FIN 2004 Finance Tutorial 5 :

Bonds

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Bond Definitions

- Bond
  - Debt contract
  - Interest-only loan
- Par value (face value) = $1,000 unless otherwise stated
- Coupon rate
- Coupon payment
- Maturity date
- Yield to maturity

Key Features of a Bond

- Par value:
  - Face amount
  - Re-paid at maturity
  - Assume $1,000 for corporate bonds
- Coupon interest rate:
  - Stated interest rate
  - Usually = YTM at issue if bond is priced at par
  - Multiply by par value to get coupon payment

Key Features of a Bond

- Maturity:
  - Years until bond must be repaid
- Yield to maturity (YTM):
  - The market required rate of return for bonds of similar risk and maturity. It is also known as market interest rat of bond.
  - The discount rate used to value a bond
  - Return if bond held to maturity
  - Usually = coupon rate at issue if bond is price at par
  - Quoted as an APR

Bond Value

- The equation used to find the value of an annual coupon bond is :

$$v_b = \sum_{t=1}^{N} \frac{\text{Coupon}}{(1 + r_d)^t} + \frac{\text{Par Value}}{(1 + r_d)^N}$$

Bond value = PV(annuity) + PV(par)

- An adjustment to the formula must be made if the bond pays interest semi-annually : divide INT and r_d by 2, and multiply N by 2

$$v_b = \sum_{t=1}^{2N} \frac{\text{Coupon}/2}{(1 + r_d/2)^t} + \frac{\text{Par Value}}{(1 + r_d/2)^{2N}}$$

- As market interest rates of bond increase, present values decrease
  (r ⬆→ PV ⬇) and vice versa
- The return earned on a bond held to maturity is defined as the bond's yield to maturity (YTM).

Zero Coupon Bonds

- Make no periodic interest payments (coupon rate = 0%)
- Entire yield-to-maturity comes from the difference between the purchase price and the par value (capital gains)
- Cannot sell for more than par value
- Sometimes called zeroes, or deep discount bonds
- Treasury Bills and U.S. Savings bonds are good examples of zeroes

$$\text{Value of zero coupon} = \frac{\text{Par Value}}{(1 + r_d/2)^{2N}}$$

Callable Bonds

- A callable bond is a debt security that can be redeemed early by the issuer before its maturity at the issuer's discretion.
- A callable bond allows companies to pay off their debt early and benefit from favourable interest rate drops.
- A callable bond benefits the issuer, and so investors of these bonds are compensated with a more attractive interest rate than on otherwise similar non-callable bonds.

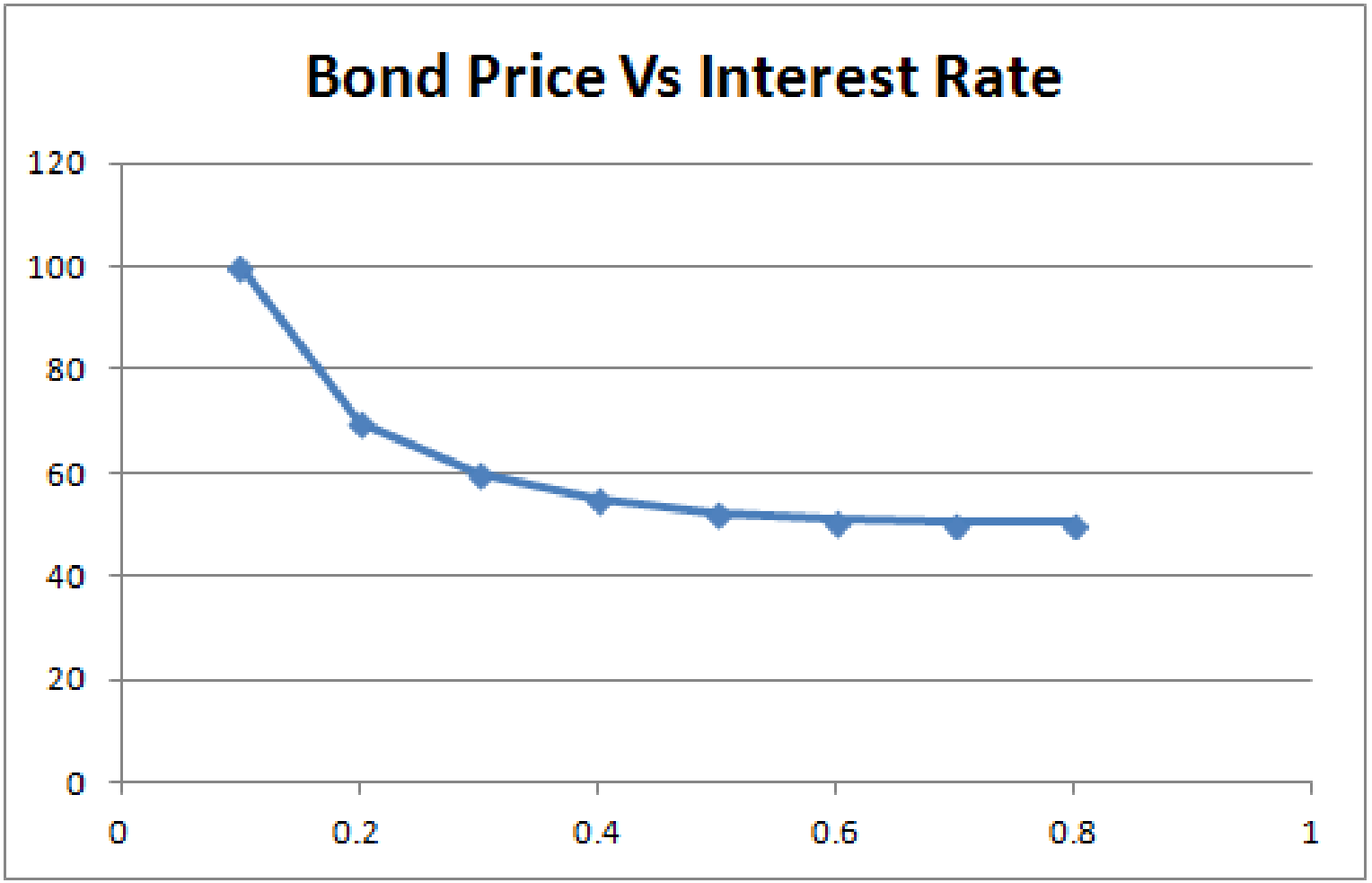
Puttable Bonds

- A put bond is a debt instrument with an embedded option that gives bondholders the right to demand early repayment of the principal from the issuer.
- The embedded put option acts an incentive for investors to buy a bond that has a lower return.
- Bondholders can exercise their options if interest rate levels in the markets increase. As there is an inverse relationship between interest rates and bond prices, when interest rates increase, the value of a bond decreases.

Convertible Bonds

- Convertible bonds are corporate bonds that can be exchanged for common stock in the issuing company.
- Companies issue convertible bonds to lower the coupon rate on debt and to delay dilution.
- A bond's conversion ratio determines how many shares an investor will get for it.
- Companies can force conversion of the bonds if the stock price is higher than if the bond were to be redeemed.

Graphical Relationship Between Price and Yield-to-maturity



Bond Prices:
Relationship Between Coupon and Yield

- Coupon rate = YTM ➡ Price = Par
- Coupon rate < YTM ➡ Price < Par
  - "Discount bond" … Why?
- Coupon rate > YTM ➡ Price > Par
  - "Premium bond" … Why?

Computing Yield-to-Maturity (YTM)

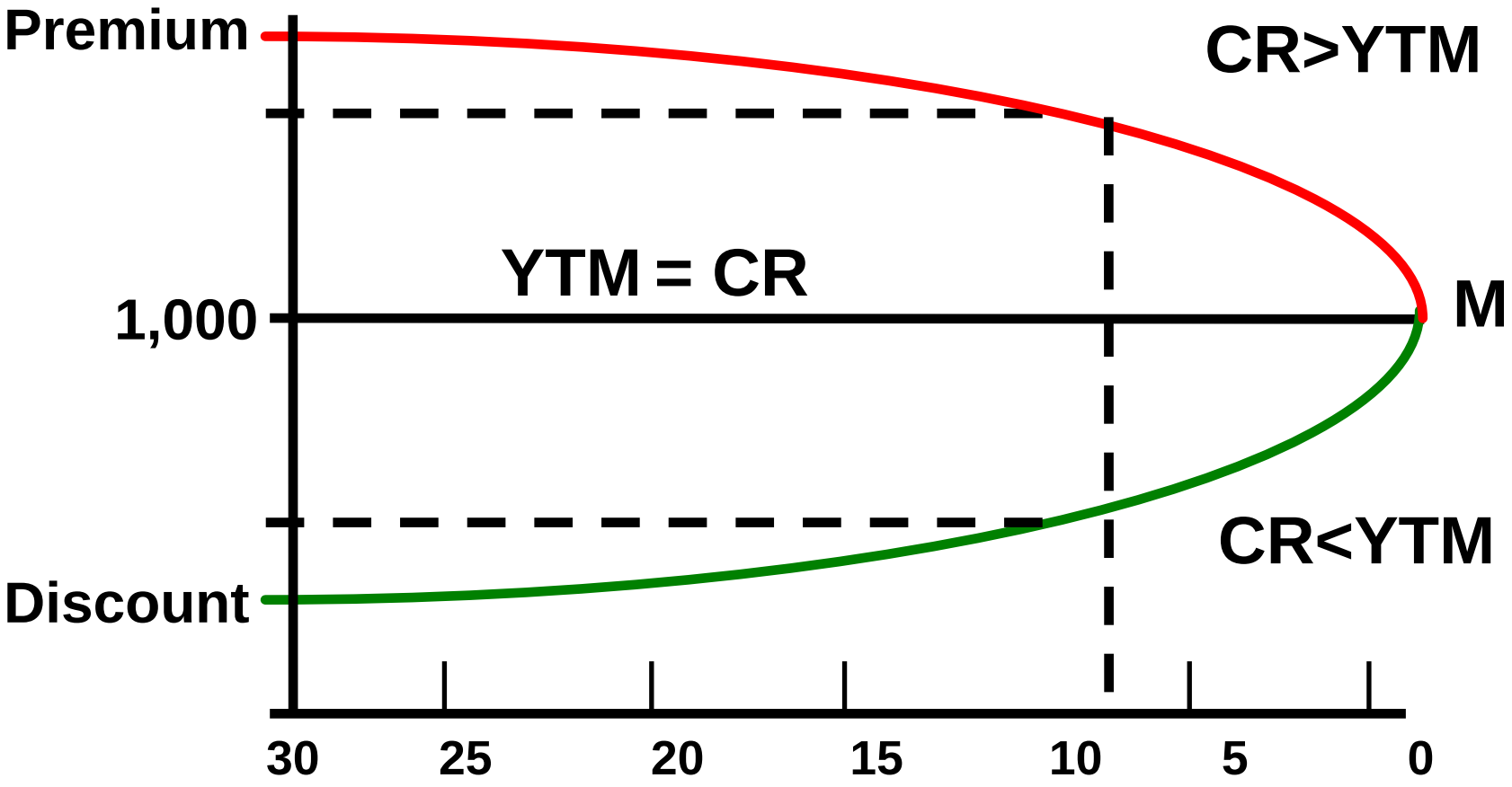
Yield-to-maturity (YTM) = the market required rate of return implied by the current bond price. It is the discount rate that equate bond price to the present value of cash flows from the bond.

With a financial calculator,

- Enter N, PV, PMT, and FV
- **Remember the sign convention**
  - PMT and FV need to have the same sign (+)
  - PV the opposite sign (-)
  - CPT I/Y for the yield

Bondholder will realize the YTM implied by the bond purchase price if the bond coupon can be reinvested at implied YTM.

Bond Value ($) vs Years remaining to Maturity



Interest Rate Risk

- Price Risk
  - Change in price due to changes in interest rates (change in YTM or market interest rate of bond)
  - Long-term bonds have more price risk (or interest rate risk) than short-term bonds
  - Low coupon rate bonds have more price risk (or interest rate risk) than high coupon rate bonds

Interest Rate Risk

- 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
  - High coupon rate bonds have more reinvestment rate risk than low coupon rate bonds

Bond Ratings

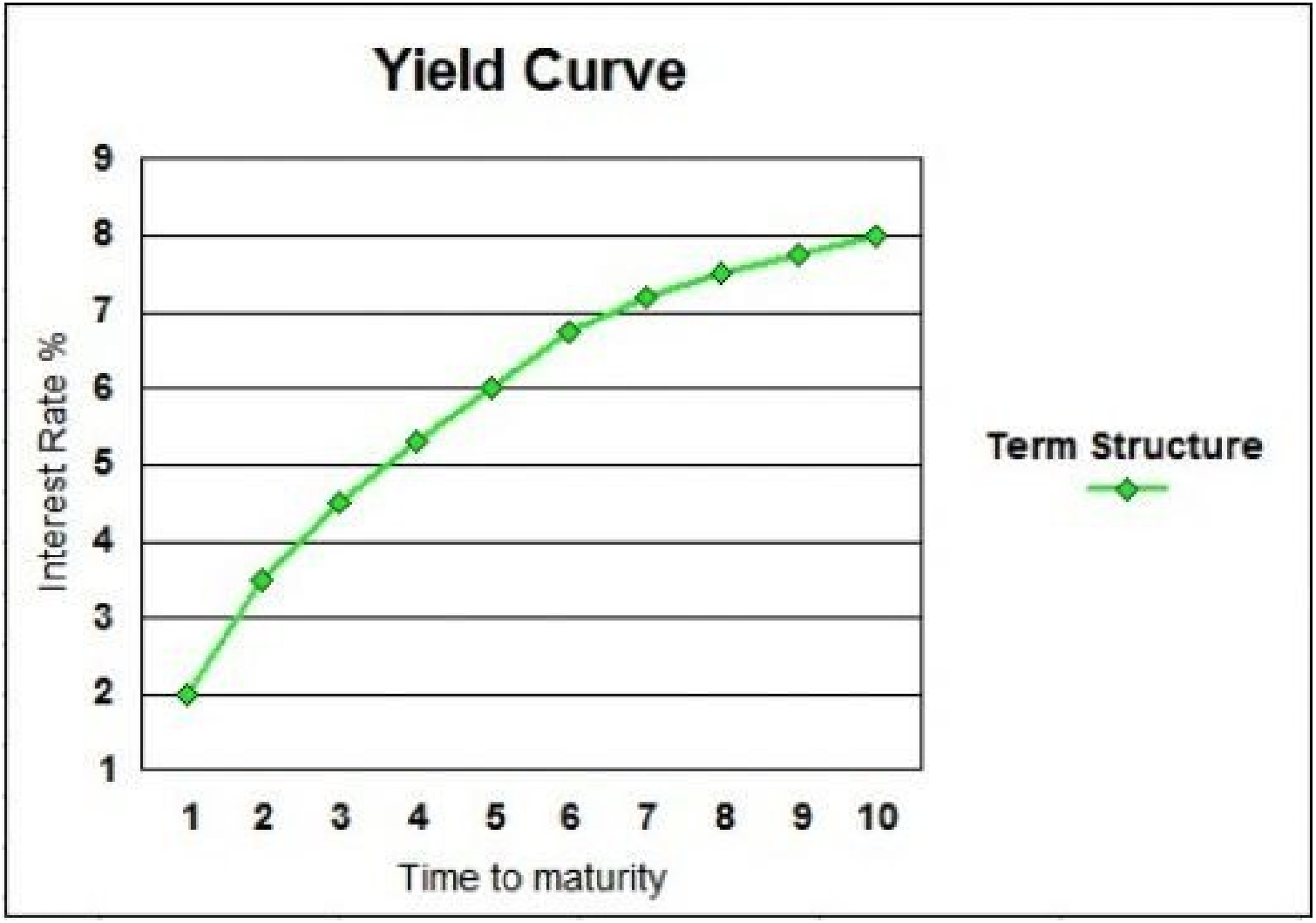
- Bonds are rated by the issuer's default risk
- Large bond investors, traders and managers evaluate default risk by analyzing the issuer's financial ratios and security prices
- Two major bond rating agencies are Moody's and Standard & Poor's (S&P)
- Bonds assigned a letter grade based on perceived probability of issuer default

Term structure of Interest Rates

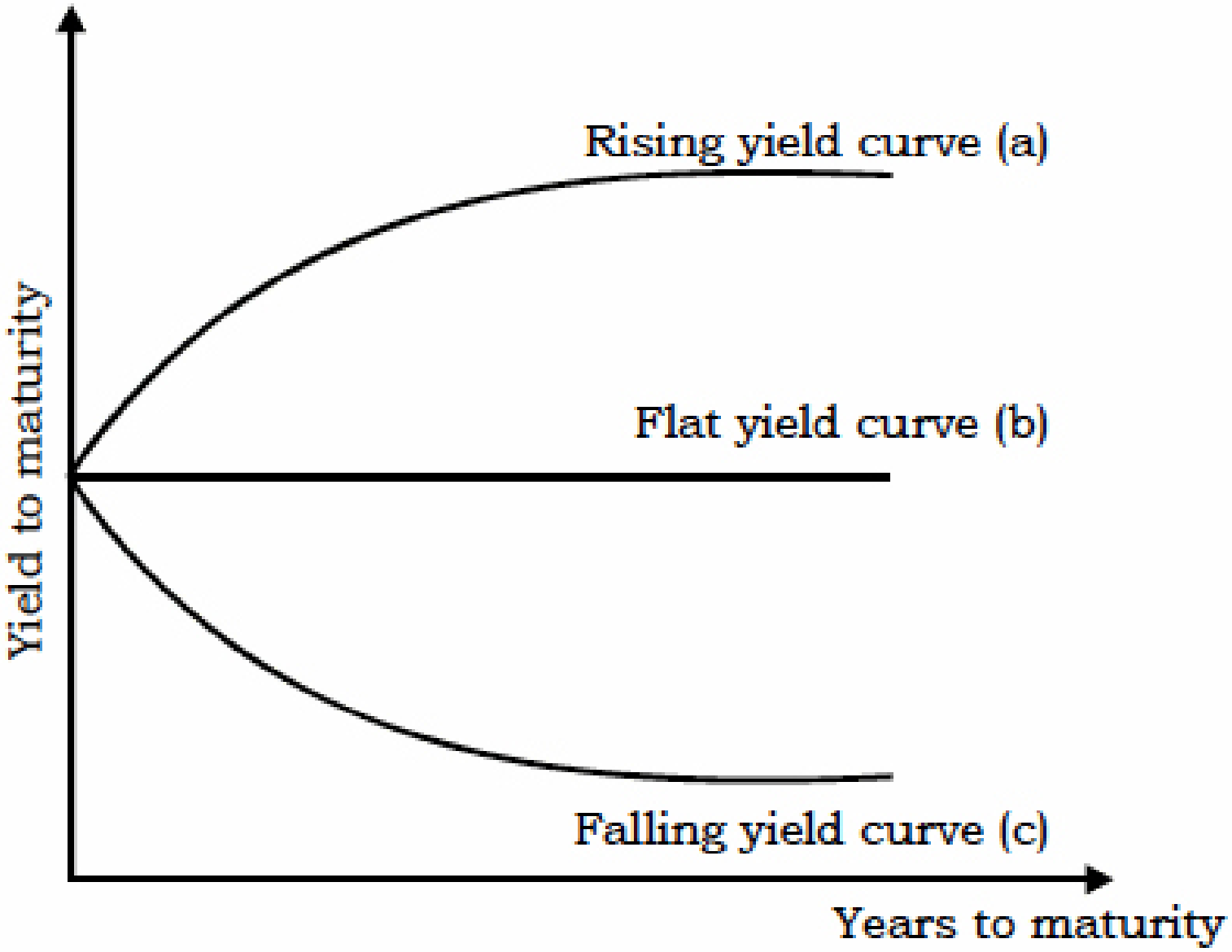
- Term structure of interest rates is the relationship between interest rates or bond yields and different terms or maturities.

- When graphed, the term structure of interest rates is known as a yield curve, and it plays a crucial role in identifying the current state of an economy.

Term structure of Interest Rates



Shape of Yield Curve



Bond Ratings

	Moody's	Standard & Poor's	Safety
Investment grade	Aaa	AAA	The strongest rating; ability to repay interest and principal is very strong.
	Aa	AA	Very strong likelihood that interest and principal will be repaid
	A	A	Strong ability to repay, but some vulnerability to changes in circumstances
	Baa	BBB	Adequate capacity to repay; more vulnerability to changes in economic circumstances
Speculative	Ba	BB	Considerable uncertainty about ability to repay.
	B	B	Likelihood of interest and principal payments over sustained periods is questionable.
	Caa	CCC	Bonds in the Caa/CCC and Ca/CC classes may already be
	Ca	CC	in default or in danger of imminent default
	C	C	C-rated bonds offer little prospect for interest or principal on the debt ever to be repaid.

#1:

Bond X is a premium bond making annual payments. The bond pay an 8% coupon, has a YTM of 6% and has 13 years to maturity.

Bond Y is a discount bond making annual payments. This bond pays a 6% coupon, has a YTM of 8%, and also has 13 years to maturity.

If the interest rates remain unchanged, what do you expect the price of these bonds to be one year from now? In three years? In eight years? In 12 years? In 13 years?

Illustrate your answers by graphing bond prices versus time to maturity.

Bond X

Enter	13	6%		$80	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,177.05		

P_1

Enter	12	6%		$80	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,167.68		

P_3

Enter	10	6%		$80	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,147.20		

P_8

Enter	5	6%		$80	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,084.25		

Cont'd

Bond X

P_{12}

Enter	1	6%		$80	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,018.87		

P_{13} = $1,0000

Cont'd

Bond Y

P_0

Enter	13	8%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$841.92		

P_1

Enter	12	8%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$849.28		

P_3

Enter	10	8%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$865.80		

P8

Enter	5	8%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$920.15		

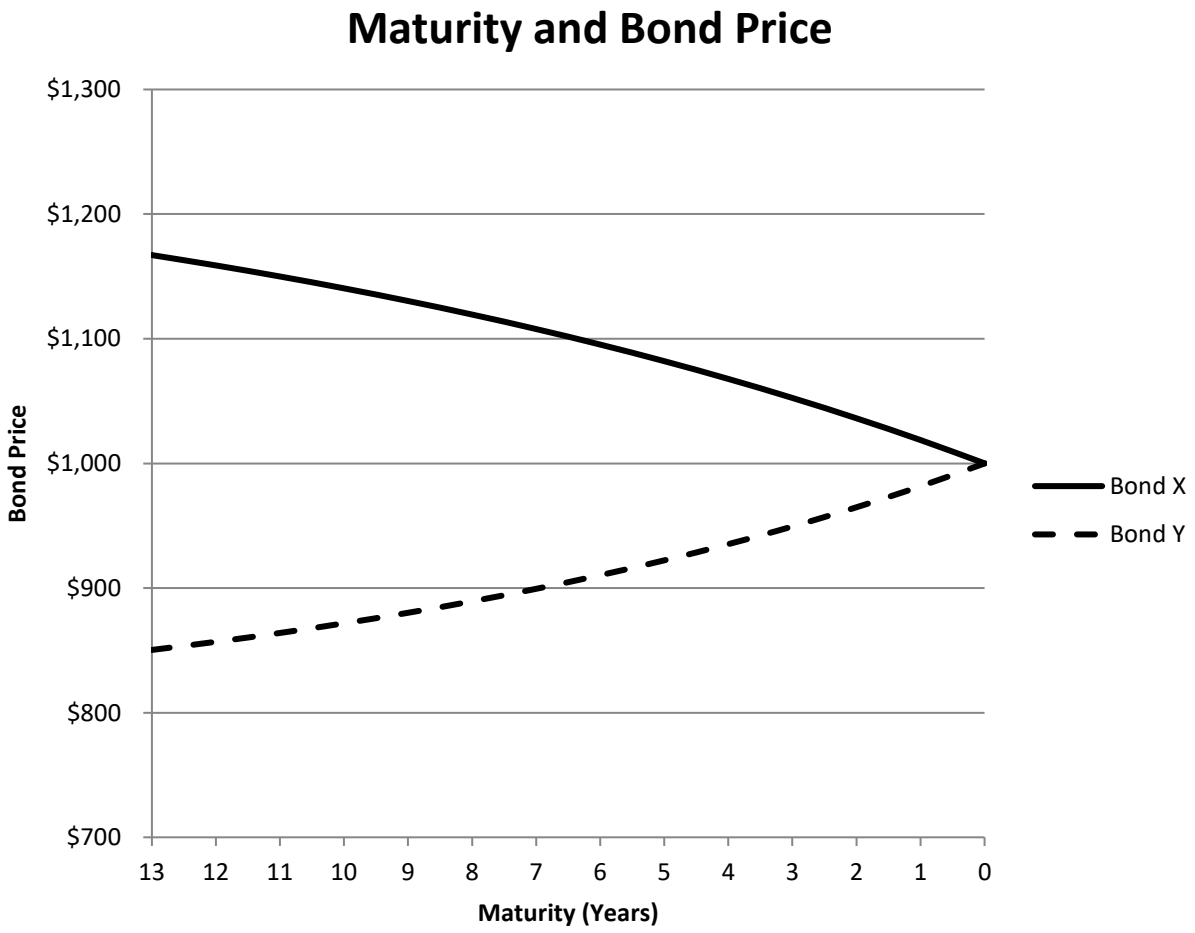
Cont'd

Bond Y

P_{12}

Enter	1	8%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$981.48		

P_{13} = $1,0000


Maturity and Bond Price
$1,300
$1,200
$1,100
$1,000
$900
$800
$700
Bond Price
13
12
11
10
9
8
7
6
5
4
3
2
1
0
Maturity (Years)
Bond X
Bond Y

#2:

Both Bond Sam and Bond Dave have 9% coupons, make semi-annual payments, and are priced at par value.

Bond Sam has 3 years to maturity, whereas Bond Dave has 20 years to maturity.

If the interest rates suddenly rise by 2%, what is the percentage change in the price of Bond Sam? Of Bond Dave?

If the interest rates were to suddenly fall by 2% instead, what would the percentage change in the price of Bond Sam be then? Of Bond Dave?

Illustrate your answers by graphing bond prices versus YTM. What does this problem tell you about the interest rate risk of longer maturity bond?

P_{Sam}

Enter	6	5.5%		$45	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		$950.04			

ΔP_{Sam} % = ($950.04 – 1,000) / $1,000 = - 5.00%

P_{Dave}

Enter	40	5.5%		$45	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		$839.54			

ΔP_{Dave} % = ($839.54 – 1,000) / $1,000 = - 16.05%

<u>If the YTM suddenly falls to 7%:</u>

P_{Sam}

Enter	6	3.5%		$45	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		$1,053.29			

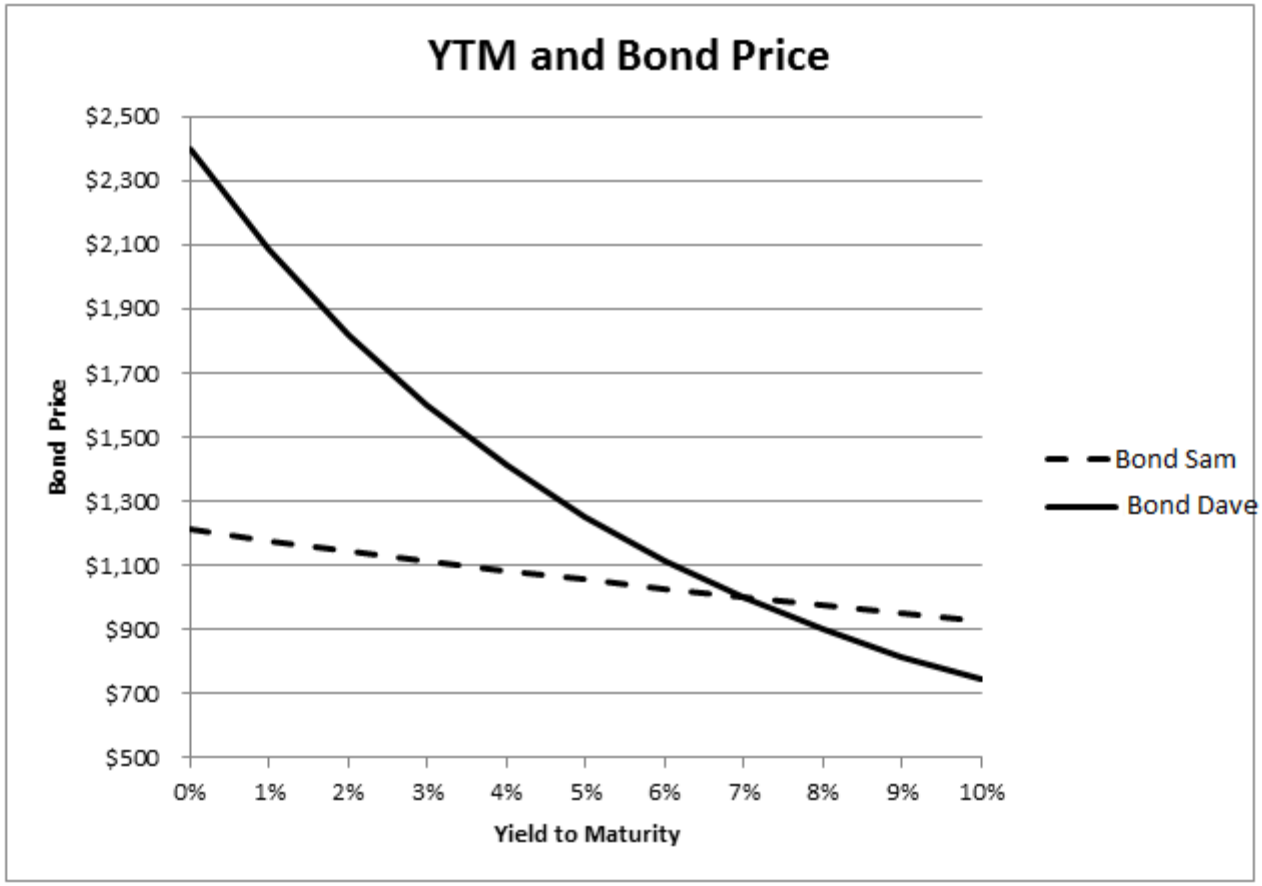
ΔP_{Sam} % = ($1,053.29 – 1,000) / $1,000 = + 5.33%

P_{Dave}

Enter	40	3.5%		$45	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,213.55		

ΔP_{Dave} % = ($1,213.55 – 1,000) / $1,000 = + 21.36%

all else the same, the longer the maturity of a bond, the greater is its price sensitivity to changes in interest rates.


YTM and Bond Price
Bond Price
$2,500
$2,300
$2,100
$1,900
$1,700
$1,500
$1,300
$1,100
$900
$700
$500
0%
1%
2%
3%
4%
5%
6%
7%
8%
9%
10%
Yield to Maturity
Bond Sam
Bond Dave

#3:

Bond J is a 4% coupon bond, Bond K is an 12% coupon bond. Both bonds have 9 years to maturity, make semi-annual payments, and have a YTM of 8%.

If interest rate suddenly rise by 2%, what is the percentage change of these bonds?

What if rates suddenly fall by 2% instead? What does this problem tell you about the interest rate risk of lower-coupon bonds?

Initially, at a YTM of 8%, the prices of the two bonds are :

P_J

Enter	18	4%		$20	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$746.81		

P_K

Enter	18	4%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,253.19		

If the YTM rises from 8% to 10%

P_J

Enter	18	5%		$20	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$649.31		

ΔP_J % = ($649.31– 746.81) / $746.81 = - 13.06%

P_K

Enter	18	5%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,116.90		

ΔP_K % = ($1,116.90– 1,253.19) / $1,253.19 = - 10.88%

If the YTM declines from 8% to 6%

P_J

Enter	18	3%		$20	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		$862.46			

ΔP_J % = ($862.46– 746.81) / $746.81 = + 15.49%

P_K

Enter	18	3%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		$1,412.61			

ΔP_K % = ($1,412.61– 1,253.19) / $1,253.19 = + 12.72%

All else the same, the lower the coupon rate on a bond, the greater is its price sensitivity to changes in interest rates.

(Additional Question on capital gain yield)

Bond P is a premium bond with a 12 percent coupon.

Bond D is a 6 percent coupon bond currently selling at a discount.

Both bonds make annual payments, have a YTM of 9 percent, and have five years to maturity.

Calculate the current yield for Bonds P and D Round your answers to 2 decimal places.

If interest rates remain unchanged, calculate the expected capital gains yield over the next year for Bonds P and D. Round your answers to 2 decimal places.

Bond	P:				
Enter	5	9%		$120	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,116.69		
Enter	4	9%		$120	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,097.19		

Current yield = $120/$1,116.69 = 0.1075 = 10.75%
Capital gain yield = ($1,097.19 – 1,111.69)/$1,1116.69 = -0.0175 = - 1.75%

Bond D:					
Enter	5	9%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$883.31		
Enter	4	9%		$60	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$902.81		

Current yield = $60/$883.81 = 0.0679 = 6.79%
Capital gain yield = ($902.81– 883.31)/$883.31= 0.0221 = 2.21%

All else held constant, premium bonds pay high current income while having price depreciation as maturity nears; discount bonds do not pay high current income but have price appreciation as maturity nears. For either bond, the total return is still 9%, but this return is distributed differently between current income and capital gains.

Additional Question (holding period yield):

The YTM on a bond is the interest rate you earn on your investment if interest rates doesn't change.

If you actually sell the bond before it matures, your realised return is known as the holding period yield (HPY).

a. Suppose that today you buy a 7% annual coupon bond for $1,060. The bond has 10 years to maturity. What rate of return do you expect to earn on your investment?

b. Two years from now, the YTM on your bond has declined by 1%, and you decided to sell. What price will your bond sell for? What is the HPY on your bond investment? Compare this yield to the YTM when you first bought the bond. Why are they different?

a.

Enter	10		-$1,060	$70	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		6.18%			

This is the rate of return you expect to earn on your investment when you purchase the bond.

b.

Enter	8	5.18%		$70	$1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			$1,116.92		

The HPY is :

Enter	2		-$1,060	$70	$1,116.92
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	9.17%				

The realized HPY is greater than the expected YTM when the bond was bought because interest rates dropped by 1 percent; bond prices rise when yields fall.

#4:

Suppose your company needs to raise $30 million and you want to issue 30-year bonds for this purpose. Assume the required return on your bond issue will be 8 percent, and you're evaluating two issue alternatives: an 8 percent semi-annual coupon bond and a zero-coupon bond. Your company's tax rate is 35 percent.

a. How many of the coupon bonds would you need to issue to raise the $30 million? How many of the zeros would you need to issue?
b. At the end of the 30th year, what will your company's repayment be if you issue the coupon bonds? What if you issue the zeros?

a. The coupon bonds have an 8% coupon which matches the 8% required return, so they will sell at par. The number of bonds that must be sold is the amount needed divided by the bond price, so:

   Number of coupon bonds to sell = $30,000,000 / $1,000 = 30,000
   The number of zero coupon bonds to sell would be:
   Price of zero coupon bonds = $1,000/$(1.04)^{60}$ = $95.06
   Number of zero coupon bonds to sell = $30,000,000 / $95.06 = 315,589

b. The repayment of the coupon bond will be the par value plus the last coupon payment times the number of bonds issued. So:

   Coupon bonds repayment = 30,000($1,040) = $31,200,000
   The repayment of the zero coupon bond will be the par value times the number of bonds issued, so:
   Zeroes: repayment = 315,589($1,000) = $315,588,822

#5:

@007 Corp wants to issue new 8-year bonds for some much-needed expansion projects. The company currently has 6.5 percent bonds on the market that sell for $1,146.57, make semiannual payments, and mature in 8 years. What should the coupon rate be on the new bonds if the firm wants to sell them at par?

Enter	16		-$1,146.57	$32.50	$1,000
	N	I/Y	PV	PMT	FV
Solve for		2.1570%			

Since the bond is priced at par. Coupon rate = YTM

Coupon rate = 2.157%*2 = **4.314%**