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Interest Rates and Bond Valuation

FIN311 Corporate Finance

FEATURES OF BONDS

1. A bond is a long-term debt instrument that pays the bondholder a specified amount of periodic interest rate over a specified period of time

2. The bond's principal is the amount borrowed by the company and the amount owed to the bond holder on the maturity date

3. The bond's maturity date is the time at which a bond becomes due and the principal must be repaid

4. The bond's coupon rate is the specified interest rate (or $ amount) that must be

COUPON PAYMENT

A bond has a 7% coupon and pays interest semi-annually.

What is the amount of each interest payment if the face value of a bond is $1,000?

$$\text{Interest payment} = \frac{\text{Coupon rate} \times \text{Face amount}}{\text{Number of interest payments per year}}$$

$$= \frac{.07 \times \$1{,}000}{2}$$

$$= \frac{\$70}{2}$$

$$= \$35$$

BONDS WITH MATURITY DATES

$$B_0 = I \times \left[\sum_{t=1}^{n} \frac{1}{(1+k_d)^t}\right] + M \times \left[\frac{1}{(1+k_d)^n}\right] \qquad (6.7)$$

$$= I \times (PVIFA_{k_d,n}) + M \times (PVIF_{k_d,n}) \qquad (6.7a)$$

For example, find the price of a 10% coupon bond with three years to maturity if market interest rates are currently 10%.

$$B_0 = \frac{\$100}{(1+.10)^1} + \frac{\$100}{(1+.10)^2} + \frac{(\$100 + \$1{,}000)}{(1+.10)^3}$$

BOND PRICING

A bond has a 9% coupon rate, matures in 12 years and pays interest semi-annually. The face value is $1,000.

What is the current price of this bond if the market rate of return is 8.3%?

$$PV = \left\{ C \times \left\{ \frac{1 - \left[1/(1+r)^t \right]}{r} \right\} \right\} + \frac{F}{(1+r)^t}$$

$$= \left\{ \frac{.09 \times \$1{,}000}{2} \times \frac{1 - \left[1/(1 + \frac{.083}{2})^{12\times 2} \right]}{\frac{.083}{2}} \right\} + \frac{\$1{,}000}{(1 + \frac{.083}{2})^{12\times 2}}$$

$$= (\$45 \times 15.015477) + \$376.8577 = \$675.6965 + \$376.8577$$

$$= \$1{,}052.55$$

	N	I/Y	PV	PMT	FV
Enter	12×2	8.3/2		90/2	1,000
Solve for			±1,052.55		

TIME TO MATURITY

A bond is currently selling at a price of $977.03. The face value is $1,000 and the coupon rate is 8%. Interest is paid semi-annually.

How many years is it until this bond matures if the market rate of return is 8.4%?

Enter	8.4/2	±977.03	80/2	1,000
N	I/Y	PV	PMT	FV

Solve for 16

There are 16 semi-annual periods, or 8 years, until the bond maturity date.

FEATURES OF BOND

1. The bond's current yield is the annual interest (income) divided by the current price of the security
2. The bond's yield-to-maturity is the yield (expressed as a compound rate of return) earned on a bond from the time it is acquired until the maturity date of the bond
3. A yield curve graphically shows the relationship between the time to maturity and yields for debt in a given risk class

CURRENT YIELD

The Current Yield measures the annual return to an investor based

$$\text{Current Yield} = \frac{\text{Annual Coupon Interest}}{\text{Current Market Price}}$$

For example, a 10% coupon bond which is currently selling at $1,150 would have a current yield of:

$$\text{Current Yield} = \frac{\$100}{\$1,150} = 8.7\%$$

CURRENT YIELD

- Annual income (interest or dividends) divided by the current price of the security.
- This measure looks at the current price of a bond instead of its face value and represents the return an investor would **expect if he or she purchased the bond and held it for a year.**
- This measure is not an accurate reflection of the actual return that an investor will receive in all cases because bond and stock prices are constantly changing due to market factors.

CURRENT YIELD

An 8%, semi-annual coupon bond has a $1,000 face value and matures in 8 years.

What is the current yield on this bond if the yield to maturity is 7.8%?

$$PV = \left\{ C \times \left\{ \frac{1 - \left[1/(1+r)^t \right]}{r} \right\} \right\} + \frac{F}{(1+r)^t}$$

$$= \left\{ \frac{.08 \times \$1{,}000}{2} \times \frac{1 - \left[1/(1 + \frac{.078}{2})^{8 \times 2} \right]}{\frac{.078}{2}} \right\} + \frac{\$1{,}000}{(1 + \frac{.078}{2})^{8 \times 2}}$$

$$= (\$40 \times 11.73873) + \$542.18967$$

$$= \$469.54920 + \$542.18967 = \$1{,}011.74$$

CURRENT YIELD

	N	I/Y	PV	PMT	FV
Enter	**8×2**	**7.8/2**		**80/2**	**1,000**
Solve for			**±1,011.74**		

$$\text{Current yield} = \frac{\text{Annual interest}}{\text{Current price}}$$

$$= \frac{\$80}{\$1{,}011.74}$$

$$= .07907$$

$$= 7.91\%$$

YIELD TO MATURITY (YTM)

The yield to maturity measures the compound annual return to an investor and considers all bond cash flows. It is essentially the bond's IRR based on the current price.

$$PV = \frac{I_1}{(1+k)^1} + \frac{I_2}{(1+k)^2} + \ldots + \frac{(I_n + M_n)}{(1+k)^n}$$

Notice that this is the same equation we saw earlier when we solved for price. The only difference then is that we are solving for a different unknown. In this case, we ***know*** the market price but are solving for return.

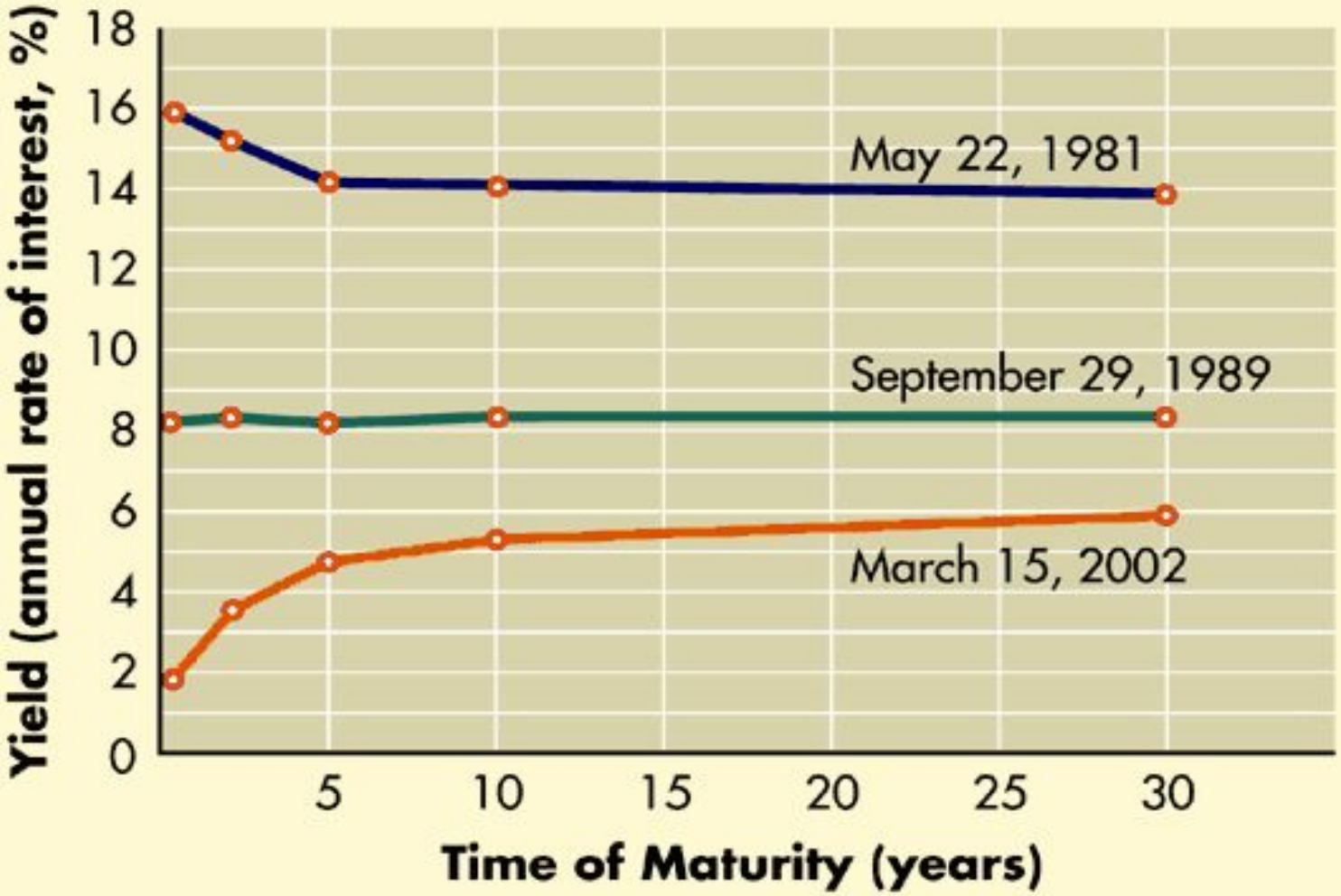
YIELD TO MATURITY

A 6% bond pays interest annually and matures in 14 years. The face value is $1,000 and the current market price is $896.30.

What is the yield to maturity?

	N	I/Y	PV	PMT	FV
Enter	14		±896.30	60	1,000
Solve for		7.2			

YIELD CURVE



Sources: Data from *Federal Reserve Bulletins* (June 1981), p. A25 and (December 1989), p. A24; and *U.S. Financial Data,* Federal Reserve Bank of St. Louis (March 14, 2002), p. 7.

HOLDING PERIOD YIELD

You bought a bond exactly one year ago for $1,004.50. Today, you sold the bond at a price of $987.40. The bond paid interest semi-annually at a coupon rate of 6%.

What is your holding period yield on this bond?

Enter	**1×2**	**/2**	**±1,004.50**	**60/2**	**987.40**
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		**4.29**			

INTEREST RATE RISK

You own two bonds. Both bonds have a 6% coupon and pay interest semi-annually. Both have a face value of $1,000. Bond A matures in two years while bond B matures in 10 years.

What is the price of each bond at a market rate of 6%? What happens if the rate increases to 7%.

Bond A:

	N	I/Y	PV	PMT	FV
Enter	2×2	6/2		60/2	1,000
Solve for			±1,000		

Bond B:

	N	I/Y	PV	PMT	FV
Enter	10×2	6/2		60/2	1,000
Solve for			±1,000		

INTEREST RATE RISK

Bond A:

Enter	2×2	7/2		60/2	1,000
	N	I/Y	PV	PMT	FV
Solve for			±981.63		

Bond B:

Enter	10×2	7/2		60/2	1,000
	N	I/Y	PV	PMT	FV
Solve for			±928.94		

The amount of bond price volatility depends on three basic factors:

- length of time to maturity
- risk
- amount of coupon interest paid by the bond

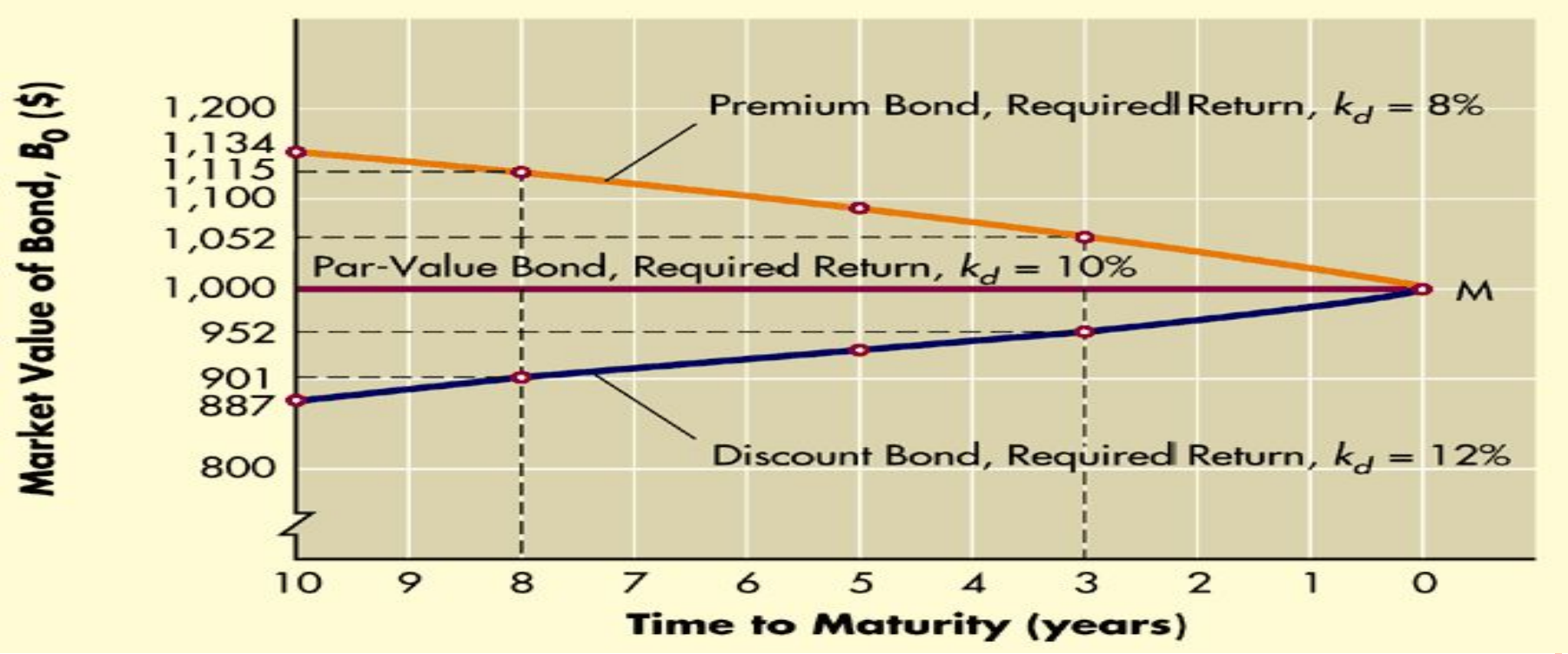
BONDS WITH MATURITY DATES

Bond Values for Various Required Returns (Mills Company's 10% Coupon Interest Rate, 10-Year Maturity, $1,000 Par, January 1, 2004, Issue Paying Annual Interest)

Required return, k_d	Bond value, B_0	Status
12%	$ 887.00	Discount
10	1,000.00	Par value
8	1,134.00	Premium

PRICE CONVERGES ON PAR AT MATURITY

It is also important to note that a bond's price will approach par value as it approaches the maturity date, regardless of the interest rate and regardless of the coupon rate



YIELD TO MATURITY

- The yield to maturity measures the compound annual return to an investor and considers all bond cash flows. It is essentially the bond's IRR based on the current price
- Note that the yield to maturity will only be equal if the bond is selling for its face value ($1,000)
- And that rate will be the same as the bond's coupon rate
- For premium bonds, the current yield > YTM

ZERO COUPON BOND

You are considering purchasing a 10-year, zero coupon bond with a face value of $1,000.

How much are you willing to pay for this bond if you want to earn a 12% rate of return? Assume annual compounding.

$$PV = \frac{F}{(1+r)^t}$$

$$= \frac{\$1{,}000}{(1+.12)^{10}} = \$321.97$$

Enter	10	12		1,000
	N	I/Y	PV	PMT	FV
Solve for			±321.97		

ZERO COUPON BOND

Winslow, Inc. issues 20-year zero coupon bonds at a price of $224.73. The face value is $1,000.

What is the amount of the implicit interest for the first year of this bond's life?

$$PV = \frac{F}{(1+r)^t}$$

$$\$224.73 = \frac{\$1{,}000}{(1+r)^{20}} \Rightarrow (1+r)^{20} = \frac{\$1{,}000}{\$224.73}$$

$$(1+r)^{20} = 4.44978 \Rightarrow 1+r = 4.44978^{.05}$$

$$1+r = 1.0775 \Rightarrow r = .0775 \Rightarrow r = 7.75\%$$

QUOTE

BONDS	CUR YLD	VOL	CLOSE	NET CHG
HuntPly 11¾04f	...	22	20.13	−0.88
IBM 7¼02	7.1	15	101.75	−0.38
IBM 5⅜09	5.6	50	96.63	0.25
IBM 8⅜19	...	20	114.25	0.38
IBM 7s25	7.0	10	100.25	−1.75
IPap dc5⅛12	5.9	20	86.50	1.88
IntShip 9s03	9.0	3	100	...
JPMChse 7½03	7.3	10	103	−0.25
JPMChse 6⅛08	6.1	25	100.88	0.63
JPMChse 6½09	6.5	40	100.13	...
JCPL 6⅜03	6.3	4	101	−0.75
KCS En 8⅞06	11.5	30	76.88	...
K&B Hm 7¾04	7.6	36	102	...
K&B Hm 9⅝06	9.2	65	104.38	−0.25
Koppers 8½04	8.6	16	99	...
Leucadia 7¾13	7.6	25	101.25	0.25
LionCT 6⅜03	6.3	15	101	−4.00
LglsLt 9s22	8.6	40	104.50	−0.50
Lucent 7¼06	8.9	585	81.63	−0.50
Lucent 5½08	7.8	240	70.75	−0.88
Lucent 6½28	10.5	89	62	0.25
Lucent 6.45s29	10.4	145	62.13	−0.38
MBNA 8.28s26	8.7	121	95.50	−0.50
MailWell 5s02	cv	30	98.75	0.25
Malan 9½04	cv	41	92.88	0.88
McDnl 6⅝05	6.5	87	102.13	0.38
Motrla zr13	...	10	73.25	−0.50
NRurU 6.55s18	7.0	50	94	−2.63
NYTel 6¼04	6.1	25	102	−0.25
NYTel 7⅝23	7.6	50	100.63	−1.25
NYTel 6.70s23	7.0	5	95	−1.75
NYTel 7s25	7.2	20	97	−0.63
NYTel 7s33	7.1	7	98.38	0.63
OcciP 10⅛09	8.4	5	121	0.13
OffDep zr07	...	30	90	−2.50

← IBM

Source: Wall Street Journal, April 23, 2002, p. C14.

CORPORATE BOND QUOTE

The closing price of a bond is quoted in the newspaper as 101.366.

What is the market price if the face value is $1,000?

$$\begin{aligned} \textit{Bond price} &= 101.366\% \text{ of } \$1{,}000 \\ &= 1.01366 \times \$1{,}000 \\ &= \$1{,}013.66 \end{aligned}$$

TYPES OF BONDS

TABLE 6.3 **Characteristics and Priority of Lender's Claim of Traditional Types of Bonds**

Bond type	Characteristics	Priority of lender's claim
Unsecured Bonds		
Debentures	Unsecured bonds that only creditworthy firms can issue. Convertible bonds are normally debentures.	Claims are the same as those of any general creditor. May have other unsecured bonds subordinated to them.
Subordinated debentures	Claims are not satisfied until those of the creditors holding certain (senior) debts have been fully satisfied.	Claim is that of a general creditor but not as good as a senior debt claim.
Income bonds	Payment of interest is required only when earnings are available. Commonly issued in reorganization of a failing firm.	Claim is that of a general creditor. Are not in default when interest payments are missed, because they are contingent only on earnings being available.
Secured Bonds		
Mortgage bonds	Secured by real estate or buildings.	Claim is on proceeds from sale of mortgaged assets; if not fully satisfied, the lender becomes a general creditor.The *first-mortgage* claim must be fully satisfied before distribution of proceeds to *second-mortgage* holders, and so on. A number of mortgages can be issued against the same collateral.
Collateral trust bonds	Secured by stock and (or) bonds that are owned by the issuer. Collateral value is generally 25% to 35% greater than bond value.	Claim is on proceeds from stock and (or) bond collateral; if not fully satisfied, the lender becomes a general creditor.
Equipment trust certificates	Used to finance "rolling stock"—airplanes, trucks, boats, railroad cars. A trustee buys such an asset with funds raised through the sale of trust certificates and then leases it to the firm, which, after making the final scheduled lease payment, receives title to the asset. A type of leasing.	Claim is on proceeds from the sale of the asset; if proceeds do not satisfy outstanding debt, trust certificate lenders become general creditors.

NOMINAL OR ACTUAL RATE OF INTEREST (RETURN)

- The nominal rate of interest is the actual rate of interest charged by the supplier of funds and paid by the demander
- The nominal rate differs from the real rate of interest, k* as a result of two factors:
  - Inflationary expectations reflected in an inflation premium (IP), and
  - Issuer and issue characteristics such as default risks and contractual provisions as reflected in a risk premium (RP)

NOMINAL OR ACTUAL RATE OF INTEREST

Using this notation, the nominal rate of interest for security 1, k_1 is given in equation 6.1, and is further defined in equations 6.2 and 6.3.

$$k_1 = \underbrace{k^* + IP}_{\text{risk-free rate, } R_F} + \underbrace{RP_1}_{\text{risk premium}} \qquad (6.1)$$

$$k_1 = R_F + RP_1 \qquad (6.2)$$

$$R_F = k^* + IP \qquad (6.3)$$

FISHER EFFECT

Last year, you earned 14.59% on your investments. The inflation rate was 4.30% for the year.

What was your real rate of return for the year?

$$(1+R) = (1+r) \times (1+h)$$

$$(1+.1459) = (1+r) \times (1+.043)$$

$$\frac{1.1459}{1.043} - 1 = r$$

$$r = .0986577$$

$$r = 9.87\%$$

FISHER EFFECT

You are considering investing $10,000 for one year. You would like to earn 9%, after inflation, on this investment. You expect inflation to average 3.25% over the coming year.

What nominal rate of return do you want to earn on your investment?

$$(1 + R) = (1 + r) \times (1 + h)$$

$$1 + R = (1 + .09) \times (1 + .0325)$$

$$1 + R = 1.125425$$

$$R = .125425 \Rightarrow R = 12.54\%$$