

20. An investor paid \$95 for a bond with face value \$100 maturing in six months. When will the bond value read \$99 if the interest rate remains constant?
21. Sketch the graph of the price of the coupon bond in Example 4.22 as a function of time. How long will it take for the price to reach \$95 for the first time?
22. A bond with face value 100 and annual coupons of \$8 maturing after 3 years is trading at par. Find the implied continuous compounding rate.
23. Find the yield of a 3-year bond that provides a coupon of 8% semiannually and has a cash price of 104.
24. The cash prices of 6-month and 1-year Treasury bills are 94.0 and 89.0. A 1.5-year bond that will pay coupons of \$4 every 6 months currently sells for \$94.84. A 2-year bond that will pay coupons of \$5 every 6 months currently sells for \$97.12. Use the bootstrap method to calculate the 6-month, 1-year, 1.5-year, and 2-year zero rates.

25. Suppose zero interest rates with continuous compounding are given by

|                    |     |     |     |     |     |
|--------------------|-----|-----|-----|-----|-----|
| Maturity (years)   | 1   | 2   | 3   | 4   | 5   |
| Rate (% per annum) | 2.0 | 3.0 | 3.7 | 4.2 | 4.5 |

- (a) Calculate forward interest rates for the second through fifth year.
  - (b) Value an FRA where you will pay 5% for the third year on \$1 million.
26. Portfolio A consists of a 1-year zero-coupon bond with a face value of \$2,000 and a 10-year zero-coupon bond with a face value of \$6,000. Portfolio B consists of a 5.95-year zero-coupon bond with a face value of \$5,000. The current yield on all bonds is 10% per annum.
    - (a) Show that both portfolios have the same duration.
    - (b) Show that the percentage changes in the values of the two portfolios for a 0.1% per annum increase in yields are the same.
    - (c) What are the percentage changes in the values of the two portfolios for a 5% per annum increase in yields?