Chapter 8
Valuing Bonds

8-1.
   a. The coupon payment is:
   \[ \text{CPN} = \frac{\text{Coupon Rate} \times \text{Face Value}}{\text{Number of Coupons per Year}} = \frac{0.055 \times \$1000}{2} = \$27.50 \]

   b. The timeline for the cash flows for this bond is (the unit of time on this timeline is six-month periods):

   0 1 2 3 60
   $27.50 $27.50 $27.50 $27.50 + $1000

8-2.
   a. The maturity is 10 years.
   b. The coupon rate is 4%.
   c. The face value is $1000.

8-3.
   a. Use the following equation:

   \[
   \frac{1}{n} = \left( \frac{\text{FV}_{\frac{1}{n}}}{\text{P}} \right) \]

   \[
   1 + \text{YTM}_1 = \left( \frac{100}{95.51} \right)^{1/1} \Rightarrow \text{YTM}_1 = 4.70\% \\
   1 + \text{YTM}_2 = \left( \frac{100}{91.05} \right)^{1/2} \Rightarrow \text{YTM}_2 = 4.80\% \\
   1 + \text{YTM}_3 = \left( \frac{100}{86.38} \right)^{1/3} \Rightarrow \text{YTM}_3 = 5.00\% \\
   1 + \text{YTM}_4 = \left( \frac{100}{81.65} \right)^{1/4} \Rightarrow \text{YTM}_4 = 5.20\% \\
   1 + \text{YTM}_5 = \left( \frac{100}{76.51} \right)^{1/5} \Rightarrow \text{YTM}_5 = 5.50\% 
   \]
b. The yield curve is

![Zero Coupon Yield Curve](image)

8-4.

a. \[ P = \frac{100}{(1.05)(1.055)} = \$90.27. \]

b. \[ P = \frac{100}{(1.05)(1.055)(1.0575)(1.0595)} = \$80.57. \]

c. 6.05%

8-5.

a. \[ $1,034.74 = \frac{40}{(1 + \frac{\text{YTM}}{2})} + \frac{40}{(1 + \frac{\text{YTM}}{2})^2} + \cdots + \frac{40+1000}{(1 + \frac{\text{YTM}}{2})^{20}} \Rightarrow \frac{\text{YTM}}{2} = .01876 \Rightarrow \text{YTM} = 3.75\% \]

b. \[ PV = \frac{40}{(1 + \frac{.09}{2})} + \frac{40}{(1 + \frac{.09}{2})^3} + L + \frac{40+1000}{(1 + \frac{.09}{2})^{20}} = \$934.96. \]

8-6.

\[ 900 = \frac{C}{(1 + .06)} + \frac{C}{(1 + .06)^2} + \cdots + \frac{C+1000}{(1 + .06)^{20}} \Rightarrow C = \$36.26, \text{ so the coupon rate is } 3.626\%. \]


8-8. Bonds trading at a discount generate a return from both receiving the coupons and from receiving a face value that exceeds the price paid for the bond. As a result, the yield to maturity of discount bonds exceeds the coupon rate.
8-9.

a. \[ \frac{40}{(1 + .03375)} + \frac{40}{(1 + .03375)^2} + \cdots + \frac{40 + 1000}{(1 + .03375)^{14}} = 1,068.83 \]

b. \[ \frac{40}{(1 + .035)} + \frac{40}{(1 + .035)^2} + \cdots + \frac{40 + 1000}{(1 + .035)^{14}} = 1,054.60 \]

8-10.

a. When it was issued, the price of the bond was

\[ P = \frac{70}{(1 + .06)} + \cdots + \frac{70 + 1000}{(1 + .06)^{10}} = 1073.60 \]

b. Before the first coupon payment, the price of the bond is

\[ P = 70 + \frac{70}{(1 + .06)} + \cdots + \frac{70 + 1000}{(1 + .06)^{9}} = 1138.02 \]

c. After the first coupon payment, the price of the bond will be

\[ P = \frac{70}{(1 + .06)} + \cdots + \frac{70 + 1000}{(1 + .06)^{9}} = 1068.02 \]

8-11.

a. First, we compute the initial price of the bond by discounting its 10 annual coupons of $6 and final face value of $100 at the 5% yield to maturity:

<table>
<thead>
<tr>
<th>NPER</th>
<th>Rate</th>
<th>PV</th>
<th>PMT</th>
<th>FV</th>
<th>Excel Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5.00%</td>
<td>6</td>
<td>6</td>
<td>100</td>
<td>= PV(0.05,10,6,100)</td>
</tr>
</tbody>
</table>

Thus, the initial price of the bond = $107.72. (Note that the bond trades above par, as its coupon rate exceeds its yield).

Next we compute the price at which the bond is sold, which is the present value of the bonds cash flows when only 6 years remain until maturity:

<table>
<thead>
<tr>
<th>NPER</th>
<th>Rate</th>
<th>PV</th>
<th>PMT</th>
<th>FV</th>
<th>Excel Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5.00%</td>
<td>6</td>
<td>6</td>
<td>100</td>
<td>= PV(0.05,6,6,100)</td>
</tr>
</tbody>
</table>


Therefore, the bond was sold for a price of \$105.08. The cash flows from the investment are therefore as shown in the following timeline:

<table>
<thead>
<tr>
<th>Year</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase Bond</td>
<td>-$107.72</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receive Coupons</td>
<td>$6</td>
<td>$6</td>
<td>$6</td>
<td>$6</td>
<td></td>
</tr>
<tr>
<td>Sell Bond</td>
<td>$105.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash Flows</td>
<td>-$107.72</td>
<td>$6.00</td>
<td>$6.00</td>
<td>$6.00</td>
<td>$111.08</td>
</tr>
</tbody>
</table>

b. We can compute the IRR of the investment using the annuity spreadsheet. The PV is the purchase price, the PMT is the coupon amount, and the FV is the sale price. The length of the investment N = 4 years. We then calculate the IRR of investment = 5%. Because the YTM was the same at the time of purchase and sale, the IRR of the investment matches the YTM.

\[
\begin{array}{c|c|c|c|c|c}
\text{Given:} & \text{NPER} & \text{Rate} & \text{PV} & \text{PMT} & \text{FV} \\
\hline
\text{Solve For Rate:} & 4 & -107.72 & 6 & 105.08 & \\
\hline
\end{array}
\]

\[
\text{Excel Formula} = \text{RATE}(4,6,-107.72,105.08)
\]

8-12.

a. We can compute the price of each bond at each YTM using Eq. 8.5. For example, with a 6% YTM, the price of bond A per $100 face value is

\[ P(\text{bond A, 6\% YTM}) = \frac{100}{1.06^1} = \$41.73 \]

The price of bond D is

\[ P(\text{bond D, 6\% YTM}) = 8 \times \frac{1}{.06} \left(1 - \frac{1}{1.06^{10}}\right) + \frac{100}{1.06^{10}} = \$114.72 \]

One can also use the Excel formula to compute the price: –PV(YTM, NPER, PMT, FV).

Once we compute the price of each bond for each YTM, we can compute the % price change as

\[
\text{Percent change} = \frac{(\text{Price at 5\% YTM}) - (\text{Price at 6\% YTM})}{(\text{Price at 6\% YTM})}
\]

The results are shown in the table below:

<table>
<thead>
<tr>
<th>Bond</th>
<th>Coupon Rate</th>
<th>Maturity</th>
<th>Price at 6% YTM</th>
<th>Price at 5% YTM</th>
<th>Percentage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0%</td>
<td>15</td>
<td>$41.73</td>
<td>$48.10</td>
<td>15.3%</td>
</tr>
<tr>
<td>B</td>
<td>0%</td>
<td>10</td>
<td>$55.84</td>
<td>$61.39</td>
<td>9.9%</td>
</tr>
<tr>
<td>C</td>
<td>4%</td>
<td>15</td>
<td>$80.58</td>
<td>$89.62</td>
<td>11.2%</td>
</tr>
<tr>
<td>D</td>
<td>8%</td>
<td>10</td>
<td>$114.72</td>
<td>$123.17</td>
<td>7.4%</td>
</tr>
</tbody>
</table>

b. Bond A is most sensitive, because it has the longest maturity and no coupons. Bond D is the least sensitive. Intuitively, higher coupon rates and a shorter maturity typically lower a bond’s interest rate sensitivity.
8-13.
  a. Purchase price = 100 / 1.06^30 = 17.41. Sale price = 100 / 1.06^25 = 23.30. Return = (23.30 / 17.41)^15 − 1 = 6.00%. I.e., since YTM is the same at purchase and sale, IRR = YTM.
  b. Purchase price = 100 / 1.06^30 = 17.41. Sale price = 100 / 1.07^25 = 18.42. Return = (18.42 / 17.41)^15 − 1 = 1.13%. I.e., since YTM rises, IRR < initial YTM.
  c. Purchase price = 100 / 1.06^30 = 17.41. Sale price = 100 / 1.05^25 = 29.53. Return = (29.53 / 17.41)^15 − 1 = 11.15%. I.e., since YTM falls, IRR > initial YTM.
  d. Even without default, if you sell prior to maturity, you are exposed to the risk that the YTM may change.

8-14.
\[ P = \frac{\text{CPN}}{1 + \text{YTM}_1} + \frac{\text{CPN}}{(1 + \text{YTM}_2)^2} + \ldots + \frac{\text{CPN} + \text{FV}}{(1 + \text{YTM}_N)^N} = \frac{60}{1 + .04} + \frac{60 + 1000}{(1 + .043)^2} = \$1032.09 \]

This bond trades at a premium. The coupon of the bond is greater than each of the zero coupon yields, so the coupon will also be greater than the yield to maturity on this bond. Therefore it trades at a premium.

8-15. The price of the zero-coupon bond is
\[ P = \frac{\text{FV}}{(1 + \text{YTM}_N)^N} = \frac{1000}{(1 + 0.048)^5} = \$791.03 \]

8-16. The price of the bond is
\[ P = \frac{\text{CPN}}{1 + \text{YTM}_1} + \frac{\text{CPN}}{(1 + \text{YTM}_2)^2} + \ldots + \frac{\text{CPN} + \text{FV}}{(1 + \text{YTM}_N)^N} = \frac{40}{1 + .04} + \frac{40 + 1000}{(1 + .043)^2} = \$986.58 \]

The yield to maturity is
\[ P = \frac{\text{CPN}}{1 + \text{YTM}} + \frac{\text{CPN}}{(1 + \text{YTM})^2} + \ldots + \frac{\text{CPN} + \text{FV}}{(1 + \text{YTM})^N} \]
\[ \$986.58 = \frac{40}{(1 + \text{YTM})} + \frac{40}{(1 + \text{YTM})^2} + \frac{40 + 1000}{(1 + \text{YTM})^3} \Rightarrow \text{YTM} = 4.488\% \]

8-17. The maturity must be one year. If the maturity were longer than one year, the yield to maturity on the bond would have to be higher than 4%, since the longer-term zero coupon yields are all higher than 4%.
8-18. Solve the following equation:
\[
1000 = \text{CPN} \left( \frac{1}{(1 + .04)} + \frac{1}{(1 + .043)^2} + \frac{1}{(1 + .045)^3} + \frac{1}{(1 + .047)^4} \right) + \frac{1000}{(1 + .047)^4}
\]

\[
\text{CPN} = \$46.76
\]
Therefore, the par coupon rate is 4.676%.

8-19.

a. The bond is trading at a premium because its yield to maturity is a weighted average of the yields of the zero coupon bonds. This implied that its yield is below 5%, the coupon rate.

b. To compute the yield, first compute the price.

\[
P = \frac{\text{CPN}}{1 + \text{YTM}_1} + \frac{\text{CPN}}{(1 + \text{YTM}_2)^2} + \frac{\text{CPN}}{(1 + \text{YTM}_3)^3} + \frac{\text{CPN}}{(1 + \text{YTM}_4)^4} + \frac{\text{CPN} + \text{FV}}{(1 + \text{YTM}_5)^5}
\]
\[
= \frac{50}{(1 + .04)} + \frac{50}{(1 + .043)^2} + \frac{50}{(1 + .045)^3} + \frac{50}{(1 + .047)^4} + \frac{50 + 1000}{(1 + .048)^5} = \$1010.05
\]
The yield to maturity is:

\[
P = \frac{\text{CPN}}{1 + \text{YTM}_1} + \frac{\text{CPN}}{(1 + \text{YTM}_2)^2} + \frac{\text{CPN}}{(1 + \text{YTM}_3)^3} + \frac{\text{CPN}}{(1 + \text{YTM}_4)^4} + \frac{\text{CPN} + \text{FV}}{(1 + \text{YTM}_5)^5}
\]
\[
1010.05 = \frac{50}{(1 + \text{YTM})} + \ldots + \frac{50 + 1000}{(1 + \text{YTM})^5} \Rightarrow \text{YTM} = 4.77%
\]

c. If the yield increased to 5.2%, the new price would be:

\[
P = \frac{\text{CPN}}{1 + \text{YTM}_1} + \frac{\text{CPN}}{(1 + \text{YTM}_2)^2} + \frac{\text{CPN}}{(1 + \text{YTM}_3)^3} + \frac{\text{CPN}}{(1 + \text{YTM}_4)^4} + \frac{\text{CPN} + \text{FV}}{(1 + \text{YTM}_5)^5}
\]
\[
= \frac{50}{(1 + .052)} + \ldots + \frac{50 + 1000}{(1 + .052)^5} = \$991.39
\]

8-20. First, figure out if the price of the coupon bond is consistent with the zero coupon yields implied by the other securities:

\[
970.87 = \frac{1000}{(1 + \text{YTM}_1)} \Rightarrow \text{YTM}_1 = 3.0%
\]
\[
938.95 = \frac{1000}{(1 + \text{YTM}_2)^2} \Rightarrow \text{YTM}_2 = 3.2%
\]
\[
904.56 = \frac{1000}{(1 + \text{YTM}_3)^3} \Rightarrow \text{YTM}_3 = 3.4%
\]
According to these zero coupon yields, the price of the coupon bond should be:

\[
\frac{100}{(1.03)^1} + \frac{100}{(1.03)^2} + \frac{100+1000}{(1.03)^3} = \$1186.00
\]

The price of the coupon bond is too low, so there is an arbitrage opportunity. To take advantage of it:

<table>
<thead>
<tr>
<th></th>
<th>Today</th>
<th>1 Year</th>
<th>2 Years</th>
<th>3 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buy 10 Coupon Bonds</td>
<td>-11,385.00</td>
<td>1,000</td>
<td>1,000</td>
<td>11,000</td>
</tr>
<tr>
<td>Short Sell 1 One-Year Zero</td>
<td>970.87</td>
<td>-1,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Sell 1 Two-Year Zero</td>
<td>938.95</td>
<td>-1,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short Sell 11 Three-Year Zeros</td>
<td>9950.16</td>
<td>-11,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Cash Flow</td>
<td>474.98</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

8-21. To determine whether these bonds present an arbitrage opportunity, check whether the pricing is internally consistent. Calculate the spot rates implied by Bonds A, B and D (the zero coupon bonds), and use this to check Bond C. (You may alternatively compute the spot rates from Bonds A, B and C, and check Bond D, or some other combination.)

\[
934.58 = \frac{1000}{(1 + YTM_1)} \Rightarrow YTM_1 = 7.0\%
\]

\[
881.66 = \frac{1000}{(1 + YTM_2)^2} \Rightarrow YTM_2 = 6.5\%
\]

\[
839.62 = \frac{1000}{(1 + YTM_3)^3} \Rightarrow YTM_3 = 6.0\%
\]

Given the spot rates implied by Bonds A, B and D, the price of Bond C should be $1,105.21. Its price really is $1,118.21, so it is overpriced by $13 per bond. YES, there is an arbitrage opportunity.

To take advantage of this opportunity, you want to (short) Sell Bond C (since it is overpriced). To match future cash flows, one strategy is to sell 10 Bond Cs (it is not the only effective strategy; any multiple of this strategy is also arbitrage). This complete strategy is summarized:

<table>
<thead>
<tr>
<th></th>
<th>Today</th>
<th>1 Year</th>
<th>2 Years</th>
<th>3 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sell Bond C</td>
<td>11,182.10</td>
<td>-1,000</td>
<td>-1,000</td>
<td>-11,000</td>
</tr>
<tr>
<td>Buy Bond A</td>
<td>-934.58</td>
<td>1,000</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Buy Bond B</td>
<td>-881.66</td>
<td>0</td>
<td>1,000</td>
<td>0</td>
</tr>
<tr>
<td>Buy 11 Bond D</td>
<td>-9,235.82</td>
<td>0</td>
<td>0</td>
<td>11,000</td>
</tr>
<tr>
<td>Net Cash Flow</td>
<td>130.04</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Notice that your arbitrage profit equals 10 times the mispricing on each bond (subject to rounding error).
8-22. We can construct a two-year zero coupon bond using the one and two-year coupon bonds as follows:

<table>
<thead>
<tr>
<th>Cash Flow in Year:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-year coupon bond ($1000 Face Value)</td>
<td>100</td>
<td>1,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: One-year bond ($100 Face Value)</td>
<td>(100)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two-year zero ($1100 Face Value)</td>
<td>-</td>
<td>1,100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Now,

\[
\text{Price(2-year coupon bond)} = \frac{100}{1.03908} + \frac{1100}{1.03908^2} = $1115.05
\]

\[
\text{Price(1-year bond)} = \frac{100}{1.02} = $98.04
\]

By the Law of One Price:

\[
\text{Price(2 year zero)} = \text{Price(2 year coupon bond)} - \text{Price(One-year bond)}
\]

\[
= 1115.05 - 98.04 = $1017.01
\]

Given this price per $1100 face value, the YTM for the 2-year zero is (Eq. 8.3)

\[
\text{YTM(2)} = \left( \frac{1100}{1017.01} \right)^{1/2} - 1 = 4.000\%
\]

b. We already know YTM(1) = 2%, YTM(2) = 4%. We can construct a 3-year zero as follows:

<table>
<thead>
<tr>
<th>Cash Flow in Year:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-year coupon bond ($1000 face value)</td>
<td>60</td>
<td>60</td>
<td>1,060</td>
<td></td>
</tr>
<tr>
<td>Less: one-year zero ($60 face value)</td>
<td>(60)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: two-year zero ($60 face value)</td>
<td>-</td>
<td>(60)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three-year zero ($1060 face value)</td>
<td>-</td>
<td>-</td>
<td>1,060</td>
<td></td>
</tr>
</tbody>
</table>

Now,

\[
\text{Price(3-year coupon bond)} = \frac{60}{1.0584} + \frac{60}{1.0584^2} + \frac{1060}{1.0584^3} = $1004.29
\]

By the Law of One Price:

\[
\text{Price(3-year zero)} = \text{Price(3-year coupon bond)} - \text{Price(One-year zero)} - \text{Price(Two-year zero)}
\]

\[
= \text{Price(3-year coupon bond)} - \text{PV(coupons in years 1 and 2)}
\]

\[
= 1004.29 - 60 / 1.02 - 60 / 1.04^2 = $889.99
\]

Solving for the YTM:

\[
\text{YTM(3)} = \left( \frac{1060}{889.99} \right)^{1/3} - 1 = 6.000\%
\]
Finally, we can do the same for the 4-year zero:

<table>
<thead>
<tr>
<th>Cash Flow in Year:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four-year coupon bond ($1000 face value)</td>
<td>120</td>
<td>120</td>
<td>120</td>
<td>1,120</td>
</tr>
<tr>
<td>Less: one-year zero ($120 face value)</td>
<td>(120)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: two-year zero ($120 face value)</td>
<td>—</td>
<td>(120)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less: three-year zero ($120 face value)</td>
<td>—</td>
<td>—</td>
<td>(120)</td>
<td></td>
</tr>
<tr>
<td>Four-year zero ($1120 face value)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1,120</td>
</tr>
</tbody>
</table>

Now,

\[
\text{Price(4-year coupon bond)} = \frac{120}{1.05783} + \frac{120}{1.05783^2} + \frac{120}{1.05783^3} + \frac{1120}{1.05783^4} = \$1216.50
\]

By the Law of One Price:

\[
\text{Price(4-year zero)} = \text{Price(4-year coupon bond)} - \text{PV(coupons in years 1–3)}
\]

\[
= 1216.50 - \frac{120}{1.02} - \frac{120}{1.04^2} - \frac{120}{1.06^3} = \$887.15
\]

Solving for the YTM:

\[
\text{YTM(4)} = \left( \frac{1120}{887.15} \right)^{1/4} - 1 = 6.000\%
\]

Thus, we have computed the zero coupon yield curve as

8-23. The yield to maturity of a corporate bond is based on the promised payments of the bond. But there is some chance the corporation will default and pay less. Thus, the bond’s expected return is typically less than its YTM.

Corporate bonds have credit risk, the risk that the borrower will default and not pay all specified payments. As a result, investors pay less for bonds with credit risk than they would for an otherwise identical default-free bond. Because the YTM for a bond is calculated using the promised cash flows, the yields of bonds with credit risk will be higher than that of otherwise identical default-free bonds. However, the YTM of a defaultable bond is always higher than the expected return of investing in the bond because it is calculated using the promised cash flows rather than the expected cash flows.
8-24.

a. The price of this bond will be
\[ P = \frac{100}{1 + .032} = 96.899 \]

b. The credit spread on AAA-rated corporate bonds is \(0.032 - 0.031 = 0.1\%\)
c. The credit spread on B-rated corporate bonds is \(0.049 - 0.031 = 1.8\%\)
d. The credit spread increases as the bond rating falls, because lower rated bonds are riskier.

8-25.

a. When originally issued, the price of the bonds was
\[ P = \frac{70}{(1 + 0.065)} + \ldots + \frac{70 + 1000}{(1 + 0.065)^{10}} = \$1065.29 \]

b. If the bond is downgraded, its price will fall to
\[ P = \frac{70}{(1 + 0.069)} + \ldots + \frac{70 + 1000}{(1 + 0.069)^{10}} = \$1012.53 \]

8-26.

a. The price will be
\[ P = \frac{65}{(1 + .063)} + \ldots + \frac{65 + 1000}{(1 + .063)^{10}} = \$1008.36 \]

b. Each bond will raise \$1008.36, so the firm must issue: \(\frac{\$10,000,000}{\$1008.36} = 9917.13 \Rightarrow 9918 \text{ bonds} \).
This will correspond to a principle amount of \(9918 \times \$1000 = \$9,918,000\).
c. For the bonds to sell at par, the coupon must equal the yield. Since the coupon is 6.5\%, the yield must also be 6.5\%, or A-rated.
d. First, compute the yield on these bonds:
\[ 959.54 = \frac{65}{(1 + \text{YTM})} + \ldots + \frac{65 + 1000}{(1 + \text{YTM})^{10}} \Rightarrow \text{YTM} = 7.5\% \]

Given a yield of 7.5\%, it is likely these bonds are BB rated. Yes, BB-rated bonds are junk bonds.
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8-27.

a. \[ P = \frac{35}{(1 + .041)} + \cdots + \frac{35 + 1000}{(1 + .041)^{10}} = $951.58 = 95.2\% \]

b. \[ P = \frac{35}{(1 + .0325)} + \cdots + \frac{35 + 1000}{(1 + .0325)^{10}} = $1,021.06 = 102.1\% \]

c. 0.17

Appendix

A.1. From Eq 8A.2,

\[ f_2 = \left(\frac{(1 + YTM_3)^2}{(1 + YTM_1)} - 1\right) = \frac{1.055^2}{1.04} - 1 = 7.02\% \]

A.2. From Eq 8A.2,

\[ f_3 = \left(\frac{(1 + YTM_3)^3}{(1 + YTM_2)^2} - 1\right) = \frac{1.055^3}{1.050^2} - 1 = 5.50\% \]

When the yield curve is flat (spot rates are equal), the forward rate is equal to the spot rate.

A.3. From Eq 8A.2,

\[ f_5 = \left(\frac{(1 + YTM_5)^5}{(1 + YTM_4)^4} - 1\right) = \frac{1.045^5}{1.050^4} - 1 = 2.52\% \]

When the yield curve is flat (spot rates are equal), the forward rate is equal to the spot rate.

A.4. Call this rate \( f_{1.5} \). If we invest for one-year at YTM1, and then for the 4 years from year 1 to 5 at rate \( f_{1.5} \), after five years we would earn

\[ (1 + YTM_1)(1 + f_{1.5})^4 \]

with no risk. No arbitrage means this must equal that amount we would earn investing at the current five year spot rate:

\[ (1 + YTM_1)(1 + f_{1.5})^4 = (1 + YTM_3)^5 \]

Therefore, \[ (1 + f_{1.5})^4 = \left(\frac{(1 + YTM_3)^5}{1 + YTM_1}\right) = \frac{1.045^5}{1.04} = 1.19825 \]

and so: \( f_{1.5} = 1.19825^{1/4} - 1 = 4.625\% \)

A.5. We can invest for 3 years with risk by investing for one year at 5%, and then locking in a rate of 4% for the second year and 3% for the third year. The return from this strategy must equal the return from investing in a 3 year zero coupon bond (see Eq 8A.3):

\[ (1 + YTM_3)^3 = (1.05)(1.04)(1.03) = 1.12476 \]

Therefore: \( YTM_3 = 1.12476^{1/3} - 1 = 3.997\% \)