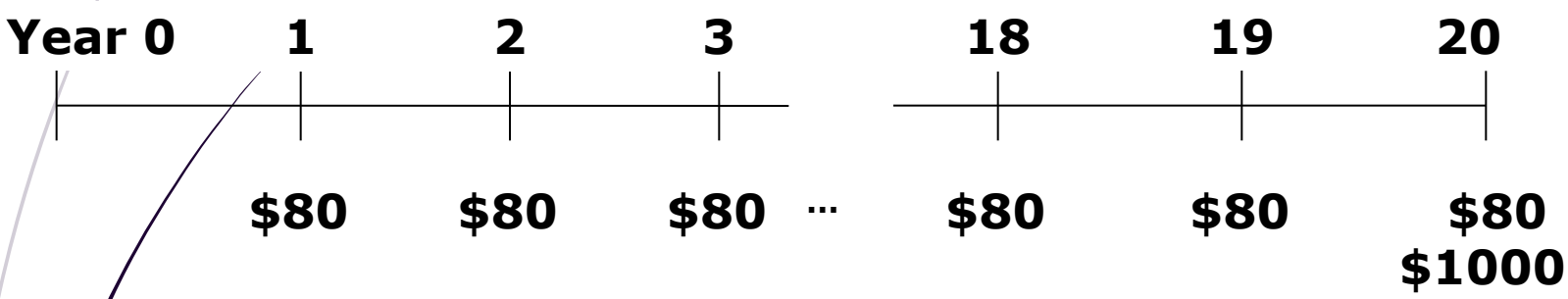
$$V_B = Coupon \times \boxed{PVIFA_{r,n}} + Par/Face\_Value \times \boxed{PVIF_{r,n}}$$

$$\boxed{V_B = PMT \times PVIFA_{r,n} + FV \times PVIF_{r,n}}$$

VALUING BONDS

Example

Calculate the price of a 20-year, 8% coupon (paid annually) corporate bond (par value = $1,000), which is expected to earn a yield to maturity of 10%.



Annual coupon = Coupon rate × Par value = 0.08 × $1,000 = **$80**

YTM = r = 10%

Maturity = n = 20

Price of bond = Present value of coupons + Present value of par value

VALUING BONDS

Solution

Present value of coupons:

$$PMT \times \left(\frac{1 - \frac{1}{(1+r)^n}}{r} \right) = \$80 \times \left(\frac{1 - \frac{1}{(1+0.10)^{20}}}{0.10} \right)$$

= $80 x 8.51359 = $681.09

Present Value of par value:

$$FV \times \frac{1}{(1+r)^n} = \$1{,}000 \times \frac{1}{(1+0.10)^{20}}$$

=$1,000 x 0.14864 = $148.64

Price of bond = $681.09 + $148.64 = $829.73

VALUING BONDS

Solution: Using a financial calculator

Input:	***N***	***i%***	***PV***	***PMT***	***FV***
Key:	**20**	**10**	**?**	**80**	**1000**
Output			***-829.7287***		

SEMIANNUAL BONDS

- Most bonds pay coupons on a semiannual basis.
- For valuing such bonds, the values of the inputs have to be adjusted according to the frequency of the coupons.
  - For example, for semiannual bonds, the annual coupon is divided by 2, the number of years is multiplied by 2, and the YTM is divided by 2.
  - The value of the bond can then be calculated by using the TVM equation, a financial calculator, or a spreadsheet.

SEMIANNUAL BONDS

Example

Four years ago, the XYZ Corporation issued an 8% coupon (paid semiannually), 20-year, AA-rated bond at its par value of $1000. Currently, the yield to maturity on these bonds is 10%. Calculate the price of the bond today.

Remaining number (n) of semiannual coupons

= (20-4)×2 = **32 (coupons will be paid 32 times = n)**

Semiannual coupon = (0.08×1000)/2 = **$40**

Par value = $1000

Periodic rate, *r* (semiannual YTM) □**YTM/2**□**10%/2 =5%**

SEMIANNUAL BONDS

Solution

$$\text{Bond Price} = \text{Par Value} \times \frac{1}{(1+r)^n} + \text{Coupon} \times \left(\frac{1 - \frac{1}{(1+r)^n}}{r} \right)$$

$$\text{Bond Price} = \$1{,}000 \times \frac{1}{(1+0.05)^{32}} + \$40 \times \left(\frac{1 - \frac{1}{(1+0.05)^{32}}}{0.05} \right)$$

Bond Price = \$1000 x 0.209866 + \$40 x 15.80268

Bond Price = \$209.866 + \$632.107

Bond Price = \$841.97

SEMIANNUAL BONDS

Solution: Using a financial calculator

Input:	*n*	*i%*	*PV*	*PMT*	*FV*
Key:	32	5	?	40	1000
Output			*-841.9732*		

Clean vs Dirty bond prices & an accrued interest

- Because many of the bonds traded in the secondary market are often traded in between coupon payment dates, the bond seller must be compensated for the portion of the coupon payment he or she earns for holding the bond since the last payment.
- This compensation is **an accrued interest (*НКД – накопленный купонный доход*)**
- **"Dirty" bond prices** include any accrued interest that has accumulated since the last coupon payment while **"clean" bond prices** do not.
- Accrued interest: Coupon rate * face value of a bond * (days between settlement and last coupon payment / total days in period)
- For semi-annual coupons: total days in a period – 180
- For annual coupons: total days in a period – 360

Clean vs Dirty bond prices & an accrued interest

- **“Clean” Eurobond price:** $90 000 (per lot)
- Coupon rate – 12% annually
- Coupons are paid semiannually – 6%
- Last coupon payment was on July 1, 20XX in the amount of $ 6000
- Next coupon payment is set for January 1, 20XX
- Eurobonds are traded on October 1, 20XX
- **“Dirty” Eurobond price:** Clean price + accrued interest = $90 000 + [$6000*90/180] = $93000
- $93 000 should be paid to the bondholder who is selling the Eurobond

YIELD TO MATURITY (YTM)

Yield to maturity: the return an investor will receive by holding a bond to maturity.

Structure of the yield to maturity:

Example (roughly): Current price of a bond is 95$

Years to maturity: 5 years

Par value – 100$

Coupon rate – 6%

1	Coupon to be paid annually	6 $	6$	6$	6$	6$
2	$ amount to be accumulated per year (difference between face value and current price divided by yeas to maturity ([100-95]/5)	1$	1$	1$	1$	1$
3	$ amount per year (1+2)	7 $	7 $	7 $	7 $	7 $
4	% of face value (this roughly is an yield to maturity: TVM is not taken into account in this example)	7%	7%	7%	7%	7%

YIELD TO MATURITY (YTM)

Example

Suppose your bond is selling for $950, and has a coupon rate of 7%; it matures in 4 years, and the par value is $1000. What is the YTM?

$$V_B = \sum_{t=1}^{n} \frac{CF_{(Coupon\_Payments)}}{(1+r)^t} + \frac{FV}{(1+r)^n}$$

$$V_B = Coupon \times \frac{1 - \frac{1}{(1+r)^n}}{r} + Par/Face\_Value \times \frac{1}{(1+r)^n}$$

YIELD TO MATURITY (YTM)

Solution

$$V_B = \sum_{t=1}^{n} \frac{CF_{(Coupon\_Payments)}}{(1+r)^t} + \frac{FV}{(1+r)^n} \rightarrow \$950 = \sum_{t=1}^{20} \frac{\$70}{(1+r)^t} + \frac{\$1000}{(1+r)^{20}}$$

$$V_B = Coupon \times \frac{1 - \frac{1}{(1+r)^n}}{r} + Par/Face\_Value \times \frac{1}{(1+r)^n}$$

$$\$950 = \$70 \times \frac{1 - \frac{1}{(1+r)^4}}{r} + \$1000 \times \frac{1}{(1+r)^4}$$

YTM (i%) = 8.5274

PV: -950

PMT: 70

n: 4

FV: 1000

Comp i%= 8.5274

Premium Bonds, Discount Bonds, & Par Value Bonds

- **DISCOUNT**
  - A bond is selling at a **discount** if its price is less than the face value.
- **PAR**
  - A bond is selling at **par** if its price is equal to the face value.
- **PREMIUM**
  - A bond is selling at a **premium** if its price is greater than the face value.

DISCOUNTS AND PREMIUMS

If a coupon bond trades **at a discount**, **an investor will earn a return both:**

1. **from receiving the coupons and**
2. **from receiving a face value that exceeds the price paid for the bond.**

If a bond trades at a discount, its yield to maturity will exceed its coupon rate.

Majority of bonds are traded at a discount

DISCOUNTS AND PREMIUMS

If a coupon bond trades at a premium it will earn a return

1. **from receiving the coupons BUT**
2. **this return will be diminished by receiving a face value less than the price paid for the bond.**

If a bond trades at a premium, its yield to maturity will be below its coupon rate.

Premium Bonds, Discount Bonds, & Par Value Bonds

Type of Bond	Coupon Rate versus Yield to Maturity	Price Relationship to Par Value
Premium bond	Coupon rate > yield to maturity	Price > par value
Par value bond	Coupon rate = yield to maturity	Price = par value
Discount bond	Coupon rate < yield to maturity	Price < par value

When <u>the bond price is greater than the face value</u>, we say the bond trades <u>"above par" or "at a premium"</u>. Coupon rate > Yield to Maturity.

When <u>the bond price is equal to the face value</u>, we say the bond trades <u>"at par".</u> Coupon rate = Yield to Maturity.

When <u>the bond price is less than the face value</u>, we say the bond trades <u>"below par" or "at a discount".</u> Coupon rate < Yield to Maturity.

Relationship of Yield to Maturity and Coupon Rate

Example

Last year, the ABC Corporation had issued 8% coupon (semiannual), 20-year, AA-rated bonds (par value = $1000) to finance its business growth.

- If investors are currently offering $1200 on each of these bonds, what is their expected yield to maturity on the investment?
- If you are willing to pay no more than $980 for this bond, what is your expected *YTM*?

Relationship of Yield to Maturity and Coupon Rate

Solution

Remaining number of coupon payments = 19×2 = 38

Semiannual coupon amount = (0.08×$1000)/2 = $40

PV = $1200

Input:	*N*	*i%*	*PV*	*PMT*	*FV*
Key:	38	?	-1200	40	1000
Output		***3.0973***			

YTM = 3.0973 % × 2 = 6.1246 %

Note: This is a premium bond, so its YTM < coupon rate of 8%

Relationship of Yield to Maturity and Coupon Rate

Solution (cont-d)

PV = $980

Input:	*N*	*I/Y*	*PV*	*PMT*	*FV*
Key:	38	?	-980	40	1000
Output		***4.1048%***			

YTM = 4.1048% × 2 = 8.2097 %

Note: This would be a discount bond, so its YTM>coupon rate of 8%.

ZERO-COUPON BONDS

- Zero-coupon bonds known as "pure" discount bonds and sold at a deep discount from face value.
- Do not pay any interest over the life of the bond.
- At maturity, the investor receives the par value, usually $1000.
- Price of a zero-coupon bond is calculated by merely discounting its par value at the prevailing discount rate or yield to maturity.

PV

$$V_{\text{zero-coupon bond}} = \frac{FV}{(1+r)^n}$$

ZERO-COUPON BONDS

Example

John wants to buy a 20-year, AAA-rated, $1000 par value, zero-coupon bond being sold by Diversified Industries, Inc. The yield to maturity on similar bonds is estimated to be 9%.

How much will he have to pay for it?

ZERO-COUPON BONDS

Solution

Using the TVM equation

$$\text{Bond Price} = \frac{\$1000}{(1+0.09)^{20}} = 178.4309$$

Using a financial calculator

Input:	*N*	*i%*	*PV*	*FV*
Key:	20	9	?	1000
Output			*-178.4309*	

Note: It is customary to price zero-coupon bonds as semiannual bonds

HA: What is the price of this bond if it is priced as a semiannual one.

THE END