LECTURE 7

Bond Prices, Yields and Portfolio Management (Chapters 10 & 11)

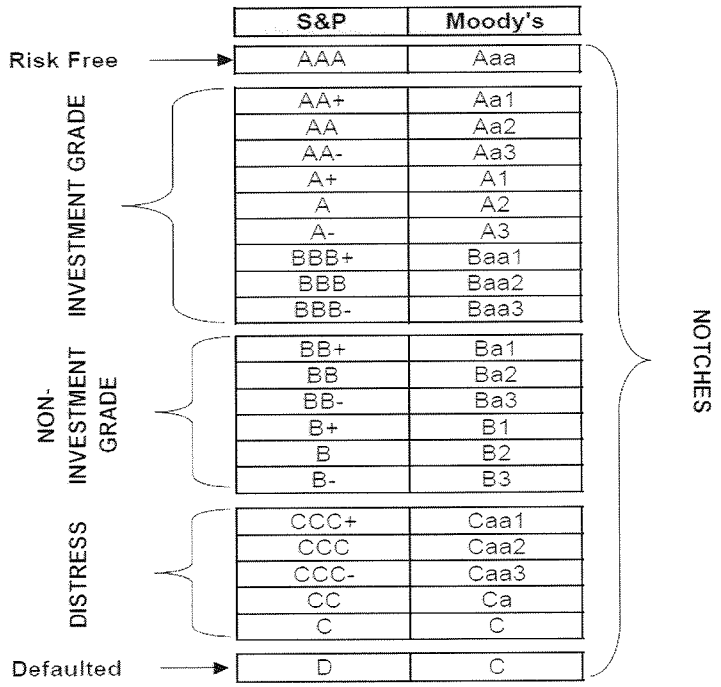
Money Terms:

- Amount
  - Face Value / Par Value ($1,000)
  - Market Value quoted as a % of Face Value (priced at 98 or 98% of $1,000)
- Coupon Payments / Coupon (Interest Rate)
  - ZERO COUPON PAYMENTS
  - Semi Annual Payments (interest payments)
  - Accrued Interest
    - Accr. Int. = (Annual Coupon /2) x (Days since last Coupon pmt / Days Separating Coupon Pmts)

Example:
Par Value = $1,000
Coupon = 4.25% therefore bond payment is $42.50 per year in $21.25 every 6 months
The Bid Price = 98:07 or 98 and 7/32 or 98.21875 % or MV = $982.19
Bought it 32 days since the last coupon.

Accrued Interest pmt on the bond = $21.25 x (32/182) = $7.47.
The purchase price = $982.19 + $7.47= $989.66 (Invoice Price)

- External Ratings



Types of Bonds:

- Treasury Bonds (10-30yr) & Notes (10 yr)
- Corporate Bonds
  - Call Provisions – Call Price / Call Protection
  - Convertible Bonds – option to convert to common stock
    - Conversion Ratio – number of shares for each bond

Example:
Bond Par Value = $1,000
Convertible ratio = 40 shares
At Current Stock = $20 per share so the option to convert is unprofitable ($20 x 40 = $800 or *Market Conversion Value*
At Current Stock = $30 per share so the option to convert is profitable ($30 x 40 = $1,200 or *Market Conversion Value*

- Conversion Premium is the excess of the bond price over its conversion value. If the bond were selling currently $950, the stock is $20 then its premium would be $150 ($950 – $800)

  - Puttable Bonds (option to the bond holders to put the bonds to the Issuer)
  - Floating-rate Bonds – T + 2.0%
  - PIK Bonds (Paid-in-Kind)

- Preferred Stock (Dividends – Waterfall ahead of the Common Stock)
- Other Domestic Bonds (Municipal, local governments, Tax exempt)
- International Bonds
  - Foreign Bonds
  - Eurobonds (Issued in the currency of one country but sold in other national market) – Eurodollar – dollar-denominated bonds sold outside the U.S.
  - Yankee Bonds (foreign bonds sold in the US)
  - Samurai Bonds (Yen-denominated bonds sold in Japan by non-Japanese issuers
  - Bulldog Bonds (British Pound-denominated foreign bonds sold in the U.K.)

Bond Pricing

Bond Value = PV of Coupons + PV of Par Value at Maturity

$$\text{Bond Value} = \Sigma \text{ (Coupon Pmt / (1 + r) ^t) + (Par Value / (1 + r) ^T}$$

Where,
Maturity Date = T – (using PV Factor tables)
Discount Rate = r
Years (t) – (using Annuity Factor tables)

Coupon * (1/r) [1 – (1 / ((1+r) ^T)]] + Par Value * (1 / ((1+r) ^T)
Or
Coupon * Annuity Factor (r, T) + Par Value * PV Factor (r, T)

Table:

Example
Par Value: $1,000
Coupon: 8.0% (4% or $40 coupon payment every six months)
Maturity: 30 years (60 payments)

Price = Σ [$40 / (1.04) ^t] + [1000 / (1.04) ^ 60]

Price = $40 x Annual Factor (4%, 60) + $1000 x PV Factor (4%, 60)

Price = $ 904.94 + 95.06 = $1,000

If the interest rates will rise to 10%

	B	C	D	E	F	G	H
2	**BOND PRICING**						
3							
4	Par/Face Value	$ 1,000.00		Semi-Annual Coupon =		4.00%	
5	Coupon % =	8.00%		Semi-Annual Payment =	$	40.00	Every 6 months
6	Maturity/Term =	30 Yrs		Semi-Annual # Payments =		60	Pmts
7							
8	Present Value of Coupon Pmts=			$904.94	*=PV(B4/2,G5,-G4)*		
9	Present Value of Principal Pmt=			$95.06	*=PV(B4/2,G5,0,-B3,0)*		
10	Total			$1,000.00			

11	11	B	C	D	E
12	Net Present Value		$904.94	$95.06	$1,000.00
13			=NPV(B4/2,C16:C75)		
14		Long-Form			
15		Period	Coupon Payment	Principal Payment	Total Payment
16		0			$ (1,000.00)
17		1	$ 40.00	$ -	$ 40.00
18		2	$ 40.00	$ -	$ 40.00
19		3	$ 40.00	$ -	$ 40.00
20		4	$ 40.00	$ -	$ 40.00
21		5	$ 40.00	$ -	$ 40.00
22		6	$ 40.00	$ -	$ 40.00
23		7	$ 40.00	$ -	$ 40.00
24		8	$ 40.00	$ -	$ 40.00
25		9	$ 40.00	$ -	$ 40.00
26		10	$ 40.00	$ -	$ 40.00
27		11	$ 40.00	$ -	$ 40.00
28		12	$ 40.00	$ -	$ 40.00
29		13	$ 40.00	$ -	$ 40.00
30		14	$ 40.00	$ -	$ 40.00
31		15	$ 40.00	$ -	$ 40.00
32		16	$ 40.00	$ -	$ 40.00
33		17	$ 40.00	$ -	$ 40.00
34		18	$ 40.00	$ -	$ 40.00
35		19	$ 40.00	$ -	$ 40.00
36		20	$ 40.00	$ -	$ 40.00
37		21	$ 40.00	$ -	$ 40.00
38		22	$ 40.00	$ -	$ 40.00
39		23	$ 40.00	$ -	$ 40.00
40		24	$ 40.00	$ -	$ 40.00
41		25	$ 40.00	$ -	$ 40.00
42		26	$ 40.00	$ -	$ 40.00
43		27	$ 40.00	$ -	$ 40.00
44		28	$ 40.00	$ -	$ 40.00
45		29	$ 40.00	$ -	$ 40.00
46		30	$ 40.00	$ -	$ 40.00
47		31	$ 40.00	$ -	$ 40.00
48		32	$ 40.00	$ -	$ 40.00
49		33	$ 40.00	$ -	$ 40.00
50		34	$ 40.00	$ -	$ 40.00
51		35	$ 40.00	$ -	$ 40.00
52		36	$ 40.00	$ -	$ 40.00
53		37	$ 40.00	$ -	$ 40.00
54		38	$ 40.00	$ -	$ 40.00
55		39	$ 40.00	$ -	$ 40.00
56		40	$ 40.00	$ -	$ 40.00
57		41	$ 40.00	$ -	$ 40.00
58		42	$ 40.00	$ -	$ 40.00
59		43	$ 40.00	$ -	$ 40.00
60		44	$ 40.00	$ -	$ 40.00
61		45	$ 40.00	$ -	$ 40.00
62		46	$ 40.00	$ -	$ 40.00
63		47	$ 40.00	$ -	$ 40.00
64		48	$ 40.00	$ -	$ 40.00
65		49	$ 40.00	$ -	$ 40.00
66		50	$ 40.00	$ -	$ 40.00
67		51	$ 40.00	$ -	$ 40.00
68		52	$ 40.00	$ -	$ 40.00
69		53	$ 40.00	$ -	$ 40.00
70		54	$ 40.00	$ -	$ 40.00
71		55	$ 40.00	$ -	$ 40.00
72		56	$ 40.00	$ -	$ 40.00
73		57	$ 40.00	$ -	$ 40.00
74		58	$ 40.00	$ -	$ 40.00
75		59	$ 40.00	$ -	$ 40.00
76		60	$ 40.00	$ 1,000.00	$ 1,040.00
77		IRR =			4.00%

Valuing the Bonds

	K	L	M	N	O	P
1						
2	**VALUING BONDS**					
3						
4	Settlement Date=		1/15/2007			
5	Maturity Date=		1/15/2011			
6	Coupon Rate=		4.250%			
7	Yield to Maturity=		4.740%			
8	Redemption value %=		100			
9	Coupon Pmts per year=		2			
10						
11	Flat Price (% Par)		98.234	=PRICE(M4,M5,M6,M7,M8,M9)		
12	Day since last coupon=		0	=COUPDAYBS(M4,M5,2,1)		
13	Days in coupon period=		181	=COUPDAYS(M4,M5,2,1)		
14	Accrued Interest=		0	=(M12/M13)*M6*100/2		
15	Invoice Price=		98.234	=+M11+M14		
16						
17						
18	Settlement Date=		**2/15/2007**			
19	Maturity Date=		1/15/2011			
20	Coupon Rate=		4.250%			
21	Yield to Maturity=		4.740%			
22	Redemption value %=		100			
23	Coupon Pmts per year=		2			
24						
25	Flat Price (% Par)		98.264			
26	Day since last coupon=		**31**			
27	Days in coupon period=		181			
28	Accrued Interest=		0.36395028			
29	Invoice Price=		98.628			
30						

Yield to Maturity

YIELD TO MATURITY

Settlement Date=	1/1/2000
Maturity Date=	1/1/2010
Coupon Rate=	8.000%
Bond Pricing=	110
Redemption Value=	100
Coupon pmts per yr=	2
Yield to Maturity=	6.617%

=*YIELD(D84,D85,D86,D87,D88,D89)*

Long-Form

Period	Coupon Payment	Principal Payment	Total Payment	
0			$ (1,100.00)	
1	$ 40.00	$ -	$ 40.00	
2	$ 40.00	$ -	$ 40.00	
3	$ 40.00	$ -	$ 40.00	
4	$ 40.00	$ -	$ 40.00	
5	$ 40.00	$ -	$ 40.00	
6	$ 40.00	$ -	$ 40.00	
7	$ 40.00	$ -	$ 40.00	
8	$ 40.00	$ -	$ 40.00	
9	$ 40.00	$ -	$ 40.00	
10	$ 40.00	$ -	$ 40.00	
11	$ 40.00	$ -	$ 40.00	
12	$ 40.00	$ -	$ 40.00	
13	$ 40.00	$ -	$ 40.00	
14	$ 40.00	$ -	$ 40.00	
15	$ 40.00	$ -	$ 40.00	
16	$ 40.00	$ -	$ 40.00	
17	$ 40.00	$ -	$ 40.00	
18	$ 40.00	$ -	$ 40.00	
19	$ 40.00	$ -	$ 40.00	
20	$ 40.00	$ 1,000.00	$ 1,040.00	
IRR =			3.3085%	6.617%

	K	L	M	N	O	P	Q
81							
82	**YIELD TO CALL Vs YIELD TO MATURITY**						
83							
84			**YTC**			**YTM**	
85	Settlement Date=		1/1/2000			1/1/2000	
86	Maturity Date=		1/1/2010			1/1/2030	
87	Coupon Rate=		8.00%			8.00%	
88	Coupon Pmt =		$ 40.00			$ 40.00	
89	Number of semiannual		20	periods		60	periods
90	Call Provision		110.00			100.00	
91	Final Payment		100.00			100.00	
92	Price		115.00			115.00	
93							
94	YIELD =		6.6434%			6.8192%	
95							
96			=YIELD(M85,M86,M87,M92,M91,2)				
97							

Bond Portfolio (Chapter 11)

Interest Rate Sensitivity – Calculating Duration and Convexity

$$D_{Mac} = \frac{\sum_{t=1}^{N} \frac{CF_t}{(1+i)^t} t}{V_B}$$

$$C = \frac{\frac{1}{(1+i)^2}\left[\sum_{t=1}^{N} \frac{CF_t}{(1+i)^t}\left(t^2+t\right)\right]}{V_B}$$

Duration: is a measure of the sensitivity of the asset's price to interest rate movements. It broadly corresponds to the length of time before the asset is due to be repaid. This **duration** is equal to the ratio of the percentage reduction in the bond's price to the percentage increase in the redemption yield of the bond (or vice versa) (Lambda)

The standard definition of duration is Macaulay duration, the PV-weighted time to receive each cash flow, defined as:

Weighted Average Wt = [cf / (1 +y) ^t] / Bond Price

Y = yield to maturity
T=time

$D = \Sigma\ t * Wt$

Duration

Int.Rate = 10%

8% coupon bond

Time until Payments	Payment	PV of Pmt DR = 10%	% Weight	P x 0 Duration
1	**80**	**72.727**	7.65%	0.0765
2	80	**66.116**	6.96%	0.1392
3	1080	**811.420**	85.39%	2.5617
		950.263	100.00%	2.7774

Duration

Zero Bond will be 3 years

Duration is a key concept in bond portfolio management for at least 3 reasons:

1. It's a simple summary measure of the effective average maturity of the portfolio
2. It turns out to be an essential tool in immunizing portfolios from interest rate risk.
3. Duration is the measurement of the interest rate sensitivity of a bond portfolio.

Convexity

Convexity is a measure of the sensitivity of the duration of a bond to changes in interest rates. There is an inverse relationship between convexity and sensitivity - in general, the

higher the convexity, the less sensitive the bond price is to interest rate shifts, the lower the convexity, the more sensitive it is.

Duration is a linear measure or 1st derivative of how the price of a bond changes in response to interest rate changes. As interest rates change, the price is not likely to change linearly, but instead it would change over some curved function of interest rates. The more curved the price function of the bond is, the more inaccurate duration is as a measure of the interest rate sensitivity.

Convexity is a measure of the curvature or 2nd derivative of how the price of a bond varies with interest rate, i.e. how the duration of a bond changes as the interest rate changes.

$$\Delta P / P = - D \times \Delta y$$

MACAULAY DURATION AND CONVEXITY

Sensitivity to interest rate movements

IRR= 10.0000%

=PV(M108/M109,M107*M109,M106*M105/M109,M105)

Bond Price	$875.38		If Yield Changes By	1.00%	
Face Value	1,000		Bond Price Will Change By	-54.63	-6.24% =+R105/M104
Coupon Rate	8.00%				=(M104+PV((M108+R104)/M109,M107*M109,M106*M105/M109,M1
Life in Years	10		Modified Duration Predicts	-57.03	=(-M112*R104*M104)
Yield	10.00%		Convexity Adjustment	2.47	=0.5*M113*R104^2*M104
Frequency	2		Total Predicted Change	-54.56	=+R107+R108
Macaulay Duration	6.84	=+P137/M104/M109	Actual New Price	$820.74	=-PV((M108+Q104)/M109,M107*M109,M106*M105/M109,M105)
Modified Duration	6.51	=+M111/(1+M108/M109)	Predicted New Price	$820.82	=+M104+R109
Convexity	56.49	=+S137/M104/M109^M109	Difference	$0.08	=+R112-R111

Period	Cash Flow	PV Cash Flow	Weighted	Duration Calc Method 1	Duration Calc Method 2	PV of pv(CF)	Factor years	Convexity Calc
0	($875.38)							
1	40.00	38.10	4.352%	0.04352	38.10	34.554	2.000	69.11
2	40.00	36.28	4.145%	0.08289	72.56	32.908	6.000	197.45
3	40.00	34.55	3.947%	0.11842	103.66	31.341	12.000	376.09
4	40.00	32.91	3.759%	0.15037	131.63	29.849	20.000	596.97
5	40.00	31.34	3.580%	0.17901	156.71	28.427	30.000	852.82
6	40.00	29.85	3.410%	0.20459	179.09	27.074	42.000	1,137.09
7	40.00	28.43	3.247%	0.22732	198.99	25.784	56.000	1,443.92
8	40.00	27.07	3.093%	0.24742	216.59	24.557	72.000	1,768.07
9	40.00	25.78	2.946%	0.26510	232.06	23.387	90.000	2,104.85
10	40.00	24.56	2.805%	0.28052	245.57	22.273	110.000	2,450.08
11	40.00	23.39	2.672%	0.29388	257.26	21.213	132.000	2,800.10
12	40.00	22.27	2.544%	0.30533	267.28	20.203	156.000	3,151.62
13	40.00	21.21	2.423%	0.31503	275.77	19.241	182.000	3,501.80
14	40.00	20.20	2.308%	0.32310	282.84	18.324	210.000	3,848.14
15	40.00	19.24	2.198%	0.32970	288.61	17.452	240.000	4,188.45
16	40.00	18.32	2.093%	0.33493	293.19	16.621	272.000	4,520.86
17	40.00	17.45	1.994%	0.33892	296.68	15.829	306.000	4,843.78
18	40.00	16.62	1.899%	0.34177	299.17	15.076	342.000	5,155.85
19	40.00	15.83	1.808%	0.34357	300.76	14.358	380.000	5,455.92
20	1,040.00	391.97	44.777%	8.95533	7,839.30	355.524	420.000	149,320.02
	Total	875.38	100%	13.68074	11,975.81	793.99866		197,783.01
	PRICE		DURATION	6.84037			CONVEXITY	56.49

Bond Terminology

Accrued Interest

Accrued interest is the interest that has been earned, but not yet been paid by the bond issuer, since the last coupon payment. Note that interest accrues equally on every day during the period. That is, it does not compound. So, halfway through the period, you will have accrued exactly one-half of the period's interest payment. It works the same way for any other fraction of a payment period.

Banker's Year

A banker's year is 12 months, each of which contains 30 days. Therefore, there are 360 (not 365) days in a banker's year. This is a convention that goes back to the days when "calculator" and "computer" were job descriptions instead of electronic devices. Using 360 days for a year made calculations easier to do. This convention is still used today in some calculations such as the Bank Discount Rate that is used for discount (money market) securities.

Bond

A bond is a debt instrument, usually tradable, that represents a debt owed by the issuer to the owner of the bond. Most commonly, bonds are promises to pay a fixed rate of interest for a number of years, and then to repay the principal on the maturity date. In the U.S. bonds typically pay interest every six months (semi-annually), though other payment frequencies are possible. Bonds are issued by corporations, banks, state and local governments (municipal bonds), and the federal government (Treasury Notes and Bonds).

Call Date

Some bonds have a provision in the indenture that allows for early, forced, redemption of the bond, often at a premium to its face value. Bonds that have such a feature usually have a series of such dates (typically once per year) at which they can be called. This series of dates is referred to as the call schedule.

Call Premium

The extra amount that is paid by a bond issuer if the bond is called before the maturity date. This is a sweetener that is used to make callable bonds attractive to investors, who would otherwise prefer to own non-callable bonds.

Clean Price

The "clean price" is the price of the bond excluding the accrued interest. This is also known as the quoted price.

Coupon Payment

This is the actual dollar amount that is paid by the issuer to the bondholders at each coupon date. It is calculated by multiplying the coupon rate by the face value of the bond and then dividing by the number of payments per year.