**Lecture 16: Fixed Income Markets.**

I. Reading.
   A. BKM, Chapter 2, Sections 2.1 and 2.2.
   B. BKM, Chapter 14, Sections 14.1-14.4.

II. Money Market.
   A. Definition.
      1. Money market instruments are those with maturities of one year or less.
   B. U.S. Treasury Bills.
      1. Introduction.
         a. These are obligations backed by the "full faith and credit" of the U.S. government. Among all money market instruments, T-bills are regarded as safest with respect to default risk.
         b. T-bills (and most money-market instruments) are discount instruments. They do not explicitly pay an interest rate. Instead they are sold below their par (face) value.
      2. Maturities.
         a. Issued weekly with maturities of 91 or 182 days.
         b. Issued monthly with a maturity of 12 months.

3. Bank Discount Rate.
   a. T-bills are quoted on a 360-day discount basis using the bank discount rate.
   b. The (bank) discount rate is defined:

$$Price = Par\left(1 - \frac{nr_{BD}}{360}\right) \Rightarrow r_{BD} = \frac{360}{n}\,\frac{Par - Price}{Par}$$

   where $r_{BD}$ is the quoted discount rate and n is the number of days from settlement to maturity. (A 360-day year is commonly used in pricing money market instruments.)
   c. The word "discount" is used in many different contexts in finance. It is sometimes used to denote any interest rate used in a present value calculation, as in "the cash flow in year ten was discounted at a rate of 5%." In money market analysis, however, it is used very precisely as the interest rate used to compute the price (as above).
   d. Example: See WSJ clipping 3/24/97 for Treasury Bills.

| *Maturity* | *Days to Mat.* | *Bid* | *Asked* | *Chg* | *Ask Yld.* |
|---|---|---|---|---|---|
| Apr 24 '97 | 31 | 5.27 | 5.23 | +0.07 | 5.33 |

Buying at the ask bank discount rate of 5.23% on Friday 3/21/97 the trade settles on 3/25/97. Hence 31 days to maturity. The price paid (for $100 face value) is $100 (1 - {31x0.0523/360}) = $99.550.

4. Holding period return.
   a. The holding period return from holding a T-bill until maturity is given by:

$$R_{hold}(0,n) = \frac{Par - Price}{Price}.$$

   b. Example (cont):Apr 24 '97 T-bill, if purchased on 3/21/97, offers a 31 day holding period return of {$100-$99.550}/$99.550 = 0.45240%.

5. Bond-equivalent yield.
   a. The bond equivalent yield for n<183 (if not a leap year) can be calculated as follows:

$$r_{BEY} = \frac{365}{n} R_{hold}(0,n).$$

   b. Since there are 365 days in a year, the bond equivalent can be thought of as an annual percentage rate (APR) with n-day compounding.
   c. The quoted "Ask Yield" in the WSJ is the bond equivalent yield.
   d. Example (cont): The bond equivalent yield for the Apr 24 '97 T-bill purchased on 3/21/97 is (365/31)x0.45240% = 5.327% which agrees with the WSJ quote of 5.33%.

6. Primary Market.
   a. T-bills are initially sold at an auction.
   b. Two sorts of bids are accepted.
      (1) A competitive bid specifies an amount and a price.
      (2) A non-competitive bid may be entered for an amount up to $1 million. No price is specified. A non-competitive bid is the easiest way for a retail investor to buy T-bills.
   c. The Fed arranges the competitive bids in order of descending price (ascending yield). It then works its way down this list until the total amount bid for (plus the non-competitive interest) is equal to the amount it wishes to sell.
   d. Pre 11/2/98:
      (1) If a competitive bid is accepted, purchase is made at the specified price.
      (2) Non-competitive bids are filled at the average price of the successful competitive bids.
      (3) The auction is not single-price.
         (a) Competitive bids get the price that is bid.
         (b) Noncompetitive bids receive an average price.
      (4) In economic terms, the Treasury "price discriminates."
   e. Post 11/2/98:
      (1) All successful bids, both competitive and non-competitive, are filled at the lowest competitive bid price that is filled.
      (2) The auction is single-price.
         (a) All successful bidders pay the same price.
      (3) The Treasury no longer price discriminates.
7. When-issued-market.
   a. This market trades instruments which obligate the delivery of T-bills not yet issued at a predetermined price at their time of issue.
   b. So investors can lock in a particular price prior to the auction date.
   c. This instrument is an example of a forward contract on the T-bill.
8. Secondary Market.
   a. This is a telephone dealer network. Some quotes are communicated via screens, but there is no centralized trade reporting.
   b. The Fed has designated some dealers as primary dealers. These are the dealers that the Fed itself uses when conducting open market operations.
   c. Spreads on T-bills are narrow.

C. Other Money Market Instruments.
   1. Commercial Paper.
      a. Short-term corporate debt (usually less than one or two months).
      b. Issued in multiples of $100,000.
      c. Most issued by finance companies.
         (1) Captive finance companies (GMAC, Ford Credit, Chrysler Financial, General Electric Credit).
         (2) Bank (and bank-related) finance companies.
         (3) Independent finance companies.
      d. Comparison with T-bills.
         (1) less liquid.
         (2) more credit risk.
         (3) subject to state & local taxation.
   2. Certificates of Deposit (CD's).
      a. CDS are issued by banks.
      b. Types.
         (1) Domestic CD's.
         (2) Eurodollar CD's ($ denominated CDS issued by banks outside of U.S.).
         (3) Yankee CD's ($ denominated CDS issued by foreign banks with offices in U.S.).
      c. Large denomination ($100000 or larger).
      d. Negotiable/non-negotiable.
   3. Federal Reserve Bank reserves.
      a. In the federal funds market, member banks of the Federal Reserve System with excess reserves lend to those with a shortage.
      b. These loans which are usually overnight are arranged at a rate of interest called the federal funds rate.
   4. London Interbank Offered Rate (LIBOR) Rate.
      a. Rate on dollar-denominated deposits at large London Banks.
      b. Used as a reference rate for floating rate loans and in the swap market.

D. Repurchase Agreements (Repos).

1. Basic arrangement.

a. Repos are loans collateralized by securities.

| | | | |
|---|---|---|---|
| Initiation: | lender | → ($)<br>(securities) ← | borrower |
| To settle: | lender | ←($)<br>(securities) → | borrower |

2. Terminology.

a. Dealer is the borrower (and so client is the lender):
   (1) "repo".
   (2) "reversing out".
   (3) "selling collateral".

b. Dealer is the lender (and so client is the borrower):
   (1) "reverse repo".
   (2) "reversing in"
   (3) "buying collateral"

c. Explains why Repo rate is less than Reverse Repo rate on Bloomberg.

3. Using Repos to sell short.

a. The lender of $ can also be viewed as a borrower of securities (which will be returned when the loan is repaid).

b. Thus, the lender could then "sell short" the security using the borrowed securities.

c. The dealer uses a reverse repo to sell short the security.

d. The client uses a repo to sell short the security.

4. Instruments.

a. Historically, the repo market developed for U.S. government securities.

b. Now you can repo practically any kind of fixed income instrument, across currencies.

c. You can also repo risky securities such as emerging market debt.

III. Long Term Credit Markets.

A. U.S. Treasury Notes and Bonds.

1. Introduction.

a. The distinction between notes and bonds is one of original maturity: notes have an original maturity of 1-10 years; bonds have a maturity>10 years.

b. A plain-vanilla bond is characterized by:

(1) Maturity: when the bond will be repaid.

(2) Par or face value: the amount that will be repaid at maturity.

(3) Coupon rate: the rate used in computing the semiannual coupon payments (0.5 x coupon rate x par value gives the semiannual coupon).

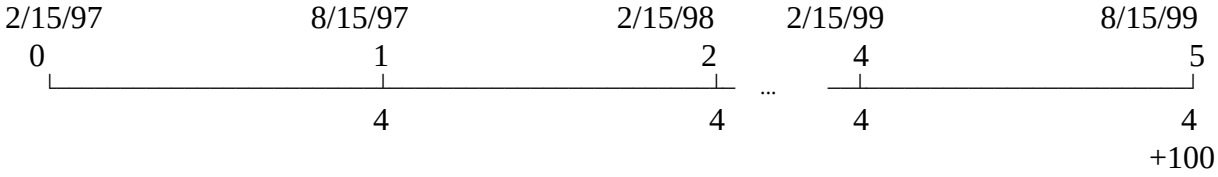
(4) Coupons are either paid on the 15th or at the end of the month.

(5) The quoted prices are on the basis of $100 par, in dollars + 1/32nds.

c. Example: See WSJ clipping for Govt Bonds and Notes on 2/18/97.

| *Rate* | *Maturity Mo/Yr* | *Bid* | *Asked* | *Chg* | *Ask Yld.* |
|---|---|---|---|---|---|
| 8 | Aug 99n | 104:28 | 104:30 | -1 | 5.84 |

(1) The time line for this bond:




(2) Coupons for this note are paid on the 15th of the month.

(3) The asked price is 104+30/32=104.9375.

2. Accrued Interest and the Quoted Price.
   a. The quoted prices does not include accrued interest; so the quoted price is not the invoice price *unless* a coupon has just been paid.
   b. To get the invoice price from the quoted price, need to add accrued interest.
   c. Example (cont): The quoted asked price for the Aug 99 note in the WSJ for 2/28/97 is 104.125. What would be the accrued interest on the Aug 99 note and the invoice price?
      (1) Accrued interest is given by

$$w(2/28/97)\ C/2 = (13/181) \times 4 = 0.0718 \times 4 = 0.2873$$

where

C is the coupon rate; and,
w(2/28/97) is the period between the last coupon payment and now expressed as a fraction of 6 months (called the accrual period).

      (2) The quoted WSJ ask price for 2/28/97 of 104.125 can be converted into the invoice price by adding the accrued interest of 0.2873 to obtain 104.4123.

3. Yield to maturity (YTM).
   a. Definition.
      (1) YTM is the interest rate such that the present value of the remaining cash flows from the note/bond exactly equals the invoice price.
      (2) The "Ask Yld" in the WSJ is the YTM expressed as an APR with semiannual compounding.
   b. Calculation.
      (1) Suppose the bond has just paid a coupon. Then the YTM expressed as an APR with semi-annual compounding satisfies:

$$V_0 = C \times PVAF_{YTM/2,N} + 100 \times PVIF_{YTM/2,N}$$

where N is the number of coupon payments to maturity and $V_0$ is the invoice price today.

      (2) If the bond has not just paid a coupon, the calculation is more complicated.
   c. Example (cont): On 2/18/97, Aug 99 note has just paid a coupon. Thus, can use the formula to get the invoice price which will also equal the quoted price:

$$V_0 = 4 \times PVAF_{(5.84/2)\%,5} + 100 \times PVIF_{(5.84/2)\%,5} = 18.361 + 86.597 = 104.958 \approx 104{:}30.$$

4. Relation of YTM to Coupon Rate: the Impact on Bond Price.
   a. YTM is expressed as an APR with semi-annual compounding.
   b. If the bond has just paid a coupon:
      (1) YTM>Coupon Rate then Price<Par; i.e, the bond is selling at a discount relative to par.
      (2) YTM<Coupon Rate then Price>Par; i.e., the bond is selling at a premium relative to par.
   c. Example: See WSJ clipping for Govt Bonds and Notes on 2/18/97.

| *Rate* | *Maturity Mo/Yr* | *Bid* | *Asked* | *Chg* | *Ask Yld.* |
|---|---|---|---|---|---|
| 5f | Feb 00n | 99:28 | 99:29 | -1 | 5.91 |
| 8½ | Feb 00n | 106:29 | 106:31 | -2 | 5.92 |

      (1) For 5f Feb 00 note, YTM>Coupon Rate and so price<par.
      (2) For 8½ Feb 00 note, YTM<Coupon Rate and so price>par.

B. Call Provisions.

1. Definition: An issuer 'calls' a bond by repaying the par early and canceling the debt.
2. When will the issuer call the bond?
   a. When interest rates (at the time of the call) are lower than the coupon rate on the bond; i.e., when the price of the bond uncalled is greater than the call price (par value).
   b. The issuer can refinance at a lower interest rate.
3. Call provisions are commonly included in both government and corporate bonds. They must be explicitly noted in the prospectus at the time the bond is issued.
   a. Example: WSJ for 2/18/97:

| *Rate* | *Maturity Mo/Yr* | *Bid* | *Asked* | *Chg* | *Ask Yld.* |
|---|---|---|---|---|---|
| 7 e | Feb 02-07 | 105:14 | 105:16 | -23 | 6.32 |

   (1) The second date, Feb, 2007 is when the bond matures.
   (2) The first date, Feb, 2002 is the first allowable call date by the Treasury.
4. Yield calculations.
   a. The usual YTM assumes that the bond will be held to maturity.
   b. This may not be possible for a callable bond, so the yield to maturity may be the yield to call.
   c. If the bond is selling at a premium relative to par:
      (1) issuer is likely to call the bond.
      (2) use yield to call.
   d. If the bond is selling at a discount relative to par:
      (1) issuer is not likely to call the bond.
      (2) use yield to maturity.
   e. Example (cont): WSJ for 2/18/97. The Feb 02-07 bond has a price > par. So Treasury is likely to call the bond. So YTM is calculated assuming the bond is called on 2/02; so N=10.

$V_0 = (0.5 \times 7\,e) \times PVAF_{(6.32/2)\%,10} + 100 \times PVIF_{(6.32/2)\%,10} = 32.257 + 73.263 = 105.520 \approx 105{:}16.$

C. Zero Coupon Bonds.

1. Definition.
   a. "Zeroes" are bonds which have no intermediate payments, and repay the principal amount at maturity.
   b. In this respect, they are the same as T-bills, except that they are for longer maturities.
2. Creation of Zero Coupon Bonds.
   a. Zero coupon bonds are created by `stripping' coupon issues: STRIPS (Separate Trading of Registered Interest and Principal Securities).
   b. Prior to 1982, zero coupon bonds were created by investment banks. A bank would buy coupon bonds, place them in a trust and sell off zero-coupon bonds as claims on the trust.
   c. In 1982, the U.S. Treasury got into the act by allowing ownership of interest and principal payments to be registered separately. They can then be traded and priced separately.
   d. Example: WSJ for 2/18/97 reports quotes for Aug 99 principal and for Aug 02 coupon strip separately.
3. A coupon bond can be regarded as a portfolio of zero-coupon bonds, each maturing at a different payment date. This observation is sometimes useful in solving bond pricing problems.

D. Corporate Bonds.

1. Example: Consider the Bloomberg listings for ADM.

a. CV: convertible.

(1) A convertible bond is convertible into a number of shares of common stock. The number is fixed at the time the bond is issued. The conversion is "one-way": you can convert to stock, but not back to a bond.

(2) The timing of the conversion is the decision of the bondholder. BUT, the issuer can sometimes force conversion by threatening to call back the bond.

(3) A convertible bond is a hybrid security. It is part debt and part equity. A conversion feature is attractive, so a convertible bond can generally be issued with a lower coupon rate than straight debt.

b. RTNG: rating.

c. TYPE: Ind is for Industrial.

d. F: frequency of coupon payment.

e. CURR: denomination of bond.

f. C: callable.

(1) A callable bond is one that the issuer can repurchase at a specified price.

(2) As discussed above, the issuer may want to do this if interest rates are low since it allows the issuer to buy back a bond that otherwise would have a high price.

g. SF: sinking fund.

(1) A sinking fund is a provision for the orderly retirement of the debt. It may take one of several forms.

(a) Firm must repurchase bonds in the open market.

(b) Firm repurchases bonds with call provisions.

(2) Note that the repurchase is an obligation. Some investors have been known to attempt to "corner the market" (i.e., buy up all of) a bond issue in order to force up the repurchase price.

E. Interest Rate Swaps.

1. Basic arrangement.
   a. An agreement between the buyer and seller of the swap.
   b. The buyer agrees to pay a fixed rate on the notional principal until maturity of the swap.
   c. The seller agrees to pay a floating rate (often determined by the LIBOR rate) on the notional principal until maturity.
   d. No money changes hands at the time that the swap is entered into: so the notional principal never changes hands.
   e. The fixed rate is referred to as the swap rate.

| | | |
|---|---|---|
| Fixed-rate Payer | fixed rate → | Floating-rate Payer |
| (bought the swap) | ← floating rate | (sold the swap) |

2. Example
   a. Terms of the Swap
      (1) Fixed-rate Payer: Company A (an S&L) agrees to pay company B 10% per year (semi-annual payments) for 5 years.
      (2) Floating-rate Payer: Company B (a hedge fund) agrees to pay company A at the prevailing six-month LIBOR rate for 5 years.
      (3) Notional Principal: $50 million.
   b. Note
      (1) Payments are scheduled for every 6 months.
      (2) The current level of LIBOR determines the floating rate payment in 6 months.
      (3) The floating rate is reset every 6 months.
   c. Schedule of Obligations
      (1) Suppose 6-month LIBOR:
         (a) equals 7% on the day that the swap is entered into.
         (b) will equal y% six months after the swap is entered into.
      (2) In 6 months:
         (a) A pays B $2.5 M = (0.5 x 10)% x $50M.
         (b) B pays A $1.75M = (0.5 x 7)% x $50M.
      (3) In 12 months
         (a) A pays B $2.5 M = (0.5 x 10)% x $50M.
         (b) B pays A (0.5 y)% x $50M.

3. Valuation
    a. At the time the swap is entered into, the fixed rate is set such that the current value of the stream of fixed payments exactly equals the current value of the floating rate payments.
    b. So at the time the swap is entered into, the value of the swap is zero for both the buyer and the seller.
    c. This explains why no money changes hands at the time the swap is entered into.
    d. But if interest rates go up, the value of the fixed-rate payer's swap position goes up, and the value of the floating-rate payers swap position goes down.
    e. Similarly if interest rates go down, the value of the fixed-rate payer's swap position goes down, and the value of the floating-rate payers swap position goes up.
4. Credit Risk
    a. The difference between the fixed and the floating changes hands each period.
    b. Consequently, credit risk is low. If your counterparty defaults, you lose the difference between her payments and your payments and not her entire payments.