Chapter 9

Interest Rates
Our goal in this chapter is to discuss the many different interest rates that are commonly reported in the financial press.

We will also:
- Find out how different interest rates are calculated and quoted, and
- Discuss theories of what determines interest rates.
U.S. Interest Rate History, 1800-2005

FIGURE 9.1  Interest Rate History (U.S. Interest Rates, 1800–2005)

Money Market Interest Rates

**Money Rates**

The key U.S. and foreign annual interest rates below are a guide to general levels but don't always represent actual transactions.

**Commercial Paper**
Yields paid by corporations for short-term financing, typically for daily operations.

<table>
<thead>
<tr>
<th>Rate Type</th>
<th>Yield (%)</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-month</td>
<td>3.35%</td>
<td>2004</td>
</tr>
<tr>
<td>6-month</td>
<td>3.43%</td>
<td>2004</td>
</tr>
<tr>
<td>1-year</td>
<td>3.45%</td>
<td>2004</td>
</tr>
</tbody>
</table>

**Prime Rate**
A 4.50% effective 06/05/05.

**Discount Rate (Primary)**
4.50% effective 06/05/05.

**Call Money**
3.25% effective 01/09/05.

**Money Market**
Placed directly by General Electric Capital Corp.:
- 3.60% to 4.59% 50 to 65 days
- 3.65% to 4.99% 60 to 90 days
- 3.75% to 4.99% 90 to 120 days
- 3.80% to 4.99% 120 to 180 days
- 3.90% to 4.99% 180 to 270 days

**Euro Commercial Paper**
Placed directly by General Electric Capital Corp.:
- 0.90% 1-month
- 1.10% 2-month
- 1.20% 3-month
- 1.30% 4-month
- 1.50% 5-month
- 1.70% 6-month

**Dealer Commercial Paper**
High-grade unsecured notes sold through dealers by major corporations:
- 1.80% 30 days
- 2.00% 60 days
- 2.20% 90 days
- 2.40% 120 days
- 2.60% 180 days

**Certificates of Deposits**
- 2.35% 3-month
- 2.50% 6-month
- 2.75% 12-month
- 3.00% 2-year
- 3.25% 3-year
- 3.50% 5-year

**London Interbank Offered Rates (Libor)**
- 1.60% 1-month
- 1.90% 3-month
- 2.20% 6-month
- 2.50% 1-year

**Euro Interbank Offered Rates (Euribor)**
- 1.10% 1-month
- 1.30% 3-month
- 1.50% 6-month

**Treasury Bills**
- 3.70% 3-month
- 4.00% 6-month
- 4.30% 12-month

Money Market Rates, I.

- **Prime rate** - The basic interest rate on short-term loans that the largest commercial banks charge to their most creditworthy corporate customers.

- **Bellwether rate** - Interest rate that serves as a leader or as a leading indicator of future trends, e.g. inflation.

- **Federal funds rate** - Interest rate that banks charge each other for overnight loans of $1 million or more.

- **Discount rate** - The interest rate that the Fed offers to commercial banks for overnight reserve loans.
Money Market Rates, II.

- **Call money rate** - The interest rate brokerage firms pay for call money loans from banks. This rate is used as the basis for customer rates on margin loans.

- **Commercial paper** - Short-term, unsecured debt issued by the largest corporations.

- **Certificate of deposit (CD)** - Large-denomination deposits of $100,000 or more at commercial banks for a specified term.

- **Banker’s acceptance** - A postdated check on which a bank has guaranteed payment. Commonly used to finance international trade transactions.
Money Market Rates, III.

- **Eurodollars** - U.S. dollar denominated deposits in banks outside the United States.

- **London Interbank Offered Rate (LIBOR)** - Interest rate that international banks charge one another for overnight Eurodollar loans.

Money Market Prices and Rates

- A **Pure Discount Security** is an interest-bearing asset:
  - It makes a **single payment** of face value **at maturity**.
  - It makes **no payments before maturity**.

- **There are several different ways market participants quote interest rates.**
  - Banker’s Discount Basis
  - Bond Equivalent Yields (BEY)
  - Annual Percentage Rates (APR)
  - Effective Annual Rates (EAR)
The Bank Discount Basis

- The *Bank Discount Basis* is a method of quoting interest rates on money market instruments.
  - It is commonly used for T-bills and banker’s acceptances.

- The formula is:

\[
\text{Current Price} = \text{Face Value} \times \left(1 - \frac{\text{Days to Maturity}}{360} \times \text{Discount Yield}\right)
\]

- Note that we use 360 days in a year in this (and many other) money market formula.
- The term “discount yield” here simply refers to the quoted interest rate.
Example: Calculating a Price Using a Bank Discount Rate

• Suppose a banker’s acceptance that will be paid is 90 days has a face value of $1,000,000.
• If the discount yield is 5%, what is the current price of the banker’s acceptance?

\[
\text{Current Price} = \text{Face Value} \times \left(1 - \frac{\text{Days to maturity}}{360} \times \text{Discount yield}\right)
\]

\[
= $1,000,000 \times \left(1 - \frac{90}{360} \times 0.05\right)
\]

\[
= $1,000,000 \times (1 - 0.0125)
\]

\[
= $987,500.
\]
FIGURE 9.3

U.S. Treasury Bills

<table>
<thead>
<tr>
<th>MatURITY</th>
<th>DAYS TO MAT</th>
<th>BID</th>
<th>ASKED</th>
<th>CHG</th>
<th>ASK YLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 08 05</td>
<td>1</td>
<td>3.26</td>
<td>3.25</td>
<td>0.01</td>
<td>3.30</td>
</tr>
<tr>
<td>Sep 15 05</td>
<td>8</td>
<td>3.45</td>
<td>3.44</td>
<td>-0.01</td>
<td>3.49</td>
</tr>
<tr>
<td>Sep 22 05</td>
<td>15</td>
<td>3.32</td>
<td>3.31</td>
<td>0.01</td>
<td>3.36</td>
</tr>
<tr>
<td>Sep 29 05</td>
<td>22</td>
<td>3.32</td>
<td>3.31</td>
<td>0.01</td>
<td>3.36</td>
</tr>
<tr>
<td>Oct 06 05</td>
<td>29</td>
<td>3.29</td>
<td>3.28</td>
<td>-0.01</td>
<td>3.33</td>
</tr>
<tr>
<td>Oct 13 05</td>
<td>36</td>
<td>3.26</td>
<td>3.25</td>
<td>-0.01</td>
<td>3.31</td>
</tr>
<tr>
<td>Oct 20 05</td>
<td>43</td>
<td>3.27</td>
<td>3.26</td>
<td>0.01</td>
<td>3.32</td>
</tr>
<tr>
<td>Oct 27 05</td>
<td>50</td>
<td>3.27</td>
<td>3.26</td>
<td>-0.01</td>
<td>3.32</td>
</tr>
<tr>
<td>Nov 03 05</td>
<td>57</td>
<td>3.33</td>
<td>3.32</td>
<td>0.02</td>
<td>3.38</td>
</tr>
<tr>
<td>Nov 10 05</td>
<td>64</td>
<td>3.24</td>
<td>3.23</td>
<td>0.02</td>
<td>3.40</td>
</tr>
<tr>
<td>Nov 17 05</td>
<td>71</td>
<td>3.36</td>
<td>3.35</td>
<td>0.02</td>
<td>3.42</td>
</tr>
<tr>
<td>Nov 24 05</td>
<td>78</td>
<td>3.40</td>
<td>3.39</td>
<td>0.04</td>
<td>3.46</td>
</tr>
<tr>
<td>Dec 01 05</td>
<td>85</td>
<td>3.43</td>
<td>3.42</td>
<td>0.02</td>
<td>3.50</td>
</tr>
<tr>
<td>Dec 08 05</td>
<td>92</td>
<td>3.43</td>
<td>3.42</td>
<td>0.02</td>
<td>3.50</td>
</tr>
<tr>
<td>Dec 15 05</td>
<td>99</td>
<td>3.39</td>
<td>3.38</td>
<td>0.02</td>
<td>3.46</td>
</tr>
<tr>
<td>Dec 22 05</td>
<td>106</td>
<td>3.42</td>
<td>3.41</td>
<td>0.02</td>
<td>3.49</td>
</tr>
<tr>
<td>Dec 29 05</td>
<td>113</td>
<td>3.45</td>
<td>3.44</td>
<td>0.03</td>
<td>3.53</td>
</tr>
<tr>
<td>Jan 05 06</td>
<td>120</td>
<td>3.46</td>
<td>3.47</td>
<td>0.04</td>
<td>3.56</td>
</tr>
<tr>
<td>Jan 12 06</td>
<td>127</td>
<td>3.49</td>
<td>3.48</td>
<td>0.04</td>
<td>3.57</td>
</tr>
<tr>
<td>Jan 19 06</td>
<td>134</td>
<td>3.50</td>
<td>3.49</td>
<td>0.04</td>
<td>3.59</td>
</tr>
<tr>
<td>Jan 26 06</td>
<td>141</td>
<td>3.51</td>
<td>3.50</td>
<td>0.04</td>
<td>3.60</td>
</tr>
<tr>
<td>Feb 02 06</td>
<td>148</td>
<td>3.53</td>
<td>3.52</td>
<td>0.05</td>
<td>3.62</td>
</tr>
<tr>
<td>Feb 09 06</td>
<td>155</td>
<td>3.52</td>
<td>3.51</td>
<td>0.04</td>
<td>3.61</td>
</tr>
<tr>
<td>Feb 16 06</td>
<td>162</td>
<td>3.54</td>
<td>3.53</td>
<td>0.04</td>
<td>3.64</td>
</tr>
<tr>
<td>Feb 23 06</td>
<td>169</td>
<td>3.55</td>
<td>3.54</td>
<td>0.06</td>
<td>3.65</td>
</tr>
<tr>
<td>Mar 02 06</td>
<td>176</td>
<td>3.57</td>
<td>3.56</td>
<td>0.06</td>
<td>3.67</td>
</tr>
</tbody>
</table>

Figure 9.3 shows a T-bill that expires February 9, 2006.
- It has 155 days to maturity.
- The bid discount is 3.52 (you use this to calculate the bid price, i.e., the price you will receive for the T-bill).
- Prices are quoted for $1,000,000 face values.

\[
\text{Current T-bill Price} = \text{Face Value} \times \left(1 - \frac{\text{Days to maturity}}{360} \times \text{Discount yield}\right)
\]

\[
= $1,000,000 \times \left(1 - \frac{155}{360} \times 0.0352\right)
\]

\[
= $1,000,000 \times (1 - 0.015156)
\]

\[
= $984,844.44
\]

Verify that the ask price is $984,887.50.
Bond Equivalent Yields

- Bond Equivalent Yields (BEY) are another way to quote an interest rate.

- You can convert a bank discount yield to a bond equivalent yield using this formula:

\[
BEY = \frac{365 \times \text{Discount yield}}{360 - \text{Days to maturity} \times \text{Discount yield}}
\]

*Note that this formula is correct only for maturities of six months or less. Moreover, if February 29 occurs within the next 12 months, use 366 days.*
Example I: Bond Equivalent Yield

Figure 9.3 shows a T-bill that expires February 9, 2006.

- It has 155 days to maturity.
- The **bid** discount is 3.52.
- What is the Bond Equivalent (bid) Yield?

\[
\text{BEY} = \frac{365 \times \text{Discount yield}}{360 - \text{Days to maturity} \times \text{Discount yield}}
\]

\[
\text{BEY} = \frac{365 \times 0.0352}{360 - 155 \times 0.0352}
\]

\[
= 0.036238, \quad \text{or about} \quad 3.62\%.
\]

Remember to multiply before you subtract.
Example II: Calculating T-bill Prices Using Bond Equivalent Yield

- We can calculate a Treasury bill asking price using the “asked” yield, which is a bond equivalent yield.
- Look at Figure 9.3 for the T-bill that expires on February 9, 2006.
  - It has 155 days to maturity.
  - The ask yield is 3.61.

\[
\text{Bill Ask Price} = \frac{\text{Face Value}}{1 + \text{Bond Equivalent Yield} \times \frac{\text{Days to Maturity}}{365}}
\]

\[
= \frac{\$1,000,000}{1 + 0.0361 \times \frac{155}{365}}
\]

\[
= \frac{\$1,000,000}{1.0153301}
\]

\[
= \$984,901.33.
\]

Note: The bill’s ask price differs from a previous slide by about $14 due to rounding of the reported asked yield. It’s really 3.6134% (verify using the BEY formula)
More Ways to Quote Interest Rates

• “Simple” interest basis - Another method to quote interest rates.
  – Calculated just like annual percentage rates (APRs).
  – Used for CDs.
  – The bond equivalent yield on a T-bill with less than six months to maturity is also an APR.

• An APR understates the true interest rate, which is usually called the effective annual rate (EAR).
Example: The BEY on a T-bill is Really Just an APR

• Earlier, using the bid discount rate, we calculated a bid price for a 155-day T-bill to be $984,844.44.
  – At maturity, this T-bill will be worth $1,000,000.
  – You will earn $15,155.56 of interest on an investment of $984,844.44 over 155 days, a percentage return of 1.5389%.
  – In a 365-day year, there are 365/155 = 2.3548 periods of 155 days in length.
  – 1.5389 times 2.3548 is 3.6238%.

• This is the bond equivalent (bid) yield that we calculated before.

Note: The Wall Street Journal rounds ask yields 2 decimal places.
Converting APRs to EARs

• In general, if we let \( m \) be the number of periods in a year, an APR can be converted to an EAR as follows:

\[
1 + \text{EAR} = \left(1 + \frac{\text{APR}}{m}\right)^m
\]

• EARs are sometimes called effective annual yields, effective yields, or annualized yields.
Example I: What is the EAR of this T-bill’s BEY (aka APR)?

\[ 1 + \text{EAR} = \left(1 + \frac{\text{APR}}{m}\right)^m \]

\[ 1 + \text{EAR} = \left(1 + \frac{0.036238}{2.3548}\right)^{2.3548} \]

\[ = 1.015389^{2.3548} \]

\[ = 1.036616 \]

so, the EAR= 3.6616%.

Note that when interest rates are low, the APR will be close to the EAR.
Example II: Converting Credit Card APRs to EARs

- Some Credit Cards quote an APR of 18%.
  - 18% is used because $18 = 12 \times 1.50$
  - That is, the monthly rate is really 1.50%.
  - What is the EAR?

\[
1 + \text{EAR} = \left(1 + \frac{\text{APR}}{m}\right)^m
\]

\[
1 + \text{EAR} = \left(1 + \frac{0.18}{12}\right)^{12}
\]

\[
= 1.015^{12}
\]

\[
= 1.1956
\]

so, the EAR = 19.56%.  

Ouch.
Treasury Bill Price and Yield Calculations

A Treasury bill traded on February 23, 2005 pays $100 on May 15, 2005. Assuming a discount rate of 4.25 percent, what are its price and bond equivalent yield? Hint: Use the Excel functions TBILLPRICE and TBILLEQ.


What is the effective annual rate (EAR) on this T-bill? Hint: Use the Excel function EFFECT.

- \#NAME? \=EFFECT(B10,12)
Rates and Yields on Fixed-Income Securities

• Fixed-income securities include long-term debt contracts from a wide variety of issuers:
  – The U.S. government,
  – Real estate purchases (mortgage debt),
  – Corporations, and
  – Municipal governments

• When issued, fixed-income securities have a maturity of greater than one year.

• When issued, money market securities have a maturity of less than one year.
The Treasury Yield Curve

• The *Treasury yield curve* is a plot of Treasury yields against maturities.

• It is fundamental to bond market analysis, because it represents the interest rates for default-free lending across the maturity spectrum.
Example: The Treasury Yield Curve

U.S. Treausuries

**Bills**

<table>
<thead>
<tr>
<th>COUPON</th>
<th>MATURITY DATE</th>
<th>CURRENT PRICE/YIELD</th>
<th>PRICE/YIELD CHANGE</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Month</td>
<td>N.A.</td>
<td>12/08/2005</td>
<td>3.40/3.48</td>
<td>0.02/-0.020</td>
</tr>
<tr>
<td>6-Month</td>
<td>N.A.</td>
<td>03/09/2006</td>
<td>3.60/3.72</td>
<td>0.03/-0.004</td>
</tr>
</tbody>
</table>

**Notes/Bonds**

<table>
<thead>
<tr>
<th>COUPON</th>
<th>MATURITY DATE</th>
<th>CURRENT PRICE/YIELD</th>
<th>PRICE/YIELD CHANGE</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Year</td>
<td>4.000</td>
<td>08/31/2007</td>
<td>100-07/9.87</td>
<td>0.00/-0.001</td>
</tr>
<tr>
<td>3-Year</td>
<td>4.125</td>
<td>08/15/2008</td>
<td>100-20/3.88</td>
<td>0.00/-0.004</td>
</tr>
<tr>
<td>5-Year</td>
<td>3.875</td>
<td>09/15/2010</td>
<td>99-24/3.93</td>
<td>0.02/-0.019</td>
</tr>
<tr>
<td>10-Year</td>
<td>4.250</td>
<td>08/15/2015</td>
<td>101-01/4.12</td>
<td>0.06/-0.025</td>
</tr>
<tr>
<td>30-Year</td>
<td>5.375</td>
<td>02/15/2031</td>
<td>114-27/4.40</td>
<td>0.18/-0.034</td>
</tr>
</tbody>
</table>

© Bloomberg LP
### Yield Comparisons

**Treasury Yield Curve**
Yield to maturity of current bills, notes and bonds.

<table>
<thead>
<tr>
<th>Month(s)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>10</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Year Ago</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
<td>7.0</td>
</tr>
<tr>
<td>1 Month Ago</td>
<td>0.0</td>
<td>1.0</td>
<td>2.0</td>
<td>3.0</td>
<td>4.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Source: Reuters

### Yield Comparisons
Based on Merrill Lynch Bond Indexes, priced as of midafternoon Eastern time.

<table>
<thead>
<tr>
<th></th>
<th>9/2</th>
<th>9/1</th>
<th>52-Week High</th>
<th>52-Week Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corp. Govt. Master</td>
<td>4.32%</td>
<td>4.30%</td>
<td>4.70%</td>
<td>3.73%</td>
</tr>
<tr>
<td><strong>Treasury</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-10 yr</td>
<td>3.81%</td>
<td>3.79%</td>
<td>4.22%</td>
<td>2.83%</td>
</tr>
<tr>
<td>10+ yr</td>
<td>4.29%</td>
<td>4.28%</td>
<td>4.93%</td>
<td>4.18%</td>
</tr>
<tr>
<td><strong>Agencies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-10 yr</td>
<td>4.08%</td>
<td>4.07%</td>
<td>4.48%</td>
<td>3.11%</td>
</tr>
<tr>
<td>10+ yr</td>
<td>4.66%</td>
<td>4.65%</td>
<td>5.35%</td>
<td>4.49%</td>
</tr>
<tr>
<td><strong>Corporate</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-10 yr High Quality</td>
<td>4.40%</td>
<td>4.39%</td>
<td>4.78%</td>
<td>3.53%</td>
</tr>
<tr>
<td>Medium Quality</td>
<td>4.76%</td>
<td>4.74%</td>
<td>5.14%</td>
<td>4.06%</td>
</tr>
<tr>
<td>10+ yr High Quality</td>
<td>5.27%</td>
<td>5.26%</td>
<td>5.76%</td>
<td>5.08%</td>
</tr>
<tr>
<td>Medium Quality</td>
<td>5.54%</td>
<td>5.53%</td>
<td>6.17%</td>
<td>5.48%</td>
</tr>
<tr>
<td><strong>Yankee bonds (1)</strong></td>
<td>4.69%</td>
<td>4.68%</td>
<td>5.08%</td>
<td>4.07%</td>
</tr>
<tr>
<td><strong>Current-coupon mortgages (2)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNMA 4.99% (3)</td>
<td>4.95%</td>
<td>4.94%</td>
<td>5.38%</td>
<td>4.74%</td>
</tr>
<tr>
<td>FNMA 5.49%</td>
<td>5.17%</td>
<td>5.16%</td>
<td>5.49%</td>
<td>4.83%</td>
</tr>
<tr>
<td>FHLMC 5.49%</td>
<td>5.21%</td>
<td>5.20%</td>
<td>5.51%</td>
<td>4.89%</td>
</tr>
<tr>
<td><strong>High-yield corporates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-12 yr G.O. (AA)</td>
<td>3.57%</td>
<td>3.57%</td>
<td>3.90%</td>
<td>3.33%</td>
</tr>
<tr>
<td>12-22 yr G.O. (AA)</td>
<td>3.92%</td>
<td>3.92%</td>
<td>4.29%</td>
<td>3.63%</td>
</tr>
<tr>
<td>22+ yr revenue (A)</td>
<td>4.26%</td>
<td>4.26%</td>
<td>4.93%</td>
<td>4.22%</td>
</tr>
</tbody>
</table>

Note: High quality rated AAA-AA; medium quality A-+BB/BBa; high yield, BB/Ba-C.

(1) Dollar-denominated, SEC-registered bonds of foreign issuers sold in the U.S. (2) Reflects the 52-week high and low of mortgage-backed securities indexes rather than the individual securities shown.

(3) Government guaranteed.
The Term Structure of Interest Rates, I.

• The term structure of interest rates is the relationship between time to maturity and the interest rates for default-free, pure discount instruments.

• The term structure is sometimes called the “zero-coupon yield curve” to distinguish it from the Treasury yield curve, which is based on coupon bonds.
The term structure can be seen by examining yields on U.S. Treasury STRIPS.

STRIPS are pure discount instruments created by “stripping” the coupons and principal payments of U.S. Treasury notes and bonds into separate parts, which are then sold separately.

The term STRIPS stands for Separate Trading of Registered Interest and Principal of Securities.
An asked yield for a U.S. Treasury STRIP is an APR, calculated as two times the true semiannual rate.

Recall:

\[
\text{Present value} = \frac{\text{Future value}}{(1+r)^N}
\]

Therefore, for STRIPS:

\[
\text{STRIPS Price} = \frac{\text{Face Value}}{(1 + \frac{\text{YTM}}{2})^{2M}}
\]

M is the number of years to maturity.
### U.S. Treasury STRIPS

<table>
<thead>
<tr>
<th>MATURITY</th>
<th>TYPE</th>
<th>BID</th>
<th>ASKED</th>
<th>CHG</th>
<th>ASK</th>
<th>YLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 05</td>
<td>d</td>
<td>90.22</td>
<td>90.22</td>
<td>0.00</td>
<td>90.22</td>
<td>90.22</td>
</tr>
<tr>
<td>Nov 05</td>
<td>d</td>
<td>90.13</td>
<td>90.13</td>
<td>0.00</td>
<td>90.13</td>
<td>90.13</td>
</tr>
<tr>
<td>Dec 05</td>
<td>d</td>
<td>90.12</td>
<td>90.12</td>
<td>0.00</td>
<td>90.12</td>
<td>90.12</td>
</tr>
<tr>
<td>Jan 06</td>
<td>d</td>
<td>90.09</td>
<td>90.09</td>
<td>0.00</td>
<td>90.09</td>
<td>90.09</td>
</tr>
<tr>
<td>Feb 06</td>
<td>d</td>
<td>90.17</td>
<td>90.17</td>
<td>0.00</td>
<td>90.17</td>
<td>90.17</td>
</tr>
<tr>
<td>Mar 06</td>
<td>d</td>
<td>90.23</td>
<td>90.23</td>
<td>0.00</td>
<td>90.23</td>
<td>90.23</td>
</tr>
<tr>
<td>Apr 06</td>
<td>d</td>
<td>90.35</td>
<td>90.35</td>
<td>0.00</td>
<td>90.35</td>
<td>90.35</td>
</tr>
<tr>
<td>May 06</td>
<td>d</td>
<td>90.19</td>
<td>90.19</td>
<td>0.00</td>
<td>90.19</td>
<td>90.19</td>
</tr>
<tr>
<td>Jun 06</td>
<td>d</td>
<td>90.17</td>
<td>90.17</td>
<td>0.00</td>
<td>90.17</td>
<td>90.17</td>
</tr>
<tr>
<td>Jul 06</td>
<td>d</td>
<td>90.24</td>
<td>90.24</td>
<td>0.00</td>
<td>90.24</td>
<td>90.24</td>
</tr>
<tr>
<td>Aug 06</td>
<td>d</td>
<td>90.22</td>
<td>90.22</td>
<td>0.00</td>
<td>90.22</td>
<td>90.22</td>
</tr>
<tr>
<td>Sep 06</td>
<td>d</td>
<td>90.43</td>
<td>90.43</td>
<td>0.00</td>
<td>90.43</td>
<td>90.43</td>
</tr>
<tr>
<td>Oct 06</td>
<td>d</td>
<td>90.62</td>
<td>90.62</td>
<td>0.00</td>
<td>90.62</td>
<td>90.62</td>
</tr>
<tr>
<td>Nov 06</td>
<td>d</td>
<td>90.21</td>
<td>90.21</td>
<td>0.00</td>
<td>90.21</td>
<td>90.21</td>
</tr>
<tr>
<td>Dec 06</td>
<td>d</td>
<td>90.22</td>
<td>90.22</td>
<td>0.00</td>
<td>90.22</td>
<td>90.22</td>
</tr>
<tr>
<td>Jan 07</td>
<td>d</td>
<td>90.48</td>
<td>90.48</td>
<td>0.00</td>
<td>90.48</td>
<td>90.48</td>
</tr>
<tr>
<td>Feb 07</td>
<td>d</td>
<td>90.47</td>
<td>90.47</td>
<td>0.00</td>
<td>90.47</td>
<td>90.47</td>
</tr>
<tr>
<td>Mar 07</td>
<td>d</td>
<td>90.31</td>
<td>90.31</td>
<td>0.00</td>
<td>90.31</td>
<td>90.31</td>
</tr>
<tr>
<td>Apr 07</td>
<td>d</td>
<td>90.29</td>
<td>90.29</td>
<td>0.00</td>
<td>90.29</td>
<td>90.29</td>
</tr>
<tr>
<td>May 07</td>
<td>d</td>
<td>90.20</td>
<td>90.20</td>
<td>0.00</td>
<td>90.20</td>
<td>90.20</td>
</tr>
<tr>
<td>Jun 07</td>
<td>d</td>
<td>90.31</td>
<td>90.31</td>
<td>0.00</td>
<td>90.31</td>
<td>90.31</td>
</tr>
<tr>
<td>Jul 07</td>
<td>d</td>
<td>90.21</td>
<td>90.21</td>
<td>0.00</td>
<td>90.21</td>
<td>90.21</td>
</tr>
<tr>
<td>Aug 07</td>
<td>d</td>
<td>90.45</td>
<td>90.45</td>
<td>0.00</td>
<td>90.45</td>
<td>90.45</td>
</tr>
<tr>
<td>Sep 07</td>
<td>d</td>
<td>90.35</td>
<td>90.35</td>
<td>0.00</td>
<td>90.35</td>
<td>90.35</td>
</tr>
<tr>
<td>Oct 07</td>
<td>d</td>
<td>90.09</td>
<td>90.09</td>
<td>0.00</td>
<td>90.09</td>
<td>90.09</td>
</tr>
<tr>
<td>Nov 07</td>
<td>d</td>
<td>90.11</td>
<td>90.11</td>
<td>0.00</td>
<td>90.11</td>
<td>90.11</td>
</tr>
<tr>
<td>Dec 07</td>
<td>d</td>
<td>90.13</td>
<td>90.13</td>
<td>0.00</td>
<td>90.13</td>
<td>90.13</td>
</tr>
<tr>
<td>Jan 08</td>
<td>d</td>
<td>90.14</td>
<td>90.14</td>
<td>0.00</td>
<td>90.14</td>
<td>90.14</td>
</tr>
<tr>
<td>Feb 08</td>
<td>d</td>
<td>90.14</td>
<td>90.14</td>
<td>0.00</td>
<td>90.14</td>
<td>90.14</td>
</tr>
<tr>
<td>Mar 08</td>
<td>d</td>
<td>90.13</td>
<td>90.13</td>
<td>0.00</td>
<td>90.13</td>
<td>90.13</td>
</tr>
<tr>
<td>Apr 08</td>
<td>d</td>
<td>90.14</td>
<td>90.14</td>
<td>0.00</td>
<td>90.14</td>
<td>90.14</td>
</tr>
<tr>
<td>May 08</td>
<td>d</td>
<td>90.12</td>
<td>90.12</td>
<td>0.00</td>
<td>90.12</td>
<td>90.12</td>
</tr>
<tr>
<td>Jun 08</td>
<td>d</td>
<td>90.17</td>
<td>90.17</td>
<td>0.00</td>
<td>90.17</td>
<td>90.17</td>
</tr>
<tr>
<td>Jul 08</td>
<td>d</td>
<td>90.15</td>
<td>90.15</td>
<td>0.00</td>
<td>90.15</td>
<td>90.15</td>
</tr>
<tr>
<td>Aug 08</td>
<td>d</td>
<td>90.16</td>
<td>90.16</td>
<td>0.00</td>
<td>90.16</td>
<td>90.16</td>
</tr>
<tr>
<td>Sep 08</td>
<td>d</td>
<td>90.21</td>
<td>90.21</td>
<td>0.00</td>
<td>90.21</td>
<td>90.21</td>
</tr>
<tr>
<td>Oct 08</td>
<td>d</td>
<td>90.39</td>
<td>90.39</td>
<td>0.00</td>
<td>90.39</td>
<td>90.39</td>
</tr>
<tr>
<td>Nov 08</td>
<td>d</td>
<td>90.19</td>
<td>90.19</td>
<td>0.00</td>
<td>90.19</td>
<td>90.19</td>
</tr>
<tr>
<td>Dec 08</td>
<td>d</td>
<td>90.23</td>
<td>90.23</td>
<td>0.00</td>
<td>90.23</td>
<td>90.23</td>
</tr>
<tr>
<td>Jan 09</td>
<td>d</td>
<td>90.28</td>
<td>90.28</td>
<td>0.00</td>
<td>90.28</td>
<td>90.28</td>
</tr>
</tbody>
</table>

Example: Pricing U.S. Treasury STRIPS, I.

Let’s verify the price of the August 2015 Strip.
- The ask quote is 66:08, or $66.25.
- The ask YTM is 4.18%.
- Matures in about 10 years from the time of the quote.

\[
\text{STRIPS Price} = \frac{\text{Face Value}}{\left(1 + \frac{\text{YTM}}{2}\right)^{2 \times \text{M}}} = \frac{100}{\left(1 + \frac{0.0418}{2}\right)^{2 \times 10}}
\]

\[
= \frac{100}{\left(1 + 0.0418\right)^{2 \times 10}} = \frac{100}{1.5124} = $68.12.
\]

- Close (considering the two-decimal rounding of the ask YTM).
Example: Pricing U.S. Treasury STRIPS, II.

- Let’s calculate the YTM from the quoted price.

\[
YTM = 2 \times \left[ \frac{\text{Face Value}}{\text{STRIPS Price}} \right]^{\frac{1}{2M}} - 1
= 2 \times \left[ \left( \frac{100}{66.25} \right)^{\frac{1}{2 \times 10}} - 1 \right]
= 2 \times \left[ (1.509434)^{0.05} - 1 \right] = 0.0416, \text{ or } 4.16%.

- Close again (reported ask YTM was 4.18%).
Nominal versus Real Interest Rates

- **Nominal interest rates** are interest rates as they are observed and quoted, with no adjustment for inflation.

- **Real interest rates** are adjusted for inflation effects.

\[
\text{Real interest rate} = \text{nominal interest rate} - \text{inflation rate}
\]
Real T-bill Rates

**FIGURE 9.5** Real T-Bill Rates

Source: Federal Reserve Board of Governors and Global Financial Data.
Nominal versus Real Interest Rates

- The *Fisher Hypothesis* asserts that the general level of nominal interest rates follows the general level of inflation.

- According to the Fisher hypothesis, interest rates are, on average, higher than the rate of inflation.
Inflation Rates and T-bill Rates

Source: Federal Reserve Board of Governors and Global Financial Data.
Traditional Theories of the Term Structure

- **Expectations Theory**: The term structure of interest rates reflects financial market beliefs about future interest rates.

- **Market Segmentation Theory**: Debt markets are segmented by maturity, so interest rates for various maturities are determined separately in each segment.

- **Maturity Preference Theory**: Long-term interest rates contain a maturity premium necessary to induce lenders into making longer term loans.
Problems with Traditional Theories

- **Expectations Theory**
  - The term structure is almost always upward sloping, but interest rates have not always risen.
  - It is often the case that the term structure turns down at very long maturities.

- **Maturity Preference Theory**
  - The U.S. government borrows much more heavily short-term than long-term.
  - Many of the biggest buyers of fixed-income securities, such as pension funds, have a strong preference for long maturities.
Problems with Traditional Theories

- **Market Segmentation Theory**
  - The U.S. government borrows at all maturities.
  - Many institutional investors, such as mutual funds, are more than willing to move maturities to obtain more favorable rates.
  - There are bond trading operations that exist just to exploit perceived premiums, even very small ones.
Long-term bond prices are much more sensitive to interest rate changes than short-term bonds. This is called **interest rate risk**.

So, the modern view of the term structure suggests that:

\[ NI = RI + IP + RP \]

In this equation:

- **NI** = Nominal interest rate
- **RI** = Real interest rate
- **IP** = Inflation premium
- **RP** = Interest rate risk premium
Modern Term Structure Theory, II.

**FIGURE 9.8** The Term Structure of Interest Rates

(a) Upward-sloping term structure

(b) Downward-sloping term structure
Modern Term Structure Theory, III.

- The previous equation showed the component of interest rates on default-free bonds that trade in a liquid market.

- Not all bonds do.

- Therefore, a *liquidity premium (LP)* and a *default premium (DP)* must be added to the previous equation:

\[ NI = RI + IP + RP + LP + DP \]
Useful Internet Sites

- [www.money-rates.com](http://www.money-rates.com) (for the latest money market rates)
- [www.gmacfs.com](http://www.gmacfs.com) (the General Motors Acceptance Corp.)
- [www.gecapital.com](http://www.gecapital.com) (General Electric Capital)
- [www.bba.org.uk](http://www.bba.org.uk) (learn more about LIBOR)
- [www.govpx.com](http://www.govpx.com) (price and yield data for U.S. Treasuries)
- [www.bondmarkets.com](http://www.bondmarkets.com) (information on fixed income securities)
- [www.bloomberg.com](http://www.bloomberg.com) (current U.S. Treasury rates)
- [www.smartmoney.com/bonds](http://www.smartmoney.com/bonds) (view a “living yield curve”)
- [www.fanniemae.com](http://www.fanniemae.com) (one of three mortgage security websites)
- [www.ginniemae.gov](http://www.ginniemae.gov) (one of three mortgage security websites)
- [www.freddiemac.com](http://www.freddiemac.com) (one of three mortgage security websites)
- [www.publicdebt.treas.gov](http://www.publicdebt.treas.gov) (information on STRIPS, and other U.S. debt)
Chapter Review, I.

• Interest Rate History and Money Market Rates
  – Interest Rate History
  – Money Market Rates

• Money Market Prices and Rates
  – Bank Discount Rate Quotes
  – Treasury Bill Quotes
  – Bank Discount Yields versus Bond Equivalent Yields
  – Bond Equivalent Yields, APRs, and EARs
Chapter Review, II.

• Rates and Yields on Fixed-Income Securities
  – The Treasury Yield Curve
  – Rates on Other Fixed-Income Investments

• The Term Structure of Interest Rates
  – Treasury STRIPS
  – Yields for U.S. Treasury STRIPS

• Nominal versus Real Interest Rates
  – Real Interest Rates
  – The Fisher Hypothesis
Chapter Review, III.

• Traditional Theories of the Term Structure
  – Expectations Theory
  – Maturity Preference Theory
  – Market Segmentation Theory

• Determinants of Nominal Interest Rates: A Modern Perspective
  – Problems with Traditional Theories
  – Modern Term Structure Theory
  – Liquidity and Default Risk