The U.S. Treasury Market

Lecture Notes # 1

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1 The U.S. Treasury bond market: general features

- Risk-free securities: free of default risk.
- Volume and liquidity: large stock of debt outstanding (four trillion), limited number of instruments (approx. 150 different issues) \( \Rightarrow \) small bid-ask spreads.
- The U.S Treasury market consists of two main markets:
  1. Primary market, where securities are first sold through an auction;
  2. Secondary market, where securities are traded after they have been issued.

2 Bills

- Treasury bills: no payment until maturity, are sold at discount from maturity value.
- Maturities: 1 month (4 weeks), 3 months (13 weeks), 6 months (26 weeks), 12 months (52 weeks).
- Smallest denomination: $1,000.
- 13, 26 weeks: auctioned weekly, every Monday.
  52 weeks: auctioned once or twice a month (every four weeks).
- 13, 26 weeks: amounts to be auctioned are announced the previous Tuesday.

3 Notes and bonds

- Coupon payments every six months.
  On maturity date: payment of last coupon and maturity value.
- \( 2 \) years \( \leq \) maturity \( \leq \) 10 years \( \Rightarrow \) notes.
  Smallest denomination: $1,000.
- Maturity > 10 years \( \Rightarrow \) bonds.
  Smallest denomination: $1,000.
- Coupons are paid semiannually.
• T-bills and notes and bonds issued after 1983 are in the form of “book entries;” they only exist in the form of a record on a computer.

• Since February 1985 callable bonds are no longer issued.

• Interest income is subject to federal income taxes, but not state or local taxes.

• Auction cycles:
  2 year notes are auctioned every month, and settle on the 15th.
  5 year notes are auctioned quarterly: February, May, August, and November, and settle at the end of the month.
  10 year notes are auctioned quarterly: February, May, August, and November, and settle on the 15th of the month.
  30 year bonds were auctioned semi-annually: February and August, and settle on the 15th of the month. These are not issued anymore, a few issues still outstanding.

• Auction announcement one week in advance; issue date 1-5 days after the auction.

4 Stripped Treasury securities

• 1982: Merrill Lynch \(\rightarrow\) Treasury Income Growth Receipts (TIGRS)
  Salomon Brothers \(\rightarrow\) Certificates of Accrual on Treasury Securities (CATS)
  Lehman \(\rightarrow\) LIONS etc.

• Create a bank custody account which would receive coupon payments and principal payments, which, in turn, would be separately transmitted to the owners of the stripped securities \(\rightarrow\) zero-coupon bonds were created from coupon bonds.

• 1985: Treasury \(\rightarrow\) Separate Trading of Registered Interest and Principal of Treasury Securities (STRIPS).
  Under this program the principal and semiannual coupon payments of eligible Treasury notes and bonds are assigned separate CUSIP numbers.

• All newly-issued 5-year and 10-year Treasury securities are eligible for the STRIPS program.
• To initiate a STRIPS request, an institution holding an eligible Treasury security sends a Fedwire message to the Federal Reserve Bank of New York. The current fee is $25 per transaction. The request is processed within the same or the next day, depending on the time it is submitted. The creation of STRIPS does not require any trading.

Since May 1, 1987, the Treasury extended the STRIPS program to allow for previously-stripped notes and bonds to be reconstituted. The fee for a reconstitution is also $25.

• STRIPS do not trade in the primary market (Treasury auctions), but trade in the secondary market.

5 Auctions

• Average of $10 billion to $12 billion of new issues each week.

• Non-competitive tenders: amount only.

  Limit: $1 million par value, bills.
  Limit: $5 million par value, notes and bonds.

  Reasons for not submitting non-competitive tenders: limit, no control on prices.

• Competitive tenders: amount and yield

  Maximum bid at single yield: 35% of offering.
  Maximum award: 35% of offering.

• Steps in the auction:
  i) Subtract non-competitive tenders from total.
  ii) Allocate remaining amount to competitive tenders, from lowest yield to highest (“stop” yield).
  iii) All tenders receive the stop yield: dutch, uniform, or single-price auction.

• Equilibrium in a dutch auction system:

  If I know that my competitors are bidding high, I have an incentive to bid low to reduce the price. Risk: quantity rationing.
  If I know that my competitors are bidding low, I have an incentive to bid high to ensure a successful bid. Risk: high price.
Example 1 Suppose the Federal Reserve auctions $100 million of 90-day bills.

The competitive bids are:

A: $30 million at 3.4%
B: $20 million at 3.5%
C: $35 million at 3.6%

Noncompetitive offers total $30 million.

From the competitive bidders, the Fed will take $100 − 30m = $70m.

Every bidder receives the stop yield: 3.6%.

Bidder A gets 30; B gets 20; C gets 20.

6 Secondary market

• The secondary market for Treasuries is very large.

Daily volume of transactions reported by major dealers averages about $100 billion

The price differential between the bid and the ask is very narrow ($.05 on a $100 actively traded instrument; by contrast, the spread in equity markets is typically $.50 on a $100 share).

• Three main types of participants in the market:

i) Primary dealers: large and sound dealers that the Fed recognizes as potential trading partners; they have a direct link to the Open Market Trading Desk of the Federal Reserve. Primary dealers trade (anonymously) with each other through a network of brokers in the inside market. Currently there are about 40 primary dealers.

ii) Secondary dealers: about 300 secondary dealers which purchase securities from the primary dealers and sell them to the public.

iii) Brokers: they collect quotes from primary dealers and provide them to other primary dealers. Four or five brokers (RMJ Securities Corp., Cantor Fitzgerald Securities Corp., and Garban Ltd.) run most of the business.
7 Treasury-bill quotes

- T-bills are quoted on a 360-day discount basis. We define the bank-discount rate as

\[ \text{BDR} \equiv \frac{D}{M} \times \frac{360}{t}, \]

where \( t \) is the number of days from settlement to maturity, and \( D \) is the discount from par, \( D = M - P \), \( M \) being the par or maturity value, and \( P \) being the price. Hence the discount from par is given by

\[ D = \text{BDR} \times M \times \frac{t}{360}, \]

while

\[ P = M - D. \]

**Example 2** The WSJ on Monday, Feb 7, 1994 gives the ask quote on the May 05, '94 T-bill as 3.21%. (If we were to buy the bill, we would buy at the ask). The quote is for Friday, February 4. The market convention used in the WSJ is that two days are needed for settlement; under this convention settlement would take place on Tuesday, Feb 8. There are 86 days between Feb 8 and May 5. The discount on a $10,000 par bill is

\[ D = 3.21\% \times 10,000 \times \frac{86}{360} = 76.68, \]

and the price is

\[ P = 10,000 - 76.68 = 9,923.32. \]

Conversely, assume the price of the T-bill were $9,900. The discount amounts to

\[ D = 10,000 - 9,900 = 100, \]

and the bank-discount rate equals

\[ \text{BDR} \equiv \frac{100}{10,000} \times \frac{360}{86} = 4.19\%. \]
8 Treasury-bond quotes

- In the following, we consider pricing conventions for notes and bonds.

**Example 3** Consider a $4\frac{3}{8}$, maturing 8/15/96, issued 8/15/93 (3-year note, on the February-August cycle). For $100,000$ face value, it pays a semi-annual coupon $C$ of

$$C = \frac{100,000 \times 4\frac{3}{8}\%}{2} = 2,187.5$$

every six months.

The price is $99 : 15 = 99 \frac{15}{32}$ for 100 face value for settlement 2/15/94.

For 100,000 face value, its price (average of bid and ask) is

$$P = 100,000 \times 99 \frac{15}{32} = 99,468.75.$$

9 Yield to maturity

- **Yield to maturity**: internal rate of return of the investment in the bond.

- For a zero-coupon bond, the yield to maturity is simply:

$$P = \frac{M}{(1 + y)^n}$$

- For a coupon bond we have

$$P = \frac{C}{(1 + y)} + \frac{C}{(1 + y)^2} + \frac{C}{(1 + y)^3} + \ldots + \frac{C}{(1 + y)^n} + \frac{M}{(1 + y)^n},$$

which we can rewrite as

$$P = \sum_{t=1}^{n} \frac{C}{(1 + y)^t} + \frac{M}{(1 + y)^n}.$$

The annualized rate

$$2 \times y$$

is the bond equivalent yield.

**Example 4** Consider a $4\frac{5}{8}$ coupon bond, maturing in two years, with quoted price 100:12 (settlement 2/15/94). Assuming $M = 100,000$, we have $P = 100,375$, and $C = 2,312.5$. We have

$$100,375 = \frac{2,312.5}{(1 + y)} + \frac{2,312.5}{(1 + y)^2} + \frac{2,312.5}{(1 + y)^3} + \frac{102,312.5}{(1 + y)^4},$$

and $y = .022135$. 
One way to look at the payoffs generated by a coupon bond is that of an annuity plus a zero.

The annuity has semi-annual payments of $C$, until maturity; the last coupon payment is on the maturity date.

The zero matures when the coupon bond does and has a face value equal to the par value of the coupon bond.

Hence, the present-value relation for a coupon bond becomes

$$P = \frac{C}{y} \left[ 1 - \frac{1}{(1 + y)^n} \right] + \frac{M}{(1 + y)^n}.$$  

**Example 5** Consider again the $4\frac{5}{8}$ coupon bond. We have

$$P = 2,312.5 \left[ 1 - \frac{1}{(1 + .022135)^4} \right] + \frac{100,000}{(1 + .022135)^4}$$

$$= 8,759.93 + 91,615.07 = 100,375.$$

- Note that we can write

$$\frac{P}{M} = \frac{c}{y} \left[ 1 - \frac{1}{(1 + y)^n} \right] + \frac{1}{(1 + y)^n},$$

where $c = C/M$.

For $c = y$, $P/M = 1 \implies P = M$: the bond sells at par

For $c < y$, $P/M < 1 \implies P < M$: the bond sells at a discount

For $c > y$, $P/M > 1 \implies P > M$: the bond sells at a premium

10 Practice Problems

1. **T-bills**

Assume a T-bill trades at $BDR = 3.03\%$ where maturity is 182 days away from settlement. Calculate discount from par and price for $M = 10,000$.

Now, assume that the maturity date of the bill falls exactly six months away from the settlement date. Calculate the yield to maturity on the bill (semi-annual). Convert the YTM to an annualized rate using the Bond Equivalent Yield convention.
2. *Treasury Auctions*

Suppose the Federal Reserve auctions $10 million (worth of maturity value) of 5-year notes. The competitive bids are:

A: $3.5 million at 5.60%
B: $2 million at 5.592%
C: $3 million at 5.5%

Note that the yields above are quoted on a bond equivalent basis. Noncompetitive offers total $2 million.

The auction is conducted using the Dutch system (single-price auction). Calculate the stop yield on the accepted competitive bids.

Assume the annualized coupon rate on the bond is 5.5%. Calculate the price that bidders pay for $100,000 of par value.