Topic 5

FIXED INCOME SECURITIES (3)

OTHER FIXED INCOME SECURITIES

ROADMAP

Part 0) PRESENT VALUE

Aim: Given expected cash flows and discount rates, find PV

Part I) VALUING SECURITIES

Aim: Given expected cash flows and discount rates, price specific securities

- Fixed Income Securities
  - Topic 3: Default Free Bonds: Pricing
  - Topic 4: Default Free Bonds: Risk and Risk Management
  - **Topic 5: Other Fixed Income Securities**
- Common Stocks
- Options and Other Derivatives

Part II) THE PRICING OF RISK

Aim: Determining the risk-adjusted discount rate

Part III) CORPORATE FINANCE

Aim: Study the value implications of financial decisions by firms

Readings: BM 23, 24, BKM 13, 14

OVERVIEW

- Theories of the Term Structure
  - Current and Future Yield Curves
  - Expectations Hypothesis
  - Liquidity Preference Hypothesis
  - Market Segmentation Hypothesis
- Credit Risk and Corporate Bonds
  - Credit Risk
  - Bond Ratings
  - Default Premium
  - Risk Premium

AN EXTREME ILLUSTRATION (1)

Today's yield curve contains the market's information about future yield curves

To see this, consider an extreme example:

- **The market knows the future yield curves**
- That is, the market knows today what the yield curve will be 1 year from today, 2 years from today, etc.
- In particular, it knows today:
  - the 1-year spot rate 1 year from today: $r_1(1)$
  - the 1-year spot rate 2 years from today: $r_1(2)$
  - Note: Today's spot rates are $r_t = r_t(0)$

Question:

Suppose that:

- You do not know the future yield curves
- You know that the market knows them
- You observe today's yield curve

Can you retrieve the market's information about future yield curves?

AN EXTREME ILLUSTRATION (2)

Remember the definition of the Forward Rate between dates $t-1$ and t:

$$f_t = \frac{(1+r_t)^t}{(1+r_{t-1})^{t-1}} - 1$$

Claim: *Under our extreme assumption, the current forward rate for year t equals the value of the one-year spot rate that will prevail t years from today*

$$f_t = r_1\,(t-1)$$

Suppose for instance, that today's yield curve is

$$r_1 = 7\%,\ r_2 = 8\%,\ r_3 = 7\%, \text{ etc.}$$

which implies (by definition)

$$f_1 = 7\%,\ f_2 = 9.01\%,\ f_3 = 5.03\%$$

The claim is that you can infer

$$r_1(1) = 9.01\% \text{ and } r_1(2) = 5.03\%$$

Question:

If you think that the market knows (for sure!) the future yield curves, can it be that $r_1(2) = 6\%$?

AN EXTREME ILLUSTRATION (3)

It this were the case, there would be an arbitrage opportunity.

- Today, enter a one year forward loan: agree to borrow $\$100$ in year 2 at rate $f_3 = 5.03\%$
- Wait two years. Lend $\$100$ for 1 year at the spot rate $r_1(2) = 6\%$

	year 0	year 1	year 2	year 3
forward loan	0	0	$+100$	-105.03
loan in year 2	0	0	-100	$+106.00$
total	0	0	0	$+0.97$

Hence, it cannot be that $r_1(2) > f_3$

Similarly, it cannot be that $r_1(2) < f_3$

(can you show this?)

Hence, from today's yield curve you can infer the market's information about $r_1(1)$, $r_1(2)$ etc.

Analogy: If I know next year's coal price and it differs from today's 1 year forward coal price, I can make an arbitrage profit

THEORIES OF THE TERM STRUCTURE

- Of course, even sophisticated investors cannot read the future!
- Hence, the market does **not** know for sure the future yield curves
- Still, it can have some information about changes in the yield curve
- This information is reflected in today's yield curve
- There are theories about how this information is reflected in today's yield curve
- We will examine briefly the most popular ones:
  - Expectations Hypothesis
  - Liquidity Preference Hypothesis
  - Market Segmentation Hypothesis

BEWARE!!

- **To price a default-free fixed income security, you only need today's yield curve**
- In particular, you do **not** need to know how the yield curve will change

  (unless you think you have more information than "the market"!)
- This does not mean that future changes of the yield curve are irrelevant
- Rather this means that the available information about these changes is already reflected in today's yield curve

THE (UNBIASED) EXPECTATIONS HYPOTHESIS

The first and simplest extension of our example

Today's forward rate between year $t-1$ and year t is the market's expectation of the 1-year spot rate that will prevail in year $t-1$

$$f_t = E_0\left[r_1(t-1)\right]$$

The index 0 means that the expectation is formed (with the information available) at date 0

Example: The market anticipates $r_1(1)$ to be:

$r_1(1)$	Proba
6%	$1/3$
8%	$1/2$
9%	$1/6$

If the Expectation Hypothesis is correct, today's forward rate between years 1 and 2 should be

$$f_2 = \frac{1}{3}\times 6\% + \frac{1}{2}\times 8\% + \frac{1}{6}\times 9\% = 7.5\%$$

IMPLICATION 1

The slope of the term structure reflects the market's expectations of future short-term interest rates.

Beware: Even under the expectations hypothesis, an upward sloping yield curve does not imply that future spot rates are expected to increase.

For instance, the following expectations would generate an increasing yield curve

$$r_1 = 5\% \text{ and } E_0[r_1(1)] = ... = E_0[r_1(t)] = 7\%$$

(Think of taking the average as an approximation)

Empirical Problem:

- Generally, forward rates are increasing (which implies but is not implied by an increasing yield curve)
- However, short-term spot rates are not generally increasing (over time)
- More generally, forward rates tend to "overpredict" future short-term spot rates

IMPLICATION 2

Each period's expected rate of return is the same for bonds of all maturities.

IN-CLASS EXERCISE

The yield curve is

r_1	r_2	r_3	r_4	flat
3%	4%	4.5%	5%	5%

1. Forward Rates?
2. Prices of zeros $B_t = B(0,T)$ for $T = 1$ to 4?
3. Assume that Expectations Hypothesis holds.
   (a) Expected future 1-period spot rate at $t = 1$?
   (b) Expected bond prices at $t = 1$? $E_0[B(1,T)]$
   (c) Expected 1-year Holding Period Return (i.e. between $t = 0$ and $t = 1$)?

THE LIQUIDITY PREFERENCE HYPOTHESIS

Long-term bonds command a premium over shorter maturity bonds because of interest rate risk considerations.

$$f_t > E_0[r_1(t-1)]$$

The difference

$$f_t - E_0[r_1(t-1)]$$

is called the **Liquidity Premium** for maturity t.

WHY A LIQUIDITY PREMIUM?

Assume: $r_1 = 8\%$ and $E_0[r_1(1)] = 10\%$

You are a short-term investor who (for some reason) wants to have $\$108,000$ next year.

Case 1: No uncertainty about $r_1(1) = 10\%$

We know that $f_2 = 10\%$

Hence the 2-year spot rate is:

$$\begin{aligned} r_2 &= [(1+f_1)(1+f_2)]^{\frac{1}{2}} - 1 \\ &= [1.08 \times 1.10]^{\frac{1}{2}} - 1 \\ &= 9\% \end{aligned}$$

We have seen that the 1-year Holding Period Returns of 1-year and 2-year zeros are the same, 8%

Hence, you are indifferent between:

- Investing $\$100,000$ in 1-year zeros with par value $\$108,000$
- Investing $\$100,000$ in 2-year zeros because after one year they will sell for $\$108,000$

Case 2: Uncertainty about $r_1(1)$

Now if the expected 1-year holding period return for 2-year zeros were 8%, you would prefer to invest in 1-year bonds.

Indeed, the 2-year bonds would sell at **an average** of $\$108,000$ but you would incur interest rate risk.

- If $r_1(1)$ turns out to be above 10%, your 2-year bonds would sell for less than $\$108,000$
- If $r_1(1)$ turns out to be below 10%, your 2-year bonds would sell for more than $\$108,000$

To convince you to buy 2-year zeros, their price today, i.e.

$$\frac{1}{(1+r_1)(1+f_2)}$$

should be lower than

$$\frac{1}{(1+r_1)(1+E_0[r_1(1)])}$$

That is, it should be the case that:

$$f_2 > E_0[r_1(1)]$$

Note: What if you were a "long-term" investor who wants money at $t = 2$ but not at $t = 1$?

- If $f_2 = E_0[r_1(1)]$, you would strictly prefer holding the 2-year zeros to rolling over the 1-year zeros because you do not know how what $r_1(1)$ will be
- For you not to strictly prefer 2-year zeros, their price today, i.e.

$$\frac{1}{(1+r_1)(1+f_2)}$$

  should be higher than

$$\frac{1}{(1+r_1)(1+E_0[r_1(1)])}$$

- That is,

$$f_2 < E_0[r_1(1)]$$

IMPLICATIONS

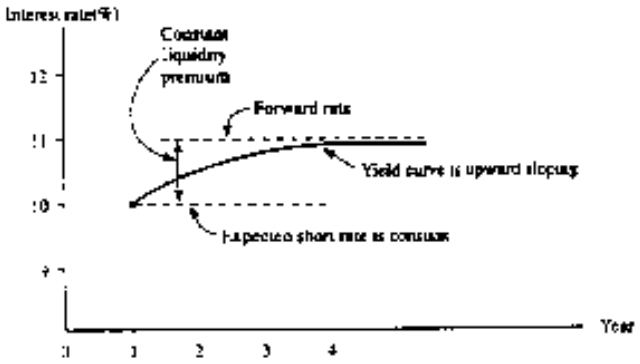
The Liquidity Preference Theory makes the assumption that bond prices are determined by the demand of short-term investors

This is why it predicts that longer maturity bonds command a risk premium rather than a discount.

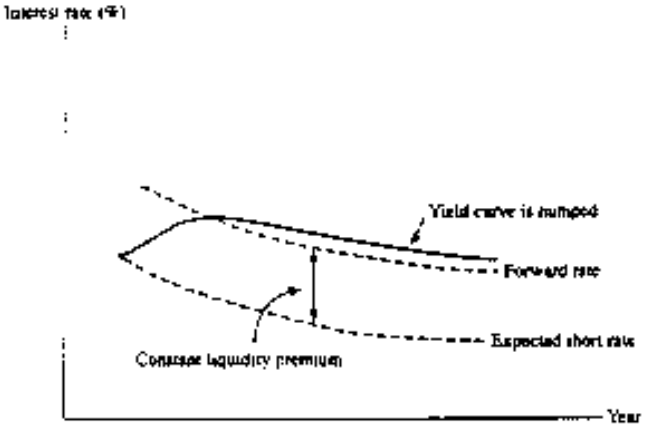
Implications:

- On average, investors in long-term bonds receive, higher returns than investors in short bonds
- The term structure reflects
  - (a) the expectations of future interest rates and
    (b) the risk premia demanded by investors in long maturity bonds
- The term structure is upward sloping even if future short-term rates are expected to be constant

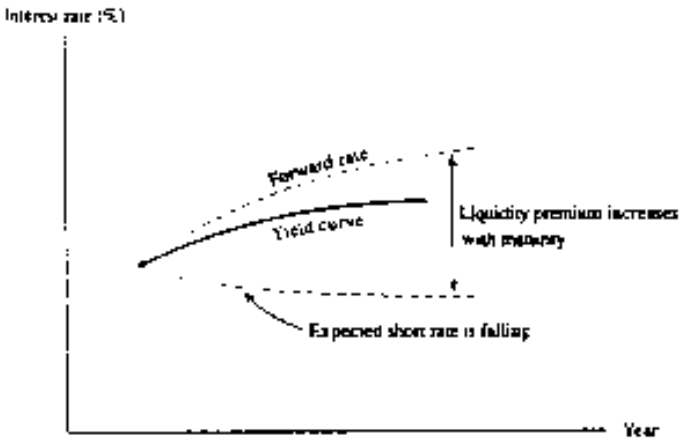
Yield curve with constant expected short rate and constant liquidity premium



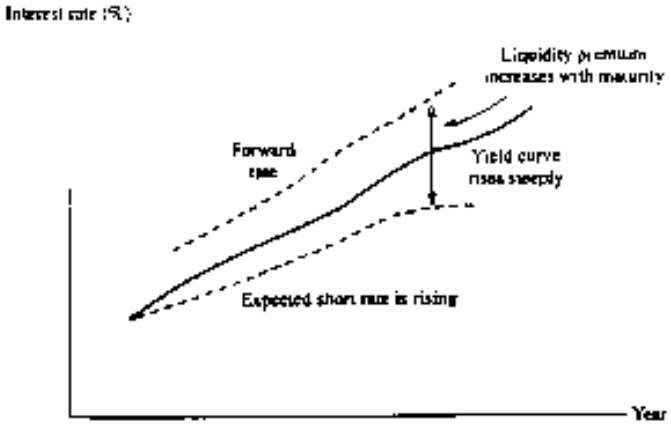
Yield curve with decreasing expected short rate and constant liquidity premium



Yield curve with decreasing expected short rate and increasing liquidity premium



Yield curve with increasing expected short rate and increasing liquidity premium



MARKET SEGMENTATION HYPOTHESIS

(a.k.a. Preferred Habitat Theory)

- The Liquidity Preference Theory assumes that:
  - Short-term investors are indifferent between short and long maturity bonds, i.e. all bonds are substitutes
  - Long-term investors strictly prefer long maturity bonds
- The Market Segmentation Hypothesis assumes that:
  - Bonds of different maturities are no substitutes, i.e. they have different markets
  - Short-term investors prefer short-term bonds
  - Long-term investors prefer long-term bonds
- Hence, there is no particular relationship between the prices of bonds of different maturities

BOTTOM LINE

- These "theories" should not be viewed as mutually exclusive
- Rather, each is a useful polar case to think about the yield curves
- Market segmentation is too extreme
- Investors may have a preferred habitat but they are not totally stubborn
- If the price of bonds with a maturity different from their preferred habitat is low enough, they will switch
- Practitioners tend to consider a combination of expectations and risk premium theories

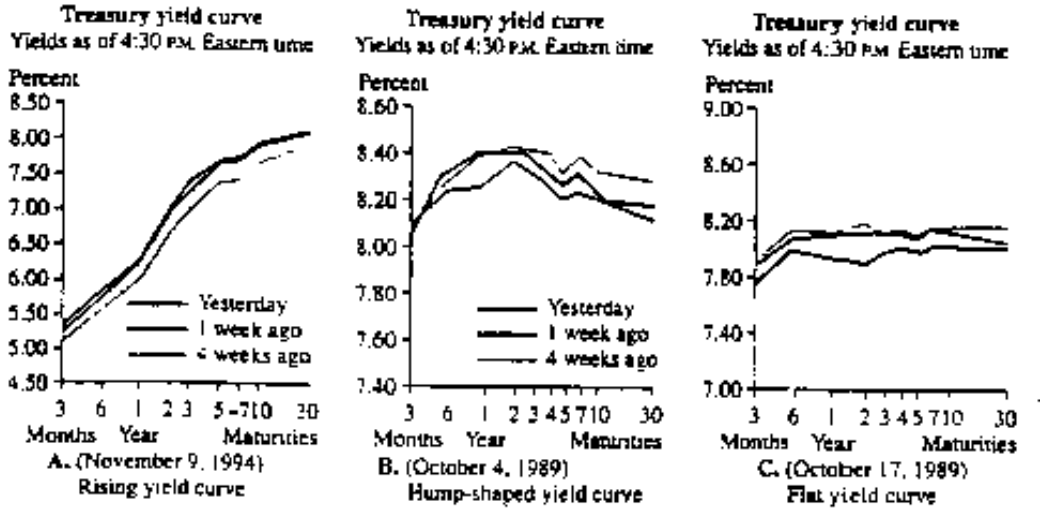
TREASURY YIELD CURVES

Average rates of return on treasuries, 1926 – 1994
(Source: Ibbotson Associates, 1995 Yearbook)

	Long-term	Bills
Nominal	5.2%	3.7%
Real	2.1%	0.6%

(Inflation: 3.1%)

Treasury yield curves



CREDIT RISK AND CORPORATE BONDS

Credit Risk: Risk that a debt issuer does not pay off as promised.

The credit risk associated with **Corporate Bonds** is the most important dimension that distinguishes them from US Treasury bonds.

Default: When the issuer fails to meet a coupon or principal payment

Question:

Why would anyone invest in bond with a risk of default when there exist default-free bonds?

DEFAULT RISK

Rating Agencies: Give grades to bonds indicating the likelihood of default

Moody's and Standard & Poor's (and others)

Description	Moody's	S&P
Gilt-edge	Aaa	AAA
Very high grade	Aa	AA
Upper medium grade	A	A
Lower medium grade	Baa	BBB
Low grade	Ba	BB
	B	B

- Investment grade bonds:
  - Aaa – Baa by Moody's
  - AAA – BBB by S&P
- Speculative (junk) bonds:
  - Ba and below by Moody's
  - BB and below by S&P

Moody's Corporate Debt Rating Definitions

Aaa

Bonds which are rated **Aaa** are judged to be of the best quality. They carry the smallest degree of investment risk and are generally referred to as "gilt edge." Interest payments are protected by a large or by an exceptionally stable margin and principal is secure. While the various protective elements are likely to change, such changes as can be visualized are most unlikely to impair the fundamentally strong position of such issues.

Aa

Bonds which are rated **Aa** are judged to be of high quality by all standards. Together with the **Aaa** group they comprise what are generally known as high grade bonds. They are rated lower than the best bonds because margins of protection may not be as large as in **Aaa** securities or fluctuation of protective elements may be of greater amplitude or there may be other elements present which make the long term risks appear somewhat larger than in **Aaa** securities.

A

Bonds which are rated **A** possess many favorable investment attributes and are to be considered as upper medium grade obligations. Factors giving security to principal and interest are considered adequate but elements may be present which suggest a susceptibility to impairment sometime in the future.

Baa

Bonds which are rated **Baa** are considered as medium grade obligations, i.e., they are neither highly protected nor poorly secured. Interest payments and principal security appear adequate for the present but certain protective elements may be lacking or may be characteristically unreliable over any great length of time. Such bonds lack outstanding investment characteristics and in fact have speculative characteristics as well.

Ba

Bonds which are rated **Ba** are judged to have speculative elements; their future cannot be considered as well assured. Often the protection of interest and principal payments may be very moderate and thereby not well safeguarded during other good and bad times over the future. Uncertainty of position characterizes bonds in this class.

B

Bonds which are rated **B** generally lack characteristics of the desired investment. Assurance of interest and principal payments or of maintenance of other terms of the contract over any long period of time may be small.

Caa

Bonds which are rated **Caa** are of poor standing. Such issues may be in default or there may be present elements of danger with respect to principal or interest.

Ca

Bonds which are rated **Ca** represent obligations which are speculative in a high degree. Such issues are often in default or have other marked shortcomings.

C

Bonds which are rated **C** are the lowest rated class of bonds and issues so rated can be regarded as having extremely poor prospects of ever attaining any real investment standing.

Standard & Poor's Corporate Debt Rating Definitions

A Standard & Poor's corporate or municipal debt rating is a current assessment of the creditworthiness of an obligor with respect to a specific obligation. This assessment may take into consideration obligors such as guarantors, insurers, or lessees.

The debt rating is not a recommendation to purchase, sell or hold a security, inasmuch as it does not comment as to market price or suitability for a particular investor.

The ratings are based on current information furnished by the issuer or obtained by Standard & Poor's from other sources it considers reliable. Standard & Poor's does not perform any audit in connection with any rating and may, on occasion, rely on unaudited financial information. The ratings may be changed, suspended or withdrawn as a result of changes in, or unavailability of, such information, or for other circumstances.

The ratings are based, in varying degrees, on the following considerations:

I. Likelihood of default-capacity and willingness of the obligor as to the timely payment of interest and repayment of principal in accordance with the terms of the obligation;

II. Nature of and provisions of the obligation;

III. Protection afforded by, and relative position of, the obligation in the event of bankruptcy, reorganization or other arrangement under the laws of bankruptcy and other laws affecting creditors' rights

AAA Debt rated AAA has the highest rating assigned by Standard & Poor's. Capacity to pay interest and repay principal is extremely strong.

AA Debt rated AA has a very strong capacity to pay interest and repay principal and differs from the higher rated issues only in small degree.

A Debt rated A has a strong capacity to pay interest and repay principal although it is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than debt in higher rated categories.

BBB Debt rated BBB is regarded as having an adequate capacity to pay interest and repay principal. Whereas it normally exhibits adequate protection parameters, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity to pay interest and repay principal for debt in this category than in higher rated categories.

BB, B, CCC, CC, C Debt rated BB, B, CCC, CC and C is regarded, on balance, as predominantly speculative with respect to capacity to pay interest and repay principal in accordance with the terms of the obligation. BB indicates the lowest degree of speculation and C the highest degree of speculation. While such debt will likely have some quality and protective characteristics, these are outweighed by large uncertainties or major risk exposures to adverse conditions.

CI The rating CI is reserved for income bonds on which no interest is being paid.

D Debt rated D is in default, and payment of interest and/or repayment of principal is in arrears.

DEFAULT PREMIUM

- **A bond's Promised (or Stated) YTM:** The YTM assuming that default will not occur
- **A bond's Expected YTM:** The bond's YTM computed replacing promised payments with expected actual payments
- **A bond's Default Premium:** Difference between promised and expected YTM
- **A bond's Risk Premium:** Difference between the expected yield and the yield on a risk-free bond of same maturity and coupon rate

IN-CLASS EXERCISE

- The yield curve is flat at 10%
- XYZ Inc.'s 10-year bonds with annual coupon rate $c = 9\%$ currently trade at 75% of par.
- XYZ Inc. is experiencing financial difficulties.
  - It is expected to meet all coupon payments
  - However, with probability $1/2$ it will be unable to repay the principal.
  - In this case, XYZ will default and only repay 50% of the principal.

1. What is XYZ's bond promised YTM?
2. What is its expected YTM?
3. What is its default premium?
4. What is its risk premium?

DETERMINANTS OF DEFAULT PREMIA

- Probabilities of default
- Financial loss in the event of default

Every bond that might default should offer a default premium, but not necessarily a risk premium.

Example: A group of companies all face default risk, but from totally unrelated causes. What should the risk premium on their bonds be?

- A portfolio of these bonds should provide actual return close to its expected return
- Default premiums earned on bonds that did not default offset losses from bonds that default
- The expected return on the bond portfolio should be the same as that of a default-free bond
- Each bond should offer no risk premium

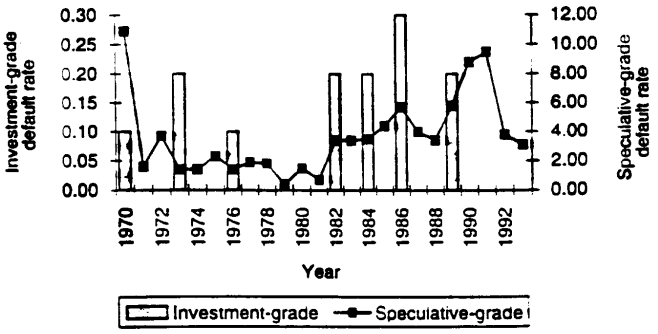
Note: In general

- Risks associated with bonds are not unrelated
- When business is bad, most firms are affected
- Risk premium of a bond depends on how its default relates to general business conditions
- Much more on this when we present the CAPM

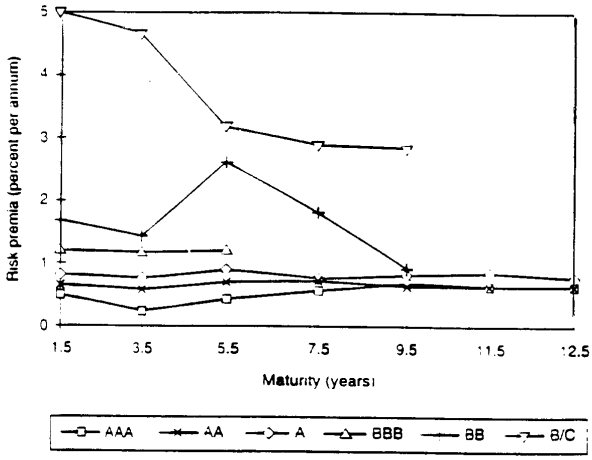
One-Year Default Rates

Year	*Aaa*	*Aa*	*A*	*Baa*	*Ba*	*B*	*Investment Grade*	*Speculative Grade*
1970	0.00	0.00	0.00	0.30	8.40	21.60	0.10	10.90
1971	0.00	0.00	0.00	0.00	1.50	0.00	0.00	1.60
1972	0.00	0.00	0.00	0.00	0.50	11.80	0.00	3.70
1973	0.00	0.00	0.00	0.50	0.50	3.40	0.20	1.40
1974	0.00	0.00	0.00	0.00	0.00	6.90	0.00	1.40
1975	0.00	0.00	0.00	0.00	1.60	3.00	0.00	2.30
1976	0.00	0.00	0.00	0.00	1.10	0.00	0.10	1.40
1977	0.00	0.00	0.00	0.30	0.60	8.80	0.00	1.90
1978	0.00	0.00	0.00	0.00	1.10	5.30	0.00	1.80
1979	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.40
1980	0.00	0.00	0.00	0.00	0.00	4.40	0.00	1.50
1981	0.00	0.00	0.00	0.00	0.00	4.10	0.00	0.70
1982	0.00	0.00	0.20	0.30	2.60	2.20	0.20	3.40
1983	0.00	0.00	0.00	0.00	1.00	6.00	0.00	3.40
1984	0.00	0.00	0.00	0.60	0.50	7.30	0.20	3.50
1985	0.00	0.00	0.00	0.00	2.00	8.70	0.00	4.40
1986	0.00	0.00	0.00	1.10	1.90	11.60	0.30	5.70
1987	0.00	0.00	0.00	0.00	2.60	5.30	0.00	4.00
1988	0.00	0.00	0.00	0.00	1.50	5.70	0.00	3.40
1989	0.00	0.30	0.00	0.50	2.70	8.60	0.20	5.80
1990	0.00	0.00	0.00	0.00	3.30	12.90	0.00	8.80
1991	0.00	0.00	0.00	0.20	5.10	13.10	0.00	9.50
1992	0.00	0.00	0.00	0.00	0.20	6.40	0.00	3.80
1993	0.00	0.00	0.00	0.00	0.50	5.20	0.00	3.10

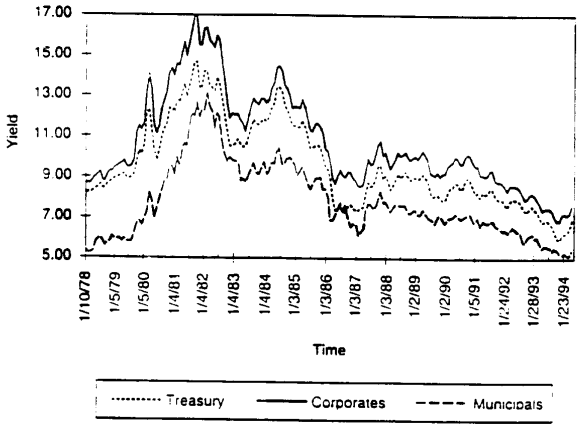
Source: Moody's Investors Services (1994)



Term structure of risk premium



Yields of corporates, treasury, and municipals



OTHER FEATURES OF CORPORATE BONDS

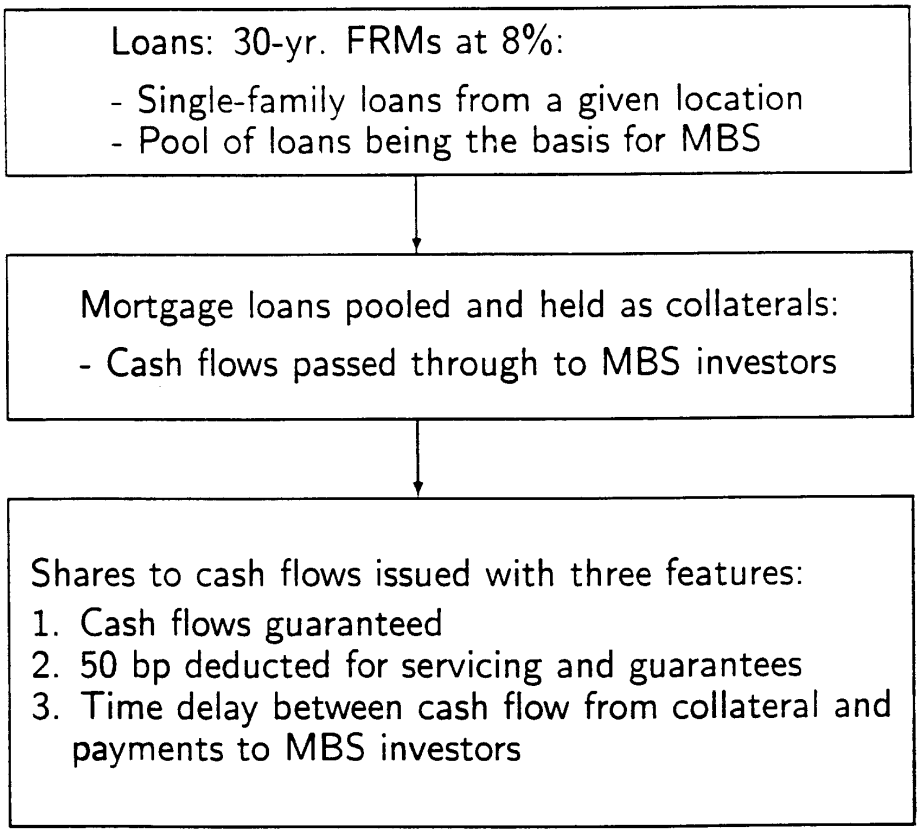
- **Convertible Bonds**
- **Callable Bonds**
- **Put(table) Bonds**: Bondholders have the option to put the debt back to the issuer

  Note: This is equivalent to having the option to extend the maturity
- **Collateral:** A specific asset pledged against default
- **Sinking Fund Provisions:** Require issuers to make annual payments into a sinking fund to retire part of the debt
- **Bonds with Warrants:** Bondholders are provided with the right to buy shares of the issuer's common stock
- **Seniority:** The bond's seniority determines who gets paid in priority in case of default
- Etc.

OTHER FIXED INCOME SECURITIES

Mortgage Backed Securities (MBS)

Example: Creation of a MBS



MUNICIPAL BONDS

Tax Exempt

- **General Obligation Bond (GO)**: backed by full faith, credit and taxation power of issuer
- **Revenue Bond:** issued to fund specific projects and backed by their revenues
- **Municipal Notes**: short term obligations
  - Tax anticipation notes (TAN)
  - Bond anticipation notes (BAN)
  - Grant anticipation notes (GAN)
  - Revenue anticipation notes (RAN)
  - etc.

Municipal yield spread:

$$r_{\mathrm{M}} = r_{\mathrm{C}} \times (1 - \tau)$$

$$r_{\mathrm{C}} - r_{\mathrm{M}} = r_{\mathrm{C}} \times \tau$$

where r_{M} is municipal yield, r_{C} is corporate yield and τ is the tax rate.