

### Bond Prices and Yields

- Bond Basics
- Bond Prices
- Yield to Maturity
- Yield to Call
- Current Yield
- More on Yields

### Bond Terms

- Bond definition
- Indenture
- Primary market / secondary market
- Par value
- Coupon rate and coupon payment
- Maturity date and maturity value
- Call provision
- Debenture / Secured Debt
- Zero coupon bonds
- Junk bonds
- Bearer bonds
- Sinking fund provision
- Warrants

### Bond Issue Terms

Issue amount	\$20 million	Bond issue total face value is \$20 million
Issue date	12/15/98	Bonds offered to the public in December 1998
Maturity date	12/31/18	Remaining principal is due December 31, 2018
Face value	\$1,000	Face value denomination is \$1,000 per bond
Coupon interest	\$100 per annum	Annual coupons are \$100 per bond
Coupon dates	6/30, 12/31	Coupons are paid semiannually
Offering price	100	Offer price is 100% of face value
Yield to maturity	10%	Based on stated offer price
Call provision	Callable after 12/31/03	Bonds are call protected for 5 years after issuance
Call price	110 before 12/31/08, 100 thereafter	Callable at 110 percent of par value through 2008. Thereafter callable at par.
Trustee	United Bank of Florida	Trustee is appointed to represent bondholders
Security	None	Bonds are unsecured debenture
Rating	Moody's A1, S&P A+	Bond credit quality rated upper medium grade by Moody's and S&P's rating

### Corporate Bond Ratings

Moody's	Duff & Phelps	S&P's	Credit Rating Description
Investment-Grade Bond Ratings			
Aaa	1	AAA	Highest credit rating, maximum safety
Aa1	2	AA+	High credit quality, investment-grade bonds
Aa2	3	AA	
Aa3	4	AA-	
A1	5	A+	Upper-medium quality, investment grade bonds
A2	6	A	
A3	7	A-	Lower-medium quality, investment grade bonds
Baa1	8	BBB+	
Baa2	9	BBB	
Baa3	10	BBB-	Speculative-Grade Bond Ratings
Ba1	11	BB+	
Ba2	12	BB	Very low credit quality, speculative-grade bonds
Ba3	13	BB-	
B1	14	B+	
B2	15	B	Extremely Speculative-Grade Bond Ratings
B3	16	B-	
Caa	17	CCC+	Extremely speculative
		CCC	
Ca		CC	
C		C	
		D	Bonds in default

### Bond Calculations

Bond's coupon rate:

$$\text{Coupon rate} = \frac{\text{Annual coupon}}{\text{Par value}}$$

Bond's current yield:

$$\text{Current yield} = \frac{\text{Annual coupon}}{\text{Bond price}}$$

### Current Yield

- Many investors are interested in the bond's current yield.
- This is the coupon payment divided by the current closing price.

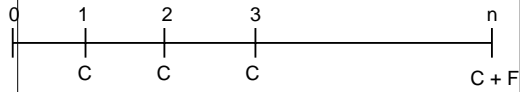
$$CY = C / V_B$$

A bond that has a 10% coupon and closes at \$900, has a current yield of

$$CY = \$100 / \$900 = 11.11\%$$

## Bond Valuation

- Bond value is the present value of all expected cash flows
- Two sources:
  - coupon interest & principal repayment



where: C = coupon interest and  
F = face value

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## The Bond Pricing Formula

- The price of a bond is found by adding together the present value of the bond's coupon payments and the present value of the bond's face value.

- The formula is:

$$\text{Bond Price} = \frac{C}{\text{YTM}} \left[ 1 - \frac{1}{\left(1 + \frac{\text{YTM}}{2}\right)^{2M}} \right] + \frac{\text{FV}}{\left(1 + \frac{\text{YTM}}{2}\right)^{2M}}$$

C = annual coupon  
FV = face value  
M = maturity (years)  
YTM = Yield to maturity

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## Example: Using the Bond Pricing Formula

Assume a bond has 15 years to maturity, a 9% coupon, and the YTM is 8%. What is the price?

$$\text{Bond price} = \frac{C}{\text{YTM}} \left[ 1 - \frac{1}{\left(1 + \frac{\text{YTM}}{2}\right)^{2M}} \right] + \frac{\text{FV}}{\left(1 + \frac{\text{YTM}}{2}\right)^{2M}}$$

$$\text{Bond price} = \frac{90}{.08} \left[ 1 - \frac{1}{\left(1 + \frac{.08}{2}\right)^{30}} \right] + \frac{1000}{\left(1 + \frac{.08}{2}\right)^{30}} = \$1,086.46$$

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## More on Bond Prices

$$\text{Bond price} = \frac{C}{\text{YTM}} \left[ 1 - \frac{1}{\left(1 + \frac{\text{YTM}}{2}\right)^{2M}} \right] + \frac{\text{FV}}{\left(1 + \frac{\text{YTM}}{2}\right)^{2M}}$$

Now assume a bond has 25 years to maturity, a 9% coupon, and the YTM is 8%. What is the price? Is the bond selling at premium or discount?

$$\text{Bond price} = \frac{90}{.08} \left[ 1 - \frac{1}{\left(1 + \frac{.08}{2}\right)^{50}} \right] + \frac{1000}{\left(1 + \frac{.08}{2}\right)^{50}} = \$1,107.41$$

Now assume the same bond has a YTM of 10%. (9% coupon & 25 years to maturity) What is the price? Is the bond selling at premium or discount?

$$\text{Bond price} = \frac{90}{.10} \left[ 1 - \frac{1}{\left(1 + \frac{.10}{2}\right)^{50}} \right] + \frac{1000}{\left(1 + \frac{.10}{2}\right)^{50}} = \$908.72$$

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## More on Bond Prices (cont'd)

Now assume the same bond has 5 years to maturity (9% coupon & YTM of 8%) What is the price? Is the bond selling at premium or discount?

$$\text{Bond price} = \frac{90}{.08} \left[ 1 - \frac{1}{\left(1 + \frac{.08}{2}\right)^{10}} \right] + \frac{1000}{\left(1 + \frac{.08}{2}\right)^{10}} = \$1,040.55$$

Now assume the same bond has a YTM of 10%. (9% coupon & 5 years to maturity) What is the price? Is the bond selling at premium or discount?

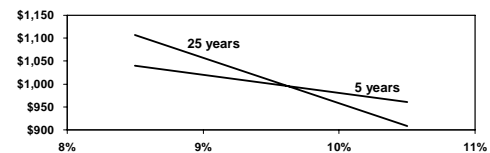
$$\text{Bond price} = \frac{90}{.10} \left[ 1 - \frac{1}{\left(1 + \frac{.10}{2}\right)^{10}} \right] + \frac{1000}{\left(1 + \frac{.10}{2}\right)^{10}} = \$961.39$$

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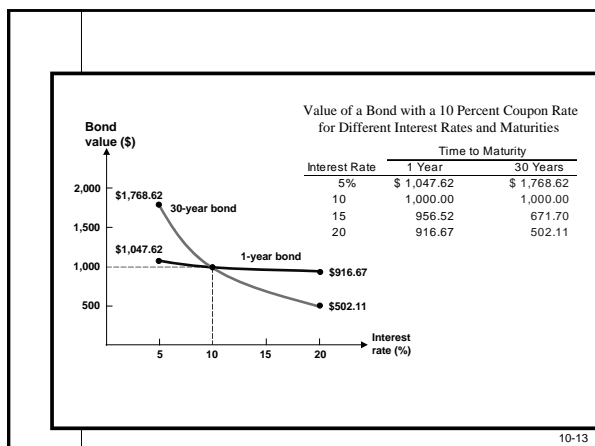
## More on Bond Prices (cont'd)

Where does this leave us? We found:

Coupon	Years	YTM	Price
9%	25	8%	\$1,107
9%	25	10%	\$ 908
9%	5	8%	\$1,040
9%	5	10%	\$ 961

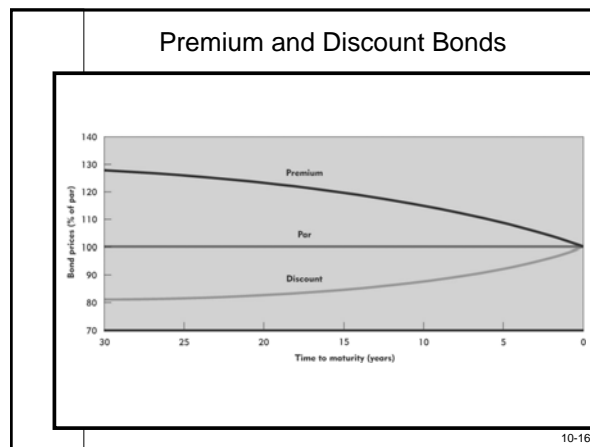


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- ### Important points to remember:
- Coupon never changes, but yield changes with the risk-free rate, risk premium, inflation, and bond prices.
  - Discount
  - Premium
  - Par Value Bonds
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- ### Bond Risk
- **Interest Rate Risk**
    - Change in price due to changes in interest rates
    - Long-term bonds have more price risk than short-term bonds
  - **Reinvestment Rate Risk**
    - Uncertainty concerning rates at which cash flows can be reinvested
    - Short-term bonds have more reinvestment rate risk than long-term bonds
  - **Default Risk**
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### Calculating Yields

Suppose we know the current price of a bond, its coupon rate, and its time to maturity. How do we calculate the YTM?

The formula:

$$\text{Bond price} = \frac{C}{YTM} \left[ 1 - \frac{1}{\left(1 + \frac{YTM}{2}\right)^{2M}} \right] + \frac{FV}{\left(1 + \frac{YTM}{2}\right)^{2M}}$$

- Use the same formula, but solve for YTM
- How?
  - Trial and error . . .
  - Financial calculator
- Prices versus yields

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### Bond YTM

$$\text{Bond price} = \frac{C}{YTM} \left[ 1 - \frac{1}{\left(1 + \frac{YTM}{2}\right)^{2M}} \right] + \frac{FV}{\left(1 + \frac{YTM}{2}\right)^{2M}}$$

Assume a bond has 15 years to maturity, a 9% coupon, and the bond is selling for is \$1,080. What is the YTM?

$$\$1,080 = \frac{90}{YTM} \left[ 1 - \frac{1}{\left(1 + \frac{YTM}{2}\right)^{30}} \right] + \frac{1000}{\left(1 + \frac{YTM}{2}\right)^{30}}$$

**YTM = 4.0354% x 2 = 8.07%**

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## A Quick Note on Bond Quotations

- We have seen how bond prices are quoted in the financial press, and how to calculate bond prices.
- If you buy a bond between coupon dates, you will receive the next coupon payment (and might have to pay taxes on it).
- However, when you buy the bond between coupon payments, you must compensate the seller for any **accrued interest**.
- 
- The convention in bond price quotes is to ignore accrued interest.
  - This results in what is commonly called a **clean price** or **flat price**.
- The price the buyer actually pays is called the **dirty price**
  - Accrued interest is added to the **clean price**.
  - The price the buyer actually pays is known as the **full price** or **invoice price**.

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## Callable Bonds

- So far, we have calculated bond prices assuming that the bond will held until maturity.
- However, most bonds are **callable bonds**.
- A **callable bond** gives the **issuer** the option to buy back the bond at a specified **call price** anytime **after** an initial **call protection period**.
- Therefore, for callable bonds, YTM may not be useful.

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## Bond Yield to Call

$$\text{Callable bond price} = \frac{C}{YTC} \left[ 1 - \frac{1}{(1 + YTC/2)^{2T}} \right] + \frac{CP}{(1 + YTC/2)^{2T}}$$

Assume the previous bond has 5 years until it can be called with a \$90 call premium. (9% coupon & selling for \$1,080.) What is the YTM?

$$1,080 = \frac{90}{YTC} \left[ 1 - \frac{1}{(1 + YTC/2)^{10}} \right] + \frac{1090}{(1 + YTC/2)^{10}}$$

$$YTC = 4.243\% \times 2 = 8.49\%$$

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## Zero-Coupon Bonds – Pure Discount Bonds

- No periodic interest payments
- Full YTM derived from the difference between purchase price and par value
- Cannot sell for more than par value
- Also called zeroes or deep discount bonds
- Examples:
  - Treasury Bills and principal only Treasury strips

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## Zero-Coupon Bonds Example

$$\text{Value}_{\text{Zero}} = FV / (1 + R)^T$$

You own a zero with 20 years to maturity and a 10% yield. What is its value today?

$$\text{Value}_{\text{Zero}} = FV / (1 + R)^T$$

$$\text{Value}_{\text{Zero}} = \$1,000 / (1 + .10)^{20}$$

$$\text{Value}_{\text{Zero}} = \$148.64$$

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## Malkiel's Theorems

Summarizes the relationship between bond prices, yields, coupons, and maturity:

Malkiel's Theorems paraphrased (see text for exact wording);

all theorems are ceteris paribus:

- 1) Bond prices move inversely with interest rates.
- 2) The longer the maturity of a bond, the more sensitive is its price to a change in interest rates.
- 3) The price sensitivity of any bond increases with its maturity, but the increase occurs at a decreasing rate.
- 4) The lower the coupon rate on a bond, the more sensitive is its price to a change in interest rates.
- 5) For a given bond, the volatility of a bond is not symmetrical, i.e. a decrease in interest rates raises bond prices more than a corresponding increase in interest rates lower prices.

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### Useful Internet Sites

- [www.bondmarkets.com](http://www.bondmarkets.com) (Check out the bonds section)
- [www.bondsonline.com](http://www.bondsonline.com) (Bond basics and current market data)
- [www.jamesbaker.com](http://www.jamesbaker.com) (A practical view of bond portfolio management)

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### Example Problem 1

CIR Inc. has 7% coupon bonds on the market that have 11 years left to maturity. If the YTM on these bonds is 8.5%, what is the current bond price?

Solution:

$$\text{Bond price} = \frac{70}{.085} \left[ 1 - \frac{1}{(1 + .085/2)^{22}} \right] + \frac{1000}{(1 + .085/2)^{22}} = \$894.16$$

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### Example Problem 2

Trincor Company bonds have coupon rate of 10.25%, 14 years to maturity, and a current price of \$1,225. What is the YTM? The current yield?

Solution:

$$\$1,225 = \frac{102.50}{\text{YTM}} \left[ 1 - \frac{1}{(1 + \text{YTM}/2)^{28}} \right] + \frac{1000}{(1 + \text{YTM}/2)^{28}}$$

$$\text{YTM} = 3.805\% \times 2 = 7.61\%$$

$$\text{Current yield} = \$102.50 / \$1,225 = 8.37\%$$

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### Example Problem 3

XYZ Company has a 9% callable bond outstanding on the market with 12 years to maturity, call protection for the next 5 years, and a call premium of \$100. What is the YTC for this bond if the current price is 120% of par value?

Solution:

$$\$1,200 = \frac{90}{\text{YTC}} \left[ 1 - \frac{1}{(1 + \text{YTC}/2)^{10}} \right] + \frac{1100}{(1 + \text{YTC}/2)^{10}}$$

$$\text{YTC} = 3.024\% \times 2 = 6.05\%$$

[see next slide for additional information]

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### Problem 3 (cont'd)

Since the bond sells at a premium to par, you know the coupon is greater than the yield. If interest rates stay at current levels, the bond issuer will likely call the bonds to refinance at the earliest possible time.

What is the YTM, with zero call premium?

Solution:

$$\$1,200 = \frac{90}{\text{YTM}} \left[ 1 - \frac{1}{(1 + \text{YTM}/2)^{24}} \right] + \frac{1000}{(1 + \text{YTM}/2)^{24}}$$

$$\text{YTM} = 3.283\% \times 2 = 6.57\%$$

[see next slide for additional information]

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