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The accrued interest on a bond is calculated by taking the fraction of the coupon period that has passed, in this case two months out of six, and multiplying this fraction by the next coupon, \$60. So, the accrued interest in this example is $2/6 \times \$60 = \20 . The bond's quoted price (i.e., its clean price) would be $\$1,080 - 20 = \$1,060$.⁶ page 152

5.6 INFLATION AND INTEREST RATES

So far, we haven't considered the role of inflation in our various discussions of interest rates, yields, and returns. Because this is an important consideration, we discuss the impact of inflation next.

Real versus Nominal Rates

In examining interest rates, or any other financial market rates such as discount rates, bond yields, rates of return, and required returns, it is often necessary to distinguish between **real rates** and **nominal rates**. Nominal rates are called *nominal* because they have not been adjusted for inflation. Real rates are rates that have been adjusted for inflation.

To see the effect of inflation, suppose prices are currently rising by 5 percent per year. In other words, the rate of inflation is 5 percent. An investment is available that will be worth \$115.50 in one year. It costs \$100 today. Notice that with a present value of \$100 and a future value in one year of \$115.50, this investment has a 15.5 percent rate of return. In calculating this 15.5 percent return, we did not consider the effect of inflation, however, so this is the nominal return.

What is the impact of inflation here? To answer, suppose pizzas cost \$5 apiece at the beginning of the year. With \$100, we can buy 20 pizzas. Because the inflation rate is 5 percent, pizzas will cost 5 percent more, or \$5.25, at the end of the year. If we take the investment, how many pizzas can we buy at the end of the year? Measured in pizzas, what is the rate of return on this investment?

Our \$115.50 from the investment will buy us $\$115.50/5.25 = 22$ pizzas. This is up from 20 pizzas, so our pizza rate of return is 10 percent. What this illustrates is that even though the nominal return on our investment is 15.5 percent, our buying power goes up by only 10 percent because of inflation. Put another way, we are really only 10 percent richer. In this case, we say that the real return is 10 percent.

Alternatively, we can say that with 5 percent inflation, each of the \$115.50 nominal dollars we get is worth 5 percent less in real terms, so the real dollar value of our investment in a year is:

$$\$115.50/1.05 = \$110$$

What we have done is to *deflate* the \$115.50 by 5 percent. Because we give up \$100 in current buying power to get the equivalent of \$110, our real return is again 10 percent. Because we have removed the effect of future inflation here, this \$110 is said to be measured in current dollars.

The difference between nominal and real rates is important and bears repeating:

The nominal rate on an investment is the percentage change in the number of dollars you have.

The real rate on an investment is the percentage change in how much you can buy with your dollars, in other words, the percentage change in your buying power.

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The Fisher Effect

Our discussion of real and nominal returns illustrates a relationship often called the **Fisher effect** (after the great economist Irving Fisher). Because investors are ultimately concerned with what they can buy with their money, they require compensation for inflation. Let R stand for the nominal rate and r stand for the real rate. The Fisher effect tells us that the relationship between nominal rates, real rates, and inflation can be written as:

$$1 + R = (1 + r) \times (1 + h) \quad [5.2]$$

where h is the inflation rate.

In the preceding example, the nominal rate was 15.50 percent and the inflation rate was 5 percent. What was the real rate? We can determine it by plugging in these numbers:

$$\begin{aligned} 1 + .1550 &= (1 + r) \times (1 + .05) \\ 1 + r &= 1.1550/1.05 = 1.10 \\ r &= .10, \text{ or } 10\% \end{aligned}$$

This real rate is the same as we had before. If we take another look at the Fisher effect, we can rearrange things a little as follows:

$$\begin{aligned} 1 + R &= (1 + r) \times (1 + h) \\ R &= r + h + r \times h \end{aligned} \quad [5.3]$$

What this tells us is that the nominal rate has three components. First, there is the real rate on the investment, r . Next, there is the compensation for the decrease in the value of the money originally invested because of inflation, h . The third component represents compensation for the fact that the dollars earned on the investment are also worth less because of the inflation.

This third component is usually small, so it is often dropped. The nominal rate is then approximately equal to the real rate plus the inflation rate:

$$R \approx r + h \quad [5.4]$$

Fisher's thinking is that investors are not foolish. They know that inflation reduces purchasing power, and therefore, they will demand an increase in the nominal rate before lending money. Fisher's hypothesis, typically called the **Fisher effect**, can be stated as:

A rise in the rate of inflation causes the nominal rate to rise just enough so that the real rate of interest is unaffected. In other words, the real rate is invariant to the rate of inflation.

EXAMPLE 5.5

The Fisher Effect

If investors require a 2 percent real rate of return, and the inflation rate is 8 percent, what must be the approximate nominal rate? The exact nominal rate?

First of all, the nominal rate is approximately equal to the sum of the real rate and the inflation rate: 2 percent + 8 percent = 10 percent. From the Fisher effect, we have:

$$\begin{aligned}1 + R &= (1 + r) \times (1 + h) \\ &= 1.02 \times 1.08 \\ &= 1.1016\end{aligned}$$

Therefore, the nominal rate will actually be closer to 10.16 percent. In this example, you can also see how negative nominal interests can come about, e.g., in the unusual situation when inflation rates are expected to be sufficiently negative.

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It is important to note that financial rates, such as interest rates, discount rates, and rates of return, are almost always quoted in nominal terms. To remind you of this, we will henceforth use the symbol R instead of r in most of our discussions about such rates. page 154

5.7 DETERMINANTS OF BOND YIELDS



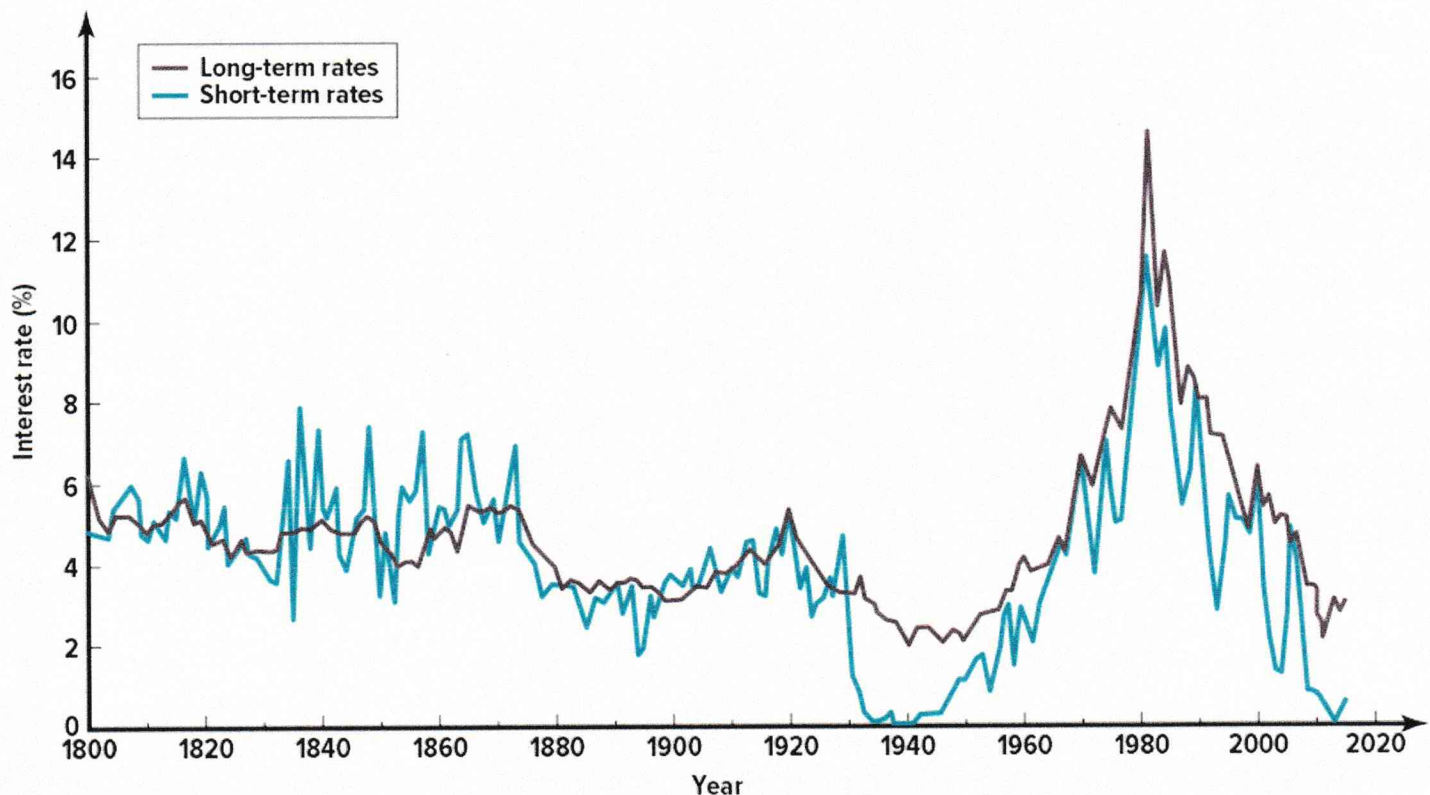
www.mhhe.com/RossCore5e

We are now in a position to discuss the determinants of a bond's yield. As we will see, the yield on any particular bond is a reflection of a variety of factors, some common to all bonds and some specific to the issue under consideration.

The Term Structure of Interest Rates

At any point in time, short-term and long-term interest rates will generally be different. Sometimes short-term rates are higher, sometimes lower. Figure 5.5 gives us a long-range perspective on this by showing about two centuries of short- and long-term U.S. Treasury interest rates. As shown, through time, the difference between short- and long-term rates has ranged from essentially zero to up to several percentage points, both positive and negative.

FIGURE 5.5
U.S. Interest Rates: 1800–2015



Source: Jeremy J. Siegel, *Stocks for the Long Run*, 4th edition, © McGraw-Hill, 2008, updated by the authors.

The relationship between short- and long-term interest rates is known as the **term structure of interest rates**. To be a little more precise, the term structure of interest rates tells us what *nominal* interest rates are on *default-free, pure discount* bonds of all maturities. These rates are, in essence, “pure” interest rates because they involve no risk of default and a single, lump-sum future payment. In other words, the term structure tells us the pure time value of money for different lengths of time.

When long-term rates are higher than short-term rates, we say that the term structure is upward sloping, and, when short-term rates are higher, we say it is downward sloping. The term structure can also be “humped.” When this occurs, it is usually because rates increase at first, but then begin to decline as we look at longer- and longer-term rates. The most

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common shape of the term structure, particularly in modern times, is upward sloping, but the degree of steepness has varied quite a bit. page 155

What determines the shape of the term structure? There are three basic components. The first two are the ones we discussed in our previous section, the real rate of interest and the rate of inflation. The real rate of interest is the compensation investors demand for forgoing the use of their money. You can think of it as the pure time value of money after adjusting for the effects of inflation.

The real rate of interest is the basic component underlying every interest rate, regardless of the time to maturity. When the real rate is high, all interest rates will tend to be higher, and vice versa. Thus, the real rate doesn't really determine the shape of the term structure; instead, it mostly influences the overall level of interest rates.

In contrast, the prospect of future inflation very strongly influences the shape of the term structure. Investors thinking about loaning money for various lengths of time recognize that future inflation erodes the value of the dollars that will be returned. As a result, investors demand compensation for this loss in the form of higher nominal rates. This extra compensation is called the **inflation premium**.

If investors believe that the rate of inflation will be higher in the future, then long-term nominal interest rates will tend to be higher than short-term rates. Thus, an upward-sloping term structure may be a reflection of anticipated increases in inflation. Similarly, a downward-sloping term structure probably reflects the belief that inflation will be falling in the future.

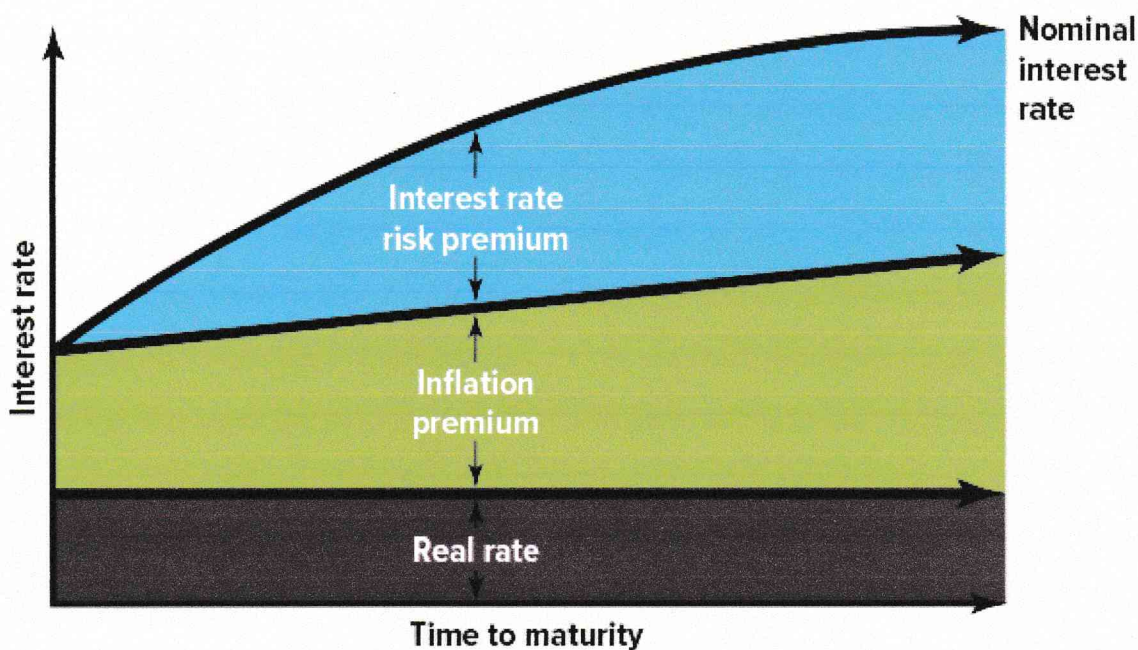
The third, and last, component of the term structure has to do with interest rate risk. As we discussed earlier in the chapter, longer-term bonds have much greater risk of loss resulting from changes in interest rates than do shorter-term bonds. Investors recognize this risk, and they demand extra compensation in the form of higher rates for bearing it. This extra compensation is called the **interest rate risk premium**. The longer the term to maturity, the greater is the interest rate risk, so the interest rate risk premium increases with maturity. However, as we discussed earlier, interest rate risk increases at a decreasing rate, so the interest rate risk premium does as well.⁷

Putting the pieces together, we see that the term structure reflects the combined effect of the real rate of interest, the inflation premium, and the interest rate risk premium. Figure 5.6 shows how these can interact to produce an upward-sloping term structure (in the top part of Figure 5.6) or a downward-sloping term structure (in the bottom part).

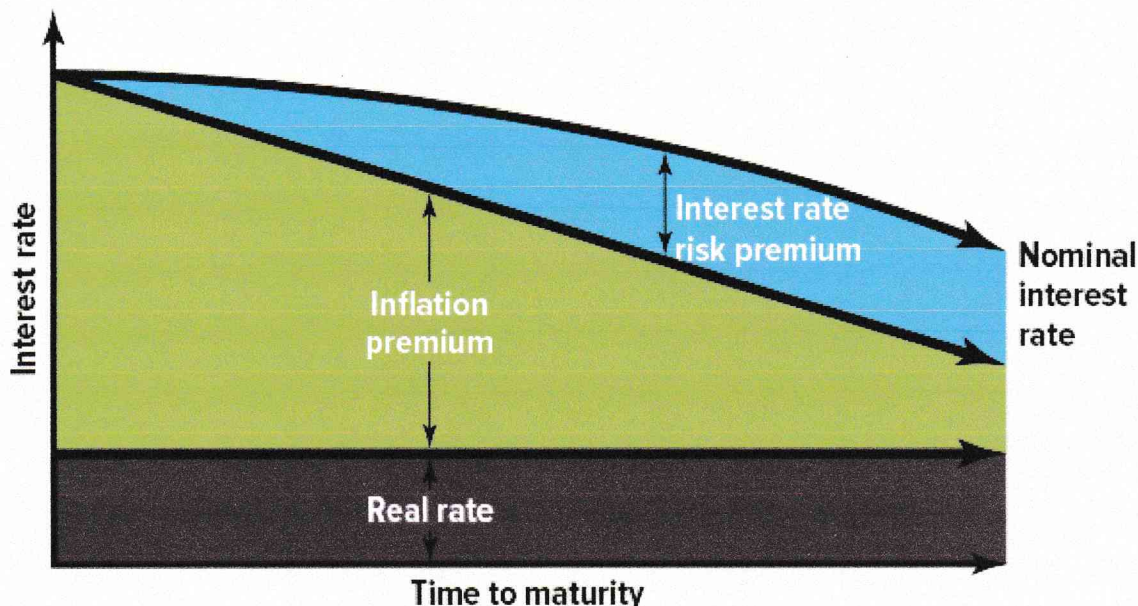
FIGURE 5.6

The Term Structure of Interest Rates

A. Upward-sloping term structure



B. Downward-sloping term structure



In the top part of Figure 5.6, notice how the rate of inflation is expected to rise gradually. At the same time, the interest rate risk premium increases at a decreasing rate, so the combined effect is to produce a pronounced upward-sloping term structure. In the bottom part of Figure 5.6, the rate of inflation is expected to fall in the future, and the expected decline is enough to offset the interest rate risk premium and produce a downward-sloping term structure. Notice that if the rate of inflation was expected to decline by only a small amount, we could still get an upward-sloping term structure because of the interest rate risk premium.

We assumed in drawing Figure 5.6 that the real rate would remain the same. Actually, expected future real rates could be larger or smaller than the current real rate. Also, for simplicity, we used straight lines to show expected future inflation rates as rising or declining, but they do not necessarily have to look like this. They could, for example, rise and then fall, leading to a humped yield curve.

Bond Yields and the Yield Curve: Putting It All Together

Going back to Figure 5.4, recall that we saw that the yields on Treasury notes and bonds of different maturities are not the same. Each day, in addition to the Treasury prices and yields shown in Figure 5.4, the U.S Treasury Department website provides a plot of Treasury

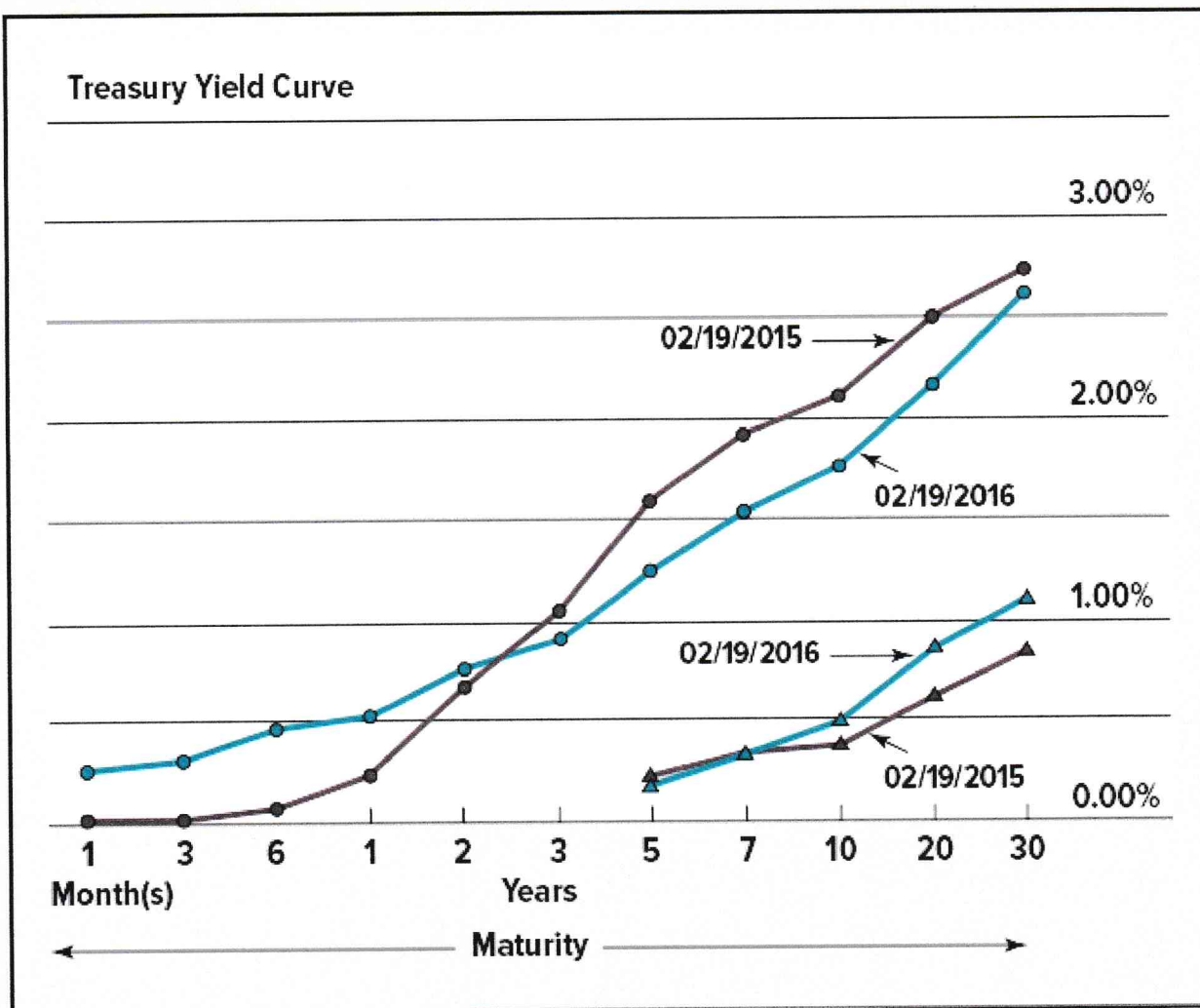
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yields relative to maturity. This plot is called the **Treasury yield curve** (or just the yield curve). Figure 5.7 shows the yield curve as of February 2016. Note, the yield curve available on the U.S. Treasury website will display both the nominal and real yield curves.

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FIGURE 5.7

The Treasury Yield Curve: February 19, 2016



Source: <https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/Historic-Yield-Data-Visualization.aspx>, February 19, 2016.

Online yield curve information is available at www.bloomberg.com/markets.

As you probably now suspect, the shape of the yield curve is a reflection of the term structure of interest rates. In fact, the Treasury yield curve and the term structure of interest rates are almost the same thing. The only difference is that the term structure is based on pure discount bonds, whereas the yield curve is based on coupon bond yields. As a result, Treasury yields depend on the three components that underlie the term structure—the real rate, expected future inflation, and the interest rate risk premium.

To see the current Treasury yield curve, check out the Data and Charts Center at: www.treasury.gov.

Treasury notes and bonds have three important features that we need to remind you of: they are default-free, they are taxable, and they are highly liquid. This is not true of bonds in general, so we need to examine what additional factors come into play when we look at bonds issued by corporations or municipalities.

The first thing to consider is credit risk, that is, the possibility of default. Investors recognize that issuers other than the Treasury may or may not make all the promised payments on a bond, so they demand a higher yield as compensation for this risk. This extra compensation is called the **default risk premium**. Earlier in the chapter, we saw how bonds were rated based on their credit risk. What you will find if you start looking at bonds of different ratings is that lower-rated bonds have higher yields.

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An important thing to recognize about a bond's yield is that it is calculated assuming that all the promised payments will be made. As a result, it is really a promised yield, and it may or may not be what you will earn. In particular, if the issuer defaults, your actual yield will be lower, probably much lower. This fact is particularly important when it comes to junk bonds. Thanks to a clever bit of marketing, such bonds are now commonly called high-yield bonds, which has a much nicer ring to it; but now you recognize that these are really high *promised* yield bonds.

Next, recall that we discussed earlier how municipal bonds are free from most taxes and, as a result, have much lower yields than taxable bonds. Investors demand the extra yield on a taxable bond as compensation for the unfavorable tax treatment. This extra compensation is the **taxability premium**.

Finally, bonds have varying degrees of liquidity. As we discussed earlier, there are an enormous number of bond issues, most of which do not trade on a regular basis. As a result, if you wanted to sell quickly, you would probably not get as good a price as you could otherwise. Investors prefer liquid assets to illiquid ones, so they demand a **liquidity premium** on top of all the other premiums we have discussed. As a result, all else being the same, less liquid bonds will have higher yields than more liquid bonds.

Conclusion

If we combine all of the things we have discussed regarding bond yields, we find that bond yields represent the combined effect of no fewer than six things. The first is the real rate of interest. On top of the real rate are five premiums representing compensation for (1) expected future inflation, (2) interest rate risk, (3) default risk, (4) taxability, and (5) lack of liquidity. As a result, determining the appropriate yield on a bond requires careful analysis of each of these effects.

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transparency. However, unlike the situation with bond markets in general, trading in Treasury issues, particularly recently issued ones, is very heavy. Each day, representative prices for outstanding Treasury issues are reported. page 150

The Federal Reserve Bank of St. Louis maintains dozens of online files containing macroeconomic data as well as rates on U.S. Treasury issues. Go to research.stlouisfed.org/fred2/.

Figure 5.4 shows a portion of the daily Treasury bond listings from the website wsj.com. Examine the entry that begins “02/15/2026.” Reading from left to right, the “02/15/2026” tells us that the bond’s maturity is February 15, 2026. The 1.625 is the bond’s coupon rate.

FIGURE 5.4

Sample *Wall Street Journal* U.S. Treasury Bond Prices

Treasury Bonds

Maturity	Coupon	Bid	Asked	Chg	Asked yield
3/31/2016	2.375	100.1953	100.2109	-0.0313	0.34
1/31/2017	0.875	100.2813	100.2969	0.0078	0.558
4/15/2018	0.75	99.9219	99.9375	-0.0547	0.779
4/30/2018	0.625	99.6328	99.6484	-0.0703	0.787
5/15/2019	3.125	106.8984	106.9141	-0.0625	0.945
5/31/2020	1.375	100.8594	100.875	-0.0625	1.164
6/30/2021	2.125	104.1563	104.1719	0.0156	1.315
8/15/2022	7.25	135.8906	135.9063	-0.0313	1.429
8/15/2023	2.5	106.8125	106.8281	0.0625	1.531
11/15/2024	2.25	104.5078	104.5234	0.125	1.69
8/15/2025	6.875	145.0703	145.0859	0.0469	1.705
2/15/2026	1.625	98.875	98.8906	0.1172	1.747
2/15/2027	6.625	147.7656	147.8281	0.1094	1.804
8/15/2028	5.5	139.5156	139.5781	0.1406	1.919
2/15/2029	5.25	137.6094	137.6719	0.1328	1.951
5/15/2030	6.25	152.7344	152.7969	0.1641	1.975
2/15/2031	5.375	143.5625	143.625	0.2422	1.992
2/15/2036	4.5	138.2656	138.3281	0.3906	2.134
2/15/2037	4.75	142.6641	142.7266	0.3594	2.197
2/15/2038	4.375	136.2188	136.2813	0.4375	2.269
8/15/2039	4.5	138.0625	138.125	0.4688	2.373
5/15/2040	4.375	135.6797	135.7109	0.3984	2.419
11/15/2041	3.125	112.1641	112.1953	0.4766	2.481
8/15/2042	2.75	104.0234	104.0547	0.5156	2.539
5/15/2044	3.375	116.7656	116.7969	0.5859	2.538
8/15/2045	2.875	105.6484	105.6797	0.5781	2.598
11/15/2045	3	108.4844	108.5156	0.6016	2.588
2/15/2046	2.5	97.8281	97.8594	0.5391	2.603

Source: *The Wall Street Journal*, February 19, 2016.

The next two pieces of information are the **bid** and **asked prices**. In general, in any OTC or dealer market, the bid price represents what a dealer is willing to pay for a security, and the asked price (or just “ask” price) is what a dealer is willing to take for it. The difference between the two prices is called the **bid-ask spread** (or just “spread”), and it represents the dealer’s profit.

Treasury prices are quoted as a percentage of face value. The bid price, or what a dealer is willing to pay, on the 02/15/2026 bond is 98.875. With a \$1,000 face value, this quote represents \$988.75. The asked price, or the price at which the dealer is willing to sell the bond, is 98.8906, or \$988.906.

The next number quoted is the change in the asked price from the previous day, measured as a percentage of face value, so this issue’s asked price rose by .1172 percent, or \$1.172, in value from the previous day. Finally, the last number reported is the yield to maturity, based on the asked price. Notice that this is a discount bond

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The last bond listed, the 02/15/2046, is often called the “bellwether” bond. This bond’s yield is the one that is usually reported in the evening news. So, for example, when you hear that long-term interest rates rose, what is really being said is that the yield on this bond went up (and its price went down).

Current and historical Treasury yield information is available at www.publicdebt.treas.gov/.

If you examine the yields on the various issues in Figure 5.4, you will clearly see that they vary by maturity. Why this occurs and what it might mean are some of the things we discuss in our next section. Government (referred to as “sovereign”) bond yields also vary by country of origin. Below we show the 10-year bond yields of several countries. The yields vary according to default risks and foreign exchange risks (to be discussed later in the text).

SELECTED INTERNATIONAL GOVERNMENT 10-YEAR BOND YIELDS

	YIELD (%)
Switzerland	-.36
Japan	.00
Germany	.20
United Kingdom	1.41
United States	1.75
Australia	2.43
Mexico	3.96
Brazil	6.87
Greece	10.25

EXAMPLE 5.4

Treasury Quotes

Locate the Treasury issue in Figure 5.4 that matures on May 15, 2019. What is its coupon rate? What is its bid price? What was the *previous day's* asked price?

The bond listed as 05/15/2019 is the one we seek. Its coupon rate is 3.125 percent of face value. The bid price is 106.8984, or 106.8984 percent of face value. The ask price is 106.9141, which is down by .0625 from the previous day. This means that the ask price on the previous day was equal to $106.9141 + .0625 = 106.9766$.

A Note on Bond Price Quotes

If you buy a bond between coupon payment dates, the price you pay is usually more than the price you are quoted. The reason is that standard convention in the bond market is to quote prices net of “accrued interest,” meaning that accrued interest is deducted to arrive at the quoted price. This quoted price is called the **clean**

price. The price you actually pay, however, includes the accrued interest. This price is the **dirty price**, also known as the “full” or “invoice” price.

An example is the easiest way to understand these issues. Suppose you buy a bond with a 12 percent annual coupon, payable semiannually. You actually pay \$1,080 for this bond, so \$1,080 is the dirty, or invoice, price. Further, on the day you buy it, the next coupon is due in four months, so you are between coupon dates. Notice that the next coupon will be \$60.