
Chapter 6

The Risk and Term Structure of Interest Rates

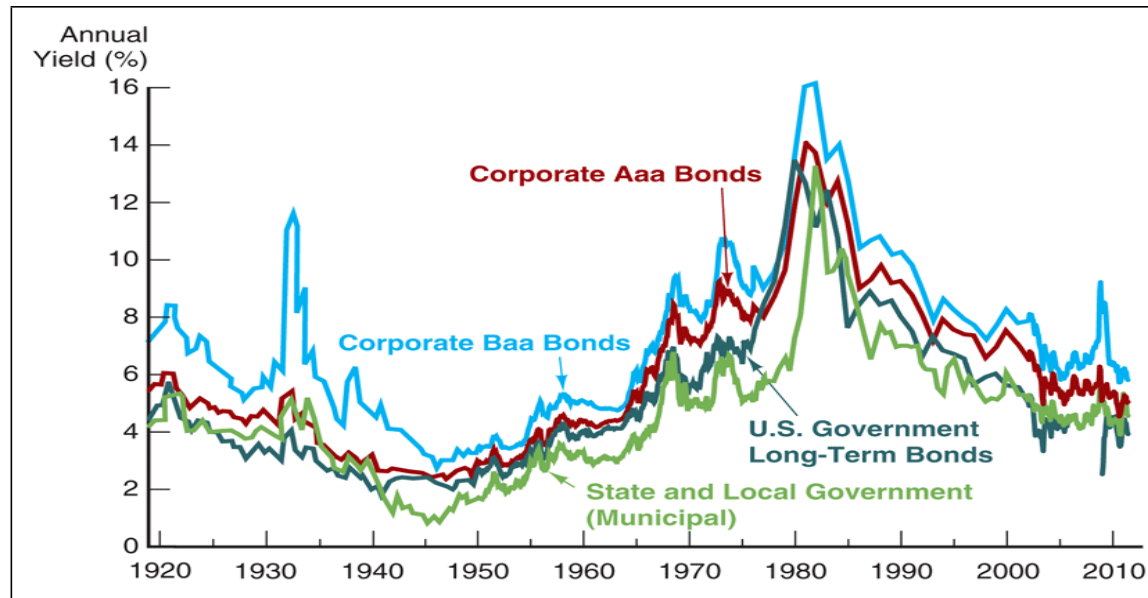
Money and Banking

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1 Introduction

- In our supply and demand analysis of interest-rate behavior in Chapter 5, we examined the determination of *just one interest rate* (or the *overall level of interest rates*).
 - But we saw earlier that there are enormous numbers of bonds on which interest rates can and do differ.
- In this chapter, **we explain why interest rates differ from bond to bond**: the *risk structure of interest rates* and the *term structure of interest rates*.
 1. Bonds "with the same maturity" will have different interest rates because of three factors: **default risk, liquidity, and tax considerations**.
 - The relationship among interest rates on bonds "with the same maturity" that arises because of these three factors is known as the **RISK STRUCTURE of interest rates**.
 - (a) The greater a bond's default risk, the higher its interest rate relative to other bonds.
 - (b) The greater a bond's liquidity, the lower its interest rate relative to other bonds.
 - (c) Bonds with tax-exempt status will have lower interest rates than they otherwise would.
 2. A bond's **term to maturity** also affects its interest rate.
 - The relationship among interest rates on bonds "with different terms to maturity" (but with *identical* default risk, liquidity, and tax characteristics) is called the **TERM STRUCTURE of interest rates**.
 - Four theories of the term structure is provided to explain how interest rates on bonds with different terms to maturity are related:
 - (a) Expectations theory
 - (b) Segmented markets theory
 - (c) Liquidity premium theory/Preferred habitat theory

2 Risk Structure of Interest Rates

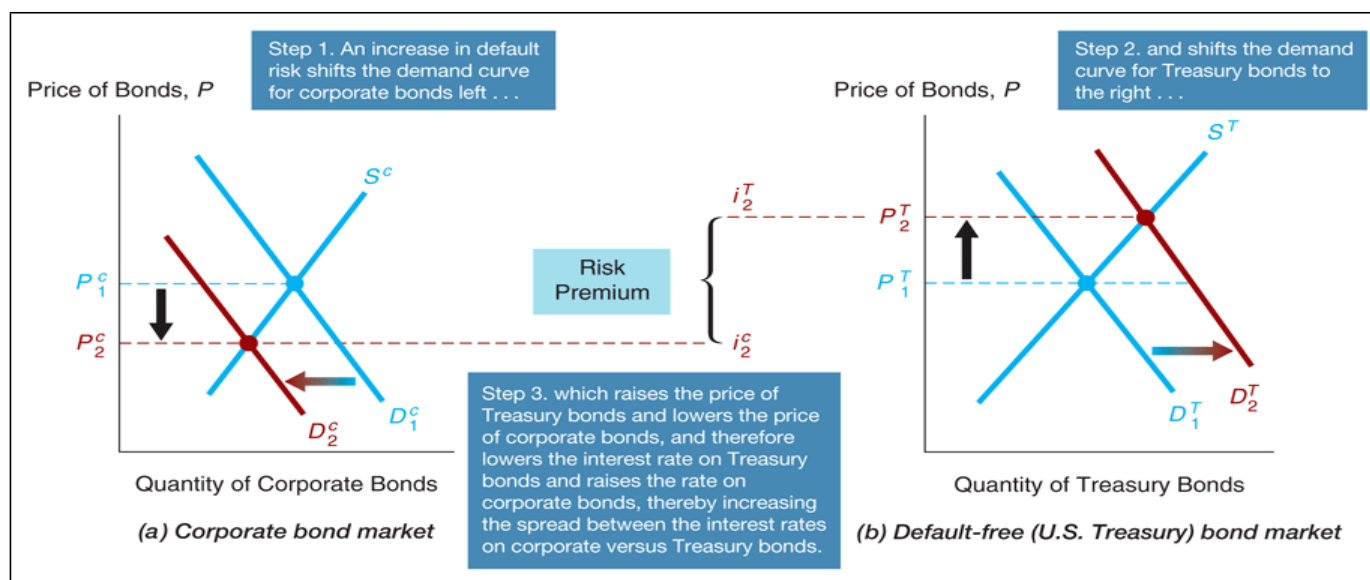


- Figure 1 above shows the yields to maturity for several categories of long-term bonds (**bonds with the same maturity**) from 1919 to 2011.
 1. Interest rates on different categories of bonds differ from one another in any given year.
 2. The spread (or difference) between the interest rates varies over time.
- Which factors are responsible for these phenomena, that is, the **risk structure of interest rates** (the relationship among interest rates on bonds "with the same maturity")?
 - It is explained by the following three factors:
 1. **Default risk**
 2. **Liquidity**
 3. **Tax considerations**

2.1 Default Risk

- One attribute of a bond that influences its interest rate is its "risk of **default**," which occurs when the issuer of the bond is unable/unwilling to make interest payments when promised or pay off the face value when the bond matures.
 - A corporation suffering big losses (such as the major airline companies like Delta in the mid-2000s) might be more likely to suspend interest payments on its bonds (**corporate bonds**). Hence, the default risk on its bonds would be quite high.
 - In contrast, **U.S. Treasury bonds** have usually been considered to have no default risk because the federal government can always increase taxes or print money to pay off its obligations. Such bonds are called **default-free bonds**.
 - The **risk premium**, the spread (difference) between interest rates on bonds with default risk and default-free bonds (*"both of the same maturity"*), indicates how much additional interest people must earn to be willing to hold that risky bond.
- Using our supply and demand analysis of the bond market, we can explain:
 1. **why a bond with default risk always has a positive risk premium, and**
 2. **why the higher the default risk is, the larger the risk premium will be.**

- Let's consider the supply and demand diagrams for (a) the default risk corporate long-term bond and (b) the default-free (U.S. Treasury) long-term bond.
 - In addition, **we assume that "initially" two bonds have the same default risk**, which means that they have the same attributes (identical risk and maturity).
 - So their initial equilibrium prices and interest rates are equal ($P_1^c = P_1^T$ and $i_1^c = i_1^T$), and the initial risk premium on the corporate bond is zero ($i_1^c - i_1^T = 0$).
 - Now, suppose the possibility of a default increases because a corporation begins to suffer large losses.
 - Then, the default risk on the corporate bond will increase, which results in more uncertainty of the corporate bond's return (i.e., more risky). As predicted by the theory of portfolio choice, investors demand less corporate bonds (D^c shifts to the left) and more Treasury bonds (D^T shifts to the right).
- So the risk premium on corporate bonds turns positive ($i_2^c - i_2^T > 0$).
 - Moreover, the greater a bond's default risk, the higher its risk premium ($i_2^c - i_2^T \gg 0$): risk premiums on investment-grade bonds vs. junk bonds.



- As we saw, **because default risk is so important to the size of the risk premium, purchasers of bonds need to know whether a corporation is likely to default on its bonds.**
 - This information is provided by **credit-rating agencies**, investment advisory firms that rate the quality of corporate and municipal bonds in terms of the probability of default.
 - Table 1 provides the ratings and their description for the three largest credit-rating agencies, Moody's Investor Service, Standard and Poor's Corporation, and Fitch Ratings.
 1. Bonds with relatively low risk of default, that is, ones with ratings of Baa (BBB) and above, are called **investment-grade securities**.
 2. Bonds with ratings below Baa (or BBB) have higher default risk and are dubbed **speculative-grade or junk bonds** – because these bonds always have higher interest rates than investment-grade securities, they are also referred to as **high-yield bonds**.

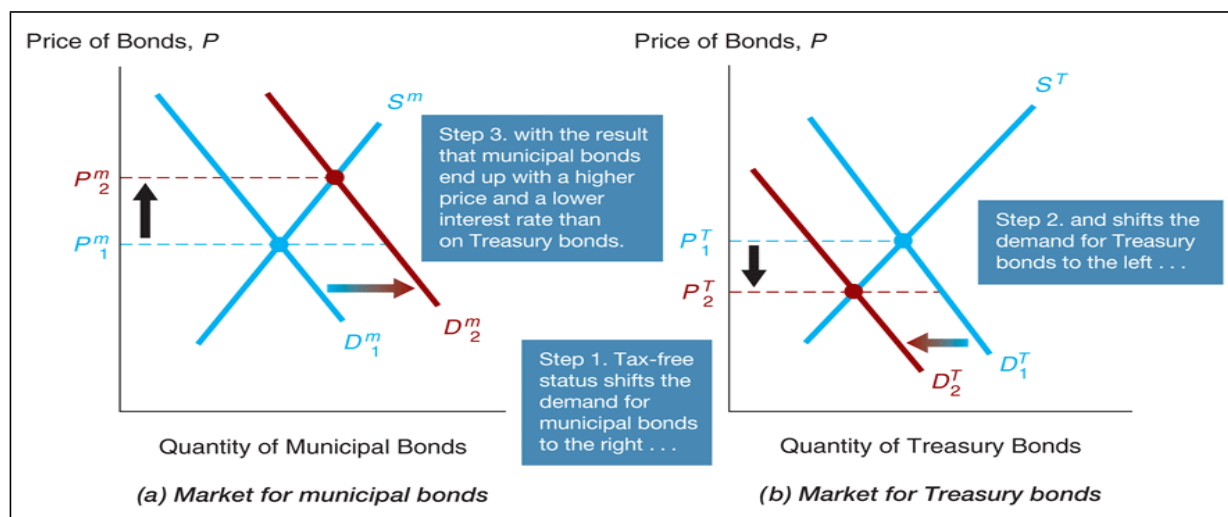
Bond Ratings by Moody's, Standard and Poor's, and Fitch			
Moody's	Rating S&P	Fitch	Definitions
Aaa	AAA	AAA	Prime Maximum Safety
Aa1	AA–	AA–	High Grade High Quality
Aa2	AA	AA	
Aa3	AA–	AA–	
A1	A+	A+	Upper Medium Grade
A2	A	A	
A3	A–	A–	
Baa1	BBB+	BBB+	Lower Medium Grade
Baa2	BBB	BBB	
Baa3	BBB–	BBB–	
Ba1	BB+	BB+	Noninvestment Grade
Ba2	BB	BB	
Ba3	BB–	BB–	
B1	B–	B–	Highly Speculative
B2	B	B	
B3	B–	B–	
Caa1	CCC+	CCC	Substantial Risk In Poor Standing
Caa2	CCC	—	
Caa3	CCC–	—	
Ca	—	—	Extremely Speculative
C	—	—	May Be in Default
—	—	DDD	Default
—	—	DD	—
—	D	D	—

2.2 Liquidity

- Another attribute of a bond that influences its interest rate is its **liquidity**.
 - As we learned earlier, a liquid asset is one that can be quickly and cheaply converted into cash if the need arises.
 - **The more liquid an asset is, the more desirable it is (holding everything else constant).**
 - * U.S. Treasury bonds are the most liquid of all long-term bonds.
 - Because they are so widely traded, they are the easiest to sell quickly and the cost of selling them is low.
 - * Corporate bonds are not as liquid.
 - As predicted by the theory of portfolio choice, **the greater a bond's liquidity, the higher the demand for the bond, which means a lower level of its interest rate.**
 - * To derive this conclusion, the previous supply and demand diagrams for (a) the corporate long-term bond and (b) the U.S. Treasury long-term bond can be applied in a similar way.

2.3 Income Tax Considerations

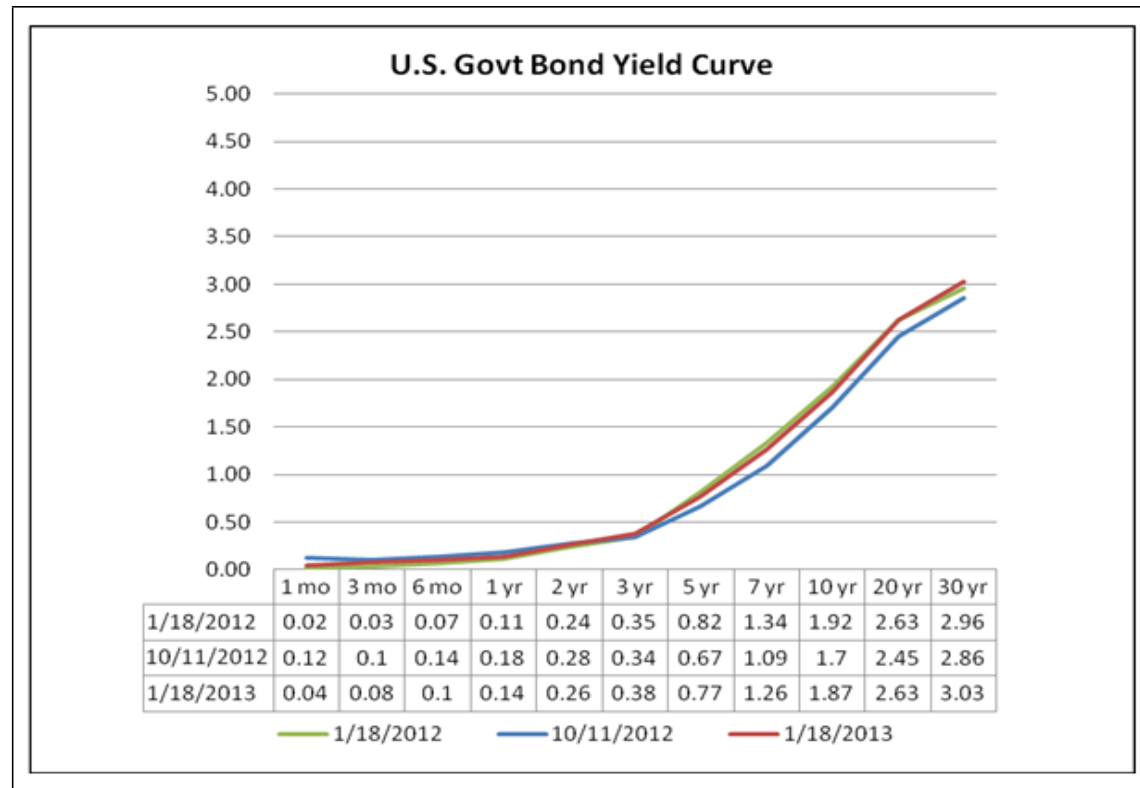
- Local and state government (municipal) bonds are certainly not default-free. Also, they are not as liquid as U.S. Treasury bonds.
 - However, the data show that **municipal bonds have had lower interest rates than U.S. Treasury bonds most of the past 70 years** (see Figure 1).
- How can we explain this phenomenon?
 - Municipal bonds have a favorable tax treatment: that is, their interest payments are exempt from federal income taxes. As a result, their interest rates will be lower.**
 - We initially assume that municipal and Treasury bonds have identical attributes and so have the same bond prices and interest rates ($P_1^m = P_1^T$ and $i_1^m = i_1^T$).
 - Once the municipal bonds are given a tax advantage that raises their after-tax expected return relative to Treasury bonds and makes them more desirable, the demand for municipal bonds relatively rises and the demand for Treasury bonds falls relatively.
 - * As a result, $P^m \uparrow$ and $P^T \downarrow$ (or equivalently, $i^m \downarrow$ and $i^T \uparrow$).



2.4 Application: Effects of the Bush Tax Cut and Its Possible Repeal on Bond Interest Rates

1. The Bush tax cut passed in 2001 scheduled a reduction of the top income tax bracket from 39% to 35% over a ten-year period.
 - What is the **effect of this income tax decrease** on *interest rates in the municipal bond market relative to those in the Treasury bond market*?
 - A decreased income tax rate for wealthy people means that the after-tax expected return on tax-free municipal bonds relative to that on Treasury bonds is lower, because the interest rate on Treasury bonds is now taxed at a lower rate. Thus,
 - (a) Municipal bonds now become relatively less desirable, and their demand decreases. As a result, their prices decrease and hence their interest rates rises.
 - (b) Treasury bonds become relatively more desirable, raising their prices and hence lowering their interest rates.
2. The Obama administration has supported repeal of the Bush tax cut.
 - What is the effect of the possible repeal of this tax cut?
 - The analysis of the possible repeal of the tax cut would be reversed.

3 Term Structure of Interest Rates



- Another factor that influences the interest rate on a bond is its **term to maturity**.
 - **Bonds with "identical" risk, liquidity, and tax characteristics** (e.g., U.S. government bonds) may have different interest rates because their time remaining to maturity is different.
 - A plot of the yields on bonds with differing terms to maturity but the same risk, liquidity, and tax considerations is called a **yield curve**.
 - * It describes the **term structure of interest rates** for particular types of bonds, such as government bonds (i.e., the relationship among interest rates on bonds of different maturities, but with identical characteristics).

- Yield curves can be classified as **(a) upward-sloping, (b) flat, and (c) downward-sloping** (also an inverted yield curve).
 1. When yield curves slope upward (the most usual case), the long-term interest rates are above the short-term interest rates.
 2. When yield curves are flat, short- and long-term interest rates are the same.
 3. When yield curves are inverted, long-term interest rates are below short-term interest rates.

Thus, we develop theories that explain why yield curves take on such different shapes at different times. Besides explaining why yield curves take on different shapes at different times, a good theory of the term structure of interest rates must explain the following **three important empirical facts**:

- 1. **Fact 1:** interest rates on bonds with different maturities move together over time.
- 2. **Fact 2:** When short-term interest rates are low (high), yield curves are more likely to have an upward slope (slope downward and be inverted).
- 3. **Fact 3:** Yield curves almost always slope upward.

In what follows, we will discuss four theories of the term structure of interest rates:

1. *the expectations theory*
2. *the segmented markets theory*
3. *the liquidity premium theory*
4. *the preferred habitat theory.*

3.1 Expectations Theory

- The **expectations theory** of the term structure states that **the interest rate on a long-term bond will equal an average of the short-term interest rates that people expect to occur over the life of the long-term bond.**

- The key assumption behind this theory is that buyers of bonds do not prefer bonds of one maturity over another, so they will not hold any quantity of a bond if its expected return is less than that of another bond with a different maturity.

* That is, bond holders consider "bonds with different maturities" to be **perfect substitutes**.

- Consider the following two strategies:

1. Purchase a one-year bond, and when it matures in one year, purchase another one-year bond.

(a) i_t = today's (time t) interest rate on a one-period bond

(b) i_{t+1}^e = interest rate on a one-period bond expected for next period (time $t + 1$)

(c) With this strategy, the expected return on the \$1 investment over the two periods is:

$$(1 + i_t)(1 + i_{t+1}^e) - 1 = i_t + i_{t+1}^e + (i_t i_{t+1}^e) \approx \boxed{i_t + i_{t+1}^e}$$

2. Purchase a two-year bond and hold it until maturity.

(a) i_{2t} = today's (time t) (annual) interest rate on the two-period bond

(b) In this case, the expected return on the \$1 investment over the two periods is:

$$(1 + i_{2t})(1 + i_{2t}) - 1 = 2i_{2t} + (i_{2t})^2 \approx \boxed{2i_{2t}}$$

3. **If these two bonds with different maturities are perfect substitutes**, the expected returns on these bonds must be equal:

$$2i_{2t} = i_t + i_{t+1}^e \Rightarrow i_{2t} = \frac{i_t + i_{t+1}^e}{2}$$

- * That is, the two-period interest rate must equal the average of the two one-period interest rates.
- By conducting the same steps for bonds with a longer maturity, we can examine the whole term structure of interest rates.
- * Doing so gives us the finding that **the n -period interest rate i_{nt} equals the average of the one-period interest rates expected to occur over the n -period life of the bond:**

$$i_{nt} = \frac{i_t + i_{t+1}^e + i_{t+2}^e + \cdots + i_{t+(n-1)}^e}{n} \quad (3.1)$$

- **The expectations theory is an elegant theory that explains why the term structure of interest rates (as represented by yield curves) changes at different times.**

1. When the yield curve is upward-sloping,
 - the theory suggests that short-term interest rates are expected to rise in the future, so the average of future short-term interest rates is expected to be higher than the current short-term rate.
2. When the yield curve is downward-sloping (inverted),
 - the theory suggests that short-term interest rates are expected to fall, on average, in the future, so the average of future short-term interest rates is expected to be lower than the current short-term rate.
3. When the yield curve is flat,
 - the theory suggests that short-term interest rates are not expected to change, on average, in the future.

- **The expectations theory explains only two empirical facts: Fact 1 and Fact 2, but "not" Fact 3.**

1. Fact 1: interest rates on bonds with different maturities move together over time.
 - Historically, short-term interest rates have had the characteristic that *if they increase today, they will tend to be higher in the future*. Hence, a rise in short-term rates will raise people's expectations of future short-term rates, which raises long-term rates (the average of expected future short-term rates). As a result, short-term and long-term rates move together.
2. Fact 2: when short-term interest rates are low (high), yield curves are more likely to have an upward slope (slope downward and be inverted).
 - When short-term rates are low, people generally expect them to rise to *some normal level* in the future, and the average of future expected short-term rates (i.e., long-term rates) is high relative to the current short-term rate. Therefore, the yield curve would have an upward slope.
 - Conversely, when short-term rates are high, people usually expect them to come back down, making the average of future expected short-term rates (i.e., long-term rates) lower than the current short-term rate. As a result, the yield curve would slope downward and become inverted.
3. Fact 3: yield curves almost always slope upward.
 - The typical upward slope of yield curves implies that short-term rates are usually expected to rise in the future. In practice, however, short-term rates are just as likely to fall as they are to rise, and so the expectations theory suggest the typical yield curve should be flat rather than upward-sloping.

3.2 Segmented Markets Theory

- The **segmented markets theory** of the term structure sees markets for different-maturity bonds as completely separate and segmented. Then, **the interest rate for each bond with a different maturity is determined by the supply of and demand for that bond, with no effects from expected returns on other bonds with other maturities.**
 - The key assumption is that bonds of different maturities are **not substitutes at all**, so the expected return from holding a bond of one maturity has no effect on the demand for a bond of another maturity.
 - * This theory of the term structure is at the opposite extreme to the expectations theory, which assumes that bonds of different maturities are perfect substitutes.
 - The argument for why bonds of different maturities are not substitutes is that investors have very strong preferences for bonds of one maturity but not for another, so they will be concerned with the expected returns only for bonds of the maturity they prefer.
 - * This might occur because investors have a particular holding period in mind, and if they match the maturity of the bond to the desired holding period, they can obtain a certain return with no risk at all (no interest-rate risk exists; see Chapter 4).
 - For example, people who have a short holding period would prefer to hold short-term bonds.
- **The segmented markets theory explains only Fact 3.**
 - It seems sensible that "risk averse" investors have short desired holding periods and generally prefer bonds with shorter maturities that have less interest-rate risk.
 - * Thus, in the typical situation the demand for long-term bonds is relatively lower than that for short-term bonds, long-term bonds will have lower prices and hence higher interest rates, which implies that the yield curve will typically slope upward (Fact 3).
 - The theory cannot explain Facts 1 and 2:

1. Because it views the market for bonds of different maturities as completely segmented, there is no reason for a rise in interest rates on a bond of one maturity to affect the interest rate on a bond of another maturity. Therefore, it cannot explain why interest rates on bonds of different maturities tend to move together (Fact 1).
2. Because it is not clear how demand and supply for short- versus long-term bonds change with the level of short-term interest rates, it cannot explain why yield curves tend to slope upward when short-term interest rates are low and to be inverted when short-term interest rates are high (Fact 2).

3.3 Liquidity Premium and Preferred Habitat Theories

- The **liquidity premium theory** of the term structure states that the interest rate on a long-term bond will equal an average of the short-term interest rates expected to occur over the life of the long-term bond **"plus" a liquidity premium (also called a term premium)** that responds to supply and demand condition for that bond.
 - The key assumption is that bonds of different maturities are *substitutes*, which means that the expected return on one bond *does* influence the expected return on a bond of a different maturity, but it allows investors to prefer one bond maturity over another.
 - * In other words, bonds of different maturities are assumed to be **substitutes but not perfect substitutes**.
 - **Investors tend to prefer shorter-term bonds because these bonds bear less interest rate risk.**
 - * For this reason, they must be offered a positive liquidity premium to induce them to hold longer-term bonds.

Thus, the liquidity premium theory is written as:

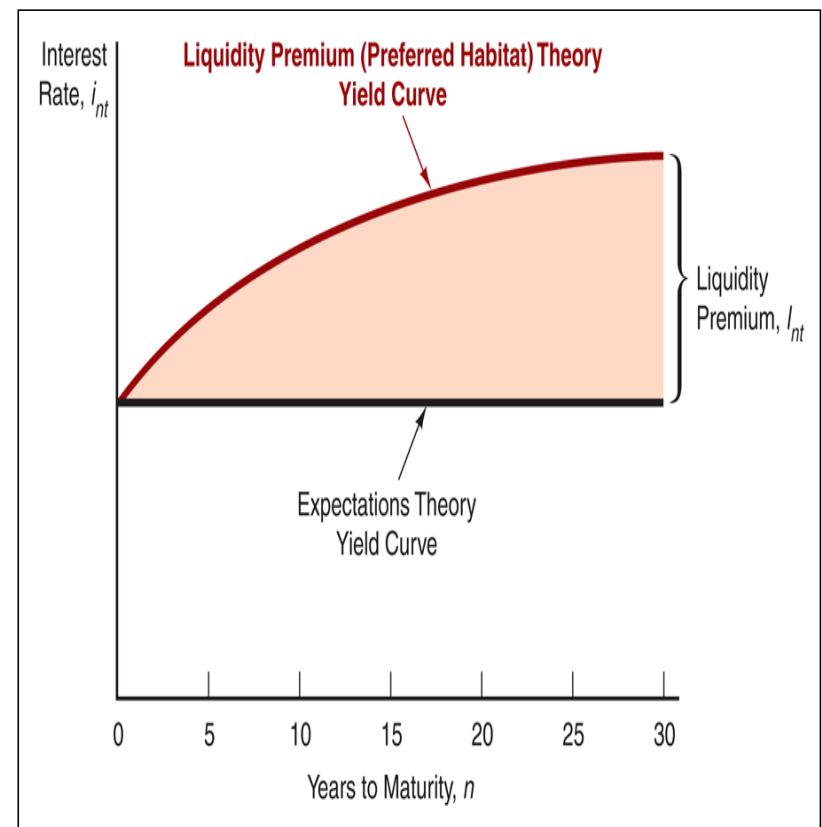
$$i_{nt} = \frac{i_t + i_{t+1}^e + i_{t+2}^e + \cdots + i_{t+(n-1)}^e}{n} + l_{nt} \quad (3.2)$$

where l_{nt} is the **liquidity premium** for the n -period bond at time t , **which is always positive and rises with the term to maturity of the bond, n .**

- Closely related to the liquidity premium theory is the **preferred habitat theory**, which takes a somewhat less direct approach to modifying the expectations hypothesis but comes to a similar conclusion.
 - It assumes that investors have a preference for bonds of one maturity over another, a particular bond maturity (preferred habitat) in which they prefer to invest.
 - * It means that investors will be willing to buy bonds that do not have the preferred maturity (habitat)

only if they earn a somewhat higher expected return.

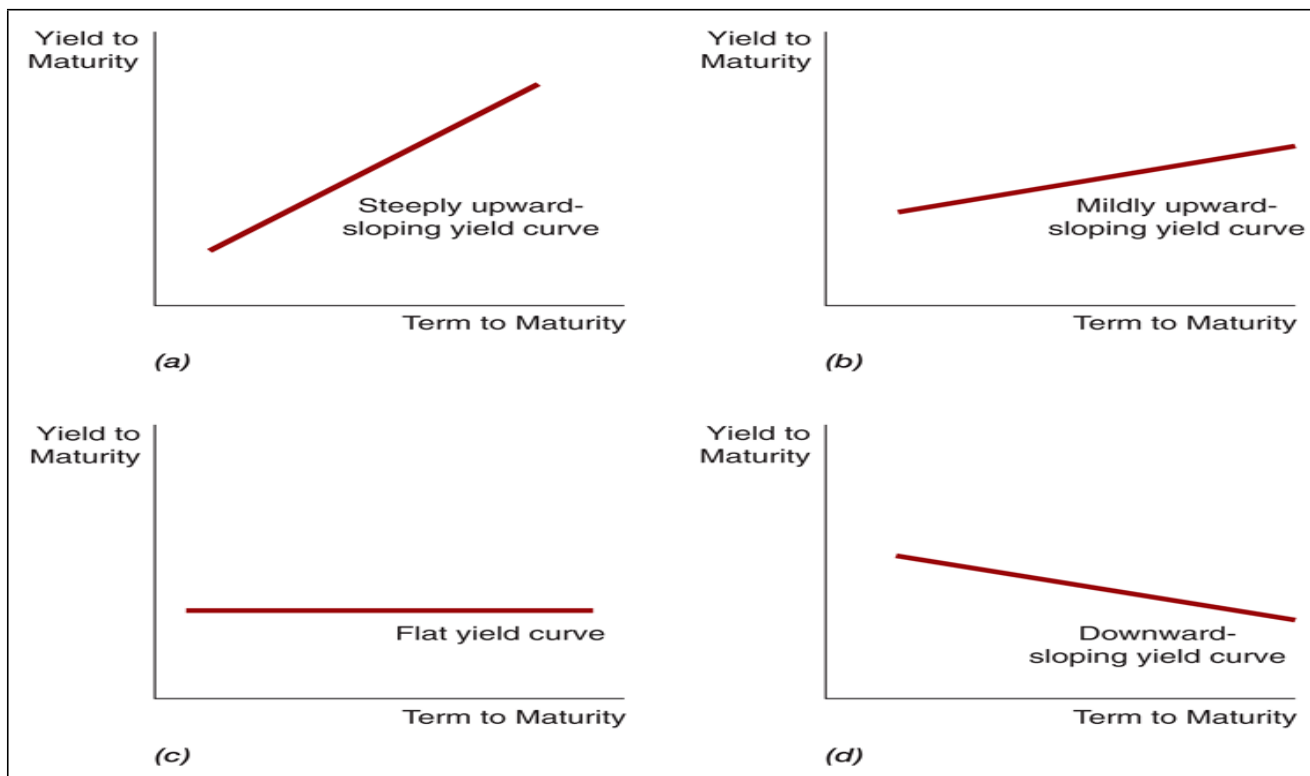
- Because investors are likely to prefer the habitat of short-term bonds over that of longer-term bonds, they are willing to hold long-term bonds only if they have higher expected returns.
- * This reasoning leads to the same Equation (3.2) implied by the liquidity premium theory, with a term premium that typically rises with maturity.
- The figure shows the relationship between the expectations theory and the liquidity premium and preferred habitat theories:
 - For simplicity, the yield curve implied by the expectations theory is drawn under the scenario of unchanging future one-year interest rates.
 - Because the liquidity premium is always positive and grows as the term to maturity increases, the yield curve implied by the liquidity premium and preferred habitat theories is always above the yield curve implied by the expectations theory and has a steeper slope.



- **The liquidity premium and preferred habitat theories explain all three empirical facts:**

1. Fact 1: interest rates on bonds with different maturities move together over time.
 - The first term in Equation (3.2) represents the expectations theory part, so these two theories explain Fact 1 by following the same reasoning as one described in the expectations theory.
2. Fact 2: when short-term interest rates are low (high), yield curves are more likely to have an upward slope (slope downward and be inverted).
 - In addition to the reasoning described in the expectations theory, with the additional boost of a positive liquidity premium, long-term rates will be "substantially" higher than current short-term rates when short-term rates are low, and the yield curve will then have a "steep" upward slope.
 - Conversely, if short-term rates are high, people usually expect them to come back down. Long-term rates will then drop below short-term rates because the average of expected future short-term rates will be so far below current short-term rates that despite positive liquidity premiums, the yield curve will slope downward.
3. Fact 3: yield curves almost always slope upward.
 - The liquidity premium rises with a bond's maturity. Even if short-term rates are expected to stay the same on average in the future, long-term rates will be above short-term rates, and yield curves will typically slope upward.

- A particular attractive feature of the liquidity premium and preferred habitat theories is that **they tell us what the market is predicting about future short-term interest rates just from the "slope" of the yield curve.**
1. **A steeply rising yield curve** indicates that short-term interest rates are expected to rise in the future.
 2. **A moderately steep yield curve** indicates that short-term interest rates are not expected to rise or fall much in the future.
 3. **A flat yield curve** indicates that short-term interest rates are expected to fall moderately in the future.
 4. **An inverted yield curve** indicates that short-term interest rates are expected to fall sharply in the future.



3.4 Application: Interpreting Yield Curves, 1980 – 2011

- Figure 7 illustrates several yield curves that have appeared for U.S. government bonds for different dates from 1980 to 2011.
 - What do these yield curves tell us about the public's expectations of future movements of short-term interest rates?**

1. The steep inverted yield curve on January 15, 1981.

- It indicated that short-term interest rates were expected to decline sharply in the future.
- Indeed, the public's expectations of sharply lower short-term interest rates evident in the yield curve were realized soon after January 15:
 - By March, three-month Treasury bill rates had declined from the 16% level to 13%.

2. The steep upward-sloping yield curves on March 28, 1985 and July 11, 2011.

- It indicated that short-term interest rates would climb in the future.

3. The moderately upward-sloping yield curves on May 16, 1980 and March 3, 1997.

- It indicated that short-term interest rates were expected neither to rise nor to fall in the future.

4. The flat yield curve on February 6, 2006.

- It indicated that short-term interest rates were expected to fall slightly.

