Lecture Notes on

MONEY, BANKING, AND FINANCIAL MARKETS

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Chapter 6: The Risk and Term Structure of Interest Rates

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In developing the loanable funds framework in Chapter 5, we kept things simple by assuming that there is just one type of bond, and hence just one interest rate, for the economy as a whole.

Our overview of the financial system, however, showed us that there in fact many different types of credit market instruments, with potentially different interest rates.

For instance, bonds of the same maturity may still differ in terms of their riskiness. The relationship between interest rates on bonds with the same term to maturity is called the risk structure of interest rates.

Bonds can also differ in terms of their term to maturity. The relationship between interest rates on bonds of different maturities is called the term structure of interest rates.

This chapter focuses on the risk and term structure of interest rates.

The chapter begins by identifying three facts about the risk structure of interest rates.

At the heart of the analysis of the risk structure of interest rates is a concept called default risk, which refers to the chance that the issue of the bond (the borrower) will be unable to make interest payments on the bond or to pay off the face value of the bond when it matures. But in addition to default risk, there are two other factors that contribute to the risk structure of interest rates: liquidity and income tax considerations.

Thus, this chapter shows how these three factors—default risk, liquidity, and income tax considerations—can jointly explain our three facts about the risk structure.

The chapter then goes on to consider the term structure of interest rates.

It begins, again, by identifying three facts about the term structure.

It then goes on to consider three theories of the term structure—the expectations hypothesis, segmented markets theory, and liquidity premium or preferred habitat theory—and evaluates each theory in terms of its ability to explain our three facts.

1 Risk Structure of Interest Rates

1.1 Three Facts About the Risk Structure

Risk structure = the relationship between interest rates on bonds with the same term to maturity.

Mishkin's Figure 1 (p.121) plots the interest rates on various types of long-term bonds, 1919-2002.

By examining this graph, we can identify three important facts about the risk structure of interest rates:

1. Corporate bonds tend to have higher interest rates than US government bonds.
2. The spread between the interest rates on corporate bonds and US government bonds varies over time. In particular, the spread tends to widen during periods of recession or depression.
3. Since 1940, the interest rate on municipal bonds has been lower than the interest rate on US government bonds.

We can explain these three facts by appealing to three factors:

1. Default risk.

2. Liquidity.
3. Income tax considerations.

1.2 Default Risk

Default risk = the chance that the issuer of the bond (borrower) will default, that is, be unable to make interest payments when they are due or pay off the face value of the bond when it matures.

The loanable funds framework implies that when the riskiness of a bond increases, the interest rate rises.

Hence, the loanable funds framework also implies that bonds with higher default risk will have higher interest rates.

US Treasury securities are default-free, or almost default-free, since there is very little chance that the US government will go bankrupt.

But corporations sometimes do default on their bonds.

Hence, default risk can explain fact (1): why corporate bonds tend to have higher interest rates than US government bonds.

The spread between interest rates on bonds with default risk and interest rates on default-free bonds is called the risk premium.

During recessions and depressions, more corporations go bankrupt. Since default risk on corporate bonds increases during these times, the risk premium also rises.

Hence, default risk can also explain fact (2); why the spread between interest rates on corporate and US government bonds varies over time and tends to widen during recessions and depressions.

Two major firms, Moody's and Standard and Poor's, are in the business of rating bonds according to their default risk. The categories are shown in Mishkin's Table 1 (p.123).

Moody's Rating	S&P's Rating	Description	Examples (2003)
Aaa	AAA	Highest Quality	General Electric
Aa	AA	High Quality	Wal-Mart
A	A	Upper Medium Grade	Hewlett-Packard
Baa	BBB	Medium Grade	Motorola
Ba	BB	Lower Medium Grade	Levi Strauss
B	B	Speculative	Rite Aid
Caa	CCC, CC	Poor	United Airlines
Ca	C	Highly Speculative	Polaroid
C	D	Lowest Grade	Enron

Bonds with ratings of Baa/BBB or above are referred to as "investment grade" bonds.

Bonds with ratings of Ba/BB or below are called "speculative grade," "high-yield," or "junk" bonds.

1.3 Liquidity

Liquidity = the ease and speed with which an asset can be bought and sold, that is, converted to a medium of exchange.

US Treasury bonds are more widely and actively traded than corporate bonds. Hence, US government bonds are more liquid than corporate bonds.

The loanable funds framework implies that when the liquidity of a bond increases, the interest rate falls.

Hence, the loanable funds framework also implies that more liquid bonds will have lower interest rates.

Hence, liquidity can also help explain fact (1): why corporate bonds tend to have higher interest rates than US government bonds.

1.4 Income Tax Considerations

Municipal bonds = bonds issued by state and local governments.

Unlike the US government, state and local governments sometimes do go bankrupt.

For example, Orange County, California defaulted on its debt in 1994.

Thus, municipal bonds are not default free.

In addition, municipal bonds are not as widely-traded, and hence not as liquid, as US government bonds.

Thus, based on risk and liquidity considerations alone, municipal bonds should have higher interest rates than US government bonds.

So how can we explain fact (3): that interest rates on municipal bonds are actually lower than interest rates on US government bonds.

The answer is that interest payments on municipal bonds are exempt from federal income taxes.

This tax advantage increases the demand for municipal bonds and thereby makes their interest rate lower.

Hence, income tax considerations can explain fact (3): why, since 1940, interest rates on municipal bonds have been lower than interest rates on US government bonds.

Before 1940, federal income tax rates were quite low; hence, the tax advantages of municipal bonds were not as important.

Hence, risk and liquidity considerations can explain why, before 1940, interest rates on municipal bonds were higher than interest rates on US government bonds.

2 Term Structure of Interest Rates

2.1 Three Facts About the Term Structure

Term Structure = the relationship between interest rates on bonds with different terms to maturity.

Yield curve = a plot of interest rates (yields) on bonds with different maturities.

Each day, the yield curve for Treasury bills, notes, and bonds is printed in the Wall Street Journal. For an example, see Mishkin, page 128.

By examining how the yield curve behaves over time, we can identify three important facts about the term structure of interest rates:

1. Interest rates on bonds of different maturities tend to move together over time.
2. The yield curve can slope up or down. It tends to slope up when short-term interest rates are low, and tends to slope down when short-term interest rates are high.
3. Most of the time, the yield curve is upward-sloping.

Note: the atypical case, where the yield curve slopes down, is often referred to as the case of an "inverted yield curve."

Three main theories of the term structure have been proposed:

1. The Expectations Hypothesis — explains facts (1) and (2).
2. Segmented Markets Theory — explains fact (3).
3. Liquidity Premium or Preferred Habitat Theory — a combination of the first two theories — explains all three facts.

2.2 Expectations Hypothesis

Expectations hypothesis = the interest rate on a long-term bond will equal an average of the short-term interest rates that people expect to prevail over the life of the long-term bond.

Key assumption = investors regard bonds of different maturities to be perfect substitutes.

To see how this assumption leads to the expectations hypothesis, consider two investment strategies:

Strategy 1: Buy a one-year bond, and when it matures in one year, buy another one-year bond.

Strategy 2: Buy a two-year bond and hold it until maturity.

If bonds of different maturities really are perfect substitutes, then these two strategies must provide the same expected return.

Example: If the interest rate on a one-year bond is 9% today and is expected to be 11% one year from now, then the annualized interest rate on a two-year bond today must be 10%.

To make this argument more formal, let

$$i_t = \text{ today's (time } t\text{) interest rate on a one-year bond}$$

$$i^e_{t+1} = \text{expected interest rate on a one-year bond next year (time } t+1\text{)}$$

$$i_{2t} = \text{ today's (time } t\text{) annualized interest rate on a two-year bond}$$

Then the expected return on strategy 1 can be calculated as

$$\begin{aligned} \text{Expected Return on Strategy 1} &= (1+i_t) \times (1+i^e_{t+1}) \\ &= 1 + i_t + i^e_{t+1} + i_t \times i^e_{t+1} \\ &\approx 1 + i_t + i^e_{t+1}. \end{aligned}$$

And the expected return on strategy 2 can be calculated as

$$\begin{aligned}\text{Expected Return on Strategy 2} &= (1+i_{2t})\times(1+i_{2t}) \\ &= 1+i_{2t}+i_{2t}+i_{2t}^2 \\ &\approx 1+2i_{2t}.\end{aligned}$$

Hence, if these strategies have the same expected return, it must be that

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

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

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

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

that is, the annualized interest rate on the two-year bond is an average of the one-year rates that are expected to prevail over the next two years.

Extending this argument would tells that if

$$i_{nt} = \text{ today's annualized interest rate on an } n\text{-year bo}$$

then

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

Example: Suppose that

$$i_t = 5\%$$

$$i_{t+1}^e = 6\%$$

$$i_{t+2}^e = 7\%$$

$$i_{t+3}^e = 8\%$$

$$i_{t+4}^e = 9\%.$$

Then the expectations hypothesis predicts that

$$i_{2t} = \frac{i_t+i_{t+1}^e}{2} = \frac{5\%+6\%}{2} = \frac{11\%}{2} = 5.5\%$$

and

$$i_{5t} = \frac{i_t+i_{t+1}^e+i_{t+2}^e+i_{t+3}^3+i_{t+4}^e}{5} = \frac{5\%+6\%+7\%+8\%+9\%}{5} = \frac{35\%}{5} = 7\%.$$

Note that in this example, the one-year rate is expected to rise. Hence, the yield curve slopes up.

Suppose, on the other hand, that

$$i_t = 9\%$$
$$i^e_{t+1} = 8\%$$
$$i^e_{t+2} = 7\%$$
$$i^e_{t+3} = 6\%$$
$$i^e_{t+4} = 5\%.$$

Then the expectations hypothesis predicts that

$$i_{2t} = \frac{i_t + i^e_{t+1}}{2} = \frac{9\% + 8\%}{2} = \frac{17\%}{2} = 8.5\%$$

and

$$i_{5t} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + i^3_{t+3} + i^e_{t+4}}{5} = \frac{9\% + 8\% + 7\% + 6\% + 5\%}{5} = \frac{35\%}{5} = 7\%.$$

Now, the one year-rate is expected to fall, and so the yield curve slopes down, or is inverted.

The expectations hypothesis can explain fact (1). Since interest rates at all maturities depend on today's short-term rate i_t, then they will tend to move together, rising when i_t rises and falling when i_t falls.

The expectations hypothesis can also explain fact (2). As our examples show, the yield curve can slope up or down. Moreover, it tends to slope up when short-term interest rates are low (and therefore expected to rise) and to slope up when short-term interest rates are high (and therefore expected to fall).

But the expectations hypothesis cannot explain fact (3). Since short-term interest rates are as likely to rise as they are to fall, the expectations hypothesis predicts that the yield curve is as likely to slope upward as it is to slope down. It cannot explain why most of the time the yield curve slopes up.

2.3 Segmented Markets Theory

Recall that the key assumption underlying the expectations hypothesis is that investors regard bonds of different maturities as perfect substitutes.

Segmented markets theory starts with exactly the opposite assumption: that investors regard markets for bonds of different maturities as completely separate, or segmented. That is, bonds of different maturities are not substitutes at all.

Example:

Investors saving for a short period of time buy only short-term bonds.

Investors saving for a long period of time buy only long-term bonds.

Such behavior makes sense, if we recall from our previous analysis that an investor who sells a bond before it matures may incur large capital losses if interest rates rise between the time the bond is bought and sold.

If bonds of different maturities are not substitutes at all, then the interest rate for each maturity is determined solely by the supply of and demand for bonds of that maturity, with no effects from interest rates on bonds of other maturities.

Segmented markets theory can explain fact (3). If most investors prefer short-term bonds, the demand for short-term bonds will be greater than the demand for long-term bonds. Hence, the interest rate on short-term bonds will be lower than the interest rate on long-term bonds. That is, the yield curve will typically slope upward.

Why might most investors prefer short-term bonds?

They may wish to avoid the risk of incurring capital losses if they need to sell long-term bonds before maturity.

They may also wish to take advantage of the greater liquidity of short-term bonds.

But segmented markets theory cannot explain fact (1). If bonds of different maturities are really traded in completely separated markets and are not substitutes at all, then their interest rates should show no tendency to move together.

Likewise, segmented markets theory cannot explain fact (2) without assuming that investors preferences for bonds of different maturities shift drastically over time, so that they sometimes prefer short-term bonds and sometimes prefer long-term bonds. It does not seem likely that preferences would shift in this way.

2.4 Liquidity Premium and Preferred Habitat Theories

We have seen that the expectations hypothesis can explain two of our three facts, while segmented markets theory can explain the third.

We've also seen that both the expectations hypothesis and segmented markets theory make assumptions that are somewhat extreme:

Expectations hypothesis = bonds of different maturities are perfect substitutes.

Segmented markets theory = bonds of different maturities are not substitutes at all.

These observations suggest that if we combine the two theories in a way that makes less extreme assumptions, we'll have an explanation for all three facts.

This is exactly when liquidity premium or preferred habitat theory does.

The key assumption of liquidity premium or preferred habitat theory is that investors regard bonds of different maturities as substitutes, but not perfect substitutes.

To see how this theory works, recall that according to the expectations hypothesis:

$$i_{nt} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + ... + i^e_{t+(n-1)}}{n},$$

so that the interest rate on a n-year bond is the average of the one-year interest rates that are expected to prevail over the next n years.

Liquidity premium theory modifies this equation to:

$$i_{nt} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + ... + i^e_{t+(n-1)}}{n} + l_{nt},$$

where

$$l_{nt} = \text{liquidity (term) premium for the } n\text{-year bond at time } t.$$

The first part of this equation comes from the expectations hypothesis. It implies that investors still care about the interest rates on bonds of different maturities, so they will not let the expected returns on different investment strategies to get too far out of line.

But the second part of this equation comes from segmented markets theory. It tells us that investors do have preferences for some maturities over others.

If, in particular, investors prefer short-term bonds—that is, if their "preferred habitat" is in short-term bonds—then the demand for short-term bonds will be greater than the demand for long-term bonds. Thus, the interest rate on long-term bonds will be higher than the interest rate on short-term bonds.

In other words, if investors prefer short-term bonds, then the liquidity or term premium l_{nt} will be positive and will tend to rise as n increases.

The term premium makes investors willing to hold long-term bonds, even though they would otherwise prefer short-term bonds.

Again, why might most investors prefer short-term bonds?

They may wish to avoid the risk of incurring capital losses if they need to sell long-term bonds before maturity.

They may also wish to take advantage of the greater liquidity of short-term bonds.

Example: Suppose that investors' preferred habitat is in short-term bonds, so that

$$l_{2t} = \text{liquidity premium on 2-year bonds} = 0.25\%$$

$$l_{5t} = \text{liquidity premium on 5-year bonds} = 1\%$$

Case 1: Short-term interest rates are expected to rise:

$$i_t = 5\%$$

$$i^e_{t+1} = 6\%$$
$$i^e_{t+2} = 7\%$$
$$i^e_{t+3} = 8\%$$
$$i^e_{t+4} = 9\%.$$

Then

$$i_{2t} = \frac{i_t + i^e_{t+1}}{2} + l_{2t} = \frac{5\% + 6\%}{2} + 0.25\% = \frac{11\%}{2} + 0.25\% = 5.75\%$$

and

$$i_{5t} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + i^3_{t+3} + i^e_{t+4}}{5} + l_{5t} = \frac{5\% + 6\% + 7\% + 8\% + 9\%}{5} + 1\% = \frac{35\%}{5} + 1\% = 8\%.$$

Hence, when short-term interest rates are expected to rise, the yield curve slopes up.

Case 2: Short-term interest rates are expected to fall slightly:

$$i_t = 9\%$$

$$i^e_{t+1} = 8.75\%$$
$$i^e_{t+2} = 8.50\%$$
$$i^e_{t+3} = 8.25\%$$
$$i^e_{t+4} = 8\%.$$

Then

$$i_{2t} = \frac{i_t + i^e_{t+1}}{2} + l_{2t} = \frac{9\% + 8.75\%}{2} + 0.25\% = 9.125\%$$

and

$$i_{5t} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + i^3_{t+3} + i^e_{t+4}}{5} + l_{5t} = \frac{9\% + 8.75\% + 8.50\% + 8.25\% + 8\%}{5} + 1\% = 9.5\%.$$

Hence, when short-term rates are expected to fall only slightly, the yield curve still slopes up.

Case 3: Short-term interest rates are expected to fall sharply:

$$i_t = 9\%$$

$$i^e_{t+1} = 8\%$$
$$i^e_{t+2} = 7\%$$
$$i^e_{t+3} = 6\%$$
$$i^e_{t+4} = 5\%.$$

Then

$$i_{2t} = \frac{i_t + i^e_{t+1}}{2} + l_{2t} = \frac{9\% + 8\%}{2} + 0.25\% = 8.75\%$$

and

$$i_{5t} = \frac{i_t + i^e_{t+1} + i^e_{t+2} + i^3_{t+3} + i^e_{t+4}}{5} + l_{5t} = \frac{9\% + 8\% + 7\% + 6\% + 5\%}{5} + 1\% = 8\%.$$

Hence, only when short-term rates are expected to fall sharply does the yield curve slope down.

This example shows that liquidity premium or preferred habitat theory can explain all three facts:

1. Since interest rates at all maturities depend on today's short-term rate i_t, then they will tend to move together, rising when i_t rises and falling when i_t falls.
2. The yield curve will slope up if investors expect short-term interest rates to rise or fall slightly; the yield curve will slope down if investors expect short-term interest rates to fall sharply. Hence, in general, the yield curve can slope up or down. Moreover, the yield curve will tend to slope up when short-term interest rates are low—and therefore expected to rise—while the yield curve will tend to slope down when short-term interest rates are high—and therefore expected to fall.
3. Since the yield curve slopes down only when short-term interest rates are expected to fall sharply, most of the time the yield curve will slope up.

3 Conclusion

The first part of this chapter introduces us to three facts about the risk structure of interest rates:

1. Corporate bonds tend to have higher interest rates than US government bonds.
2. The spread between the interest rates on corporate bonds and US government bonds varies over time. In particular, the spread tends to widen during periods of recession or depression.
3. Since 1940, the interest rate on municipal bonds has been lower than the interest rate on US government bonds.

The first part of this chapter also shows us how these three facts can be explained by a combination of three factors:

1. Default risk.
2. Liquidity.
3. Income tax considerations.

The second part of this chapter introduces us to three facts about the term structure of interest rates:

1. Interest rates on bonds of different maturities tend to move together over time.
2. The yield curve can slope up or down. It tends to slope up when short-term interest rates are low, and tends to slope down when short-term interest rates are high.
3. Most of the time, the yield curve is upward-sloping.

The second part of this chapter also shows us how some or all of these facts can be explained by three theories of the term structure:

1. The Expectations Hypothesis — explains facts (1) and (2).
2. Segmented Markets Theory — explains fact (3).
3. Liquidity Premium or Preferred Habitat Theory — a combination of the first two theories — explains all three facts.